HP 8644A
SYNTHESIZED SIGNAL GENERATOR
(Including Options 001, 002, 003, 004, 005, 007, 009 010, and 011)

Operation and Calibration Manual

HEWLETT PACKARD

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 resulting 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 autotransformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

Servicing instructions are for use by service trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at may points may, if contacted, result in personal injury.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source os supply.

For continued protection against fire hazard, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.) Do not use repaired fuses or short circuited fuseholders.

OPERATION GUIDE

TABLE OF CONTENTS

Chapter 1
Learnning About the HP 8644A

Chapter 2
What About Modulating?

Chapter 3
What About Sweeping?

Chapter 4
What About Programming?

Appendix A
Installation

Appendix B
Options and Accessories

Appendix C
Special Functions

Appendix D
Error Messages

Appendix E
HP-SL Quick Reference Guide

Appendix F
Synthesized Audio Oscillator

Appendix G
Miscellaneous Operating Features

Appendix H
Glossary

Appendix I
Specified Avionics Performance

1 Introduction
2 Modulation

1 Learning About the HP 8644A

Getting Started the Easy Way

This *Operation Guide* provides you with a quick and easy way to learn about the HP 8644A Synthesized Signal Generator. If this is your first introduction to the HP 8644A, we recommend that you read this chapter before proceeding on to other chapters.

Note *If you are unpacking a new HP 8644A, you will want to refer to to the installation suggestions provided in appendix A.*

What's in this Guide?

This Guide will help you learn how to operate the Synthesized Signal Generator from both the front panel and via HP-IB. Specifically:

- Chapter 2 shows how to FM, AM, Pulse, and simultaneously modulate the Synthesized Signal Generator.
- Chapter 3 shows how to frequency sweep the HP 8644A using digitally-stepped or phase-continuous sweep.
- Chapter 4 describes how to program the HP 8644A in detail using HP-SL. (Refer to the syntax drawings in appendix E for quick reference information.)
- Appendixes provide reference and technical information about special functions, error messages, HP-SL, complex signal generation, and much more.

Equipment You Will Need

The following table lists the equipment we recommend that you use throughout this Guide. You can substitute equipment; however, be aware that you may get different results than the ones shown in this Guide.

Table 1-1. List of Recommended Equipment.

Equipment	Recommended Model Numbers	Used in Chapter(s)
Spectrum Analyzer	HP 8562A/B, or HP 8566B, or HP 8568B	1-3
Oscilloscope	HP 1741A, HP 54100A, or HP 54200A	2
Function Generator	HP 3312A, HP 3314A, HP 8111A, HP 8116A, or HP 8904A	2

Meet the HP 8644A

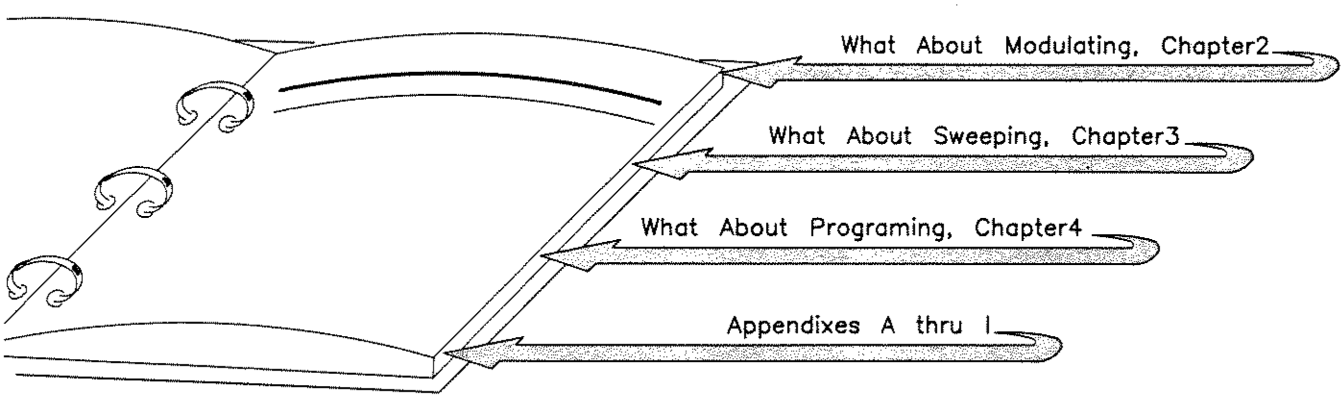
The HP 8644A is specifically designed as a general purpose 1 (or 2) GHz RF signal generator with modulation, amplitude control, and sweep functions, to perform out-of-channel tests on high-performance radios.

Specifically, the HP 8644A meets general purpose RF testing needs in the following ways:

- A frequency range of 251.5 kHz to 2060 MHz (1030–2060 MHz is covered by ordering Option 002).
- Modulation formats of AM, FM, ΦM, and Pulse.
- Digitally-stepped, or phase-continuous frequency sweeping.
- Remote ATE programming through HP-IB (Hewlett-Packard's implementation of IEEE Standard 488.2).
- Complex signal generation with the synthesized audio oscillator (HP 8644A with Option 007 only).

Manual Orientation

The following illustration gives you a visual "road map" to the various topics in this manual. It is also helpful for you to use the table of contents and index as you look for specific information.



2 What About Modulating?

In this Chapter

This chapter describes how to modulate the HP 8644A Synthesized Signal Generator. Three kinds of modulation will be discussed: FM, AM, and Pulse. Instructions to modulate the HP 8644A with both an internal and an external audio source are given; also, one example of simultaneous modulation is given.

Additional information contained in this chapter:

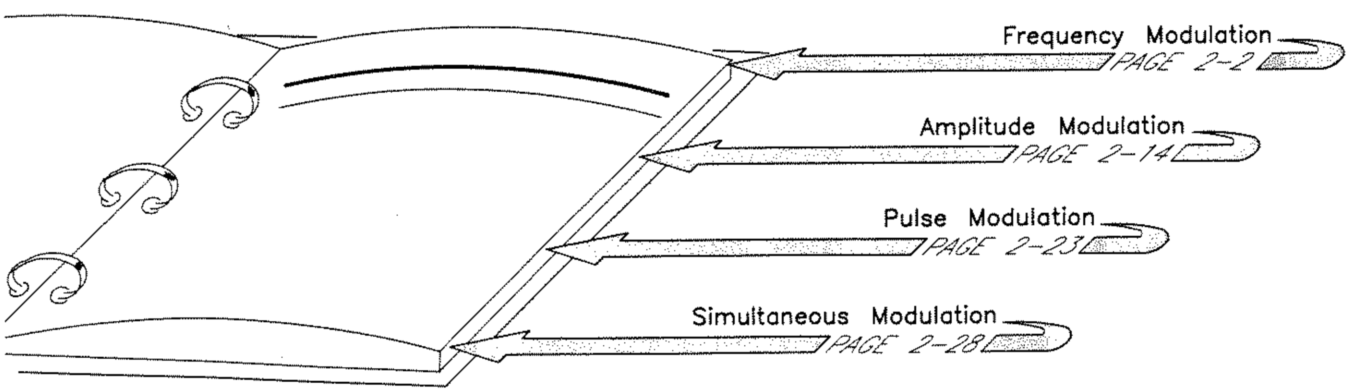
- **Digitized and Linear FM Synthesis.** How carrier frequency accuracy, audio frequency rates, and group delay affect frequency modulation.
- **Synthesis Modes.** How to control the RF output characteristic (when FM deviation, switching time, and phase noise are considerations).
- **Special Functions.** How to select special functions relating to modulation.
- **Save and Recall registers.** How to save and recall front-panel settings.

Note

If your HP 8644A is equipped with the Synthesized Audio Oscillator, Option 007, refer to appendix F for instructions. There you will learn how to create complex audio signals for modulating the RF Output.

The Directory

Use the following illustration shown below and find the subject you want. Turn to that subject, and notice a look-up table which provides you with an overview of the specific topics covered in that section of the chapter.



Frequency Modulation – An Overview

If You Need to Know:	Refer to:
Frequency Modulation	
• *About Digitized vs Linear FM synthesis in relation to carrier frequency accuracy, audio frequency rates, group delay, and synthesis modes*	***Frequency Modulation–An Introduction (2–2 to 2–5)***
• *How to FM the HP 8644A using the internal audio source*	***Frequency Modulation–An Exercise. Procedure #1 (2–6 to 2–9)***
• *How to FM the HP 8644A with an external audio source*	***Frequency Modulation–An Exercise. Procedure #2 (2–10 to 2–12)***
• *The key things to remember about frequency modulating the HP 8644A*	***Frequency Modulation–Things to Remember (2–13)***

Frequency Modulation – An Introduction

The HP 8644A will simulate many different types of FM signals used in RF communication systems. Also, a wide variety of asymmetrical modulation signals, such as digital FSK squelching sequences and FM telemetry are available through the use of dc-coupled FM.

You can FM the RF output over a wide bandwidth, with deviations up to 10 MHz (20 MHz with Option 002) using either internally or externally generated modulation signals. External modulation signals can be ac or dc coupled. You can simultaneously modulate AM, FM, and Pulse. The **FM** input connector has an input impedance of 600 Ω.

The HP 8644A has an internal audio source that generates a sinewave at 300 Hz, 400 Hz, 1 kHz, and 3 kHz rates. If your HP 8644A is equipped with Option 007, the internal audio source becomes a two channel multifunction synthesizer. Five different internal audio waveforms are then available: sine, square, triangle, sawtooth, or white Gaussian noise as demonstrated in Procedure #1. (Refer to appendix F for further information about Option 007.)

The HP 8644A generates FM in two ways. Digitized FM synthesis is the default method, and Linear FM synthesis is the method you access from Special Function 120; you have control over selection of either method.

Both Digitized FM and Linear FM synthesis have their advantages and disadvantages. Your signal generation and testing needs will determine which method to use. Let's examine the different factors to be considered:

Carrier Frequency Accuracy

Carrier frequency accuracy is a measure of the frequency shift in the RF output relative to its desired frequency.

Digitized FM synthesis offers you the best carrier frequency accuracy. This accuracy is a function of the programmed FM deviation (**FM Indicator Accuracy**, as shown in the specification table, chapter 1 of the *Calibration Manual*).

Linear FM can have center frequency inaccuracies of up to ±50 kHz in Mode 1, and up to ±5 kHz in Modes 2 and 3. In general, the center frequency accuracy in Linear FM is not a function of FM deviation.

Audio Frequency Rates

The HP 8644A can be frequency modulated by either an external audio source, or its own internal audio source. The external (or internal, with Option 007) audio waveform can be sine, or can be complex (for example, square, sawtooth, and so on).

The HP 8644A accepts external FM rates up to 100 kHz depending upon the carrier frequency selected. In addition, four internal rates are available: 300 Hz, 400 Hz, 1 kHz, and 3 kHz. (Refer to appendix F for information about internal rates up to 400 kHz if your HP 8644A is equipped with Option 007.)

Digitized FM synthesis is primarily used for single-tone (sinewave) audio modulation; however, complex waveforms can be used as long as their rates are less than 10 kHz. Linear FM synthesis is primarily used for complex audio modulation.

Group Delay

Group delay is a measure of the time delay between the information input at the **FM** Modulation Input connector, and the signal effects at the **RF** Output connector. Effects from group delay are most apparent when the complex audio modulation signal has significant harmonic content between 10 kHz and 100 kHz. The modulation rate and the method of FM synthesis both determine the amount of group delay that is present.

Digitized FM synthesis causes a greater amount of group delay than Linear FM synthesis, as shown in figure 2–1. For this reason, Linear FM synthesis should be used in phase-locked loop applications, where the HP 8644A is used as the voltage-controlled oscillator (VCO).

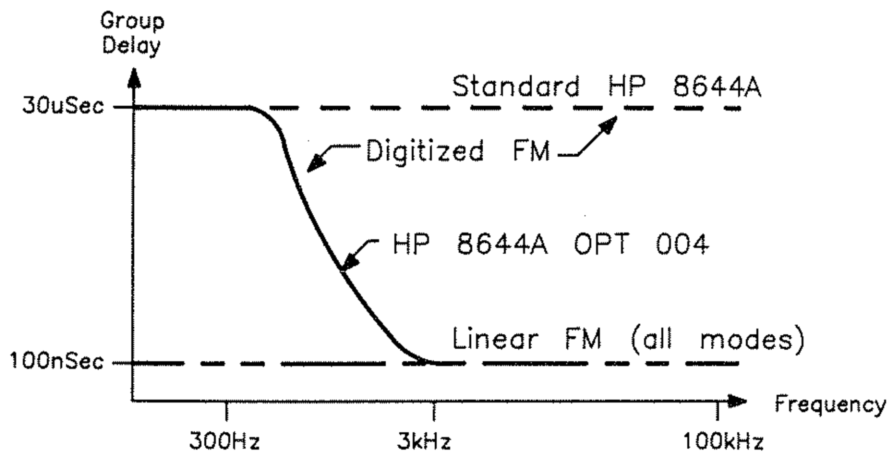


Figure 2–1. Group Delay for Digitized and Linear FM Synthesis.

Synthesis Modes

On the lower-right side of the HP 8644A's front panel, you will notice a group of keys under the label **SYNTHESIS MODE**. With these keys, the HP 8644A allows you control the character of the RF output.

In most applications, the HP 8644A can be kept in the Auto Select mode. As you tune the HP 8644A over its RF frequency range with FM turned on, you will notice that different LED annunciators associated with the Mode keys will light up. This is a visual indication that the HP 8644A is automatically selecting the "best" Synthesis Mode for the selected RF frequency and modulation settings. In the Auto Select mode, the "best" Synthesis Mode is an RF output with the lowest phase noise.

In other applications, you may want the RF output to switch faster and have more FM deviation. In this case, press the Mode key of your choice to take the HP 8644A out of the Auto Select mode. There are three basic factors to consider when you choose a "Synthesis Mode"– they are, (1) FM deviation, (2) switching speed, and (3) phase noise. A typical comparison of these three factors for an RF output of 1 GHz is shown in figure 2–2:

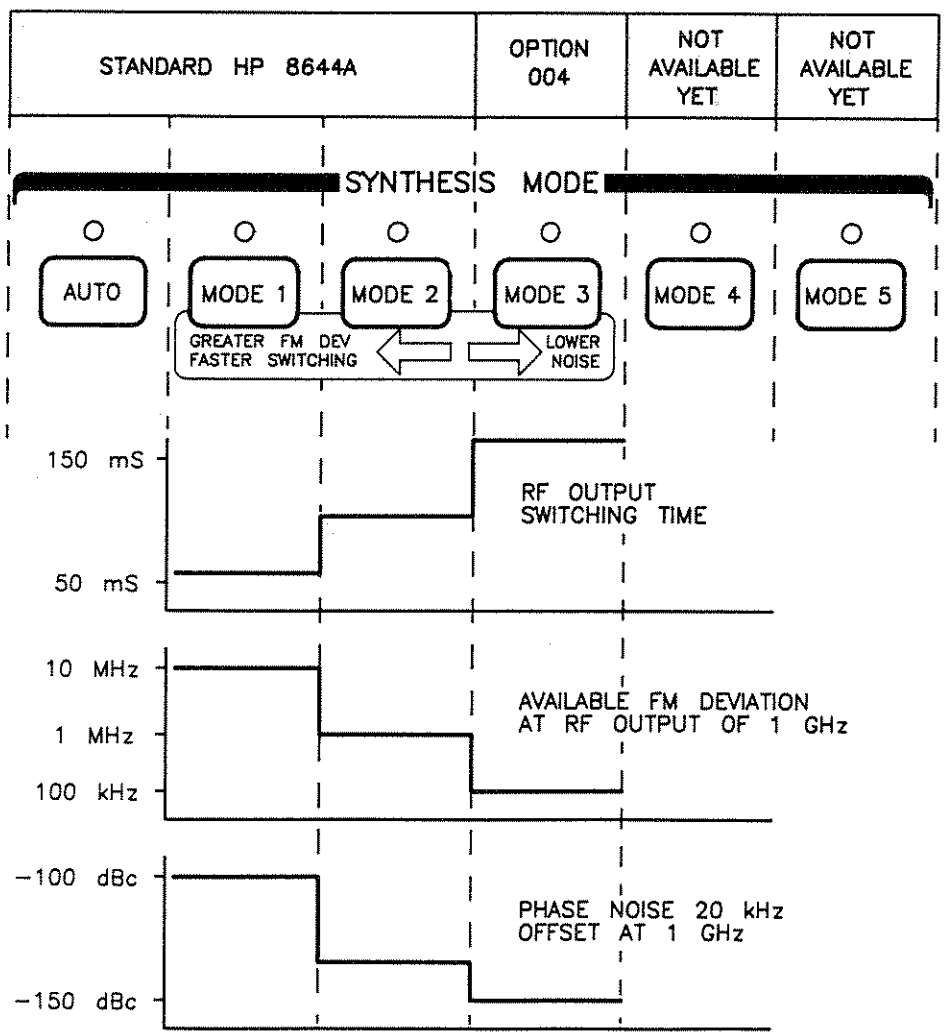


Figure 2–2. Synthesis Modes for RF Output of 1 GHz.

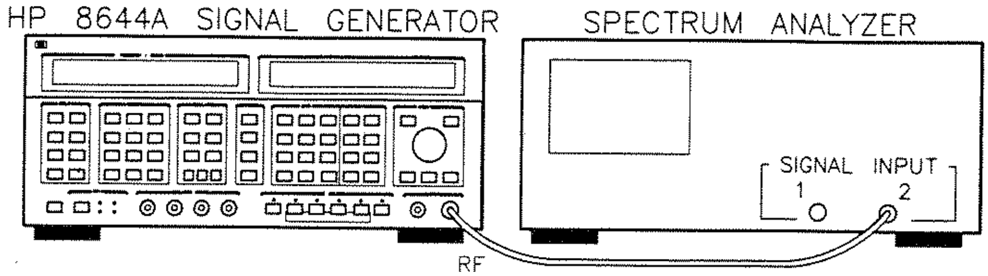


Figure 2-3. Equipment Setup for FM Procedure #1.

Frequency Modulation – An Exercise

The following exercise is made up of two procedures. Each procedure takes about 10 minutes to complete. The first procedure frequency modulates the HP 8644A using the internal audio source. The second procedure frequency modulates the HP 8644A using an external audio source.

Equipment Needed

Both procedures require use of the following equipment:

Equipment	Recommended Model Numbers
Spectrum Analyzer	HP 8562A/B, or HP 8566B, or HP 8568B
Function Generator	HP 3312A, or HP 3314A, or HP 8111A, HP 8116A, or HP 8904A

Procedure #1 – FM Using the Internal Audio Source

Procedure #1 starts with step 1 shown on the next page. A review of the four major steps in the procedure are:

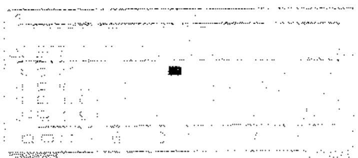
- Set up and adjust the Spectrum Analyzer, and connect it to the HP 8644A.
- Adjust the RF output to 600 MHz, and the output amplitude to 0 dBm on the HP 8644A.
- Adjust the FM deviation to 10 MHz, and the audio frequency rate to 3 kHz on the HP 8644A.
- Observe and modify the results.

Set Up and Adjust the Spectrum Analyzer

1. **Connect the HP 8644A to the Spectrum Analyzer as shown in figure 2-3.** Turn on the equipment, and make the following adjustments on the Spectrum Analyzer:

Center Frequency	600 MHz
Frequency Span	50 MHz
Reference Level	0 dBm

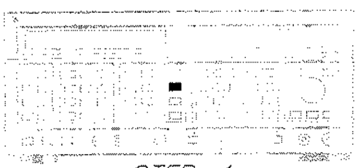
Adjust RF Output and Output Amplitude on the HP 8644A



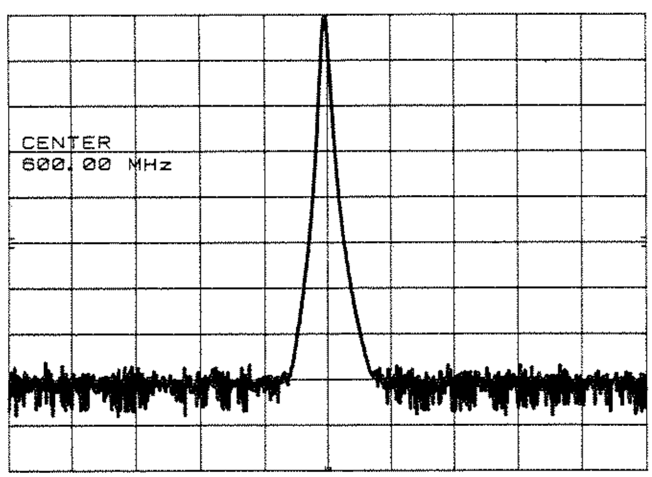
2. **Press the green INSTR PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.
3. **Press the FREQ key, and enter a frequency of 600 MHz.**

Remember

On the HP 8644A, a "▽" cursor appears in either the FREQUENCY/STATUS or the MODULATION/AMPLITUDE display, and points to the currently active function. This means, for example, that presently you could change the frequency of the HP 8644A without having to first press the **FREQ** *key.*



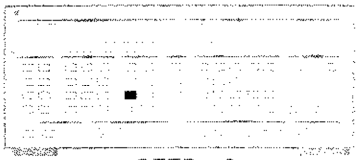
4. **Press the AMPTD key, and enter an output amplitude of 0 dBm.** You will notice that the "▽" cursor is now in the MODULATION/AMPLITUDE display. The following display should appear on the Spectrum Analyzer:



Adjust FM Deviation and Audio Frequency Rate on the HP 8644A

5. **Press the FM key, and enter an FM deviation of 10 MHz.** When FM deviation is first turned on, the audio frequency rate defaults to 1 kHz.

   Notice that the yellow annunciators above the **FM** and **INT** keys light up; this indicates that FM, using its internal audio source, is active.



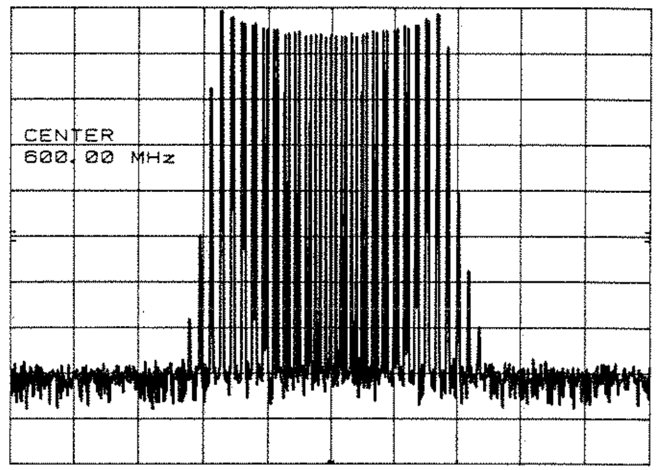
STEP 6

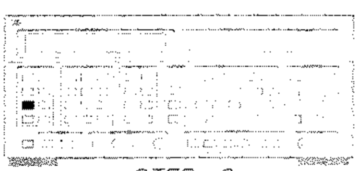
6. **Press the AUDIO FREQ key, and enter an audio frequency rate of 3 kHz.** The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

10.0MHz 3.000kHz +0.0dBm
FM AUDIO

Observe and Modify the Results.

7. **The following display should appear on the Spectrum Analyzer:**





STEP 8

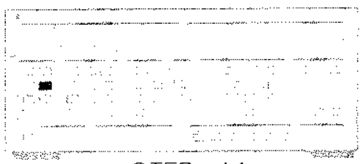
8. **Press the SAVE key.** The HP 8644A should show the following in the FREQUENCY/STATUS display:

Save Register # =

9. **Press the 0 key, and the ENTER key.** This step enters the frequency, modulation and amplitude settings in Register 0 for use in Procedure #2; the FREQUENCY/STATUS display should now show the last RF output setting (600 MHz).

10. **Press the FM key, the INCR/DECR ⇐▽ key, and turn the knob counterclockwise to decrease the FM deviation.** You will notice the Spectrum Analyzer display changing as FM deviation is adjusted.

    If you have an HP 8644A with Option 007, return FM deviation to 10 MHz and proceed to the next step where you will change the audio frequency waveform by using Special Function 130. If Option 007 is not installed, you are done with this procedure, continue on to Procedure #2, FM using an external audio source.



STEP 11

11. **Press the SPECIAL key.** The HP 8644A should now show the following in the FREQUENCY/STATUS display:

```
Enter Special Number
```

12. **Enter number "130" and press the ENTER key.** (If you get an error "No such special", then the HP 8644A does not have Option 007, continue on to the procedure on the next page.). The HP 8644A should now show the following in the FREQUENCY/STATUS display:

```
130:Audio Wave Sine
```

13. **Turn the knob to change the audio frequency waveform.** Notice how the Spectrum Analyzer responds to the Square, Triangle, Sawtooth, and White Gaussian Noise waveforms.

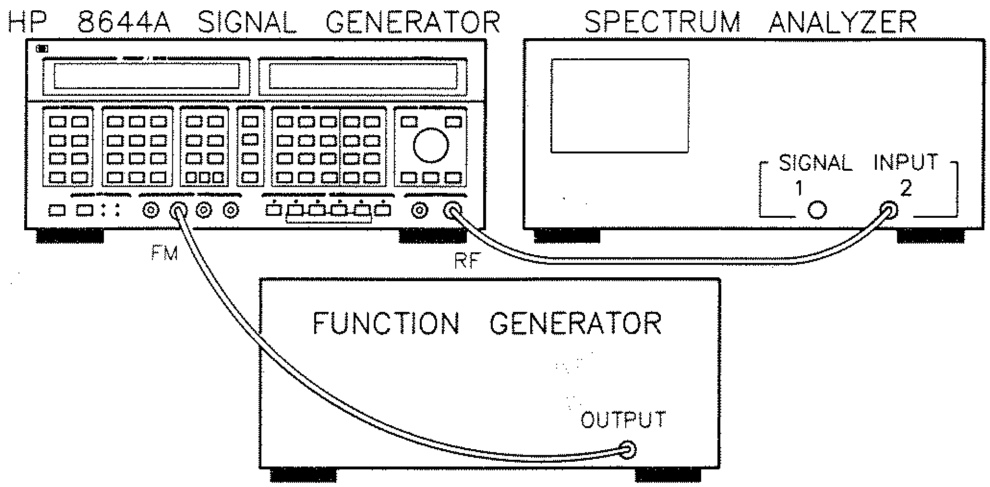


Figure 2-4. Equipment Setup for FM Procedure #2.

Procedure #2 - FM Using an External Audio Source

Procedure #2 starts with step 1 shown below. A review of the four major steps in the procedure are:

- Set up and adjust the Spectrum Analyzer and Function Generator, and connect them to the HP 8644A.
- Adjust the RF output to 600 MHz, and the output amplitude to 0 dBm on the HP 8644A.
- Adjust the FM deviation to 10 MHz on the HP 8644A.
- Observe and modify the results.

Set Up and Adjust the Spectrum Analyzer and Function Generator

1. **Connect the HP 8644A to the Spectrum Analyzer and Function Generator as shown in figure 2-4.** Turn on the equipment and make the following adjustments:

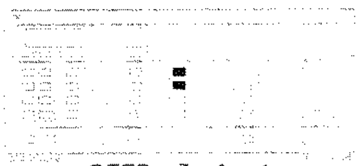
   On the Spectrum Analyzer

   Center Frequency .... 600 MHz
   Frequency Span .... 50 MHz
   Reference Level .... 0 dBm

   On the Function Generator

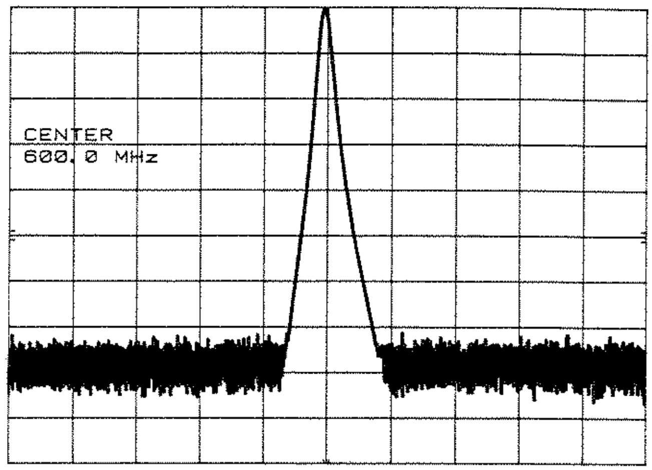
   Frequency .... 100 kHz
   Amplitude .... 1 Vpk
   Waveform.. Sine

Adjust RF Output and Output Amplitude on the HP 8644A

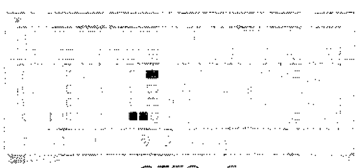


STEP 3 & 4

2. **Press the green INSTR PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.
3. **Press the FREQ key, and enter a frequency of 600 MHz.**
4. **Press the AMPTD key, and enter an output amplitude of 0 dBm.** The following display should appear on the Spectrum Analyzer:



Adjust FM Deviation on the HP 8644A



STEP 5

5. **Press the FM key, the EXT AC key, the INT key, and then enter an FM deviation of 10 MHz.** The **INT** key is pressed in this step to turn off the internal audio source.

   Notice that the yellow annunciators above the **FM** and **EXT AC** keys light up; this indicates that FM using an external audio source is active.

   The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

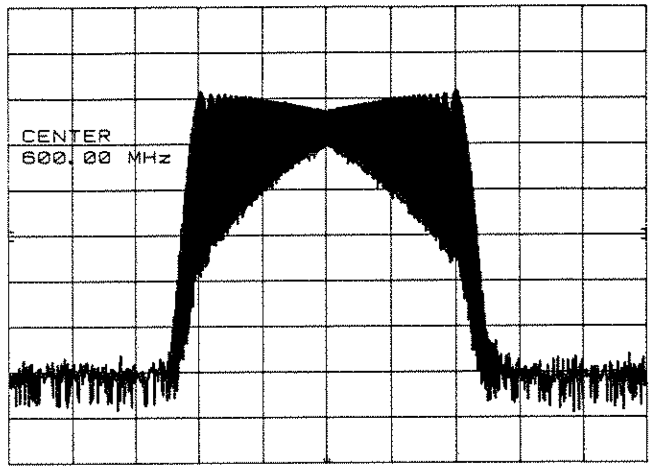
```
10.0MHz Ext AC    +0.0dBm
FM              EXT  LO
```

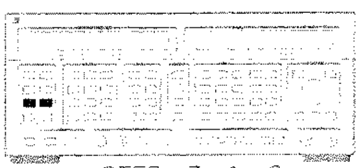
Remember

The EXT HI and EXT LOW annunciators in the MODULATION/AMPLITUDE display indicate if the amplitude of the external audio source is too high or too low. When the input signal is at 1 Vpk ±1%, both annunciators are off. However, both annunciators only work at external audio rates from 20 Hz to 100 kHz.

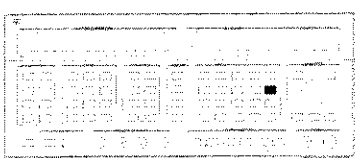
Observe and Modify the Results

6. **The following display should appear on the Spectrum Analyzer:**





STEP 7 & 8



STEP 9

7. **Press the SAVE key, and put the current front-panel settings in Register 1.**

8. **Press the Recall key.** The HP 8644A should show the following in the FREQUENCY/STATUS display:

```
Recall  Register =
```

9. **Press the 0 and the ENTER key to recall the settings from Procedure #1.** Notice that the display on the Spectrum Analyzer reflects the recalled settings from Procedure #1.

10. **Recall Register 1 to return to the Procedure #2 settings.** Notice once again that the display on the Spectrum Analyzer reflects the recalled settings for Procedure #2.

Remember

The HP 8644A has 50 available storage registers. The first 10, Registers 0–9, accepts all front panel settings (except for some Special Functions). The next 40, Registers 10–49, accepts only frequency and amplitude settings.

Performing an Instrument Preset, or unplugging the HP 8644A does not alter contents of the 50 storage registers.

Frequency Modulation – Things to Remember

The following list is a summary of the most important points previously discussed in the FM modulation section:

- Digitized FM synthesis, and Linear FM synthesis are two methods of generating FM in the HP 8644A. Special Function 120 allows you to choose between either method.
- The **FM** input connector has an input impedance of 600 Ω.
- Carrier frequency accuracy, audio frequency rates, and group delay are three factors to consider when you decide on a method of FM synthesis.
- FM deviation, switching time, and phase noise are three factors to consider if you decide to use a Synthesis Mode other than the Auto mode.
- The internal audio source generates sine, square, triangle, sawtooth, or white Gaussian noise waveforms if you have an HP 8644A with Option 007. Refer to appendix F for instructions.

Amplitude Modulation – An Overview

If You Need to Know:	Refer to:
Amplitude Modulation	
• *Some general information about amplitude modulation*	***Amplitude Modulation–An Introduction (2–14)***
• *How to AM the HP 8644A using the internal audio source*	***Amplitude Modulation–An Exercise. Procedure #1 (2–15 to 2–18)***
• *How to AM the HP 8644A with an external audio source*	***Amplitude Modulation–An Exercise. Procedure #2 (2–19 to 2–21)***
• *The key things to remember about amplitude modulating the HP 8644A*	***Amplitude Modulation–Things to Remember (2–22)***

Amplitude Modulation – An Introduction

The HP 8644A amplitude modulates the RF output with the internal audio source, with an ac or dc-coupled external audio source applied to the front-panel **AM** connector, or with both the internal and an external audio source.

The internal audio source generates a sinewave at 300 Hz, 400 Hz, 1 kHz, and 3 kHz rates; however, for precise AM depth, the audio frequency rates should not exceed the specified limits shown in chapter 1 of the HP 8644A *Calibration Manual* for the RF Output. If your HP 8644A is equipped with Option 007, the internal audio source becomes a two channel Multifunction Synthesizer. Five different internal audio waveforms are then available: sine, square, triangle, sawtooth, or white Gaussian noise as demonstrated in Procedure #1. (Refer to appendix F for further information about Option 007.)

You can simultaneously modulate AM with FM, ΦM, or pulse modulation.

Note *AM accuracy and distortion specifications are not valid when you simultaneously modulate AM and Pulse together.*

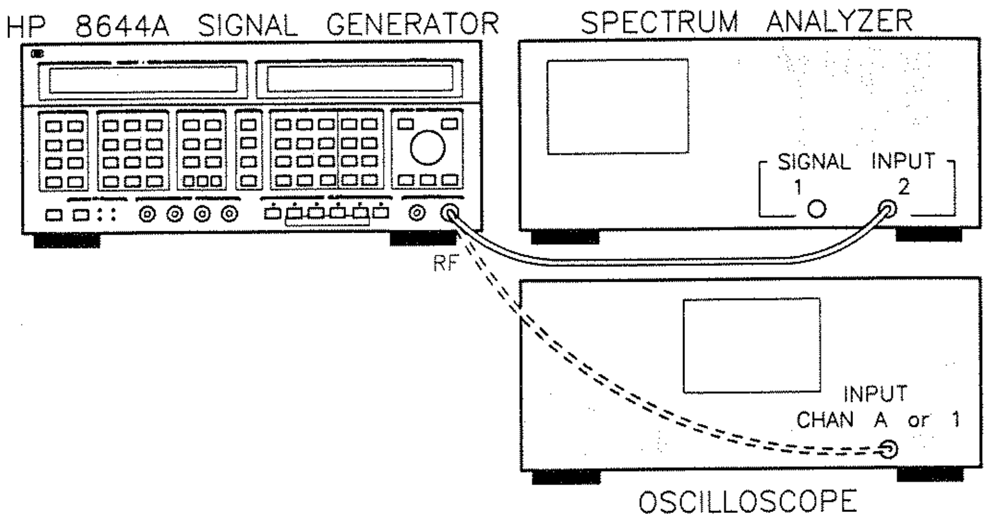


Figure 2–5. Equipment Setup for AM Procedure #1.

Amplitude Modulation – An Exercise

The following exercise is made up of two procedures. Each procedure takes about 10 minutes to complete. The first procedure amplitude modulates the HP 8644A using the internal audio source. The second procedure amplitude modulates the HP 8644A using an external audio source. In both procedures, you have the choice of viewing results either on a Spectrum Analyzer or on an Oscilloscope.

Equipment Needed

Both procedures require use of the following equipment:

Equipment	Recommended Model Numbers
Spectrum Analyzer	HP 8562A/B, or HP 8566B, or HP 8568B
Function Generator	HP 3312A, or HP 3314A, or HP 8111A, HP 8116A, or HP 8904A
Oscilloscope	HP 1741A, or HP 54100A, or HP 54200A

Procedure #1 – AM Using the Internal Audio Source

Procedure #1 starts with step 1 shown on the next page. A review of the four major steps in the procedure are:

- Set up and adjust the Spectrum Analyzer (or Oscilloscope), and connect it to the HP 8644A.
- Adjust the RF output to 20 MHz, and the output amplitude to 0 dBm on the HP 8644A.
- Adjust the AM depth to 50%, and the audio frequency rate to 3 kHz on the HP 8644A.
- Observe and modify the results.

Set Up and Adjust the Spectrum Analyzer (or Oscilloscope)

1. **Connect the HP 8644A to the Spectrum Analyzer (or Oscilloscope) as shown in figure 2–5.** Turn on the equipment, and make the following adjustments:

On the Spectrum Analyzer

Center Frequency .... 20 MHz
Frequency Span .... 10 kHz
Reference Level .... 0 dBm

On the Oscilloscope

Volts/Div 0.5
Time/Div .... 100 μsec

STEP 3

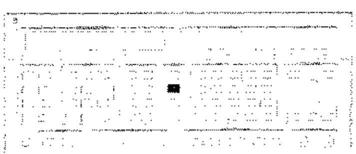
Adjust RF Output and Output Amplitude on the HP 8644A

2. **Press the green INSTR PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.

3. **Press the FREQ key, and enter a frequency of 20 MHz.**

Remember

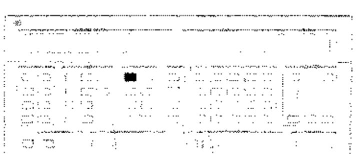
On the HP 8644A, a "▽" cursor appears in either the FREQUENCY/STATUS or the MODULATION/AMPLITUDE display, and points to the currently active function. This means, for example, that presently you could change the frequency of the HP 8644A without having to first press the **FREQ** *key.*



STEP 4

4. **Press the AMPTD key, and enter an output amplitude of 0 dBm.** You will notice that the "▽" cursor is now in the MODULATION/AMPLITUDE display.

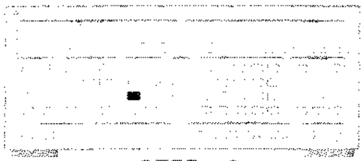
Adjust AM Depth and Audio Frequency Rate on the HP 8644A



STEP 5

5. **Press the AM key, and enter an AM depth of 50%.** When AM depth is first turned on, the audio frequency rate defaults to 1 kHz.

   Notice that the yellow annunciators above the **AM** and **INT** keys light up; this indicates that AM, using its internal audio source, is active.



STEP 6

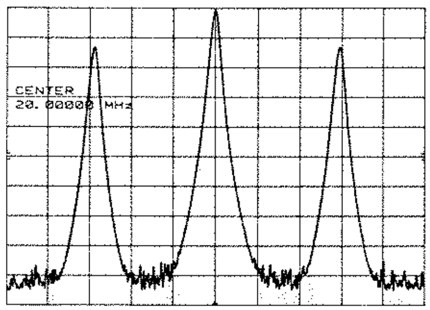
6. **Press the AUDIO FREQ key, and enter an audio frequency rate of 3 kHz.** The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

50.0%	3.000kHz	+0.0dBm
AM	AUDIO	

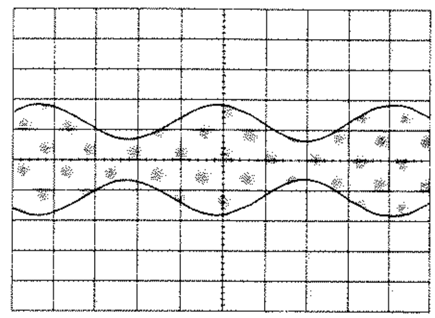
Observe and Modify the Results.

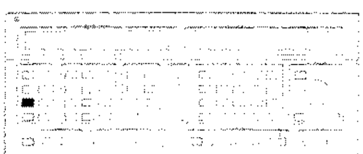
7. **The following display should appear on the Spectrum Analyzer (or Oscilloscope):**

Spectrum Analyzer



Oscilloscope

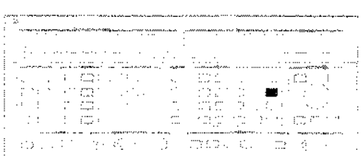




STEP 8

8. **Press the SAVE key.** The HP 8644A should show the following in the FREQUENCY/STATUS display:

Save Register =



STEP 9

9. **Press the 0 key, and the ENTER key.** This step enters the frequency, modulation and amplitude settings in Register 0 for use in Procedure #2; the FREQUENCY/STATUS display should now show the last RF output setting (20 MHz).

10. **Press the AM key, and turn the knob counterclockwise to decrease the AM depth.** You will notice the Spectrum Analyzer (or Oscilloscope) display changing as AM depth is adjusted.

    If you have an HP 8644A with Option 007, return AM depth to 50 % and proceed to the next step where you will change the audio frequency waveform by using Special Function 130. If Option 007 is not available, continue on to Procedure #2, AM using an external audio source.

STEP 11

11. **Press the SPECIAL key.** The HP 8644A should now show the following in the FREQUENCY/STATUS display:

```
Enter Special Number
```

12. **Enter number "130" and press the ENTER key.** If you get an error "No such special", then the HP 8644A does not have Option 007. The HP 8644A should now show the following in the FREQUENCY/STATUS display:

```
130:Audio Wave Sine
```

13. **Turn the knob to change the audio frequency waveform.** Notice how the Spectrum Analyzer (or Oscilloscope) responds to the Square, Triangle, Sawtooth, and White Gaussian Noise waveforms.

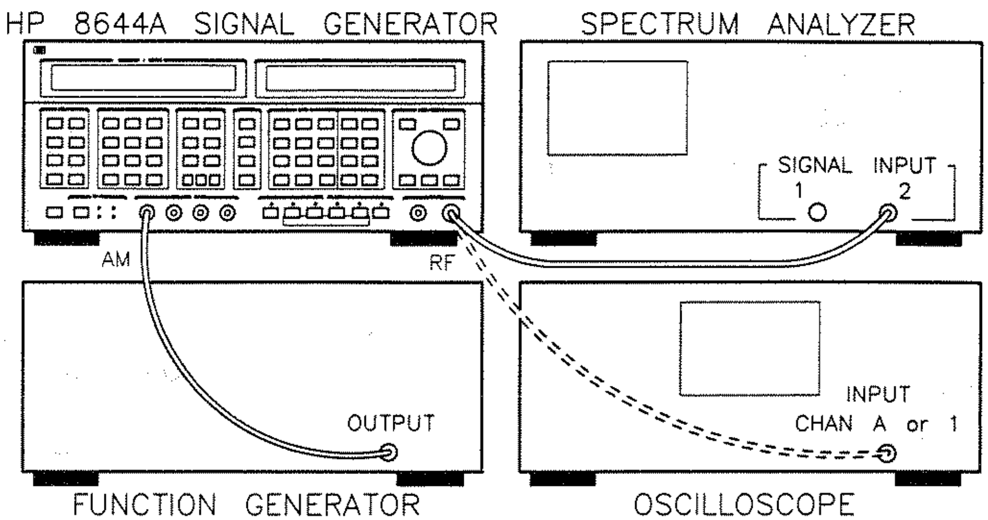


Figure 2–6. Equipment Setup for AM Procedure #2.

Procedure #2 – AM Using an External Audio Source

Procedure #2 starts with step 1 shown below. A review of the five major steps in the procedure are:

- Set up and adjust the Spectrum Analyzer (or Oscilloscope) and Function Generator, and connect them to the HP 8644A.
- Adjust the RF output to 150 MHz, and the output amplitude to 0 dBm on the HP 8644A.
- Adjust the AM depth to 90% on the HP 8644A.
- Adjust output amplitude on the Function Generator.
- Observe and modify the results.

Set Up and Adjust the Spectrum Analyzer (or Oscilloscope), and Function Generator

1. **Connect the HP 8644A to the Spectrum Analyzer (or Oscilloscope) and Function Generator as shown in figure 2-6.** Turn on the equipment and make the following adjustments:

On the Spectrum Analyzer

Center Frequency .... 150 MHz
Frequency Span .... 250 kHz
Reference Level .... 0 dBm

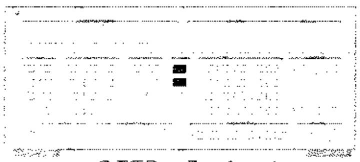
On the Oscilloscope

Volts/Div 0.175
Time/Div .... 5 μsec

On the Function Generator

Frequency .... 50 kHz
Amplitude .... 1 Vpk
Waveform .... Sine

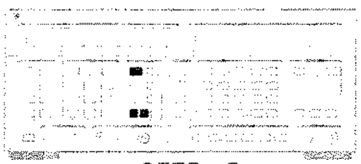
Adjust RF Output and Output Amplitude on the HP 8644A



STEP 3 & 4

2. **Press the green INSTR PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.
3. **Press the FREQ key, and enter a frequency of 150 MHz.**
4. **Press the AMPTD key, and enter an output amplitude of 0 dBm.**

Adjust AM Depth on the HP 8644A



STEP 5

5. **Press the AM key, the EXT AC key, the INT key, and then enter an AM depth of 90%.** The **INT** key is pressed in this step to turn off the internal audio source.

   Notice that the yellow annunciators above the **AM** and **EXT AC** keys light up; this indicates that AM using an external audio source is active.

   The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

```
 90.0%  Ext AC    +0.0dBm
 AM           EXT LO
```

Remember *The EXT HI and EXT LOW annunciators in the MODULATION/AMPLITUDE display indicate if the amplitude of the external audio source is too high or too low. When the input signal is at 1 Vpk ±1%, both annunciators are off. However, both annunciators only work at external audio rates from 20 Hz to 100 kHz.*

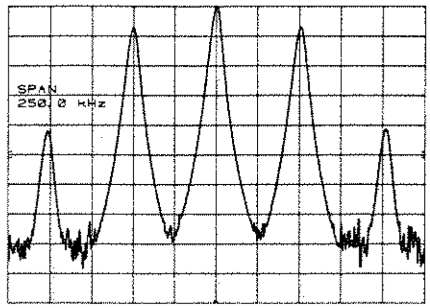
Adjust Output Amplitude on the Function Generator

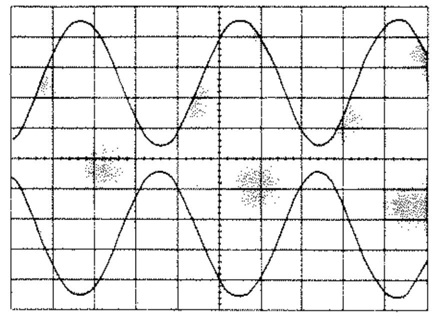
Note *Proceed to step 7 if both the EXT HI and EXT LOW annunciators are off.*

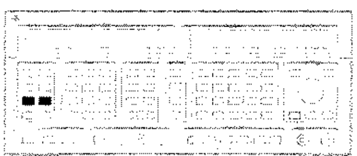
6. **Slowly increase the output amplitude on the function generator until both the EXT HI and EXT LOW annunciators are off.** For specified results, the HP 8644A requires the input signal to the **AM** connector to be exactly 1 Vpk. When both annunciators are off, the input signal will be within 1% of the specified accuracy.

Observe and Modify the Results

7. **The following display should appear on the Spectrum Analyzer (or Oscilloscope):**







STEP 8 & 9

8. **Press the SAVE key, and put the current front-panel settings in Register 1.**

9. **Press the Recall key.** The HP 8644A should show the following in the FREQUENCY/STATUS display:

```
Recall  Register =
```

10. **Press the 0 and the ENTER key to recall the settings from Procedure #1.** You will have to re-adjust the Spectrum Analyzer. Then, notice that the display on the Spectrum Analyzer reflects the recalled settings from Procedure #1.

11. **Recall Register 1 to return to the Procedure #2 settings.** Re-adjust the Spectrum Analyzer's center frequency to 100 MHz. Notice once again that the display on the Spectrum Analyzer reflects the recalled settings for Procedure #2.

Remember

The HP 8644A has 50 available storage registers. The first 10, Registers 0–9, accepts all front panel settings (except for some Special Functions). The next 40, Registers 10–49, accepts only frequency and amplitude settings.

Performing an Instrument Preset, or unplugging the HP 8644A does not alter contents of the 50 storage registers.

Amplitude Modulation – Things to Remember

The following list is a summary of the most important points previously discussed in the AM modulation section:

- For accurate AM depth, audio frequency rates should not exceed the specified limits shown in the HP 8644A *Calibration Manual* for the RF output.
- The **AM** input connector has an input impedance of 600 Ω.
- An internal, external, or both internal and external audio source can be used to amplitude modulate the RF output.
- The internal audio source generates sine, square, triangle, sawtooth, or white Gaussian noise waveforms if you have an HP 8644A with Option 007. Refer to appendix F for instructions.

Pulse Modulation – An Overview

If You Need to Know:	Refer to:
Pulse Modulation	
• *Some general information about pulse modulation*	***Pulse Modulation–An Introduction (2–23)***
• *How to Pulse Modulate the HP 8644A with an external audio source*	***Pulse Modulation–An Exercise (2–24 to 2–26)***
• *The key things to remember about pulse modulating the HP 8644A*	***Pulse Modulation–Things to Remember (2–27)***

Pulse Modulation – An Introduction

The HP 8644A pulse modulates the RF output with a dc-coupled external audio source applied to the front-panel **PULSE** connector. **INT** and **EXT AC** Pulse modulation is not allowed. You can simultaneously modulate AM or FM with pulse modulation.

Note *AM accuracy and distortion specifications are not valid when you simultaneously modulate AM and Pulse together.*

To generate pulse modulation, use an external audio source with a pulse waveform. When the pulse waveform from the external audio source goes high, the pulse output from the HP 8644A turns on. Vary the external pulse rate, amplitude, and width to simulate the pulse modulated signal you need.

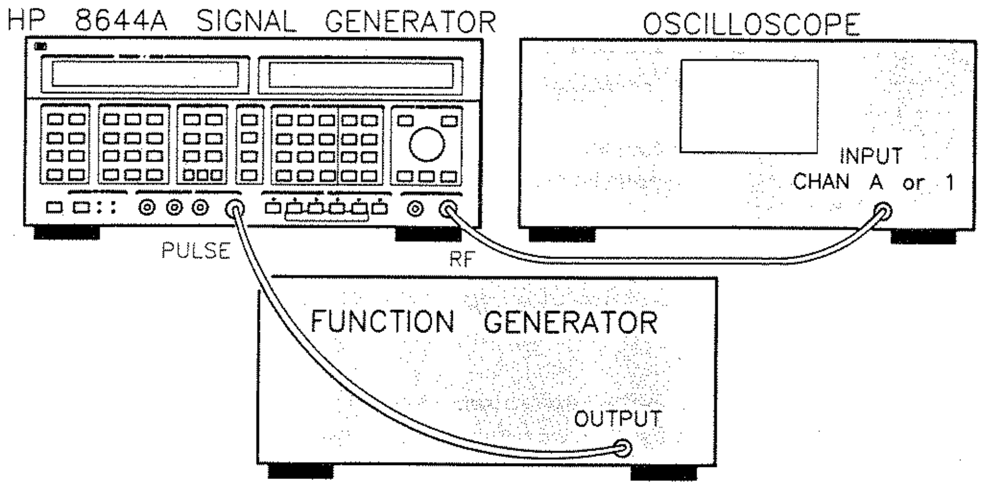


Figure 2-7. Equipment Setup for Pulse Modulation Procedure.

Pulse Modulation – An Exercise

In this exercise you will pulse modulate the HP 8644A with an external audio source. This procedure takes about 10 minutes. The results from the pulse modulation exercise are displayed on an oscilloscope.

Equipment Needed

This procedure requires use of the following equipment:

Equipment	Recommended Model Numbers
Function Generator	HP 3314A, or HP 8111A, HP 8116A, or HP 8904A
Oscilloscope	HP 1741A, or HP 54100A, or HP 54200A

Procedure – Pulse Modulation Using an External Audio Source

The procedure starts with step 1 shown on the next page. A review of the five major steps in the procedure are:

- Set up and adjust the Oscilloscope and Function Generator, and connect them to the HP 8644A.
- Adjust the RF output to 50 MHz, and the output amplitude to 0 dBm on the HP 8644A.
- Set up pulse modulation on the HP 8644A.
- Adjust output amplitude on the Function Generator.
- Observe and modify the results.

Set Up and Adjust the Oscilloscope, and Function Generator

1. **Connect the HP 8644A to the Oscilloscope and Function Generator as shown in figure 2-7.** Turn on the equipment and make the following adjustments:

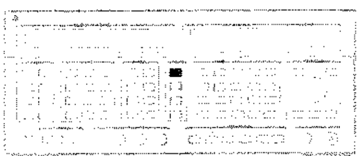
On the Oscilloscope

Volts/Div 0.2
Time/Div .... 0.5 msec

On the Function Generator

Frequency .... 1 kHz
Amplitude .... 3 Vpk
Waveform .... Pulse
Width .... 100 μsec

Adjust RF Output and Output Amplitude on the HP 8644A

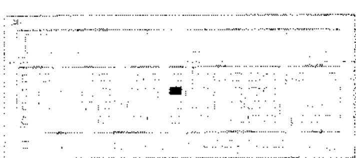


STEP 3

2. **Press the green INSTR PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.
3. **Press the FREQ key, and enter a frequency of 50 MHz.**

Remember

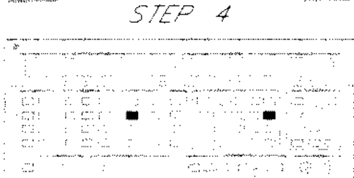
On the HP 8644A, a "▽" cursor appears in either the FREQUENCY/STATUS or the MODULATION/AMPLITUDE display, and points to the currently active function. This means, for example, that presently you could change the frequency of the HP 8644A without having to first press the **FREQ** *key.*



STEP 4

4. **Press the AMPTD key, and enter an output amplitude of 0 dBm.** You will notice that the "▽" cursor is now in the MODULATION/AMPLITUDE display.

Set Up Pulse Modulation on the HP 8644A



STEP 5

5. **Press the PULSE key, and then press the ENTER key.**

   Notice that the yellow annunciators above the **PULSE** and **EXT DC** keys light up; this indicates that pulse modulation using an external audio source is active.

   The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

```
Pulse  Ext DC   +0.0dBm
PULSE
```

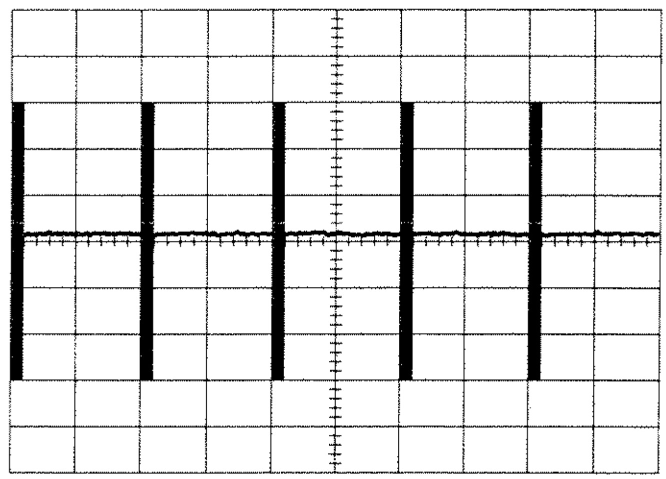
Adjust Output Amplitude on the Function Generator

6. **Slowly increase the output amplitude on the function generator until the Oscilloscope displays the pulse modulated signal.** The external input level required to pulse modulate the HP 8644A is a value greater than 3 Vpk.

Note *The EXT HI and EXT LOW annunciators are not active with pulse modulation.*

Observe and Modify the Results

7. **The following display should appear on the Oscilloscope:**



8. **Vary the width and rate of the external audio source, and notice the corresponding changes on the Oscilloscope.** Periodically adjust the Oscilloscope to compensate for changes you make to the external audio source.

Caution *Do not apply more than 10 Vpk to the* **PULSE** *connector or you may damage the Synthesized Signal Generator's circuitry.*

Pulse Modulation – Things to Remember

The following list is a summary of the most important points discussed in the pulse modulation section:

- Use an external audio source to generate pulse modulation with the HP 8644A.
- An external input level greater than 3 Vpk (but less than 10 Vpk) is required to turn on pulse modulation from the HP 8644A.
- Damage to circuitry in the HP 8644A could result if the **PULSE** input is driven by a voltage greater than ±10 Vpk.
- RF Output is turned on for the duration of the pulse from the Function Generator.
- The external audio source controls the rate and width of the pulse modulated signal from the HP 8644A.

Simultaneous Modulation – An Overview

If You Need to Know:	Refer to:
Simultaneous Modulation	
• *Some general information about simultaneous modulation*	***Simultaneous Modulation–An Introduction (2–28)***
• *How to simultaneously modulate FM with AM*	***Simultaneous Modulation–An Exercise (2–29 to 2–32)***
• *The key things to remember about simultaneous modulating the HP 8644A*	***Simultaneous Modulation–Things to Remember (2–33)***

Simultaneous Modulation – An Introduction

The HP 8644A generates simultaneous modulation in one of five ways:

1. Simultaneous FM and AM is selected using a common or separate audio source.
2. Simultaneous FM at two rates using both the internal and an external audio source.
3. Simultaneous FM and AM using a common audio source (either internal or external), and FM from a different audio source.
4. Pulse modulation may be selected and entered along with any of the three ways mentioned in statements 1–3.
5. Phase modulation may be selected with AM and/or Pulse modulation. If phase modulation is selected, FM is turned off.

Refer to appendix F if your HP 8644A is equipped with Option 007. The multifunction synthesis capabilities of Option 007 allows you to generate a subcarrier from complex audio signals that is applied, in turn, as a modulating wave to the RF carrier signal.

Note

AM accuracy and distortion specifications are not valid when you simultaneously modulate AM and Pulse together.

The **AM**, **FM**, **ΦM**, *and* **PULSE** *input connectors each have an external input impedance of 600 Ω.*

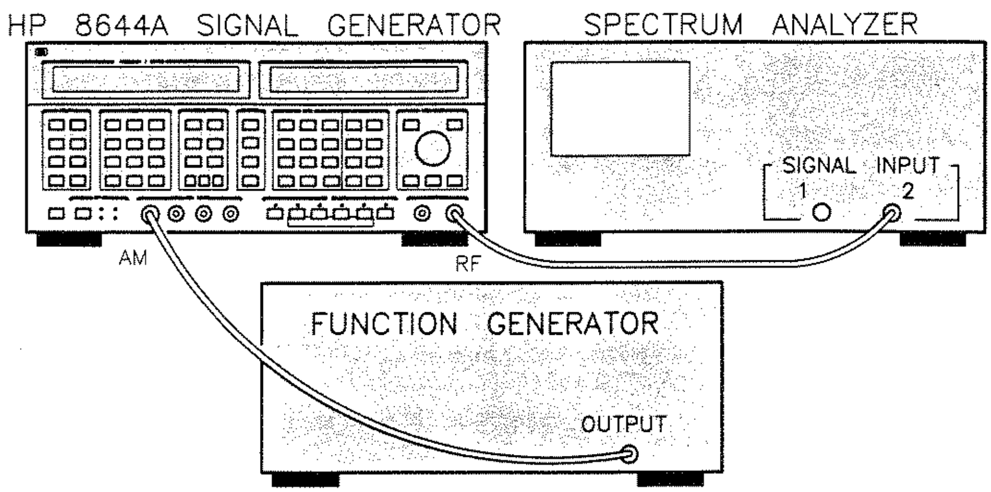


Figure 2–8. Equipment Setup for Simultaneous FM and AM Procedure.

Simultaneous Modulation – An Exercise

There are many possible combinations and applications for simultaneous modulation. In this exercise, the HP 8644A simultaneously modulates FM with AM. The application for this exercise represents an FM radio signal fading 30 dB as a result of interference. This procedure takes about 15 minutes.

Equipment Needed

This procedure requires use of the following equipment:

Equipment	Recommended Model Numbers
Spectrum Analyzer	HP 8562A/B, or HP 8566B, or HP 8568B
Function Generator	HP 3312A, or HP 3314A, or HP 8111A, HP 8116A, or HP 8904A

Procedure – Simultaneous FM and AM

In the procedure, you will set up the HP 8644A with a wanted FM signal modulated by the internal audio source, and then introduce an AM signal used for fading, which is modulated with an external audio source.

The procedure starts with step 1 shown on the next page. A review of the five major steps in the procedure are:

- Set up and adjust the Spectrum Analyzer and Function Generator, and connect them to the HP 8644A.
- Adjust the RF output to 150 MHz, and the output amplitude to 0 dBm on the HP 8644A.
- Adjust the AM depth to 90% on the HP 8644A.
- Adjust the FM deviation to 75 kHz, and the audio frequency rate to 1 kHz on the HP 8644A.
- Observe and modify the results.

Set Up and Adjust the Spectrum Analyzer, and Function Generator

1. **Connect the HP 8644A to the Spectrum Analyzer and Function Generator as shown in figure 2-8.** Turn on the equipment and make the following adjustments:

   On the Spectrum Analyzer

Center Frequency	150 MHz
Frequency Span	500 kHz
Reference Level	+10 dBm

   On the Function Generator

Frequency	0.5 Hz
Amplitude	1 Vpk
Waveform	Sine

Adjust RF Output and Output Amplitude on the HP 8644A

2. **Press the green INSTR PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.

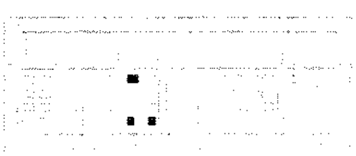
Remember

On the HP 8644A a "▽" cursor appears in either the FREQUENCY/STATUS or the MODULATION/AMPLITUDE display, and points to the currently active function. This means, for example, that presently you could change the frequency of the HP 8644A without having to first press the FREQ key.

STEP 3 & 4

3. **Press the FREQ key, and enter a frequency of 150 MHz.**
4. **Press the AMPTD key, and enter an output amplitude of 0 dBm.** You will notice that the "▽" cursor is now in the MODULATION/AMPLITUDE display.

Adjust AM Depth on the HP 8644A



STEP 5

5. **Press the AM key, the EXT DC key, the INT key, and then enter an AM depth of 90%.** The **INT** key is pressed in this step to turn off the internal audio source.

   Notice that the yellow annunciators above the **AM** and **EXT DC** keys light up; this indicates that AM using an external audio source is active.

   The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

```
90.0% Ext DC   +0.0dBm
AM
```

Remember

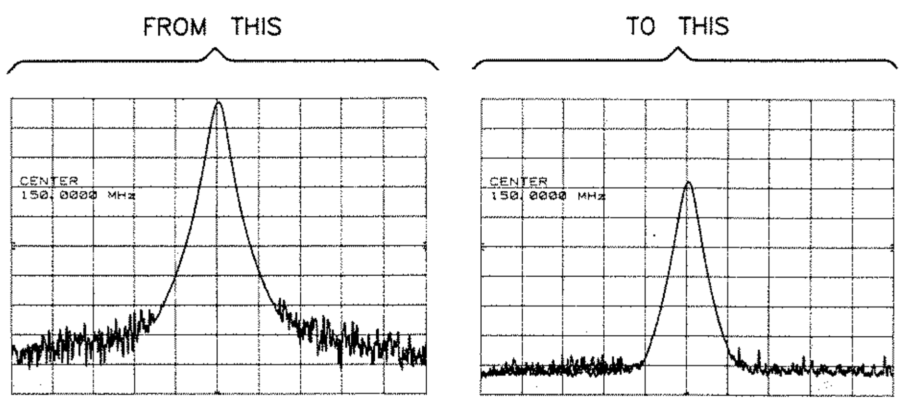
The EXT HI and EXT LOW annunciators in the MODULATION/AMPLITUDE display indicate if the amplitude of the external audio source is too high or too low. When the input signal is at 1 Vpk ±1%, both annunciators are off. However, both annunciators only work at external audio rates from 20 Hz to 100 kHz.

Since the external audio rate is at 0.5 Hz, you can ignore the EXT HI and EXT LOW annunciator displays.

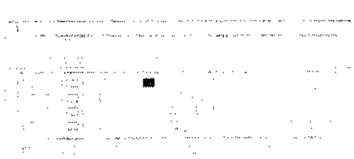
6. **The following display should appear on the Spectrum Analyzer:** The RF output should be slowly changing for a full amplitude swing of about 30 dB.

Note

Increase the Function Generator's output amplitude if a full 30 dB swing is not present. Decrease the Function Generator's output amplitude if more than a 30 dB swing is present.



Adjust FM Deviation and Audio Frequency Rate on the HP 8644A


STEP 7

7. **Press the FM key, and enter an FM deviation of 75 kHz.** When FM deviation is first turned on, the audio frequency rate defaults to 1 kHz.

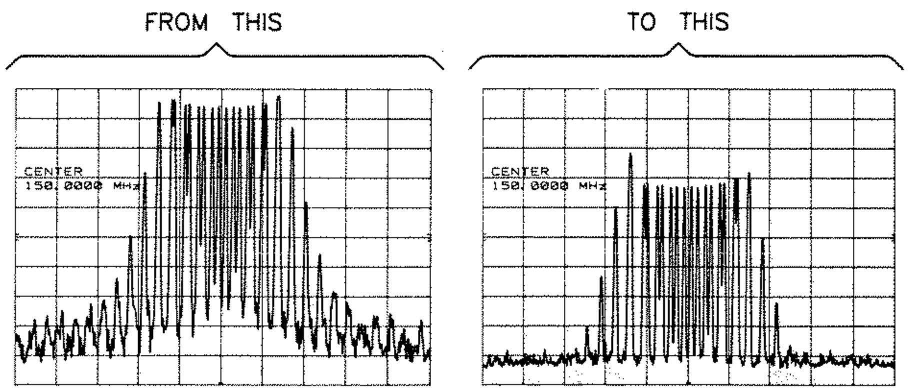
   Notice that the yellow annunciators above the **FM** and **INT** keys light up; this indicates that FM, using its internal audio source, is active.

The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

```
75.0kHz 1.000kHz +0.0dBm
FM      AUDIO
```

Observe and Modify the Results

8. **The following display should appear on the Spectrum Analyzer:** The FM signal should be slowly changing for a full amplitude swing of about 30 dB.



9. **Vary the Function Generator's output amplitude in 0.1 Vpk steps, and notice the corresponding changes on the Spectrum Analyzer.** The FM signal will have a greater swing as output amplitude is increased, and a smaller swing as output amplitude is decreased.

   When you are done, put the Function Generator's output amplitude back to the 1 Vpk setting for the 30 dB swing.

10. **Vary the Function Generator's audio frequency rate in small steps.** The amplitude swings of the FM signal take longer to change as the audio frequency rate is decreased, and will change faster as the audio frequency rate is increased.

    When you are done, put the Function Generator's audio frequency rate back to 0.5 Hz.

11. **Vary AM depth on the HP 8644A.** The amplitude swings of the FM signal are smaller as the AM depth is decreased.

Simultaneous Modulation – Things to Remember

The following list is a summary of the most important points discussed in the simultaneous modulation section:

- There are five ways simultaneous modulation can be generated, refer to page 2-28.
- The Modulation Input connectors all have an external input impedance of 600 Ω
- All features and limitations previously described for FM, AM, and Pulse apply when simultaneously modulating the HP 8644A.

Note

The HP 8644A requires a 1 Vpk signal from an external audio source, and a 2 Vpk signal from the Internal Audio Source to provide calibrated operation when the RF carrier is being modulated. Voltage levels less than these reduce the amount of modulation on the RF carrier.

However, you may want to reduce the output level of the Internal Audio Source during simultaneous internal and external modulation. Doing so would allow you to increase the amount of external modulation. The sum of the internal and external voltages should not exceed 1.4 Vpk or clipping may occur.

The Internal Audio Source on a standard HP 8644A provides a sinusoidal waveform at either 2 Vpk or 0 Vpk into a 600 Ω load. With Option 007 (as described in appendix F), the **AUDIO LEVEL** *affecting the audio source may be reduced to a value between 2 Vpk and 0 Vpk.*

This is done by first pressing the blue **SHIFT** *key, and then the* **AUDIO LEVEL** *key. Turn the knob or press one of the* ⇧ ⇩ *keys to change the output level.*

3 Sweeping

3 What About Sweeping?

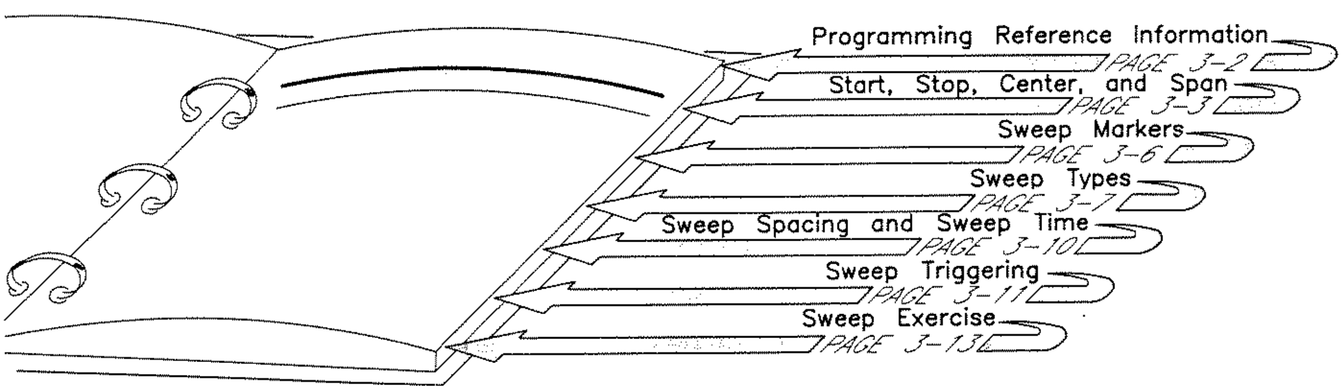
In this Chapter

This chapter describes how to frequency sweep the HP 8644A Synthesized Signal Generator. Information is provided regarding front-panel control of frequency sweeping. Refer to chapter 4 if you need information about HP-SL programming control over HP-IB.

Two types of sweep are available to help you characterize RF devices: digitally-stepped and phase-continuous sweep. This chapter focuses on each frequency sweep feature; advantages and limitations are mentioned where appropriate. At the end of this chapter is an exercise that may be helpful to you.

The Directory

Use the following illustration shown below to find the subject you want. Turn to that subject for specific information.



Frequency Sweep – General Information

The process to frequency sweep the HP 8644A can be summarized in five basic steps. The following steps reflect the order in which sweeping is described in this chapter; you are not constrained to use this sequence of steps once you become familiar with the process of frequency sweeping the HP 8644A:

1. Set up a start, stop, center, or span frequency.
2. Activate sweep markers (optional step).
3. Decide which type of frequency sweeping to use (digitally-stepped, or phase-continuous).
4. Select the sweep spacing (linear is the default spacing, log is selectable from the front panel), and set the sweep time.
5. Trigger the HP 8644A to frequency sweep (using Auto, Single, or Manual).

The HP 8644A has attributes of two different types of instruments. First, it acts as a non-swept CW signal source, and second, it acts as a frequency-swept signal source (that is, a sweeper). By pressing any of the front-panel keys shaded in figure 3–1, the HP 8644A becomes a sweeper.

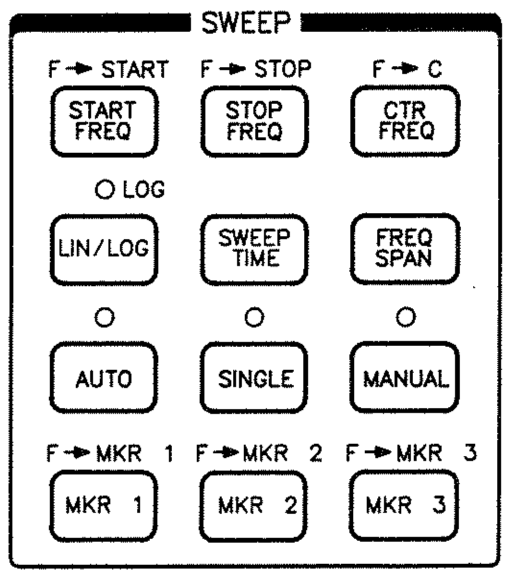


Figure 3–1. Keys that Turn the HP 8644A into a Sweeper.

When the HP 8644A has become a sweeper, whether the signal source is paused or running, you will notice a **SWEEP** annunciator in the FREQUENCY/STATUS display. For example, after an instrument preset, if you were to press the **START FREQ** key, you would see the following display:

Start 251,464.86 Hz
SWEEP

Start, Stop, Center, and Span

To set up a frequency-swept measurement, the HP 8644A must know the start, stop, center, and span frequency values that you want. Simply press any one of the front-panel keys shaded in figure 3-2:

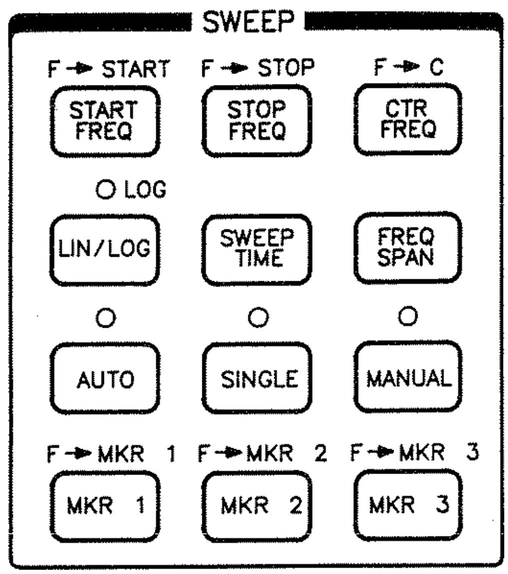


Figure 3-2. Start, Stop, Center, and Span Frequency Keys.

You may then specify a sweep frequency in one of four ways, as follows:

- Use the front-panel **DATA** keys shaded in figure 3-3:

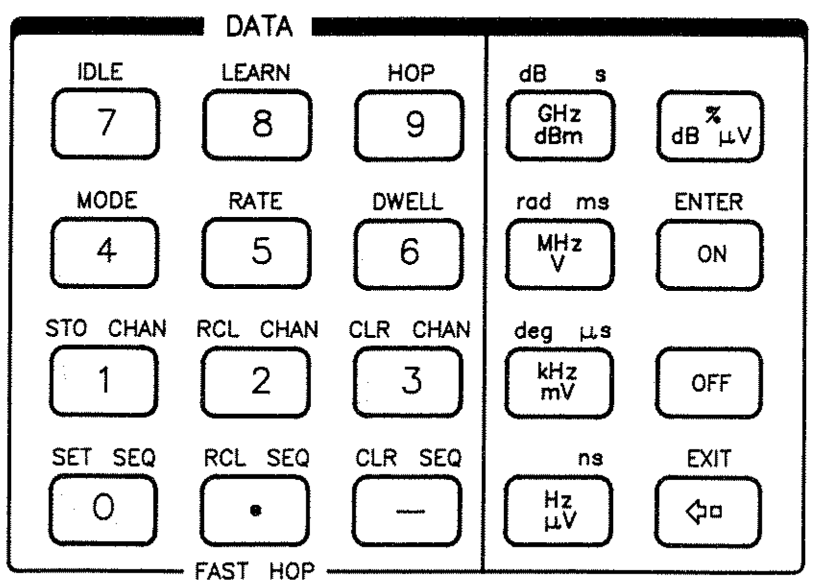


Figure 3-3. Data Keys for Start, Stop, Center, and Span.

- Press one of the increment or decrement front-panel keys shaded in figure 3–4:

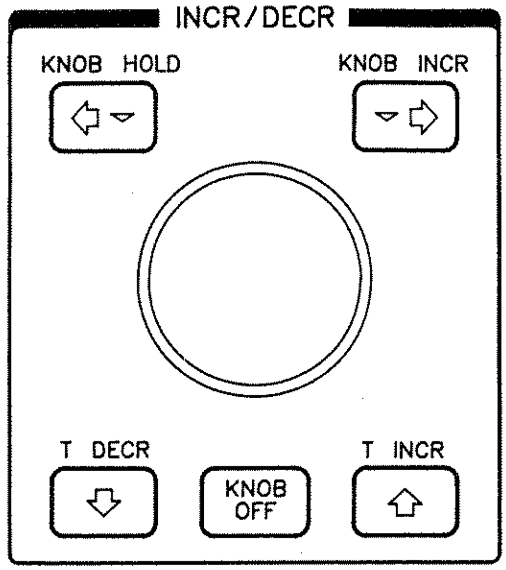


Figure 3–4. Increment/Decrement Keys for Start, Stop, Center, and Span.

- Turn the knob (shaded in figure 3–5) clockwise to increase frequency, or turn the knob counterclockwise to decrease the displayed frequency:

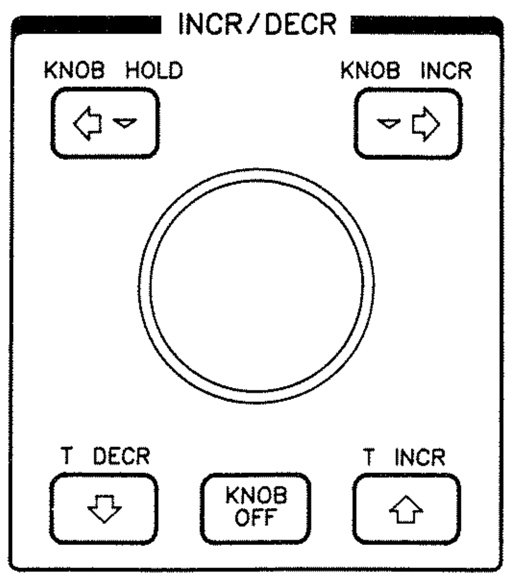


Figure 3–5. Knob for Start, Stop, Center, and Span.

- Sometimes it is useful to make the start, stop, center, or span equal to the value of the RF output frequency last displayed. To do this, press the blue **SHIFT** key, and then one of the start, stop, center, or span keys shaded in figure 3-6.

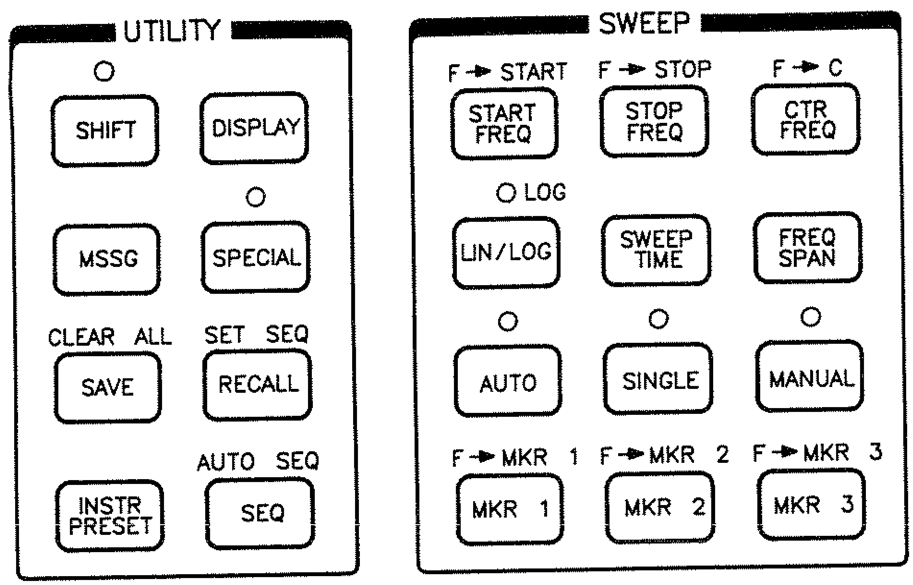


Figure 3-6. Shift Key for Start, Stop, Center, and Span.

When you specify a sweep frequency, the start, stop, center, and span frequency values are interactive; they affect each other in the following ways:

If **START FREQ** is changed:

STOP FREQ	is unchanged
CTR FREQ	is set to (START FREQ + STOP FREQ)/2
FREQ SPAN	is set to (STOP FREQ - START FREQ)

If **STOP FREQ** is changed:

START FREQ	is unchanged
CTR FREQ	is set to (START FREQ + STOP FREQ)/2
FREQ SPAN	is set to (STOP FREQ - START FREQ)

If **CTR FREQ** is changed:

FREQ SPAN	is unchanged
START FREQ	is set to (CTR FREQ - (FREQ SPAN/2))
STOP FREQ	is set to (CTR FREQ + (FREQ SPAN/2))

If **FREQ SPAN** is changed:

CTR FREQ	is unchanged
START FREQ	is set to (CTR FREQ - (FREQ SPAN/2))
STOP FREQ	is set to (CTR FREQ + (FREQ SPAN/2))

Sweep Markers

Up to three sweep markers can be set to locate positions of interest during the frequency sweep. When you set a sweep marker, the HP 8644A is not put into the sweep mode; this allows you to set sweep markers at any time. Simply press one of the front-panel keys shaded in figure 3-7:

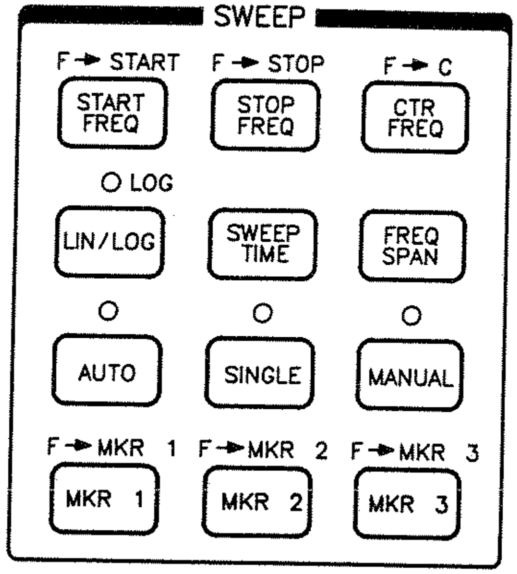


Figure 3-7. Marker Keys.

For example, if you were to press the **MKR 1** key after an instrument preset, you would see the following:

```
Mkr 1 OFF
```

Select a frequency for the marker position in any one of the four ways previously mentioned for selecting start, stop, center, and span frequencies. Press the marker key, and then the **OFF** key to disable a sweep marker.

Sweep markers are active only when the HP 8644A is a sweeper. The X-axis and Z-axis outputs are used to display the sweep markers. Voltage levels from the X-axis and Z-axis outputs are compatible with most typical analog oscilloscopes as follows:

The rear-panel **X AXIS** output connector provides a voltage ramp with a nominal +0 to +10 V dc signal when sweep is triggered in one of three ways (Auto, Single, or Manual). As shown in figure 3-8, voltage points at the extremities of the X-axis ramp coincide with start and stop frequency values. That is, +0 V dc is the start frequency value, and +10 V dc is the stop frequency value. As the sweep time decreases, the slope of the X-axis ramp increases.

Z-Axis

The rear-panel **Z AXIS** output connector provides a +1 V dc output signal that changes to a +5 V dc pulse during retrace to blank the oscilloscope CRT, and also changes to a 0 V dc level whenever a sweep marker is present as shown in figure 3–8.

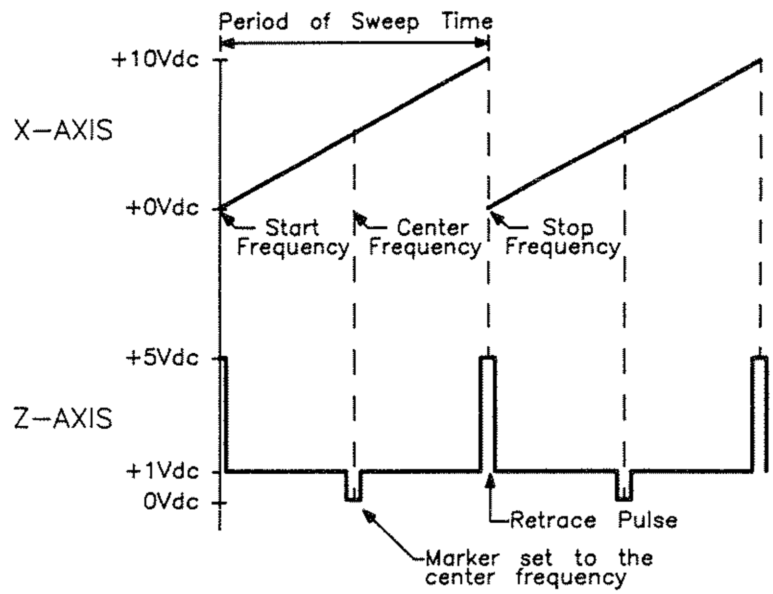


Figure 3–8. X-Axis and Z-Axis.

Sweep Types

Two types of frequency sweep are available:

- Digitally-stepped sweep.
- Phase-continuous sweep.

Both digitally-stepped and phase-continuous sweep have synthesized frequency accuracy. Continue reading for a description of each sweep type.

Digitally-Stepped Sweep

The digitally-stepped sweep can be used to characterize broad band devices such as wideband filters, RF power amplifiers, and mixers by sweeping between two selected endpoints. The frequency sweep is synthesized across any span in either a linear or log frequency spacing. The number of discrete steps is determined by both the frequency span, the active Synthesis Mode, and the sweep time selected by the user.

The main advantage of digitally-stepped sweeping is that it provides an RF synthesized sweep across a broad frequency range. This sweep type is useful for quick verification of broadband RF devices when used with a stored graphic display such as the Maximum Hold feature on certain spectrum analyzers.

Sweep time for the digitally-stepped sweep can range from 0.5 to 1000 seconds with each discrete step requiring 125 msec (typically, in Mode 1) to complete.

To reduce the amount of transient switching spurs when each frequency change occurs, the output amplitude is reduced approximately 60 dB between each frequency step. This amplitude reduction may cause dropouts on the displayed frequency response of the RF device being swept; if this kind of characterization is not satisfactory, use phase-continuous sweep.

Phase-Continuous Sweep

With phase-continuous sweep, precise measurements can be made when characterizing narrowband devices such as passband filters, SAWs, cavity tuned resonators, receiver crystals or ceramic IF filters. The frequency sweep occurs between two selected endpoints in a linear, phase-continuous manner, subject to the span limitations shown in table 3–1.

Narrowband devices generally have large time constants. This means that they respond slowly to stepping transients, and it also implies that they cannot be swept too quickly. Since phase-continuous sweeping has no discrete steps, you can sweep high-Q devices more rapidly than with the digitally-stepped sweep, and be assured of not missing critical response peaks or dips.

Sweep time for the phase-continuous sweep can range from 10 msec to 10 seconds (depending upon the span frequency selected). For example, for Synthesis Mode, **MODE 1**, sweep times of 20 msec and greater is possible with a 20 MHz span. However, to get a sweep time of 10 msec, you must reduce the span frequency to 15 MHz in order to maintain linearity.

The maximum and minimum span is limited by frequency range of the start and stop frequencies. This relationship is shown in table 3–1.

Table 3-1. Maximum and Minimum Span in Phase-Continuous Sweep.

Frequency Range (MHz)	Maximum Span* (MHz)	Minimum Span* (Hz)
1030 to 2060	40	400
515 to 1030	20	200
257 to 515	10	100
128 to 257	5	50
64 to 128	2.5	25
32 to 64	1.25	12.50
16 to 32	0.625	6.25
8 to 16	0.31	3.13
4 to 8	0.15	2
2 to 4	0.078	2
1 to 2	0.039	2
0.5 to 1	0.019	2
0.25 to 0.5	0.009	2

* Maximum and minimum span shown is valid for Mode 1 frequency synthesis.

Phase-continuous sweep is enabled by activating Special Function 112.

- The HP 8644A cannot have modulation on, and cannot have the internal audio frequency on when you enable the phase-continuous sweep, or you will get the error message: "Mod and sweep conflict".
- Log sweep is not allowed with phase-continuous sweep, or you will get the error message: "Log sweep not allowed".

Sweep Spacing and Sweep Time

The HP 8644A allows you to choose two types of sweep spacing, linear and log. Setting the sweep spacing and sweep time will not put the HP 8644A into the sweep mode. Also, various sweep times are available, depending upon whether digitally-stepped sweep or phase-continuous sweep is running. Sweep spacing and sweep time keys are shaded in figure 3-9:

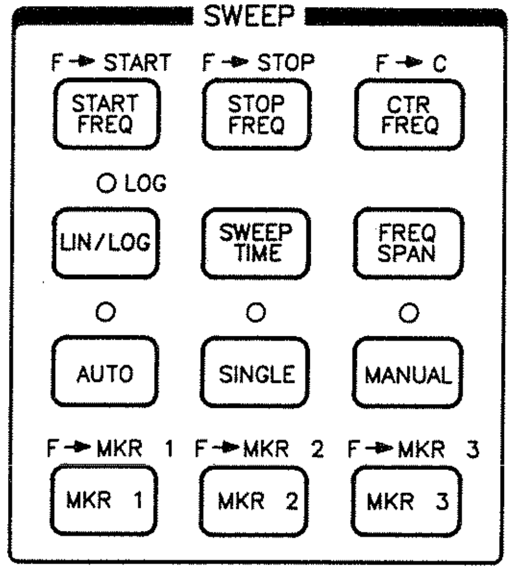


Figure 3-9. Sweep Spacing and Sweep Time Keys.

Linear or Log Sweep Spacing

Selecting either linear or log sweep spacing is done with the front-panel **LIN/LOG** key. When log sweep spacing is active, the yellow LED annunciator above the **LIN/LOG** key lights up.

Permissible Sweep Times

The graph in figure 3-10 lists the permissible sweep times for each sweep type.

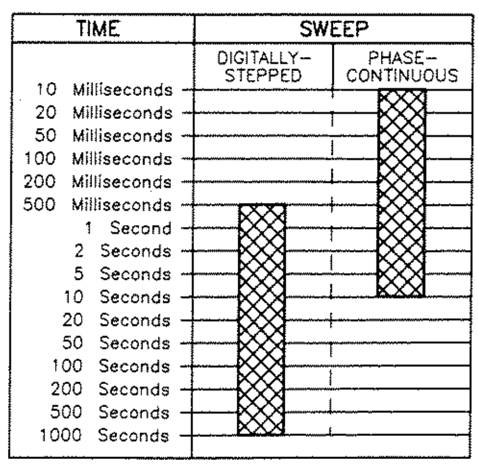


Figure 3-10. Sweep Times for Each Sweep Type.

You may set the sweep time in one of three ways:

- Turn the knob.
- Press either the ⇧ or the ⇩ key.
- Enter a sweep time, chosen from figure 3–10, by using the Data keys. (If you choose an incorrect sweep time, the HP 8644A will display an error if the sweep time is out of range, or it will choose the closest allowable sweep time within the range shown in figure 3–10.)

Sweep Triggering

Auto and Single sweep triggering may be done in conjunction with digitally-stepped, and phase-continuous sweep. Manual sweep triggering is available only with digitally-stepped sweep). Sweep triggering keys are shaded in figure 3–11:

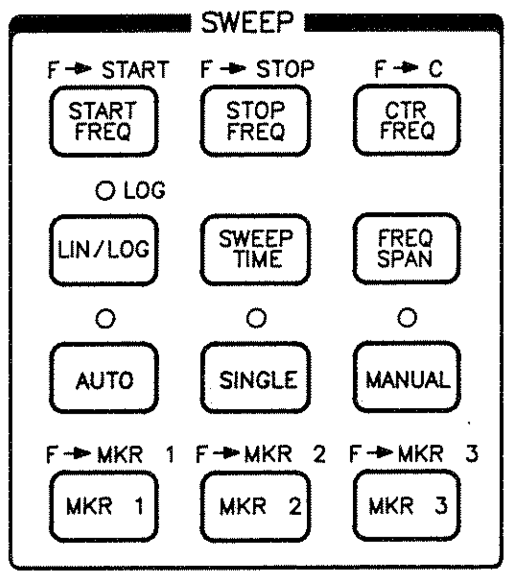


Figure 3–11. Sweep Trigger Keys.

Auto Sweep

The Auto sweep continually repeats the sweep sequence from the start frequency to the stop frequency. Press the **AUTO** key to start the Auto sweep. When Auto sweep is running, the yellow LED annunciator above the **AUTO** key lights up. Press the **AUTO** key again to turn off the sweep.

Single Sweep

The Single sweep starts or restarts a single sweep sequence. Single sweep initiates one sweep only when you press the **SINGLE** key; at the end of the sweep, the RF output returns to the Start Frequency value. When Single sweep is running, the yellow LED annunciator above the **SINGLE** key lights up for the duration of the sweep.

Manual Sweep

Selecting Manual sweep by pressing the **MANUAL** key does not start a sweep, but enables the knob, or the ⇧ and ⇩ keys to control a sweep. When Manual sweep is running, the yellow LED annunciator above the **MANUAL** key lights up, and the FREQUENCY/STATUS display shows the current frequency of the RF output. For example, if you press the **MANUAL** key after doing an instrument preset, you will see the following:

```
Manual     251,464.85 Hz
              SWEEP
```

When you turn the knob or press one of the ⇧ or ⇩ keys to activate a sweep, the RF output changes in discrete steps determined by three different factors:

- Sweep time. The number of sweep steps may be different depending upon the sweep time you select.
- Synthesis Mode. The number of sweep steps may be different between one frequency synthesis Mode and another.
- Linear or log sweep. The frequency of the RF output is different depending upon whether linear or log sweep is active.

Stopping the Sweep

There are two ways to stop the sweep and make the HP 8644A a non-swept CW signal source:

- Press the **FREQ** key.
- Press the blue **SHIFT** key and then the **EXIT** key.

Sweep Triggering Characteristics

A synchronization period occurs whenever the HP 8644A performs an Auto, or Single **phase-continuous** sweep. The synchronization period may pose a problem, depending upon the kind of measurement you are making.

- The synchronization period happens everytime the **SINGLE** key is pressed.
- The synchronization period happens once when the **AUTO** key is pressed, and then a shorter synchronization period happens successively after each sweep when the RF output moves from the stop frequency to the start frequency. (The shorter syncronization periods between each sweep vary in duration depending upon the sweep time set at the front panel.)

Three triggering characteristics always happen during the synchronization period and prior to the actual start of the sweep, as follows:

1. The RF output turns off and/or shifts in frequency (several times) in a seemingly random manner immediately after a sweep is triggered.
2. The RF output is then set to the start frequency, and remains there for approximately 10 msec before the sweep begins.
3. The Z-axis blanking signal is active during the entire synchronization period, and becomes un-blanked only during the actual sweep.

After the synchronization period, the sweep begins at the start frequency and ends at the stop frequency.

Calculating Steps in a Digitally-Stepped Sweep

The number of steps in a digitally-stepped sweep can be calculated from the sweep-time and step-time values, as follows:

- **Sweep Time.** Is set from the front panel **SWEEP TIME** key, and may range from 0.5 to 1000 seconds.
- **Step Time.** Is set by the HP 8644A and is dependent upon the frequency synthesis mode, as follows:

Mode	(Minimum) Step Time (ms)
1	125
2	225
3	300

The formula to calculate the number of steps in a sweep is:

$$\textit{Number of steps} = \frac{\textit{Sweep Time} - (\textit{Step Time} \times 0.3)}{\textit{Step Time}}$$

The HP 8644A allows for a maximum number of steps equal to 1023 (even if your calculations exceeds this value). The HP 8644A also rounds down any calculation to the last step (for example, a calculated value of 9.7 steps is rounded down to 9 steps for each sweep).

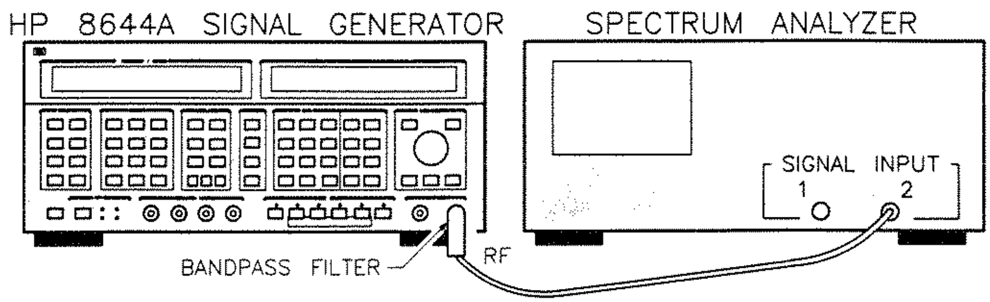


Figure 3–12. Equipment Setup for the Sweep Exercise.

Sweep Exercise

The following exercise takes about 15 minutes to complete. In the procedure, you will characterize a bandpass filter using digitally-stepped sweep, and phase-continuous sweep.

Equipment Needed

This procedure uses the following equipment:

Equipment	Recommended Model Numbers
Spectrum Analyzer	HP 8562A/B, or HP 8566B, or HP 8568B
Bandpass Filter	HP 11697A*

* You may use any bandpass, highpass or lowpass filter. However, your results will be different than those shown in the following procedure.

Procedure

The procedure starts on the next page with step 1. A review of the five major steps in the procedure are:

- Set up and adjust the Spectrum Analyzer, and connect it to the HP 11697A bandpass filter and HP 8644A.
- Set the start and stop frequencies for the sweep.
- Set the sweep time.
- Trigger the sweep.
- Observe and modify the results.

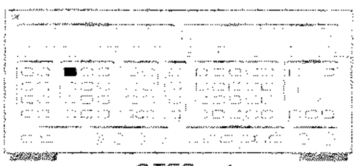
Set Up and Adjust the Spectrum Analyzer

1. **Connect the HP 8644A to the Bandpass Filter and the Spectrum Analyzer as shown in figure 3-12.** Turn on the equipment and make the following adjustments on the Spectrum Analyzer:

Center Frequency	500 MHz
Frequency Span	1000 MHz
Reference Level	10 dBm

Set the Start, and Stop Frequencies

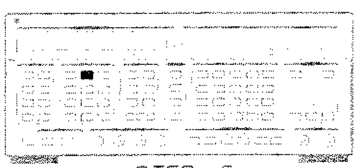
2. **Press the green INST PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.
3. **Press the AMPTD key and enter an output amplitude of 0 dBm.**
4. **Press the START FREQ key, and enter a start frequency of 300 kHz.** You should then see the following in the FREQUENCY/STATUS display:



STEP 4

```
Start        300.000,00 kHz
                 SWEEP
```

5. **Press the STOP FREQ key, and enter a stop frequency of 1 GHz.** You should then see the following in the FREQUENCY/STATUS display:



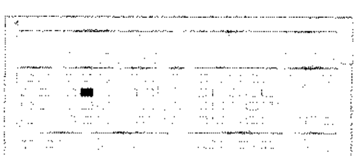
STEP 5

```
Stop  1.000,000,000,00 GHz
                 SWEEP
```

6. **Press the CENT FREQ key.** You will see that the HP 8644A has automatically calculated the center frequency to be 500,150,000.00 Hz.
7. **Press the FREQ SPAN key.** You will see that the HP 8644A has automatically calculated the span frequency to be 999,700,000.00 Hz.

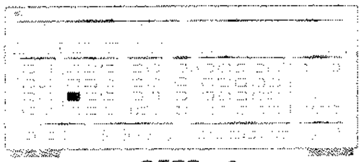
Set the Sweep Time

8. **Press the SWEEP TIME key, and enter a sweep time of 10 seconds.** There are four ways to set the sweep time as previously mentioned in this chapter. You should then see the following in the FREQUENCY/STATUS display:



STEP 8

```
Sweep Time   10.00 s
             SWEEP
```

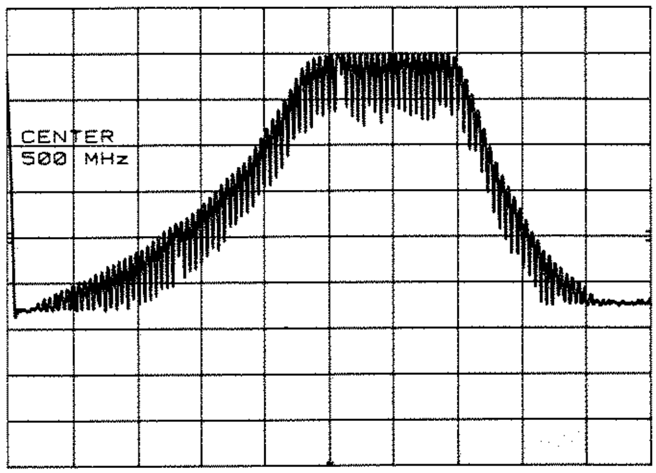

STEP 9

Trigger the Sweep

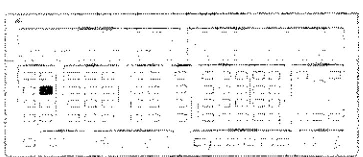
9. **Press the AUTO sweep key.** Notice that the yellow LED annunciator above the **AUTO** sweep key lights to indicate that the sweep is continually repeated from the start frequency to the stop frequency.

Observe and Modify the Results

10. **The following display should appear on the Spectrum Analyzer.** Use the Maximum Hold function on the Spectrum Analyzer to capture the bandpass filter response using digitally-stepped sweep:



11. **Press the AUTO sweep key, to turn off the sweep.** The yellow LED annunciator light above the **AUTO** sweep key should turn off.


STEP 12

12. **Press the Utility SPECIAL key, enter number "112" and press the ENTER key.** You should then see the following in the FREQUENCY/STATUS display:

```
112:Phase Cont Sweep OFF
                 SWEEP
```

13. **Press the ON key to activate Special Function 112.** This step allow you to activate phase-continuous sweep. The yellow LED annunciator above the **SPECIAL** key should light up to indicate that a special function is active.

    With phase-continuous sweep, you may characterize any segment of the bandpass filter response that is of interest to you.

14. **Make the following adjustments on the Spectrum Analyzer to look at the bandpass filter response where the 3 dB roll-off occurs.**

    Center Frequency .... 460 MHz
    Frequency Span .... 20 MHz
    Reference Level .... 10 dBm

15. **Press the SPAN FREQ key, and enter a span frequency of 10 MHz.**
16. **Press the CENTER FREQ key, and enter a center frequency of 460 MHz.** The HP 8644A will automatically calculate the start frequency to be 455 MHz, and the stop frequency to be 465 MHz.
17. **Press the AUTO sweep key to activate the phase-continuous sweep.** The following display should appear on the Spectrum Analyzer with the Maximum Hold function active:

18. **Try duplicating any of the previous steps using another sweep mode, either Single or Manual.**
19. **Try duplicating any of the previous steps using a different sweep time.**
20. **Try duplicating any of the previous steps using a logarithmic sweep instead of a linear sweep.** Remember, log sweep spacing is not allowed with phase-continuous sweep.

4 Programming

4 What About Programming?

In this Chapter

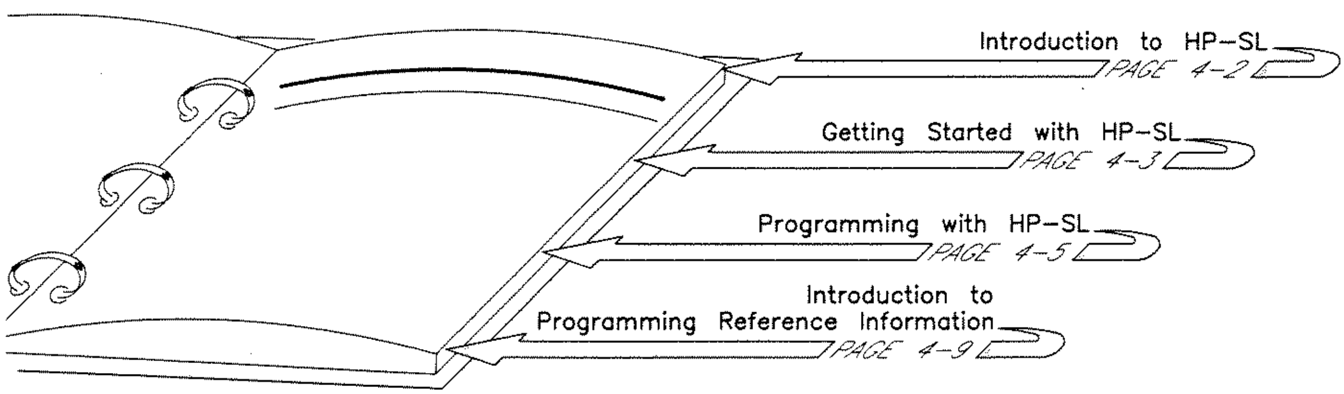
This chapter has three main objectives. First, it provides you with an introduction to the Hewlett-Packard System Language (HP-SL) which is the new programming language for remote control of the HP 8644A over HP-IB. Second, it provides tutorial information helpful to the HP-SL programmer. Third, it provides reference information for programming the HP 8644A with HP-SL.

Novice programmers of HP-SL should read this chapter thoroughly up to the *Programming Reference Information* section (first eight pages). Once you understand the concept of programming with HP-SL, use the reference information as needed.

Note *Refer to appendix E for "HP-SL Quick Reference Information" once you become familiar with the information in this chapter.*

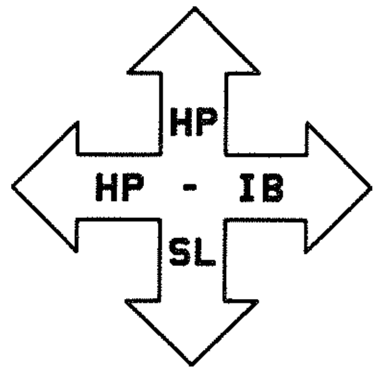
The Directory

Use the following illustration shown below as your guide for each subject in this chapter. If you are unfamiliar with HP-SL, please read the first eight pages, they have been written especially for you.



Introduction to HP-SL

Hewlett-Packard Systems Language (HP-SL) is the new programming language adopted by Hewlett-Packard for controlling instrument functions. This language uses standard HP-IB hardware (connectors and cables) and will be used in many future Hewlett-Packard products.



HP-SL isn't just another set of HP-IB commands. The general use of HP-SL provides you with programming commands that are common from one Hewlett-Packard product to another thereby eliminating "device specific" commands.

HP-SL uses easy to learn, self explanatory commands, and is flexible for both novice and expert programmers. Once you become familiar with the organization and structure of HP-SL, you will see that it reduces your effort to write programs for controlling instrumentation regardless of the programming language you use.

HP-SL was developed to conform to the new IEEE 488.2 standard (which replaces IEEE 728–1982). The advantage of the IEEE 488.2 standard is that it provides codes, formats, protocols, and common commands that were not available in the previous IEEE 488.1 standards. For more information, refer to the IEEE 488.2 standard itself.

Another advantage of HP-SL is that commands can be grouped in a single output statement without regard to the order in which the commands are combined. This eliminates the problem of "sequence dependency", where the lines in a program must be written in a specific order to prevent illegal instrument states from occurring.

Getting Started with HP-SL

This section explains how HP-SL is organized, and introduces you to its basic structure. Once you understand the fundamental parts of HP-SL, proceed to the next section titled *Programming With HP-SL* where command messages are described.

How is HP-SL Organized?

HP-SL commands are organized in a "tree" structure. In its simplest form, figure 4-1 helps you visualize HP-SL syntax. Starting from the base of the tree, you move along a path from the root, up the tree to the different branches as shown in trees "A–D". Each branch represents an optional path that the programmer can use in writing a command statement. Keywords on the trunk and branches are used to build command statements and command messages.

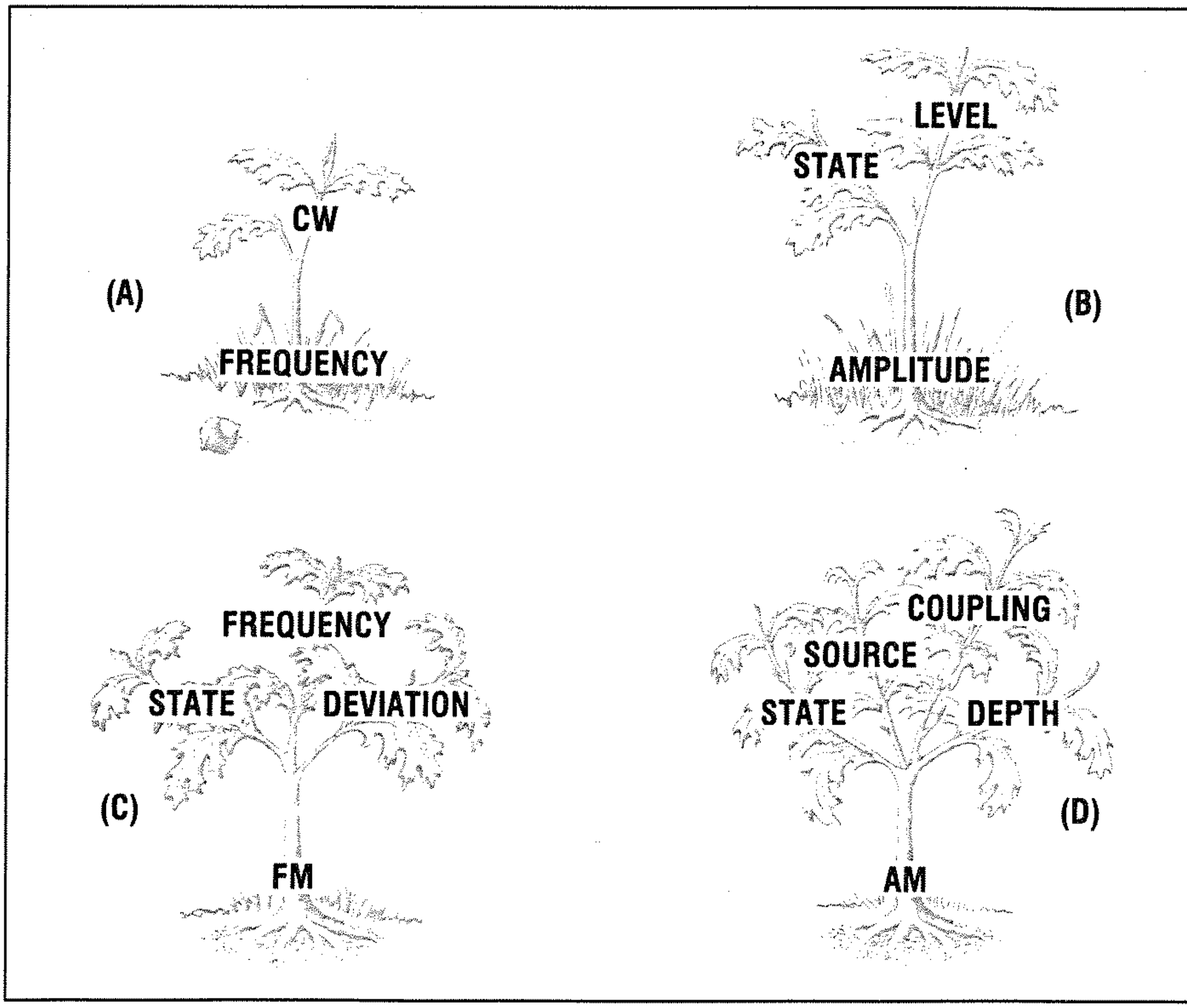


Figure 4–1. Simple HP-SL Tree Structures.

The HP-SL Colon

HP-SL uses the colon " : " to separate the keyword in the root from a branch. For example, the command statement for setting a CW frequency of 1 GHz, as shown in tree "A", would be as follows:

```
FREQUENCY:CW 1GHZ
```

Notice that the command parameter 1 GHz was added to the command statement.

Example command statements for trees "B–D" depict a sampling of the different command parameters avaliable for your use; command parameters must always be preceded by a space:

Tree B

```
AMPLITUDE:LEVEL 10DBM
AMPLITUDE:STATE ON
```

Tree C

```
FM:DEVIATION 10KHZ
FM:FREQUENCY 1KHZ
FM:STATE ON
```

Tree D

```
AM:DEPTH 50%
AM:SOURCE EXTERNAL
AM:COUPLING AC
AM:STATE ON
```

Programming with HP-SL

This section explains how to generate command messages in HP-SL. A command message is two or more command statements put on the same line in a program.

Once you understand the concepts contained in this section, you will be able to start programming the HP 8644A. You may then proceed to the *Programming Reference Information* section for further details on HP-SL programming.

HP-SL Command Statements

Let's expand the analogy of the HP-SL "tree". In reality, the tree structure as shown in figure 4-1 is really more complex. You will find that an HP-SL command statement has a hierarchy that may contain many branches. Tree "A" from figure 4–1 is shown in greater (but not complete) detail in figure 4–2 to depict the branching that occurs. Any command that ends with a question mark "?" is a query for information from the HP 8644A.

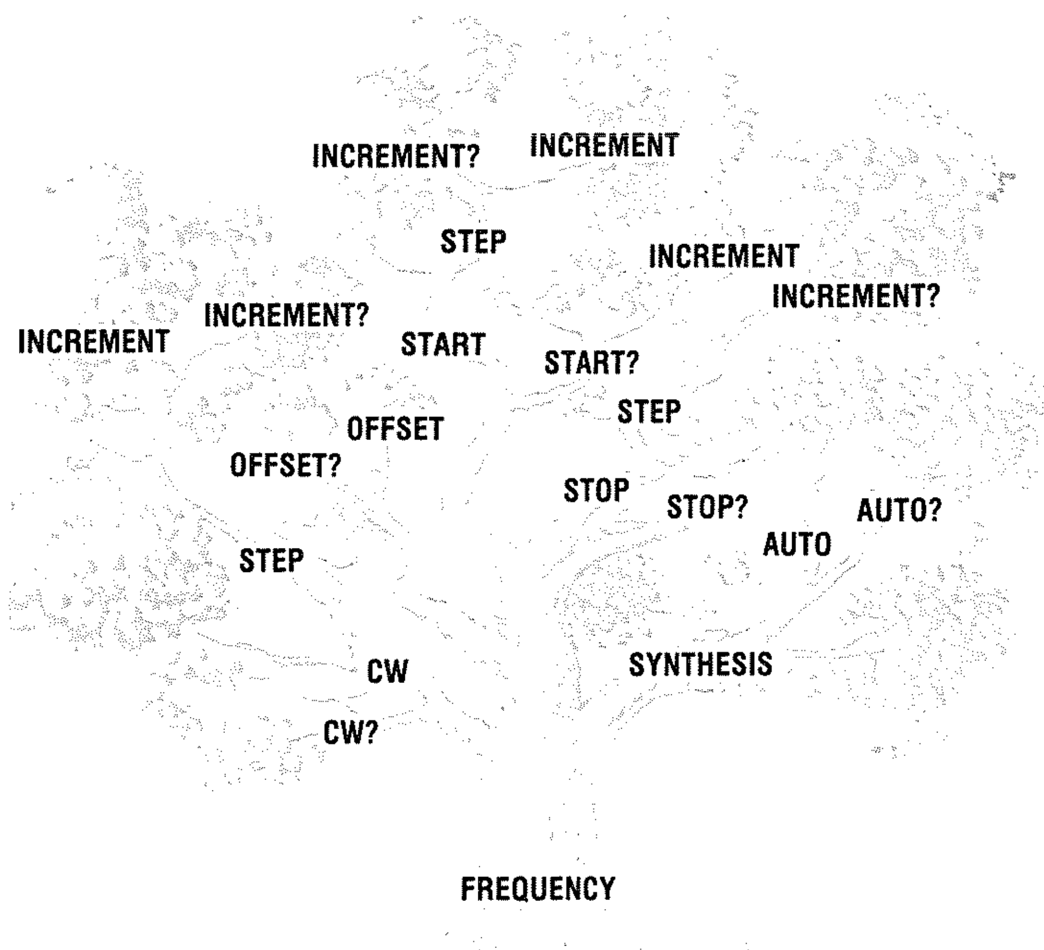


Figure 4–2. Expanding the Detail of Tree "A".

More about the Colon

The colon has another function in the command statement. It is used to connect segments of the same branch. For example, to set the HP 8644A at a frequency increment of 5 MHz, you could write the following command statement:

```
FREQUENCY:STEP:INCREMENT 5MHZ
```

Notice how the colon is used to connect one segment of the branch to the next. Also, the keyword "CW" was left out. You will find that HP-SL has optional keywords in its branches that may be kept in or left out depending upon your programming needs.

An important concept to understand with HP-SL is that only one input or output command may be put in a command statement. You could not have tried to change the RF output and set the frequency increment in the same command statement. To have more than one input or output command on the same line you must create a command message.

The HP-SL Semicolon

The semicolon " ; " is used to create a command message, and has two functions. It separates one command statement from another on the same line of code, and it backs the following command down the HP-SL hierarchy to the previous keyword.

You can see how the semicolon works by using two branches from the tree in figure 4–2. For example, to set an RF output of 175 MHz with the HP 8644A in Mode 2 frequency synthesis, you would write the following in HP-SL:

```
FREQUENCY 175MHZ;FREQUENCY:SYNTHESIS 2
```

In this case, the semicolon is simply used to separate one command statement from the other.

More about HP-SL Command Statements

There is no "one way" to program with HP-SL. You may write programs in HP-SL that reflect your style of programming. The previous example may have been written in a number of ways. For example:

```
FREQUENCY:CW 175MHZ;SYNTHESIS 2
```

In this case, notice how the semicolon is used not only to separate one command statement from the other, but also to back the command "SYNTHESIS" down to the previous colon in the HP-SL hierarchy.

The command statements shown so far have been lengthy. In the *Reference Information Section*, you will see that all statements can be written in a short form. For example, the previous command statement may be rewritten as follows:

```
FREQ:CW 175MHZ;SYNT 2
```

Remember

Command statements are not sequence dependent. A line of code may be written with the command statements placed in any order as long as you never have conflicting conditions in a command message.

A conflicting condition occurs when ambiguous command statements are found in the same command message. Turning FM on and then off, or setting the RF output frequency to one value and then to another value are examples of ambiguous command statements in the same command message.

The path for each command statement starts at the root and proceeds up the tree to the different branches. The previous command statement could be rewritten as:

```
FREQ:SYNT 2;CW 175MHZ.
```

Optional keywords may be ignored; use the colon and semicolon in the appropriate places, and have a space before command parameters.

Combining the HP-SL Semicolon and Colon

A special case exists when the semicolon and colon " ;: " are placed next to each other between command statements. This situation lets you start with another keyword at the root of any tree. By using the semicolon and colon sequence in the command statement, you may even string together operations from other trees.

For example, if you were to string an operation from another tree (say setting output amplitude to 10 dBm) to the previous command statement, you could do it as follows (in the short form):

```
FREQ:CW 175MHZ;SYNT 2;:AMPL 10DBM
```

Note

Never leave a space after a colon or you will get the following message:

```
Error\Space after colon
```

What Else do I Need to Know?

Always use the common command *RST (equivalent to instrument preset) on a separate line of code. If *RST is put on a line of code with other command statements, the other command statements would be ignored by the instrument preset.

You will need to initially rely upon the reference information contained in the remaining part of this chapter in order to complete your introduction to HP-SL programming. In time, you will find that the syntax and mnemonics used in HP-SL are predictable. Your reliance on the reference section will then be reduced.

It may be necessary for you to run some example programs to gain experience with HP-SL before attempting to write programs of you own. If this is true, refer to the following illustration found on the next page, and you will see where the example programs are located. All example programs are written in BASIC, however, you may use any programming language with HP-SL.

Note *Appendix D contains a list of any error messages you may receive while programming with HP-SL.*

Introduction to the Programming Reference Information

The remaining part of this chapter provides you with detailed reference information for programming the HP 8644A with HP-SL. HP-IB addressing, HP-IB capabilities, and data input/output information is available for all of you remote operating needs.

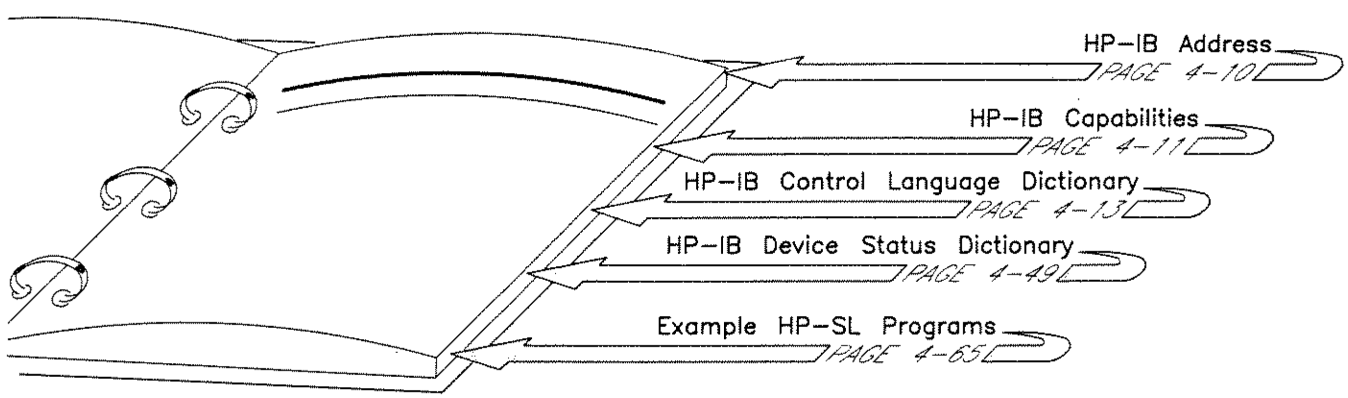
All data input/output operations are described in the *HP-IB Control Language Dictionary* and the *HP-IB Device Status Dictionary* sections. Helpful example programs are provided for your use at the end of these sections.

Use the following illustration shown below as your guide for each subject in this section. Turn to the subject you want; where it is appropriate, you will find a table of contents to give you an overview of the specific topics covered for that subject.

Note

Refer to appendix E for "HP-SL Quick Reference Information" once you become familiar with the information in the "HP-IB Control Language Dictionary".

Also, you may want to refer to the document "Tutorial Description of the Hewlett-Packard Interface Bus" HP Part Number 5952-0156 for detailed information about the HP-IB bus.



HP-IB Address

The HP-IB address for the HP 8644A is set at the factory to 19. You can display or change the HP-IB address at any time from the front panel. Any HP-IB address from 00 to 30 can be assigned.

The HP-IB address is stored in non-volatile memory, and remains valid through switching the Power from Standby to On and unplugging the ac power cord; performing a RAM wipe (Special Function 172) does not change the HP-IB address.

How to Display or Change the HP-IB Address

Display the HP-IB address:

1. If the yellow **REM** (remote) annunciator is turned on, press the **LOCAL** key to put the HP 8644A into Local operation. All front panel keys (except for the Power switch and the **LOCAL** key) are inoperative when the HP 8644A is in Remote operation.
2. Press the blue **SHIFT** key, and then the **ADRS** key. You will see the following in the FREQUENCY/STATUS display:

```
HP-IB Address = 19
```

Change the HP-IB address:

3. Select a new HP-IB address from 00 to 30, and press the **ENTER** key. The new HP-IB address should then be displayed.
4. Press the **FREQ** key to clear the HP-IB address off of the front-panel display. Then, re-display the HP-IB address to verify the new HP-IB address.

HP-IB Capabilities

The HP 8644A Synthesized Signal Generator is designed to be compatible with a controller that interfaces in terms of the 14 bus messages summarized in table 4-1. This table describes each of the interface functions available as defined by the IEEE Standard 488 and the identical ANSI Standard MC1.1.

When the HP 8644A is in the remote mode (the front-panel **REM** annunciator lights up), all front-panel controls are disabled except the **POWER** switch, and the **LOCAL** key (the **LOCAL** key can be disabled by configuring the HP 8644A in Local Lockout over HP-IB).

Table 4-1. HP-IB Capability Reference Table. (1 of 2)

HP-IB Capability	Applicable	Response	Related Commands and Controls*	Interface Functions*
Talker/ Listener	Yes	All Signal Generator functions with the exception of Knob control are programmable over HP-IB. The Signal Generator can send query responses and status information. The front-panel annunciators (TALK, REM, LSTN, SRQ) show the Signal Generator's current HP-IB state.	MLA MTA EOI	AH1 SH1 T6 L4
Trigger	No	The Signal Generator does not have a device trigger capability.	GET	DT0
Clear	Yes	The Signal Generator responds equally to DCL and SDC bus commands. The Clear capability does not reset instrument parameters.	DCL SDC	DC1
Remote	Yes	The Signal Generator's remote mode is enabled when the REN bus line is true. However, it remains in local (that is, the keyboard is active) until it is first addressed to listen. The output signal is unchanged when the Signal Generator enters remote mode. The front-panel RMT annunciator turns on when in remote mode.	REN MLA	RL1
Local	Yes	The Signal Generator returns to front-panel control when it enters local mode. The output signal is unchanged. Responds either to the GTL bus command or the front-panel Local key. The LOCAL key will not work if the instrument is in the LOCAL LOCKOUT state.	GTL	RL1

* 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 fourteen HP-IB messages shown in the left column.

Table 4–1. HP-IB Capability Reference Table. (2 of 2)

HP-IB Capability	Applicable	Response	Related Commands and Controls*	Interface Functions*
Local Lockout	Yes	The LOCAL key is disabled during Local Lockout so that only the controller or the POWER switch can return the Signal Generator to Local.	LLO	RL1
Clear Lockout/ Set Local	Yes	The Signal Generator returns to Local and Local Lockout is no longer true when the REN bus line goes false.	$\overline{REN}$	RL1
Pass Control/ Take Control	No	The Signal Generator cannot take control of HP-IB.	ATN IFC	C0
Request Service	Yes	The Signal Generator sets the SRQ bus line true if there is an unmasked bit in the status byte.	SRQ	SR1
Abort	Yes	The Signal Generator stops talking or listening.	IFC	T6 L4
Status Byte	Yes	The Signal Generator responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte when addressed to talk. Bit 6 (RQS bit) is true if the Signal Generator has sent the Service Request Message. Each bit requires different conditions for clearing.	SPE SPD MTA	T6
Status Bit	No	The Signal Generator does not respond to a parallel poll.	ATN EOI	PP0
Extended Talker/ Listener	No	The Signal Generator does not have secondary addressing capabilities for talking or listening.	MSA	TE0 LE0
Driver Electronics	Yes	The Signal Generator uses tri-state electrical drivers.	None	E2

* 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 fourteen HP-IB messages shown in the left column.

HP-IB Control Language Dictionary

All IEEE 488.2 common commands, and HP-SL commands are contained in the control language dictionary. All devices that comply with the IEEE 488.2 standard must have a set of common commands. The requirement of having common commands guarantees that all devices will have a minimum set of capabilities to permit programmers to write code that will work with all devices.

Before you proceed to use the dictionary, please read the HP-SL notes starting on the next page. The notes provide you with essential information and directions for using the dictionary.

The dictionary is alphabetically arranged by subsystems. A table of contents for all subsystems is as follows:

Table of Contents

HP-SL Notes

The entire dictionary is for use with the IEEE 488.2 standard.

All HP-SL entries in the dictionary are written in either uppercase or lowercase letters. Also, all entries are shown in either **bold** or *italics* typeface. The following notes explain why.

Any HP-SL entries in the dictionary that are written in *italics* are commands which allow you to set or query parameters which have only one accepted value, or are commands that cause an event which has no useful effect on the HP 8644A, or are commands that are aliases to another. In any case, the commands are accepted for purposes of HP-SL compatibility.

All HP-SL entries in the dictionary show the "short form" of the command in uppercase letters. The "long form" of the command includes both the uppercase and lowercase letters. For example, the keyword "frequency" is listed as "FREQuency". This indicates that "FREQ" is all that is required to execute this command. You could even have "FrEq" as the command since case is ignored.

Command messages sent to the HP 8644A must be terminated by a linefeed character (ASCII character 10) or EOI on the last character.

Commands statements must be separated by a semicolon. The keywords within the command message are separated by colons. Refer to the first part of this chapter for details about the HP-SL colon and semicolon.

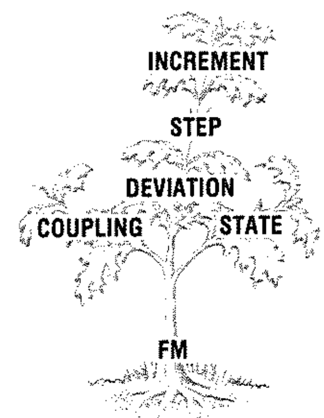
All HP-SL entries in the dictionary that are enclosed in square brackets " [ ] "are considered optional keywords. The optional keywords are assumed by default and may be omitted.

HP-SL Notes (Continued)

Where MINimum and MAXimum are listed as command parameters, they will set that function to its specified minimum or maximum value. For example, the command statement "FREQ MAX" will set the standard HP 8644A to 1030 MHz. MINimum and MAXimum may also be coupled to a subsystem state. For example, if FM is off, FM? MAX is not limited by the RF Frequency and would be 10 MHz. But if FM is on, FM? MAX is reduced by the active synthesis mode and may be less than 10 MHz.

All HP-SL entries in the dictionary are arranged in a manner that explicitly defines its hierarchy in the tree structure. The keyword at the root is located at the extreme left, branching from the root is indicated by indentation. For example, a portion of the FM subsystem command tree is as follows:

```
FM
    [:DEViation]
        :STEP
            [:INCRement]
    :STATe
    :COUPling
```



The following command statements and messages can be derived from this portion of the FM subsystem command tree. You will notice that several of the command statements are aliases for each other due to implicit couplings of optional keywords.

```
FM
FM:DEViation
FM:DEViation:STEP
FM:DEViation:STEP:INCRement
FM:STEP
FM:STEP:INCRement
FM:STATe
FM:COUPling
```

Any command message whose first character is an asterisk (such as *CLS) is treated as though the leading asterisk were a colon. For example, "FM:SOURce EXTernal;*CLS" is interpreted as "FM:SOURce EXTernal" and "*CLS".

HP-SL Notes (Continued)

When you query a command which has mnemonic settings, like GROund or INTernal, the shortform version will be returned. For example, after setting "AM:COUPling" to "GRO","GROUND", or "GND" the response from a query would always be "GRO".

To read instrument settings over HP-IB, send the query form of the command statement with the correct syntax as specified with a "?" in the dictionary, and address the HP 8644A to talk.

Phase Modulation "ΦM" will be referred to as PM in the dictionary.

<AM term>	When found in the dictionary, indicates that a "%" or "PCT" termination is required in the command statement. If no termination is specified, then a "% " value is assumed.
<ampl step term>	When found in the dictionary, indicates that a "dB", "V", "mV", "uV" termination is required in the command statement. If no termination is specified, then a "dB" value is assumed.
<ampl step unit>	When found in the dictionary, indicates that a "dB", or "V" termination must be specified in the command statement.
<ampl term>	When found in the dictionary, indicates that "dBm", "dBmW" ("dBmW" is alias for "dBm"), "dBuV", "V", "mV", "uV", or no termination is required in the command statement. If the command statement is not terminated, then "AMPLitude:UNIT" is assumed, except on "STEP" in which case "AMPLitude:STEP:UNIT" is assumed.
<ampl unit term>	When found in the dictionary, indicates that a "dBm", "dBmW", "V", or "dBuV" termination must be specified in the command statement.
<angle term>	When found in the dictionary, indicates that a "DEG", "RAD", or no termination must be specified in the command statement. If no termination is specified, then a "RAD" (radian) value is assumed.
<coupling type>	When found in the dictionary, indicates that sources "AC", "DC", "GROund", or "GND" are available.

HP-SL Notes (Continued)

<freq term>	When found in the dictionary, indicates that "HZ", "KHZ", "MHZ", "MAHZ", "GHZ", or no termination is required in the command statement. If the command statement is not terminated, then "HZ" is assumed.
<lin ampl term>	When found in the dictionary, indicates that "V", "mV", "uV", or no termination is required in the command statement. If the command statement is not terminated, then "V" is assumed.
<mod_type>	When found in the dictionary, indicates that "AM", "FM", "PM", or "PULSe" is required in the command statement.
<non-decimal numeric program data>	When found in the dictionary, indicates that the pound symbol "#" should be followed by either a "B" and a binary representation of a number, or "Q" and a octal representation of a number, or "H" and a hexadecimal representation of a number. For example, the number 943 could be represented as "B1110101111", or "Q1657", or "H3AF".
<nrf>	When found in the dictionary, indicates that an ASCII representation of a number is required in the command statement. The number may be integer or floating-point, and may include a decimal exponent. (nrf stands for – flexible numeric representation – for further information, refer to the IEEE 488.2 standard.)
<ohms term>	When found in the dictionary, indicates that an "OHM", "KOHM", "MOHM" or no termination is required in the command statement. If the command statement is not terminated, "OHM" is assumed.
<source list>	When found in the dictionary, indicates that "INTernal", or "EXTernal", or more than one source separated by commas is required in the command statement. For example: "INTernal,EXTernal" or "EXTernal,INTernal".
<time term>	When found in the dictionary, indicates that "S", "mS", "uS", "nS" or no termination is required in the command statement. If the command statement does not have a termination "S" (seconds) is assumed.

AM Subsystem

AM

[:DEPTh]? **[MINimum | MAXimum]**

[:DEPTh] **<nrf> [<AM term>] | UP | DOWN | MINimum | MAXimum**
Sets AM depth in percent. *RST value is 0%.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<AM term>] | MINimum | MAXimum**

Sets AM depth step size in percent. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1% .

:STATe?

:STATe **ON | OFF | 1 | 0**
Turns AM modulation ON or OFF. AM is not turned ON by just setting AM:DEPth. *RST value is OFF.

:SOURce?

:SOURce **<source list>**
Selects AM source: "EXTernal" or "INTernal". *RST value is INTernal.

:COUPling?

:COUPling **<coupling type>**
Set source coupling for AM. GROund coupling is equivalent to having NONE displayed on the front panel; it does not turn AM OFF, but all sources are disconnected. *RST value is DC.

:FREQuency? *[MINimum | MAXimum]*

:FREQuency *<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum*
Alias to LFSource:FREQuency.

:STEP

[:INCRement]? *[MINimum | MAXimum]*

[:INCRement] *<nrf> [<freq term>] | MINimum | MAXimum*

Alias to LFSource:FREQuency:STEP.

Amplitude Subsystem

POWer may be used in place of AMPLitude as an alias. AMPLitude:OUT may be used in place of AMPLitude to specify front-panel output. AMPLitude:SOURce may be used in place of AMPLitude to refer to driving source voltage (EMF).

AMPLitude or POWer

[:OUT] or :SOURce

[:LEVel]? **[MINimum | MAXimum]**

[:LEVel] **<nrf> [<ampl term>] | UP | DOWN | MINimum | MAXimum**
Sets CW AMPLitude. LEVel is assumed if omitted in the command statement. *RST value is -137.0 dBm.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<ampl step term>] | MINimum | MAXimum**

Sets or queries the AMPLitude step size. MINimum/MAXimum refers to the smallest/largest programmable step size, not the allowed change. *RST value is 10 dB.

:UNIT?

:UNIT **<ampl step unit>**

Sets or queries the UNIT for amplitude steps. Allowable values of UNIT are V and dB.

If STEP:UNIT is specified as volts, an AMPLitude increment causes the amplitude to be stepped in volts regardless of AMPLitude:UNIT.

If STEP:UNIT is specified as dB, an AMPLitude increment causes the amplitude to be stepped in dB regardless of AMPLitude:UNIT. This allows operations such as setting level in volts and changing it in dB steps.

Setting AMPLitude:STEP with a UNIT suffix causes AMPLitude:STEP:UNIT to be set to dB or V based on the units sent. *RST value is dB.

:STATe?

:STATe **ON | OFF | 1 | 0**
Turns RF output ON or OFF. OFF disables the output. Setting LEVel does not turn this ON implicitly. *RST value is OFF.

:UNIT?

:UNIT **<ampl unit term>**

Specifies the units of AMPLitude for the HP 8644A. This command sets the implied UNIT for all parameters which have units of power or amplitude (except when the AMPLitude:STEP:UNIT command is sent). It is also used in a query response for these parameters.

If AMPLitude is set with a units suffix different than AMPLitude:UNIT, that UNIT is used in the command, but AMPLitude:UNIT is not changed. *RST is dBm.

:ULIMit? **[MINimum | MAXimum]**

:ULIMit **<nrf> [<ampl term>] | MINimum | MAXimum**

Sets MAXimum upper limit for AMPLitude. This command is equivalent to activating Special Function 103 from the front panel.

ULIMit is affected by POWer:GAIN in the same way as AMPLitude. If AMPLitude:ULIMit is set to less than AMPLitude, then AMPLitude is set to AMPLitude:ULIMit and an error is issued.

The MINimum value that can be set is 1 dB more than the minimum allowable amplitude setting. *RST value is 19.9 dBm.

:ATTenuation? **[MINimum | MAXimum]**

:ATTenuation **<nrf> [dB] | UP | DOWN | MINimum | MAXimum**

Sets or reads the value of the attenuator. This command is equivalent to activating Special Function 101 from the front panel.

Units are in dB of attenuation. Setting attenuation in dB sets POW:ATT:AUTO to OFF. Changing attenuation in dB changes the output level. *RST value is dependent on the option configuration, and is coupled to POWer:LEVel.

:STEP

[:INCRement]?

Reads the attenuator step size.

:AUTO?

:AUTO **ON | OFF | 1 | 0**

When set ON, the firmware will control the attenuators.

Turning it OFF, causes the attenuator range to hold to its present setting. This command is equivalent to activating Special Function 100 from the front panel. *RST value is ON.

:GAIN? **[MINimum | MAXimum]**

:GAIN **<nrf> [dB] | MINimum | MAXimum**

Adjusts displayed/entered power level. Changing the GAIN does not change the actual output level, but it does change the displayed values shown on the front panel. This command is equivalent to setting the amplitude offset, **AMPTD OFS**, from the front panel. *RST value is 0 dB.

:ALC

:BANDwidth

:AUTO?

:AUTO **ON | OFF | 1 | 0**

Enables or disables automatic selection of ALC bandwidth based on frequency and modulation. When OFF the widest ALC BANDwidth is forced. This command is equivalent to activating Special Function 104 from the front panel (in which case, off = narrowband and on = wideband). *RST value is ON.

:MUTing?

:MUTing **ON | OFF | 1 | 0**

The muting command is equivalent to activating Special Function 105 from the front panel.

Calibration Subsystem

CALibration

[:ALL]?
Performs an instrument self-calibration, and then returns an error code (an error code of "0" indicates no failures). Alias to *CAL?

:AMPLitude

:STATe?

:STATe **ON | OFF | 1 | 0**
Enables or disables the use of AMPLitude correction data. This command is equivalent to activating Special Function 102 from the front panel. *RST value is ON.

Diagnostic Subsystem

These command descriptions are detailed in the Service Diagnostics Manual (part number 08645-90024).

Display Subsystem

Front Panel display and annunciators may be blanked completely or in selective function groups.

DISPlay

:STATe?

:STATe **ON | OFF | 1 | 0**

:ANNotation

[:ALL]?

[:ALL] ***ON | OFF | 1 | 0***
Enables or disables the front-panel display. This command is equivalent to activating Special Function 191 from the front panel. *RST value is ON.

:FREQuency?

:FREQuency **ON | OFF | 1 | 0**
Enables or disables front-panel display of RF output frequency. This command is equivalent to activating Special Function 192 from the front panel. *RST value is ON.

:MODulation?

:MODulation **ON | OFF | 1 | 0**
Enables or disables front-panel display of modulation. This command is equivalent to activating Special Function 193 from the front panel. *RST value is ON.

:AMPLitude?

:AMPLitude **ON | OFF | 1 | 0**
Enables or disables front-panel display of amplitude. This command is equivalent to activating Special Function 195 from the front panel. *RST value is ON.

:LFSource?

:LFSource **ON | OFF | 1 | 0**
Enables or disables front-panel display of audio source. This command is equivalent to activating Special Function 194 from the front panel. *RST value is ON.

:RADix?

:RADix **US | EURopean**
When US (United States) is active, numbers shown on the front panel use a decimal to indicate the "ones" digit position. Commas are used to indicate thousands, millions, and so forth, positions.
When EURopean is active, the commas and decimals shown on the front panel are reversed. For example 123456789 Hz would be shown as 123,456,789.00 Hz in US mode and 123.456.789,00 Hz in EURopean.
This command affects the front-panel display only, all numbers sent over HP-IB must be sent in the US radix.
This command is equivalent to activating Special Function 196 from the front panel. *RST value is US.

FM Subsystem

The HP 8644A cannot do simultaneous FM and PM. If PM is on, and someone requests FM, the following will happen: FM is turned on, PM is turned off, and an error is displayed on the front panel.

FM

[:DEViation]? **[MINimum | MAXimum]**

[:DEViation] <nrf> **[<freq term>] | UP | DOWN | MINimum | MAXimum**
Set or query FM deviation. *RST value is 1 kHz.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] <nrf> **[<freq term>] | MINimum | MAXimum**

Set or query the step size for FM. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1 kHz.

:STATe?

:STATe ON | OFF | 1 | 0
Queries or turns FM ON or OFF. *RST value is OFF.

:SOURce?

:SOURce <source list>
Selects FM source: "INTernal", "EXTernal", or "INTernal,EXTernal". *RST value is INTernal.

:COUPling?

:COUPling <coupling type>
Sets or queries coupling for FM. GROund coupling is equivalent to having NONE displayed on the front panel; it does not turn FM OFF but disconnects all sources. *RST value is DC.

:PREemphasis

:STATe?

:STATe ON | OFF | 1 | 0
Enables or disables the use of a 750 μsec pre-emphasis on the FM modulating signals. This command is equivalent to activating Special Function 122 from the front panel. *RST value is ON.

:MODE?

:MODE LINear | DIGitized
Sets or queries true (LINear) or synthesized (DIGitized) FM. This command is equivalent to activating Special Function 120 from the front panel. *RST value is DIGitized.

:FREQuency? [MINimum | MAXimum]

:FREQuency <nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum
Alias to LFSource:FREQuency.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<freq term>] | MINimum | MAXimum
Alias to LFSource:FREQuency:STEP.

:DELay?

:DELay ON | OFF | 1 | 0
Enables or disables the FM Delay Equalizer circuitry. This command is equivalent to activating Special Function 124 from the front panel. *RST value is ON.

Frequency Subsystem

FREQuency

[:CW]? **[MINimum | MAXimum]**

[:CW] **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**
Set or query non-swept frequency. Does not disable SWEep. *RST value is 100 MHz.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<freq term>] | MINimum | MAXimum**

Sets STEP size for RF output frequency related commands (FREQuency, FREQuency:STARt, FREQuency:STOP, CENTer, SPAN, MARKer, MARKer2, MARKer3).

MINimum/MAXimum refers to the smallest/ largest programmable step size, not the smallest/largest allowed change. *RST value is 10 MHz.

:STARt? **[MINimum | MAXimum]**

:STARt **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**
Sets STARt frequency for a sweep. Does not enable SWEep. May change other SWEep parameters as listed in the following *"Rules for Couplings Between:"*. *RST value is 251,464.85 Hz.

:STEP

[:INCRement]? *[MINimum | MAXimum]*

[:INCRement] *<nrf> [<freq term>] | MINimum | MAXimum*

Alias to FREQuency:STEP.

:STOP? **[MINimum | MAXimum]**

:STOP **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**
Sets STOP frequency for a sweep. Does not enable SWEep. May change other SWEep parameters as listed in the following *"Rules for Couplings Between:"*. *RST value is 1030 MHz.

:STEP

[:INCRement]? *[MINimum | MAXimum]*

[:INCRement] *<nrf> [<freq term>] | MINIMUM | MAXIMUM*

Alias to FREQuency:STEP.

:CENTer? **[MINimum | MAXimum]**

:CENTer **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets CENTer frequency for a sweep. Does not enable SWEep. May change other SWEep parameters as listed in the following *"Rules for Couplings Between:"*. *RST value is (STARt+STOP)/2.

:STEP

[:INCRement]? *[MINimum | MAXimum]*

[:INCRement] *<nrf> [<freq term>] | MINimum | MAXimum*

Alias to FREQuency:STEP.

:SPAN? **[MINimum | MAXimum]**

:SPAN **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets frequency SPAN for a sweep. Does not enable SWEep. May change other SWEep parameters as listed in the following *"Rules for Couplings Between:"*. *RST value is STOP-STARt.

:STEP

[:INCRement]? *[MINimum | MAXimum]*

[:INCRement] *<nrf> [<freq term>] | MINimum | MAXimum*

Alias to FREQuency:STEP.

Rules for Couplings Between: FREQuency:STARt, FREQuency:STOP, FREQuency:CENTer, and FREQuency:SPAN

If only STARt is sent in the command message:

STOP	is unchanged
CENTer	is set to (STARt + STOP)/2
SPAN	is set to (STOP - STARt)

If only STOP is sent in the command message:

STARt	is unchanged
CENTer	is set to (STARt + STOP)/2
SPAN	is set to (STOP - STARt)

If only CENTer is set in the command message:

SPAN	is unchanged
STARt	is set to (CENTer - (SPAN/2))
STOP	is set to (CENTer + (SPAN/2))

If only SPAN is set in the command message:
CENTer is unchanged
STARt is set to (CENTer - (SPAN/2))
STOP is set to (CENTer + (SPAN/2))

If STARt and STOP are set in the same command message:
CENTer is set to (STARt + STOP)/2
SPAN is set to (STOP - STARt)

If STARt and CENTer are set in the same command message:
STOP is set to (STARt + 2(CENTer-STARt))
SPAN is set to 2(CENTer-STARt)

If STARt and SPAN are set in the same command message:
STOP is set to (STARt + SPAN)
CENTer is set to (STARt + (SPAN/2))

If STOP and CENTer are set in the same command message:
STARt is set to (STOP - 2(STOP-CENTer))
SPAN is set to 2(STOP-CENTer))

If STOP and SPAN are set in the same command message:
STARt is set to (STOP - SPAN)
CENTer is set to (STOP - (SPAN/2))

If CENTer and SPAN are set in the same command message:
STARt is set to (CENTer - (SPAN/2))
STOP is set to (CENTer + (SPAN/2))

If more than two of STARt, STOP, CENTer SPAN commands are sent in one statement, the last two sweep parameters modified will be used, as previously described in the *"Rules for Couplings Between:"* shown above. All changes to the other parameters will be ignored.

:MANual? [MINimum | MAXimum]

:MANual <nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum
Controls frequency during a manual sweep. Limits are FREQuency:STARt to FREQuency:STOP. *RST value is the same as FREQuency:STARt.

:OFFSet? [MINimum | MAXimum]

:OFFSet <nrf> [<freq term>] | MINimum | MAXimum
Sets a reference frequency for other absolute frequency settings in the HP 8644A (CW, STARt, STOP, but not FM or SPAN).
Changes the entered or displayed values, but does not change RF output frequency. *RST value is 0 Hz. The coupling equation is as follows:

Entered/Displayed Frequency = (Hardware Freq × Multiplier) + Offset

:MULTiplier? **[MINimum | MAXimum]**

:MULTiplier <nrf> **| MINimum | MAXimum**

Sets a reference multiplier for other frequency settings in the HP 8644A (CW, STARt, STOP, as well as FM and SPAN). This command is equivalent to activating Special Function 111 from the front panel.
This command changes the entered/displayed values, but does not actually change the RF output frequency.
Resolution for this command is integer values, or one over integer values (1/2, 1/3, 1/4 ...).
*RST value is 1.
The coupling equation is as follows:

Entered/Displayed Frequency = (Hardware Freq × Multiplier) + Offset

OR

Entered/Displayed Frequency = (Hardware Freq × Multiplier) in cases where offset is not to be used.

:SYNThesis?

:SYNThesis <nrf>

Sets synthesis mode for the HP 8644A. This command is equivalent to pressing one of the Synthesis Mode keys on the front panel.
Setting this value sets FREQuency:SYNThesis:AUTO to OFF. *RST value is dependent on the hardware configuration and Options installed.

:AUTO?

:AUTO **ON | OFF | 1 | 0**

Turning AUTO to ON, allows the firmware to select the synthesis mode. This command is equivalent to pressing the Synthesis Mode key AUTO on the front panel.
Turning AUTO to OFF, leaves the HP 8644A in its current synthesis mode. *RST value is ON.

:MODE?

:MODE **CW | SWEep**

Determines which commands control the frequency subsystem. If SWEep is selected, then the commands FREQ:STARt, STOP, CENTer, SPAN, and MANual control the frequency subsystem.
*RST value is CW.

:INSTantaneous?

Returns the instantaneous RF output frequency during DIGitized FM. This command is equivalent to activating Special Function 121 from the front panel.

Frequency Counter Subsystem

COUNter

:[FREQuency]?
Query for the currently measured frequency.

:RANGe?
Query for the currently set frequency range.

:RANGe <nrf> | UP | DOWN | MINimum | MAXimum
Sets the counter to a specific frequency measurement range where the entered "nrf" value is the upper limit of the selected range. The three ranges are:
20 Hz to 10 MHz, nrf value must be 10 MHz;
10 MHz to 640 MHz, nrf value must be 640 MHz;
640 MHz to 2 GHz, nrf value must be 2 GHz.
For example, for measuring frequencies between 20 Hz and 10 MHz, you must enter 10 MHz as the counter range value (nrf), otherwise the error message "Counter setting too low" is displayed.

:TIME?
Query for the currently set gate time.

:TIME <nrf> | UP | DOWN | MINimum | MAXimum
Sets the counter to measure frequencies within a specific, selectable "gate" time between .1 and 1.0 seconds.

:TRIGger?
Query to see if the trigger is busy. 0 = NO, 1 = YES.

:TRIGger
Activates the Frequency Counter to make a measurement. Every time you want a new frequency measurement, you must trigger and query the instrument using the following commands:

COUNter:TRIGger
COUNter:[FREQuency]?

HP-SL System Commands

SYSTem

:ERRor? **[NUMeric | STRing]**

Reads an error from the system error queue. Returns a zero if the queue is empty. If SYSTem:ERRor? or SYSTem:ERRor? NUMeric is used, the HP 8644A returns only a number as described in the table shown below. If SYSTem:ERRor? STRing is used, the HP 8644A returns a number followed by a comma, and a quoted string containing a standard generic error message, a colon, and a specific error message.

Numeric	Error Message	Numeric	Error Message
100	Command Error	211	Legal Command but Settings Conflict
101	Invalid Character Received	212	Argument out of Range
110	Command Header Error	222	Insufficient Capability or Configuration
111	Header Delimiter Error	232	Output Buffer Full or Overflow
120	Numeric Argument Error	300	Device Failure
121	Wrong Data Type (Numeric Expected)	310	RAM Error
123	Numeric Overflow	311	RAM Failure
129	Missing Numeric Argument	312	RAM Data Loss
130	Non Numeric Argument Error	313	Calibration Data Loss
131	Wrong Data Type (Char Expected)	320	ROM Error
132	Wrong Data Type (String Expected)	321	ROM Checksum
133	Wrong Data Type (Block Type #D Required)	322	Hardware and Firmware Incompatible
139	Missing Non Numeric Argument	330	Power on Test Failed
142	Too Many Arguments	340	Self Test Failed
143	Argument Delimiter Error	400	Query Error
144	Invalid Message Unit Delimiter	410	Query Interrupted
200	No Can Do	420	Query Unterminated
201	Not Executable in Local Mode	422	Addressed to Talk with Nothing to Say
202	Settings Lost Due to RTL* or PON*	430	Query Deadlocked

* Return to Local (RTL) or Power On (PON).

For example, if an attempt is made to set the frequency to a value higher than is possible, SYSTem:ERRor? would return: −212 which is an argument out of range error. Under the same conditions a SYSTem:ERRor? STRing query would return: −212,"ARGUMENT OUT OF RANGE:FREQUENCY TOO HIGH" Refer to appendix D for a descriptive list of all error messages.

:STATe

:CALL

This event causes all save/recall registers to be cleared.

:SECurity?

:SECurity **ON | OFF | 1 | 0**

Controls the security mode of the HP 8644A. This command is equivalent to activating Special Function 173 from the front panel. When in the secure mode, any display annunciators which have been disabled cannot be re-enabled. This value is not affected by *RST or *RCL. This value is not effected by power cycles unless memory is lost during power down. When this value is switched from ON to OFF, all memory in the HP 8644A is erased when the equivalent of Special Function 172 (RAM Wipe) is performed.

IEEE 488.2 Common commands

***CAL? Self calibration query**

Causes the HP 8644A to perform an internal self-calibration and returns an integer error code. An error code of zero indicates no failures, other numbers indicate some error. A list of specific error codes are defined in the Service Diagnostics Manual (part number 08645-90024). This command is equivalent to activating Special Function 171 from the front panel.

***CLS Clear status command**

Clears the status register and associated status data structures summarized in the Status Byte, such as the Event Status Register. Clears output and error queues. Clears all event registers.

***ESE <nrf> <non-decimal numeric program data> Event status enable command**

Sets the Standard Event Status Enable Register. A more detailed description of the status reporting is included in the *"HP-IB Device Status Dictionary"*.

***ESE? Event status enable query**

Queries the Standard Event Status Enable Register. A more detailed description of the status reporting is included in the *"HP-IB Device Status Dictionary"*.

***ESR? Event status register query**

Queries the Standard Event Status Register. A more detailed description of the status reporting is included in the *"HP-IB Device Status Dictionary"*.

***IDN? Identification query**

Returns an identification string which is 4 fields separated by commas.

Field 1 : Is always HEWLETT-PACKARD.
Field 2 : Is model number like 8644A.
Field 3 : Is a serial number in HP format e.g. 2419A00873 or a 0 if the serial number is unknown (Equivalent to activating Special Function 190).
Field 4 : Is the firmware version number.
For example: HEWLETT-PACKARD,8644A,2813A09875,REV 1.0.0

***OPC Operation complete command**

Will cause the OPC bit to be set in the standard event status register when a sweep or learn operation is complete. Since the bus is released before a sweep or learn is completed, you may re-synchronize after these operations are complete.

***OPC? Operation complete query**

Will cause an ASCII 1 to be returned when a sweep or learn operation is complete. Since the bus is released before a sweep or learn is completed, you may re-synchronize after these operations are complete.

***IDN? Identification query**

Returns an identification string which is 4 fields separated by commas.

Field 1 : Is always HEWLETT-PACKARD.

Field 2 : Is model number like 8644A.

Field 3 : Is a serial number in HP format e.g. 2419A00873 or a 0 if the serial number is unknown (Equivalent to activating Special Function 190).

Field 4 : Is the firmware version number.

For example: HEWLETT-PACKARD,8644A,2813A09875,REV 1.0.0

***OPC Operation complete command**

Will cause the OPC bit to be set in the standard event status register when a sweep or learn operation is complete. Since the bus is released before a sweep or learn is completed, you may re-synchronize after these operations are complete.

***OPC? Operation complete query**

Will cause an ASCII 1 to be returned when a sweep or learn operation is complete. Since the bus is released before a sweep or learn is completed, you may re-synchronize after these operations are complete.

***OPT? Option query**

Identifies reportable options in current instrument configuration. Each option is indicated by a mnemonic and multiple reportable options are separated by commas. If the HP 8644A has no reportable options in place, the option query returns a zero. For example, "DOUBLER" refers to Option 002, 2 GHz Doubled Output; "COMM_DISCR" refers to Option 004, Enhanced Spectral Purity; "SYNTH_AUDIO" refers to Option 007, Synthesized Audio Oscillator; "ELEC_ATTEN" refers to Option 005, Electronic Attenuator.

***RST Reset command**

Causes the HP 8644A to do an instrument preset. Sets all operating parameters to the known states listed in this Dictionary. It does not effect the status reporting information, nor does it clear the error or message queue, and does not affect the contents of the 50 storage registers.

The *RST command must be put on a separate line of code.

***SAV <nrf> Save instrument state**

Saves the instrument state in the specified register number. The HP 8644A has 50 available storage registers. The first ten registers (0-9) accepts all front panel settings (except for some Special Functions). The next forty registers (10-49) accepts only frequency and amplitude settings.

***SRE <nrf> <non-decimal numeric program data> Service request enable command**

Sets the Service Request Enable Register. A more detailed description of the status reporting is included in the *"HP-IB Device Status Dictionary"*.

***SRE? Service request enable query**

Queries the Service Request Enable Register. A more detailed description of the status reporting is included in the *"HP-IB Device Status Dictionary"*.

***STB? Read status byte query**

Sets or queries the HP-IB Status Byte. A more detailed description of the status reporting is included in the *"HP-IB Device Status Dictionary"*.

***RCL <nrf> Recall instrument state**

Recalls the instrument state which was stored in the specified register number. The HP 8644A has 50 available storage registers. The first ten registers (0–9) accepts all front panel settings (except for some Special Functions). The next forty registers (10–49) accepts only frequency and amplitude settings.

***TST? Self-test query**

Causes the HP 8644A to perform internal instrument level diagnostics and returns an integer error code. An error code of zero indicates no failures, other numbers indicate some error. A list of specific error codes are defined in the Service Diagnostics Manual (part number 08645-90024). This command is equivalent to activating Special Function 170 from the front panel.

***WAI Wait-to-continue command**

Causes the HP 8644A to not accept any further input or output between the end of the message containing *WAI, and the completion of all command processing for that message.

Initialize Subsystem

INITialize

:STATe?

:STATe **PAUSe | RUN**

Returns PAUSe or RUN to determines if the HP 8644A is actually sweeping or idle. This parameter only has meaning when FREQuency:MODE is SWEep, and when SWEep:MODE is AUTO. *RST value is PAUSe.

:MODE?

:MODE **CONTinuous | SINGle**

Determines if the HP 8644A is performing single sweep or continuous sweep. After a single SWEep is done, INITialize:STATe becomes PAUSe, and an INITialize command is required to restart the SWEep. *RST value is CONTinuous.

:ABORt

Aborts any current sweep. Sets INITialize:STATe to PAUSe.

[:IMMediate]

Sets INITialize:STATe to RUN, and starts a single SWEep or a continuous SWEep. If a SWEep is already in progress, it is aborted and restarted.

LF Source Subsystem

LFSource

[:FREQuency]? **[MINimum | MAXimum]**

[:FREQuency] **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets frequency of the audio source. This command is equivalent to the command <mod_type>:FREQ. *RST value is 1 kHz.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<freq term>] | MINimum | MAXimum**

Sets the step size for the audio source. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 100 Hz.

:STATe?

:STATe ON | OFF | 1 | 0

Turns the LF source ON or OFF. Setting the frequency or level for the LF does not by itself turn the source ON.

Any attempt to turn LFSource:STATe OFF while any <mod_type>'s STATe is ON, and its SOURce includes INTernal will result in an error. In other words, the HP 8644A will not turn off the LFSource while it is being used for modulation. *RST value is OFF.

:WAVeform?

:WAVeform SINe | SQUare | TRIangle | SAWTooth | WGNoise

Selects a waveform for the LF Source: SINe, SQUare, TRIangle, SAWTooth or White Gaussian Noise (WGNoise) is available if the HP 8644A is equipped with Option 007. This command is equivalent to activating Special Function 130 from the front panel. *RST value is SINe.

:LEVel? [MINimum | MAXimum]

:LEVel <nrf> [<lin ampl term>] | UP | DOWN | MINimum | MAXimum

Sets level of the audio source in volts. *RST value is 2 V.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<lin ampl term>] | MINimum | MAXimum

Sets the LFSource:LEVel step size. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/ largest allowed change. *RST value is 0.1 V.

:TRIGger

[:IMMediate]

Causes a one-shot trigger of the LFSource if SOURce is set to EXT. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 132 with 131 turned ON, from the front panel.

:SOURce?

:SOURce EXTernal | CONTinuous

Defines whether the LFSource is continuous or triggered by an external transition. This command is equivalent to activating Special Function 131 from the front panel. In which case, ON would be EXTernal and OFF would be CONTinuous. *RST value is CONTinuous.

:FREQuency2? **[MINimum | MAXimum]**

:FREQuency2 **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets the frequency of the audio source in Channel 2. This command is available on an HP 8644A equipped with Option 007 and is equivalent to setting frequency for the second audio source with Special Function 133 turned ON. *RST value is 400 Hz.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<freq term>] | MINimum | MAXimum**

Sets the LFSource:FREQuency2 step size for the audio source in Channel 2. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 100 Hz.

:WAVeform2?

:WAVeform2 **SIN | SQUare | TRIangle | SAWTooth | WGNoise**

Selects a waveform for the audio source in Channel 2: SINe, SQUare, TRIangle, SAWTooth or White Gaussian Noise (WGNoise) is available if the HP 8644A is equipped with Option 007. This command is equivalent to activating Special Function 135 from the front panel. *RST value is SINe.

:STATe2?

:STATe2 **ON | OFF | 1 | 0**

Turns the audio source in Channel 2 either ON or OFF if you have an HP 8644A equipped with Option 007. Setting the frequency or level does not by itself turn the audio source in Channel 2 ON. This command is equivalent to activating Special Function 133 from the front panel. *RST value is OFF.

:LEVel2? **[MINimum | MAXimum]**

:LEVel2 **<nrf> [<lin ampl term>] | UP | DOWN | MINimum | MAXimum**

Sets the level of the audio source in Channel 2. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 134 from the front panel. *RST value is 100 mV.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<lin ampl term>] | MINimum | MAXimum**

Sets the LFSource:LEVel2 step size for the audio source in Channel 2. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 100 mV.

:PHASe2

[:ADJust]? [MINimum | MAXimum]

[:ADJust] <nrf> [<angle term>] | UP | DOWN | MINimum | MAXimum

Adjusts the phase of the audio source in Channel 2 in terms of degrees or radians. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 136 from the front panel. *RST value is 0°.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<angle term>] | MINimum | MAXimum

Sets the LFSource:PHASe2 step size for the audio source in Channel 2 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1°(0.017 radians).

:AM

[:DEPTh]? [MINimum | MAXimum]

[:DEPTh] <nrf> [<am term>] | UP | DOWN | MINimum | MAXimum

Sets the percentage of AM depth applied to the audio source in Channel 1. This command is available on an HP 8644A equipped with Option 007, and is equivalent to setting AM depth on the sub-carrier with Special Function 137 turned ON. *RST value is 0%.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<am term>] | MINimum | MAXimum

Sets the LFSource:AM:DEPTh step size for the AM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1%.

:STATe?

:STATe ON | OFF | 1 | 0

Turns the AM source in Channel 1 either ON or OFF if you have an HP 8644A equipped with Option 007. Setting AM frequency or depth does not by itself turn the AM source in Channel 1 ON. This command is equivalent to activating Special Function 137 from the front panel. *RST value is OFF.

:FREQuency? **[MINimum | MAXimum]**

:FREQuency **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets the frequency rate for the AM source in Channel 1. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 138 from the front panel. *RST value is 100 Hz.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<freq term>] | MINimum | MAXimum**

Sets the LFSource:AM:FREQuency step size for the AM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 100 Hz.

:WAVeform?

:WAVeform **SIN | SQUare | TRIangle | SAWTooth | WGNoise**

Selects a waveform for the AM source in Channel 1: SINe, SQUare, TRIangle, SAWTooth or White Gaussian Noise (WGNoise) is available if the HP 8644A is equipped with Option 007. This command is equivalent to activating Special Function 139 from the front panel. *RST value is SINe.

:PHASe

[:ADJust]? **[MINimum | MAXimum]**

[:ADJust] **<nrf> [<angle term>] | UP | DOWN | MINimum | MAXimum**

Adjusts the phase of the AM source in Channel 1 in terms of degrees or radians. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 140 from the front panel. *RST value is 0°.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<angle term>] | MINimum | MAXimum**

Sets the LFSource:AM:PHASe step size for the AM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1°(0.017 radians).

:FM

[:DEViation]? **[MINimum | MAXimum]**

[:DEViation] <nrf> **[<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets the percentage of FM deviation applied to the audio source in Channel 1. This command is available on an HP 8644A equipped with Option 007, and is equivalent to setting FM deviation on the sub-carrier with Special Function 141 turned ON. *RST value is 0 Hz.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] <nrf> **[<freq term>] | MINimum | MAXimum**

Sets the LFSource:FM:DEViation step size for the FM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 10 Hz.

:STATe?

:STATe **ON | OFF | 1 | 0**

Turns the FM source in Channel 1 either ON or OFF if you have an HP 8644A equipped with Option 007. Setting FM frequency or deviation does not by itself turn the FM source in Channel 1 ON. This command is equivalent to activating Special Function 141 from the front panel. *RST value is OFF.

:FREQuency? **[MINimum | MAXimum]**

:FREQuency <nrf> **[<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets the frequency rate for the FM source in Channel 1. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 142 from the front panel. *RST value is 100 Hz.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] <nrf> **[<freq term>] | MINimum | MAXimum**

Sets the LFSource:FM:FREQuency step size for the FM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 100 Hz.

:WAVeform?

:WAVeform **SIN | SQUare | TRIangle | SAWTooth | WGNoise**

Selects a waveform for the FM source in Channel 1: SINe, SQUare, TRIangle, SAWTooth or White Gaussian Noise (WGNoise) is available if the HP 8644A is equipped with Option 007. This command is equivalent to activating Special Function 143 from the front panel. *RST value is SINe.

:PHASe

[:ADJust]? **[MINimum | MAXimum]**

[:ADJust] **<nrf> [<angle term>] | UP | DOWN | MINimum | MAXimum**

Adjusts the phase of the FM source in Channel 1 in terms of degrees or radians. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 144 from the front panel. *RST value is 0°.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<angle term>] | MINimum | MAXimum**

Sets the LFSource:FM:PHASe step size for the FM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1°(0.017 radians).

:PM

[:DEViation]? **[MINimum | MAXimum]**

[:DEViation] **<nrf> [<angle term>] | UP | DOWN | MINimum | MAXimum**

Sets the percentage of ΦM deviation applied to the audio source in Channel 1. This command is available on an HP 8644A equipped with Option 007, and is equivalent to setting ΦM deviation on the sub-carrier with Special Function 145 turned ON. *RST value is 0°.

:STEP

[:INCRement]? **[MINimum | MAXimum]**

[:INCRement] **<nrf> [<angle term>] | MINimum | MAXimum**

Sets the LFSource:PM:DEViation step size for the ΦM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1°(0.017 radians).

:STATe?

:STATe ON | OFF | 1 | 0

Turns the ΦM source in Channel 1 either ON or OFF if you have an HP 8644A equipped with Option 007. Setting ΦM frequency or deviation does not by itself turn the ΦM source in Channel 1 ON. This command is equivalent to activating Special Function 145 from the front panel. *RST value is OFF.

:FREQuency? [MINimum | MAXimum]

:FREQuency <nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum

Sets the frequency rate for the ΦM source in Channel 1. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 146 from the front panel. *RST value is 100 Hz.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<freq term>] | MINimum | MAXimum

Sets the LFSource:PM:FREQuency step size for the ΦM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 100 Hz.

:WAVeform?

:WAVeform SIN | SQUare | TRIangle | SAWTooth | WGNoise

Selects a waveform for the ΦM source in Channel 1: SINe, SQUare, TRIangle, SAWTooth or White Gaussian Noise (WGNoise) is available if the HP 8644A is equipped with Option 007. This command is equivalent to activating Special Function 147 from the front panel. *RST value is SINe.

:PHASe

[:ADJust]? [MINimum | MAXimum]

[:ADJust] <nrf> [<angle term>] | UP | DOWN | MINimum | MAXimum

Adjusts the phase of the ΦM source in Channel 1 in terms of degrees or radians. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 148 from the front panel. *RST value is 0°.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<angle term>] | MINimum | MAXimum

Sets the LFSource:PM:PHASe step size for the ΦM source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1°(0.017 radians).

:PULSe

:STATe?

:STATe ON | OFF | 1 | 0

Turns the Pulse source in Channel 1 either ON or OFF if you have an HP 8644A equipped with Option 007. Setting Pulse frequency does not by itself turn the Pulse source in Channel 1 ON. This command is equivalent to activating Special Function 149 from the front panel. *RST value is OFF.

:FREQuency? [MINimum | MAXimum]

:FREQuency <nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum

Sets the frequency rate for the Pulse source in Channel 1. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 150 from the front panel. *RST value is 100 Hz.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<freq term>] | MINimum | MAXimum

Sets the LFSource:PULSe:FREQuency step size for the Pulse source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 100 Hz.

:PHASe

[:ADJust]? [MINimum | MAXimum]

[:ADJust] <nrf> [<angle term>] | UP | DOWN | MINimum | MAXimum

Adjusts the phase of the Pulse source in Channel 1 in terms of degrees or radians. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 151 from the front panel. *RST value is 0°.

:STEP

[:INCRement]? [MINimum | MAXimum]

[:INCRement] <nrf> [<angle term>] | MINimum | MAXimum

Sets the LFSource:PULSe:PHASe step size for the Pulse source in Channel 1 when the HP 8644A is equipped with Option 007. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1°(0.017 radians).

:AVIonics

:SETup

:VOR

Configures the instrument for VOR receiver testing. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 220 from the front panel.

:LOCalizer

Configures the instrument for Localizer receiver testing. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 221 from the front panel.

:GSLope

Configures the instrument for Guideslope receiver testing. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 222 from the front panel.

:OMBeacon

Configures the instrument for Outer Marker (OM) beacon testing. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 223 from the front panel.

:MMBeacon

Configures the instrument for Middle (MM) beacon testing. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 224 from the front panel.

:IMBeacon

Configures the instrument for Inner Marker (IM) beacon testing. This command is available on an HP 8644A equipped with Option 007, and is equivalent to activating Special Function 225 from the front panel.

Marker Subsystem

The HP 8644A firmware contains three markers. The behavior of each marker is identical, however, MARKer 1 has two references (that is, MARKer or MARKer1, MARKer2, and MARKer3).

MARKer or MARKer1 or MARKer2 or MARKer3

[:FREQuency]? **[MINimum | MAXimum]**

[:FREQuency] **<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum**

Sets frequency of selected marker. The marker may be set outside of the START and STOP frequency range, if so, the marker is not shown but is still considered active.
The markers will have the same offset and multiplier values as determined by FREQ:OFFSet and FREQ:MULT. *RST value is 251,464.85 Hz.

:STEP

Step size for the markers will always be in increments equal to FREQ:CW:STEP.

[:INCRement]? *[MINimum | MAXimum]*

[:INCRement] *<nrf> [<freq term>] | MINimum | MAXimum*

Alias to FREQuency:STEP.

:STATe?

:STATe **ON | OFF | 1 | 0**

Turns the specified marker ON or OFF. Marker state is not turned ON when the marker frequency is set. *RST condition is OFF.

:AOFF

Turns off all markers (this is the *RST condition). This command is accepted for any specific marker (MARK2:AOFF) but will still turns off all the markers. This command cannot be queried.

Modulation Subsystem

MODulation

:STATe?

:STATe **ON | OFF | 1 | 0**

The MODulation:STATe ON and MODulation:STATe OFF commands toggle on and off the modulation type (<mod_type>) that was previously selected. If the modulation is already on when the MODulation:STATe ON command is received, the command has no effect.
The command MODulation:STATe OFF turns off all modulation types, and turns LF-Source:STATe OFF.
The command MOD:STATe? will give the response "1" if any modulation state is on, and will give the response "0" if all modulation states are off. *RST causes the list of "previously active modulation types" to be FM.

Phase Modulation Subsystem

The HP 8644A cannot do simultaneous FM and PM. If FM is on, and someone requests PM, the following will happen: PM is turned on, FM is turned off, and an error displayed on the front panel.

PM

:STATe?

:STATe **ON | OFF | 1 | 0**
Turns PM ON or OFF. *RST value is OFF.

:SOURce?

:SOURce **<source list>**
Selects PM source: "INTernal", "EXTernal", or "INTernal,EXTernal". *RST value is INTernal.

:COUPling?

:COUPling **<coupling type>**
Set source coupling for FM. GROund coupling is equivalent to having NONE displayed on the front panel, it does not turn FM off, but disconnects all sources. *RST value is DC.

:FREQuency? *[MINimum | MAXimum]*

:FREQuency *<nrf> [<freq term>] | UP | DOWN | MINimum | MAXimum*
Alias to LFSource:FREQuency.

:STEP

[:INCRement]? *[MINimum | MAXimum]*

[:INCRement] *<nrf> [<freq term>] | MINimum | MAXimum*
Alias to LFSource:FREQuency:STEP.

Phase Subsystem

This subsystem allows you to increment or decrement the phase of the RF output signal in steps relative to the present frequency reference.

PHASe

[:ADJust]? **[MINimum | MAXimum]**

[:ADJust] **<nrf> [<angle term>] | UP | DOWN |MINimum | MAXimum**
Controls the phase offset value relative to the reference. This command is equivalent to activating Special Function 110 from the front panel. *RST value is 0.

:STEP

[INCRement]? **[MINimum | MAXimum]**

[INCRement] **<nrf> [<angle term>] | MINimum | MAXimum**

Controls the step size in degrees. MINimum/MAXimum refers to the smallest/largest programmable step size, not the smallest/largest allowed change. *RST value is 1°(0.017 radians). (NOTE - base unit for angle measurements is radians. All queries will be returned in radians).

:REFerence
This event resets the PHASe value to 0 without changing the actual PHASe of the HP 8644A. This means that any further references to PHASe will be considered to be relative to the PHASe at the time this command was last issued.

Power Meter Subsystem

PMETer

[:POWer]?
Queries the internal power meter. This command is equivalent to activating Special Function 182 from the front panel.

Pulse Subsystem

PULSe

[:STATe]?

[:STATe] **ON | OFF | 1 | 0**
Turns PULSe ON or OFF. *RST value is OFF.

:SOURce?

:SOURce **<source list>**
Selects the PULSe source. The only allowable value for the HP 8644A is EXTernal. INTernal,EXTernal or INTernal will cause execution errors. *RST value is EXTernal.

Reference Oscillator Subsystem

ROSCillator

:CALibration? **[MINimum | MAXimum]**

:CALibration **<nrf> | UP | DOWN | MINimum | MAXimum**
Adjusts frequency of internal reference oscillator. Values used to adjust the reference frequency are in the range of 0 to 255. A change in the value of "1" corresponds to about a 4 Hz change in the reference frequency. The value required to set the reference to exactly 10 MHz will vary from instrument to instrument. Value is returned to calibrated value at *RST. This command is equivalent to activating Special Function 160 from the front panel.

:STEP

[:INCRement]?

The reference oscillator calibration increment is always one. This command is included to meet an HP-SL requirement of allowing the step size to be queried on any value which can be stepped.

:SOURce?
A SOURCe? query returns the status of the current reference source (INT or EXT). The query command is equivalent to activating Special Function 161 from the front panel.

Sequence Subsystem

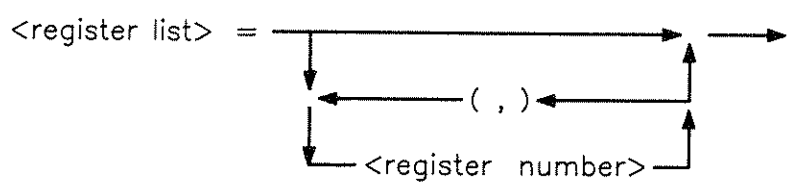
SEQuence

:REGister?

:REGister **<register list>**

Sets up a list of save/recall registers to step through. All registers are cleared from memory when you send the null list SEQuence:REGister. The REGister command sets up registers 0–9 only. The maximum sequence length is 10 registers. Sending any command statement or message over HP-IB aborts the Auto Sequence state.

The syntax used to generate a <register list> is:



<register number> = number of save/recall register

[:IMMediate]

Causes a step to the next register in the sequence list.

:STATe?

:STATe **ON | OFF | 1 | 0**

When ON, the HP 8644A automatically steps through the registers in the sequence list. The step time for each register is 1 second, except if a sweep sequence occurs (in which case the step time lasts for the duration of the sweep).

Status Subsystem

STATus

[:DEVice]

[:EVENt]?
Queries the Device Dependent Event Status Register.

:CONDition?
Queries the Device Dependent Condition Status Register.

:ENABle <nrf> | **<non-decimal numeric program data>**

:ENABle?
Sets or queries the Device Dependent Event Enable Register.

:PTRansition?
Queries the Device Dependent Positive Transition Filter. Always returns 65535.

:NTRansition?
Queries the Device Dependent Negative Transition Filter.
Always returns 0.

:DQUestionable

[:EVENt]?

Queries the HP-SL Signal Integrity Event Status Register.

:CONDition?

Queries the HP-SL Signal Integrity Condition Status Register.

:ENABle <nrf> | **<non-decimal numeric program data>**

:ENABle?

Sets or queries the HP-SL Signal Integrity Event Enable Register.

:PTRansition?

Queries the HP-SL Signal Integrity Positive Transition Filter. Always returns 65535.

:NTRansition?

Queries the HP-SL Signal Integrity Negative Transition Filter. Always returns 0.

:SINTegrity

[:EVENt]?

Queries the HP 8644A Signal Integrity Event Status Register.

:CONDition?

Queries the HP 8644A Signal Integrity Condition Status Register.

:ENABle <nrf> | **<non-decimal numeric program data>**

:ENABle?

Sets or queries the HP 8644A Signal Integrity Event Enable Register.

:PTRansition?

Queries the HP 8644A Signal Integrity Positive Transition Filter. Always returns 65535.

:NTRansition?

Queries the HP 8644A Signal Integrity Negative Transition Filter. Always returns 0.

:HARDware

[:EVENt]?

Queries the HP 8644A HARDware Integrity Event Status Register.

:CONDition?

Queries the HP 8644A HARDware Integrity Condition Status Register.

:ENABle <nrf> | **<non-decimal numeric program data>**

:ENABle?

Sets or queries the HP 8644A HARDware Integrity Event Enable Register.

:PTRansition?

Queries the HP 8644A HARDware Integrity Positive Transition Filter. Always returns 65535.

:NTRansition?

Queries the HP 8644A HARDware Integrity Negative Transition Filter. Always returns 0.

:AMPLitude

[:EVENt]?

Queries the AMPLitude Integrity Event Status Register.

:CONDition?

Queries the AMPLitude Integrity Condition Status Register.

:ENABle **<nrf> | <non-decimal numeric program data>**

:ENABle?

Sets or queries the AMPLitude Integrity Event Enable Register.

:PTRansition?

Queries the AMPLitude Integrity Positive Transition Filter. Always returns 65535.

:NTRansition?

Queries the AMPLitude Integrity Negative Transition Filter. Always returns 0.

:FREQuency

[:EVENt]?

Queries the FREQuency Integrity Event Status Register.

:CONDition?

Queries the FREQuency Integrity Condition Status Register.

:ENABle **<nrf> | <non-decimal numeric program data>**

:ENABle?

Sets or queries the FREQuency Integrity Event Enable Register.

:PTRansition?

Queries the FREQuency Integrity Positive Transition Filter. Always returns 65535.

:NTRansition?

Queries the FREQuency Integrity Negative Transition Filter. Always returns 0.

:REFerence

[:EVENt]?

Queries the REFerence Integrity Event Status Register.

:CONDition?

Queries the REFerence Integrity Condition Status Register.

:ENABle <nrf> | **<non-decimal numeric program data>**

:ENABle?

Sets or queries the REFerence Integrity Event Enable Register.

:PTRansition?

Queries the REFerence Integrity Positive Transition Filter. Always returns 65535.

:NTRansition?

Queries the REFerence Integrity Negative Transition Filter. Always returns 0.

:MODulation

[:EVENt]?

Queries the MODulation Integrity Event Status Register.

:CONDition?

Queries the MODulation Integrity Condition Status Register.

:ENABle <nrf> | **<non-decimal numeric program data>**

:ENABle?

Sets or queries the MODulation Integrity Event Enable Register.

:PTRansition?

Queries the MODulation Integrity Positive Transition Filter. Always returns 65535.

:NTRansition?

Queries the MODulation Integrity Negative Transition Filter. Always returns 0.

Sweep Subsystem

Other commands used with the sweep function are found in the Initialize Subsystem.

SWEep

[:FREQuency]

:TIME? **[MINimum | MAXimum]**

:TIME **<nrf> [<time term>] | UP | DOWN | MINimum | MAXimum**

Sets the sweep time. The commands UP and DOWN will step to the next/previous valid setting since the HP 8644A has 1, 2, 5, 10, 20, 50 ... steps on sweep time.
This command does not turn the SWEep ON. The command statements FREQ:MODE SWEep or INITialize:STATe RUN activate the SWEep. *RST value is 1 second.

:STEP

[:INCRement]?

Always returns 3. This indicates that the step on the sweep time is 3 steps per decade.

:MODE?

Always returns LOG. This indicates that the sweep time is stepped logarithmically.

:MODE?

:MODE **AUTO | MANual**

Selects sweep type. AUTO allows single or continuous sweeps, MANual allows control of frequency with FREQuency:MANual. *RST value is AUTO.

:SPACing?

:SPACing **LINear | LOGarithmic**

Selects LINear or LOGarithmic sweep. *RST value is LINear.

:GENeration?

:GENeration **STEPped | ANALog**

Selects STEPped, or phase continuous (ANALog) SWEep. This command is equivalent to activating Special Function 112 from the front panel. *RST value is STEPped.

Take Sweep Subsystem

TSWeep

Has the same effect as:

```
INIT:ABORt
SWE:MODE AUTO
FREQ:MODE SWEEP
INIT:MODE SINgle
INIT:IMMediate
```

This causes any sweep action to stop and a single sweep to take place.

Voltmeter Subsystem

VMETer

[:VOLTage]?
Uses the internal voltmeter to measure voltage at the rear panel voltmeter port.

:MODE?

:MODE AC | DC
Selects DC or AC (rms) measurement for voltmeter. This command is equivalent to activating Special Functions 180 or 181 from the front panel. *RST is DC.

HP-IB Device Status Dictionary

The HP 8644A has a great amount of status information available for your needs via the HP-IB bus. Unfortunately, the single 8 bit status byte register defined in the IEEE 488 standard is not large enough or flexible enough to contain the necessary information for an instrument with the complexity of the Synthesized Signal Generator. Consequently, the HP 8644A contains different levels of registers to overcome this limitation.

The new IEEE 488.2 standard, does however, expand the status byte definition to provide an extremely flexible mechanism for organizing status information. In addition, Hewlett Packard Systems Language (HP-SL) defines a portion of the 488.2 device status model in order to promote as much commonality as possible within various HP instruments. The *HP-IB Device Status Dictionary* describes in detail the HP 8644A implementation of the IEEE 488.2 standard, and HP-SL device status models.

To use the *HP-IB Device Status Dictionary*, refer to the table of contents shown below. All entries in the table of contents are arranged in an order of progressive dependency.

Figure 4–3 helps you understand how each set of registers are progressively dependent upon each other. For example, a bit in the HP-IB Status Byte Register "DEV" is dependent upon the status of bits in the Device Dependent Condition/Event Status Register, and so forth.

Table of Contents

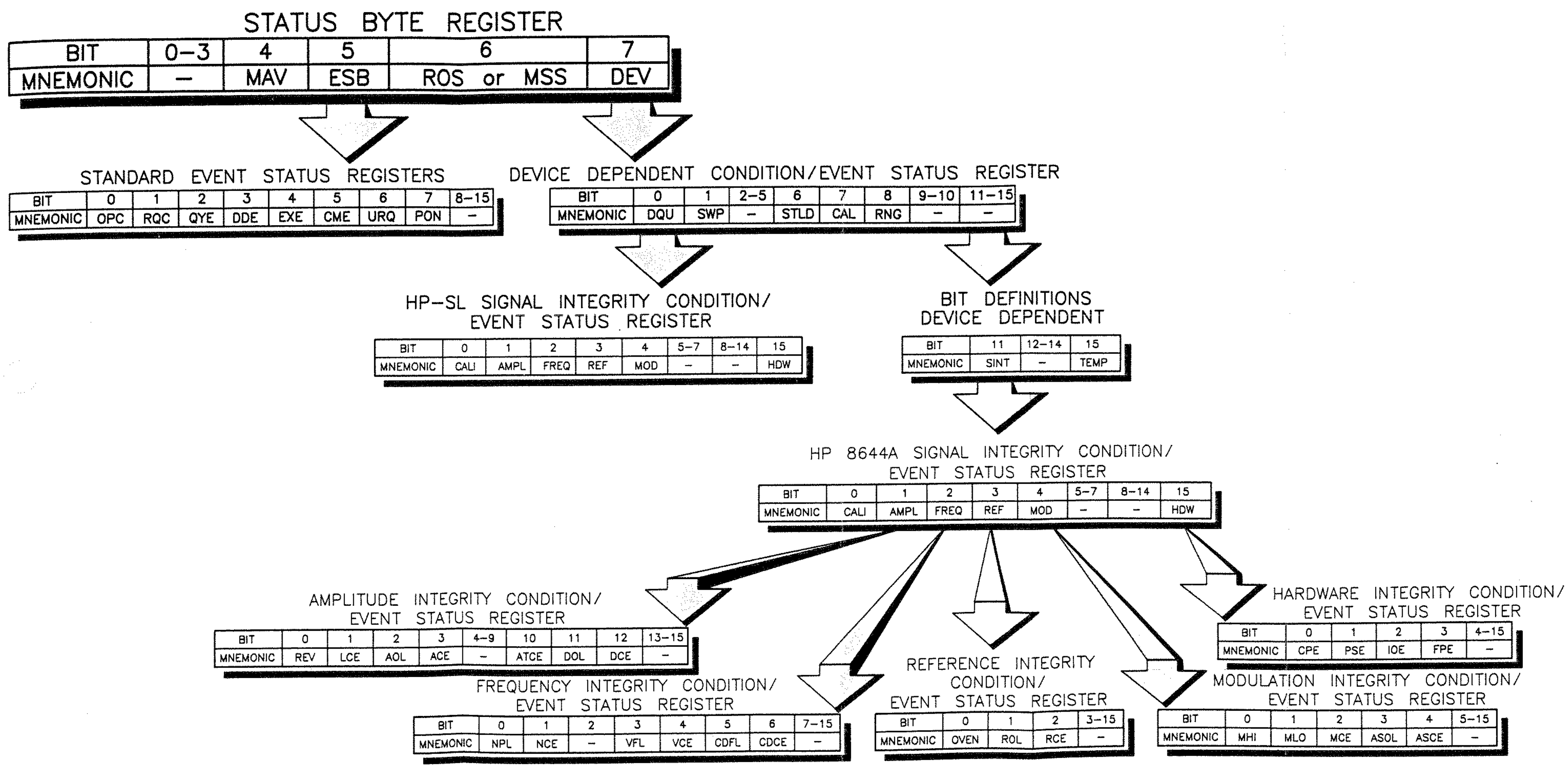


Figure 4-3. Register Map for the HP-SL Device Status Dictionary.

IEEE 488.2 Definitions

The full IEEE 488.2 and HP-SL specifications for device status reporting are beyond the scope of this document, but the following definitions taken from the IEEE 488.2 standard will be sufficient to explain the HP 8644A implementation.

Condition Register

A condition is a device state which is either TRUE or FALSE. A condition register reflects these states in its condition bits. A condition register may range from 1 to 16 bits in length and may contain unused bits. All unused bits are read as a value of zero. A condition bit may also be a summary bit, in which case it represents the status of an event register or a queue.

Event Register

An event register captures changes in conditions. Each bit in an event register corresponds to a condition bit in an associated condition register (or a device condition if there is no condition register).

An event becomes TRUE when there is a certain transition of the associated device condition. Event bits are "sticky" bits; they cannot be cleared (even if they no longer reflect the associated condition) until the event register is read by a user application.

An event register may range from 1 to 16 bits in length and may contain unused bits. All unused bits are read as a value of zero. An event register is cleared after it has been read by a user application and may also be cleared by the IEEE 488.2 *CLS common command.

Transition Filter

A transition filter defines the condition bit changes that set the associated event bit. There are two transition filters for every event register, a positive filter and a negative filter.

When a bit is set in a transition filter, the associated event bit is set after a FALSE to TRUE (positive filter) or TRUE to FALSE (negative filter) transition in the associated condition bit. If a bit is set in both transition filters then the event bit is set after any transition of the condition bit.

Transition filters may or may not be programmable, depending on the implementation. A transition register may range from 1 to 16 bits in length and may contain unused bits. All unused bits are read as a value of zero. A *RST command will reset programmable transition filters to their device dependent default values.

Event Enable Register

Event enable registers select which event bits in the corresponding event register will cause a TRUE summary message when set. Each event bit will have a corresponding enable bit in the event enable register. Each event enable register will be the same length as the corresponding event status register.

All unused bits are read as a value of zero and cannot be written to by the associated event enable command. Any time a bit in the event status register or the event enable register changes, a logical AND is performed on all bits of the event status register and the event enable register. If the result is not zero then the associated summary message is set TRUE.

Queue

A queue is a data structure containing a sequential list of data. Data may be placed in the queue in any order and a single item of data is removed every time the queue is read. A queue has a summary message that is TRUE whenever there is data in the queue and FALSE when the queue is empty.

The data in a queue may be in any format, but all data items must be in that same format. A queue may be cleared using the *CLS command (except for the IEEE 488.2 output queue).

Summary Bit

A summary bit is a condition bit that reflects the current status of the associated summary message. The summary message may be generated by the current values of an event status register and an event enable register or the contents of a queue.

Status Register Model

The diagram in figure 4–4 shows the relationship between the various components of a status register.

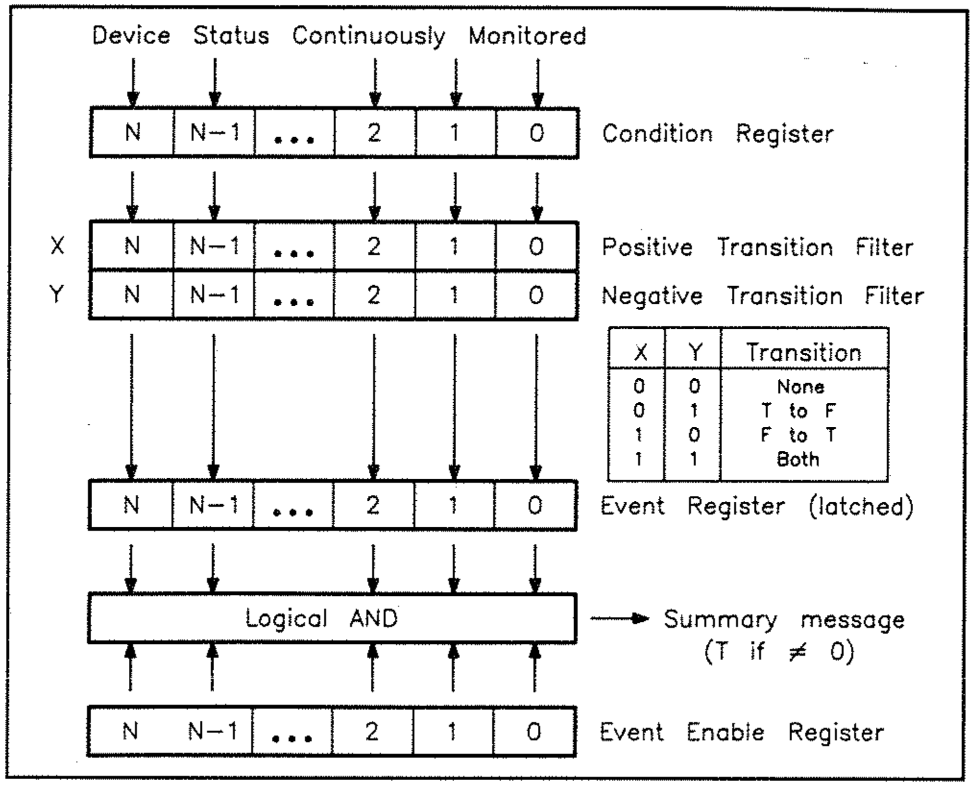


Figure 4–4. Status Register Map.

IEEE 488.2 HP-IB Status Byte Register

The IEEE 488.2 standard and HP-SL defines the 8 bit HP-IB status byte register as follows :

Table 4–1. Status Byte Register.

Bit #	Mnemonic	Definition
7	DEV	HP-SL device dependent event status register summary bit.
6	RQS or MSS	IEEE 488.2 master status summary bit.
5	ESB	IEEE 488.2 standard event status register summary bit.
4	MAV	IEEE 488.2 output queue summary bit.
0–3	-	Device dependent summary bits.

Device Dependent Summary Bits

Bits 0 through 3 are not defined in IEEE 488.2 or HP-SL and may be used as the device designer sees fit, as long as their use does not violate the IEEE 488.2 rules for summary bits. Bits 0 through 3 are not used in the HP 8644A implementation and will always be read as zero.

The status byte register is accessed using the *STB common command and *STB? common query or by performing a HP-IB serial poll operation.

MAV Summary Bit

Bit 4, the MAV (message available) summary bit indicates that there are characters in the instrument output queue. The output queue is read by addressing the instrument to talk and reading data bytes until a line feed character is sent with the EOI control line asserted.

A complete description of the behavior of the output queue is beyond the scope of the *HP-IB Device Status Dictionary*. Interested readers should refer to IEEE 488.2 for the complete definition and behavior of the output queue.

RQS and MSS Summary Bits

Bit 6 of the HP-IB status register has two definitions, depending on the method used to access the status register.

If the register is accessed via the HP-IB serial poll mechanism, then the bit is called the RQS (request service) bit and indicates to the active controller that the instrument is asserting the service request control line (SRQ). The RQS bit is cleared after the active controller performs a serial poll operation.

When the register is accessed via the IEEE 488.2 *STB? common query, the bit is called the MSS (master status summary) bit and indicates that the device has at least one reason for requesting service. Unlike the RQS bit, the MSS bit is not cleared as a result of a serial poll and will always reflect the current status of all of the instrument status registers.

IEEE 488.2 Service Request Enable Register

The service request enable register is an 8 bit register that enables corresponding summary bits in the status byte register. When a status bit is enabled and makes a FALSE to TRUE transition, the instrument will generate a service request.

A service request will also be generated when a status bit is enabled and the bit is already set. The service request enable register is accessed using the *SRE common command and the *SRE? common query. Bit 6 of the service request enable register is unused and will always be read as a zero. The service request enable register may be cleared when the instrument is turned on.

IEEE 488.2 Standard Event Status Register

The standard event status register is a 16 bit event register with the following bit definitions :

Table 4–2. Standard Event Status Register.

Bit #	Mnemonic	Definition
8–15	–	Reserved for future use by IEEE.
7	PON	Power on.
6	URQ	User request.
5	CME	Command error.
4	EXE	Execution error.
3	DDE	Device dependent error.
2	QYE	Query error.
1	RQC	Request control.
0	OPC	Operation complete.

The standard event status register is accessed using the *ESR common command and the *ESR? common query. Because this is an event register, the register is cleared after it is read.

Power On Bit

The power on event bit 7 is set TRUE whenever there has been an OFF to ON transition of the instrument power supply.

User Request Bit

The user request bit 6 is set whenever one of a set of device dependent local instrument controls is activated. At present this feature is not implemented in the HP 8644A firmware and the bit will always be read as a zero.

Command Error Bit

The command error bit 5 is set whenever the parser detects an error in the format or contents of a program message. The HP 8644A implementation will place an HP-SL defined error code in the HP-SL error queue that may specify the exact error (bad header, missing argument, wrong data type, etc.).

Execution Error Bit

The execution error bit 4 is set whenever the current command cannot be processed due to an out of range parameter, conflicting settings, etc. The HP 8644A implementation will place an HP-SL defined error code in the HP-SL error queue.

Device Dependent Error Bit

The device dependent error bit 3 is used to indicate an error that is neither a command error or an execution error. The HP 8644A implementation uses this bit to indicate a hardware failure. An HP-SL defined error code will be placed in the HP-SL error queue that may specify the exact error (self test failure, ROM CRC error, etc.).

Query Error Bit

The query error bit 2 indicates that there is a problem with the output queue. Either there has been an attempt to read the queue when it was empty or the output data has been lost. For a complete description of query errors consult the IEEE 488.2 standard.

Request Control Bit

The request control bit 1 is used to initiate the IEEE 488.2 pass control protocol. The feature is not implemented in the HP 8644A firmware and the bit will always be read as a zero.

Operation Complete Bit

The operation complete bit 0 is set in response to the *OPC common command and indicates that all overlapped commands have completed execution. The HP 8644A firmware supports frequency sweeping as an overlapped operation. For a complete description of the 'operation complete flag', consult the IEEE 488.2 standard.

Standard Event Status Enable Register

The standard event status enable register is a 16 bit register that allows one or more event bits in the standard event status register to be reflected in the ESB summary message in the HP-IB status byte. This register follows all the rules of an event enable register. The standard event status enable register is accessed using the *ESE common command and the *ESE? common query. The standard event status enable register may be cleared when the instrument is turned on.

HP-SL Device Dependent Condition/Event Status Registers

HP-SL defines a group of status registers used to contain device dependent status information. These registers include a condition register, an event register, two transition filters, and an enable register. Each register has the following bit definitions :

Table 4–3. Device Dependent Condition/Event Status Registers.

Bit #	Mnemonic	Definition
11–15	-	Device dependent.
9–10	–	Reserved for use by HP-SL language subset.
8	RNG	Autorange operation in progress.
7	CAL	Calibration in progress.
6	STLD	Signal is settled.
2–5	–	Reserved for future use by HP-SL.
1	SWP	A sweep cycle is in progress.
0	DQU	HP-SL signal integrity summary bit.

The commands used to access these registers are too complex to explain in the *HP-IB Device Status Dictionary*. Refer to *IEEE 488.2 and HP-SL Status Register Syntax* found later on in this chapter for a complete description of the status register syntax.

Device Dependent Bit Definitions.

The HP 8644A firmware defines the device dependent bits 11–15 in the *Device Dependent Condition/Event Status Register* as follows :

Table 4–4. Device Dependent Bit 11-15 Definitions.

Bit #	Mnemonic	Definition
15	TEMP	Temperature drift.
12–14	-	Reserved.
11	SINT	HP 8644A signal integrity summary bit.

Note

The programmer should be aware that in order to write fully transportable device status routines, only HP-SL mnemonics that do not use any device dependent status bits should be used.

Temperature Drift Bit

The temperature drift bit 15 is set when the internal instrument temperature has changed by more that 10°C since the last time the instrument was calibrated.

Signal Integrity Bit

The signal integrity summary bit 11 is described in detail later on in this chapter in the section titled *HP 8644A Signal Integrity Condition/Event Status Registers.*

Autorange Bit

The autorange bit 8 is set whenever the instrument halts the current measurement in order to automatically select the proper range. The HP 8644A firmware does not support any autorange operations and this bit will always be read as a zero.

Calibration Bit

The calibration bit 7 is set whenever the instrument is performing a calibration operation. Because the HP 8644A calibration is not an overlapped command, the condition register bit will always be read as a zero but the event register bit may be used to see if the instrument has been calibrated since the last time the event register was read.

Signal Settled Bit

The signal settled bit 6 is set when the output signal has settled to its final value. The HP 8644A firmware does not currently support this feature and this bit will always be read as a one.

Sweep in Progress Bit

The sweep in progress bit 1 is set whenever the instrument is in the sweep active state.

Data Questionable Bit

The data questionable bit 0 refers to the HP-SL signal integrity status registers in the following ways.

The HP-SL signal integrity status registers have the same bit definitions as the device dependent signal integrity registers with the following critical difference.

The HP-SL signal integrity condition status register bits are current device conditions, not summary bits. These device conditions are derived from the condition and enable registers associated with the corresponding summary bits in the device dependent signal integrity condition status register.

The HP 8644A firmware provides these two redundant registers so that novice programmers can follow the exact HP-SL model while expert programmers can expand the signal integrity condition bits to the full resolution of the instrument.

HP 8644A Signal Integrity Condition/Event Status Registers

The HP 8644A firmware defines a group of status registers used to contain information about the integrity of the output signal. These registers include a condition register, an event register, two transition filters, and an enable register. Each register has the following bit definitions :

Table 4-5. HP 8644A Signal Integrity Condition/Event Status Registers.

Bit #	Mnemonic	Definition
15	HDW	Misc. hardware integrity summary bit.
8-14	-	Reserved for future use.
5-7	-	Reserved for future use by HP-SL.
4	MOD	Modulation integrity summary bit.
3	REF	Reference integrity summary bit.
2	FREQ	Frequency integrity summary bit.
1	AMPL	Amplitude integrity summary bit.
0	CALI	Calibration integrity condition bit.

Note

Each of the summary bits in these registers refer to other groups of condition/event registers whose format is device dependent.

Hardware Integrity Summary Bit

The hardware integrity summary bit 15 indicates that there is some reason to suspect that the miscellaneous support hardware is not performing correctly. The HP 8644A firmware defines the hardware integrity condition/event register bits as follows :

Table 4-6. Hardware Integrity Summary Bit.

Bit #	Mnemonic	Definition
4-15	-	Reserved for future use.
3	FPE	Front panel hardware error.
2	IOE	I/O board hardware error.
1	PSE	Power supply error.
0	CPE	CPU hardware error.

Modulation Integrity Summary Bit

The modulation integrity summary bit 4 indicates that there is some reason to suspect that the modulation performance of the instrument is not correct. The HP 8644A firmware defines the modulation integrity condition/event register bits as follows:

Table 4-7. Modulation Integrity Summary Bit.

Bit #	Mnemonic	Definition
5-15	-	Reserved for future use.
4	ASCE	Audio source calibration error.
3	ASOL	Audio source PLL out of lock.
2	MCE	Mod distribution calibration error.
1	MLO	External modulation too low.
0	MHI	External modulation too high.

Reference Integrity Summary Bit

The reference integrity summary bit 3 indicates that there is some reason to suspect that the instrument reference frequency is not correct. The HP 8644A firmware defines the reference integrity condition/event register bits as follows:

Table 4-8. Reference Integrity Summary Bit.

Bit #	Mnemonic	Definition
3-15	-	Reserved for future use.
2	RCE	Reference calibration error.
1	ROL	Reference out of lock.
0	OVEN	10811 crystal reference oven cold.

Frequency Integrity Summary Bit

The frequency integrity summary bit 2 indicates that there is some reason to suspect that the output frequency performance of the instrument is not correct. The HP 8644A firmware defines the frequency integrity condition/event register bits as follows :

Table 4-9. Frequency Integrity Summary Bit.

Bit #	Mnemonic	Definition
7-15	-	Reserved for future use.
6	CDCE	140 nS coax FLL calibration error.
5	CDFL	140 nS coax FLL out of lock.
4	VCE	VCO calibration error.
3	VFL	VCO 70 nS FLL out of lock.
2	-	Reserved.
1	NCE	NF calibration error.
0	NPL	NF PLL out of lock.

Amplitude Integrity Summary Bit

The amplitude integrity summary bit 1 indicates that there is some reason to suspect that the output amplitude of the instrument is not correct. The HP 8644A firmware defines the amplitude integrity condition/event register bits as follows :

Table 4-10. Amplitude Integrity Summary Bit.

Bit #	Mnemonic	Definition
13-15	-	Reserved for future use.
12	DCE	Freq doubler calibration error.
11	DOL	Freq doubler ALC out of lock.
10	ATCE	Attenuator calibration error.
4-9	-	Reserved.
3	ACE	ALC calibration error.
2	AOL	ALC out of lock.
1	LCE	Level calibration error.
0	REV	Reverse power detected.

Calibration Integrity Condition Bit

The calibration integrity condition bit 0 indicates that an error has occurred during a calibration or diagnostic operation. This bit will remain set until the entire instrument has been re-calibrated with no errors using the *CAL? query.

IEEE 488.2 and HP-SL Status Register Syntax

All of the status registers defined in the previous sections may be accessed using the following commands :

Table 4–11. IEEE 488.2 and HP-SL Status Register Syntax. (1 of 2)

<table>
<tr><th>Command syntax</th><th>Definition</th></tr>
<tr><td>*CLS</td><td>Clears all event registers and queues.</td></tr>
<tr><td>*STB?</td><td>HP-IB status byte register.</td></tr>
<tr><td>*SRE <nrf>|?</td><td>HP-IB service request enable register.</td></tr>
<tr><td>*ESR?</td><td>IEEE 488.2 standard event status register.</td></tr>
<tr><td>*ESE <nrf>|?</td><td>IEEE 488.2 standard event status enable register.</td></tr>
<tr><td>STATus</td><td></td></tr>
<tr><td> [:DEVICE]</td><td></td></tr>
<tr><td>   [:EVENt]?</td><td>HP-SL device dependent event status register.</td></tr>
<tr><td>   :CONDition?</td><td>HP-SL device dependent condition status register.</td></tr>
<tr><td>   :PTRansition(1) ?</td><td>HP-SL device dependent positive transition filter.</td></tr>
<tr><td>   :NTRansition(1) ?</td><td>HP-SL device dependent negative transition filter.</td></tr>
<tr><td>   :ENABle <nrf>|?</td><td>HP-SL device dependent event enable register.</td></tr>
<tr><td>   :DQUestionable</td><td></td></tr>
<tr><td>   [:EVENt]?</td><td>HP-SL signal integrity event status register.</td></tr>
<tr><td>   :CONDition?</td><td>HP-SL signal integrity condition status register.</td></tr>
<tr><td>   :PTRansition(1) ?</td><td>HP-SL signal integrity positive transition filter.</td></tr>
<tr><td>   :NTRansition(1) ?</td><td>HP-SL signal integrity negative transition filter.</td></tr>
<tr><td>   :ENABle(2) <nrf>|?</td><td>HP-SL signal integrity event enable register.</td></tr>
<tr><td>   :SINTegrity</td><td></td></tr>
<tr><td>   [:EVENt]?</td><td>HP 8644A signal integrity event status register.</td></tr>
<tr><td>   :CONDition?</td><td>HP 8644A signal integrity condition status register.</td></tr>
<tr><td>   :PTRansition(1) ?</td><td>HP 8644A signal integrity positive transition filter.</td></tr>
<tr><td>   :NTRansition(1) ?</td><td>HP 8644A signal integrity negative transition filter.</td></tr>
<tr><td>   :ENABle(2) <nrf>|?</td><td>HP 8644A signal integrity event enable register.</td></tr>
<tr><td>   :HARDware</td><td></td></tr>
<tr><td>   [:EVENt]?</td><td>HP 8644A hardware integrity event status register.</td></tr>
<tr><td>   :CONDition?</td><td>HP 8644A hardware integrity condition status register.</td></tr>
<tr><td>   :PTRansition(1) ?</td><td>HP 8644A hardware integrity positive transition filter.</td></tr>
<tr><td>   :NTRansition(1) ?</td><td>HP 8644A hardware integrity negative transition filter.</td></tr>
<tr><td>   :ENABle(2) <nrf>|?</td><td>HP 8644A hardware integrity event enable register.</td></tr>
</table>

(1) The HP 8644A firmware does not implement programmable transition filters. All positive transition filters will be fixed at all ones and all negative transition filters will be fixed at all zeros.

(2) The HP 8644A firmware will set the default value of these event enable registers to all ones.

Table 4-11. IEEE 488.2 and HP-SL Status Register Syntax. (2 of 2)

<table>
<tr><th>Command syntax</th><th>Definition</th></tr>
<tr><td>:MODulation</td><td></td></tr>
<tr><td>[:EVENt]?</td><td>HP 8644A modulation integrity event status register.</td></tr>
<tr><td>:CONDition?</td><td>HP 8644A modulation integrity condition status register.</td></tr>
<tr><td>:PTRansition[3] ?</td><td>HP 8644A modulation integrity positive transition filter.</td></tr>
<tr><td>:NTRansition[3] ?</td><td>HP 8644A modulation integrity negative transition filter.</td></tr>
<tr><td>:ENABle[4] <nrf>|?</td><td>HP 8644A modulation integrity event enable register.</td></tr>
<tr><td>:REFerence</td><td></td></tr>
<tr><td>[:EVENt]?</td><td>HP 8644A reference integrity event status register.</td></tr>
<tr><td>:CONDition?</td><td>HP 8644A reference integrity condition status register.</td></tr>
<tr><td>:PTRansition[3] ?</td><td>HP 8644A reference integrity positive transition filter.</td></tr>
<tr><td>:NTRansition[3] ?</td><td>HP 8644A reference integrity negative transition filter.</td></tr>
<tr><td>:ENABle[4] <nrf>|?</td><td>HP 8644A reference integrity event enable register.</td></tr>
<tr><td>:FREQuency</td><td></td></tr>
<tr><td>[:EVENt]?</td><td>HP 8644A frequency integrity event status register.</td></tr>
<tr><td>:CONDition?</td><td>HP 8644A frequency integrity condition status register.</td></tr>
<tr><td>:PTRansition[3] ?</td><td>HP 8644A frequency integrity positive transition filter.</td></tr>
<tr><td>:NTRansition[3] ?</td><td>HP 8644A frequency integrity negative transition filter.</td></tr>
<tr><td>:ENABle[4] <nrf>|?</td><td>HP 8644A frequency integrity event enable register.</td></tr>
<tr><td>:AMPLitude</td><td></td></tr>
<tr><td>[:EVENt]?</td><td>HP 8644A amplitude integrity event status register.</td></tr>
<tr><td>:CONDition?</td><td>HP 8644A amplitude integrity condition status register.</td></tr>
<tr><td>:PTRansition[3] ?</td><td>HP 8644A amplitude integrity positive transition filter.</td></tr>
<tr><td>:NTRansition[3] ?</td><td>HP 8644A amplitude integrity negative transition filter.</td></tr>
<tr><td>:ENABle[4] <nrf>|?</td><td>HP 8644A amplitude integrity event enable register.</td></tr>
</table>

(3) The HP 8644A firmware does not implement programmable transition filters. All positive transition filters will be fixed at all ones and all negative transition filters will be fixed at all zeros.

(4) The HP 8644A firmware will set the default value of these event enable registers to all ones.

Example HP-SL Programs

In this section, you will find example programs to assist you in becoming familiar with HP-SL. Also, a program to help you develop HP-SL code is provided for your use.

All of the following examples have been written in BASIC Programming Language, however, you may convert the examples into PASCAL or into any other language.

The example HP-SL programs are alphabetically arranged. A table of contents for all examples is as follows:

Table of Contents

A Tool for Developing HP-SL Programs

Programs written in HP-SL are not instrument dependent; that is, HP-SL has removed the one-to-one correspondence between front-panel keystrokes and HP-IB codes. In previous instruments, development of controller programs could be done by trying out functions on the front panel, and then converting the keystrokes into HP-IB codes to send to the instrument.

The following program, written in BASIC, allows you to send command statements and messages to test their effect on the HP 8644A. In addition, the program traps error conditions and reads the error messages back to the controller in an underlined format.

The program is written for HP 8644A instruments with an HP-IB address of 19. You may modify the program to have any HP-IB address.

When you run the program, simply type in the command statement or message and press the **ENTER** key. For example, the command statement:

```
FREQ 1.234 MHz
```

Will set an RF output frequency of 1.234 MHz. If the command statement or message contains a query "?", the program will generate a response in an inverse video window.

A Tool for Developing HP-SL Programs

```
100   DIM A$[255],L$[255],E$[255]
200   PRINT "ENTER MESSAGE STRING TO SEND TO 8644. REPLIES ARE SHOWN IN INVERSE"
300   PRINT "AND ERROR MESSAGES ARE UNDERLINED."
400   PRINT "################################################################################"
500   ON KBD GOSUB 1100
600   CLEAR 719
700   OUTPUT 719;"*ESE 60;*SRE 48"
800   GOSUB 1600
900   ON INTR 7 GOSUB 1600
1000  GOTO 1000
1100  OUTPUT 2;KBD$;
1200  INPUT "ENTER MESSAGE STRING TO SEND TO 8644:",A$
1300  PRINT A$
1400  OUTPUT 719;A$
1500  RETURN
1600  Z=SPOLL(719)
1700  IF BIT(Z,4)=0 THEN GOTO 2000
1800  ENTER 719;L$
1900  PRINT CHR$(129);L$;CHR$(128)
2000  OUTPUT 719;"*ESR?"
2100  ENTER 719;Z
2200  OUTPUT 719;"SYST:ERR? STR"
2300  ENTER 719;E$
2400  IF E$[1;1]="0" THEN GOTO 2700
2500  PRINT CHR$(132);E$;CHR$(128)
2600  GOTO 2200
2700  ENABLE INTR 7;2
2800  RETURN
2900  END
```

AM Examples

Set the AM depth to a value of 57% and select External AC, AM.

```
100  ! Set the Source to external and the coupling to AC.
200  OUTPUT  719;"AM:SOUR EXT;COUP AC"
300  ! Set the AM depth to a value of 57% and turn AM on.
400  OUTPUT  719;"AM:DEPT 57%;STATE ON"
```

Set the AM depth to 73% with internal AM at 2.5 kHz modulation frequency.

```
100  ! Set the Source to internal and no coupling.
200  OUTPUT  719;"AM:SOUR INT"
300  ! Set the AM depth to a value of 73%.
400  OUTPUT  719;"AM 73 %"
500  ! Set the LFSource Frequency to 3 kHz.
600  OUTPUT  719;"LFS:FREQ 3 KHZ"
```

Amplitude Examples

Set amplitude to 100 mV, increment in 0.1 dB steps until some other measurement returns proper reading. Query amplitude in volts.

```
100  ! Set output level to 100 mV and enable RF output
200  OUTPUT  719;"AMPL 100mV;AMPL:STATE ON"
300  ! Set default instrument amplitude units to return volts
400  ! and default instrument amplitude step to dB this allows
500  ! logarithmic stepping of the amplitude in volts.
600  OUTPUT  719;"AMPL:UNIT V;STEP:UNIT DB"
700  ! Set increment to 0.1 dB.
800  OUTPUT  719;"AMPL:STEP:INCR 0.1"
900  ! Loop testing value and incrementing output level by 0.1 dB
1000   ! Make what ever tests are required here, if proper level
1100   ! has been reached, goto line 1700
1200 ! Increase source amplitude by 0.1 dB.
1300 OUTPUT  719;"AMPL UP"
1400 ! Jump back to test.
1500 GOTO 1000
1600 ! Read current amplitude back from source.
1700 OUTPUT  719;"AMPL?"
1800 ENTER   719;Level
1900 PRINT   "Level required was ";Level;" Volts."
```

FM Example

Set the FM deviation to a value read in from controller keyboard. Also set the FM Source to external.

```
100  ! Set the Source to external and the coupling to DC.
200  OUTPUT  719;"FM:SOUR EXT;COUP DC"
300  ! Input the FM deviation from the console.
400  INPUT  "Enter the FM Deviation in kHz:  ",Fm_deviation
500  ! Set the FM deviation to the value given as input.
600  OUTPUT  719;"FM ";Fm_deviation;"KHZ"
700  ! Now turn FM on.
800  OUTPUT  719;"FM:STATE ON"
```

Frequency Examples

Reset the instrument, then set frequency to 137 MHz, and turn amplitude on at 4.5 dBm:

```
100  ! Set instrument to known state.
200  OUTPUT  719;"*RST"
300  ! Set frequency to 137 MHz
400  OUTPUT  719;"FREQ 137MHZ"
500  ! Set output level to 4.5 dBm and enable RF output
600  OUTPUT  719;"AMPL 4.5DBM;AMPL:STATE ON"
```

Reset the instrument, turn amplitude on and set frequency and amplitude to values read in from controller keyboard:

```
100  ! Set instrument to known state.
200  OUTPUT  719;"*RST"
300  ! Input the Frequency and the Amplitude from the console.
400  INPUT   "Enter frequency in MHz: ",Freq
500  INPUT   "Enter amplitude in dBm: ",Ampl
600  ! Set the Frequency and Amplitude to the input values.
700  OUTPUT  719;"FREQ ";Freq;"MHZ;AMPL ";Ampl;"DBM;AMPL:STATE ON"
```

Reset the instrument, turn amplitude on at 0 dBm and step frequency from 200 to 300 MHz in 1 MHz steps, making some measurement at each frequency:

```
 100  ! Set instrument to known state.
 200  OUTPUT  719;"*RST"
 300  ! Set frequency to 200 MHz and set frequency increment to 1MHz.
 400  OUTPUT  719;"FREQ 200MHZ;FREQ:STEP 1MHZ"
 500  ! Turn RF on at 0 dBm
 600  OUTPUT  719;"AMPL 0;AMPL:STATE ON"
 700  FOR X = 0 TO 100
 800    !  Add code to make whatever
 900    !  measurement is needed here.
1000    !  Increase frequency by 1MHz
1100    OUTPUT  719;"FREQ UP"
1200  NEXT X
```

The instrument is to be used as a local oscillator where it's output frequency will be doubled, and that signal will be mixed with the "frequency of interest" and put through a 10.7 MHz I.F. bandpass filter.

This means (Frequency of interest) = (L.O. Frequency) X 2 - 10.7 MHz. Set up frequency offsets and multipliers to allow the signal generator to be programmed to the frequency of interest, rather than the L.O. frequency.

```
100  ! Set freq multiplier to two and frequency offset to -10.7MHz
200  OUTPUT  719;"FREQ:MULT 2;OFFSET -10.7MHZ"
300  ! Set signal generator so that frequency of interest will be
400  ! 107.7 (actual signal generator output frequency is 59.2 MHz).
500  OUTPUT  719;"FREQ 107.7MHZ"
```

EMF Mode Examples

```
10  ! SAMPLE PROGRAM TO TURN EMF MODE ON AND OFF IN PSG.
20  !
30  Address=719
40  OUTPUT  Address; "AMPLITUDE:SOURCE:UNIT V" ! SETS EMF MODE
50  !
60  OUTPUT  Address; "AMPLITUDE:OUT:UNIT V"    ! SETS NON EMF MODE
70  !
80  END
```

HP-IB Device Status Examples

The following section presents several examples of the use of HP 8644A device status mnemonics.

Example 1:

Configure the instrument to generate a service request whenever an error is placed in the error queue.

```
*ESE 60;*SRE 32
```

Enable the CME, EXE, QYE, and DDE bits in the standard event status register and the ESB summary message in the HP-IB status byte.

Example 2:

Configure the instrument to generate a service request whenever the fractional-N phase locked loop goes out of lock.

```
STAT:ENAB 2048;SINT:ENAB 4;FREQ:ENAB 1;*SRE 128
```

Enable the signal integrity summary message, the frequency integrity summary message, the NPL event bit, and the DEV summary message in the HP-IB status byte.

Example 3:

Respond to a service request and decode the instrument status.

```
*STB?                 Read the HP-IB status byte.
data = 128            The DEV summary message is set.
STAT?                 Read the device dependent event status
                       register.
data = 2048           The HP-SL signal integrity summary bit is set.
STAT:DQU?             Read the HP 8644A signal integrity event
                       status register.
data = 4              The frequency integrity summary bit is
                       set.
STAT:SINT:FREQ?       Read the HP 8644A frequency integrity event
                       status register.
data = 1              The NF PLL has been out of lock.
STAT:SINT:FREQ:COND?  Read the frequency integrity condition
                       status register.
data = 0              The NF PLL is not currently out of lock.
```

It is clear from this dialog that there has been a transient out of lock in the NF PLL.

Initialize Example

Set up a ten second logarithmic sweep. Prompt user for the start frequency and sweep over a 200 MHz span. Put markers at start freq +50 MHz, +100 MHz, and +150 MHz. Make a single sweep.

```
 100  ! Get start frequency from user.
 200  INPUT  "Enter Start Frequency in Hz: ";Startfreq
 300  ! Set start frequency and span for sweep.
 400  OUTPUT  719;"FREQ:START ";Startfreq;";SPAN 200MHZ"
 500  ! Set sweep time to 10 Sec. and select log sweep
 600  OUTPUT  719;"SWEEP:TIME 10;SPACING LOG"
 700  ! Set markers
 800  OUTPUT  719;"MARKER ";Startfreq+50000000;";MARKER:STATE ON"
 900  OUTPUT  719;"MARK2 ";Startfreq+100000000;";MARK2:STATE ON"
1000  OUTPUT  719;"MARK3 ";Startfreq+150000000;";MARK3:STATE ON"
1100  ! Become sweeper, enable auto sweeping and select single.
1200  OUTPUT  719;"FREQ:MODE SWEEP;:SWEEP:MODE AUTO"
1300  OUTPUT  719;"INITialize:MODE SINGle"
1400  ! The next line will cause the sweep to begin.
1500  OUTPUT  719;"INITialize:IMMediate"
```

Modulation Example

If in the middle of some procedure, it may be necessary to make some measurement which require that the HP 8644A be at the current RF output frequency and output amplitude level, but all modulation must be turned off.

The following example will disable all modulation, make necessary measurements, and then turn back on whatever modulation was on before this section of code started. (Note: this section of programming code will work regardless of what modulation(s) were on when it was executed.)

```
   .     .
   .     .
   .     .
7100  ! Shut off all modulation.
7200  OUTPUT  719;"MOD:STATE OFF"
7300  ! Make any necessary tests/measurements ...
7400  !
7500  ! Return modulation to the state it was in before line 7200
7600  OUTPUT  719;"MOD:STATE ON"
   .     .
   .     .
   .     .
```

Phase Examples

Adjust the phase to set the quadrature between two sources.

```
100  ! Set the phase step to 1 degree
200  OUTPUT  719;"PHAS:STEP 1DEG"
300  ! Continue adjusting the Phase by 1 degree until the voltage is
400  ! equal.
450  DONE = 0
500  REPEAT
600    ! Measure mixer voltage using appropriate equipment and store
700    ! the value as "Measurement".
800    ! If measurement is greater than 0.1 V increment phase.
900    IF (Measurement) $>$ 0.1V THEN
1000    OUTPUT  719;"PHAS UP"
1100   ELSE
1200   ! If measurement is less than -0.1 V decrement phase.
1300   IF (Measurement) $<$ -0.1V THEN OUTPUT  719;"PHAS DOWN"
1400   ! If measurement is okay then set done to quit looping.
1500   ELSE
1600     Done = 1
1700 UNTIL (Done  = 1)
```

Shift Carrier Phase by 30°and make a measurement. Then set the Phase back to 0.

```
100  ! Set Phase value to 0.
200  OUTPUT  719,"PHAS:REF"
300  ! Shift Phase by 30 degrees.
400  OUTPUT  719,"PHAS 30DEG"
500  ! Make some appropriate measurement.
600  ! Set Phase back to zero.
700  OUTPUT  719,"PHAS 0DEG"
```

Appendixes A-H

A Installation

Unpack Your HP 8644A

Inspect the shipping container for damage. If the shipping container is damaged or the cushioning material inside is stressed, keep them until you have checked the shipment for completeness and the instrument for proper operation.

If items are missing from your shipment, or if there is mechanical damage or defect, notify the nearest Hewlett-Packard office. If the shipping container or cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for inspection by the carrier.

Connect Power

The HP 8644A Synthesized Signal Generator requires a power source of 100 to 120 V ac (±10%) at 48 to 440 Hz, or 220 to 240 V ac (±10%) at 48 to 440 Hz. Power consumption is 400 VA maximum. If you need further information about the power requirements for your instrument, refer to the HP 8644A Operation and Calibration Manual.

Warning

This is a Safety Class I product (i.e., 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.

Turn On Instrument

If you are operating this instrument in extreme environmental conditions, refer to the HP 8644A *Calibration Manual* for specific operating limitations.

Press the **POWER** key to the ON position. The front panel annunciators momentarily light up for a quick visual inspection.

If the **MSSG** annunciator is displayed in the lower right corner of the FREQUENCY/STATUS display, an instrument error has occurred. Press the UTILITY **MSSG** key as many times as needed to scroll through the error messages. Error messages may be viewed again by first pressing the blue **SHIFT** key and then repeatedly pressing the **MSSG** key. Refer to appendix D for error message descriptions.

B Options and Accessories

Available for the HP 8644A

The following table lists the options and accessories that are presently available for the HP 8644A. Refer to your nearest Hewlett-Packard office for ordering information, and for an update on options that have been made available since the printing of this Operation Guide.

Option:

001:	High Stability Time Base.
002:	2 GHz Output
003:	Rear Panel Inputs/Outputs (deletes front panel inputs/outputs)
004:	Enhanced Spectral Purity
005:	Electronic Attenuator (5 year warranty on attenuator)
007:	Synthesized Audio Oscillator
009:	Specified VOR/ILS Performance
010:	Reduced Leakage Configuration
011:	2 GHz Frequency Counter
907:	Front Handle Kit (5061-9690)
908:	Rack Flange Kit (5061-9678)
909:	Combined Front Handle/Rack Flange Kit (5061-9684)
910:	Extra Manual Set (includes Service Manual)
915:	Add Service Manual
W03:	90 day On-site Warranty (replaces 1-year standard warranty)
W30:	3-year Extended Return to Hewlett-Packard Warranty

Accessories Available:

HP 11844A 2 GHz Retrofit Kit
HP 08644-61080 2 GHz Frequency Counter Retrofit Kit
Service Kit (08645-61116)
Transit Case, includes handles and wheels (9211-2662)
Transit Case Wheels (1490-0913)
Non-tilting Rack Slide Kit (1494-0059)
Tilting Rack Slide Kit (1494-0063)

C Special Functions

How to Access the Special Functions

There are two ways to access special functions for the HP 8644A.

1. Press the **SPECIAL** key and then turn either the knob or press one of the knob ⇩⇧ keys to show the available special functions in the FREQUENCY/STATUS display. Access the special function of your choice by pressing the **ENTER** key.

-OR-

2. Press the **SPECIAL** key and enter the special function number of your choice. Access the special function by pressing the **ENTER** key.

The yellow annunciator above the **SPECIAL** key lights up to indicate that a special function is invoked. At any time, you may display all of the special functions that are invoked by pressing the **DISPLAY** key, and then the **SPECIAL** key.

Listed numerically, the special functions are as follows:

`100:Auto Attenuation`

This special function allows you to lock or unlock the attenuators at their present setting. When ON (unlocked), the instrument's output amplitude can be set at any level within the range of the instrument. When OFF (locked), the instrument's output amplitude can only be set within the vernier range of the locked attenuators.

`101:Attenuation`

This special function gives you the choice of manually selecting which attenuators to switch in for operating the instrument. Activating this special function essentially turns off Auto Attenuation described in Special Function 100.

`102:Amptd Correction`

This special function allows you to either have a calibrated or an uncalibrated output amplitude level. When ON, internal calibration data is used. When OFF, the internal calibration data is not used.

`103:Amptd Limit`

This special function allows you to specify the upper limit for the instrument's output amplitude.

104:Wideband ALC

This special function allows you to determine the ALC bandwidth. When OFF, the ALC is configured for the most narrow bandwidth. When ON, the ALC is configured for the widest bandwidth possible for the RF output selected.

105:Amplitude Muting

This special function, when OFF, allows you to minimize the affect of changes that occur when the HP 8644A is in transition from one output amplitude level to another or from one center frequency value to another as seen at the RF Output. Typically, the carrier frequency can swing several MHz while in transition, and the output amplitude may change ±6 dBm while in transition. In the default condition, Amplitude Muting ON, output amplitude and center frequency changes occur with 20 to 40 dB of attenuation.

110:Rel Φ Adjust

This special function allows you to increment or decrement the phase of the RF output signal in one-degree steps relative to the present frequency reference.

111:Freq Multiplier

This special function allows you to use an external divider or multiplier on the RF output and still have the instrument display the final RF output signal. A positive integer, for example +2 would cause the frequency display to be multiplied by 2. A negative integer, for example −2 would cause the frequency display to be divided by 2. The front-panel **OFFSET** annunciator turns on when the frequency multiplier is a value other than +1.

112:Phase Cont Sweep

This special function allows you to put the instrument's sweep in a phase-continuous mode. During phase-continuous frequency sweep, the instrument sweeps between two selected endpoints in a linear, phase-continuous manner. This sweep function resembles a true sweeper in that it has no frequency transients; yet it is fully synthesized, yielding a very linear, precise sweep.

120:FM Synthesis

This special function allows you to have the instrument synthesize the FM signal in a digitized or linear manner. Digitized FM is best for single-tone modulation and provides a very accurate center frequency at low deviation rates. Linear FM is best for multi-tone modulation and provides a more constant group delay than the Digitized FM.

121:F(t)

This special function displays the phase-locked loop frequency during digitized FM. The display is continually updated.

122:FM Pre\emphasis

This special function allows you to pre-emphasize internal or external FM modulating signals with a 750 μsec time constant. Pre-emphasis boosts high frequencies in the modulating signal prior to modulating the RF output. With pre-emphasis turned ON, the displayed FM deviation applies for rates at approximately 3 kHz. Refer to figure C-1 for specific details:

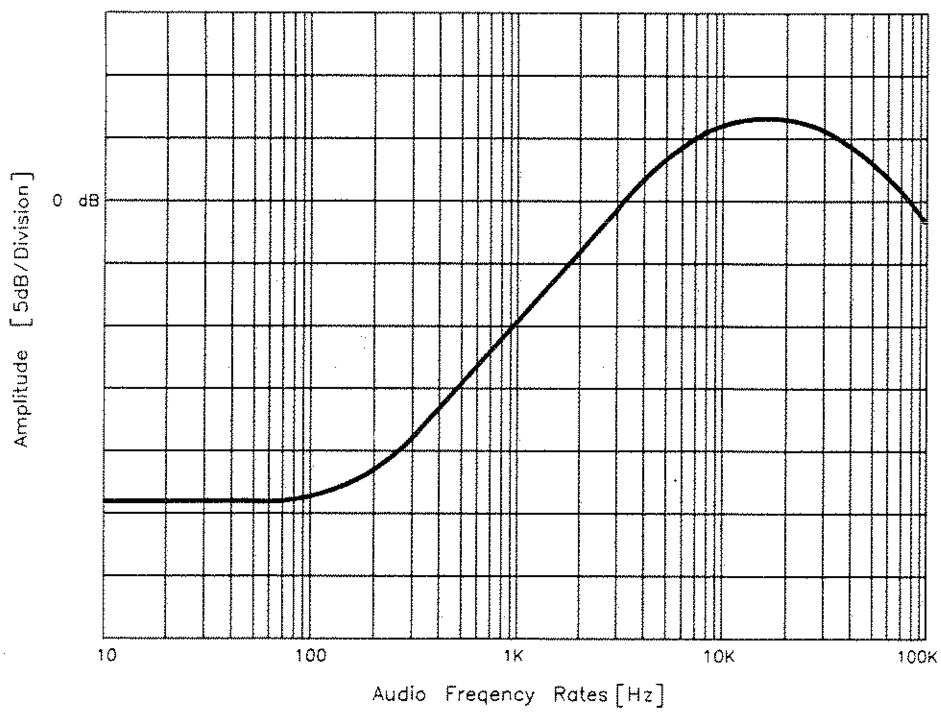


Figure C-1. FM Audio Pre-emphasis.

124:FM Dly Equalizer

This special function allows you to turn off the FM Delay Equalizer circuitry. When ON (the preset condition), 30 μsec of group delay is added to the FM modulating signal to get better FM frequency response.

You may want to turn OFF the FM Delay Equalizer circuitry when the HP 8644A is used as the VCO in a phase-locked loop application to reduce phase shift, or when you want to extend the FM bandwidth to 200 kHz. When OFF, FM Indicator Accuracy is worse for rates of 1–5 kHz and better beyond 30 kHz, refer to figure C–2 for specific details:

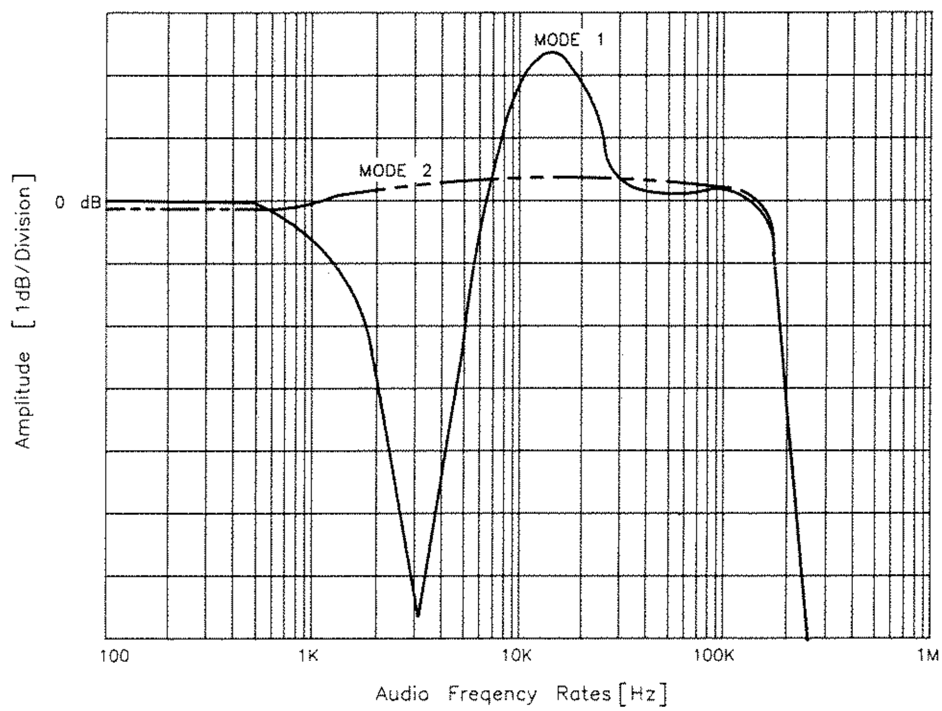


Figure C–2. FM Indicator Accuracy with Special Function 124 Off.

130:Audio Wave

This special function is available with Option 007. It allows you to select the waveform for the audio source in Channel 1. You have five choices: Sine, Square, Triangle, Sawtooth, or White Gaussian Noise.

131:Audio Triggered

This special function is available with Option 007. When ON, it enables Special Function 132.

132:Trig Audio

This special function is available with Option 007. When enabled by Special Function 131, it allows you to trigger the audio source to output a single 360° cycle. When the audio is triggered for a single cycle of White Gaussian Noise, the result is a burst of noise for the duration of "1/audio frequency". You can output any one of the five audio waveforms. Triggering is done from either the front-panel **ON** key or from the rear-panel **AUDIO TRIG** connector.

133:Aud2 Freq

This special function is available with Option 007. It allows you to turn on and off the audio source for Channel 2, and it allows you to set the audio source frequency for Channel 2. The audio source frequency for Channel 2 may be set to a minimum of 0.1 Hz, a maximum of 400 kHz, or any value in between.

134:Aud2 Level

This special function is available with Option 007. It allows you to adjust the level of the audio source for Channel 2. The level for the audio source in Channel 2 may be set to a minimum of 0 V, a maximum of 2 V, or any value in between.

135:Aud2 Wave

This special function is available with Option 007. It allows you to select the waveform for the audio source in Channel 2. You have five choices: Sine, Square, Triangle, Sawtooth, or White Gaussian Noise.

136:Aud2 Φ

This special function is available with Option 007. It allows you to adjust the phase of the audio source in Channel 2. Phase may be expressed in terms of radians or degrees. The front panel display immediately changes units of degrees and radians when you switch between the **deg** and **rad** keys. Entries may be scaled; for example, entering 560° would yield −160°.

137:Aud AM Depth

This special function is available with Option 007. It allows you to turn on and off the AM source in Channel 1, and it allows you to set the percentage of depth for the AM source. Depth may be set to a minimum of 0%, a maximum of 100%, or any value in between.

138:Aud AM Freq

This special function is available with Option 007. It allows you to set the frequency for the AM source in Channel 1. The frequency may be set to a minimum of 0.1 Hz, a maximum of 400 kHz, or any value in between.

139:Aud AM Wave

This special function is available with Option 007. It allows you to select the waveform for the AM source in Channel 1. You have five choices: Sine, Square, Triangle, Sawtooth, or White Gaussian Noise.

140:Aud AM Φ

This special function is available with Option 007. It allows you to adjust the phase of the AM source in Channel 1. Phase may be expressed in terms of radians or degrees. The front panel display immediately changes units of degrees and radians when you switch between the **deg** and **rad** keys. Entries may be scaled; for example, entering 560° would yield −160°.

141:Aud FM Dev

This special function is available with Option 007. It allows you to turn on and off the FM source in Channel 1, and it allows you to set the amount of deviation for the FM source. Deviation may be set to a minimum of 0 Hz, a maximum of 400 kHz, or any value in between.

142:Aud FM Freq

This special function is available with Option 007. It allows you to set the frequency for the FM source in Channel 1. The frequency may be set to a minimum of 0.1 Hz, a maximum of 400 kHz, or any value in between.

143:Aud FM Wave

This special function is available with Option 007. It allows you to select the waveform for the FM source in Channel 1. You have five choices: Sine, Square, Triangle, Sawtooth, or White Gaussian Noise.

144:Aud FM Φ

This special function is available with Option 007. It allows you to adjust the phase of the FM source in Channel 1. Phase may be expressed in terms of radians or degrees. The front panel display immediately changes units of degrees and radians when you switch between the **deg** and **rad** keys. Entries may be scaled; for example, entering 560° would yield −160°.

145:Aud ΦM Dev

This special function is available with Option 007. It allows you to turn on and off the ΦM source in Channel 1, and it allows you to set the amount of deviation for the ΦM source. Deviation may be set to a minimum of 0° , a maximum of 179.9°, or any value in between. ΦM deviation may be expressed in terms of radians or degrees. The front panel display immediately changes units of degrees and radians when you switch between the **deg** and **rad** keys. Entries may be scaled; for example, entering 560° would yield −160°.

146:Aud ΦM Freq

This special function is available with Option 007. It allows you to set the frequency for the ΦM source in Channel 1. The frequency may be set to a minimum of 0.1 Hz, a maximum of 400 kHz, or any value in between.

147:Aud ΦM Wave

This special function is available with Option 007. It allows you to select the waveform for the ΦM source in Channel 1. You have five choices: Sine, Square, Triangle, Sawtooth, or White Gaussian Noise.

148:Aud ΦM Φ

This special function is available with Option 007. It allows you to adjust the phase of the ΦM source in Channel 1. Phase may be expressed in terms of radians or degrees. The front panel display immediately changes units of degrees and radians when you switch between the **deg** and **rad** keys. Entries may be scaled; for example, entering 560° would yield −160°.

149:Aud Pulse

This special function is available with Option 007. It allows you to turn on and off the Pulse source in Channel 1.

150:Aud Pulse Freq

This special function is available with Option 007. It allows you to set the frequency for the Pulse source in Channel 1. The frequency may be set to a minimum of 0.1 Hz, a maximum of 50 kHz, or any value in between.

151:Aud Pulse Φ

This special function is available with Option 007. It allows you to adjust the phase of the Pulse source in Channel 1. Phase may be expressed in terms of radians or degrees. The front panel display immediately changes units of degrees and radians when you switch between the **deg** and **rad** keys. Entries may be scaled; for example, entering 560° would yield −160°.

160:Ref Calibration

This special function allows you to adjust the frequency of the internal reference oscillator. Values used to adjust the reference frequency are in the range of 0 to 255. A change in the value of "1" corresponds to about a 4 Hz change in the reference frequency. The value required to set the reference to approximately 10 MHz will vary from instrument to instrument. When an instrument preset or power on/off is done, the reference frequency value is returned to its calibrated value. (Activate service Special Function 331 to save the reference calibration value.)

161:Ref Source

This special function monitors whether the instrument is using its internal reference oscillator source or if an external timebase source is connected. (The High Stability timebase Option 001 is seen by the HP 8644A as an external timebase source to the rear-panel **REF IN** connector.) The display is continuously updated.

`170:Test`

This special function tests the instrument and module hardware for failures. Turn the knob to select the test you want, and then press the **ENTER** key. The message `Result Code = 0` indicates that the instrument is operating normally. A result code other than the numeral "0" appearing on the front-panel display indicates a failure. All error codes are defined in the Service Diagnostics Manual.

`171:Recal`

This special function allows you to recalibrate the whole instrument. A recalibration takes about five minutes. The message `Result Code = 0` appears if the recalibration passes. All error codes are defined in the Service Diagnostics Manual.

`172:RAM Wipe`

This special function allows you to do a 'hard' reset of the instrument to wipe out the memory contents of RAM (including the calibration data). This eliminates any instrument settings entered by the user through the front panel or through HP-IB. An instrument recalibration is then automatically done.

`173:Security`

This special function allows you to secure Special Functions 191 to 195. When ON, Special Functions 191 to 195 cannot be turned off without first forcing an automatic RAM wipe as described in Special Function 172. When this special function is active (turned ON), it executes a RAM wipe when turned OFF. Also, if the instrument's power switch is turned to STBY and then back to ON, a RAM wipe will be executed.

`180:DC Voltmeter`

This special function allows you to use the instrument as a DC voltmeter. DC voltages are monitored from the rear-panel **VOLTMETER IN** connector. The front-panel displays a continuously updated DC voltage reading. The following typical operating characteristics apply:

Range: ±50 V dc
Sensitivity: 0.5 V dc
Maximum Input Voltage: ±180 V dc
Input Impedance: 130 kΩ

181:AC Voltmeter

This special function allows you to use the instrument as an AC voltmeter. AC voltages are monitored from the rear-panel **VOLTMETER IN** connector. The front-panel displays a continuously updated AC voltage reading in V rms. The following typical operating characteristics apply:

Range: ±50 Vpk
Bandwidth: 10 kHz
Sensitivity: 0.5 Vpk
Maximum Input Voltage: ±180 Vpk
Input Impedance: 130 kΩ

182:Power Meter

This special function allows you to use the instrument as a power meter. Power is monitored from a connector located under the instrument's top cover. The front-panel displays a continuously updated power reading in dBm. The following typical operating characteristics apply:

Power Range: −10 to +20 dBm
Frequency Range: 250 kHz to 2 GHz
Accuracy: ±5 dBm at −10 to 0 dBm
±3 dBm at 0 to +10 dBm
±1 dBm at +10 to +20 dBm
Maximum Input Power: 25 dBm
Input Impedance: 50Ω AC coupled

183:Counter Range

This special function allows you to select the correct frequency range for accurate measurements when using the HP 8644A Frequency Counter. The three ranges are:

20 Hz to 10 MHz
10 MHz to 640 MHz
640 MHz to 2 GHz.

The INSTRUMENT PRESET default range for the Frequency Counter is 20 Hz to 10 MHz. (If the instrument power is cycled without pressing INSTRUMENT PRESET, then the previously set counter range is still in effect.)

184:Cntr

This special function allows you to use the HP 8644A as a frequency counter for frequencies up to 2 GHz. Frequencies are monitored in Hz, through the front panel **MEAS INPUT** connector and displayed in the left screen. Frequency resolution is always displayed to within 0.01 Hz. Actual measurement resolution is a function of frequency and gate time.

185:Counter Gate

This special function allows you to select the gate time that determines how often the frequency counter makes and updates the displayed frequency reading. Gate time selection can be from 0.1 s to 1.00 s in 100 ms increments. The larger the gate time (that is, the longer the sampling time), the more accurate the reading. The INSTRUMENT PRESET default gate time for the Frequency Counter is 0.1 s. (If the instrument power is cycled without pressing INSTRUMENT PRESET, then the previously set gate time is still in effect.)

190:Serial #

This special function displays the instrument's serial number.

191:Blank Display

This special function allows you to blank out all instrument settings displayed on the front panel (including the LED annunciator lights). User interaction with the instrument is not displayed on the front panel.

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192:Blank Frequency
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This special function allows you to blank out just the frequency setting from being displayed on the front panel. When ON, each segment in the Frequency/Status display will show a dash, Mode Select LED annunciators turn off, and any special functions relating to frequency are blanked.

`193:Blank Modulation`

This special function allows you to blank out just the modulation level setting from being displayed on the front panel. When ON, each segment in the Modulation Level display will show a dash, Modulation LED annunciators turn off, and any special functions relating to modulation are blanked.

`194:Blank Audio`

This special function allows you to blank out just the audio frequency setting from being displayed on the front panel. When ON, each segment in the Modulation Frequency display will show a dash, and any special functions relating to audio frequency are blanked.

`195:Blank Amptd`

This special function allows you to blank out just the RF amplitude setting from being displayed on the front panel. When ON, each segment in the Amplitude display will show a dash, and any special functions relating to RF amplitude are blanked.

`196:European Radix`

This special function allows you to determine which 'radix mark' and which 'separator mark' to use in a number. A radix mark is the divider between the integer portion of a number and the fractional portion of a number. The separator mark is the separator between groups of digits in a large number.

When OFF, the radix mark displayed on the front panel is a period and the separator mark is a comma. When ON, the radix mark displayed on the front panel is a comma, and the separator mark is a period. For example, 123456789 Hz would be shown as 123,456,789.00 Hz in normal operation, however, it would be shown as 123.456.789,00 with the European Radix ON.

`220:VOR Setup`

This special function is available with Option 007. It allows you to generate a composite VOR test signal. The instrument is set for a bearing of 0° to the station on a carrier of 108.0 MHz.

221:Localizer Setup

This special function is available with Option 007. It allows you to generate a composite Localizer test signal. The instrument is set for 0 DDM on a carrier of 108.1 MHz.

222:Glideslope Setup

This special function is available with Option 007. It allows you to generate a composite Guideslope test signal. The instrument is set for 0 DDM on a carrier of 334.7 MHz.

223:OM Beacon Setup

This special function is available with Option 007. It allows you to generate an OM Beacon test signal. The instrument is set for a 2 Hz pulsed tone beacon.

224:MM Beacon Setup

This special function is available with Option 007. It allows you to generate an MM Beacon test signal. The instrument is set for a 2 Hz pulsed tone beacon.

225:IM Beacon Setup

This special function is available with Option 007. It allows you to generate an IM Beacon test signal. The instrument is set for a 2 Hz pulsed tone beacon.

300:Service Mode

This special function allows you to run the instrument's service diagnostic routines. The service-diagnostic switch (referred to in the Service Diagnostics Manual) must be in the correct position in order to access and run any of the diagnostic tests.

D Error Messages

What Happens When You Get an Error Message

The Signal Generator interacts with the user to communicate error messages about its operating condition. The error messages suggest or imply that a problem exists either with the instrument or the way in which the user is operating the instrument. Error messages are presented to the user in two ways.

First, if the user attempts to operate the instrument beyond its capabilities, intentionally or not, an error message is immediately shown in the FREQUENCY/STATUS display. Refer to table D-1 for a description of the error messages that occur under these circumstances.

Second, if the instrument detects a malfunction at power up, or as a result of performing service diagnostics or calibration, an error message is put into the message queue. You will know that this has occurred because the **MSSG** annunciator lights up in the FREQUENCY/STATUS display. Refer to table 7-2 for a description of the error messages that occur under these circumstances.

The error messages in the message queue can then be viewed at the users request by simply pressing the Utility **MSSG** key on the front panel; repetitively pressing the **MSSG** key allows you to view all of the error messages.

To view the error messages again, simply press the blue **SHIFT** key, and then the **MSSG** key. If you have corrected the malfunction shown in the error message list, the message for that error will not reappear.

Note

A hardware failure message does not always indicate that a hardware problem exists. Certain operating conditions may also cause a hardware problem.

Also, if you program the Signal Generator to operate outside of its specified operating ranges a hardware failure may occur. For example, if the current output amplitude and AM depth results in an output signal greater than approximately +16 dBm you may get a hardware failure message.

Table D-1. Error Messages Immediately Shown to the User. (1 of 8)

Error Message	Description
AM depth too large	The entered amount of AM depth is greater than the maximum permitted (100%). Also, AM depth is limited by the current amplitude setting; Special Function 103 (Amptd Limit) sets the maximum amplitude limit. For example, if the current amplitude setting is +19.9 dBm, the maximum AM depth is 0%.
AM depth too small	The AM depth value entered is less than the minimum permitted (0%).
AM incr too large	The AM increment value entered is greater than the maximum permitted (100%).
AM incr too small	The AM increment value entered is less than the minimum permitted (0.1%).
Amptd incr too large	The amplitude increment value entered is greater than the maximum permitted (100 dB or 1V).
Amptd incr too small	The amplitude increment value entered is less than the minimum permitted (0.1 dB or 0.001 μV).
Amptd limit too high	The Amplitude Limit value entered is greater than the maximum permitted (+19.9 dBm specified by Special Function 103).
Amptd limit too low	The Amplitude Limit value entered is less than the minimum permitted (−137 dBm specified by Special Function 103).
Amptd offset too large	The amplitude offset value entered is greater than the maximum permitted (50 dB).
Amptd offset too small	The amplitude offset value entered is less than the minimum permitted (−50 dB).
Amptd setting too low	The carrier amplitude value entered is less than the minimum permitted (−137 dBm).
Amptd setting too high	The carrier amplitude value entered is greater than the maximum permitted (+19.9 dBm).
Argument out of range	An attempt was made over HP-IB to send an invalid numeral in the command parameter. For example, sending "FM:STATE 2"(there is no STATE 2), or "FREQ:SYNT 6" (there is no Mode 6 synthesis) would give you this error.
Attenuation too large	The attenuation value entered is greater than the maximum permitted (145 dB).
Attenuation too small	The attenuation value entered is less than the minimum permitted (0 dB).
Audio2 freq too high	With an HP 8644A Option 007, the frequency of the audio source in Channel 2, entered from Special Function 133, is greater than the maximum permitted (400 kHz).
Audio2 freq too low	With an HP 8644A Option 007, the frequency of the audio source in Channel 2, entered from Special Function 133, is less than the minimum permitted (0.1 Hz).

Table D–1. Error Messages Immediately Shown to the User. (2 of 8)

Error Message	Description
`Audio2 level too high`	With an HP 8644A Option 007, the level of the audio source in Channel 2, entered from Special Function 134, is greater than the maximum permitted (2V).
`Audio2 level too low`	With an HP 8644A Option 007, the level of the audio source in Channel 2, entered from Special Function 134, is less than the minimum permitted (0V).
`Audio Φ incr too large`	With an HP 8644A Option 007, the increment value for phase in the audio source is greater than the maximum permitted (359.9°).
`Audio Φ incr too small`	With an HP 8644A Option 007, the increment value for phase in the audio source is less than the minimum permitted (0.1°).
`Audio ΦM dev too large`	With an HP 8644A Option 007, the ΦM deviation for the audio source in Channel 1, entered from Special Function 145, is greater than the maximum permitted (179.9°).
`Audio ΦM dev too small`	With an HP 8644A Option 007, the ΦM deviation for the audio source in Channel 1, entered from Special Function 145, is less than the minimum permitted (0°).
`Audio ΦM freq too high`	With an HP 8644A Option 007, the ΦM frequency for the audio source in Channel 1, entered from Special Function 146, is greater than the maximum permitted (400 kHz).
`Audio ΦM freq too low`	With an HP 8644A Option 007, the ΦM frequency for the audio source in Channel 1, entered from Special Function 146, is less than the minimum permitted (0.1 Hz).
`Audio ΦM incr too large`	With an HP 8644A Option 007, the increment value of ΦM deviation for the audio source in Channel 1, entered from Special Function 145, is greater than the maximum permitted (179.9°).
`Audio ΦM incr too small`	With an HP 8644A Option 007, the increment value of ΦM deviation for the audio source in Channel 1, entered from Special Function 145, is less than the minimum permitted (0.1°).
`Audio AM depth too large`	With an HP 8644A Option 007, the AM depth for the audio source in Channel 1, entered from Special Function 137, is greater than the maximum permitted (100%).
`Audio AM depth too small`	With an HP 8644A Option 007, the AM depth for the audio source in Channel 1, entered from Special Function 137, is less than the minimum permitted (0%).
`Audio AM freq too high`	With an HP 8644A Option 007, the AM frequency for the audio source in Channel 1, entered from Special Function 138, is greater than the maximum permitted (400 kHz).
`Audio AM freq too low`	With an HP 8644A Option 007, the AM frequency for the audio source in Channel 1, entered from Special Function 138, is less than the minimum permitted (0.1 Hz).
`Audio AM incr too large`	With an HP 8644A Option 007, the increment value of AM depth for the audio source in Channel 1, entered from Special Function 137, is greater than the maximum permitted (100%).
`Audio AM incr too small`	With an HP 8644A Option 007, the increment value of AM depth for the audio source in Channel 1, entered from Special Function 137, is less than the minimum permitted (0.1%).

Table D–1. Error Messages Immediately Shown to the User. (3 of 8)

Error Message	Description
Audio FM dev too large	With an HP 8644A Option 007, the FM deviation for the audio source in Channel 1, entered from Special Function 141, is greater than the maximum permitted (400 kHz).
Audio FM dev too small	With an HP 8644A Option 007, the FM deviation for the audio source in Channel 1, entered from Special Function 141, is less than the minimum permitted (0 kHz).
Audio FM freq too high	With an HP 8644A Option 007, the FM frequency for the audio source in Channel 1, entered from Special Function 142, is greater than the maximum permitted (400 kHz).
Audio FM freq too low	With an HP 8644A Option 007, the FM frequency for the audio source in Channel 1, entered from Special Function 142, is less than the minimum permitted (0.1 Hz).
Audio FM incr too large	With an HP 8644A Option 007, the increment value of FM deviation for the audio source in Channel 1, entered from Special Function 141, is greater than the maximum permitted (400 kHz).
Audio FM incr too small	With an HP 8644A Option 007, the increment value of FM deviation for the audio source in Channel 1, entered from Special Function 141, is less than the minimum permitted (0.1 Hz).
Audio freq incr too low	With an HP 8644A Option 007, the audio frequency increment value entered is less than the minimum permitted (0.1 Hz).
Audio freq incr too high	With an HP 8644A Option 007, the audio frequency increment value entered is greater than the maximum permitted (400 kHz).
Audio freq too low	The audio frequency value entered is less than the minimum permitted (300 Hz for an HP 8644A Option 007, and 0.1 Hz for a standard HP 8644A).
Audio freq too high	The audio frequency value entered is greater than the maximum permitted (3 kHz for an HP 8644A Option 007, and 400 kHz for a standard HP 8644A).
Audio level/AM conflict	With an HP 8644A Option 007, the sum of the audio levels in Channels 1 and 2 cannot exceed 2 Vpk with the AM source in Channel 1 ON.
Audio level conflict	With an HP 8644A Option 007, the sum of the audio levels in Channels 1 and 2 cannot exceed 2 Vpk.
Audio level incr high	With an HP 8644A Option 007, the audio level increment value entered is greater than the maximum permitted (2V).
Audio level incr low	With an HP 8644A Option 007, the audio level increment value entered is less than the minimum permitted (1.0 mV).
Audio level too high	The audio level value entered is greater than the maximum permitted (2 V).
Audio level too low	The audio level value entered is less than the minimum permitted (0V).
Aud lev/source conflict	With an HP 8644A Option 007, the sum of the audio levels in Channels 1 and 2 cannot exceed 2 Vpk, and too many audio sources are turned ON.

Table D–1. Error Messages Immediately Shown to the User. (4 of 8)

Error Message	Description
Aud pulse freq too high	With an HP 8644A Option 007, the frequency of the audio pulse entered from Special Function 150 is greater than the maximum permitted (50 kHz).
Aud pulse freq too low	With an HP 8644A Option 007, the frequency of the audio pulse entered from Special Function 150 is less than the minimum permitted (0.1 Hz).
Bad char during numeric	While the instrument was reading in a numeric argument, a character other than "0" through "9" occurred at a place where it is not valid to end the number.
Bad/missing exponent	After getting a valid mantissa and an "E" (for exponential), a character was found that was not a digit "0" through "9" or a ± sign, or the character was not a digit "0" through "9" after an "E+" or an "E−".
Bad register number	The recalled Save Register does not contain a SAVE setting, or the recalled Save Register is less than 0 or greater than 49.
Bad sequence entry	An attempt was made to enter a register value less than 0 or greater than 9 into the Save/Recall Sequence list.
Cannot continue	An attempt has been made to restart diagnostic testing after altering an internal cable or module without being in the repair mode, or you have come to the point where no additional tests are available or the test sequence has ended.
Center freq too high	The center frequency value entered for the sweep is greater than the maximum permitted.
Center freq too low	The center frequency value entered for the sweep is less than the minimum permitted.
Counter setting too low	With an HP 8644A Option 011, an attempt has been made to set the lower limit of the frequency counter range or gate time to an invalid value over the HP-IB bus.
Counter setting too high	With an HP 8644A Option 011, an attempt has been made to set the upper limit of the frequency counter range or gate time to an invalid value over the HP-IB bus.
Empty sequence list	An attempt was made to sequence through an empty Save/Recall sequence list.
EOC during numeric	While the instrument was reading in a numeric argument, an end-of-command (EOC) condition occurred at a place where it is not valid to end the number (for example, after a ± sign, after a decimal with no leading digits, or after an "E" for exponential).
EOM during numeric	While the instrument was reading in a numeric argument, an end-of-message (EOM) condition occurred at a place where it is not valid to end the number (for example, after a ± sign, after a decimal with no leading digits, or after an "E" for exponential).
EOM in #B/Q/H W/O data	An end-of-message (EOM) was encountered without getting any data in, or without getting the "B" (for binary), "Q" (for octal), or "H" (for hexadecimal) while the instrument was reading in a non-decimal numeric argument.

Table D–1. Error Messages Immediately Shown to the User. (5 of 8)

Error Message	Description
`EOM in arbitrary block`	An end-of-message (EOM) was encountered before the end of data while the instrument was reading in an "arbitrary block program data".
`Error-EOC after colon`	An end-of-command (EOC) was encountered after a colon in the command header. A colon in the command header must always be followed by a keyword mnemonic.
`Error-EOC after comma`	An end-of-command (EOC) was found after a comma. A comma in the data string must be followed with an additional data item(s).
`Error-EOM after colon`	An end-of-message (EOM) condition was encountered after a colon in the command header. A colon in the command header must always be followed by a keyword mnemonic.
`Error-EOM after comma`	An end-of-message (EOM) was found after a comma. A comma in the data string must be followed with an additional data item(s).
`Error-Space after colon`	A space character was encountered after a colon in the command header. A colon in the command header must always be followed by a keyword mnemonic.
`Exponent too big`	The numeric exponent was either less than −127 or greater than 127.
`FM deviation too large`	The FM deviation value entered is greater than the maximum permitted. Refer to the specifications in the technical data sheet or to Section 1 in the *Calibration Manual* for FM deviation limits.
`FM deviation too small`	The FM deviation value entered is less than the minimum permitted. Refer to the specifications in the technical data sheet or to Section 1 in the *Calibration Manual* for FM deviation limits.
`FM incr too large`	The FM increment value entered is greater than the maximum permitted (100 MHz).
`FM incr too small`	The FM increment value entered is less than the minimum permitted (0.01 Hz).
`FM out of range for mode`	An attempt was made to change from a Synthesis Mode setting with a higher deviation range, to a Synthesis Mode setting with less deviation range for the set RF output. Push the Synthesis Mode *AUTO* key to let the HP 8644A determine the best mode for the deviation and RF output you have selected.

Table D-1. Error Messages Immediately Shown to the User. (5 of 8 Cont.)

Error Message	Description
`Freq divider too large`	The frequency divider value entered is greater than the maximum permitted (−10 from the front panel, 0.1 over HP-IB).
`Freq incr too large`	The frequency increment value entered is greater than the maximum permitted (10 GHz).
`Freq incr too small`	The frequency increment value entered is less than the minimum permitted (0.01 Hz).
`Freq mult too large`	The frequency multiplier value entered is greater than the maximum permitted (10).
`Freq offset too large`	The frequency offset value entered is greater than the maximum permitted (50 GHz).
`Freq offset too small`	The frequency offset value entered is less than the minimum permitted (−50 GHz).
`Freq setting too high`	The frequency value entered is greater than the maximum permitted.
`Freq setting too low`	The frequency value entered is less than the minimum permitted.

Table D–1. Error Messages Immediately Shown to the User. (6 of 8)

Error Message	Description
Frequency span too large	The frequency span value entered for the sweep is greater than the maximum permitted.
Frequency span too small	The frequency span value entered for the sweep is less than the minimum permitted.
Hardware not installed	An attempt was made to activate a Synthesis Mode setting presently not installed in the instrument.
HP\IB Command error	This is a generic HP-IB command error. Something is wrong with the command, but the firmware does not recognize the specific problem.
HP\IB No response data	The instrument was given the HP-IB interface command to "talk", but has not been told to "say" anything.
HP\IB Query interrupted	The instrument was given a command to return some data, then given another command before the entire response was read back from the instrument.
HP\IB Query unterminated	The instrument was given the HP-IB interface command to talk, and has received part of a message including a command to return some data, but the message was not terminated (not completely sent, or no end-of-message sent).
Insufficient capability	An attempt has been made to activate a function or feature presently not configured or accessible.
Int modulation enabled	An attempt has been made over HP-IB to turn off the audio source with the internal modulation source turned on.
Invalid char after ''.''	While the instrument was reading in a numeric argument, a character other than "0" through "9", or an "E" (for exponential) with no digits before the decimal occurred.
Invalid char after sign	While the instrument was reading in a numeric argument, a character other than "0" through "9", or a decimal point occurred after the ± sign.
Invalid data mnemonic	A mnemonic was not recognized as the instrument was reading in a non-numeric parameter.
Invalid header mnemonic	A keyword mnemonic in the command header is not recognized as a keyword. Incorrect protocol or a spelling mistake might be the cause.
Invalid suffix	While the instrument was reading in a numeric argument, an invalid suffix occurred after a comma, semicolon, or end-of-command.
Log sweep not allowed	An attempt has been made to do phase continuous log sweep.
Marker freq too high	The marker frequency value entered is greater than the maximum permitted.
Marker freq too low	The marker frequency value entered is less than the minimum permitted (251,464.85 Hz).
Missing space after ''?''	A non-blank character other than a semicolon followed a question mark. The question mark must either be followed by an end-of-message, an end or command, or a space before a parameter.

Table D-1. Error Messages Immediately Shown to the User. (7 of 8)

Error Message	Description
Mod and sweep conflict	An attempt was made to phase continuous sweep with internal modulation on, or with internal or external FM, ΦM, or the audio source turned on.
Needs space after header	The characters following the command header must have a space or an end-of-command message.
No manual Φ cont. sweep	An attempt was made to do Manual phase continuous sweep.
No such special	An invalid Special Function number was entered. Refer to Appendix C for a list of available Special Functions.
Not allowed\Security on	An attempt has been made to turn on a "Blanked" display area when the security Special Function 173 is active.
Notice >> FM turned off	An attempt was made to turn on ΦM with FM on, or an attempt was made to go from CW to sweep or from sweep to CW with FM set to a value out of range for the frequency that was entered.
Notice >>ΦM turned off	An attempt was made to turn on FM with ΦM already on.
Notice Aud state changed	A conflict has occured which causes a subcarrier modulation source to be turned off in order to allow modulation on the RF carrier.
Not in service mode	An attempt has been made over HP-IB to access a service Special Function that is not accessible because the service mode switch has been turned off.
Numeric overflow	The number was out of range for the parameter being set.
Reference cal too high	The reference calibration value entered is greater than the maximum permitted (255).
Reference cal too low	The reference calibration value entered is less than the minimum permitted (0).
Reverse power detected	A reverse power condition was detected at either the RF Output. (Disconnect the affected output from any external equipment and re-enter the key sequence that originally resulted in the error. If an error is still detected by the instrument, a reverse power problem still exists.)
Sequence overflow	An attempt was made to enter more than 10 entries into the Save/Recall Sequence list.
Settings conflict	Certain operating conditions are in conflict. For example, an attempt was made over HP-IB to set the Amplitude Limit to a value less than the current amplitude setting.
Start frequency too high	The start frequency value entered for the sweep is greater than the maximum permitted.
Start frequency too low	The start frequency value entered for the sweep is less than the minimum permitted.

Table D-1. Error Messages Immediately Shown to the User. (8 of 8)

Error Message	Description
`Stop frequency too high`	The stop frequency value entered for the sweep is greater than the maximum permitted.
`Stop frequency too low`	The stop frequency value entered for the sweep is less than the minimum permitted.
`Sweep settings conflict`	An attempt was made over HP-IB to send a command message with conflicting sweep statements.
`Sweep time too large`	The sweep time value entered is greater than the maximum permitted. Refer to the specifications in the technical data sheet or to Section 1 in the *Calibration Manual* for sweep time limits.
`Sweep time too small`	The sweep time value entered is less than the minimum permitted. Refer to the specifications in the technical data sheet or to Section 1 in the *Calibration Manual* for sweep time limits.
`Too many audio sources`	With an HP 8644A Option 007, there cannot be more than three other audio sources turned ON with the audio source in Channel 1 turned ON.
`Too many commands`	Too many commands were sent in a single message. The message must be broken up into several messages with less commands in each one.
`Unexpected ''?''`	A question mark was found in the data string. A question mark should only occur immediately after the command header.
`Unexpected colon`	A colon was found in the command header in an invalid location (for example, after another colon, after a question mark, or found with a command parameter).
`Unexpected comma`	A comma was found in the command header, before the first argument, or after another comma. Commas are only allowed between certain arguments in the command header or message.
`Unexpected EOC`	An unexpected end-of-command (EOC) condition was found by the instrument before a valid command was complete. This includes not having a required parameter in a command.
`Unexpected EOM`	An unexpected end-of-message (EOM) condition was found by the instrument before a valid command was complete. This includes not having a required parameter in a command.
`Unrecognized ''#'' format`	In a non-decimal numeric argument you must use a binary, octal, hexadecimal, or "arbitrary block program data" format.
`Wrong char after suffix`	An unexpected character was encountered by the instrument after reading in a numeric suffix. This may indicate a missing comma, semicolon, or an end-of-message.
`Wrong position for ''?''`	A question mark was found at the start of the message, after a colon or a space, or after an argument or a suffix. Question marks must follow directly after command header mnemonics.

Table D–2. Error Messages Put In the Message Queue for the User. (1 of 4)

Error Message	Description
Hardware Failure 1	A communications discriminator failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 2	A VCO failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 3	A Fractional-N failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 4	A modulation distribution failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 5	An ALC failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 6	An attenuator failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 7	An audio source failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 8	A reference failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 9	A doubler failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 13	A front panel failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 14	A power supply failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 15	An I/O board failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.

Table D–2. Error Messages Put In the Message Queue for the User. (2 of 4)

Error Message	Description
Hardware Failure 16	A controller failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 18	A frequency counter failure has been detected at power up. Refer to figure D–1 for corrective action.
Hardware Failure 21	A communications discriminator out-of-lock (OOL) condition exists. Refer to figure D–1 for corrective action.
Hardware Failure 23	A Fractional-N (NF) phase-locked-loop (PLL) out-of-lock (OOL) condition exists. Refer to figure D–1 for corrective action.
Hardware Failure 24	A VCO frequency-locked-loop (FLL) out-of-lock (OOL) condition exists. Refer to figure D–1 for corrective action.
Hardware Failure 25	A VCO phase-locked-loop (PLL) out-of-lock (OOL) condition exists. Refer to figure D–1 for corrective action.
Hardware Failure 26	A fast controller failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 27	An audio source out-of-lock (OOL) condition exists. Refer to figure D–1 for corrective action.
Hardware Failure 28	A reference out-of-lock (OOL) condition exists. Refer to figure D–1 for corrective action.
Hardware Failure 31	A ROM failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 32	A ROM failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 33	A ROM failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.

Table D–2. Error Messages Put In the Message Queue for the User. (3 of 4)

Error Message	Description
Hardware Failure 34	A ROM failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 35	A voltmeter failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Hardware Failure 36	A RAM failure has been detected at power up, or detected as a result of a self-calibration or self-test. Refer to figure D–1 for corrective action.
Calibration Error 1	A condition occurred where invalid level calibration data resides in either the Output or the Attenuator modules. Follow the external calibration procedures outlined in figure D–1 .
Calibration Error 2	At some time during the calibration or self-test, a condition occurred where some hardware was unable to be calibrated. Fix the hardware and re-calibrate. Refer to figure D–1 for corrective action. This error message will always be accompanied by other error messages.
Calibration Error 3	A sensor indicates that inside temperature has varied $\pm 10°$ Centigrade ($\pm 18°$ Fahrenheit) from where the temperature was when the instrument was last calibrated. A re-calibration by activating Special Function 171 may be necessary for the instrument to maintain its specifications.
Amplitude Error 1	An Automatic-Level-Control (ALC) out-of-lock (OOL) condition exists. An operating condition may have caused the OOL error, or a hardware problem may exist; check out both possibilities.
Amplitude Error 2	A doubler amplitude out-of-lock (OOL) condition exists. An operating condition may have caused the OOL error, or a hardware problem may exist; check out both possibilities.
User Memory Cleared	A memory failure has been detected, all battery backup memory is lost. Refer to figure D–1 for corrective action.
Reverse power detected	A reverse power condition was detected at the RF Output. (Disconnect the affected output from any external equipment and re-enter the key sequence that originally resulted in the error. If an error is still detected by the instrument, a reverse power problem still exists.)

Note

The "Transient Errors" listed in the following table (4 of 4) will only appear if Special Function 328 is activated. Refer to the Service Documentation for corrective action if you see one of these messages.

Table D-2. Error Messages Put In the Message Queue for the User. (4 of 4)

Error Message	Description
`Transient Error 1`	A transient communications discriminator out-of-lock (OOL) condition occurred. Refer to the service documentation for corrective action.
`Transient Error 3`	A transient Fractional-N (NF) phase-locked-loop (PLL) out-of-lock (OOL) condition occurred. Refer to the service documentation for corrective action.
`Transient Error 5`	A transient Automatic-Level-Control (ALC) out-of-lock (OOL) condition occurred. Refer to the service documentation for corrective action.
`Transient Error 7`	A transient audio source out-of-lock (OOL) condition occurred. Refer to the service documentation for corrective action.
`Transient Error 8`	A transient reference out-of-lock (OOL) condition occurred. Refer to figure D–1 for corrective action.
`Transient Error 9`	A transient doubler out-of-lock (OOL) condition occurred. Refer to figure D–1 for corrective action.
`Transient Error 24`	A transient VCO frequency-locked-loop (FLL) out-of-lock (OOL) condition occurred. Refer to the service documentation for corrective action.
`Transient Error 25`	A transient VCO phase-locked-loop (PLL) out-of-lock (OOL) condition occurred. Refer to the service documentation for corrective action.

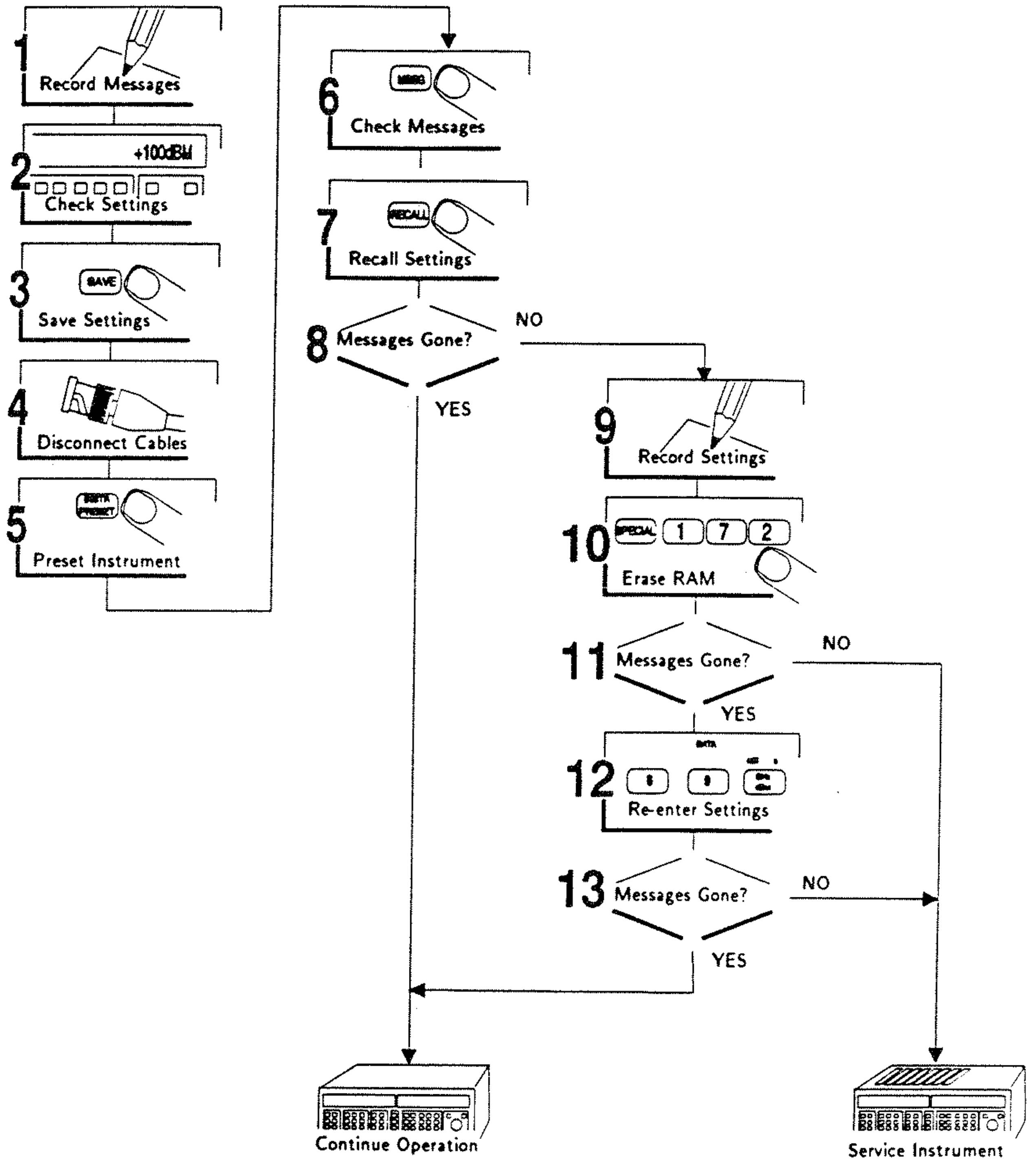


Figure D-1. Corrective Action for Error Messages

E HP-SL Quick Reference Guide

Introduction to HP-SL Syntax Drawings

This appendix provides syntax drawings with Hewlett-Packard System Language (HP-SL) information for remote operation of the HP 8644A over the Hewlett-Packard Interface Bus (HP-IB). Use this appendix once you are familiar with the basic structure of HP-SL. Refer to Chapter 4 *What About Programming?* for an introduction to HP-SL, and for programming reference information.

Command Statements

Command statements are used to either modify or query the HP 8644A. A general representation of a command statement is shown in figure E–1. Keywords are recognized in the command statement as those listed in either the *HP-IB Control Language Dictionary* or the *HP-SL Device Status Dictionary*.

Keywords may be followed by a question mark for a query, or by a space and then a command parameter (as described in the *HP-SL Notes* in Chapter 4).

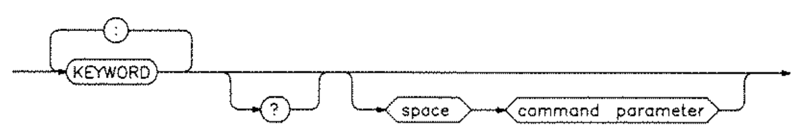


Figure E–1. Command Statement Syntax Drawing.

Command Message

One or more command statements on a line of programming code make up a command message. A general representation of a command message is shown in figure E–2. All command messages are terminated by either a new line (ASCII character 10), or an HP-IB end or identify (EOI). (The EOI is not a separate character but is a bus message sent along with a data character "new line" or the last character of the command statement.)

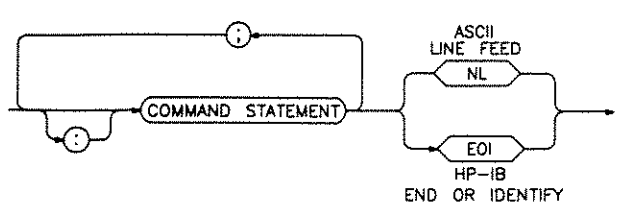
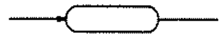


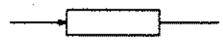
Figure E–2. Command Message Syntax Drawing.

Subsystem Syntax

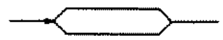
All subsystem syntax drawings are represented pictorially. The following rules apply to all syntax drawings:



- A rounded envelope indicates that the HP-SL command must be included in the command statement.



- A rectangular box indicates an optional HP-SL command which may or may not be included in the command statement.



- A diamond shaped envelope usually indicates a command parameter preceeded by a space, and in some cases the diamond shaped envelope is used to indicate that a "term" (terminator) is required to finish the command statement. Refer to the *HP-SL Notes* shown below for a description of each command parameter.

MINimum

- Any HP-SL command written in *italics* is an alias to another HP-SL command.

HP-SL Notes

<AM term> indicates that a "%" or "PCT" termination is required. " % " is assumed as the default value .

<ampl step term> indicates that a "dB", "V", "mV", "uV" termination is required. "dB" is assumed as the default value.

<ampl step unit> indicates that a "dB", or "V" termination must be specified.

<ampl term> indicates that "dBm", "dBmW" ("dBmW" is alias for "dBm"), "dBuV", "V", "mV", "uV", or no termination is required.

<ampl unit term> indicates that a "dBm", "dBmW", "V", or "dBuV" termination must be specified.

<angle term> indicates that a "DEG", "RAD", or no termination must be specified. "RAD" (radian) is assumed as the default value.

<coupling type> indicates that sources "AC", "DC", "GROund", or "GND" are available.

<freq term> indicates that "HZ", "KHZ", "MHZ", "MAHZ", "GHZ", or no termination is required. "HZ" is assumed as the default value.

<lin ampl term> indicates that "V", "mV", "uV", or no termination is required. "V" is assumed as the default value.

<mod_type> indicates that "AM", "FM", "PM", or "PULSe" is required.

<non-decimal numeric program data> indicates that the pound symbol "#" should be followed by either a "B" and a binary representation of a number, or "Q" and a octal representation of a number, or "H" and a hexadecimal representation of a number.

<nrf> indicates that an ASCII representation of a number is required.

<ohms term> indicates that an "OHM", "KOHM", "MOHM" or no termination is required. "OHM" is assumed as the default value.

<source list> indicates that "INTernal", or "EXTernal", or more than one source separated by commas is required.

<space> indicates an ASCII character in the range of 0 through 9 or 11 through 32 decimal.

<time term> indicates that "S", "mS", "uS", "nS" or no termination is required. "S" (seconds) is assumed as the default value.

Table of Contents

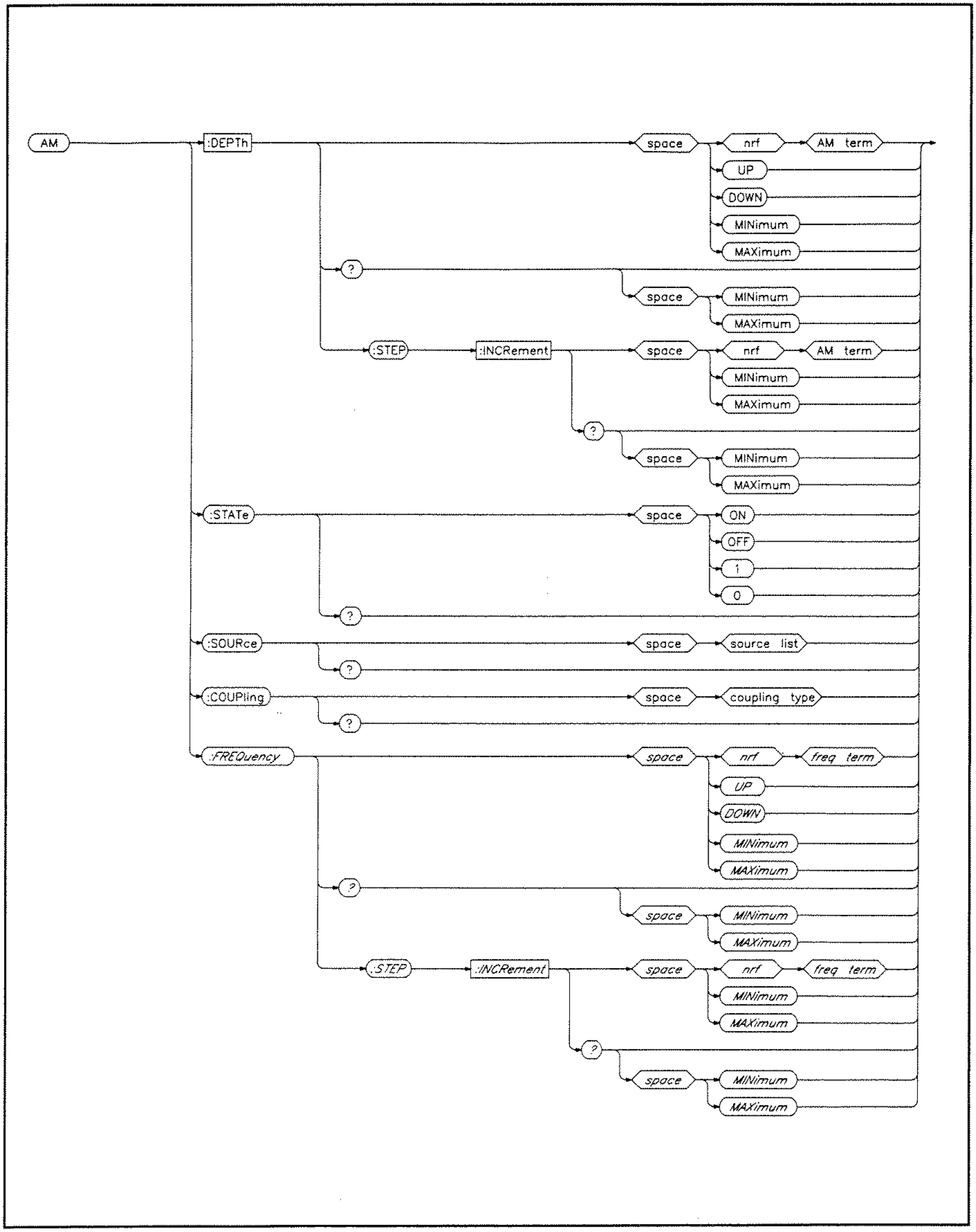


Figure E-3. AM Subsystem.

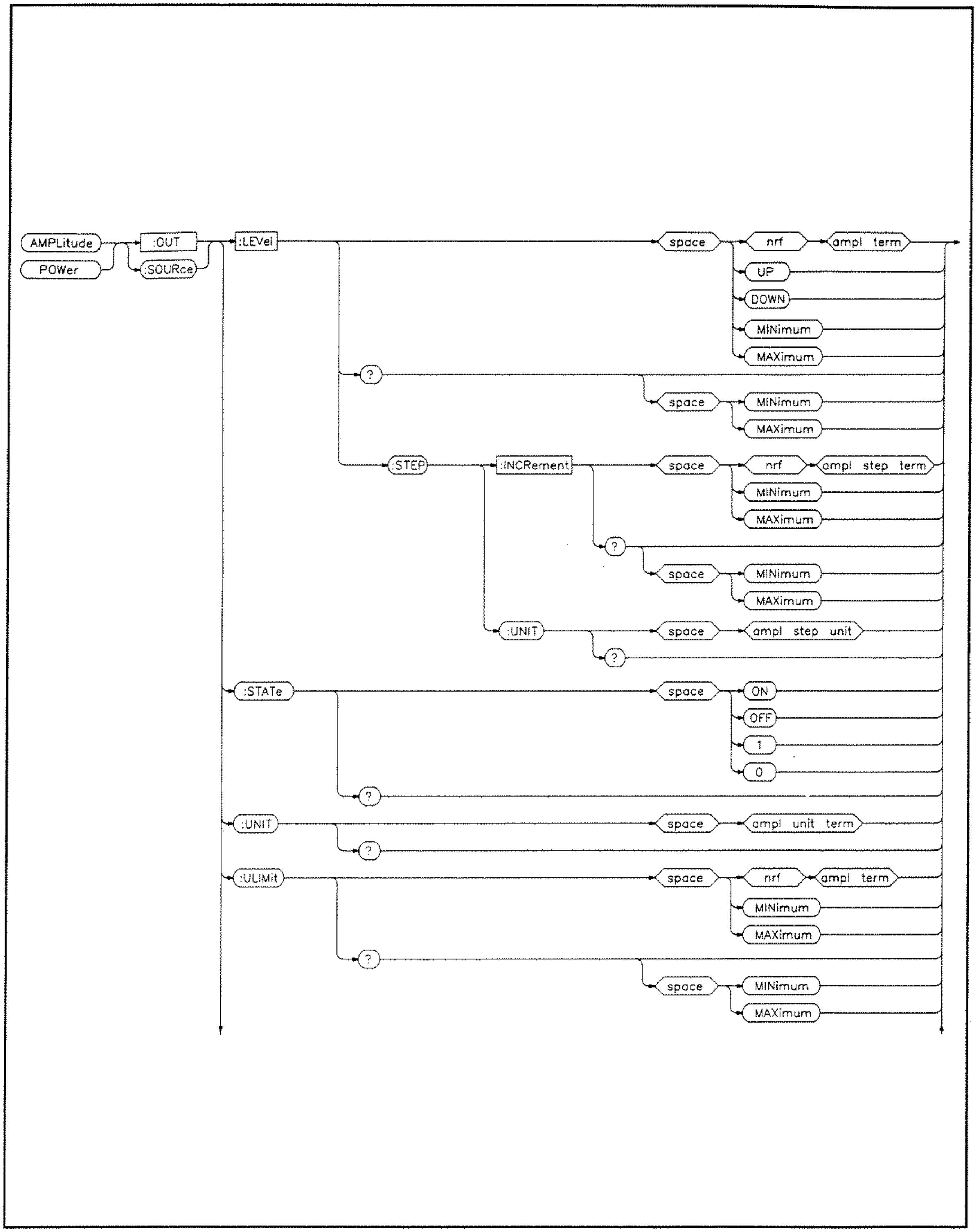


Figure E–4. Amplitude Subsystem. (1 of 2)

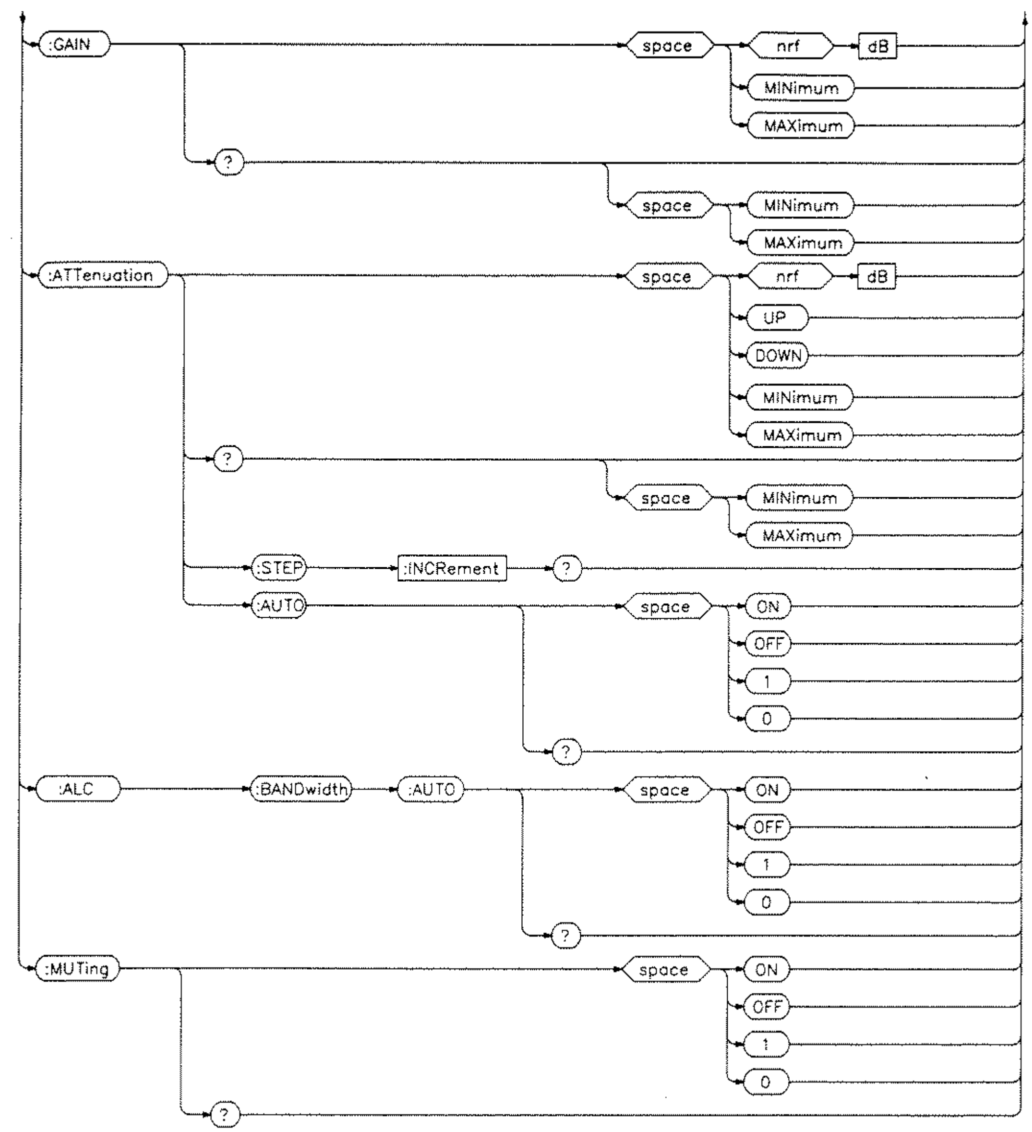


Figure E-4. Amplitude Subsystem. (2 of 2)

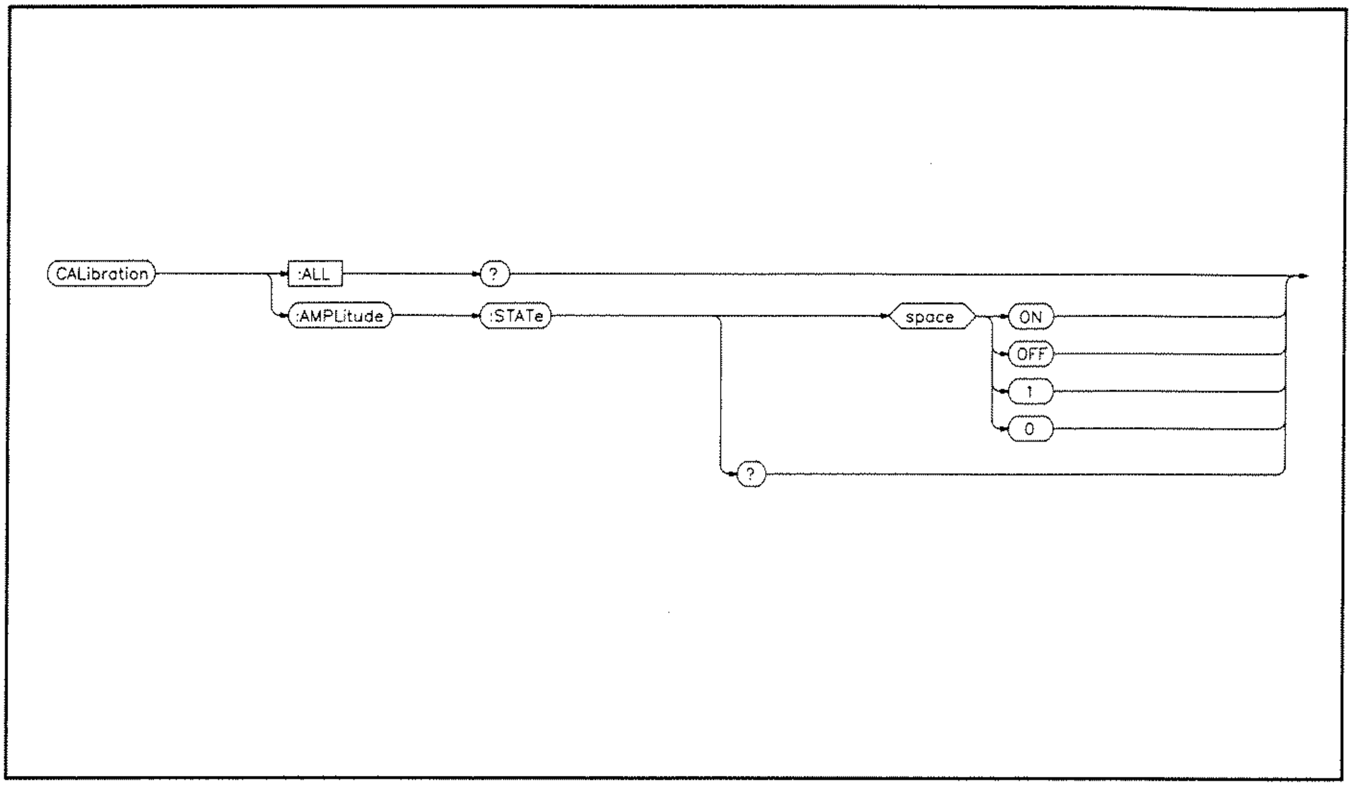


Figure E-5. Calibration Subsystem.

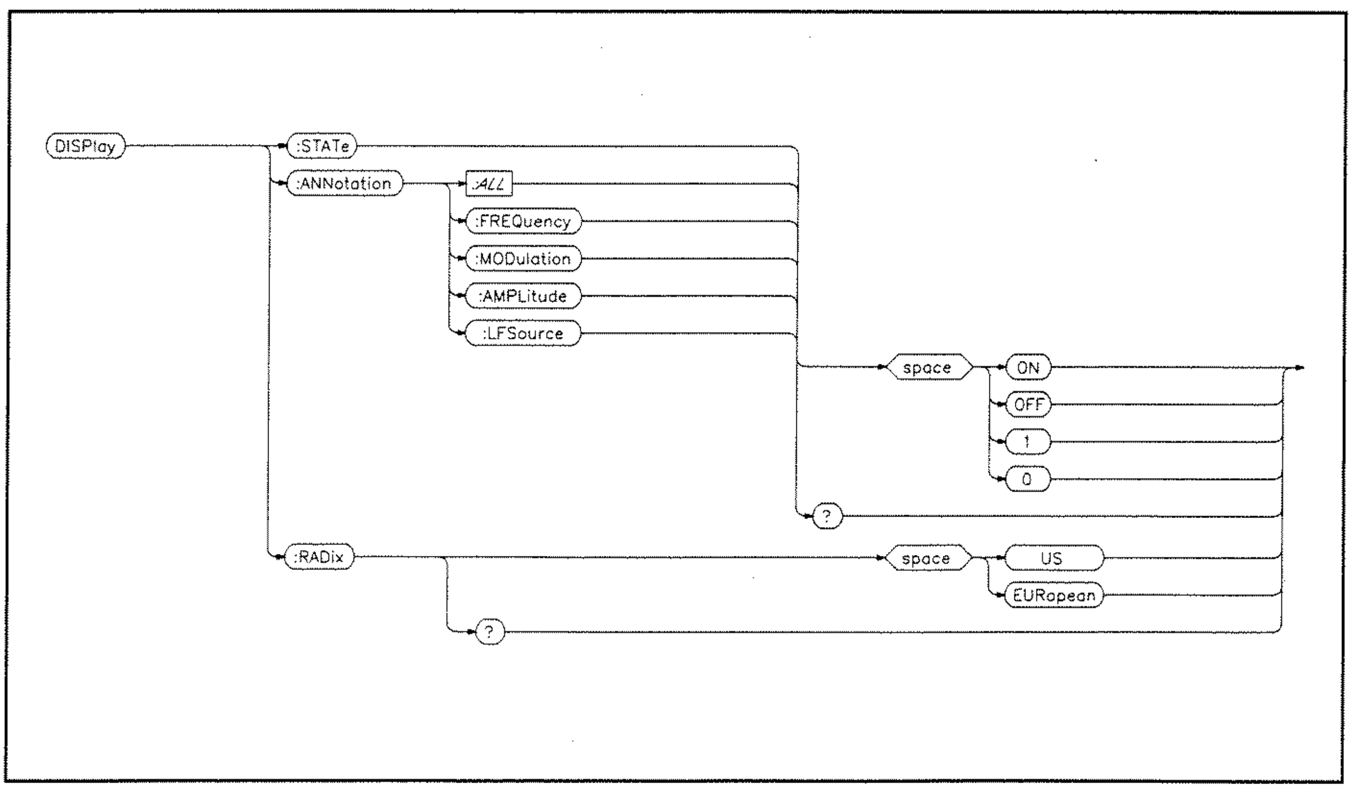


Figure E-6. Display Subsystem.

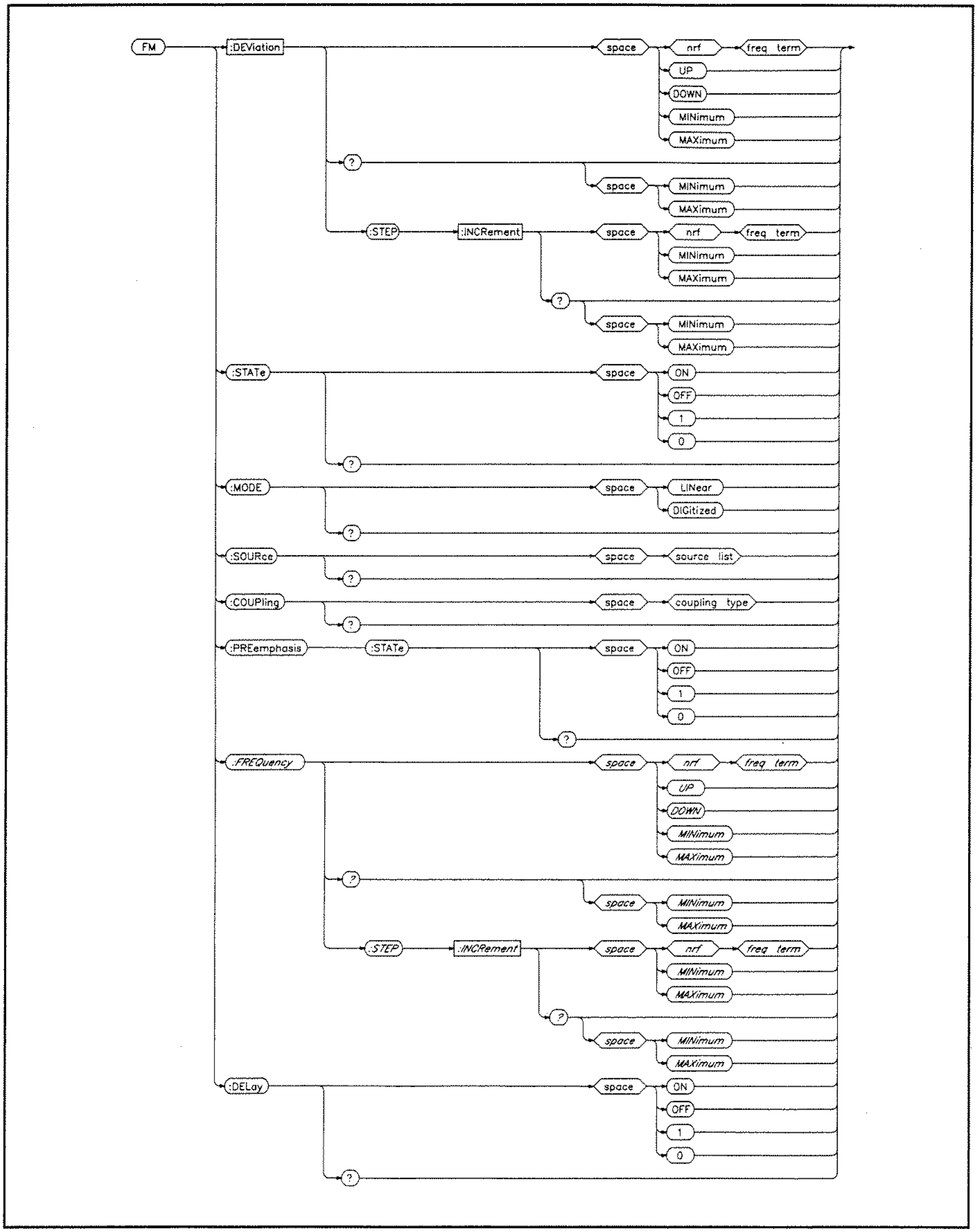


Figure E-7. FM Subsystem.

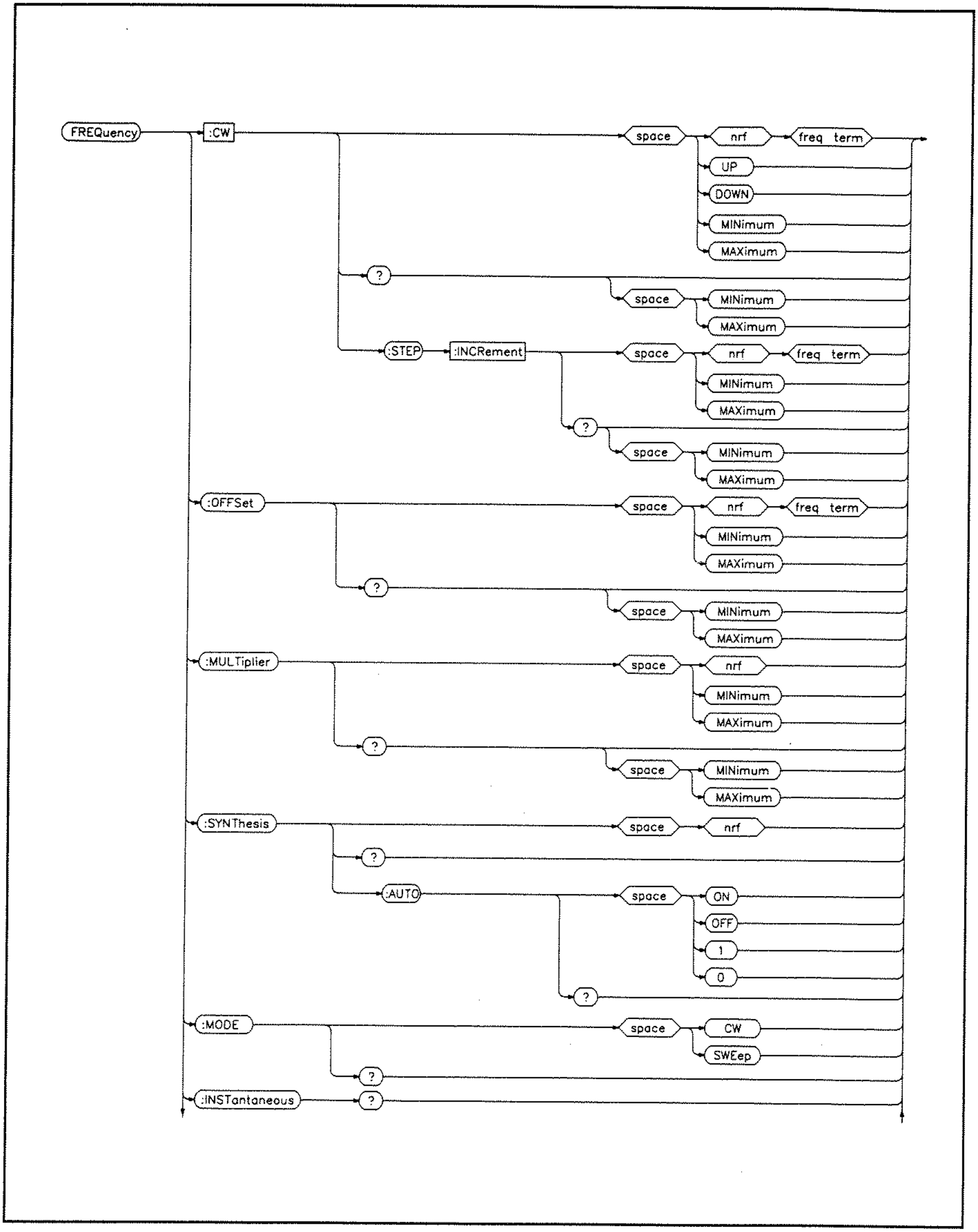


Figure E-8. Frequency Subsystem. (1 of 2)

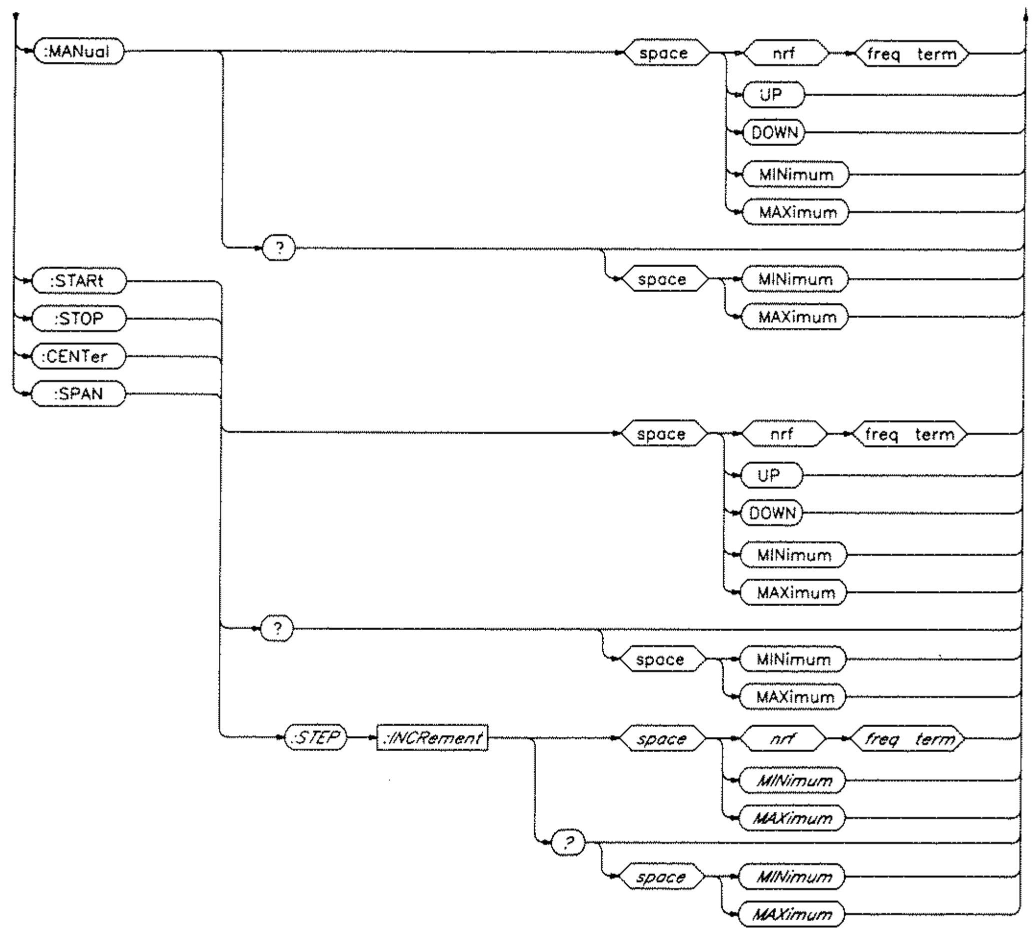


Figure E–8. Frequency Subsystem. (2 of 2)

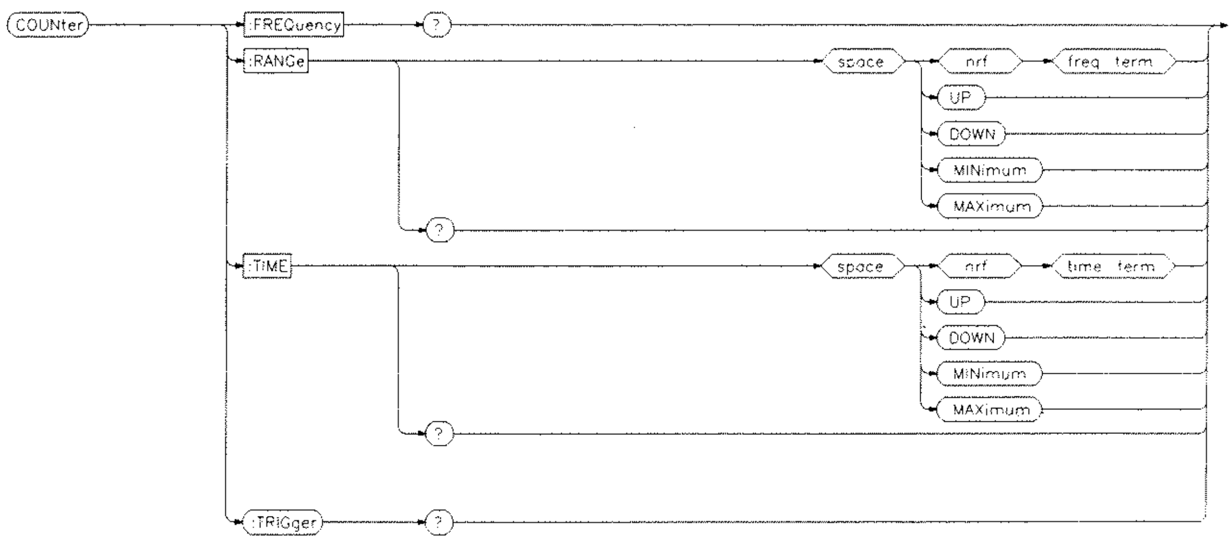


Figure E–8.1. Frequency Counter Subsystem.

rev.30MAY90

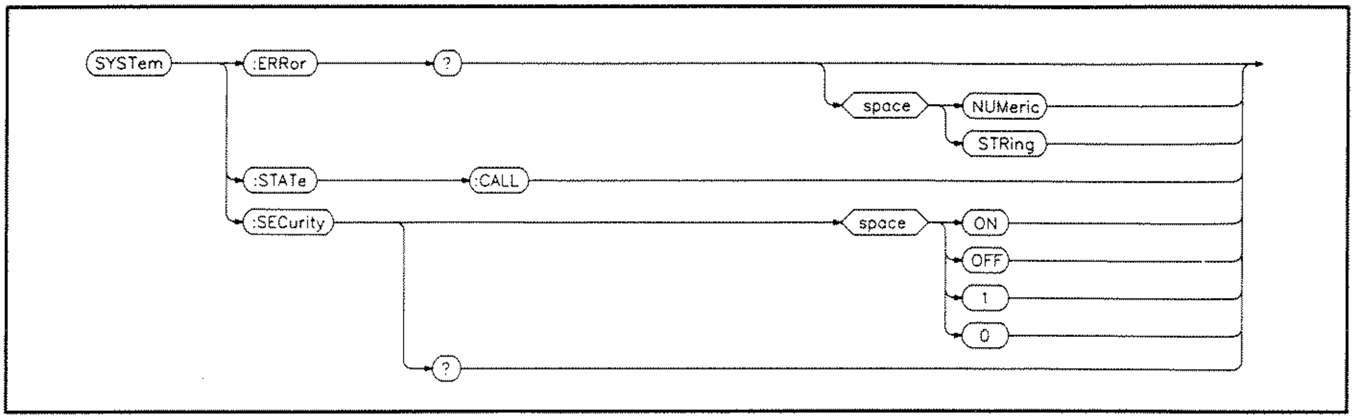


Figure E-9. HP-SL System Commands.

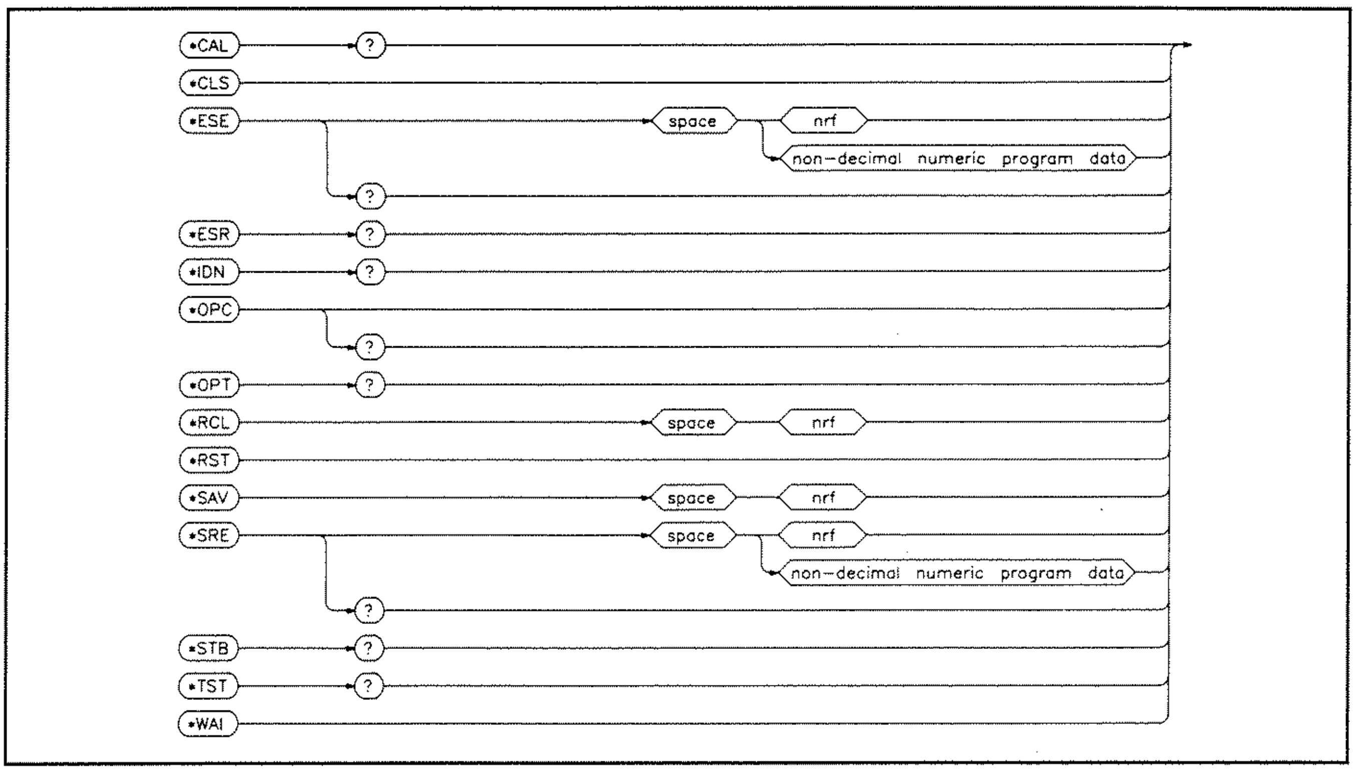


Figure E-10. IEEE 488.2 Common Commands.

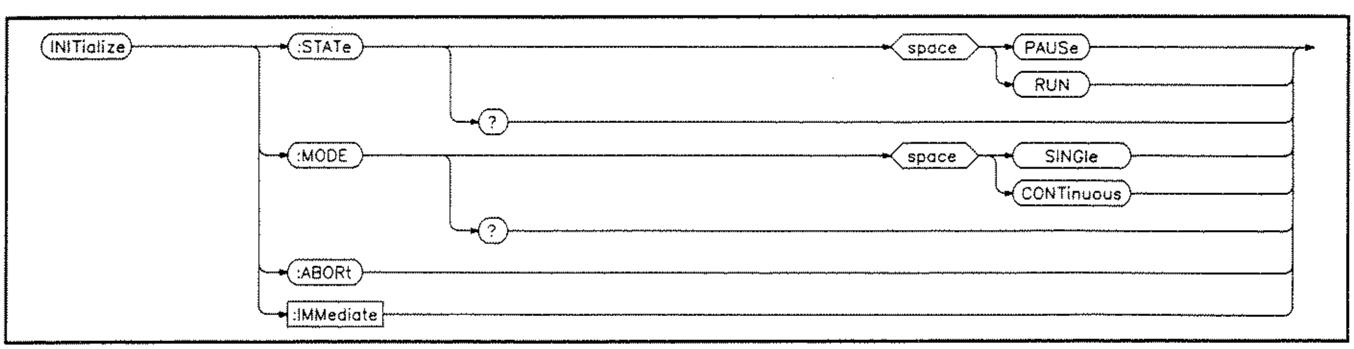


Figure E-11. Initialize Subsystem.

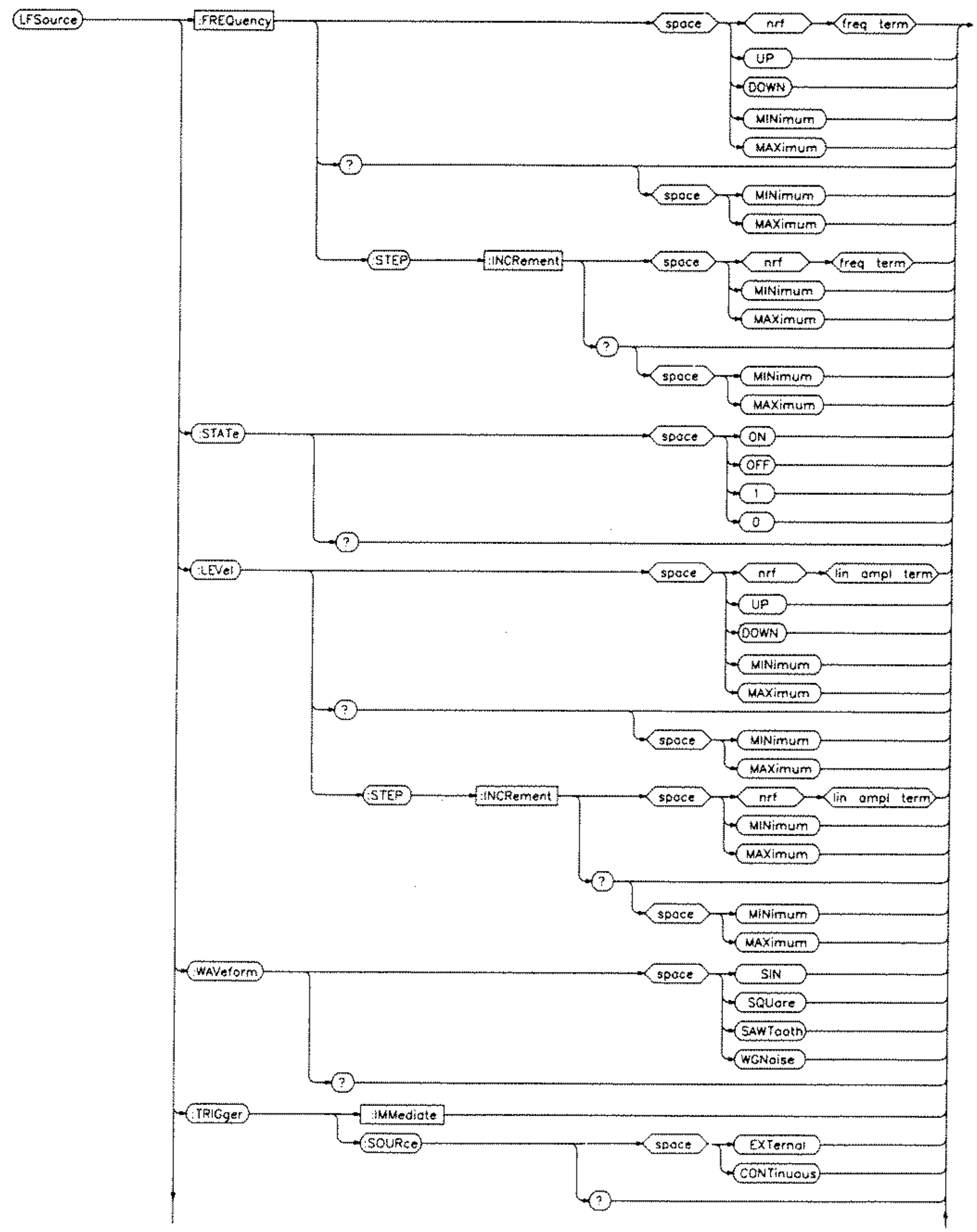


Figure E-12. LF Source Subsystem. (1 of 6)

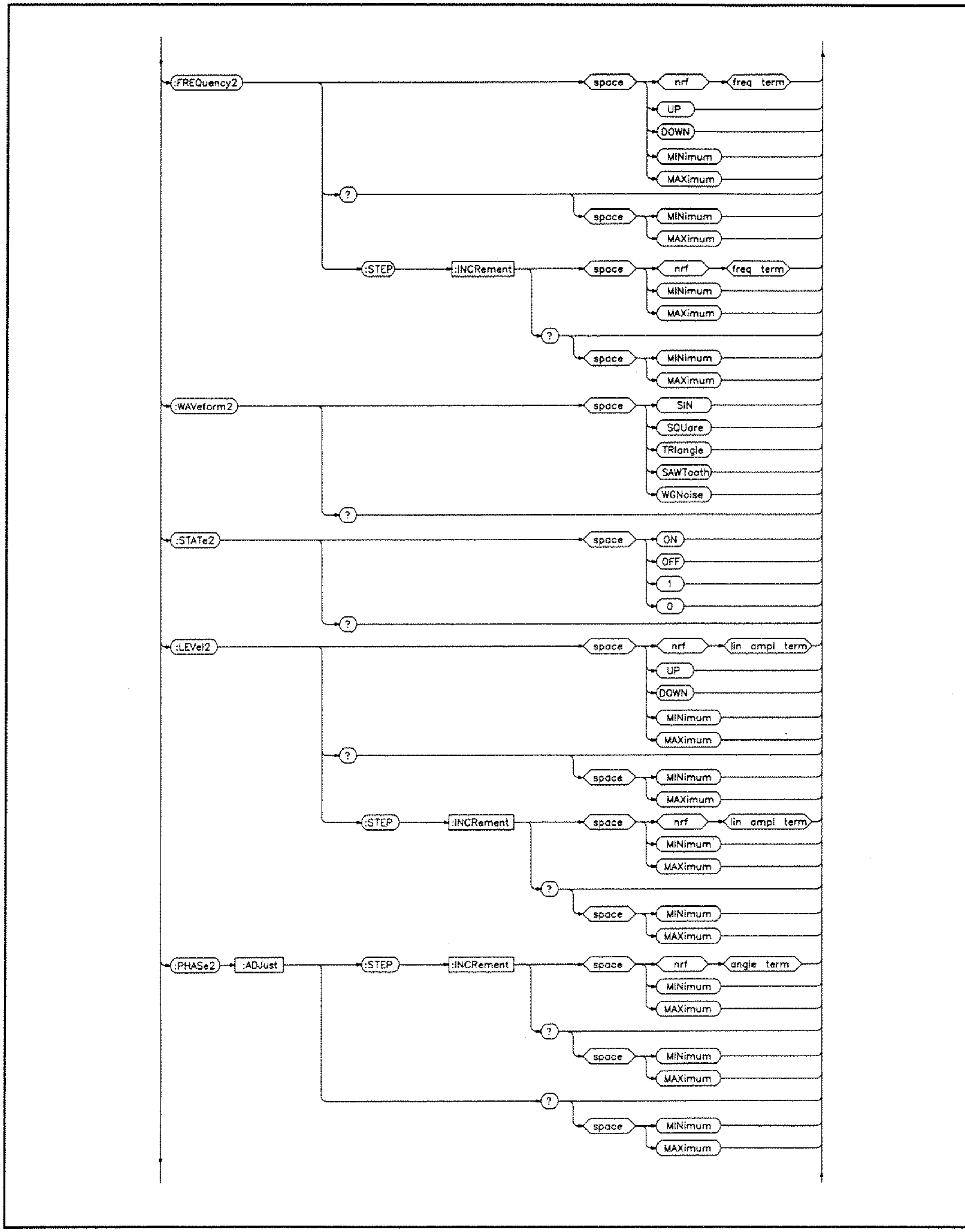


Figure E–12. LF Source Subsystem. (2 of 6)

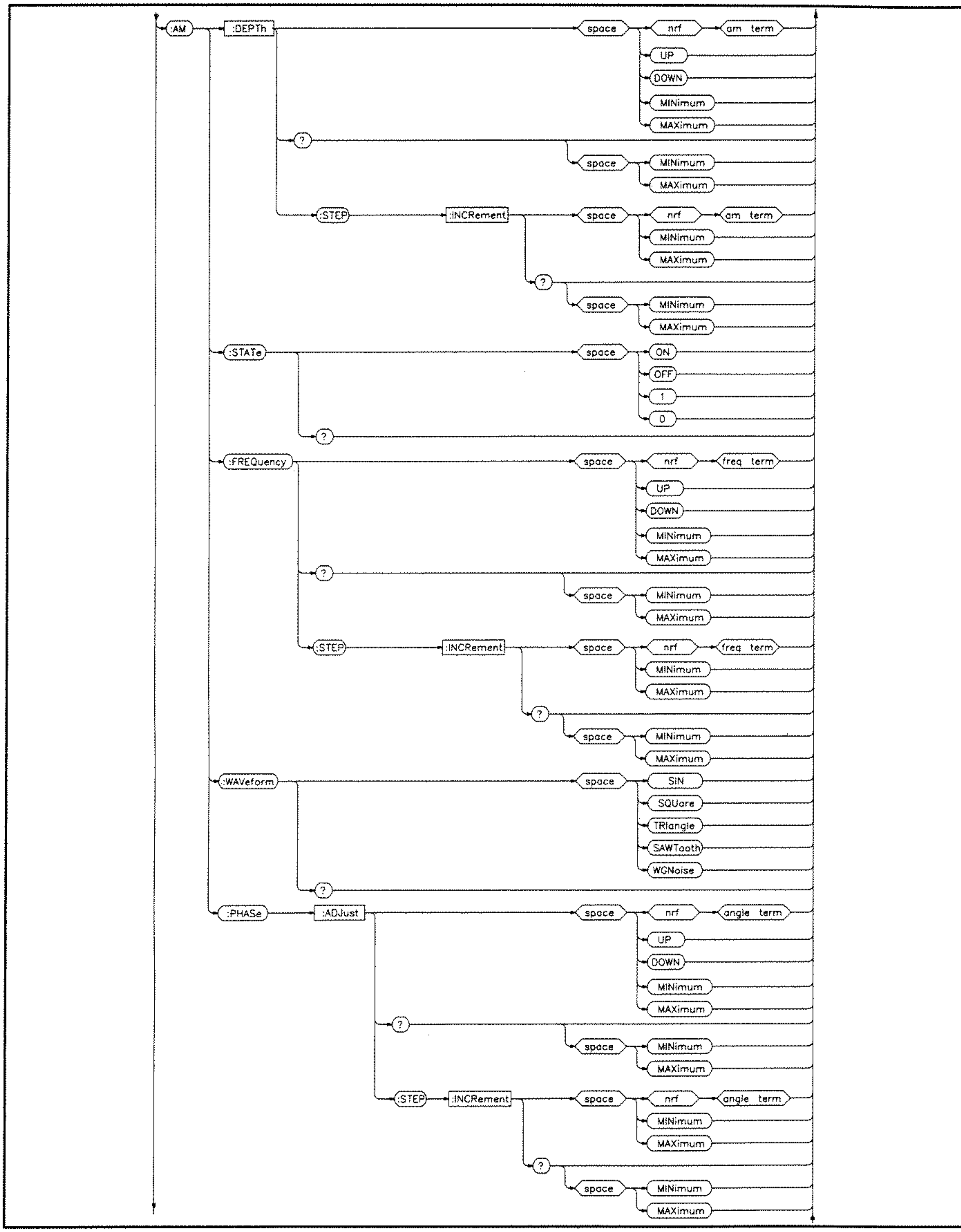


Figure E-12. LF Source Subsystem. (3 of 6)

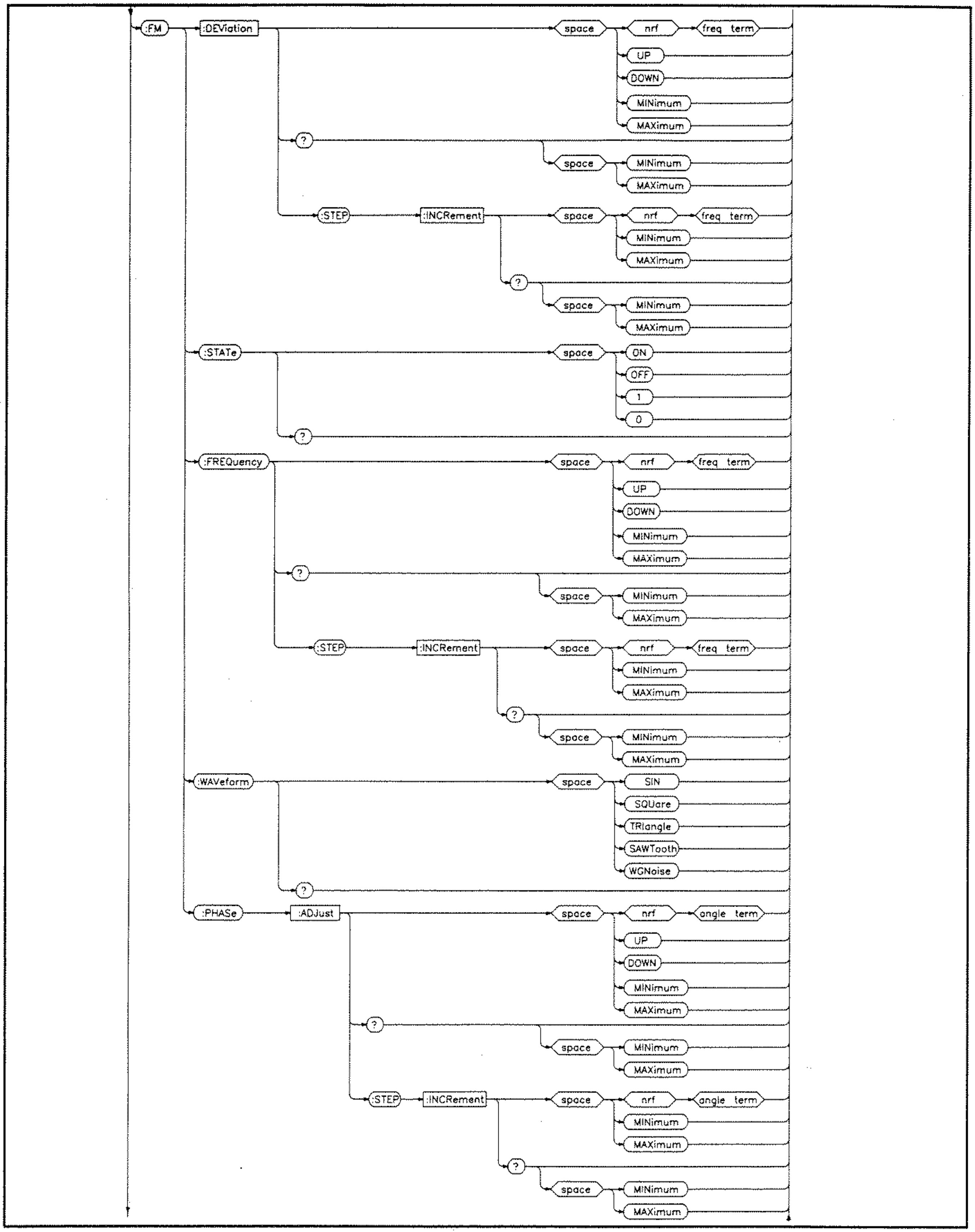


Figure E-12. LF Source Subsystem. (4 of 6)

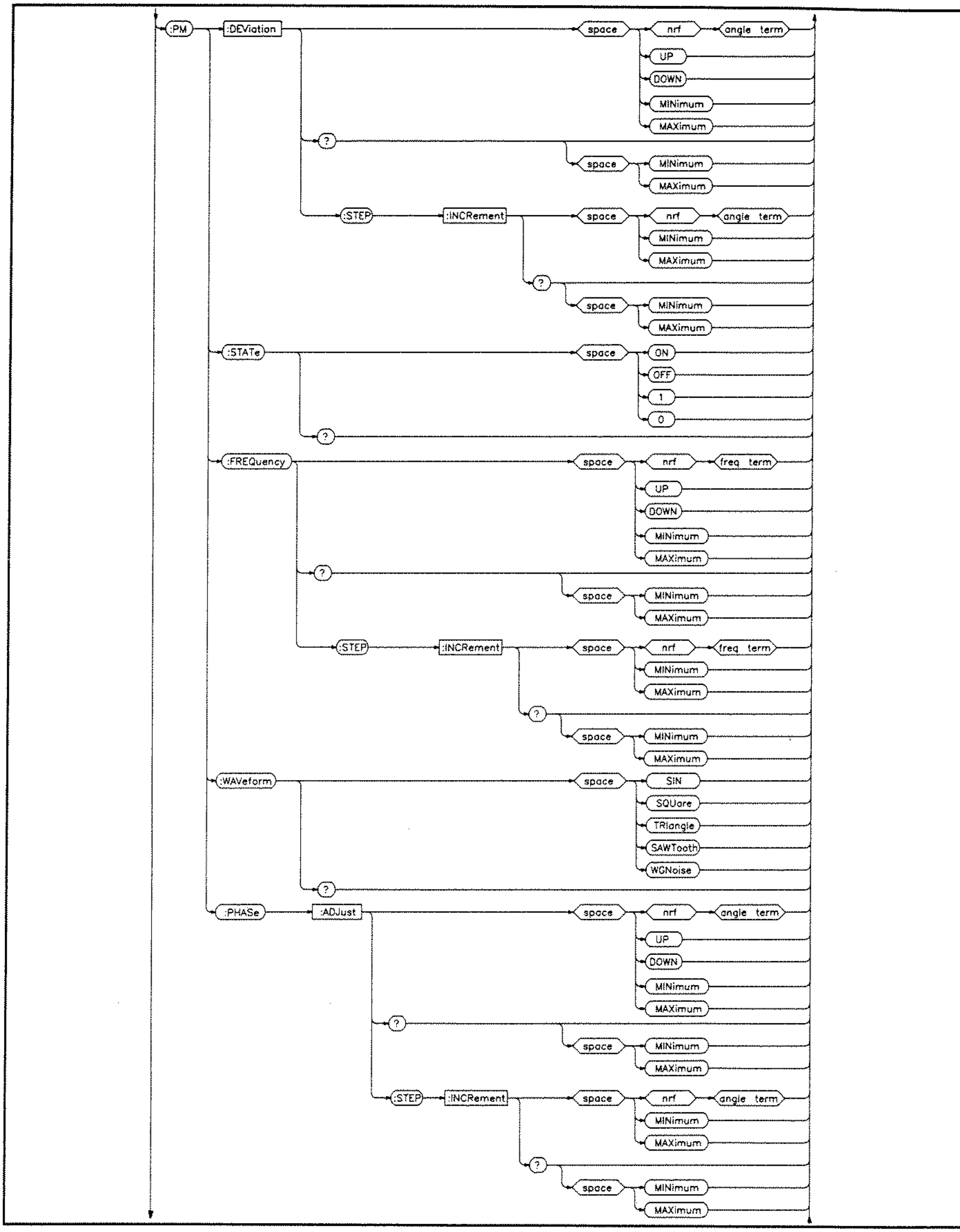


Figure E-12. LF Source Subsystem. (5 of 6)

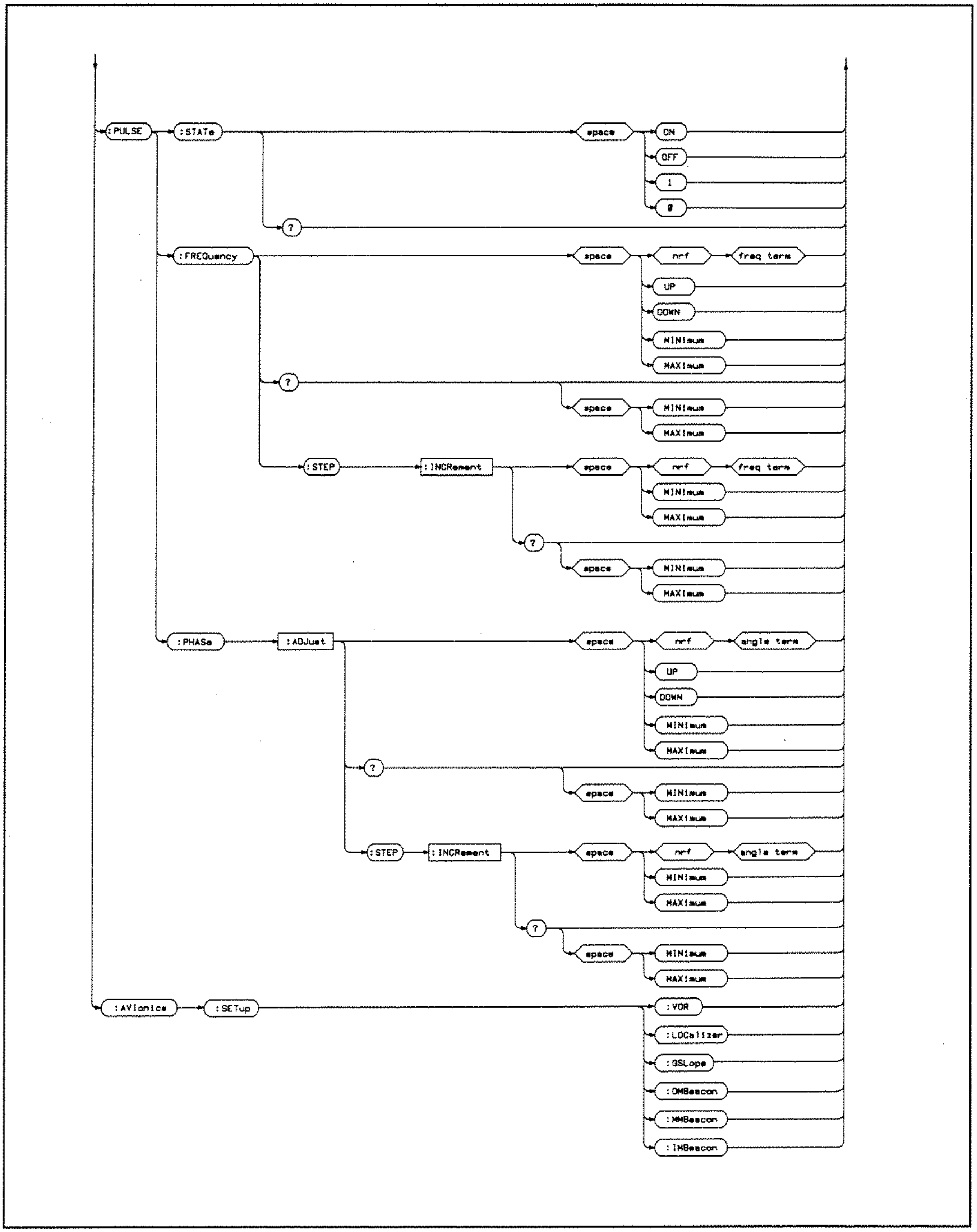


Figure E-12. LF Source Subsystem. (6 of 6)

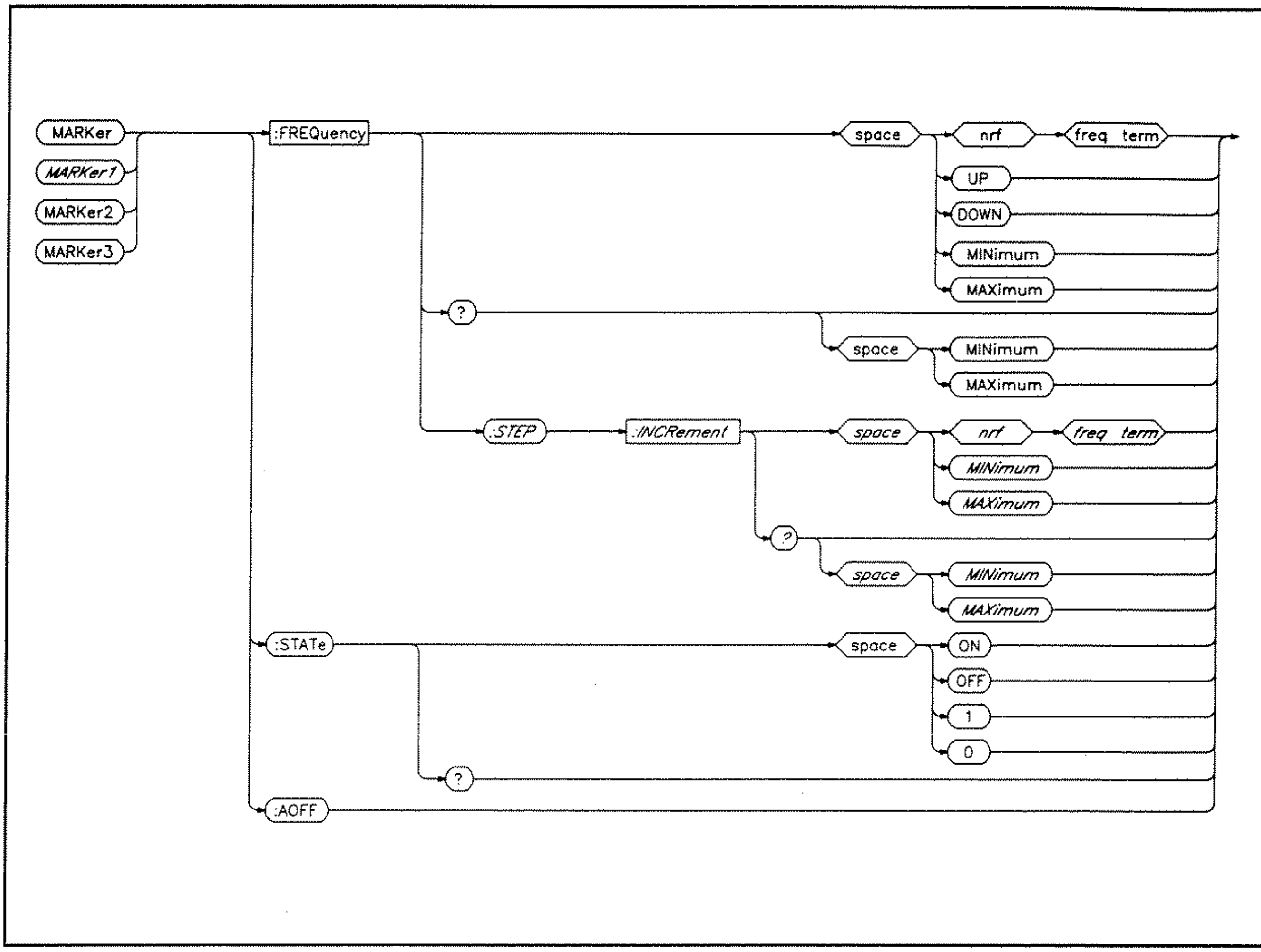


Figure E-13. Marker Subsystem.

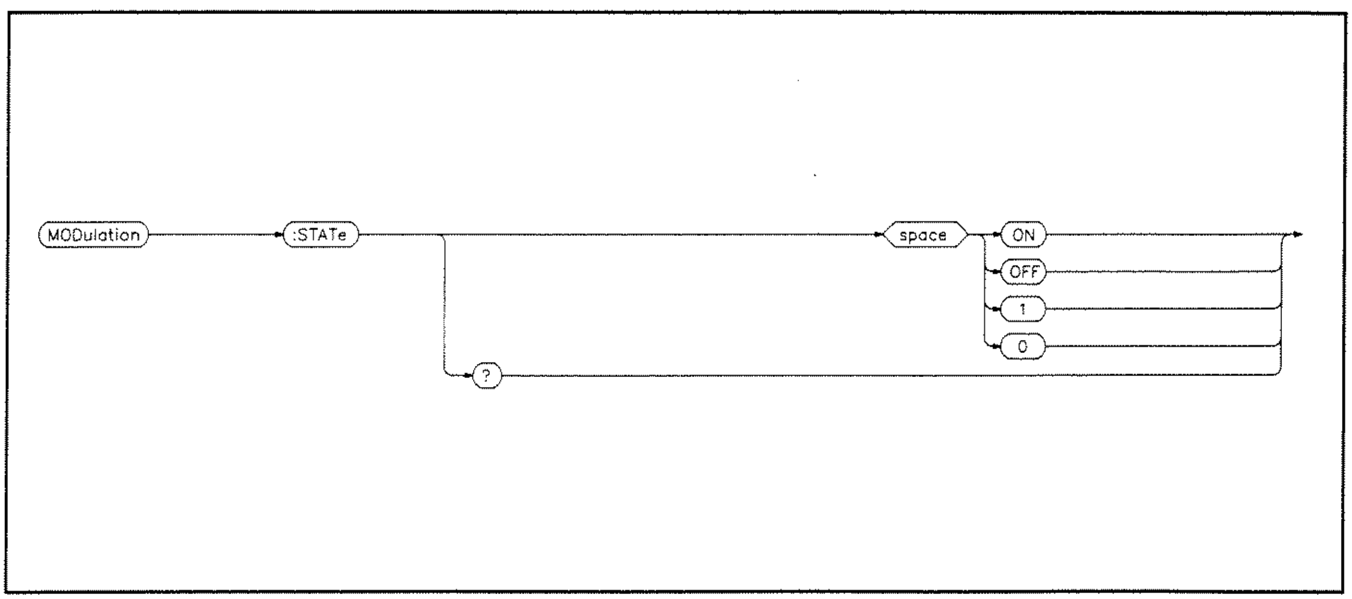


Figure E-14. Modulation Subsystem.

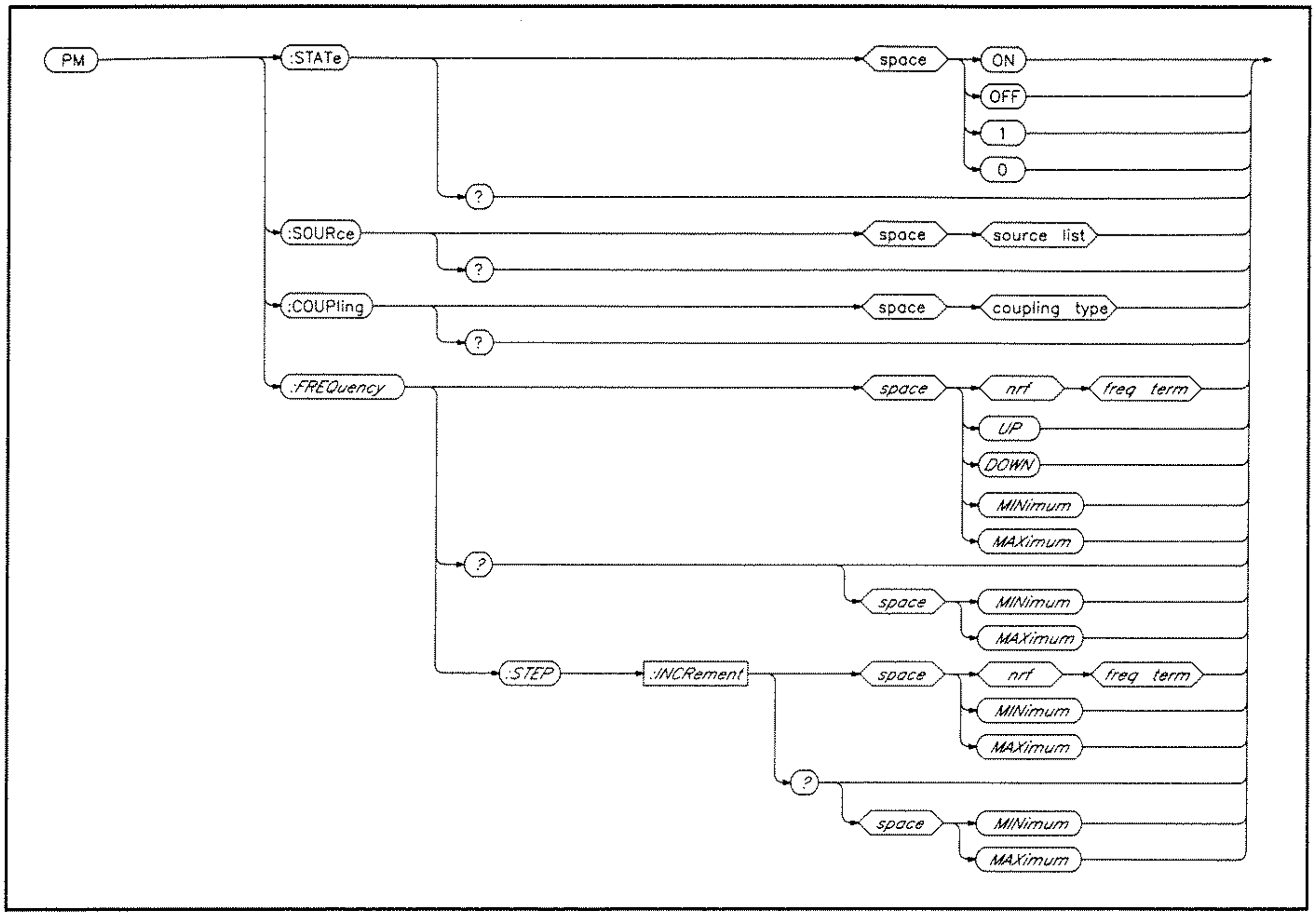


Figure E-15. Phase Modulation Subsystem.

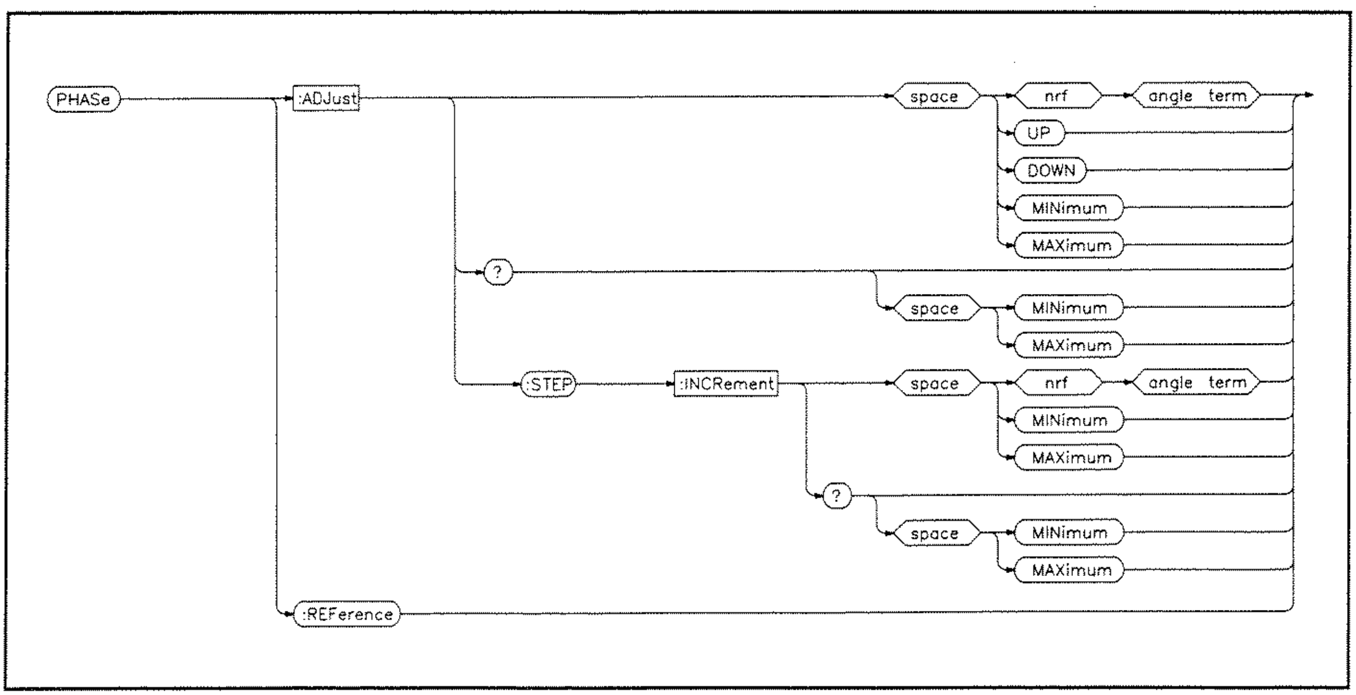


Figure E-16. Phase Subsystem.

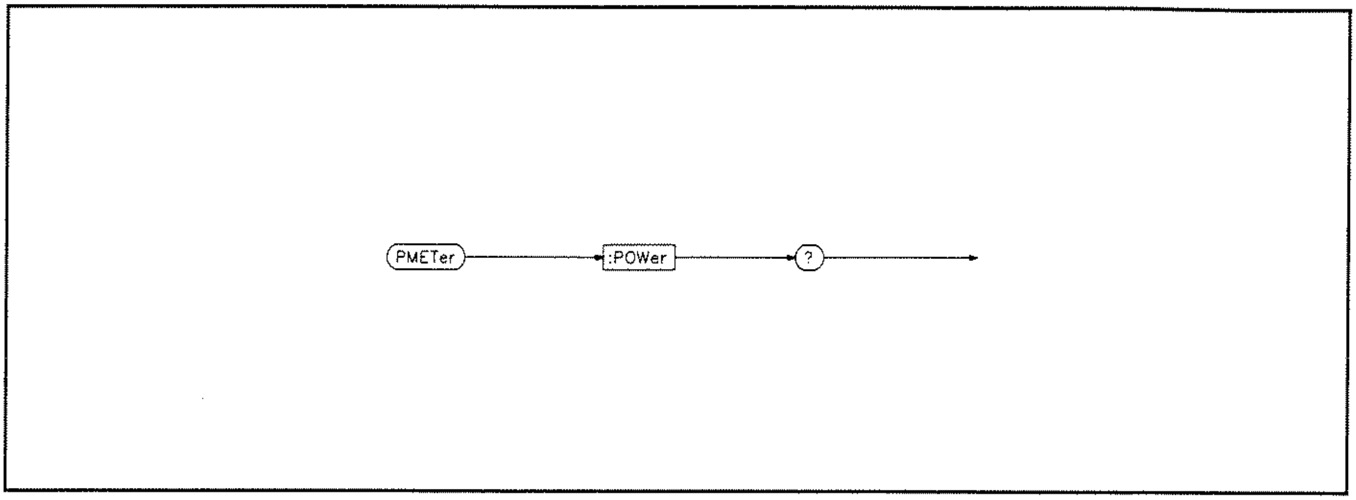


Figure E-17. Power Meter Subsystem.

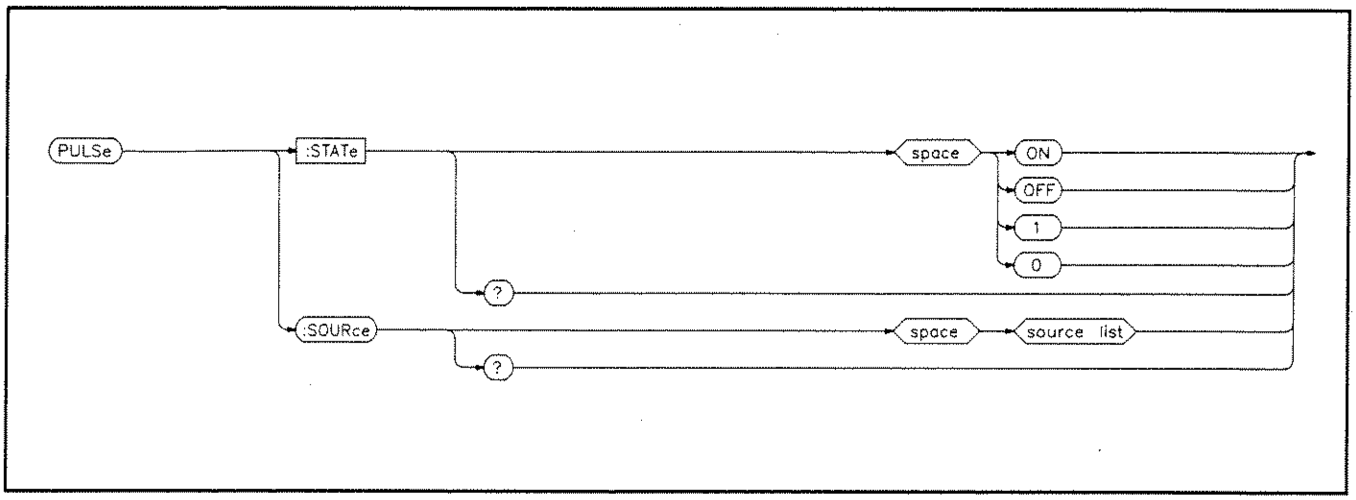


Figure E-18. Pulse Subsystem.

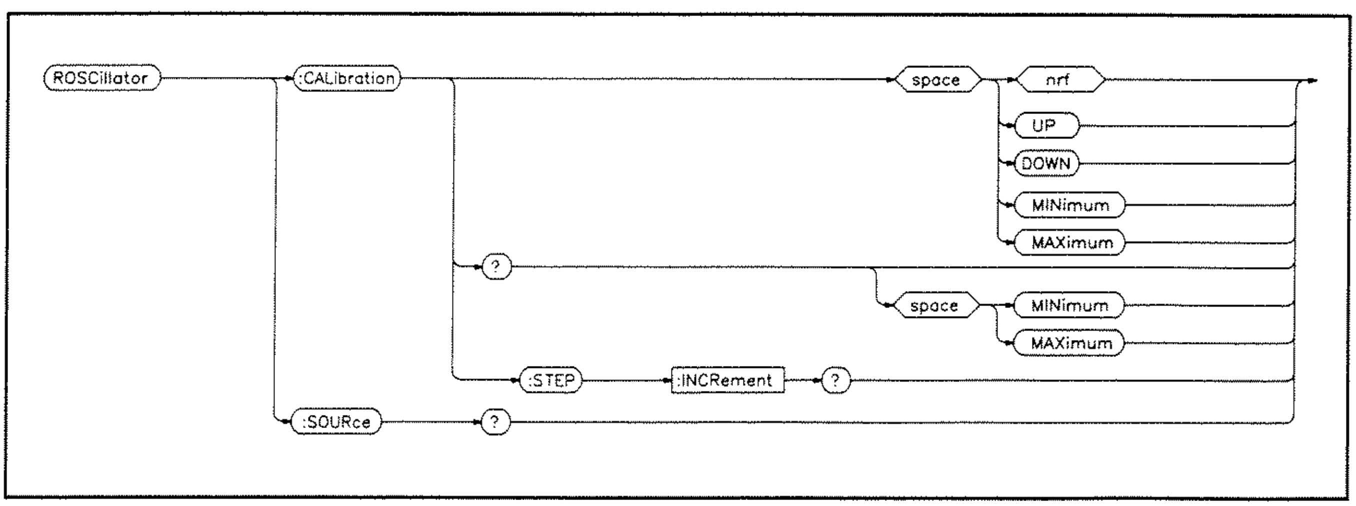


Figure E-19. Reference Oscillator Subsystem.

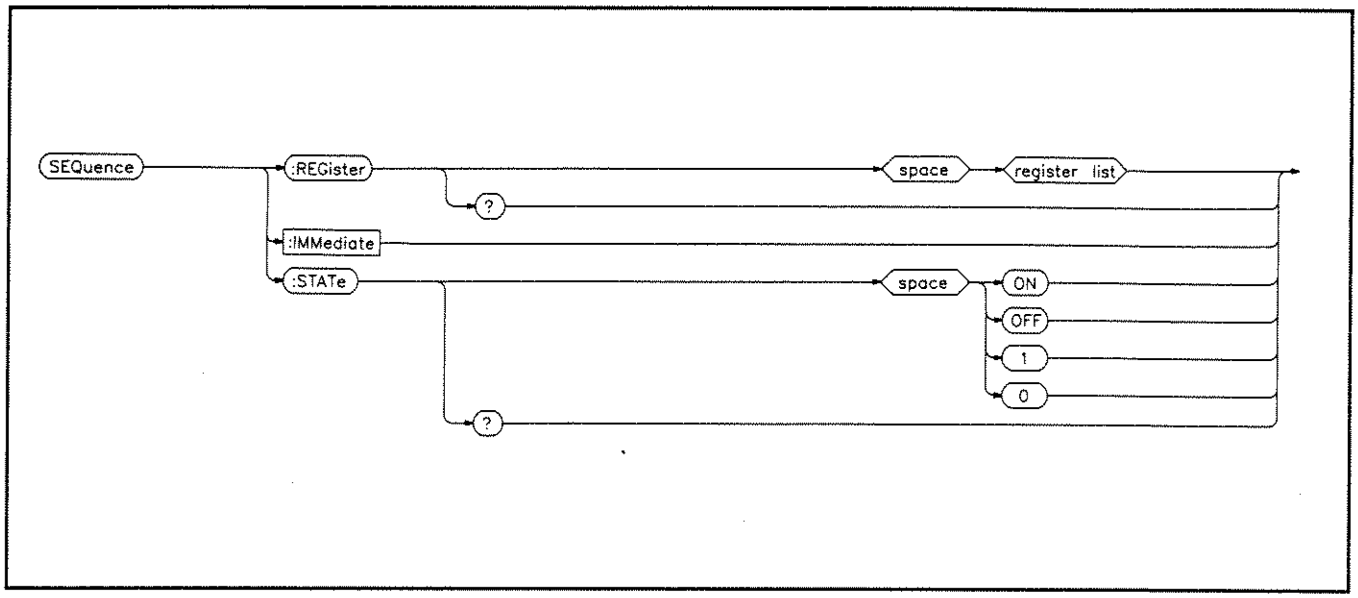


Figure E-20. Sequence Subsystem.

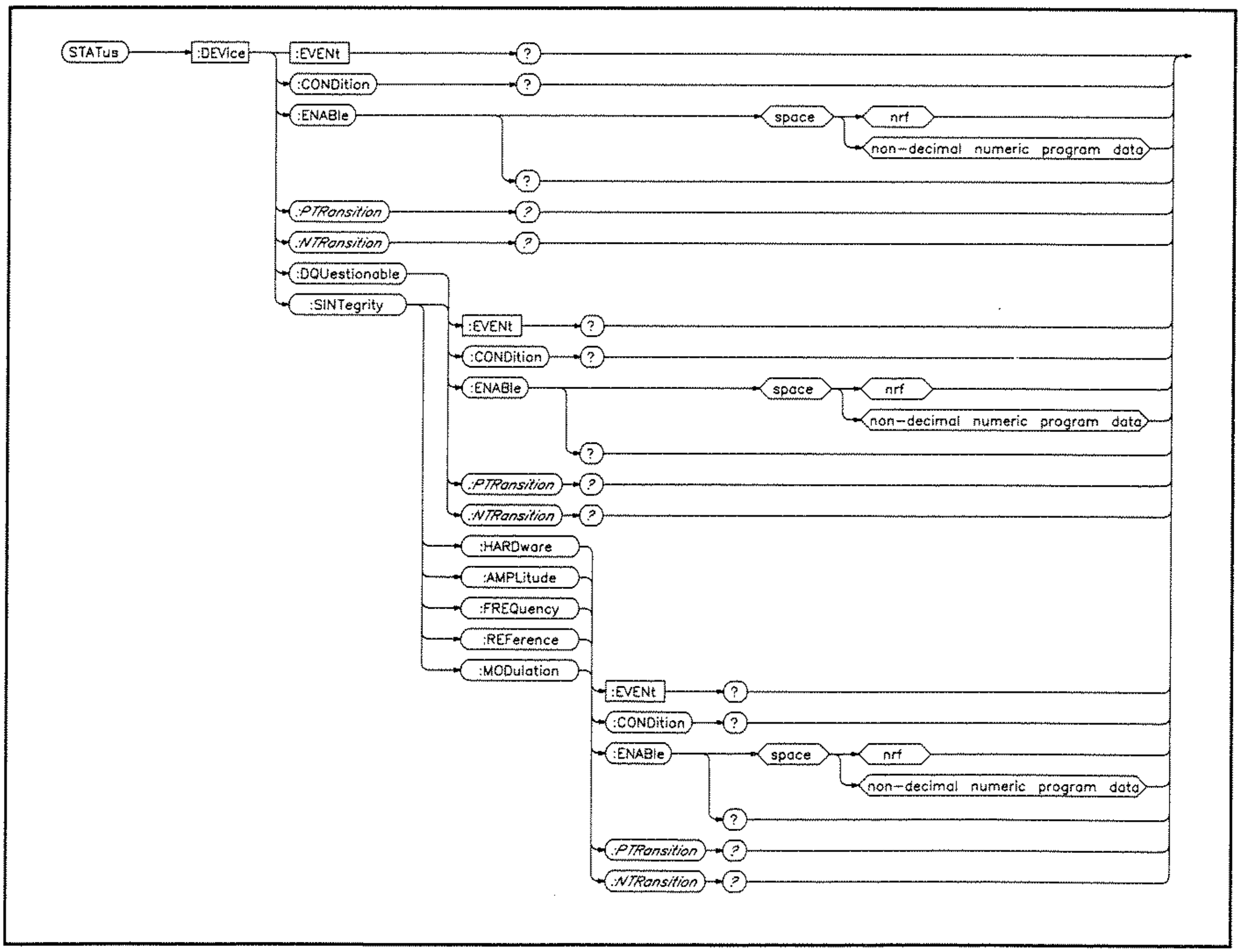


Figure E-21. Status Subsystem.

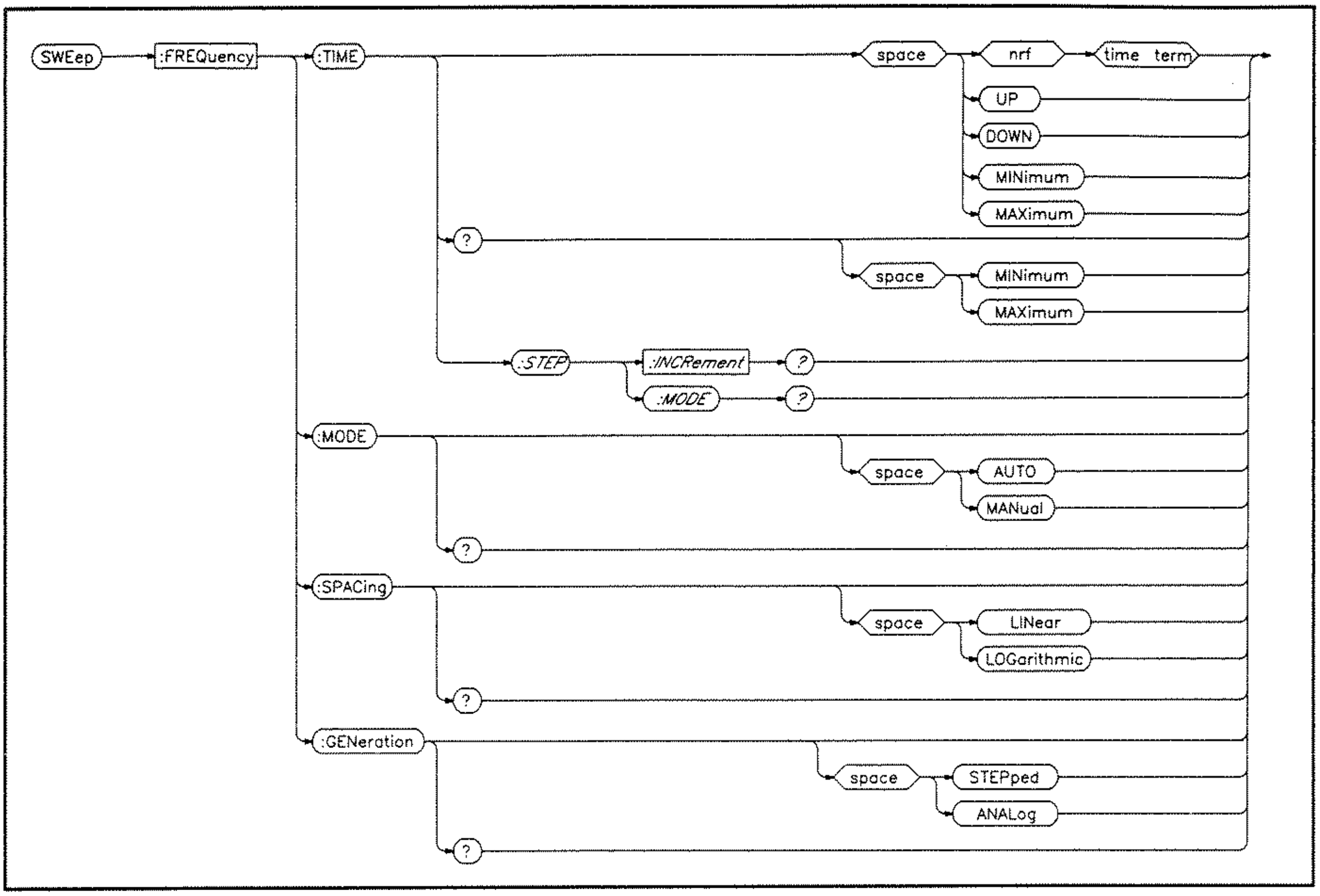


Figure E-22. Sweep Subsystem.

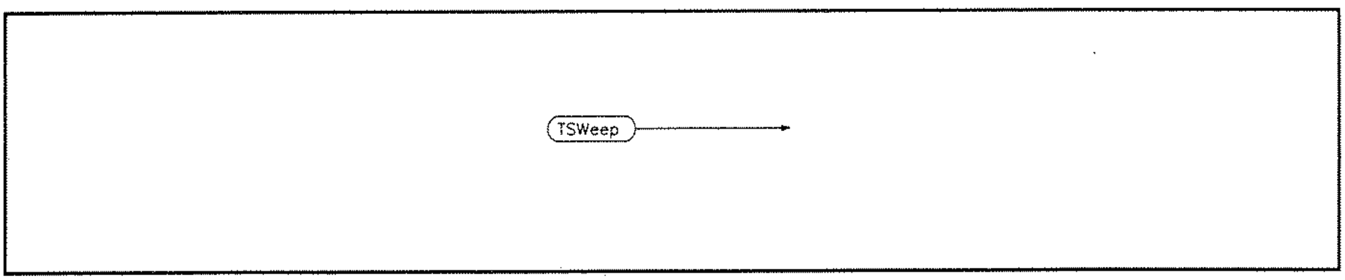


Figure E-23. Take Sweep Subsystem.

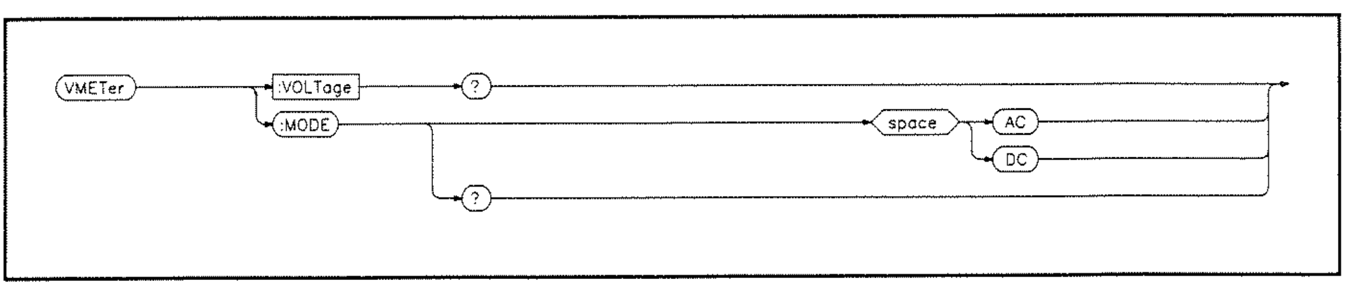


Figure E-24. Voltmeter Subsystem.

F Synthesized Audio Oscillator

In this Appendix

This appendix describes how to use the HP 8644A when it is equipped with the Synthesized Audio Oscillator, Option 007. The multifunction synthesis capabilities of Option 007 allows you to generate a subcarrier from complex audio signals. The subcarrier is applied, in turn, as a modulating wave to the RF carrier signal. You will also see that the **AUDIO** connector provides access to the complex audio signals for external applications.

Option 007 consists of two audio source channels that may be summed together. In addition, the audio signal in one channel may be modulated with a combination of AM, FM, ΦM, or Pulse. Five fundamental waveforms are at your disposal: sine, square, triangle, sawtooth, and white Gaussian noise. Read this appendix to:

- Learn how to use the audio source as a subcarrier to modulate the RF carrier.
- Understand the multifunction synthesis capabilities by reviewing block diagrams.
- Create complex audio signals by activating Special Functions.
- Apply the Option 007 feature set to your specific testing or experimental needs.

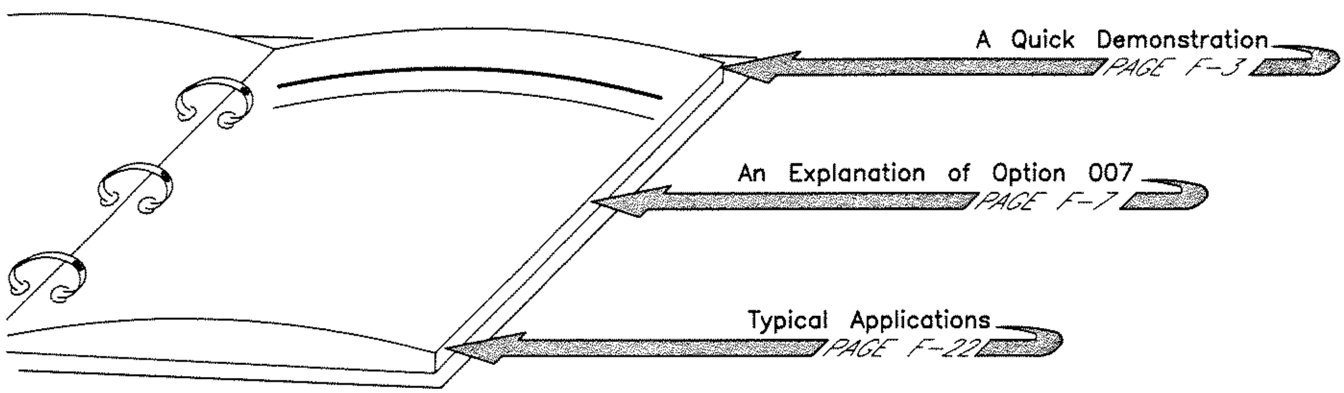
When the HP 8644A is equipped with Option 007, Special Functions 130 through 151, and Special Functions 220 through 225, become available. As you will see, these special functions control the multifunction synthesis for the Internal Audio Source. (A brief description of each special function is found in appendix C.)

The Directory

Use the illustration shown below as your guide for each subject in this appendix. Two choices are recommended for first time users:

1. Get some "hands on" experience by doing the *Quick Demonstration* starting on the next page.
2. Otherwise, turn to the section titled *An Explanation of Option 007* for specific information about the multifunction synthesis capabilities of the HP 8644A.

Refer to the section titled *Typical Applications* once you are familiar with Option 007.



A Quick Demonstration

In the following procedure (which takes about 15 minutes), you will learn how to make the HP 8644A, equipped with Option 007, sum the audio source in Channel 1 with the audio source in Channel 2 to simulate dual-tone modulation on a subcarrier. The next section of this appendix *An Explanation of Option 007* fully describes both Channels 1 and 2.

Use an oscilloscope to observe the results of the following procedure:

Procedure to Sum Channel 1 with Channel 2.

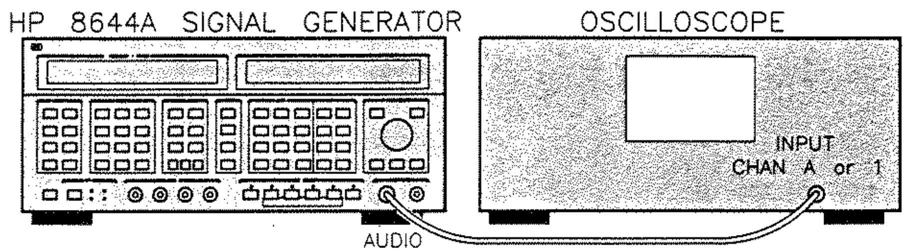


Figure F-1. Equipment Setup for the Quick Demonstration

Set Up and Adjust the Oscilloscope

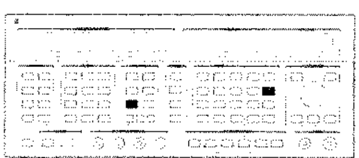
1. **Connect the HP 8644A to the oscilloscope as shown in figure F-1.** Turn on the equipment and make the following adjustments:

   On the Oscilloscope:

   Volts/Div 1
   Time/Div . . . . 300 μsec

Adjust the Audio Source in Channel 1

2. **Press the green INSTR PRESET key.** Doing so presets the HP 8644A to a known state for the following steps.

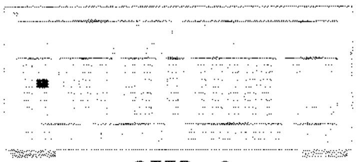


3. **Press the AUDIO FREQ key, and then the ON key.** An audio frequency of 1 kHz should be displayed on the front panel.
4. **Press the blue SHIFT key, and then the AUDIO LEVEL key.** The HP 8644A should now show the following in the MODULATION/AMPLITUDE display:

2.000 V 1.000kHz RF OFF AUDIO

5. **Turn the knob counterclockwise to reduce the audio level to 1 V.** In a following step, the audio source in Channel 2 will also be set to 1 Vpk; this is because the HP 8644A cannot sum together more than 2 Vpk from both channels.

   A 1 kHz sine wave 1 Vpk is then applied to the oscilloscope from the 600 Ω **AUDIO** output connector.


STEP 6

Adjust the Audio Source in Channel 2

6. **Press the SPECIAL key, number "134", and press the ON key.** If your HP 8644A does not have the Option 007 installed, you will get an error message saying, `No such special.`

7. **Adjust the audio source level in Channel 2 to be 1 Vpk.** The HP 8644A should now show the following in the FREQUENCY/STATUS display:

```
134:Aud2 Level   1.000 V
```

8. **Press the SPECIAL key, number "133", and press the ON key.** The HP 8644A should now show the following in the FREQUENCY/STATUS display:

```
133:Aud2 Freq    OFF
```

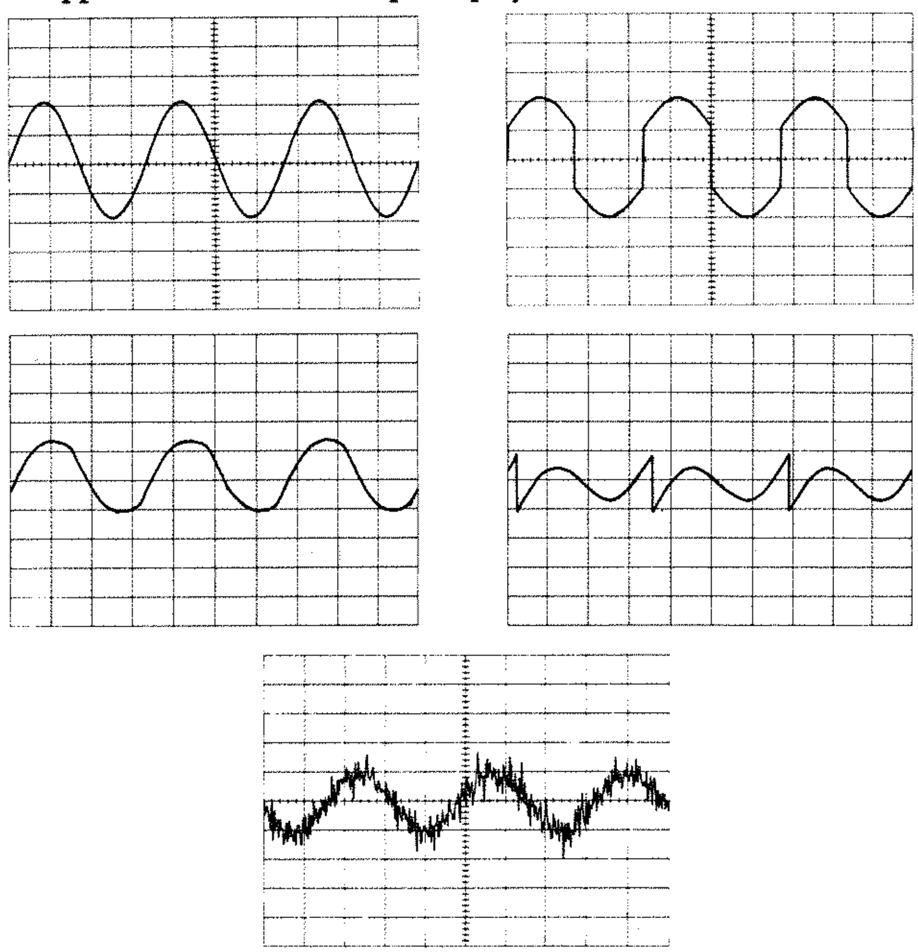
9. **Press the ON key, and then adjust the audio source of Channel 2 to a frequency of 1 kHz.** A 1 kHz sine wave 2 Vpk should appear on the oscilloscope display. The 2 Vpk signal is the result of Channel 1 and Channel 2 being summed together.

Observe and Modify the Results

10. **Press the SPECIAL key, number "135", and press the ON key.** The HP 8644A should now show the following in the FREQUENCY/STATUS display:

135:Aud2 Wave Sine

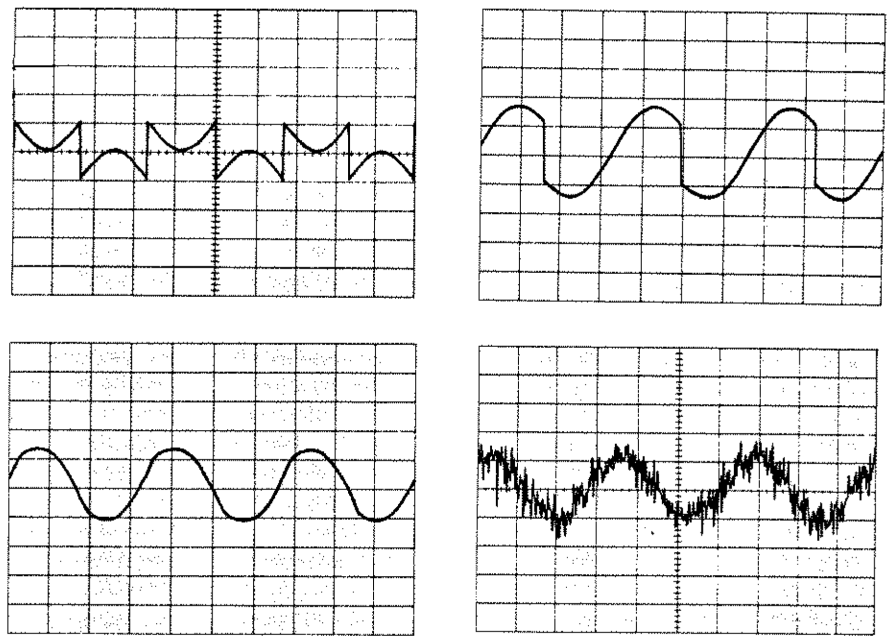
11. **Turn the knob. For each waveform, a different composite signal appears on the oscilloscope display:**



Remember *The signal from the Internal Audio Source can be used to modulate the RF carrier. The same signal taken from the* AUDIO *connector may also be used for external applications (for example, on an external speaker).*

12. **Turn the knob to display the sine wave on the oscilloscope.**

13. **Press the SPECIAL key, number "136", and press the ON key.**
14. **Turn the knob to adjust the audio source in Channel 2 to be +180° out of phase with the audio source in Channel 1.** Notice the sine wave shown in the oscilloscope display decreases in amplitude until 0 V dc is left.
15. **Press the SPECIAL key, number "135", and press the ON key.** Turn the knob. For each waveform, a different composite signal appears on the oscilloscope display (the Volts/Division setting on your oscilloscope may need to be changed to get the same displays shown below):



Note *The subcarrier waveforms shown above do not refer to a specific application. They are simply shown to provide you with an example of the multifunction synthesis that takes place with Option 007. Refer to "Typical Applications" for specific application examples.*

An Explanation of Option 007

If You Need to Know:	Refer to:
• *the comparison between a standard HP 8644A and one equipped with Option 007*	***Block Diagrams – An Introduction (F-8)***
• *how many subcarrier sources can be active at any time*	***Subcarrier Sources – Maximum that may be Active (F-10)***
• *what is the maximum output voltage from the Internal Audio Source*	***Subcarrier Sources – Maximum Voltage Levels (F-10)***
• *about the main audio source*	***Audio Source: Channel 1 (F-11***
• *about the second audio source*	***Audio Source: Channel 2 (F-12)***
• *how to modulate the main audio source*	***Subcarrier Modulation Sources in Channel 1 (F-14)***
• *how Option 007 affects the modulated RF carrier*	***Modulating the RF Carrier with Option 007 (F-19)***
• *how to set increment and decrement values*	***Increment/Decrement the Internal Audio Source (F-21)***
• *how to save and recall storage registers*	***Save and Recall Settings (F-21)***

Block Diagrams – An Introduction

The HP 8644A Signal Generator is depicted by the simplified block diagram shown in figure F–2. The Internal Audio Source shown in figure F–2 produces four fixed frequencies (300 Hz, 400 Hz, 1 kHz, and 3 kHz) unless Option 007 is installed.

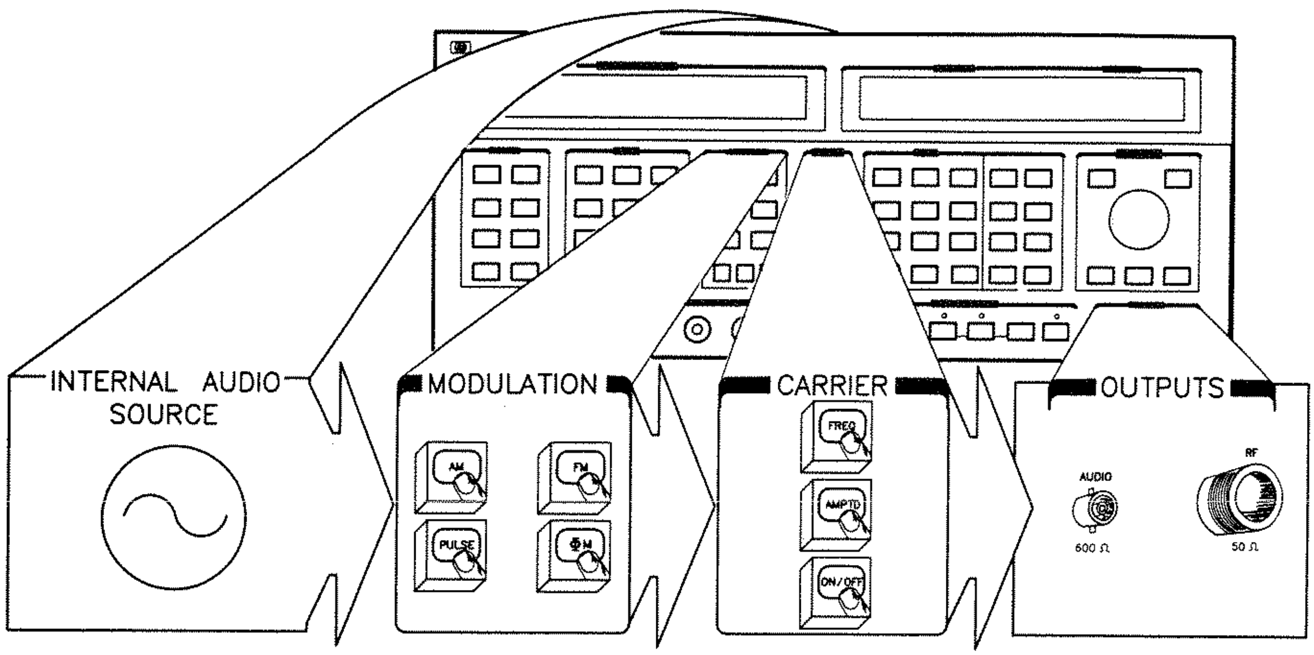


Figure F–2. Simplified Overall Block Diagram

With Option 007, the Internal Audio Source becomes a two channel Multifunction Synthesizer as shown in figure F-3. The audio source in Channel 1 may be modulated; AM, FM, ΦM, and Pulse subcarrier modulation are available.

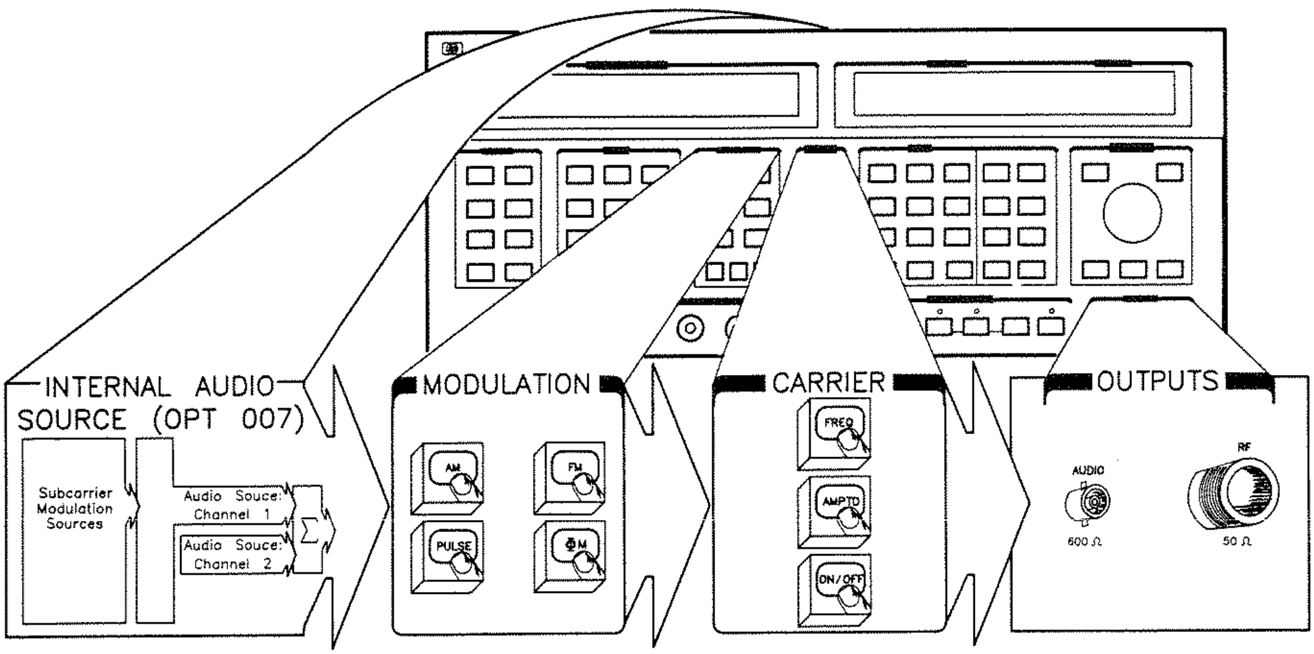
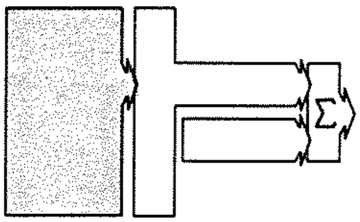


Figure F-3. Introducing the Option 007 Internal Audio Source

Subcarrier Sources – Maximum that may be Active



It is not permissible to turn **ON** all the subcarrier sources at once. The following rule applies to the maximum allowed **ON** at any time:

> **Rule:** The audio source in Channel 1 may be turned **ON** in combination with any **three** other sources.

Besides the audio source in Channel 1, there are five other sources, as follows:

- Audio Source: Channel 2
- Subcarrier AM Source
- Subcarrier FM Source
- Subcarrier ΦM Source
- Subcarrier Pulse Source

Note

The error message "`Too many audio sources`*" appears if you exceed the maximum limit described above.*

Subcarrier Sources – Maximum Voltage Levels

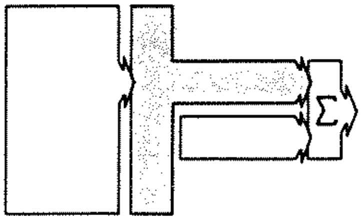
The Internal Audio Source may have a maximum of 2 Vpk summed (Σ) together from the audio sources in Channels 1 and 2. The preset condition of the HP 8644A sets the **AUDIO LEVEL** of the audio source in Channel 1 to 2 Vpk into 600 Ω. You must reduce this level before turning **ON** any one of the other five sources.

Note

The error message "`Audio level conflict`*" appears if you attempt to exceed the maximum summed limit of 2 Vpk for Channels 1 and 2.*

Also, the error message "`Audio level/AM conflict`*" appears if you attempt to exceed the maximum summed limit of 2 Vpk for Channels 1 and 2 with the subcarrier AM source in Channel 1 turned* **ON.**

Audio Source: Channel 1



The *Quick Demonstration* showed that frequency, level, and on/off state are controlled by keys on the front panel; whereas, waveform is controlled only after Special Function 130 is activated. As shown in figure F-4, the audio source in Channel 1 has four parts:

- Audio Frequency
- Audio Level
- Waveform
- On/Off State

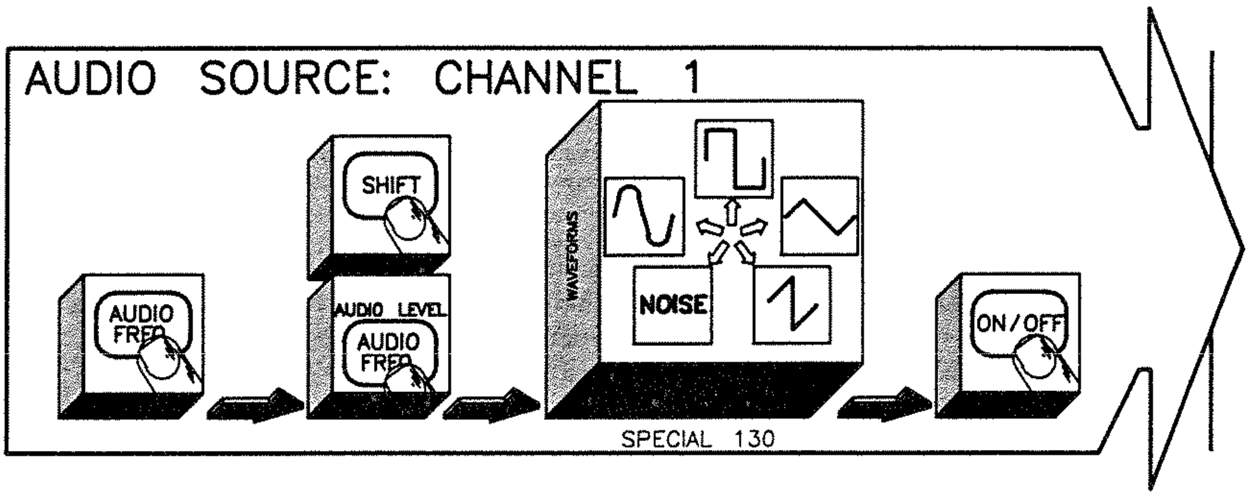


Figure F-4. Block Diagram of the Audio Source in Channel 1.

Note *The audio source in Channel 1 is the reference to which the phase of the other sources is relative to.*

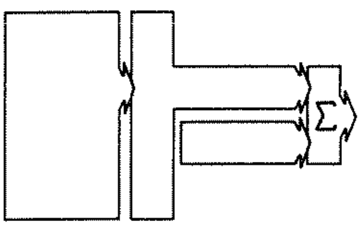
The audio source in Channel 1 operates within the limits shown in table F-1. You'll receive an appropriate error message if the limits are exceeded. (Appendix D provides error message descriptions.)

Table F-1. Limits for the Audio Source in Channel 1.

Limits	Frequency	Level
Minimum	0.1 Hz	0 Vpk
Maximum	400 kHz*	2 Vpk
Resolution	4 digits	0.001 Vpk

* The **AUDIO** output has a typical bandwidth of 400 kHz for all waveforms. This affects complex waveforms with frequency components greater than 400 kHz.

Audio Source: Channel 2



The *Quick Demonstration* showed that special functions are used to control the audio source in Channel 2. As shown in figure F-5, the audio source in Channel 2 has five parts:

- On/Off State
- Frequency
- Level
- Waveform
- Phase

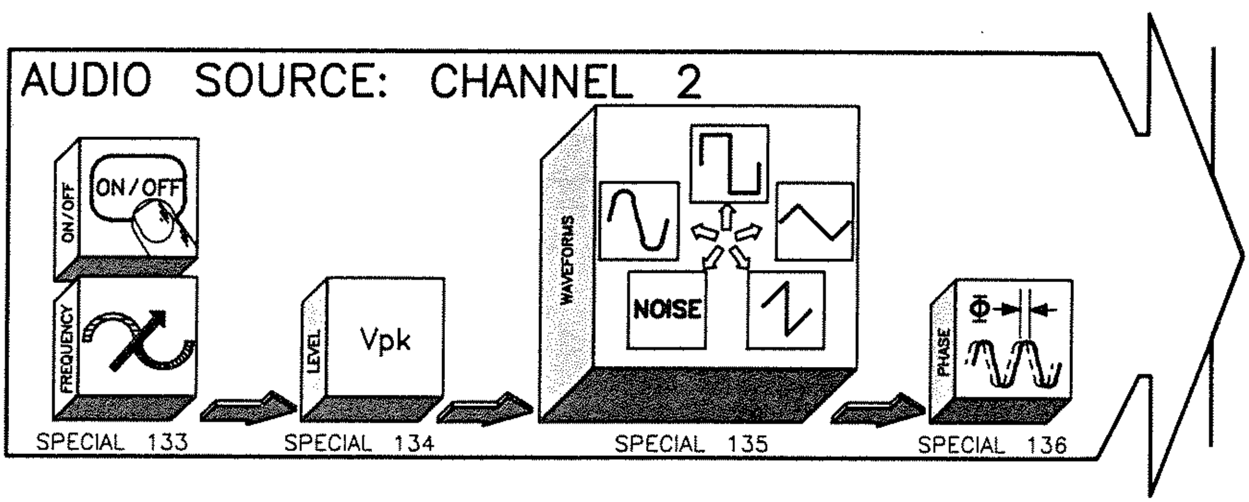


Figure F-5. Block Diagram of the Audio Source in Channel 2.

Remember *The phase of the audio source in Channel 2 is relative to the phase of the audio source in Channel 1.*

The audio source in Channel 2 operates within the limits shown in table F–2. You'll receive an appropriate error message if the limits are exceeded. (Appendix D provides error message descriptions.)

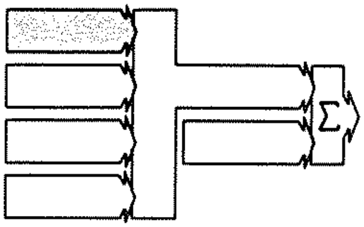
Table F–2. Limits for the Audio Source in Channel 2.

Limits	**Frequency**	**Level**	**Phase****
Minimum	0.1 Hz	0 Vpk	−179.9°
Maximum	400 kHz*	2 Vpk	+180°
Resolution	4 digits	0.001 Vpk	0.1°

* The **AUDIO** output has a typical bandwidth of 400 kHz for all waveforms. This affects complex waveforms with frequency components greater than 400 kHz.

** Phase may also be expressed in terms of radians by pressing the front panel **rad** key. Any entry beyond the maximum and minimum limits will be scaled. For example, entering 560° would yield −160°.

Subcarrier Modulation Sources in Channel 1



Four subcarrier sources (AM, FM, ΦM, and Pulse) are available to modulate the audio source in Channel 1. Each subcarrier modulation source may be modified to control frequency, phase, level, depth, or deviation; also, each may be turned **ON** and **OFF**.

AM Modulating the Audio Source in Channel 1.

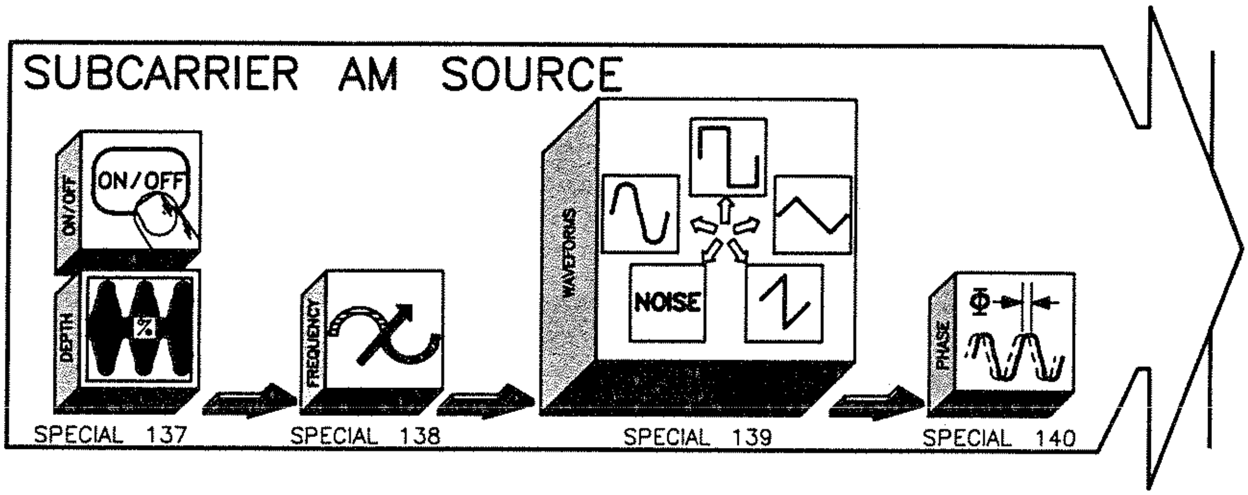


Figure F–6. Block Diagram of the Subcarrier AM Source

Remember

The phase of each subcarrier modulation source is relative to the phase of the audio source in Channel 1.

The on/off state, depth, frequency, waveform, and phase of the subcarrier AM source in Channel 1 is controlled by special functions as shown in figure F–6. The subcarrier AM source operates within the limits shown in table F–3. You'll receive an appropriate error message if the limits are exceeded. (Appendix D provides error message descriptions.)

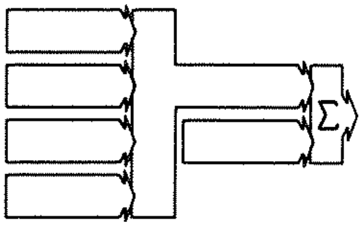
Note *A common operator's mistake occurs when the subcarrier AM source is turned* **ON** *with the* **AUDIO LEVEL** *of the audio source in Channel 1 set to 2 Vpk (the preset condition), or to a value greater than the amount allowed for the desired AM depth. The error message* `Audio level/AM conflict` *will then appear. Simply reduce the* **AUDIO LEVEL** *to an appropriate value for the amount of subcarrier AM depth selected.*

Table F–3. Limits for the Subcarrier AM Source.

Limits	**Depth**	**Frequency**	**Phase****
Minimum	0 %	0.1 Hz	−179.9°
Maximum	100 %	400 kHz*	+180°
Resolution	0.1 %	4 digits	0.1°

* The **AUDIO** output has a typical bandwidth of 400 kHz for all waveforms. This affects complex waveforms with frequency components greater than 400 kHz.

** Phase may also be expressed in terms of radians by pressing the front panel **rad** key. Any entry beyond the maximum and minimum limits will be scaled. For example, entering 560°would yield −160°.



FM Modulating the Audio Source in Channel 1

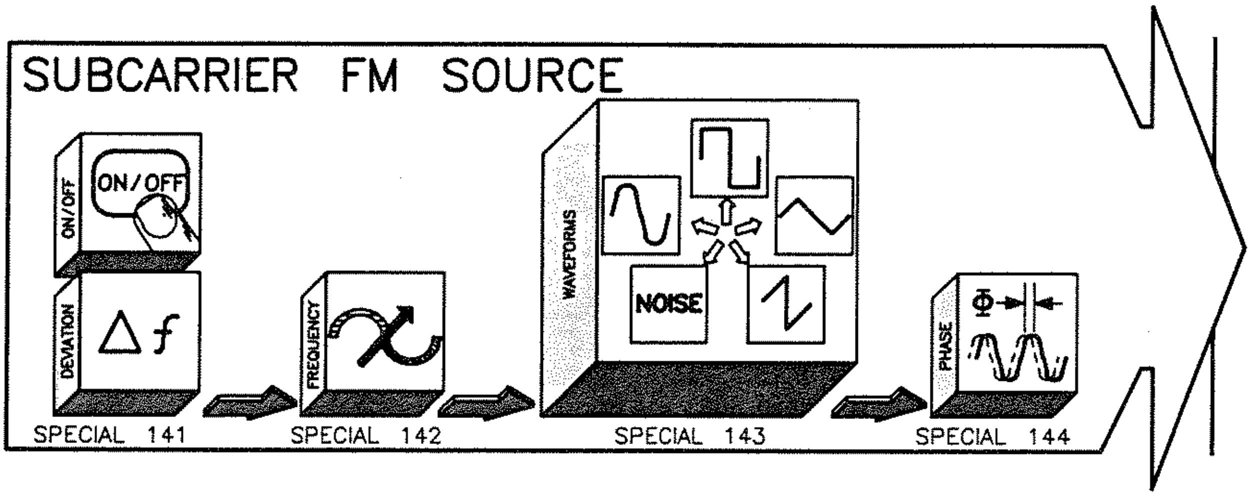


Figure F–7. Block Diagram of the Subcarrier FM Source.

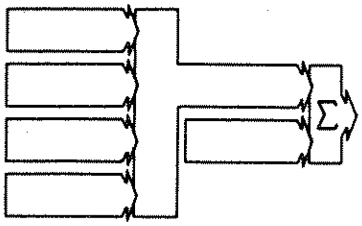
The on/off state, deviation, frequency, waveform, and phase of the subcarrier FM source in Channel 1 is controlled by Special Functions as shown in figure F–7. The subcarrier FM source operates within the limits shown in table F–4. You'll receive an error message if the limits are exceeded. (Appendix D provides error message descriptions.)

Table F–4. Limits for the Subcarrier FM Source.

Limits	Deviation	Frequency	Phase**
Minimum	0 Hz	0.1 Hz	−179.9°
Maximum	400 kHz	400 kHz*	+180°
Resolution	0.001 Hz	4 digits	0.1°

* The **AUDIO** output has a typical bandwidth of 400 kHz for all waveforms. This affects complex waveforms with frequency components greater than 400 kHz.

** Phase may also be expressed in terms of radians by pressing the front panel **rad** key. Any entry beyond the maximum and minimum limits will be scaled. For example, entering 560° would yield −160°.



ΦM Modulating the Audio Source in Channel 1

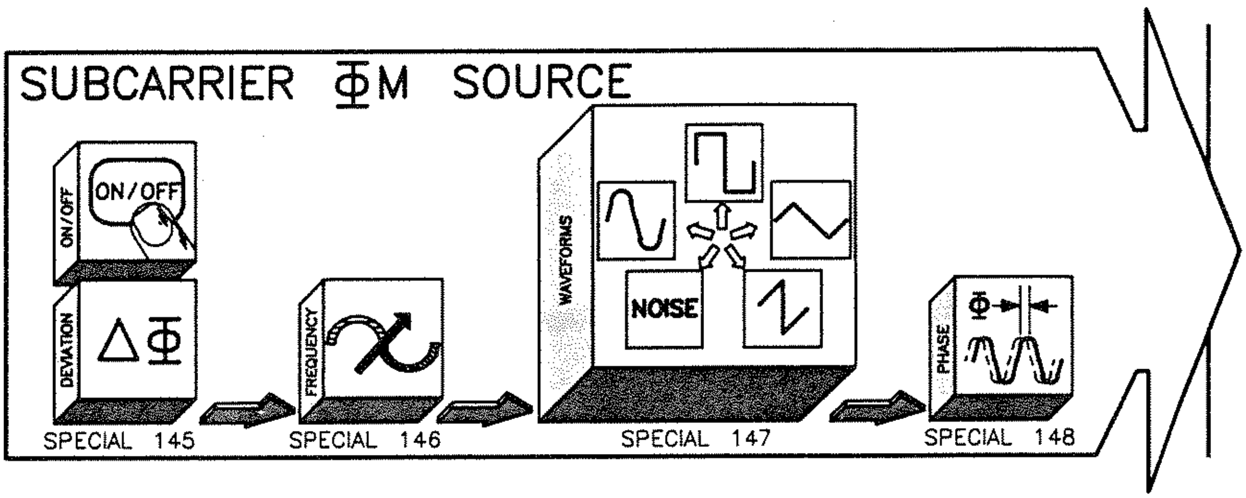


Figure F–8. Block Diagram of the Subcarrier ΦM Source.

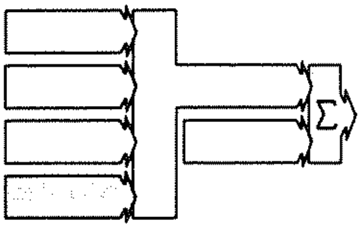
The on/off state, deviation, frequency, waveform, and phase of the subcarrier ΦM source in Channel 1 is controlled by Special Functions as shown in figure F–8. The subcarrier ΦM source operates within the limits shown in table F–5. You'll receive an error message if the limits are exceeded. (Appendix D provides error message descriptions.)

Table F–5. Limits for the Subcarrier ΦM Source.

Limits	Deviation	Frequency	Phase**
Minimum	0°	0.1 Hz	−179.9°
Maximum	+179.9°	400 kHz*	+180°
Resolution	0.1°	4 digits	0.1°

* The **AUDIO** output has a typical bandwidth of 400 kHz for all waveforms. This affects complex waveforms with frequency components greater than 400 kHz.

** Phase may also be expressed in terms of radians by pressing the front panel **rad** key. Any entry beyond the maximum and minimum limits will be scaled. For example, entering 560° would yield −160°.



Pulse Modulating the Audio Source in Channel 1

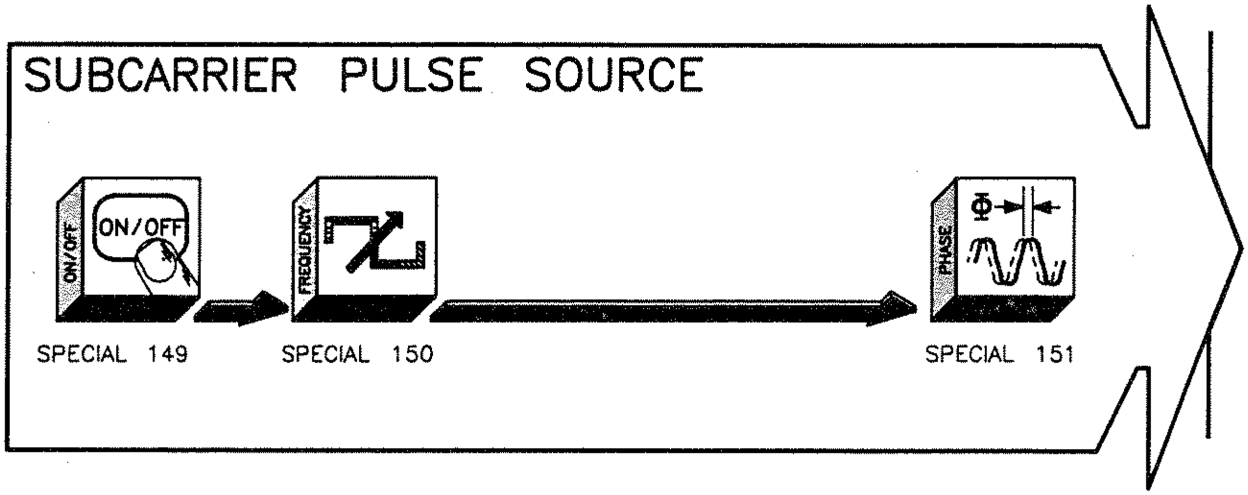


Figure F–9. Block Diagram of the Subcarrier Pulse Source.

The on/off state, frequency, and phase of the subcarrier Pulse source i Channel 1 is controlled by Special Functions as shown in figure F–9. Th subcarrier Pulse source operates within the limits shown in table F– You'll receive an error message if the limits are exceeded. (Appendix provides error message descriptions.)

Table F–6. Limits for the Subcarrier Pulse Source.

Limits	Frequency	Phase*
Minimum	0.1 Hz	−179.9°
Maximum	50 kHz	+180°
Resolution	4 digits	0.1°

* Phase may also be expressed in terms of radians by pressing the front panel **rad** key. Any entry beyond the maximum and minimum limits will be scaled. For example, entering 560° would yield −160°.

Modulating the RF Carrier with Option 007

The Internal Audio Source on a standard HP 8644A provides a sinusoidal waveform at either 2 Vpk or 0 Vpk. With Option 007, the **AUDIO LEVEL** affecting the audio source in Channel 1 may be reduced to a value between 2 Vpk and 0 Vpk. Reducing the **AUDIO LEVEL** allows you to turn **ON** the audio source in Channel 2, and to set depth for the subcarrier AM source.

As shown in figure F-10, the HP 8644A requires a 1 Vpk signal from an external audio source, and/or a 2 Vpk signal from the Internal Audio Source to provide calibrated operation when the RF carrier is being modulated. Voltage levels less than these reduce the amount of modulation on the RF carrier.

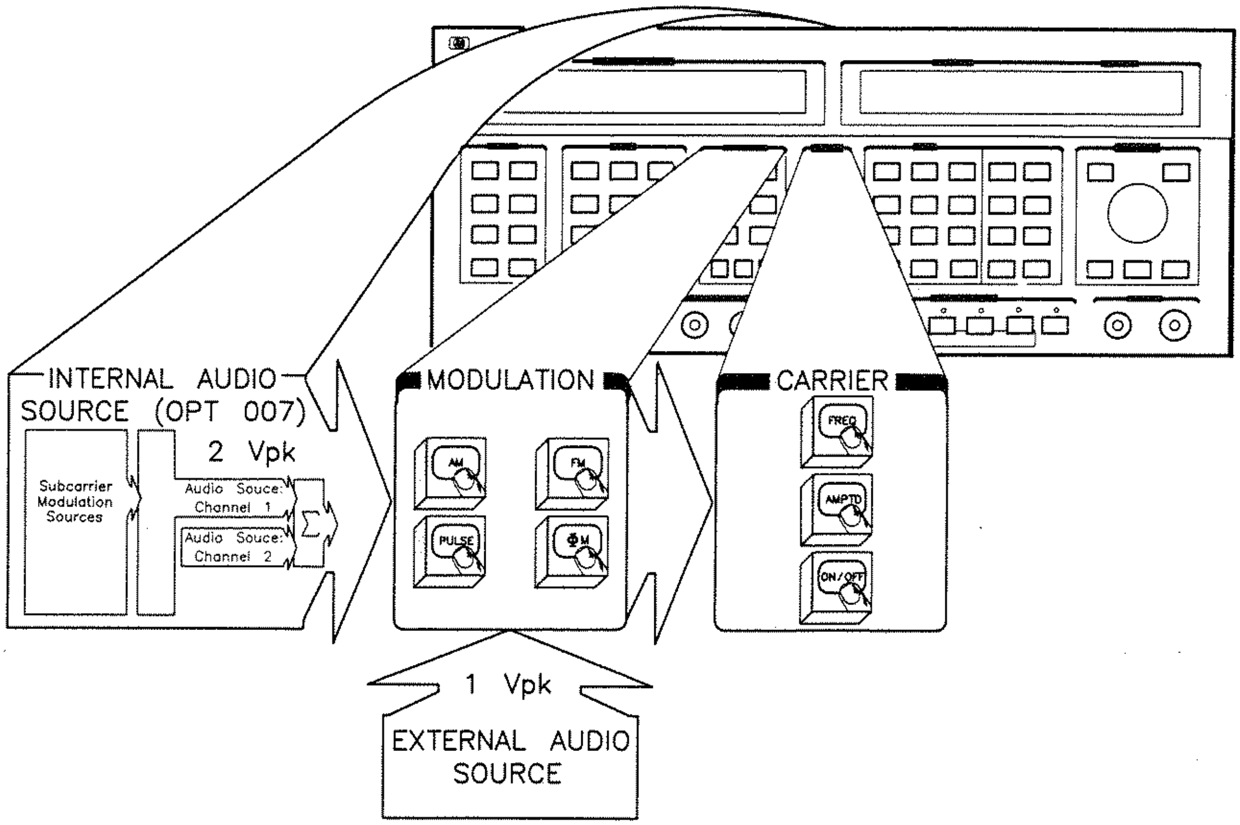


Figure F-10. Voltage Levels to Produce a Calibrated RF Output.

Internal Audio Source voltage originates from:

- Channel 1 only, or
- summing Channel 1 with any of the other subcarrier modulation sources, or
- summing Channels 1 and 2, or
- summing Channels 1 and 2 with any of the other subcarrier modulation sources.

If you use the Internal Audio Source, you can calculate the amount of modulation on the RF carrier by using the following formulas:

$$\begin{aligned} \%\ Depth &= (Vpk\ from\ Int.\ Aud.\ Source \bullet displayed\ AM\ depth)/2 \\ FM\ Deviation &= (Vpk\ from\ Int.\ Aud.\ Source \bullet displayed\ FM\ deviation)/2 \\ \Phi M\ Deviation &= (Vpk\ from\ Int.\ Aud.\ Source \bullet displayed\ \Phi M\ deviation)/2 \end{aligned}$$

For example, if you FM the RF carrier with the Internal Audio Source at an audio level of 1 Vpk (Channel 1 only), you will get half the specified amount of deviation shown in the **MODULATION** display. However, if you also turn on the audio source in Channel 2 and set its level to 1 Vpk (summing Channels 1 and 2 to get 2 Vpk), the HP 8644A will output the full amount of deviation.

Audio frequency rates up to 400 kHz are allowed with Option 007, which is also the typical bandwidth of the audio output circuitry. This bandwidth affects complex waveforms with frequency components greater than 400 kHz, causing waveform degradation.

When the Internal Audio Source is used, the maximum bandwidth is specified as the maximum rate (AM bandwidth is a function of the carrier frequency). Refer to the specification table in the *Calibration Manual* for maximum rates. If higher FM bandwidths are required than those specified, see Special Function 124 in appendix C.

Increment/Decrement the Internal Audio Source

The **INCR SET** key allows you to change increment and decrement values for frequency, level, phase, depth, and deviation of the Internal Audio Source. Use the following procedure:

1. **Select the special function.** For example, after an instrument preset, if Special Function 138 is active, you would then see the following in the FREQUENCY/STATUS display:

```
138:Aud AM Freq  100 Hz
```

2. **Press the INCR SET key.** With Special Function 138 active, you would see the following:

```
Audio Freq Incr  100 Hz
```

3. **Change the increment value.** If you want the Audio Frequency Increment to be 10 Hz instead of 100 Hz, simply press the **1**, **0**, and **Hz** keys. You can then verify that the new increment value is 10 Hz by pressing the **INCR SET** key once again.

Increment values can have a global affect. In the previous example, the new increment value of 10 Hz for Special Function 138 would be effective whenever frequency is incremented or decremented for any audio source. Increment values for phase exhibit the same global affect in the Internal Audio Source.

Save and Recall Settings

The HP 8644A has 50 available storage registers. The first 10, Registers 0–9, accepts all front panel settings for special functions associated with Option 007. The remaining 40, Registers 10–49, accepts only RF frequency and output amplitude settings.

Performing an Instrument Preset, or unplugging the HP 8644A does not alter the contents of the 50 storage registers.

Typical Applications

The multifunction synthesis capabilities of the HP 8644A Option 007 creates complex signals for:

1. VHF omnidirectional range (VOR),
2. ILS two-tone signaling,
3. dual-tone modulation,
4. audio-tone sweep,
5. AM radio testing,
6. amplitude sweep,
7. modem testing,
8. AM noise generation,

   and more...

The following collection of waveforms present a sample of the many different waveforms possible using the HP 8644A equipped with Option 007. The collection is intended to give you an indication of the capabilities of the instrument and to stimulate ideas for creating other waveforms. In most cases, the waveforms may be altered to match your specific application by changing frequency, phase, waveforms, or their amplitudes.

Each waveform in the collection is numerically organized by the list shown above. Use the foldout in figure F–11, and the list of special functions in table F–7 to assist you in generating waveforms with your HP 8644A Option 007.

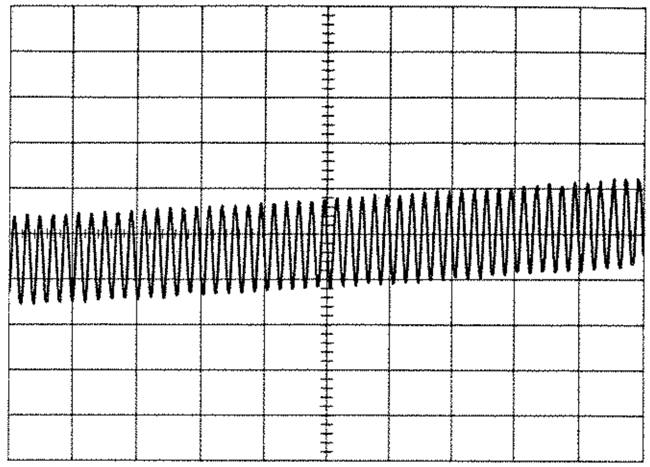
Note *Waveforms in the collection are output at the* **AUDIO** *connector (600 Ω), and viewed on an oscilloscope. If the waveform is designated as being applied to an RF carrier, the display is output from the* **RF OUTPUT** *connector (50 Ω), and viewed on a spectrum analyzer.*

Table F–7. Special Functions 130 to 151 for Option 007

SPECIAL FUNCTIONS					
Number	**Name (Abbreviated)**	**Limits**	**Number**	**Name (Abbreviated)**	**Limits**
130	Audio Wave	5 Waveforms	141	Aud FM Dev	0 Hz to 400 kHz
131	Audio Triggered	ON/OFF	142	Aud FM Freq	0.1 Hz to 400 kHz
132	Trig Audio	Press ON	143	Aud FM Wave	5 Waveforms
133	Aud2 Freq	0.1 Hz to 400 kHz	144	Aud FM Φ	* −179.9° to +180°
134	Aud2 Level	0 V to 2 V	145	Aud ΦM Dev	0°to +179.9°
135	Aud2 Wave	5 Waveforms	146	Aud ΦM Freq	0.1 Hz to 400 kHz
136	Aud2 Φ	* −179.9° to +180°	147	Aud ΦM Wave	5 Waveforms
137	Aud AM Depth	0 to 100%	148	Aud ΦM Φ	* −179.9° to +180°
138	Aud AM Freq	0.1 Hz to 400 kHz	149	Aud Pulse	ON/OFF
139	Aud AM Wave	5 Waveforms	150	Aud Pulse Freq	0.1 Hz to 50 kHz
140	Aud AM Φ	* −179.9° to +180°	151	Aud Pulse Φ	* −179.9° to +180°

* Phase may also be expressed in terms of radians by pressing the front panel **rad** key. Any entry beyond these limits will be scaled. For example, entering 560° would yield −160°.

No. 1. HP 8644A Synthesized Audio Oscillator Waveform



Waveform Name/Description: VHF omnidirectional range (VOR) composite signal.

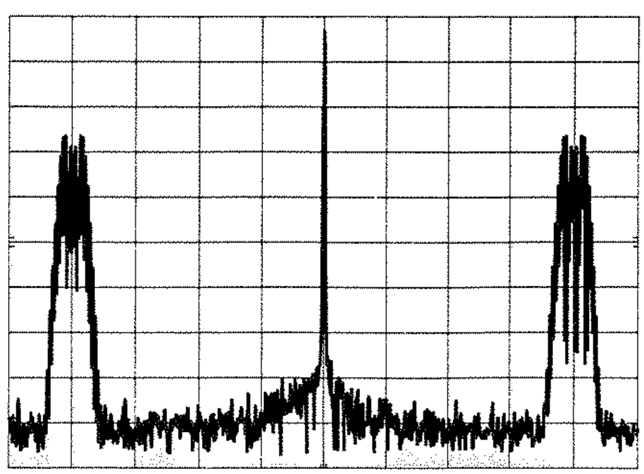
Waveform Application: Avionics receiver test and metrology for VOR test equipment.

Instrument Settings

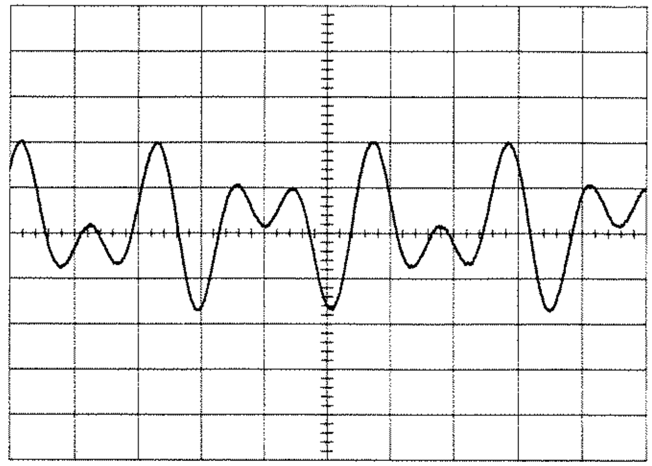
Source	Frequency	Phase	Waveform	Amplitude	Deviation
Audio-Channel 1	9960 Hz	0°	Sine	1 V	–
Audio-Channel 2	30 Hz	0°	Sine	1 V	–
FM	30 Hz	0°(1)	Sine	–	480 Hz

(1) The phase of the FM Source sets the bearing direction.

Waveform Applied to an RF Carrier: The RF carrier has AM at a 90% depth.



No. 2. HP 8644A Synthesized Audio Oscillator Waveform



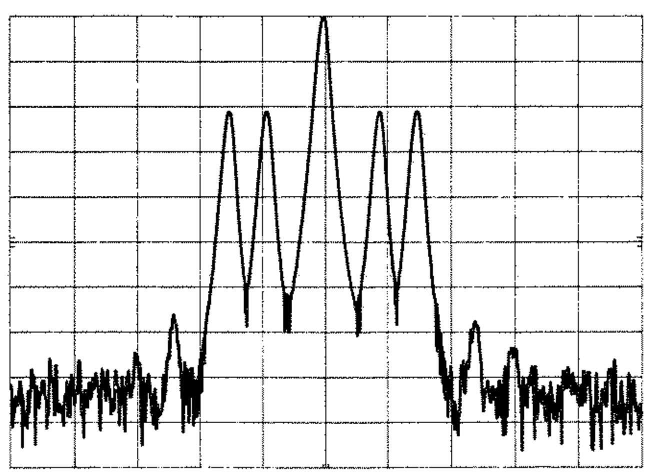
Waveform Name/Description: ILS two-tone composite signal.

Waveform Application: ILS receiver testing.

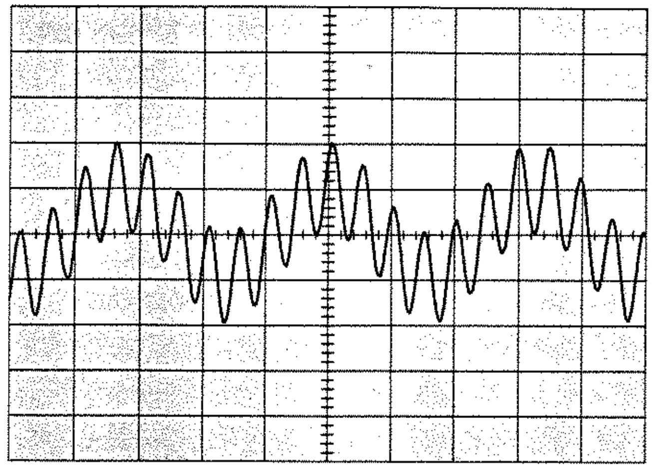
Instrument Settings

Source	Frequency	Phase	Waveform	Amplitude
Audio-Channel 1	90 Hz	0°	Sine	1 V
Audio-Channel 2	150 Hz	0°	Sine	1 V
Comments: Difference in depth of modulation is set by the relative amplitudes of Channels 1 & 2.				

Waveform Applied to an RF Carrier: The RF carrier has AM at a 50% depth.



No. 3. HP 8644A Synthesized Audio Oscillator Waveform



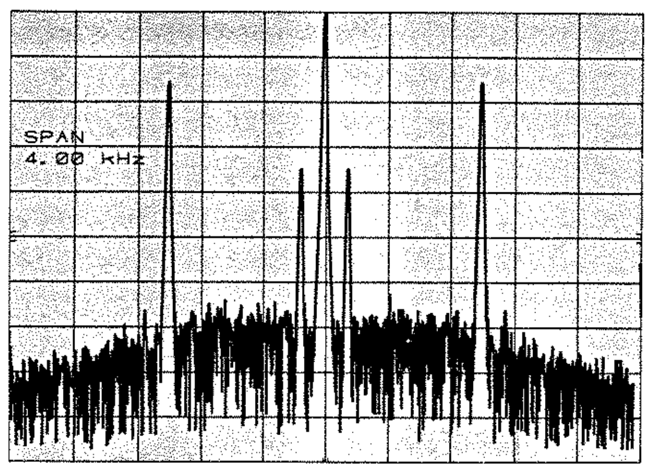
Waveform Name/Description: Dual-tone modulation.

Waveform Application: Sub-audible squelch testing, pocket pagers.

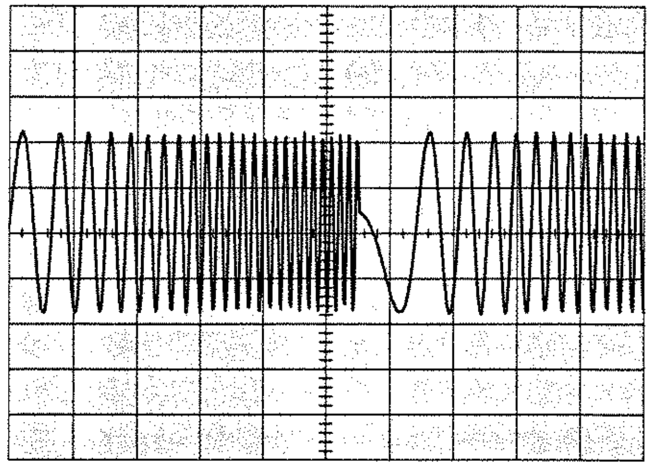
Instrument Settings

Source	Frequency	Phase	Waveform	Amplitude
Audio-Channel 1	1 kHz	0°	Sine	1 V
Audio-Channel 2	150 Hz	0°	Sine	1 V

Waveform Applied to an RF Carrier: The RF carrier has AM at a 50% depth.



No. 4. HP 8644A Synthesized Audio Oscillator Waveform



Waveform Name/Description: Audio-tone sweep.

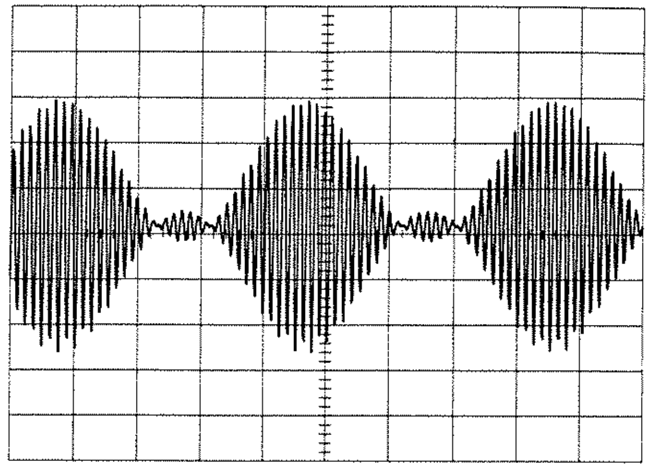
Waveform Application: Audio response of FM receiver.

Instrument Settings

Source	Frequency	Phase	Waveform	Amplitude	Deviation
Audio-Channel 1	2.5 kHz	0°	Sine	2 V	–
FM	150 Hz(1)	0°	Sawtooth	–	2.5 kHz

(1) Change the FM Source frequency to vary rate for the audio-tone sweep.

No. 5. HP 8644A Synthesized Audio Oscillator Waveform



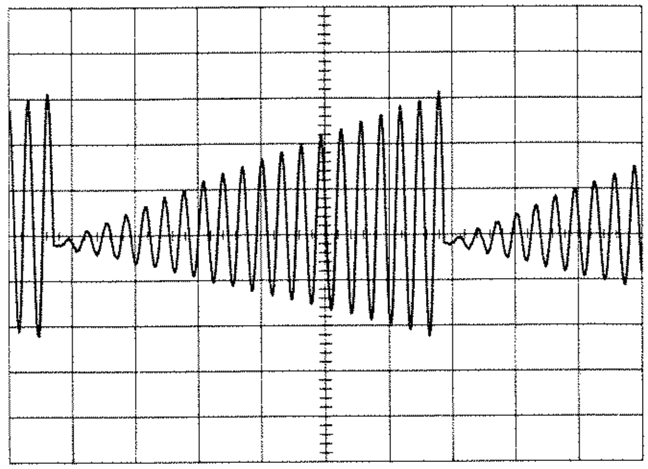
Waveform Name/Description: AM signal with over 100% negative peak modulation.

Waveform Application: AM radio testing.

Instrument Settings

Source	Frequency	Phase	Waveform	Amplitude	Depth
Audio-Channel 1	50 kHz	0°	Sine	900 mV	–
Audio-Channel 2	50 kHz	180°	Sine	200 mV	–
AM	1 kHz	0°	Sine	–	100%
Comments: A 180°phase inversion of the carrier occurs at the trough of the modulating waveform.					

No. 6. HP 8644A Synthesized Audio Oscillator Waveform



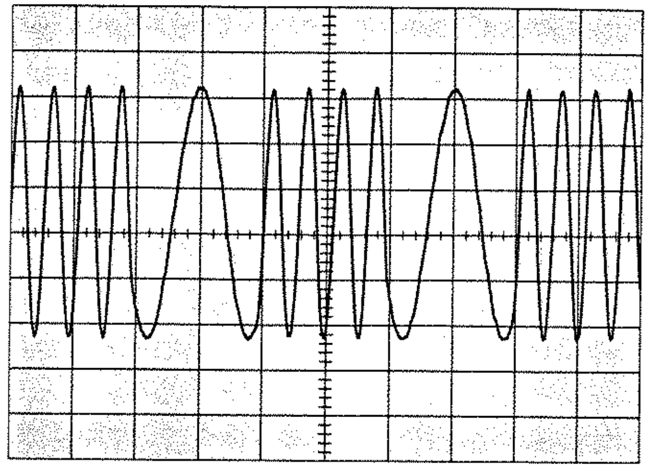
Waveform Name/Description: Amplitude sweeps.

Waveform Application: Receiver testing.

Instrument Settings

Source	Frequency	Phase	Waveform	Amplitude	Depth
Audio-Channel 1	1 kHz	0°	Sine	900 mV	–
AM	50 Hz	0°	Sawtooth	–	100%

No. 7. HP 8644A Synthesized Audio Oscillator Waveform



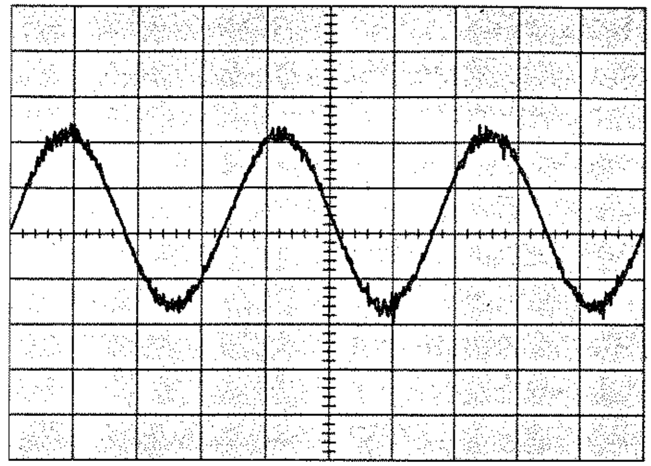
Waveform Name/Description: Two-tone FSK with 50% duty cycle.

Waveform Application: Modem testing.

Instrument Settings

Source	Frequency	Phase	Waveform	Amplitude
Audio-Channel 1	10 kHz	0°	Sine	2 V
FM	2 kHz	0°	Square	5 kHz
Comments: The frequencies of the two tones are the frequency of Audio-Channel 1 plus or minus the amplitude of the FM Source. The data rate is set by the frequency of the FM Source.				

No. 8. HP 8644A Synthesized Audio Oscillator Waveform

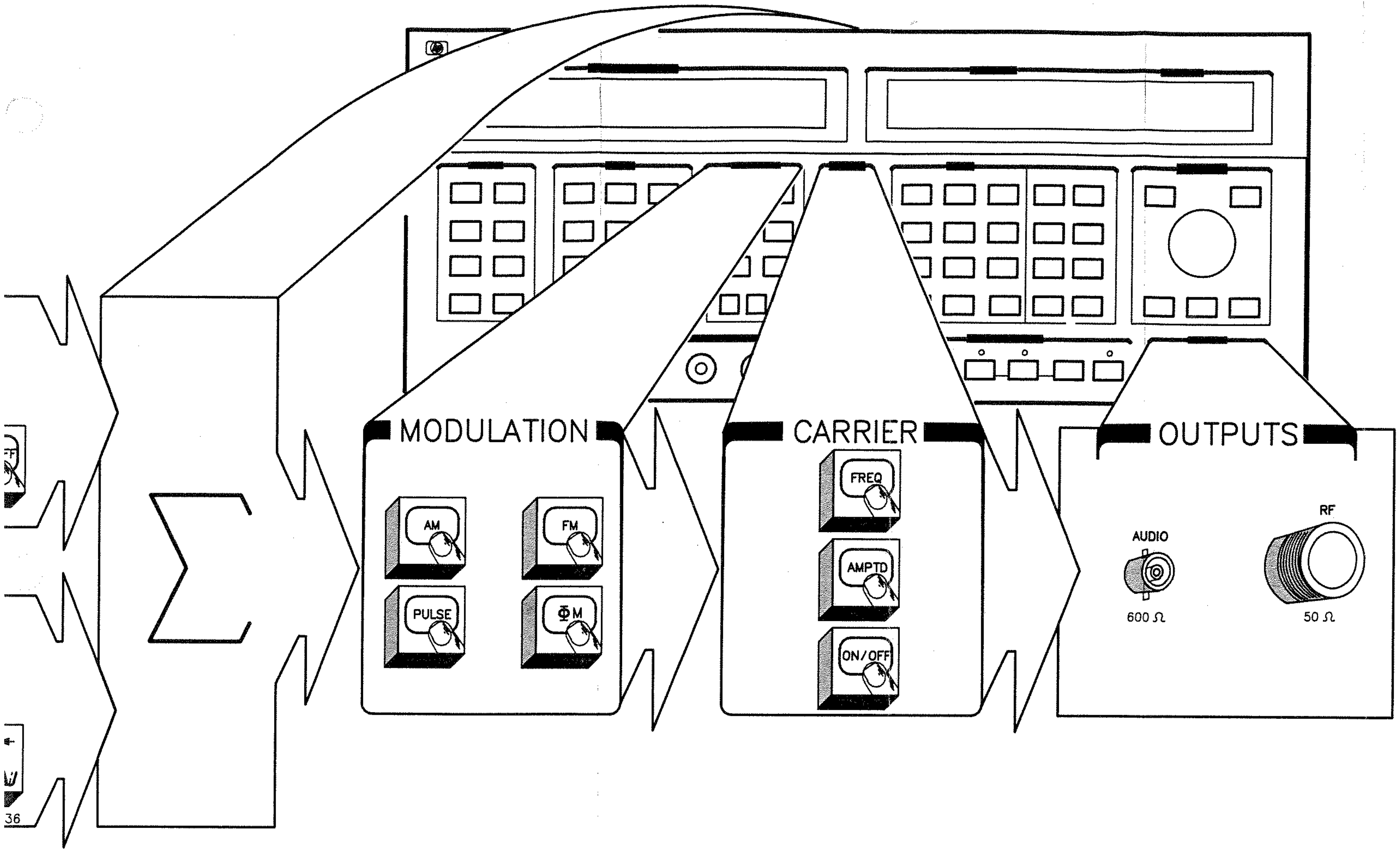


Waveform Name/Description: Sine wave with AM noise.

Waveform Application: Receiver rejection of AM noise.

Instrument Settings

Source	Frequency	Phase	Waveform	Amplitude
Audio-Channel 1	1 kHz	0°	Sine	1.6 V
AM	100 Hz	0°	Noise	20%



ı Synthesis to Produce Complex Signals

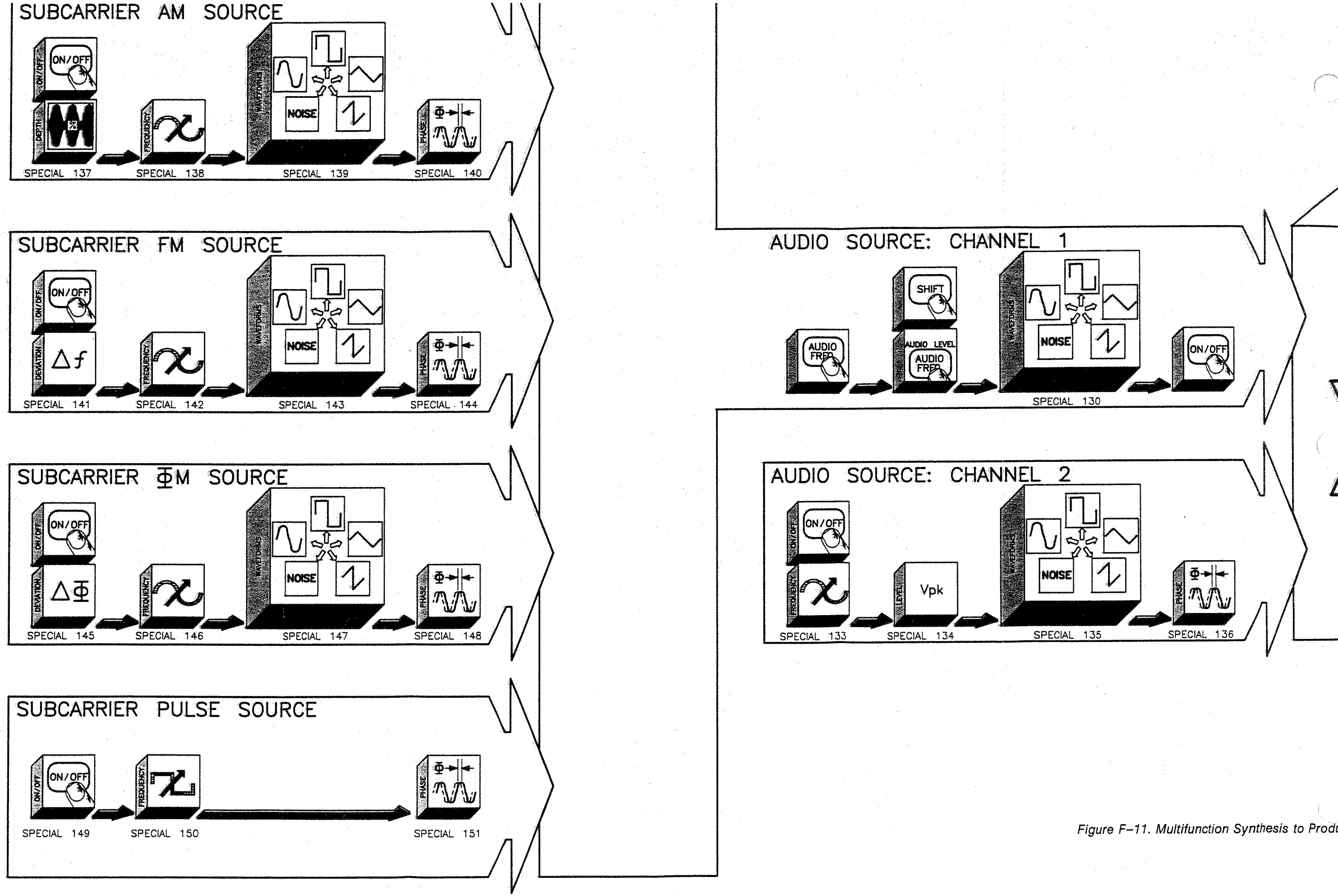


Figure F–11. Multifunction Synthesis to Produc

G Miscellaneous Operating Features

Everything Else You Need to Know

The chapters and appendixes in this *Operation Guide* have provided you with operating information for most of your needs. This appendix describes the operating features that include everything else you need to know to operate the HP 8644A.

The miscellaneous operating features are alphabetically arranged. A table of contents for each feature is as follows:

Table of Contents

Amplitude Offset

The CARRIER **AMPTD OFS** key allows you to change the output amplitude displayed on the front panel by a value ranging from +50 dB to –50 dB without changing the actual output amplitude value. Press the blue **SHIFT** key, and then the **AMPTD OFS** key; you will see the following in the FREQUENCY/STATUS display:

```
Amptd Offset    OFF
```

Simply enter the amplitude offset that you want. The default amplitude offset value is 0 dB.

Auto Sequence

The UTILITY **AUTO SEQ** key allows you to continually sequence through the first 10 storage registers (0–9) in the order you determine by using the **SET SEQ** key; any storage register 0–9 may be recalled more than once in the Auto Sequence. The RF output will reflect the recalled setting in the storage register.

Press the blue **SHIFT** key, and then the **AUTO SEQ** key to start the Auto Sequence routine. The Auto Sequence routine performs a frequency sweep under the following condition:

- If a frequency sweep occurs when the Auto Sequence is active, the HP 8644A outputs a single sweep and then proceeds to output the settings recalled from the next sequence. (Frequency sweep parameters must be saved while the HP 8644A is sweeping.)

Stop the Auto Sequence by pressing the blue **SHIFT** key, and then the **EXIT** key.

Clear All

The UTILITY **CLEAR ALL** key allows you to clear all storage registers from memory. When you press the **CLEAR ALL** key, you will see the following in the FREQUENCY/STATUS display:

```
Clr Registers (Press ON)
```

Simply press the **ON** key to execute the clear all function.

Display

The UTILITY **DISPLAY** key allows you to see the settings for three things:

- The currently active special functions.
- The settings for any storage register.
- The storage register numbers used with the sequence function.

Press the **DISPLAY** key, and you will see the following:

```
Press SPECIAL,RECALL,or SEQ
```

Display Special

Press the **SPECIAL** key to see the numeral of any special function that has been activated. For example, if Special Functions 112, and 130 are active, you would see the following in the FREQUENCY/STATUS display:

```
112,130
```

Display Recall

Press the **RECALL** key to see the following in the FREQUENCY/STATUS display:

```
Display Register # =
```

Simply enter the number of the storage register you want to recall, and press the **ENTER** key. Then for approximately 5 seconds, the contents of the storage register are displayed. The RF output does not change to the settings in the displayed storage register.

Display Sequence

Press the **SEQ** key to see the storage register sequence that was set up by using the **SET SEQ** key. For example, if a sequence was set up using storage registers 0, 5, 2, and 6, you would see the following in the FREQUENCY/STATUS display:

```
Seq=0,5,2,6
```

Only 10 storage registers are allowed in a sequence. The storage registers may be any from 0 through 9; storage registers 10 through 49 are not allowed in the sequence.

EMF

The CARRIER **emf** key allows you to display the output amplitude in emf units. When emf units are active, the output amplitude is referenced in volts to an open circuit output impedance. Press the blue **SHIFT** key, and then the **emf** key; you will see the following in the FREQUENCY/STATUS display:

```
Amptd      Units      EMF   OFF
```

Simply press the **ON** key to activate the emf function. You will notice that the **emf** annunciator appears in the AMPLITUDE display. The emf function has no effect on output amplitude values in dBm. However, if the displayed output amplitude is 1 V, for example, it would be 2 Vemf.

Frequency Counter

The 2 GHz Frequency Counter (Option 011) provides accurate frequency counter measurements for Audio and RF frequencies. The 2 GHz Frequency Counter is fully programmable. The Frequency Counter is activated through Special Function 184.

The 2 GHz Frequency Counter is a reciprocal counter that determines signal frequency by measuring the time period of the signal. Frequency resolution is determined by a selectable gate time used by the counter, and can be expressed as 0.01 ppm per second of gate time. The counter display will always show digits to 0.01 Hz, while the actual measurement resolution (in Hz) is determined by the counter resolution (as a function of gate time) and frequency.

The Frequency Counter features selectable gate time (Special Function 185) and frequency range (Special Function 183). These two functions are not sequence dependent. You can use them in any order providing that after each time you select a different frequency range or gate time you enter Special Function 184 to turn on the Frequency Counter.

Note

When operating the Counter from the instrument front panel, changing other signal generator functions (such as amplitude or frequency) will disable the counter. Under these conditions, it is necessary to use SP 184 to re-activate the Counter.

The Frequency Counter can not be used when the signal generator is in sweep mode.

Turning On the Frequency Counter

Connect an RF cable between the frequency source to be measured and the MEAS INPUT connector on the front panel. Enter **SPECIAL** 184, then press the **ON** key. You will see the following in the left display:

```
184: Cntr (measured frequency) Hz
```

At turn on, the default frequency range is 20 Hz to 10 MHz, and the default gate time is 100 ms. (If instrument power is cycled without pressing the INSTRUMENT PRESET key, the previously set frequency range or gate time is still in effect.) A frequency measurement is displayed as long as there is sufficient input signal to the MEAS INPUT connector.

To turn off the counter function press any key.

Setting Frequency Counter Range

There are three selectable frequency ranges for making measurements. The frequency counter does not auto-range; for accurate measurements it is neccessary that the correct frequency range be selected. The frequency ranges are as follows:

- 20 Hz to 10 MHz, (with a non-warranted frequency range of 15 Hz to 15 MHz);
- 10 MHz to 640 MHz, (with a non-warranted frequency range of 3 MHz to 1 GHz);
- 640 MHz to 2 GHz, (with a non-warranted frequency range of 200 MHz to 2.1 GHz).

To change the frequency range, enter **SPECIAL** 183 and press the **ON** key. Turn the KNOB until the selected range upper limit (10 MHz, 640 MHz, or 2.00 GHz) is displayed. Only the upper limit of the selected frequency range is displayed on the screen. To exit this function, use another special function or any of the front panel keys except the **INSTR PRESET** key (which returns the instrument to the default setting).

Setting Frequency Counter Gate Time

The Frequency Counter features selectable gate times from 0.1 s to 1.00 s in 100 ms increments. The larger the gate time (that is, a longer sampling time) the more stable and accurate the measurement.

To change gate time, enter **SPECIAL** 185 and press the **ON** key. Rotate the KNOB until the desired gate time is displayed. To exit this function, use another special function or any of the front panel keys except the **INSTR PRESET** key (which returns the instrument to the default setting).

Frequency Offset

The CARRIER **FREQ OFS** key allows you to change the RF output displayed on the front panel by a value from +50 GHz to –50 GHz without changing the actual RF output value. Press the blue **SHIFT** key, and then the **FREQ OFS** key; you will see the following in the FREQUENCY/STATUS display:

```
Offset OFF
```

Simply enter the frequency offset that you want. The default value of frequency offset is 0 Hz.

Knob Hold

The INCR/DECR **KNOB HOLD** key allows you to hold knob control to one of the following functions:

- Frequency
- Amplitude
- Audio Frequency
- AM Depth
- FM Deviation
- Start Frequency
- Stop Frequency
- Center Frequency
- Span Frequency
- Marker Frequency

When the Knob Hold is active, you may change any other function by entering the parameter value with the Data keys, or the INCR/DECR [⇧] and [⇩] keys.

To activate the Knob Hold, select a function (so the "▽" cursor is located in that area), press the blue **SHIFT** key, and then the **KNOB HOLD** key.

When you select another function, a duplicate "▽" cursor appears to indicate that the function is active.

Knob Increment

The INCR/DECR **KNOB INCR** key allows you to set knob increment values for any front-panel function that can be modified by turning the knob, or pressing the [⇧] or [⇩] keys. Use the following directions:

1. Select the function you want.
2. Press the blue **SHIFT** key, and the **KNOB INCR** key.
3. Press the **INCR SET** key, and then enter the new Knob Increment value.

There are two ways to turn off the Knob Increment, as follows:

- Press the **KNOB OFF** key.
- Press either the INCR/DECR [⇐▽] or [▽⇒] keys.

Phase Decrement

The INCR/DECR Φ **DECR** key allows you to decrease the phase of the RF output in one-degree decrements each time the key is pressed. If the Φ **DECR** key remains pressed, the phase of the RF output continues to decrease in one-degree decrements. This feature is equivalent to having Special Function 110 active and turning the knob counterclockwise.

Phase Increment

The INCR/DECR Φ **INCR** key allows you to increase the phase of the RF output in one-degree increments each time the key is pressed. If the Φ **INCR** key remains pressed, the phase of the RF output continues to increase in one-degree increments. This feature is equivalent to having Special Function 110 active and turning the knob clockwise.

Sequence

The UTILITY **SEQ** key allows you to sequence through the first 10 storage registers (0–9), one register at a time, in the order you determine by using the **SET SEQ** key; any storage register may be recalled more than once in the sequence.

Repetitively press the **SEQ** key to cycle through each storage register in the sequence. The HP 8644A will output the settings for each storage register that was saved in the sequence.

Set Sequence

The UTILITY **SET SEQ** key allows you to recall storage registers 0–9 in any order. You may only set up 10 sequences; however, storage registers 0–9 may be recalled more than once. Storage registers 10 through 49 are not allowed in the sequence. The **AUTO SEQ** key or the **SEQ** key are used to recall the set sequences.

Press the blue **SHIFT** key, and then the **SET SEQ** key; you will then see the following in the FREQUENCY/STATUS display:

```
Seq #0 => Register
```

Simply enter the storage register you want in the #0 sequence position, and then press the **ENTER** key. The sequence position number increments up one number at a time to #9 and then automatically exits the set sequence mode. If you want less than 10 storage registers in the sequence, exit the sequence mode by pressing the blue **SHIFT** key, and then the **EXIT** key.

You may display the sequence positions set for each storage register. Refer to the *"Display"* directions in this appendix.

H Glossary

Alias.

A keyword or command statement in a program that is an alternate (synonymous) term for commands of the same type. For example, the command statement FM:FREQuency:STEP is an alias for the command statement LFSource:FREQuency:STEP.

Argument.

An argument is an independent variable (command parameter) whose value or state determines the value or state of a function. For example, the argument in the command statement FREQ:CW 150MHZ is "150MHZ".

Auto Select.

When the front-panel **AUTO** key is active, the HP 8644A will choose a signal path with the best possible spectral purity for the present control setting.

Command Header.

The command header is the first part of the command statement which is used to direct the control of the command. For example, in the command statement FM:STATE ON, the command header is simply "FM:STATE".

Command Message.

A command message is a line of information in a program containing one or more command statements. For example, the command statements to set FM deviation to 10 kHz, and to turn FM deviation on would make a command message as follows: FM 10KHZ;FM:STATe ON.

Command Parameter.

A command parameter is an independent variable (argument) whose value or state determines the value or state of a function. For example, the command parameter in the command statement FREQ:CW 150MHZ is "150MHZ".

Command Statement.

A command statement is a string of mnemonics used to accomplish one task, that is, either to set or query a function. For example, the string of mnemonics used to set the Auto selection of frequency synthesis would be as follows: FREQ:SYNT:AUTO ON.

Frequency Counter

The 2 GHz Frequency Counter (Option 011) is a self-contained assembly that accurately measures and displays the frequency of an input signal connected to the MEAS INPUT connector. The Frequency Counter is activated by Special Function 184.

Frequency Counter Range.

Frequency Counter Range refers to the three frequency counter range settings used to make accurate frequency measurements. The three selectable frequency ranges are: 20 Hz to 10 MHz, 10 MHz to 640 MHz, and 640 MHz to 2 GHz. Only the upper limit value of the desired frequency range is displayed on the screen. The Frequency Counter is activated by Special Function 183.

Gate Time.

Gate time refers to the length of time that the HP 8644A signal generator uses to sample the measured frequency. A larger gate time (longer sampling time) provides a more stable and accurate measurement. Gate times are selectable from .1 S to 1.0 S in 100 mS increments. The Set Gate Time function is activated by Special Function 185.

Glideslope.

The Glideslope signal is part of the Instrument Landing System. It provides up and down orientation for the ideal angle of descent to the runway.

Header.

Same as "Command Header". This is the first part of the command statement which is used to direct the control of the command. For example, in the command statement FM:STATE ON, the header is simply "FM:STATE".

HP-SL.

HP-SL is the acronym for "Hewlett-Packard System Language". Refer to chapter 4 for a thorough discussion of HP-SL.

ILS.

ILS is the acronym for "Instrument Landing System". ILS is a group of navigation signals used for aircraft landings.

Localizer.

Localizer is one of the Instrument Landing System signals. It provides left and right orientation to the center of the runway.

Marker Beacon.

The Marker Beacon signals are part of the Instrument Landing System. The three markers indicate distance from the end of the runway.

Synthesis Mode.

A row of **SYNTHESIS MODE** keys on the front panel represent the internal signal paths that are used to minimize phase noise and spurs on the RF output, as a function of the selected FM deviation. The **AUTO** key is used to choose the signal path that provides the best possible spectral purity for any control setting.

Short Form.

HP-SL commands may be written in a long or short form. The short form of any command will be three or four characters in length. For example the short form of the command AMPLitude is AMPL. The *HP-IB Control Language Dictionary* in chapter 4 lists all short form commands in upper case lettering.

Syntax.

Syntax refers to the make-up or structure of command statements and messages in HP-SL for use over the HP-IB bus.

Tree Structure.

HP-SL commands are organized in a tree structure. Commands start at a "root level" and proceed to branch out from the root. Multiple branching occurs with tree structure organization.

VOR.

VOR is the acronym for VHF Omni-Range. The VOR signal provides directional information to in-flight aircraft.

I Specified Avionics Performance

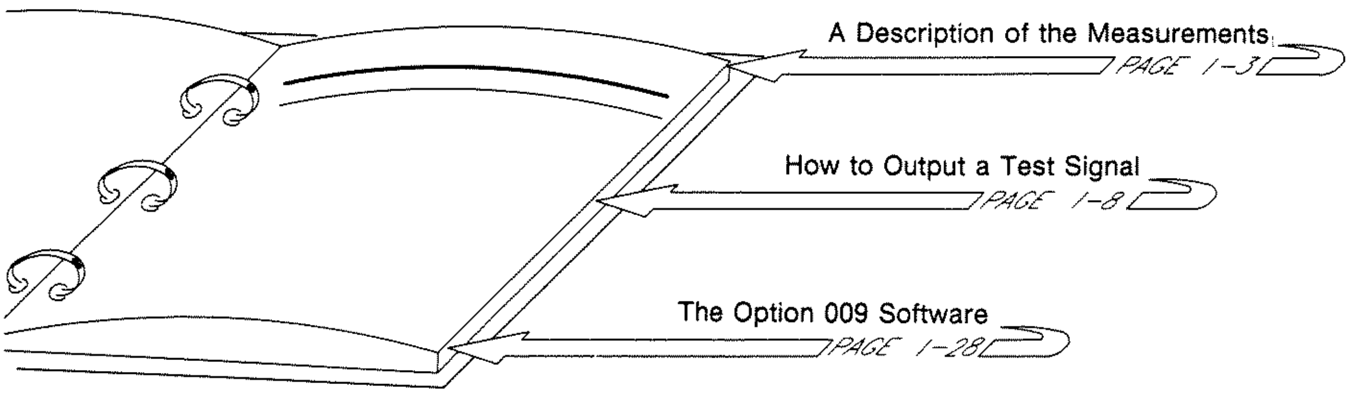
Introduction

Specified Avionics Performance requires pairing Option 009 Specified VOR/ILS Performance with Option 007 Synthesized Audio Oscillator.

Option 009 is a set of VOR/ILS test specifications for the HP 8644A and an example program to help in developing automated Avionics tests. Option 009 is dependent on Option 007 to provide the nessesary complex modulation capability. This appendix is only concerned with Option 007's ability to generate Avionics complex modulation signals; a complete description of Option 007's capabilities is contained in Appendix F.

This appendix describes using the HP 8644A for Avionics testing. Sections include; a description of VOR/ILS tests using the HP 8644A, a "how to" for VOR/ILS testing, and a description of the Option 009 software.

The Directory



VOR/ILS Test Measurements with the HP8644A

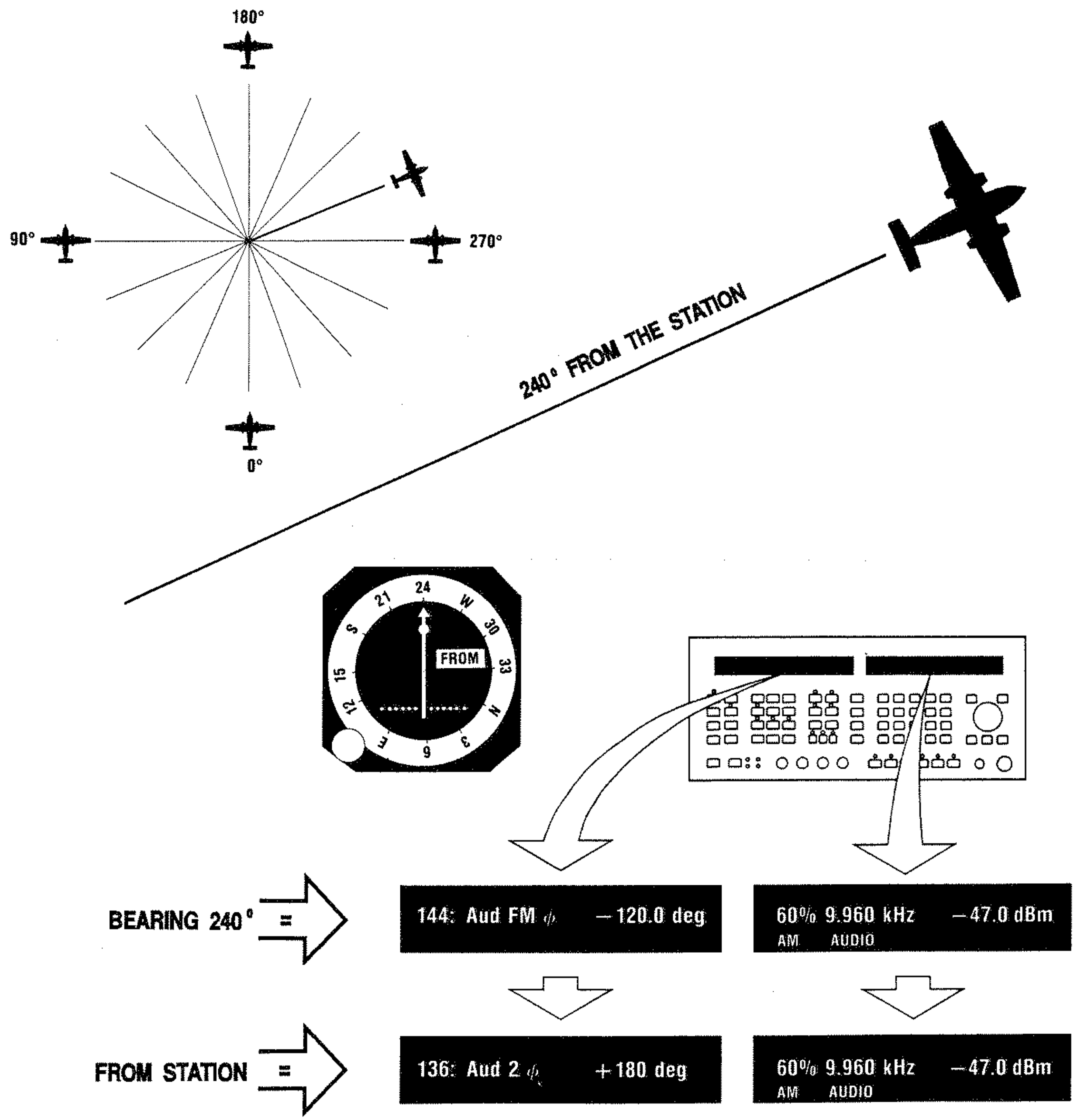
The HP 8644A generates signals to test each of the following:

- VOR
- Localizer
- Glideslope
- Marker Beacon

A description of each test is given in the following sections. The descriptions introduce how the readings on the avionics equipment are produced using the HP 8644A.

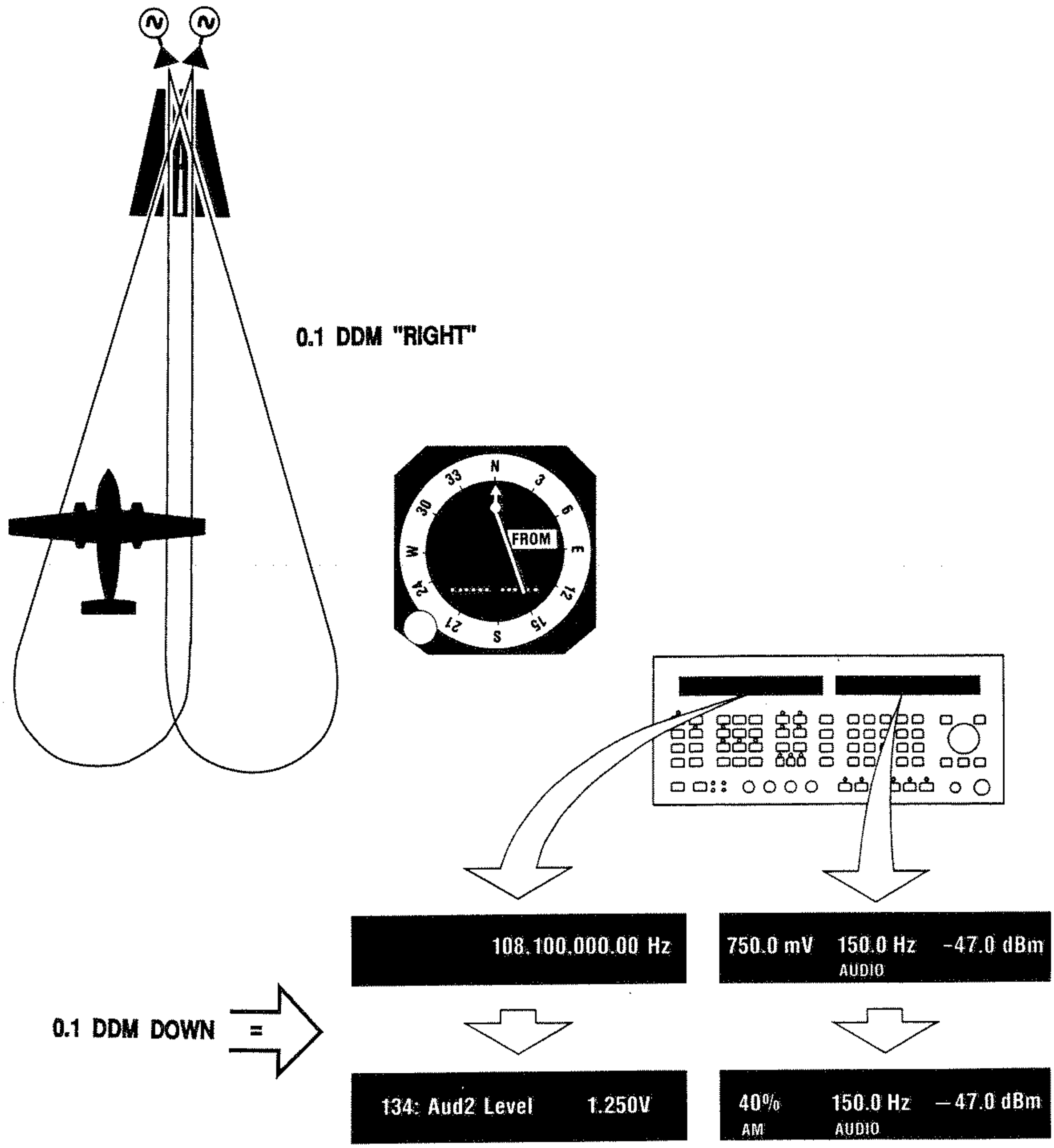
VOR

The displays shown equate the VOR reading to the signal generator settings for a particular measurement. Special Function 220 sets the instrument for VOR testing. The signal generator displays show Special Functions 144 and 136 used to adjust the bearing.



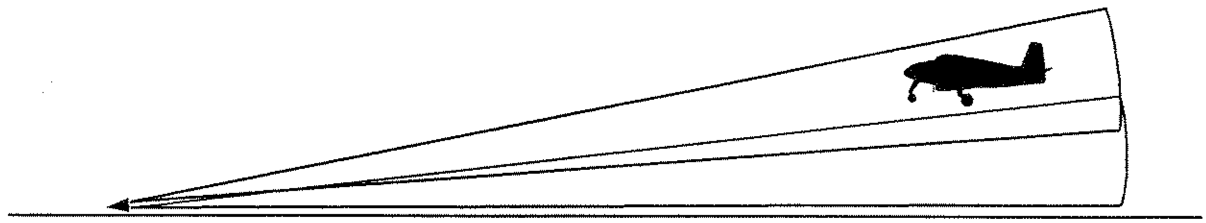
Localizer

The two displays shown relate the Localizer reading to the levels set on the signal generator to produce the reading. Special Function 221 generates the Localizer signal. The Audio Level and Special Function 134 adjust the reading.

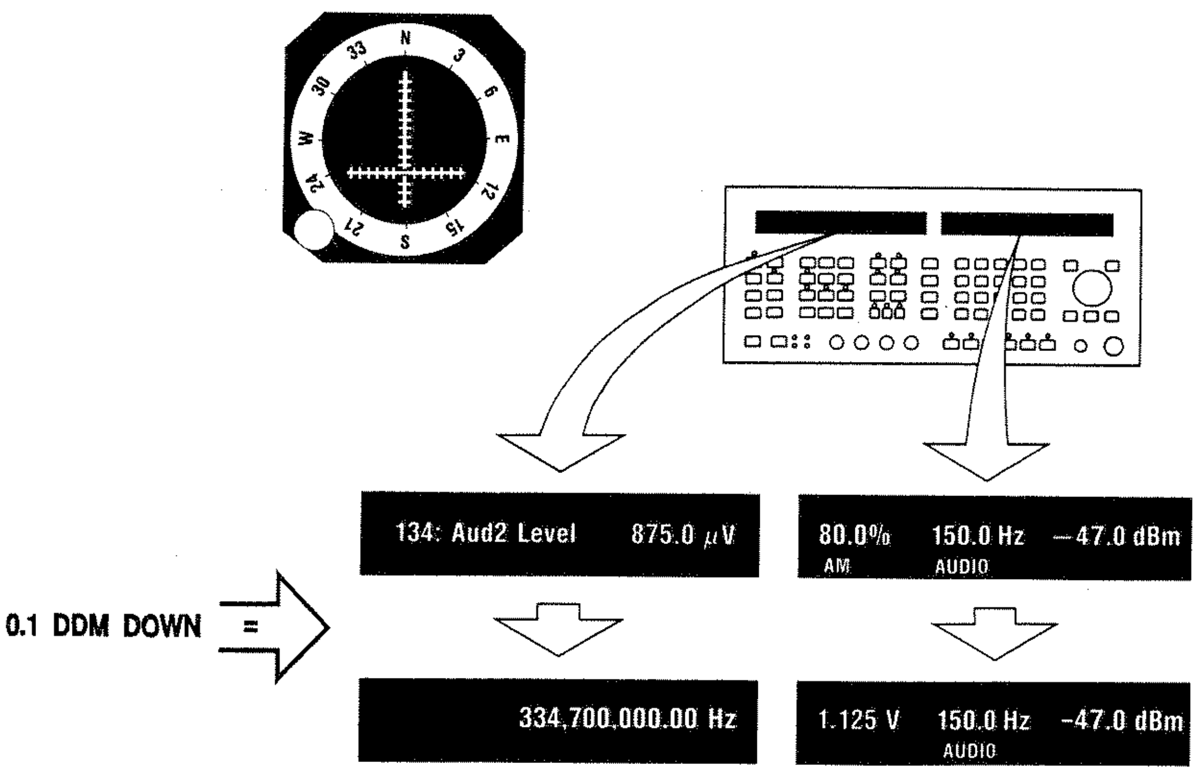


Glideslope

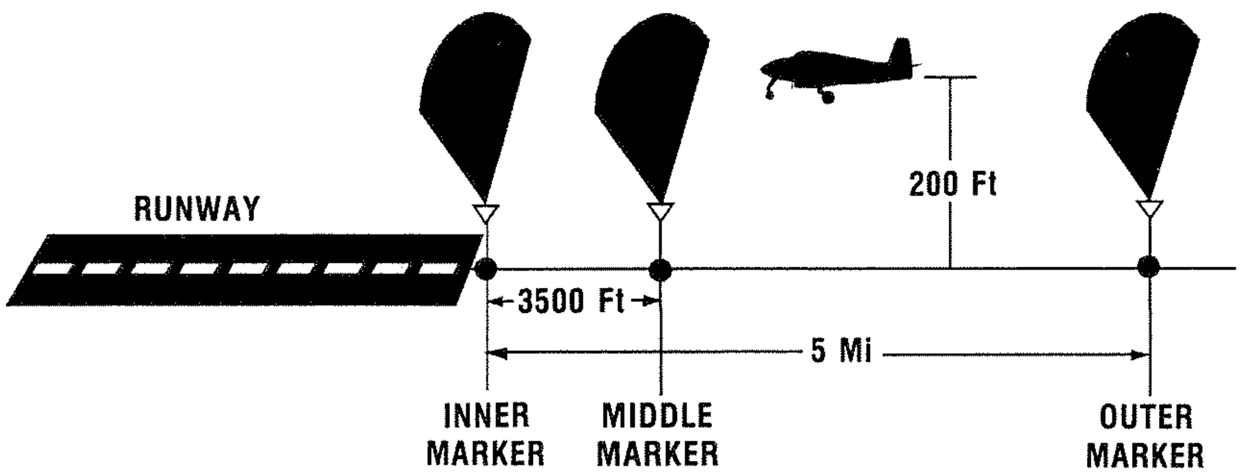
The Glideslope and signal generator displays shown side by side demonstrate how the glideslope reading was obtained using the HP 8644A. Special Function 222 sets the HP 8644A for Glideslope testing, Special Function 134 and the Audio Level adjust the levels for the reading.

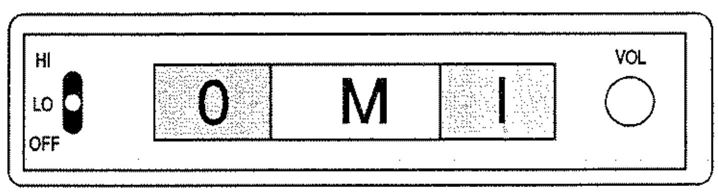


0.1 DDM "DOWN"



Marker Beacon Each of the three Marker Beacons are set by a special function.





How to Output a VOR/ILS Test Signal

Each test signal is composed of an RF signal carrying complex modulation. The complex modulation is the summation of individual audio signals.

The test signals may be generated by either of two methods:

- Avionics Special Functions numbered 220 through 225.
- Building the VOR/ILS Test Signal

The Avionics special functions automatically set all parameters except the RF amplitude, and adjustments are made only as needed.

Building the complex modulated signal allows control of all parameters from a design aspect.

Both methods are demonstrated in the following sections.

Using the Avionics Special Functions

Dedicated special functions to configure the signal generator for Avionics testing are provided by Option 007 and specified by Option 009. This section shows how to use each of the dedicated special functions, and how to make adjustments associated with the test signal.

VOR

Special Function 220 creates a VOR test signal simulating 0° "TO" the station.

To set the HP 8644A for VOR testing, use the following sequence:


```
Enter Special Number
```

You now see...

```
220:VOR Setup      (ON)
```

Now set the desired RF amplitude.

Changing the Bearing

To change the radial, use Special Function 144.


```
Enter Special Function
```

You now see...

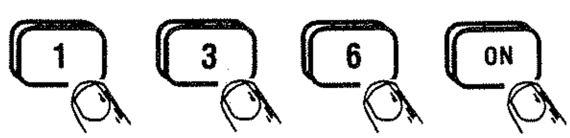
```
144:Aud FM ⇕      +0.0deg
```

Enter the desired radial in degrees.

Note *For radials greater than 180, the negative coterminal radial will be displayed, that is, 270 displays −90.*

To change TO/FROM, use Special Function 136.


```
Enter Special Function
```



You now see...

```
136:Aud2 ⇟      +180.0deg
```

Enter 0 deg for "FROM" or 180 deg for "TO".

Localizer

Special Function 221 generates a Localizer test signal at 0 DDM.

To set the HP 8644A for Localizer testing use the following sequence:


```
Enter Special Number
```

You now see...

```
221:Localizer Setup (ON)
```

Now set the desired RF amplitude.

Changing the Localizer Reading

To change the DDM value, the difference in depth of modulation must first be converted to two voltage levels that change modulation depths individually. The two values that must be changed are Audio Level and `Aud2 Level` (Special Function 134).

Table I-1 lists common Localizer values.

Table I–1. Localizer

DDM	dB	Audio Level	Aud2 Level (Special Fcn 134)
0	0	1.000 V	1.000 V
0.046	2.0	1.115 V	0.885 V
0.093	4.1	1.232 V	0.767 V
0.115	7.1	1.387 V	0.612 V
0.200	9.5	1.500 V	0.500 V
variable	—	(20+50*DDM)/20 V	(20−50*DDM)/20 V
—	variable	2−Aud2 Level V	$2/(1+10^{(dB/20)})$ V

The values shown deflect to the **left**; to deflect to the **right**, exchange Audio Level and Aud2 Level.

Note *When changing levels remember:*

- *The level that is reduced must be changed first or an* Amplitude level conflict *error will result.*
- *When calculating values, round down to the nearest millivolt.*
- *For opposite deflections exchange the Audio Level and Aud2 Level values.*

To change Audio Level, press **SHIFT** Audio Level and enter the value.

To change Aud2 Level, execute Special Function 134.

```
Enter Special Number
```

You now see...

```
134:Aud2 Level   1,000 V
```

Enter the value in volts.

Glideslope

Special Function 222 generates a Glideslope signal at 0 DDM.

To set the HP 8644A for Glideslope testing, use the following sequence:


```
Enter Special Number
```

You now see...

```
222:Glideslope Setup(ON)
```

Now set the desired RF amplitude.

Changing the Glideslope Reading

To change the DDM value, the difference in depth of modulation must first be converted to two voltage levels that change modulation depths directly. The two values that must be changed are Audio Level and `Aud2 Level` (Special Function 134).

Table I-2 lists common Glideslope values.

Table I–2. Glideslope

DDM	dB	Audio Level	Aud2 Level (Special Fcn 134)
0	0	1.000 V	1.000V
0.045	1.0	1.055 V	0.943 V
0.091	2.0	1.113 V	0.886 V
0.175	3.9	1.218 V	0.781 V
0.400	9.5	1.500 V	0.500 V
variable	—	(40+50*DDM)/40 V	(40−50*DDM)/40 V
—	variable	2−Aud2 Level V	$2/(1+10^{(dB/20)})$ V

The values shown deflect **up**; to deflect **down**, exchange the Audio Level and Aud2 Level values.

Note *When changing levels remember:*

- *The level that is reduced must be changed first or an* `Amplitude level conflict` *error will result.*
- *When calculating values, round down to the nearest millivolt.*
- *For opposite deflections exchange the Audio Level and Aud2 Level values.*

To change the Audio Level, press **SHIFT** Audio Level and enter the value.

To change the `Aud2 Level`, execute Special Function 134.

```
Enter Special Number
```

You now see...

```
134:Aud2 Level   1.000V
```

Enter the value in volts.

Marker Beacon

Special Functions 223, 224, and 225 set the Outer, Middle, and Inner Markers. The markers are pulsed at a 2 Hz rate. The procedure used for each is the same; therefore, only is one demonstrated.

To set the HP 8644A for Outer Marker Beacon testing, use the following sequence:


```
Enter Special Number
```

You now see...

```
223:OM Beacon Setup (ON)
```

Now set the desired RF amplitude.

Note *If pulsed tone markers are not desired, turn Special Function 149 OFF.*

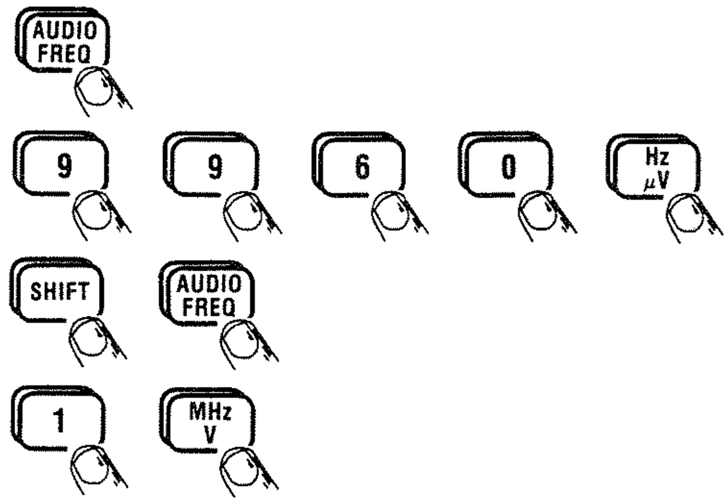
Building the VOR/ILS Test Signal

Signal building is desirable when a greater amount of control over parameters is needed. In signal building each of the audio signals of the complex modulation signal are selected and set to the proper values. The complex audio signal is then modulated onto the proper carrier. This section will demonstrate how to build each of the VOR/ILS test signals.

VOR This section describes the setup of a VOR test signals components. The setup has the same parameters as Avionics Special Function 220.

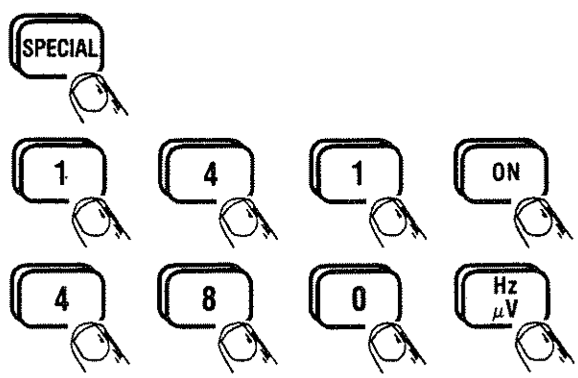
Set the Audio Source 1 as an FM Subcarrier

Set the subcarrier for 9960 Hz at 1 V.

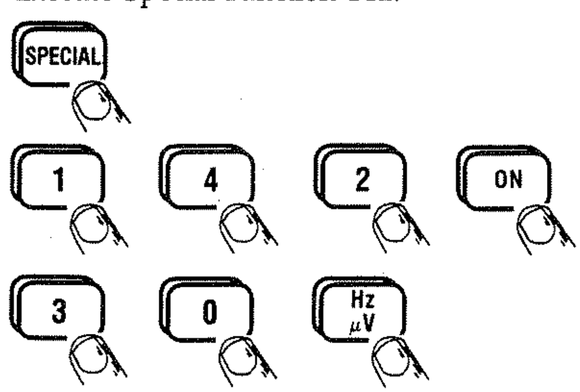


Modulate the FM Subcarrier

Set 480 Hz of deviation at a 30 Hz rate.
Execute Special Function 141.

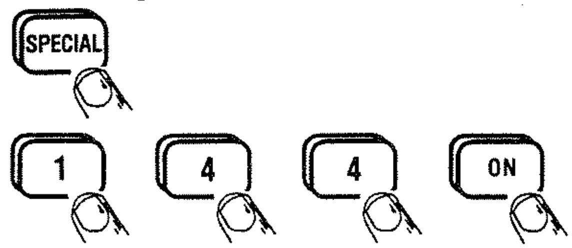


Execute Special Function 142.



Select the Radial

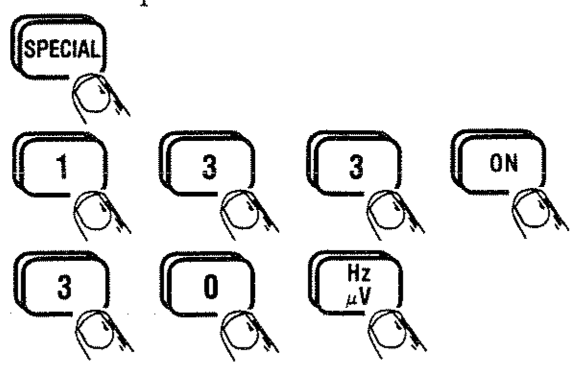
Execute Special Function 144.



Enter the desired radial in degrees.

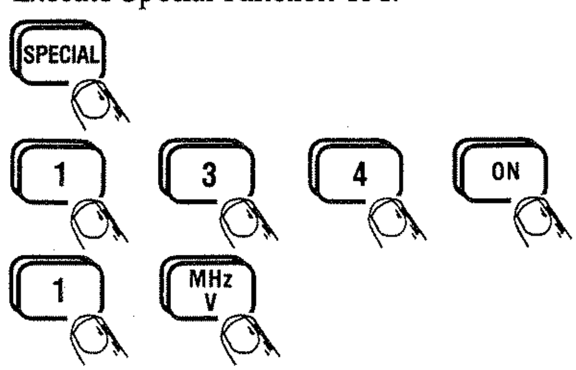
Set the Reference Signal

Execute Special Function 133.



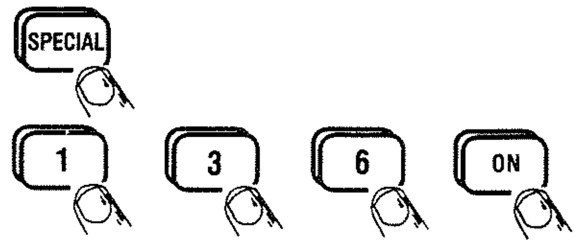
Set the Reference Amplitude

Execute Special Function 134.



Select TO or FROM

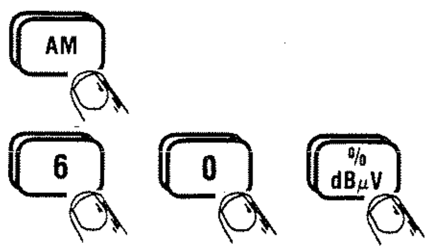
Execute Special Function 136.



Enter 0 degrees for "FROM" or 180 degrees for "TO".

Modulate the Carrier with the Subcarrier

Set the modulation depth.

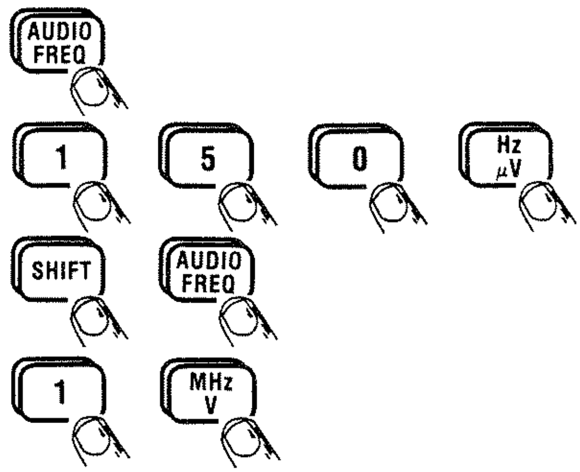


Now select the desired RF frequency and power level.

Localizer and Glideslope

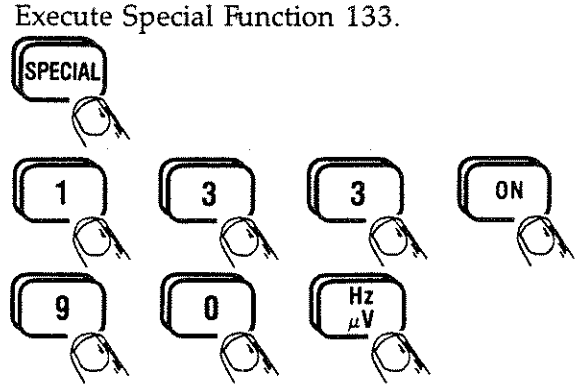
This section demonstrates setting the individual components of the complex modulation signals for Localizer or Glideslope testing. The setup is the same as Avionics Special Functions 221 and 222.

Set Audio Source 1 for 150 Hz at 1 V

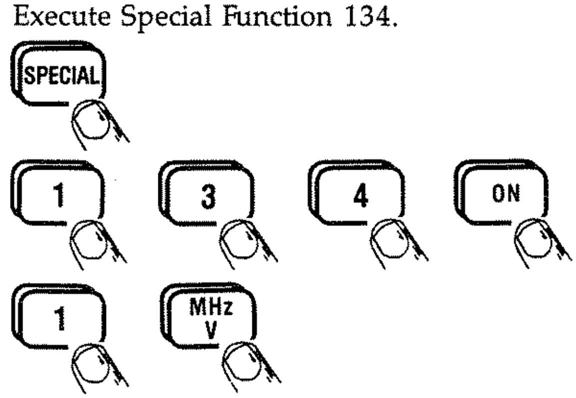


Set Audio Source 2 for 90 Hz at 1 V

Execute Special Function 133.



Execute Special Function 134.



Tables I-3 and I-4 list common Localizer and Glideslope values for deflections other than those set on the previous page.

Table I–3. Localizer

DDM	dB	Audio Level	Aud2 Level (Special Fcn 134)
0 0.046 0.093 0.115 0.200	0 2.0 4.1 7.1 9.5	1.000 V 1.115 V 1.232 V 1.387 V 1.500 V	1.000 V 0.885 V 0.767 V 0.612 V 0.500 V
variable	—	(20+50*DDM)/20 V	(20−50*DDM)/20 V
—	variable	2−Aud2 Level V	$2/(1+10^{(dB/20)})$ V

The values shown deflect to the **left**; to deflect to the **right**, exchange the values Audio Level and Aud2 Level.

Table I–4. Glideslope

DDM	dB	Audio Level	Aud2 Level (Special Fcn 134)
0 0.045 0.091 0.175 0.400	0 1.0 2.0 3.9 9.5	1.000 V 1.055 V 1.113 V 1.218 V 1.500 V	1.000V 0.943 V 0.886 V 0.781 V 0.500 V
variable	—	(40+50*DDM)/40 V	(40−50*DDM)/40 V
—	variable	2−Aud2 Level V	$2/(1+10^{(dB/20)})$ V

The values shown deflect **up**; to deflect **down**, exchange the Audio Level and Aud2 Level values.

Note *When changing levels remember:*

- *The level that is reduced must be changed first or an* `Amplitude level conflict` *error will result.*
- *When calculating values, round down to the nearest millivolt.*
- *For opposite deflections swap the Audio Level and Aud2 Level values.*

Modulate the Carrier

Set the modulation depth.

For Localizer.

For Glideslope.

Now select the desired RF frequency and output power level.

Marker Beacon

This section describes how to set the HP 8644A for Marker Beacon testing. The setup is the same as Special Functions 223, 224 and 225.

Set Audio Source 1 for the Tone Frequency

For Outer Marker.

For Middle Marker.

For Inner Marker.

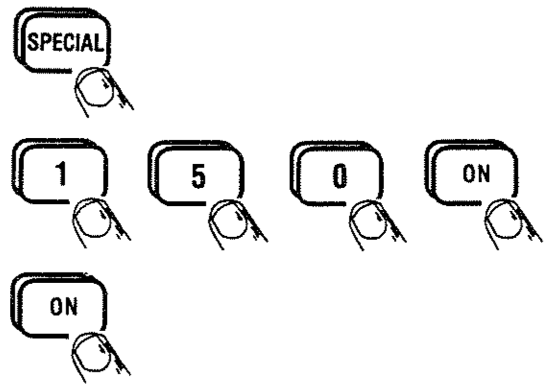
Pulse the Tone

If pulsed tone is not desired, procede to the last step.

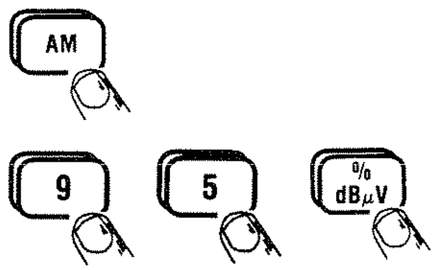
Execute Special Function 149.

Set the Pulsed Rate

Execute Special Function 150.



Modulate the Carrier



Now set the frequency to 75 MHz and set the desired RF power level.

Option 009 Software

Part of Option 009 is a demonstration disk, HP part number 08644-10001. The demonstration disk consists of two parts: a demonstration program and a group of example subroutines. The program will run on most HP Series 200 and 300 controllers.

The Demonstration Program

The demonstration program is a learning aid for automated testing with the HP 8644A for Avionics. The demonstration program has three sections:

- VOR/ILS receiver test program
- Examples of navigation subroutines
- System control of signal generator

VOR/ILS receiver test program

The VOR/ILS receiver test program emulates a receiver test package, and works either with or without an instrument connected. The routine sets the instrument to test each of the following:

- VOR
- Localizer
- Glideslope
- Marker Beacon

Examples of navigation subroutines

This section of the demonstration program states what to input to and, what is returned from, the subroutines.

System control of signal generator

The program simulates an instrument interface for adjusting test settings using the values and nomenclature of a dedicated VOR/ILS test instrument.

The Subroutines

The subroutines are intended to be placed into, and called from a receiver test package. The subroutines have parameters passed in and, string variables returned. The returned variables can be written directly to the signal generator.

VOR Subroutines

SUB Vor_setup(Direction$,Bearing,Lfsource$,Modulate$)
The Vor_setup routine accepts the passed parameters "Direction$" as "To" or "From" and "Bearing" as a radial. The subroutine interprets the bearing and returns HP-SL strings in "Lfsourse$" and "Modulate$" to output to the signal generator.

SUB Vor_bearing(Direction$,Bearing,Lfsource$)
The Vor_bearing routine accepts the same variables as Vor_setup but returns only a modifying "Lfsource$" variable. Vor_bearing assumes that Vor_setup has already been called.

Localizer Subroutines

SUB Loc_setup(Direction$,Ddm,Lfsource$,Modulate$)
The Loc_setup routine accepts a position of "Left" or "Right" and a difference in depth of modulation. These are passed in as "Direction$" and "Ddm". The routine evaluates and returns the proper string variables in "Lfsource$" and "Modulate$" to output to the HP 8644A.

SUB Loc_offset(Direction$,Ddm,Lfsource$)
The same variables passed into Loc_setup are used in Loc_offset to generate and return an offset modifying string variable to output to the instrument. Loc_offset assumes Loc_setup has been run.

Glideslope Subroutines

SUB Gs_setup(Direction$,Ddm,Lfsource$,Modulate$)
The Gs_setup routine is passed "Up" or "Down" as "Direction$" and the difference in depth of modulation as "Ddm". The subroutine returns "Lfsource$" and "Modulation$" to be output to the instrument.

SUB Gs_offset(Direction$,Ddm,Lfsource$)
This subroutine accepts the same variables as the Gs_setup routine but is used for updating the offset after Gs_offset has been run.

Marker Beacon Subroutines

SUB Mb_setup(Marker$,Lfsource$,Modulate$)
This subroutine has one variable passed in to designate the marker, either "O", "M", or "I". The routine returns two string variables to pass to the instrument in "Lfsource$" and "Modulate$".

Index

INDEX

A

B

C

D

E

F

G

H

P

Q

R

S

T

U

V

W

X

Z

CALIBRATION MANUAL

TABLE OF CONTENTS

Section 1
General Information

Section 2
Installation

Section 3
Performance Tests

1 General Information

Section 1
GENERAL INFORMATION

1-1. INTRODUCTION TO HP 8644A DOCUMENTATION

Documentation for the HP 8644A includes an *Operation and Calibration Manual*, and a *Service Diagnostics Manual*. The *Operation and Calibration Manual* is made up of a *Operation Guide* and a *Calibration Manual* both in the same 3-ringed binder. These manuals contain all the information required to install, operate, test, and service the Hewlett-Packard Model 8644A Synthesized Signal Generator. The Model 8644A will generally be referred to as the Signal Generator throughout this manual.

The information to operate, calibrate, and service this instrument is as follows:

- The *Operation Guide* is provided with each instrument.
- The *Calibration Manual* is provided with each instrument.
- The *Service Diagnostics Manual* for assembly level repair is not included with the instrument but is obtained separately by ordering through your nearest Hewlett-Packard office.

Operation Guide

The *Operation Guide* documents front-panel operation, including special functions, error messages, and HP-SL programming. All operating information for the Signal Generator is found in the *Operation Guide*.

Calibration Manual

Section 1, General Information describes the Signal Generator, options, accessories, specifications, and other basic information.

Section 2, Installation provides information about initial inspection, preparation for use (including address selection for remote operation), instrument storage, and shipment.

Section 3, Performance Tests documents the tests that verify performance of the instrument against the critical specifications in table 1-1.

Service Diagnostics Manual

The *Service Diagnostics Manual* documents repairing the Signal Generator to the module level. This manual does not include component level repair.

Additional copies of any operation, calibration, or service manual can be ordered separately through your nearest Hewlett-Packard office. The part numbers are listed on the title page of this manual, and in the paragraph 1-8, *Additional Equipment Information* under *Documentation Options*.

1-2. SPECIFICATIONS

Instrument specifications are listed in table 1-1, *Specifications*. These are the performance standards, or limits, against which the instrument may be tested after a 24 hour warm-up (connection to ac power line), and after 10 minutes turn-on. The Signal Generator has a general operating temperature range of 0 to +55°C. Whenever the instrument senses an ambient temperature variation of ±10°C, a recalibration should be done to ensure that all specifications are being met. The error message **Temp Drift. Recalibrate** is put into the message queue if the temperature variation occurs. Activate Special Function 171 to recalibrate the instrument.

Information printed in *Italics* are *Supplemental Characteristics*, and are not warranted specifications but are typical characteristics included as additional information for the user.

1-3. SAFETY CONSIDERATIONS

This product is a Safety Class I instrument (that is, one provided with a protective earth terminal). Review the Signal Generator and all related documentation to become familiar with safety markings and instructions before operation. Refer to the *Warnings* and *Cautions* found in section 2 for safety information.

Safety information pertinent to the task at hand (installation, operation, performance testing, adjustment, or service) are found throughout these manuals.

1-4. DESCRIPTION

The Hewlett-Packard Model 8644A Synthesized Signal Generator has an RF output range of 251 kHz to 1030 MHz (2060 MHz with Option 002). Its output amplitude is leveled and calibrated from +16 to −137 dBm. AM, FM, Pulse, or Phase Modulation functions can be selected. The RF output frequency, output amplitude, and modulation functions may be remotely programmed via the Hewlett-Packard Interface Bus using the new Hewlett-Packard Standard Language (HP-SL). The unique modular design, internal calibration, and service diagnostic features permit accurate calibration and service.

RF Output

The Signal Generator covers an RF output range of 251 kHz to 1030 MHz which can be extended to 2060 MHz with the optional Doubler Module (Option 002). Frequency resolution is 0.01 Hz. A 12-digit display of the RF output in Hz, kHz, MHz, and GHz gives easy viewing of the desired frequency. Pushbutton keys and rotation of the Knob permit accurate tuning, and incrementing of the RF output.

Frequency accuracy and stability are dependent upon the reference source being used, which will be either the internal reference oscillator or an external source operating at 10 MHz. An optional 10 MHz reference with a temperature stabilized crystal is available for increased stability (Option 001).

Output Amplitude

The Signal Generator has precise power levels from +16 to −137 dBm over the entire frequency range. For instruments equipped with Option 002 (Doubler Module), the maximum output levels are +14 dBm for frequencies from 251 kHz to 1030 MHz, and +13 dBm at frequencies from 1030 to 2060 MHz. Output amplitude display resolution is 0.1 dBm. An 8 digit display provides easy viewing of the desired output. Easy conversion of units between dBm, +V, EMF, and so forth is possible.

Reverse Power protection is 50 Watts from a 50 Ω source, 25 V dc.

Modulation

The Signal Generator features AM, FM, ΦM, and Pulse modulation which can be simultaneously mixed, for example, AM/FM, AM/ΦM, AM/Pulse, FM/Pulse, ΦM/Pulse, AM/FM/Pulse, or AM/ΦM/Pulse. The Signal Generator also features versatile simultaneous internal and external modulation capability for AM, FM, Pulse, and ΦM.

With the Synthesized Audio Oscillator Option 007, the Internal Audio Source produces sine, square, triangle, sawtooth, and white Gaussian noise waveforms from 0.1 Hz to 400 kHz. However, the AUDIO output has a typical bandwidth of 400 kHz which affects complex waveforms with frequency components greater than 400 kHz. A 16 digit display and LED annunciators shows information for the internal or external modulation source. Direct keyboard entry for modulation selection is provided.

Sweep

The Signal Generator has two types of sweep: phase-continuous, and digitally-stepped. Linear or log frequency spacing may be selected with digitally-stepped sweeping; only linear frequency spacing is available when phase-continuous sweeping.

1-5. HEWLETT-PACKARD INTERFACE BUS (HP-IB)

Compatibility

The Signal Generator is fully programmable via the HP Interface Bus. The The Signal Generator's capabilities are defined by the following interface functions: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2. The Signal Generator interfaces with the bus via open-collector TTL circuitry. An explanation of the compatibility code may be found in IEEE Standard 488.2, in *IEEE Standard and Digital Interface for Programmable Instrumentation* or the identical ANSI Standard MC1.1.

For detailed information relating to programmable control of the Signal Generator over HP-IB using HP-SL, refer to *chapter 4* in the *Operation Guide.*

Selecting the HP-IB Address

The instrument's HP-IB address is preset to 19 (decimal) when shipped from the factory.

The HP-IB address is front-panel programmable. To change your instrument's HP-IB address, press the blue SHIFT key, and then the ADRS key. You will see the current address in the FREQUENCY/STATUS display. Key in the desired decimal number between 00 and 30 if you want to change the HP-IB address, and then press the ENTER key.

1-6. INSTRUMENTS COVERED BY THIS MANUAL

This manual documents Signal Generators supplied with electrical options 001, 002, 003, 004, 005, 007, 009, 010 and 011. These, and various mechanical options are described in this manual under paragraph 1-8, *Additional Equipment Information.*

Serial Numbers

This instrument has a two-part serial number in the form 1234A00123 which is stamped on the serial number plate attached to the rear of the instrument (above and slightly to the right of the fan louvre). The first four digits and the letter are the serial number prefix, and the last five digits form the sequential suffix that is unique to each instrument. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument.

The contents of these manuals apply directly to instruments having serial number prefix(es) in the range listed under SERIAL NUMBERS on the respective manual title pages.

For information concerning a serial number prefix not listed in the range provided on the title page, contact your nearest Hewlett-Packard office.

1–7. DOCUMENTATION UPDATING

This manual may be revised as needed to make corrections and to document hardware and firmware changes. The latest revision of the manual can be purchased from the Hewlett-Packard locations shown below:

Inside the U.S.A. Call *HP Parts Direct Ordering* at 800-227-8164. They can also help determine if a new revision is available.

Outside the U.S.A. Contact the local Hewlett-Packard Sales and Service office for ordering information.

1–8. ADDITIONAL EQUIPMENT INFORMATION

Options are variations to the standard instrument which can be ordered during, or after the original purchase. If options were not ordered with the shipment but are now desired, they may be ordered from your nearest Hewlett-Packard office using the part number included in the following paragraphs. The following list defines all currently available options.

Electrical Options

High Stability Timebase, (Option 001). This option provides a temperature regulated 10 MHz crystal High Stability Time Base for increased frequency stability (less than 5×10^{-10}/day). A BNC 10 MHz time base output connector is provided on the rear panel as a time base reference.

2 GHz Doubler Output, (Option 002). The Signal Generator RF output range is extended from 1030 MHz to 2060 MHz.

Rear Panel Inputs/Outputs, (Option 003). This option provides rear-panel (instead of front-panel) connections for AM/FM/PULSE/PHASE MODULATION INPUTS, AUDIO and RF OUTPUTs.

Enhanced Spectral Purity, (Option 004). This option provides the Signal Generator with better phase noise and spurious performance.

Electronic Attenuator, (Option 005). This option provides the Signal Generator with an electronic attenuator for high-cycle production applications. The Option 005 cannot be used with instruments equipped with the 2 GHz doubler Option 002.

Synthesized Audio Oscillator, (Option 007). This option provides the Signal Generator with multifunction synthesis capabilities for generating complex audio signals.

Specified VOR/ILS Performance, (Option 009). This option provides a set of VOR/ILS test specifications. Option 009 must be ordered with Option 007 but without Option 002 or Option 005.

Reduced Leakage Configuration, (Option 010). This option provides the Signal Generator with RF leakage performance reduced to less than $0.05\mu V$ (typically).

2 GHz Frequency Counter, (Option 011). This option provides the Signal Generator with a progammable counter that can measure frequencies from 20 Hz to 2 GHz with up to 0.1 Hz resolution from a single input.

Mechanical Options

Front Handle Kit (Option 907). Ease of handling is increased with the front-panel handles. Order HP part 5062-3990.

Rack Flange Kit (Option 908). This kit contains all necessary hardware and installation instructions for mounting the Signal Generator in a rack with 482.5 millimeter (standard 19-inch) spacing. Order HP part 5062-3978.

Rack Flange and Front Handle Combination Kit (Option 909). This kit is simply a front handle kit and a rack flange kit packaged together. The combination is made up of unique parts which include both functions. Order HP part 5062-3984.

Chassis Slide-Mount Kit. This kit is extremely useful when the Signal Generator is rack mounted. Access to internal circuits and components or the rear panel is possible without removing the instrument from the rack. Order HP part 1494-0059 for 432 mm (17 in.) fixed slides. (To order adapters for non-HP rack enclosures, use HP part 1494-0023.)

Chassis-Tilt, Slide-Mount Kit. This kit is the same as the Chassis Slide Mount Kit above except it also allows the tilting of the instrument up or down 90°. Order HP part 1494-0063 for 432 mm (17 in.) tilting slides. To order adapters for non-HP rack enclosures, use HP part 1494-0023.

Documentation Options

Extra Manual Set (Option 910). Provides an additional copy of the *Operation and Calibration Manual* (HP part 08644-90009), and two copies of the *Service Diagnostics Manual* (HP part 08645-90104).

Add Service Manual (Option 915). Provides a copy of the Service Diagnostics Manual (HP part 08645-90104) enabling a qualified service person to troubleshoot and repair the Signal Generator to the module and cable level.

1–9. AVAILABLE ELECTRICAL AND MECHANICAL EQUIPMENT

Service Accessory Kit. A Service accessory Kit (HP part 08645-61116) is available which contains accessories (special test fixtures, cables, etc.) useful in servicing the Signal Generator.

Transit Case. Protection when transporting is increased with the Transit Case. Order HP part number 9211-2662. For ease of use when handling, Transit Case Wheels can be ordered using HP part number 1490-0913 (includes 4 wheels).

1–10. ACCESSORIES SUPPLIED

The Accessories Supplied are pieces of equipment which are shipped with every Signal Generator.

Line Power Cable. The line power cable may be supplied in several different plug configurations according to the Mains voltage available, and the country of destination of the original shipment. For the part numbers of the power cables and Mains plugs available, refer to *Power Cables* in section 2 of this manual.

Fuses. Fuses with a 4A rating for 115 V ac (HP 2110-0055) and a 2.5A rating for 230 V ac (HP 2110-0083) are supplied. One fuse is factory installed according to the voltage available in the country of original destination. This same information (part numbers and ratings of the fuses available) is in the paragraph *Line Voltage and Fuse Selection* in section 2 of this manual.

Coaxial Timebase Cable. A coaxial time base cable is supplied if the Signal Generator is equipped with Option 001. This cable must be connected between the rear-panel OVEN REF output connector from the High Stability Time Base, and the REF IN input connector.

1-11. RECOMMENDED TEST EQUIPMENT

Table 1–2, *Recommended Test Equipment* lists the test equipment required for testing, adjusting, and servicing the Signal Generator. The Critical Specifications column describes the essential requirements for each piece of test equipment. Other equipment can be substituted if it meets or exceeds these critical specifications.

Table 1-1. Specifications (1 of 4)

Specifications	HP 8644A Standard	HP 8644A With Opt 004, Mode 3
Frequency		
Range:	.252 – 1030 MHz .252 – 2060 MHz Opt. 002	
Resolution:	.01 Hz	
Accuracy (std. timebase): < 1 year of calibration	$.375 \times 10^{-6}$ times carrier in Hz	
Internal reference oscillator	Standard high stability	Option 001 high stability with EFC
Aging:	$\pm 1.5 \times 10^{-8}$/day after ten days	$\pm 3 \times 10^{-10}$/day after ten days
Temperature:	$\pm 7 \times 10^{-10}$, 0 to 55°C	$\pm 6 \times 10^{-10}$, 0 to 55°C
Line voltage:	$\pm 2 \times 10^{-10}$, (+5%, -10%)	$\pm 1 \times 10^{-10}$, ±10%
Output:	10 MHz, >0.15 V_{rms} level into 50Ω	10 MHz, >1 V_{rms} level into 50Ω
External reference input:	Accepts 10 MHz ±5 ppm and a level range of 0.5V to 2 V_{rms} into 50Ω.	
Electronic frequency control (EFC):	Option 001 only, ±0.01 ppm for ±1 Vdc at rear panel connector, voltage range ±10 Vdc, input impedance 10kΩ.	
Spectral Purity		
SSB phase noise (dBc/Hz): (@ 20 kHz offset) Carrier (MHz)		
1030 – 2060	-121 (Opt. 002)	-130 (Opt. 002)
515 – 1030	-128	-136
257.5 – 515	-134	-142
128.5 – 257.5	-134	-145
.25 – 128.5	-138	-145
Nonharmonics:	<-100 dBc, >10 kHz offset, .252 – 1030 MHz <-94 dBc, >10 kHz offset, 1030 – 2060 MHz	<-105 dBc, >10 kHz offset, .252 – 1030 MHz <-100 dBc, >10 kHz offset, 1030 – 2060 MHz
Harmonics:	<-25 dBc, output ≤+8 dBm	<-25 dBc, output ≤+10 dBm
Subharmonics:	None, .252 – 515 MHz <-52 dBc, 515 – 1030 MHz <-40 dBc, 1030 – 2060 MHz	None, .252 – 515 MHz <-52 dBc, 515 – 1030 MHz <-40 dBc, 1030 – 2060 MHz
Residual FM (Hz rms): Carrier (MHz)	3 kHz BW / 15 kHz BW	3 kHz BW / 15 kHz BW
1030 – 2060	<4 / <8	<2 / <4
515 – 1030	<2 / <4	<1 / <2
257.5 – 515	<1.2 / <2	<0.5 / <1
.25 – 257.5	<1 / <1.2	<0.5 / <0.5
Residual AM: (.3 to 3 kHz Post Det. BW)	<0.01% AM rms	<0.01% AM rms
SSB AM noise floor (dBc/Hz): (offsets >100 kHz)(typical)	<-157, 10 dBm, <1030MHz <-150, 10 dBm, <2060MHz	<-157, 10 dBm, <1030MHz <-150, 10 dBm, <2060MHz

Table 1-1. Specifications (2 of 4)

Specifications (Cont.)	HP 8644A Standard	HP 8644A With Opt 004, Mode 3
Output Level		
Range:	+16 to -137 dBm, +13 dBm, Opt.002	
Resolution:	.01 Hz	
Absolute accuracy:	±1 dB, output ≥-127 dBm ±3 dB, output <-127dBm	
Reverse power protection:	50 watts	
Amplitude Modulation		
Depth:	0 – 100%, output ≤+7 dBm	
Resolution:	.1%	
Bandwidth (3 dB):	dc to 100 kHz, 128 MHz < f_c < 1030 MHz dc to 75 kHz, f_c > 1030 MHz	
Accuracy: 1 kHz rate	±(7% of setting + 1%) up to 80% depth	
Distortion: 30% depth, 1 kHz rate	<3%; <4% Opt. 002	
Incidental phase modulation: (at 30% depth, 1 kHz rate)	<0.2radians peak	
External input impedance:	600Ω	
Frequency Modulation		
Maximum peak deviation:	2 MHz, 1030 – 2060 MHz 1 MHz, 515 – 1030 MHz 500 kHz, 257.5 – 515 MHz 250 kHz, 128.5 – 257.5MHz 125 kHz, 64 – 128.5MHz 62.5 kHz, 32 – 64 MHz Deviation halves per lower octave (>16, >8, >4, >2, >1, >.5 MHz).	20 MHz/200 kHz[3], >1030MHz 10 MHz/100 kHz[3], >515MHz 5 MHz/50 kHz[3], >257.5MHz 2.5 MHz/25 kHz, >128.5MHz 1.25 MHz/12.5 kHz[3], >64MHz 625 kHz/6.25 kHz[3], >32MHz Deviation halves per lower octave (>16, >8, >4, >2, >1, >.5 MHz).
Resolution:	2.5% of setting	2.5% of setting
Bandwidth (3 dB):	dc to 100 kHz	dc to 100 kHz
Carrier accuracy in FM:	±0.5% of setting	±0.5% of setting
Indicator accuracy:	<5%, <30kHz rates <10%, <100kHz rates	<6%[3], <30kHz rates <15%[3], <100kHz rates
Distortion:	<5%, 20 Hz to 100 kHz rates	<5%, <1%[3] 20 Hz to 100 kHz
Incidental AM:	<0.5%, deviation ≤20 kHz	<0.5%, deviation ≤20 kHz
External group delay:	<10µs, ≤100 kHz rates	<10µs, ≤100 kHz rates
External input impedance:	600Ω	600Ω

Table 1-1. Specifications (3 of 4)

Specifications (Cont.)	HP 8644A Standard	HP 8644A With Opt 004, Mode 3
Pulse Modulation		
On/off ratio:	>35dB, >80dB for fc >1030MHz	
Rise/fall time, 10 – 90%:	<100ns	
Repetition rate:	dc to 1 MHz	
Minimum width:(typical)	0.5 μs	
Video feedthrough/overshoot:(typical)	<15%	
Output level accuracy:	±2 dB	
External inputs/outputs:	Input level: On state; >3.0Vpk (600Ω input impedance) Off state; <0.8Vpk	
Internal Modulation Source		
Number of sources:	Two sources simultaneously available through summation, independently adjustable in frequency, phase, amplitude and waveform. Source One may also be internally modulated with AM, FM, phase modulation and pulse modulation to create a subcarrier waveform.	
Waveforms and rates:	Sine, white Gaussian noise; 0.1 Hz to 400 kHz Triangle, Sawtooth, Square; 0.1 Hz to 50 kHz	
Frequency accuracy:	Same as timebase	
Max output level (into 600Ω):	2 Vpk	
Output resolution:	2 mV pk	
Total harmonic distortion:	<0.2%, ≤20 kHz rates	
Frequency Sweep		
Digital sweep:	Digitally stepped sweep over entire frequency range. Linear/log selection. .5 to 1000 sec sweeps.	
Markers/Z axis output:	Three markers available /Z axis ouput nominally +5 V/X axis output nominally 0 to 10V.	
Phase continuous sweep:	40 MHz of span available at maximum carrier frequency. 20 ms to 10 sec sweep times.	
Remote Programming		
Interface:	HP-IB (IEEE 488.2-1987).	
Control language:	Hewlett-Packard Systems Language (HP-SL). All functions controlled except power.	
IEEE-488 functions:	SH1, AH1, T6, TEO, L4, LEO, SR1, RL1, PPO, DC1, DTO, CO, E2.	
Avionics Option 009	Option 009 provides guaranteed specifications for testing VOR and ILS (Localizer, Glide Slope and Marker Beacon) receivers.	
VOR (108 to 118 MHz)	Bearing accuracy: 0.1°, Frequency accuracy: Same as timebase. AM accuracy (30%): ±5% of setting, AM distortion: 2%. FM accuracy (480 Hz dev.): ±1.5Hz	
ILS: localizer/glide slope (108 to 112 MHz/329.3 to 335 MHz)	DDM resolution: Localizer: 0.0002 Glide Slope: 0.0004 DDM accuracy: Localizer: ±0.0004±5% of DDM Glide Slope: ±0.0008±5% of DDM AM accuracy: ±5% of setting AM distortion: 2%	
Marker beacon (75 MHz):	AM accuracy (95%): ±5% of setting +1% AM distortion: 5%	

Table 1-1. Specifications (4 of 4)

Specifications (Cont.)	HP 8644A Standard	HP 8644A With Opt 004, Mode 3
2 GHz Counter Option 011		
Frequency range:	20 Hz to 2 GHz in three ranges	
Sensitivity:	40 mV_{rms} (-15 dBm into 50Ω)	
Maximum input:	2.25 V_{rms} (+20 dBm into 50Ω)	
Impedance:	50Ω, 10 MHz to 2 GHz; 1 MΩ shunted by <65pf, <10MHz	
Coupling:	ac	
Gate times:	0.1s to 1s in 0.1s steps	
Measurement resolution:	Measured frequency (Hz) x 10^{-8}/gate time or 0.01 Hz if greater	
Measurement uncertainty:	(± timebase accuracy) plus (± measurement resolution)	

[3] When used in low noise mode three

General	
Power requirements:	±10% of 100V, 120V, 220V or 240V; 48 to 440 Hz; 500 VA except 48 to 100 Hz; 400 VA.
Operating temperature:	0 to 55°C
Leakage:	Conducted and radiated interference meets MIL STD 461B REO2 and FTZ 1046. Leakage is measured into a resonant dipole antenna one inch from the instrument's surface with output level <0dBm (all inputs/outputs properly terminated, f_c < 1 GHz). Leakage is typically <16μV or <2μV with Option 010, measured at the front panel. The older two-turn loop method of measurement is typically <1μV or <0.1μV for Option 010.
Acoustic noise:	Typically <5.5bels
Storage registers:	Ten full function and 40 frequency/amplitude registers.
Calibration/diagnostics:	Internal calibration and diagnostics funtions are available to the user. Built-in test capability locates circuit malfunctions to allow repair through module replacement.
Calibration interval:	Recommended two years (MTBC).
Weight:	30 kg (67 lbs).
Dimensions:	177H X 426W X 601D mm (7 X 16.8 X 23.7in.). Opt. 010 adds 35 mm (1.4 in.) to depth.

Last Rev: 3-30-93

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

Instrument Type	Critical Specifications	Recommended Model
Audio Source (not needed if the Signal Generator is equipped with Option 007)	Level: 1 Vpk into 50 ohms Frequency: 1 kHz to 100 kHz	HP 3325A
Crystal Detector with 600 Ω Feedthru	Frequency: 2060 MHz	HP 423B HP 11095A
Distortion Analyzer	Distortion Range: < 0.1% Range: 20 Hz to 100 kHz	HP 339A, HP 8903B, or HP 8903E
Measuring Receiver and Sensor Module	Frequency Range: 250 kHz to 1300 MHz Input Level: −127 to +17 dBm RF Power: 0.2 dB Tuned RF Level: 0.36 dB RSS Referenced to −10 dBm input Amplitude Modulation: Rates: 20 Hz to 100 kHz Depth: to 90% Accuracy: ±2% at 1 kHz Demodulated Output Distortion: 0.5% for 50% depth; < 1.0% for 90% depth Incidental ΦM: <0.05 radians for 30% depth at 1 kHz rate (50 Hz to 3 kHz bandwidth) Residual AM: < 0.01% rms (0.3 to 3 kHz BW) Frequency Modulation: Rates: 20 Hz to 200 kHz Deviation: to 400 kHz Accuracy: ±3% at 1 kHz Demodulated Output Distortion: <0.3% Incidental AM: 0.2% depth at 20 kHz FM deviation Residual FM: See specifications for External Local Oscillator for Measuring Receiver	HP 8902A and HP 11722A
Oscilloscope	Vertical Sensitivity: 0.01 mV/div Bandwidth: 100 MHz Time/Div: 0.05μs Input: Dual Channel	HP 1740A, or Tektronix 2245
Phase Noise Measurement System	The Performance Tests for SSB Phase Noise are complex and the procedure has been written specifically using the HP 3048A, no substitutions are recommended.	HP 3048A Opt. 101

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

Instrument Type	Critical Specifications	Recommended Model
Pulse Generator	Rates: to 1 MHz Pulse Width: 500 ns minimum Output Level: 4 Vpk into 50 ohms	HP 8116A
Reference Signal Generator	Residual FM: Less than or equal to the specification for the HP 8644A.	HP 8644A
Signal Generator	Frequency Range: 100 kHz to 2 GHz Output Amplitude: +20 dBm Range	HP 8642B
Spectrum Analyzer, RF	Frequency Range: 0.1 to 7 GHz Resolution Bandwidth: <1 kHz to 3 kHz	HP 8559A/853A or HP 8562B

2 Installation

Section 2
INSTALLATION

2–1. INTRODUCTION

This section provides the information needed to install the Signal Generator. Included is information pertinent to initial inspection, power requirements, line voltage, fuse selection, power cables, time base selection, HP-IB address selection, interconnection, mating connectors, operating environment, instrument mounting, storage, and shipment.

2–2. INITIAL INSPECTION

WARNING

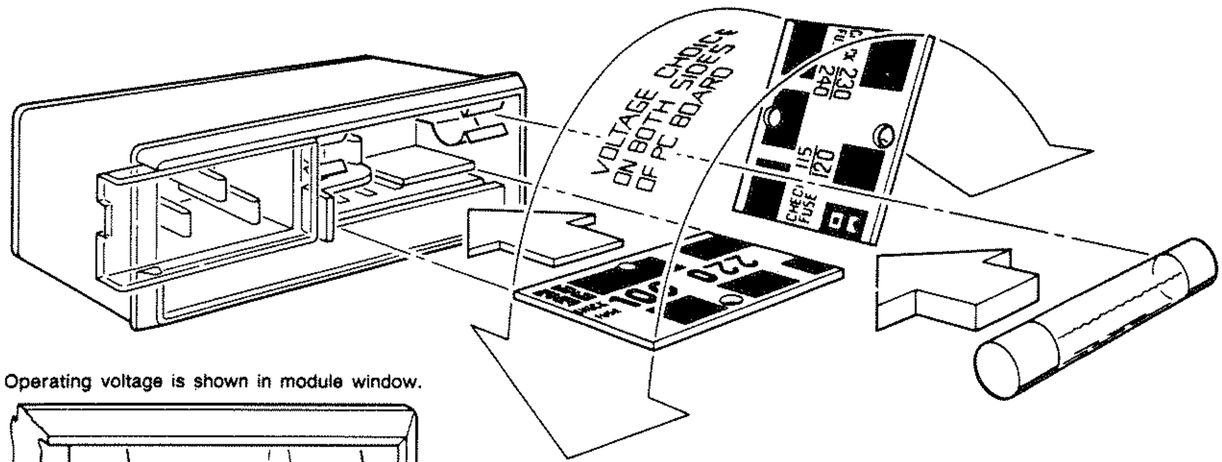
To avoid hazardous electrical shock, do not perform electrical tests when there are any signs of shipping damage to any portion of the outer enclosure (covers and panels).

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 for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in section 3, *Performance Tests*. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

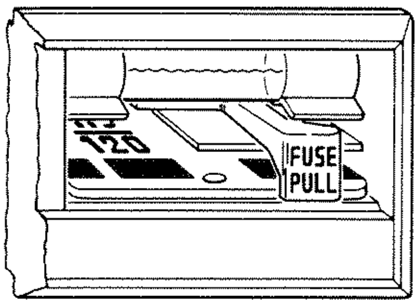
2–3. PREPARATION FOR USE

Power Requirements

The Signal Generator requires a power source of (±10%) 100, 120, 220, or 240 V ac from 48 to 440 Hz. Power consumption is 400 VA maximum.



Operating voltage is shown in module window.



WARNING

To avoid the possibility of hazardous electrical shock, do not operate this instrument at line voltages greater than 126.5 Vac with line frequencies greater than 66 Hz (leakage currents at these line settings may exceed 3.5 mA).

1. Open cover door, pull the FUSE PULL lever and rotate to left. Remove the fuse.
2. Remove the Line Voltage Selection Card. Position the card so the line voltage appears at top-left cover. Push the card firmly into the slot.
3. Rotate the Fuse Pull lever to its normal position. Insert a fuse of the correct value in the holder. Close the cover door.

Figure 2–1. *Line Voltage and Fuse Selection*

WARNING

This is a Safety Class I product (i.e., provided with a protective earth terminal). An uninteruptable safety earth ground must be provided from the Mains 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 external autotransformer for voltage reduction, make sure that the common terminal is connected to the earthed pole of the power source.

Line Voltage and Fuse Selection

CAUTION

BEFORE PLUGGING THIS INSTRUMENT into the Mains (line) voltage, be sure the correct voltage and fuse has been selected.

Verify that the Line Voltage Selection Card and fuse are matched to the power source. See figure 2-1, *Line Voltage and Fuse Selection.*

Fuses may be ordered under the HP part numbers listed in table 2-1, *Line Fuse Rating and HP Part Number.*

WARNING

For protection against fire hazard, the line fuse should only be a 250 V fuse with the correct current rating.

Table 2–1. *Line Fuse Rating and HP Part Number*

Line Voltage	Rating	Part Number
100, 120 V ac	4A, 250 V	2110-0055
220, 240 V ac	2.5A, 250 V	2110-0083

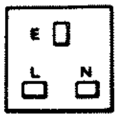
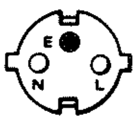
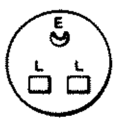
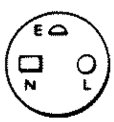
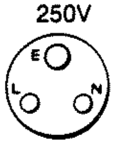
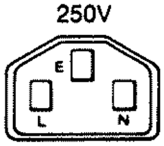
Power Cables

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 Mains plug shipped with each instrument depends on the country of destination. Refer to table 2-2, *Power Cable and Mains Plug Part Numbers* for the part numbers of the power cables and Mains plugs available.

Table 2–2. Power Cable and Mains Plug Part Numbers

Plug Type	Cable HP Part Number	C D	Plug Description	Cable Length (inches)	Cable Color	For Use In Country
250V 	8120-1351 8120-1703	0 4	90°/STR BS1363A* 90°/90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Rhodesia, Singapore
250V 	8120-1369 8120-0696	0 4	STR/STR NZSS198/ASC112* STR/90°	79 80	Gray Gray	Austrailia, New Zealand
250V 	8120-1689 8120-1692	7 2	STR/STR* STR/90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, (unpolarized in many nations)
125V 	8120-1378 8120-1521 8120-1751	1 6 1	STR/STR NEMA5-15P* STR/90° STR/STR	80 80 90	Jade Gray Jade Gray Jade Gray	United States, Canada, Mexico, Phillipines, Taiwan U.S./Canada
100V (Same plug as above)	8120-4753 8120-4754	2 3	STR/STR STR/90°	90 90	Dark Gray Dark Gray	Japan only Japan only
250V 	8120-2104 8120-2296 8120-3997	3 4 4	STR/STR SEV1011 1959-24507 Type 12 STR/90° STR/90°	79 79 177	Gray Gray Gray	Switzerland
250V 	8120-0698	6	STR/STR NEMA6-15P	90	Black	United States, Canada
250V 	8120-2956 8120-2957 8120-3997	3 4 4	90°/STR 90°/90° STR/STR	79	Gray	Denmark
250V 	8120-4211 8120-4600	7 8	STR/STR*IEC83-B1 STR/90°	79 79	Black Gray	South Africa, India
250V 	8120-1860 8120-1575 8120-2191 8120-4379	6 0 8 8	STR/STR*CEE22-V1 (Systems Cabinet Use) STR/STR STR/90° 90°/90°	59 31 59 80	Jade Gray Jade Gray Jade Gray Jade Gray	

* Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug. E = Earth Ground; L = Line; N = Neutral; STR = Straight

2–4. TIME BASE SELECTION

If your instrument has option 001 installed, the High Stability Time Base is automatically selected when the supplied coax cable is connected between the REF IN and OVEN REF OUT connectors on the rear panel.

To select the standard, internal reference oscillator remove the coax cable from between the REF IN and OVEN REF OUT connectors on the rear panel.

To confirm the time base selection, key in SPECIAL 161 ENTER. The FREQUENCY/STATUS display will show "161: Ref Source Int" if the standard internal reference oscillator is sensed, or "161: Ref Source Ext" if the High Stability Time Base oscillator is sensed.

The Signal Generator indicates any reference source connected (sensed) through the external rear-panel BNC connectors as "Ext".

2–5. HP-IB ADDRESS SELECTION

The instrument's HP-IB address is preset to 19 (decimal) when shipped from the factory.

The HP-IB address is front-panel programmable. To change your instrument's HP-IB address, press the blue SHIFT key, and then the ADRS key to show the current address in the FREQUENCY/STATUS display. Key in the desired decimal number between 00 and 30, then press the ENTER key.

2–6. INTERCONNECTIONS

Interconnection data for the Hewlett-Packard Interface Bus is provided in figure 2–2, *Hewlett-Packard Interface Bus Connections.*

Mating Connectors

Coaxial Connectors. Coaxial mating connectors used with the Signal Generator should be either 50 Ω BNC male connectors or 50 Ω Type N male connectors that are compatible with those specified in US MIL-C-39012.

Interface Connector. The HP-IB mating connector is shown in figure 2–2, *Hewlett-Packard Interface Bus Connections.* Note that the two securing screws are metric.

2–7. 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 meters (15,000 feet)

2–8. BENCH OPERATION

The instrument cabinet has plastic feet that are shaped to ensure self-alignment of instruments when they are stacked.

2-9. RACK MOUNTING

NOTE

The Signal Generator weighs approximately 26 kg (57 lbs) net, and 37 kg (81 lbs) shipping depending upon the options ordered. Care must be exercised when lifting to avoid personal injury. Use equipment slides when rack mounting.

Specific rack mounting information is provided with the rack mounting kits. If a kit was not ordered with the Signal Generator as an option, it may be ordered through the nearest Hewlett-Packard office. Paragraph 1-8, under *Mechanical Options* in section 1 includes information and part numbers for other types of rack mount kits.

Slide rack mount kits allow the convenience of rack mounting with the flexibility of easy access. Slide kits for the Signal Generator are listed below.

Standard Slide Kit for HP rack enclosures .... HP 1494-0059
Special Tilt Slide Kit for HP rack enclosures .... HP 1494-0063
Slide Adapter Bracket Kit for Standard Slides (for non HP rack enclosures) HP 1494-0023

2-10. STORAGE AND SHIPMENT

Environment

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

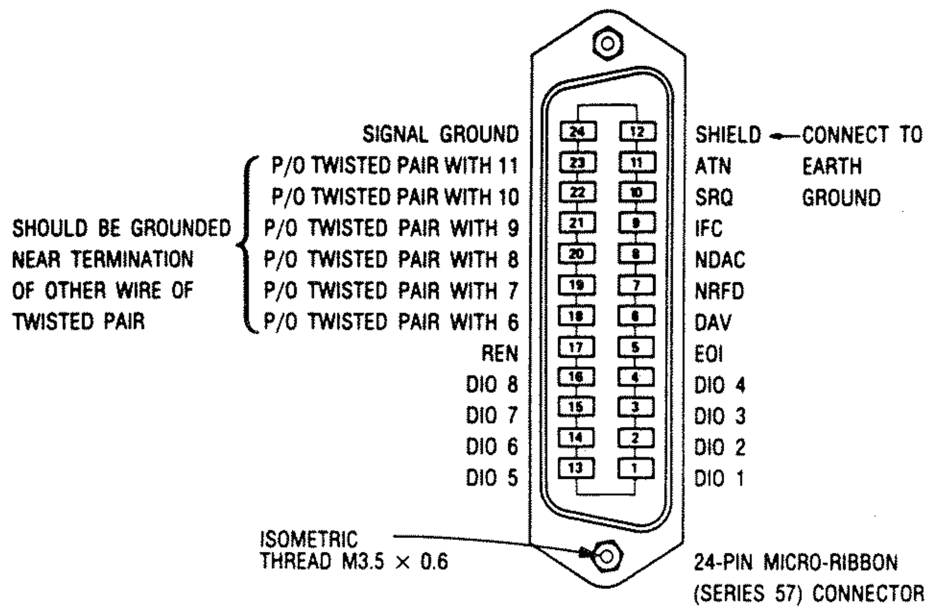
Temperature .... −55° C to + 75° C
Humidity .... < 95% relative
Altitude .... 15 300 meters (50,000 feet)

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 type of 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 millimeter layer; 3 to 4 inches) around all sides of the instrument to provide a firm cushion and to prevent movement in the container. Protect the front-panel with cardboard.
d. Seal the shipping container securely.
e. Mark the shipping container FRAGILE to assure careful handling.



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 10833A, 1 metre (3.3 ft.), HP 10833B, 2 metres (6.6 ft.)
HP 10833C, 4 metres (13.2 ft.), HP 10833D, 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 2–2. *Hewlett-Packard Interface Bus Connections* HP-IB

3 Performance Tests

Section 3
PERFORMANCE TESTS

3–1. INTRODUCTION

The procedures in this section test the instrument's electrical performance using the specifications of table 1–1 as performance standards. All tests are performed without accessing the interior of the instrument.

NOTE

Before beginning the performance tests, the Signal Generator should be allowed a 24 hour warm-up period after being connected to the ac power line and a 10 minute warm-up period after turn-on. Line voltage must be within ±10% of nominal if the results of the performance tests are to be considered valid.

Unless otherwise stated, the specifications assume the Signal Generator is operating with its Synthesis Modes set to Auto which automatically optimizes the internal hardware configuration for best performance.

3–2. EQUIPMENT REQUIRED

Equipment required for the performance tests is listed in table 1–2, *Recommended Test Equipment.* Any equipment that satisfies the critical specifications provided in the table may be substituted for the recommended model(s).

3–3. PERFORMANCE TEST RECORD

Results of the performance tests may be tabulated on the *Performance Test Record* at the end of the procedures. The *Performance Test Record* lists all of the tested specifications and their acceptable limits. The results, recorded at incoming inspection, can be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

3–4. CALIBRATION CYCLE

This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked using the following performance tests every three years.

3–5. INTERNAL VOLTMETER VERIFICATION

Internal to the Signal Generator is a precision dc voltmeter. This voltmeter is used to collect calibration correction data when the Recal function is invoked. During normal instrument operation, Recal is automatically run whenever a significant temperature change is noted by the instrument. Recal should also be run prior to running the Performance Tests. The accuracy of the voltmeter is not explicitly specified but must be within ±1% of reading ±0.25V for the Recal operation to give valid results.

3-6. BASIC FUNCTIONAL CHECKS

The basic functions of the HP 8644A can be verified by performing the instrument operating examples in the HP 8644A *Operation Guide* and comparing the output signals with the waveforms shown in the guide. Table 3-1 lists the functions that can be verified using the *Operation Guide.*

If you suspect an instrument failure when performing the Basic Functional Checks, test the Signal Generator by activating Special Function 170. Special Function 170 verifies most of the Signal Generator's circuitry. At the conclusion of the test, a result code equal to "0" indicates that the instrument is operating normally. Refer to the *Service Diagnostics Manual* whenever a result code other than "0" appears.

Table 3-1. *Basic Functional Checks*

Refer to *Operation Guide*	**Functions and Operations Verified**
Chapter 2 *What About Modulating?*	Special Functions, Save and Recall Digitized FM Synthesis Linear FM Synthesis Synthesis Mode Selection Output Amplitude, Modulation Frequency, Amplitude Pulse, Simultaneous
Chapter 3 *What About Sweeping?*	Frequency Range Start, Stop, Center, and Span Frequencies Sweep Markers Digitally-Stepped Sweep Phase-Continuous Sweep Sweep Spacing Sweep Triggering
Chapter 4 *What About Programming?*	HP-SL Programming Frequencies HP-IB Address
Appendix D *Error Messages*	Messages
Appendix F *Synthesized Audio Oscillator*	Special Functions Audio Level Audio Frequency
Appendix G *Miscellaneous Operating Features*	Amplitude Offset, Auto Sequence Clear All, Display, EMF, Frequency Offset, Knob Hold Knob Increment Phase Increment/Decrement Sequence, Set Sequence

Preliminary Test

INTERNAL VOLTMETER VERIFICATION

Specification

The accuracy of the internal voltmeter is not explicitly specified but it should be ±1% of reading ±0.25V for the Recal routine to be valid.

Description

A dc voltage is applied to the voltmeter input of the Signal Generator. The voltage is measured by both the Signal Generator's internal voltmeter and an external voltmeter and the two readings are compared.

NOTE

This test should be run before beginning the Performance Tests.

Equipment

Digital Voltmeter .... HP 3478A
Power Supply .... HP 6218C or HP 6236B

Procedure

1. Remove any connection to the Signal Generator's rear-panel VM IN connector.
2. On the Signal Generator, press INSTR PRESET then key in SPECIAL 180 ENTER to set the internal voltmeter to read the voltage at the Signal Generator's rear-panel VM IN connector. The reading should be between −0.25 and +0.25 Vdc.

   Voltmeter Offset: −0.25 ________ +0.25 Vdc

3. Connect the dc power supply and digital voltmeter to the Signal Generator's rear-panel VM IN connector using a BNC tee. (If a dual power supply is used, stack the + and − outputs to obtain the 40V if needed.)
4. Set the power supply to +40V and set the voltmeter to read +40 Vdc. The Signal Generator should display approximately +40, but more importantly it should agree with the reading of the external voltmeter within ±0.65 Vdc (that is, ±1% of 40V ±0.25V).

   Voltmeter Accuracy at +40V: −0.65 ________ +0.65 Vdc

5. Reverse the power supply leads to produce −40V at the Signal Generator's VM IN connector. The Signal Generator should display approximately −40 and should agree with the reading of the external voltmeter within ±0.65 Vdc (that is, ±1% of 40V ±0.25V).

   Voltmeter Accuracy at −40V: −0.65 ________ +0.65 Vdc

Performance Test 1

CARRIER AMPLITUDE TEST

Specification

Characteristic	Performance Limits	Conditions
Output		
Maximum Level	+16 dBm	0.25 to 1030 MHz; except Options 002 and 005
	+14 dBm	0.25 to 1030 MHz; Option 002
	+13 dBm	1030 to 2060 MHz; Option 002
	+13 dBm	0.25 to 1030 MHz; Option 005
Absolute Accuracy	±1 dB	output > −127 dBm

Description

The carrier amplitude specifications are verified with an HP 8902A Measuring Receiver. The higher amplitudes are measured directly with the measuring receiver's built-in power meter. Lower amplitudes are measured using the very sensitive tuned RF level feature of the measuring receiver. Carrier amplitude is set in the instrument both by switching attenuator pads and also by voltage-variable gain control. Both types of amplitude control are checked.

Equipment

Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A

Procedure

Initial Setup

1. On the Signal Generator, press INSTR PRESET.
2. Preset the measuring receiver, then select the RF power measurement with units of dBm.

NOTE

Verify that the measuring receiver's calibration factors match the sensor module. Zero the power sensor and calibrate the power measurement using the measuring receiver's built-in power reference.

3. Connect the input of the measuring receiver's sensor module directly to the Signal Generator's OUTPUTS RF connector.

Maximum Level

4. Set the Signal Generator's carrier frequency and amplitude as indicated in the following table. Also, key the frequency into the measuring receiver to invoke the appropriate calibration factor. The carrier amplitude should be within the limits given in the table.

Signal Generator Carrier		Amplitude Limits (dBm)	
Frequency (MHz)	Amplitude (dBm)	Minimum	Actual
Standard			
0.26	+17	+16	________
1	+17	+16	________
10	+17	+16	________
100	+17	+16	________
1000	+17	+16	________
Option 002			
0.26	+15	+14	________
1	+15	+14	________
10	+15	+14	________
100	+15	+14	________
1000	+15	+14	________
2060	+14	+13	________
Option 005			
0.26	+14	+13	________
1	+14	+13	________
10	+14	+13	________
100	+14	+13	________
1000	+14	+13	________

High-Amplitude Accuracy

5. Set the Signal Generator's carrier frequency and amplitude as indicated in the following table. Also, key the frequency into the measuring receiver to invoke the appropriate calibration factor. The output power should be within the limits given in the table.

Signal Generator Carrier		Amplitude Limits (dBm)		
Frequency (MHz)	Amplitude (dBm)	Minimum	Actual	Maximum
1000	+6	+5	______	+7
1000	+7	+6	______	+8
1000	+8	+7	______	+9
1000	+9	+8	______	+10
1000	+10	+9	______	+11
1000	+11	+10	______	+12
1000	+12	+11	______	+13
1000	+13	+12	______	+14
1000 (1)	+14	+13	______	+15
1000 (2)	+15	+14	______	+16
1000 (2)	+16	+15	______	+17
0.26 (2)	+16	+15	______	+17
1 (2)	+16	+15	______	+17
10 (2)	+16	+15	______	+17
100 (2)	+16	+15	______	+17
100 (1)	+14	+13	______	+15
10 (1)	+14	+13	______	+15
1 (1)	+14	+13	______	+15
0.26 (1)	+14	+13	______	+15
0.26	+13	+12	______	+14
1	+13	+12	______	+14
10	+13	+12	______	+14
100	+13	+12	______	+14
2060 (3)	+13	+12	______	+14
2060 (3)	+10	+9	______	+11
100	+10	+9	______	+11
10	+10	+9	______	+11
1	+10	+9	______	+11
0.26	+10	+9	______	+11
0.26	+5	+4	______	+6
1	+5	+4	______	+6
10	+5	+4	______	+6
100	+5	+4	______	+6
1000	+5	+4	______	+6
2060 (3)	+5	+4	______	+6
2060 (3)	+0	−1	______	+1
1000	+0	−1	______	+1
100	+0	−1	______	+1
10	+0	−1	______	+1
1	+0	−1	______	+1
0.26	+0	−1	______	+1

(1) Except Option 005
(2) Except Options 002 and 005
(3) Option 002

Low-Amplitude Accuracy

6. On the Signal Generator key in FREQ 1030 MHz and AMPTD 0 dBm.
7. Set the measuring receiver to the tuned RF level measurement mode and key in automatic operation to tune the measuring receiver to the Signal Generator's output. (If the measuring receiver indicates the need to calibrate, press the calibrate key.)
8. Set the Signal Generator's carrier amplitude as indicated in the following table and note the measured amplitude. The carrier amplitude should be within the limits given in the table.

NOTE

When the recalibration annunciator appears on the measuring receiver's display, press the measuring receiver's CALIBRATE *key, wait for completion of the calibration, then proceed.*

Other frequencies can be tested if they are in the range of the measuring receiver. For high frequencies, a down-converter may be required.

Signal Generator Carrier Amplitude (dBm)	Amplitude Limits (dBm)		
	Minimum	Actual	Maximum
−5	−6	______	−4
−10	−11	______	−9
−15	−16	______	−14
−20	−21	______	−19
−25	−26	______	−24
−30	−31	______	−29
−35	−36	______	−34
−40	−41	______	−39
−45	−46	______	−44
−50	−51	______	−49
−55	−56	______	−54
−60	−61	______	−59
−65	−66	______	−64
−70	−71	______	−69
−75	−76	______	−74
−80	−81	______	−79
−85	−86	______	−84
−90	−91	______	−89
−95	−96	______	−94
−100	−101	______	−99
−105	−106	______	−104
−110	−111	______	−109
−115	−116	______	−114
−120	−121	______	−119
−127	−128	______	−126

Performance Test 2

AM TEST

Specification

Characteristic	Performance Limits	Conditions
Spectral Purity		
Residual AM	<0.01% rms	0.3 to 3 kHz post-detection bandwidth
Amplitude Modulation		
	±(7% of setting + 1%)	to 80% depth; 1 kHz rate; Option 005
Distortion		400 and 1000 Hz rates
30% depth 1 kHz rate	<3% <4%	Not Option 002 Option 002
3 dB Bandwidth	>100 kHz >75 kHz	128 to 1030 MHz 1030 to 2060 MHz; Option 002
Incidental Phase Modulation	<0.2 rad peak	at 30% depth; 1 kHz rate

Description

The AM specifications are verified directly with an HP 8902A Measuring Receiver.

Equipment

Audio Source .... HP 3325A
Measuring Receiver .... HP 8902A

NOTE

If the Signal Generator has Option 007 Synthesized Audio Oscillator, the external audio source is not needed.

Procedure

Initial Setup

NOTE

Verify that the measuring receiver's AM is calibrated using its built-in AM calibrator.

1. Connect the equipment as shown in figure 3-1.

NOTE

Connect the Signal Generator's OUTPUTS RF *directly to the RF input of the measuring receiver or, if a sensor module is being used, connect it to the input of the sensor module.*

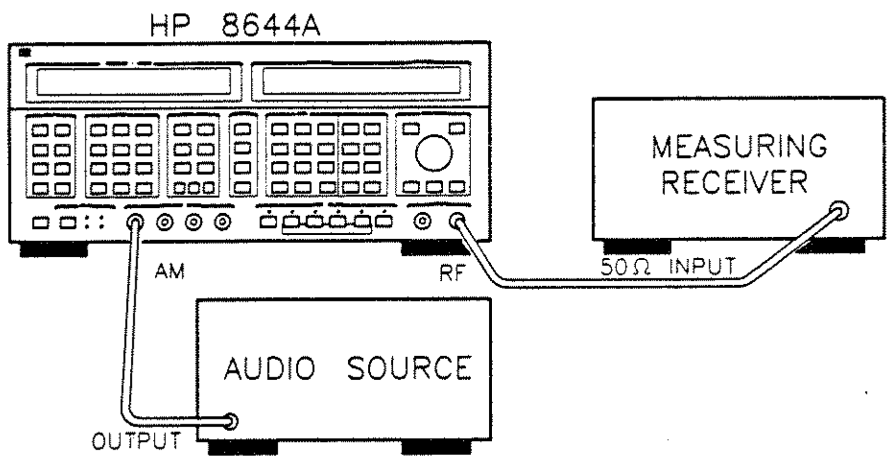


Figure 3–1. *AM Test Setup*

2. On the Signal Generator, press INSTR PRESET.
3. Preset the measuring receiver, then set it as follows.
    a. Select the AM measurement.
    b. Set the high-pass filter to 300 Hz.
    c. Set the low-pass filter to 3 kHz.
    d. Set the detector to RMS.

Residual AM

4. Set the Signal Generator's carrier frequency and amplitude as indicated in the following table. Allow the measuring receiver to retune. The residual AM should be within the limits given in the table. (Note that the Signal Generator's AM function is off.)

Signal Generator Carrier Settings		Residual AM Limits (%)	
Frequency (MHz)	Amplitude (dBm)	Actual	Maximum
1000	+13	______	0.01
1000	+6	______	0.01
1300 (1)	+6	______	0.01
1300 (1)	+13	______	0.01
(1) Option 002			

Indicator Accuracy

5. Set the measuring receiver as follows.
   a. Set the detector to peak± /2 (that is, to average peak+ and peak−). (To do this press the PEAK + and PEAK − keys simultaneously.)
   b. Set the high-pass filter off.
   c. Set the low-pass filter off.
6. Set the Signal Generator as follows.
   a. Key in FREQ 1 GHz.
   b. Key in AMPTD 0 dBm.
   c. Key in AM ON. (Note that modulation source is set to internal with a modulation rate of 1 kHz.)
7. Set the Signal Generator's AM depth as indicated in the following table. The AM depth, as read on the measuring receiver, should be within the limits shown in the table.

Signal Generator AM Depth (%)	AM Depth Limits (%)		
	Minimum	Actual	Maximum
30	26.9	______	33.1

Distortion

8. Set the measuring receiver to measure the audio distortion on the demodulated 1 kHz AM.
9. Set the Signal Generator's AM depth as indicated in the following table. The AM distortion, as read on the measuring receiver, should be within the limits shown in the table.

Signal Generator AM Depth (%)	AM Distortion Limits (%)			
	Not Option 002		Option 002	
	Actual	Maximum	Actual	Maximum
90	______	5	______	8
70	______	3	______	5
30	______	2	______	5

10. If the Signal Generator has Option 002, set its carrier frequency to 1.3 GHz. Repeat step 9 using the following table.

Signal Generator AM Depth (%)	AM Distortion Limits (%)	
	Actual	Maximum
70	______	5
90	______	8

Incidental Phase Modulation

11. On the Signal Generator key in FREQ 1 GHz and AM 30 %. (Carrier amplitude should remain at 0 dBm.)
12. Set the measuring receiver to read phase modulation (ΦM) and set its detector to peak+. (If the phase modulation reading is fluctuating, average several readings.) The phase deviation of the phase modulation should read 0.2 rad peak or less.

Incidental ΦM Limit: ______ 0.2 rad peak

3 dB Bandwidth

13. Set the measuring receiver to measure AM depth.
14. On the Signal Generator, key in AM 90 %. If the Signal Generator has the Option 007 Synthesized Audio Oscillator, continue with step 15. If the Signal Generator does not have the Option 007 Synthesized Audio Oscillator, perform the following steps.
    a. Press the INT key (in the MODULATION key group) to turn the internal AM off.
    b. Press the EXT AC key.
    c. On the audio source, set the audio frequency to 1 kHz and set its level (approximately 1V) so that the EXT HI and EXT LO annunciators on the Signal Generator are both off.
15. Set the Signal Generator's carrier frequency as indicated in the following table. For each setting perform the following steps.
    a. After setting the Signal Generator's carrier frequency, allow the measuring receiver to retune.
    b. If the Signal Generator has the Option 007, key in AUDIO FREQ 1 kHz; otherwise, set the external audio source to 1 kHz.
    c. Set the measuring receiver ratio display off (if it is on). Then set the ratio back on to establish a new ratio reference. (Also, set the ratio to read in dB, that is, log.)
    d. Set the Signal Generator's audio (modulation) frequency or the frequency of the external audio source as shown in the table.
    e. Note the dB change in AM depth on the measuring receiver. The depth should be between −3 and +3 dB (relative).

Signal Generator Settings		Relative AM Depth Limits (dB)		
Carrier Frequency (MHz)	Audio Frequency (kHz)	Minimum	Actual	Maximum
0.26	5	−3	______	+3
11	50	−3	______	+3
129	100	−3	______	+3
1020	100	−3	______	+3
1300 (1)	100	−3	______	+3

(1) Option 002

Performance Test 3

FM TEST (LOW DEVIATIONS AND RATES)

Specification

Characteristic	Performance Limits	Conditions
Spectral Purity		
Residual FM		deviation <0.01% of maximum available
		0.3 to 3 kHz post-detection bandwidth
	<1 Hz rms	0.25 to 257 MHz carrier
	<1.2 Hz rms	257 to 515 MHz carrier
	<2 Hz rms	515 to 1030 MHz carrier
	<4 Hz rms	1030 to 2060 MHz carrier; Option 002
		0.05 to 15 kHz post-detection bandwidth
	<1.2 Hz rms	0.25 to 257 MHz carrier
	<2 Hz rms	257 to 515 MHz carrier
	<4 Hz rms	515 to 1030 MHz carrier
	<8 Hz rms	1030 to 2060 MHz carrier; Option 002
		0.3 to 3 kHz post-detection bandwidth; Mode 3; Option 004
	<0.5 Hz rms	0.25 to 515 MHz carrier
	<1 Hz rms	515 to 1030 MHz carrier
	<2 Hz rms	1030 to 2060 MHz carrier; Option 002
		0.05 to 15 kHz post-detection bandwidth; Mode 3; Option 004
	<0.5 Hz rms	0.25 to 257 MHz carrier
	<1 Hz rms	257 to 515 MHz carrier
	<2 Hz rms	515 to 1030 MHz carrier
	<4 Hz rms	1030 to 2060 MHz carrier; Option 002

(Table continued on next page)

(Table continued from previous page)

Characteristic	Performance Limits	Conditions
Frequency Modulation		
Maximum Peak Deviation		Mode 1
	20 MHz	1030 to 2060 MHz carrier; Option 002
	10 MHz	515 to 1030 MHz carrier
	5 MHz	257 to 515 MHz carrier
	2.5 MHz	128 to 257 MHz carrier
	1.25 MHz	64 to 128 MHz carrier
	625 kHz	32 to 64 MHz carrier
	312 kHz	16 to 32 MHz carrier
	156 kHz	8 to 16 MHz carrier
	78 kHz	4 to 8 MHz carrier
	39 kHz	2 to 4 MHz carrier
	19.5 kHz	1 to 2 MHz carrier
	9.77 kHz	0.5 to 1 MHz carrier
	4.88 kHz	0.25 to 0.5 MHz carrier
	10% of Mode 1 maximum	Mode 2
	1% of Mode 1 maximum	Mode 3; Option 004
Maximum Rate	100 kHz	1030 to 2060 MHz carrier; Option 002
	100 kHz	8 to 1030 MHz carrier
	78 kHz	4 to 8 MHz carrier
	39 kHz	2 to 4 MHz carrier
	19.5 kHz	1 to 2 MHz carrier
	9.7 kHz	0.5 to 1 MHz carrier
	4.8 kHz	0.25 to 0.5 MHz carrier
Indicator Accuracy		accuracy at time of setting for rates that do not exceed maximum rate
	6%	30 kHz rate; 1% of maximum peak deviation; Mode 3; Option 004
	15%	100 kHz rate; 1% of maximum peak deviation; Mode 3; Option 004
	5%	30 kHz rate; 10% of maximum peak deviation
	10%	100 kHz rate; 10% of maximum peak deviation
	12%	30 kHz rate; 100% of maximum peak deviation
	20%	100 kHz rate; 100% of maximum peak deviation

(Table continued on next page)

(Table continued from previous page)

Characteristic	Performance Limits	Conditions
Distortion		20 Hz to 100 kHz rates
	<3%	5% of maximum peak deviation
	<5%	100% of maximum peak deviation
	<1%	Mode 3; Option 004
Incidental AM	<0.5% depth	deviation <6% of maximum or 20 kHz, whichever is less
Carrier Frequency Accuracy in FM	±0.5% of deviation setting	

Description

The FM specifications which can be verified directly with an HP 8902A Measuring Receiver are checked in these tests. The restrictions are that (1) the peak deviation must be less than 400 kHz for carrier frequencies above 10 MHz or 40 kHz below 10 MHz, (2) the modulation rate must be less than 200 kHz for carrier frequencies above 10 MHz or 10 kHz below 10 MHz, and (3) the local oscillator's residual FM must be no more than the HP 8644A. This latter restriction can be overcome by choosing an external local oscillator with better or equal performance (such as an HP 8662A or a second HP 8644A).

The FM indicator accuracy is checked at the high end, geometric midpoint, and low end of each carrier range. In instrument operation, a low-pass filter switches in or out at the midpoint. Indicator accuracy is checked at the highest frequency where the lower-frequency filter is in.

This test is followed by Performance Test 4, *FM Test (High Deviations and Rates),* which uses an HP 3048A Phase Noise Measurement System. This system can measure some FM specifications outside the range of the HP 8902A. Performance Tests 3 and 4 have some overlap.

Equipment

Audio Source .... HP 3325A
Distortion Analyzer.................................... HP 8903B or HP 8903E
Measuring Receiver.................................... HP 8902A Option 003
Reference Signal Generator .... HP 8662A, HP 8663A, or HP 8644A

NOTE

If the Signal Generator being tested has Option 002, the reference signal generator must have carrier frequency range of 2060 MHz.

If the Signal Generator being tested has Option 007, the external audio source is not needed.

Procedure

Initial Setup

NOTE

Verify that the measuring receiver's FM is calibrated using its built-in FM calibrator.

1. Connect the equipment as shown in figure 3–2 making note of the following details.
    a. If the measuring receiver does not have series 030 options (high selectivity), remove the rear-panel coaxial jumper from the local oscillator's input and output.
    b. Connect the reference signal generator's output to the measuring receiver's rear-panel local oscillator input.
    c. Connect the Signal Generator-under-test's OUTPUTS RF directly to the RF input of the measuring receiver or, if a sensor module is being used, connect it to the input of the sensor module.

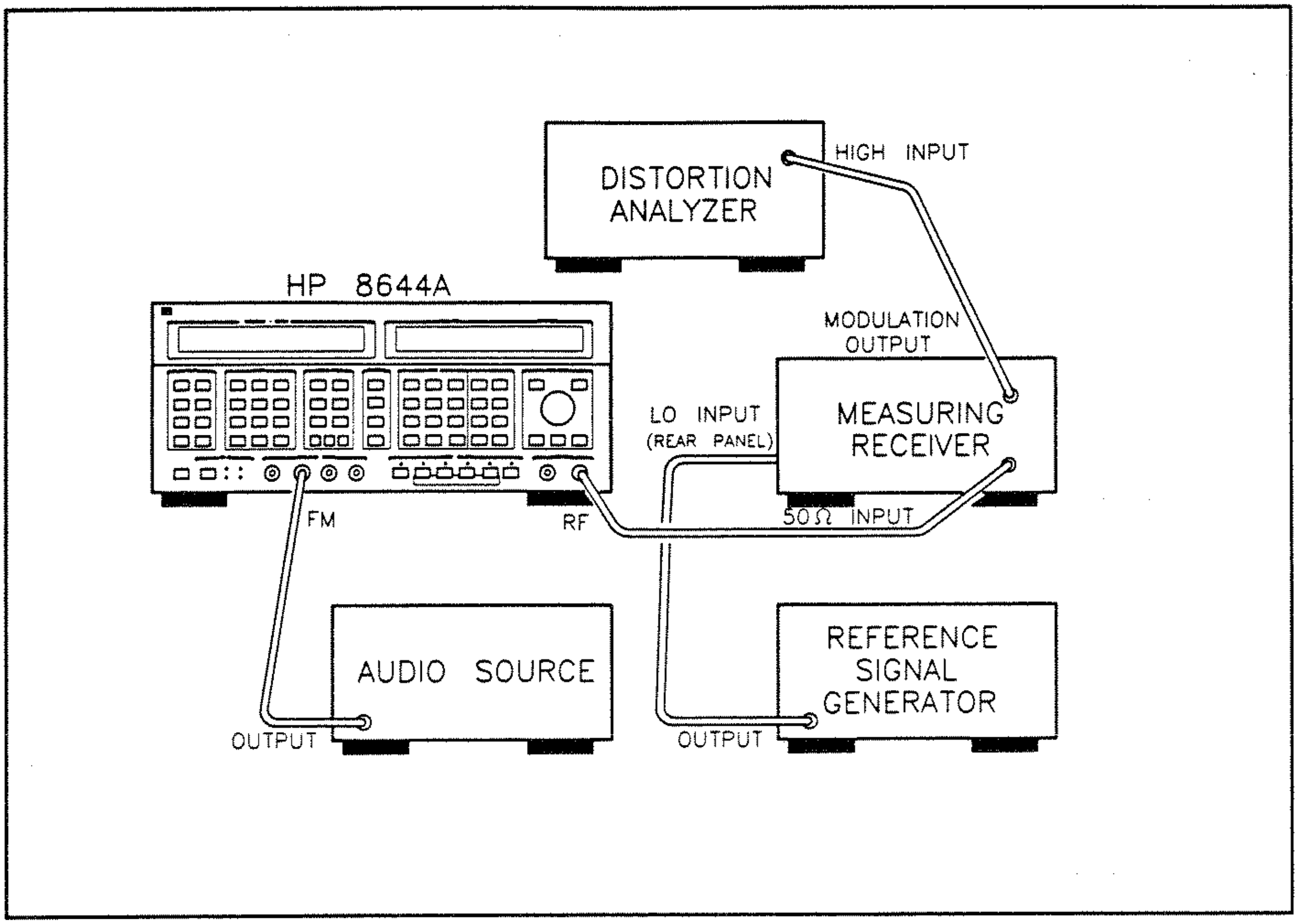


Figure 3–2. *(Low Deviation and Rates) Test Setup*

2. Set the reference signal generator's carrier to 251.5 MHz at 0 dBm.
3. On the Signal Generator under test, press INSTR PRESET and key in AMPTD 0 dBm.
4. Preset the measuring receiver, then set it to read FM with the RMS detector. (If the measuring receiver has series 030 options (high selectivity), invoke special function 23.1 to switch the local oscillator to external.)

Residual FM

5. Set the Signal Generator-under-test's carrier frequency and synthesis mode, the reference signal generator's carrier frequency, and the measuring receiver's high-pass and low-pass filters as indicated in the following table. For each setting, allow the measuring receiver to retune. The residual FM should be within the limits given in the table.

Signal Generator Under Test		Reference Generator Carrier (MHz)	Measuring Receiver Filter		Residual FM Limits (Hz rms)	
Mode	Carrier (MHz)		High-Pass	Low-Pass	Actual	Maximum
2	1000	1001.5	300 Hz	3 kHz	______	2
2	1000	1001.5	50 Hz	15 kHz	______	4
2	1300 (1)	1301.5	50 Hz	15 kHz	______	8
2	1300 (1)	1301.5	300 Hz	3 kHz	______	4
3 (2)	1300 (1)	1301.5	300 Hz	3 kHz	______	2
3 (2)	1300 (1)	1301.5	50 Hz	15 kHz	______	4
3 (2)	1000	1001.5	50 Hz	15 kHz	______	2
3 (2)	1000	1001.5	300 Hz	3 kHz	______	1

(1) Option 002
(2) Option 004

Indicator Accuracy

6. On the Signal Generator under test, set SYNTHESIS MODE to MODE 2. Key in FM ON. If the Signal Generator has Option 007, key in AUDIO FREQ 40 kHz. If the Signal Generator does not have the Option 007 Synthesized Audio Oscillator, perform the following steps.
   a. Press the INT key to turn the internal FM off.
   b. Press the EXT AC key.
   c. On the audio source, set the audio frequency to 40 kHz and its level to 4.67 dBm (that is, 1 Vpk into 600 Ω from a 50 Ω source).

NOTE

The EXT HI *or* EXT LO *annunciators on the Signal Generator may or may not be on. Either condition is acceptable. The level of the modulation input signal is set more accurately by the audio source setting than by the annunciators.*

7. If the measuring receiver does not have series 030 options, disconnect the reference generator from the rear panel and re-connect the coaxial jumper. If the measuring receiver has series 030 options, invoke special function 23.0 to switch the local oscillator back to internal.

8. Set the measuring receiver as follows.
   a. Press the automatic operation key.
   b. Set the detector to peak± /2 (that is, to average peak+ and peak−). (To do this press the PEAK + and PEAK − keys simultaneously.)
   c. Set the high-pass filter off.
   d. Set the low-pass filter off.
9. On the Signal Generator under test, set the instrument as indicated in the following table. For each setting, perform the following steps.
   a. Set the carrier frequency, peak FM deviation, and Synthesis Mode as indicated in the table.

NOTE

The order in which these settings are made may not necessarily be in the sequence stated. For example, a decrease in carrier frequency may not be possible unless the peak FM deviation is first reduced. Also, low values of FM deviation (such as 0.097 kHz) cannot be entered as shown in the table; enter such values using less-significant units (such as 97 Hz).

   b. Set the FM rate, either internal or external, as indicated in the table.
   c. Read the FM peak deviation on the measuring receiver. The FM deviation should be within the limits shown in the table.

Signal Generator Settings				FM Deviation Limits (kHz peak)		
Carrier Frequency (MHz)	Mode	FM Rate (kHz)	FM Deviation (kHz peak)	Minimum	Actual	Maximum
514	2	40	360	324	______	396
514	2	50	360	324	______	396
514	2	60	360	324	______	396
514	2	70	360	324	______	396
514	2	80	360	324	______	396
514	2	90	360	324	______	396
514	2	100	360	324	______	396
514	3 (1)	100	50	42.5	______	57.5
258	3 (1)	100	50	42.5	______	57.5
258	2	100	360	324	______	396
364.1	2	100	360	324	______	396
257	1	100	330	264	______	396
257	2	100	250	225	______	275
257	3 (1)	100	25	21.25	______	28.75
129	3 (1)	100	25	21.25	______	28.75
129	2	100	250	225	______	275
129	1	100	330	264	______	396
182	1	100	330	264	______	396
128	1	100	330	264	______	396
128	2	100	125	112.5	______	137.5
128	3 (1)	100	12.5	10.62	______	14.40
65	3 (1)	100	12.5	10.62	______	14.40
65	2	100	125	112.5	______	137.5
65	1	100	330	264	______	396
91.03	1	100	330	264	______	396
64	1	100	330	264	______	396
64	2	100	62.5	56.3	______	68.7
64	3 (1)	100	6.25	5.31	______	7.19
33	3 (1)	100	6.25	5.31	______	7.19
33	2	100	62.5	56.3	______	68.7
33	1	100	330	264	______	396
45.51	1	100	330	264	______	396

(1) Option 004

(Table continued on next page)

(Table continued from previous page)

Signal Generator Settings				FM Deviation Limits (kHz peak)		
Carrier Frequency (MHz)	Mode	FM Rate (kHz)	FM Deviation (kHz peak)	Minimum	Actual	Maximum
32	1	100	312	250	______	374
32	2	100	31.2	28.1	______	34.3
32	3 (2)	100	3.12	2.65	______	3.59
17	3 (2)	100	3.12	2.65	______	3.59
17	2	100	31.2	28.1	______	34.3
17	1	100	312	250	______	374
22.75	1	100	312	250	______	374
16	1	100	156	124.8	______	187.2
16	2	100	15.6	14.04	______	17.16
16	3 (2)	100	1.56	1.32	______	1.80
11.37	1	100	156	124.8	______	187.2
514	2	30	380	361	______	399
514	3 (2)	30	50	47.0	______	53.0
258	3 (2)	30	50	47.0	______	53.0
258	2	30	380	361	______	399
257	1	30	350	308	______	392
257	2	30	250	238	______	262
257	3 (2)	30	25	23.5	______	26.5
129	3 (2)	30	25	23.5	______	26.5
129	2	30	250	238	______	262
129	1	30	350	308	______	392
128	1	30	350	308	______	392
128	2	30	125	118.8	______	131.2
128	3 (2)	30	12.5	11.75	______	13.25
65	3 (2)	30	12.5	11.75	______	13.25
65	2	30	125	118.8	______	131.2
65	1	30	350	308	______	392
64	1	30	350	308	______	392
64	2	30	62.5	56.3	______	68.7
64	3 (2)	30	6.25	5.93	______	6.57
33	3 (2)	30	6.25	5.93	______	6.57
33	2	30	62.5	56.3	______	68.7
33	1	30	350	308	______	392

(2) Option 004

(Table continued on next page)

(Table continued from previous page)

Signal Generator Settings				FM Deviation Limits (kHz peak)		
Carrier Frequency (MHz)	Mode	FM Rate (kHz)	FM Deviation (kHz peak)	Minimum	Actual	Maximum
32	1	30	312	275	______	349
32	2	30	31.2	29.7	______	32.7
32	3 (3)	30	3.12	2.93	______	3.31
17	3 (3)	30	3.12	2.93	______	3.31
17	2	30	31.2	29.7	______	32.7
17	1	30	312	275	______	349
16	1	30	156	137.3	______	174.7
16	2	30	15.6	14.82	______	16.38
16	3 (3)	30	1.56	1.46	______	1.66
8.1	3 (3)	10	1.56	1.46	______	1.66
8.1	2	10	15.6	14.82	______	16.38
8.1	1	10	35	30.8	______	39.2
8	1	10	35	30.8	______	39.2
8	2	10	7.8	7.41	______	8.19
8	3 (3)	10	0.78	0.73	______	0.83
4.1	3 (3)	10	0.78	0.73	______	0.83
4.1	2	10	7.8	7.41	______	8.19
4.1	1	10	35	30.8	______	39.2
5.689	1	10	35	30.8	______	39.2
4	1	10	35	30.8	______	39.2
4	2	10	3.9	3.71	______	4.09
4	3 (3)	10	0.39	0.36	______	0.42
2.1	3 (3)	10	0.39	0.36	______	0.42
2.1	2	10	3.9	3.71	______	4.09
2.1	1	10	35	30.8	______	39.2
2.844	1	10	35	30.8	______	39.2
2	1	10	19.5	17.2	______	21.8
2	2	10	1.95	1.86	______	2.04
2	3 (3)	10	0.195	0.18	______	0.21
1.1	3 (3)	10	0.195	0.18	______	0.21
1.1	2	10	1.95	1.86	______	2.04
1.1	1	10	19.5	17.2	______	21.8
1.422	1	10	19.5	17.2	______	21.8

(3) Option 004

(Table continued from previous page)

Signal Generator Settings				FM Deviation Limits (kHz peak)		
Carrier Frequency (MHz)	Mode	FM Rate (kHz)	FM Deviation (kHz peak)	Minimum	Actual	Maximum
1	1	9.7	9.7	8.54	________	10.86
1	2	9.7	0.97	0.922	________	1.018
0.51	2	9.7	0.97	0.922	________	1.018
0.51	1	9.7	9.7	8.54	________	10.86
0.711	1	9.7	9.7	8.54	________	10.86
0.5	1	4.8	4.8	4.23	________	5.37
0.5	2	4.8	0.48	0.456	________	0.504
0.26	2	4.8	0.48	0.456	________	0.504
0.26	1	4.8	4.8	4.23	________	5.37
0.355	1	4.8	4.8	4.23	________	5.37

10. Set the measuring receiver as follows:
    a. Set the high-pass filter to 300 Hz.
    b. Set the low-pass filter to 3 kHz.
11. On the signal generator under test, Set the instrument as indicated in the following table.
    a. Set the carrier frequency, mode, FM rate, and FM peak deviation as indicated.
    b. Read the FM peak deviation on the measuring receiver, the FM deviation should be within the limits shown in the table.

Signal Generator Settings				FM Deviation Limits (kHz peak)		
Carrier Frequency (MHz)	Mode	FM Rate (kHz)	FM Deviation (kHz peak)	Minimum	Actual	Maximum
1	3 [4]	1.0	0.097	0.091	________	0.103
0.51	3 [4]	1.0	0.097	0.091	________	0.103
0.5	3 [4]	1.0	0.048	0.045	________	0.051
0.26	3 [4]	1.0	0.048	0.045	________	0.051

[4] Option 004

12. Record the FM Deviation for the 514 MHz carrier at 100 kHz rate and 360 kHz deviation (Mode 2) for use in Performance Test 4.

FM Deviation for 514 MHz carrier: ________ kHz

Distortion

13. Connect the distortion analyzer to the modulation output of the measuring receiver. (Refer to figure 3–2.)
14. Set the distortion analyzer to measure the distortion on the demodulated FM which will have an audio rate of 100 kHz. (Switch any low-pass filtering off.)
15. Set the frequency of the audio source (either internal or external) to 100 kHz. (Leave the audio level at 4.67 dBm if using an external source.)
16. On the Signal Generator under test, set the carrier frequency, peak FM deviation and SYNTHESIS MODE as indicated in the following table. For each step read the distortion on the distortion analyzer. The distortion should be within the limits shown in the table.

Signal Generator Settings			FM Distortion Limits (%)	
Carrier Frequency (MHz)	Synthesis Mode	FM Deviation (kHz peak)	Actual	Maximum
257	3 (1)	25	______	1
257	2	125	______	3
257	2	250	______	5
182	2	250	______	5
129	2	250	______	5
129	2	125	______	3
129	3 (1)	25	______	1

(1) Option 004

Incidental AM

17. On the Signal Generator under test, set SYNTHESIS MODE to MODE 2. Key in FREQ 17 MHz and FM 18 kHz.
18. Set the measuring receiver to read AM. The AM depth should read 0.5% or less.

Incidental AM Limit: ______ 0.5%

Carrier Frequency Accuracy in FM

19. Set the measuring receiver to measure carrier frequency. Set the counter resolution to 10 Hz (special function 7.1).
20. On the Signal Generator under test, if external modulation is used, disconnect the audio source. If internal modulation is used, press INT (to turn off the internal modulation oscillator).
21. On the Signal Generator under test, set SYNTHESIS MODE to MODE 1.
22. On the Signal Generator under test, set the carrier frequency and the FM peak deviation as indicated in the following table. For each step press FM OFF then press FM ON and note the shift in carrier frequency as read on the measuring receiver. (The frequency error measurement mode in the measuring receiver can also be used to measure carrier shift.) The carrier shift should be within the limits shown in the table.

NOTE

The FM system in the Signal Generator is turned on but no actual FM is generated because the audio source is turned off or disconnected.

Signal Generator Settings		Carrier Shift Limits (kHz)	
Carrier Frequency (MHz)	FM Deviation (MHz peak)	Actual	Maximum
10	0.15	________	0.75
20	0.3	________	1.5
50	0.625	________	3.12
100	1.25	________	6.25
200	2.5	________	12.5
500	5	________	25
1000	10	________	50

Performance Test 4

FM TEST (HIGH DEVIATIONS AND RATES)

Specification

Characteristic	Performance Limits	Conditions
Frequency Modulation		
Maximum Peak Deviation		Mode 1
	20 MHz	1030 to 2060 MHz carrier; Option 002
	10 MHz	515 to 1030 MHz carrier; Mode 1
	5 MHz	257 to 515 MHz carrier
	2.5 MHz	128 to 257 MHz carrier
	1.25 MHz	64 to 128 MHz carrier
	625 kHz	32 to 64 MHz carrier
	312 kHz	16 to 32 MHz carrier
	156 kHz	8 to 16 MHz carrier
	78 kHz	4 to 8 MHz carrier
	39 kHz	2 to 4 MHz carrier
	19.5 kHz	1 to 2 MHz carrier
	9.77 kHz	0.5 to 1 MHz carrier
	4.88 kHz	0.25 to 0.5 MHz carrier
	10% of Mode 1 maximum	Mode 2
	1% of Mode 1 maximum	Mode 3; Option 004
Maximum Rate	100 kHz	1030 to 2060 MHz carrier; Option 002
	100 kHz	8 to 1030 MHz carrier
	78 kHz	4 to 8 MHz carrier
	39 kHz	2 to 4 MHz carrier
	19.5 kHz	1 to 2 MHz carrier
	9.7 kHz	0.5 to 1 MHz carrier
	4.8 kHz	0.25 to 0.5 MHz carrier
Indicator Accuracy		accuracy at time of setting for rates that do not exceed maximum rate
	6%	30 kHz rate; 1% of maximum peak deviation; Mode 3
	15%	100 kHz rate; 1% of maximum peak deviation; Mode 3
	5%	30 kHz rate; 10% of maximum peak deviation
	10%	100 kHz rate; 10% of maximum peak deviation
	12%	30 kHz rate; 100% of maximum peak deviation
	20%	100 kHz rate; 100% of maximum peak deviation

Characteristic	Performance Limits	Conditions
Distortion		20 Hz to 100 kHz rates
	<3%	5% of maximum peak deviation
	<5%	100% of maximum peak deviation
	<1%	Mode 3; Option 004

Description

Measurements are made on signals with FM peak deviations up to 5 MHz and rates up to 100 kHz. These signals cannot be made directly by the HP 8902A Measuring Receiver which was used in Performance Test 3. (However, Performance Tests 3 and 4 have some overlap.)

FM is demodulated by an HP 3048A Phase Noise Measurement System. A power splitter and delay line (both supplied with the system) and an RF phase detector (built into the system's interface) are used as a delay-line FM discriminator. The demodulated FM is analyzed by an RF spectrum analyzer (optionally supplied with the system). The test is not run by a system program; rather, the system's interface is manually controlled from the controller's keyboard.

Equipment

Audio Source .... HP 3325A
Phase Noise Measurement System .... HP 3048A Option 101

NOTE

Since this test is written specifically for the HP 3048A, no substitute of equipment is recommended.

For this test, the HP 3048A is assumed to have the HP 11848-60132 Noise Floor Test Fixture (supplied with system) and an HP 3585A spectrum analyzer (which must have a 1 MΩ input). The HP 3561A Dynamic Signal Analyzer is required for the system but is not used in this test.

If the Signal Generator being tested has Option 007, the external audio source is not needed.

Procedure

Initial Setup and Establishing Quadrature

1. Run Performance Test 3, *FM Test (Low Deviations and Rates)*. Record the values measured in step 10 for use later in this test.
2. Connect the equipment as shown in figure 3-3. Check that the SPECTRUM ANALYZER output connector on the front panel of the HP 11848A Phase Noise Interface is terminated in 50 Ω. Also, check that the delay line connectors are tight.
3. On the Signal Generator press INSTR PRESET then key in FREQ 400 MHz and AMPTD 17 dBm (or the highest amplitude allowed for Signal Generators with Option 002 or 005).

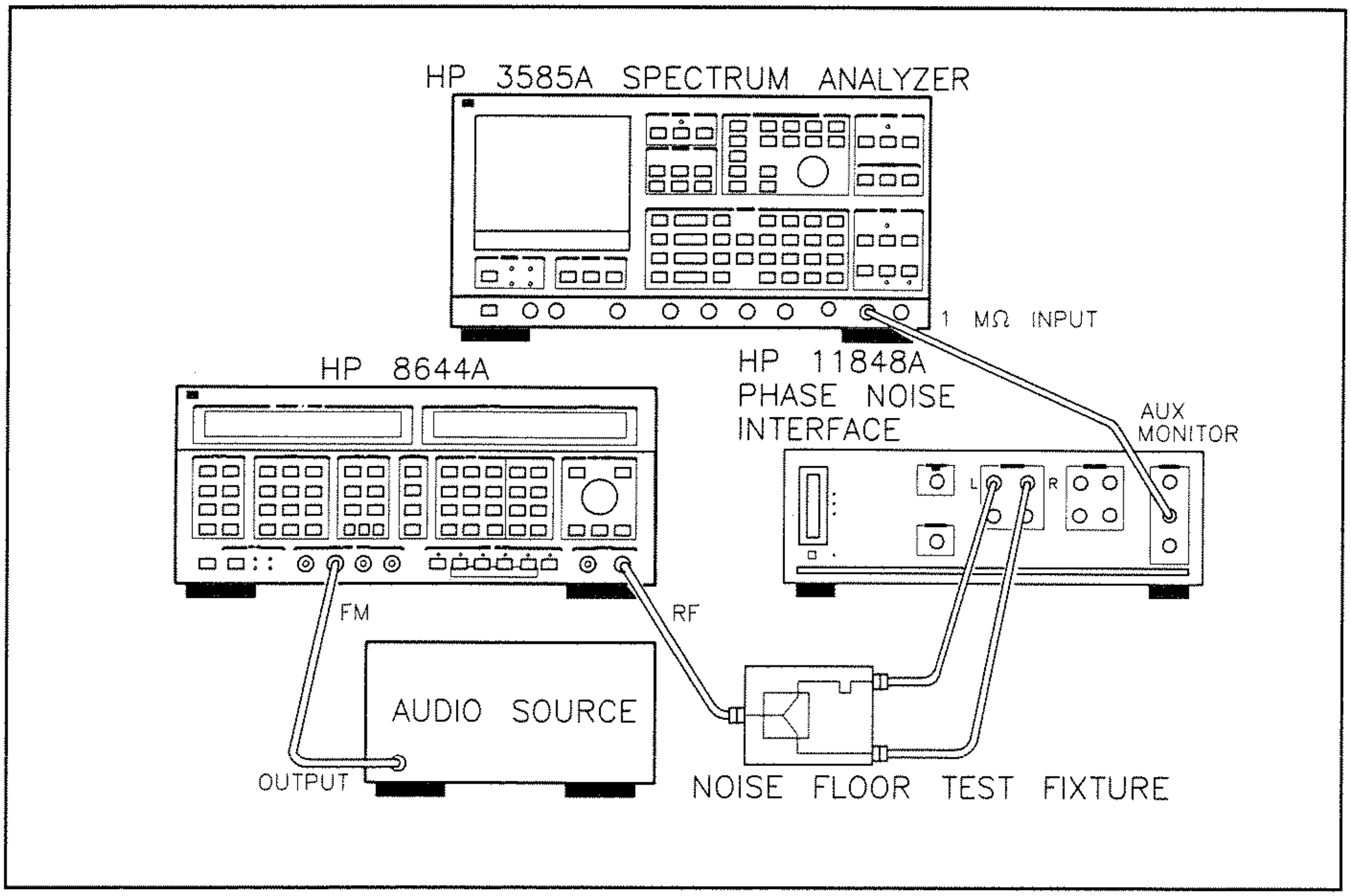


Figure 3–3. *FM (High Deviation and Rates) Test Setup*

4. Boot up the phase noise measurement system to the Main Software Menu level then set the system as follows.
   a. Press the `Spcl. Funct'n` softkey available at the Main Software Level menu.
   b. Press the `11848A Control` softkey to initiate manual control of the system's interface.
   c. Press the `Preset` softkey to preset the interface.
   d. Use the cursor control keys to move the cursor to the "SELECTED 'K' SWITCHES:" line then key in 10 and 12. (Refer to figure 3-4.)
   e. Use the cursor control keys to move the cursor to the "SELECTED 'S' SWITCHES:" line then key in 3 while not changing the "8" already present on the line.
   f. Press the `Send Command` softkey to initiate the commands. The display should appear as in figure 3-4 except for the cursor position, the values following "GAIN1:" and "GAIN2:" (which will be entered later), and the bottom line.
5. Tune the Signal Generator's carrier frequency until the front-panel meter of the system's interface reads approximately 0.

6. Set the phase noise measurement system as follows.
   a. Use the system's cursor control keys to move the cursor to the "GAIN1:" line then key in 28.
   b. Use the system's cursor control keys to move the cursor to the "GAIN2:" line then key in 20.
   c. Press the [Send Command] softkey to initiate the commands.
7. Fine tune the Signal Generator's carrier frequency until the front-panel meter of the system's interface reads approximately 0. This establishes quadrature in the interface's phase detector to make it function as a linear phase detector. (The display should now appear as in figure 3-4.)
8. Set the RF spectrum analyzer to span from 0 to 200 kHz. Set the input impedance to 1 MΩ.

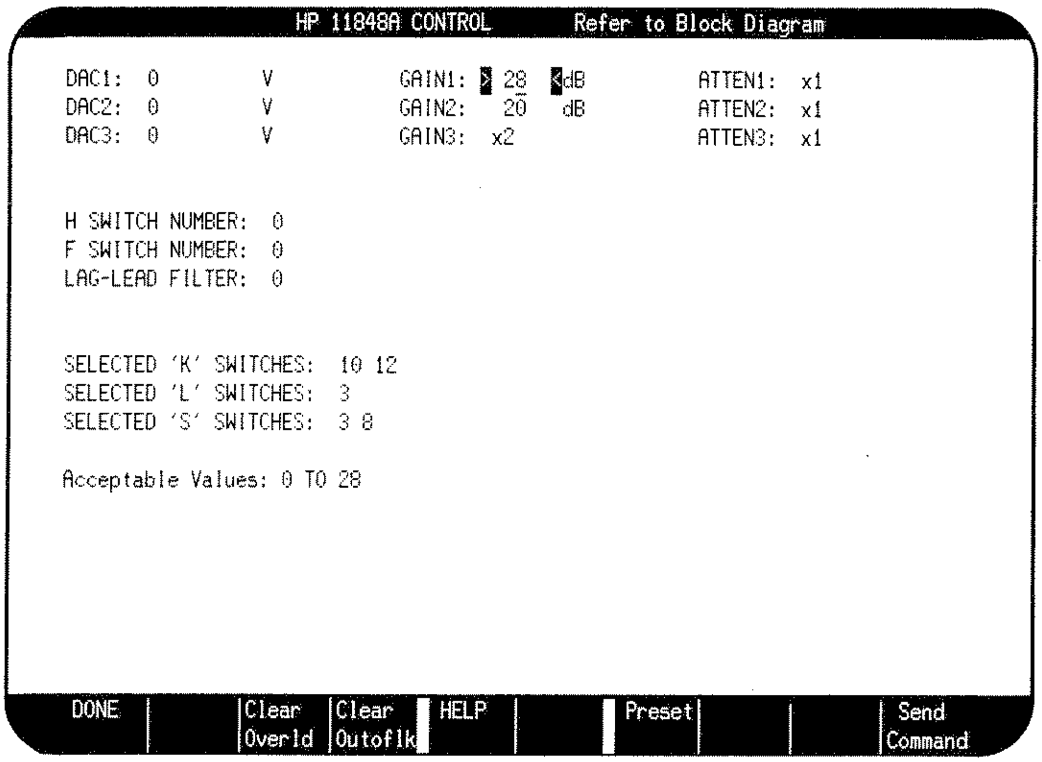


Figure 3–4. *HP 11848A Control Display for FM Test*

Indicator Accuracy

9. Let *D* equal the value in kHz of FM deviation measured in Performance Test 3, step 10, for a 514 MHz carrier at 100 kHz FM rate and 360 kHz peak FM deviation (Mode 2). Calculate 720 − *D*. (For example, if the value for *D* is 350 kHz, 720 − 350 = 370.)

720 Minus the Value of *D*: ________ kHz

10. On the Signal Generator, set SYNTHESIS MODE to MODE 2. Key in FM ON. If the Signal Generator has Option 007, key in AUDIO FREQ 100 kHz. If the Signal Generator does not have the Option 007 Synthesized Audio Oscillator, perform the following steps.
    a. Press the INT key to turn the internal FM off.
    b. Press the EXT AC key.
    c. On the audio source, set the audio frequency to 100 kHz and its level to 4.67 dBm (1 Vpk into 600 Ω from a 50 Ω source).

NOTE

The EXT HI *or* EXT LO *annunciators on the Signal Generator may or may not be on. Either condition is acceptable. The level of the modulation input signal is set more accurately by the audio source setting than by the annunciators.*

11. On the Signal Generator press the FM key. Key in the value (720 − *D*) calculated in step 9 above (for example 370) then press kHz.
12. Adjust the RF spectrum analyzer's reference level so that the 100 kHz signal is at a convenient graticule line. (This line represents 360 kHz peak deviation.)
13. On the Signal Generator under test, set the instrument as indicated in the following table. For each setting, perform the following steps.
    a. Set the peak FM deviation and Synthesis Mode as indicated in the table.

NOTE

The order in which these settings are made may not necessarily be in the sequence stated. For example, a higher mode number may not be possible unless the peak FM deviation is first reduced.

    b. Set the audio FM rate (either internal or external) as indicated in the table.
    c. Read the FM peak deviation on the spectrum analyzer by noting how far the signal increases or decreases relative to the reference set above. The FM deviation should be within the limits shown in the table.

FM Rate (kHz)	Signal Generator Settings		FM Deviation Limits (dB)		
	Mode	FM Deviation (kHz peak)	Minimum	Actual	Maximum
100	1	5000	20.9	________	24.4
100	2	500	1.9	________	3.7
30	2	500	2.4	________	3.3
30	1	5000	21.7	________	23.8

Distortion

14. Set the frequency of the audio source (either internal or external) to 100 kHz.
15. Set the RF spectrum analyzer to span from 0 to 500 kHz.
16. On the Signal Generator set the synthesis mode and FM deviation as indicated in the following table. For each setting, note the level of the harmonics of the 100 kHz signal relative to the fundamental. The harmonics should be below the limits shown in the table.

Signal Generator Settings		Harmonics Limits (dB)	
Synthesis Mode	**FM Deviation (kHz peak)**	**Actual**	**Maximum**
1	5000	______	−26
1	500	______	−26
2	500	______	−26
2	250	______	−30.5
2	50	______	−30.5
3 (1)	50	______	−40

(1) Option 004

Performance Test 5

SPECTRAL PURITY TEST (SSB PHASE NOISE)

Specification

Characteristic	Performance Limits	Conditions
Spectral Purity		
SSB Phase Noise		CW, AM, or FM (FM at 1% of maximum specified deviation for offsets >1 kHz, FM at minimum deviation for offsets <1 kHz)
		1 kHz frequency offset; Mode 2
	−81 dBc/Hz	1030 to 2060 MHz carrier; Option 002
	−88 dBc/Hz	515 to 1030 MHz carrier
	−93 dBc/Hz	257 to 515 MHz carrier
	−98 dBc/Hz	128 to 257 MHz carrier
	−103 dBc/Hz	64 to 128 MHz carrier
	−108 dBc/Hz	32 to 64 MHz carrier
	−113 dBc/Hz	16 to 32 MHz carrier
	−118 dBc/Hz	8 to 16 MHz carrier
	−123 dBc/Hz	4 to 8 MHz carrier
	−127 dBc/Hz	2 to 4 MHz carrier
	−131 dBc/Hz	1 to 2 MHz carrier
	−135 dBc/Hz	0.5 to 1 MHz carrier
	−138 dBc/Hz	0.25 to 0.5 MHz carrier
		20 kHz frequency offset; Mode 2
	−121 dBc/Hz	1030 to 2060 MHz carrier; Option 002
	−128 dBc/Hz	515 to 1030 MHz carrier
	−134 dBc/Hz	257 to 515 MHz carrier
	−138 dBc/Hz	128 to 257 MHz carrier
	−140 dBc/Hz	64 to 128 MHz carrier
	−142 dBc/Hz	32 to 64 MHz carrier
	−144 dBc/Hz	16 to 32 MHz carrier
	−145 dBc/Hz	0.25 to 16 MHz carrier
		100 kHz frequency offset; Mode 2
	−131 dBc/Hz	1030 to 2060 MHz carrier; Option 002
	−138 dBc/Hz	515 to 1030 MHz carrier
	−141 dBc/Hz	257 to 515 MHz carrier
	−142 dBc/Hz	128 to 257 MHz carrier
	−144 dBc/Hz	64 to 128 MHz carrier
	−145 dBc/Hz	0.25 to 64 MHz carrier

(Table continued on next page)

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Characteristic	Performance Limits	Conditions
Spectral Purity		
SSB Phase Noise (cont'd)		1 kHz frequency offset; Mode 3; Option 004
	−94 dBc/Hz	1030 to 2060 MHz carrier; Option 002
	−100 dBc/Hz	515 to 1030 MHz carrier
	−106 dBc/Hz	257 to 515 MHz carrier
	−111 dBc/Hz	128 to 257 MHz carrier
	−116 dBc/Hz	64 to 128 MHz carrier
	−121 dBc/Hz	32 to 64 MHz carrier
	−127 dBc/Hz	16 to 32 MHz carrier
	−130 dBc/Hz	8 to 16 MHz carrier
	−135 dBc/Hz	0.25 to 8 MHz carrier
		20 kHz frequency offset; Mode 3; Option 004
	−130 dBc/Hz	1030 to 2060 MHz carrier; Option 002
	−136 dBc/Hz	515 to 1030 MHz carrier
	−142 dBc/Hz	257 to 515 MHz carrier
	−145 dBc/Hz	0.25 to 257 MHz carrier
		100 kHz frequency offset; Mode 3; Option 004
	−136 dBc/Hz	1030 to 2060 MHz carrier; Option 002
	−142 dBc/Hz	515 to 1030 MHz carrier
	−145 dBc/Hz	0.25 to 515 MHz carrier
Nonharmonic Spurious Signals		
		Mode 2; >15 kHz offset frequency
	< −100 dBc	0.25 to 1030 MHz carrier
	< −94 dBc	1030 to 2060 MHz carrier; Option 002
		Mode 3; Option 004; >10 kHz offset frequency
	< −105 dBc	0.25 to 1030 MHz carrier
	< −100 dBc	1030 to 2060 MHz carrier; Option 002

Description

The single-sideband (SSB) phase noise and non-harmonic spurious signals are measured by a system that is specifically designed to measure these parameters—the HP 3048A Phase Noise Measurement System. Measurements are made using a phase detector in a phase lock loop.

This method requires a reference signal generator that must have lower phase noise than the source being tested. A second HP 8644A can be used as this source (and thus both sources are measured as a pair) but the following considerations apply: (1) If the measured results are within specification, both generators meet the specification individually. (2) If the measured results are out of specification, at least one generator is out of specification and a third source must be measured against the first two to determine which one is faulty.

NOTE

While the HP 8644A is not recommended as a general-purpose, tuneable reference for the HP 3048A system, this particular procedure has been shown to yield accurate results.

Equipment

Phase Noise Measurement System .... HP 3048A
Reference Signal Generator .... HP 8644A Option 004

NOTE

The Option 004 for the reference signal generator is needed only if the Signal Generator under test has Option 004. Neither the reference source nor the HP 8644A under test will be under remote control.

If a suitable reference source is unavailable, the 10 MHz A oscillator in the HP 11848A Phase Noise Interface to the HP 3048A system can be used as reference for a 10 MHz carrier.

Procedure

Initial Setup

1. Connect the equipment as shown in figure 3-5.

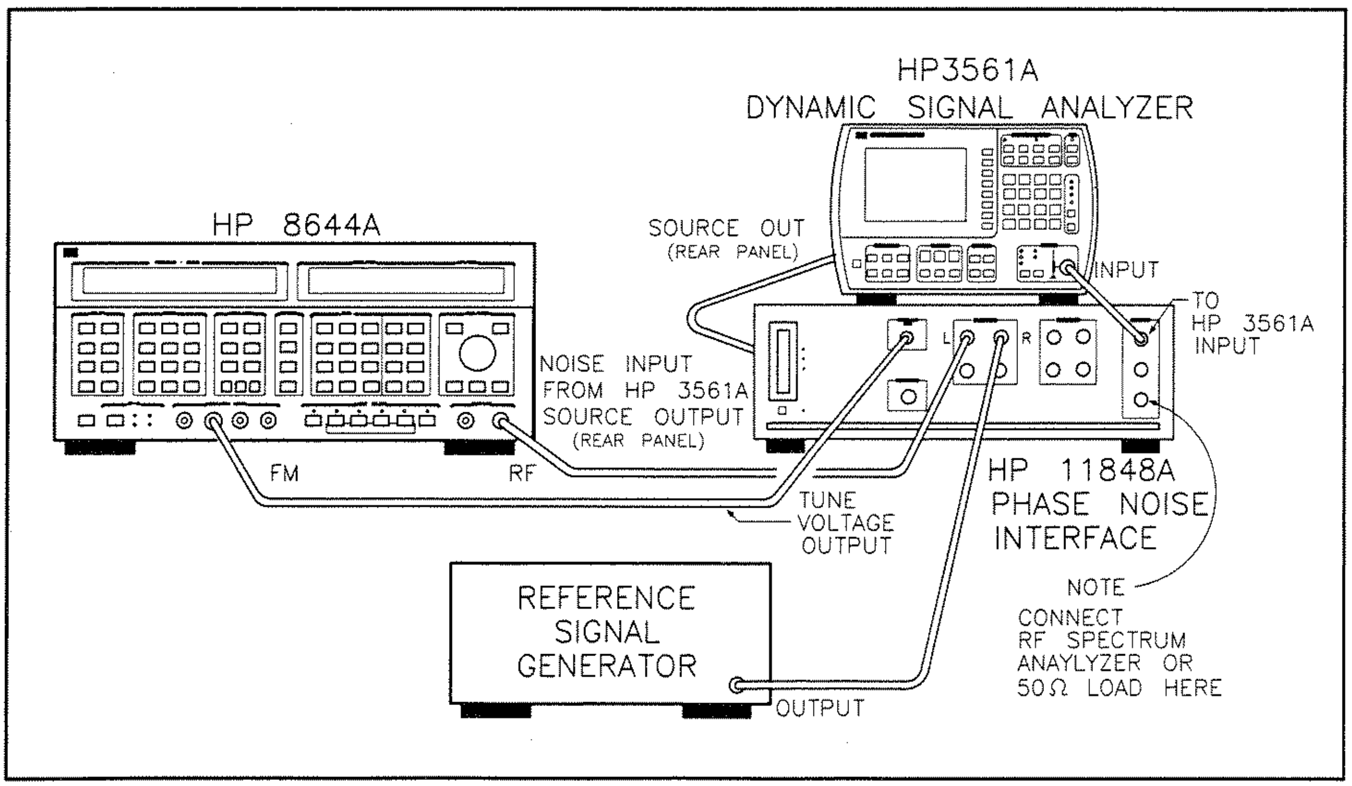


Figure 3–5. *SSB Phase Noise Test Setup*

2. Set the reference signal generator's carrier to 550 MHz + 2 Hz (that is, 550 000 002 Hz) at 6 dBm. If the reference signal generator is an HP 8644A with Option 004, set the synthesis mode to Mode 3. Otherwise set it to Mode 2. (For testing an HP 8644A Option 004, the reference generator must have phase noise performance better than or equal to the HP 8644A Option 004 if it is to be used as the reference generator.)
3. Set the Signal Generator under test as follows.
   a. Press INSTR PRESET.
   b. Key in AMPTD 13 dBm.
   c. Key in FREQ 550 MHz.
   d. Key in FM 128 Hz.
   e. Press INT in the MODULATION key group to turn the internal modulation source off.
   f. Press EXT DC in the MODULATION key group to enable DC FM.
   g. Press MODE 2 in the SYNTHESIS MODE key group.
4. Set the HP 3048A to the Main Software Level menu. Refer to figure 3–6.

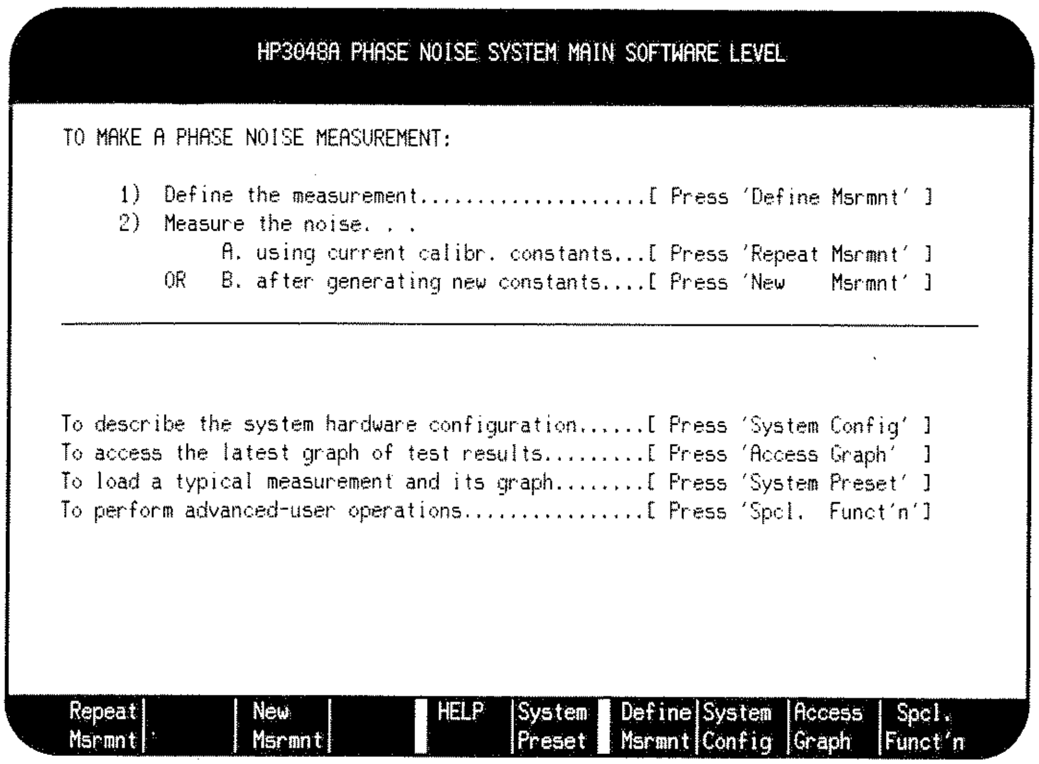


Figure 3–6. *Main Software Level Menu*

Example Measurement

NOTE

The following steps are the procedure for making a single-sideband phase noise measurement on a 550 MHz carrier in Mode 2. For other carrier frequencies and for Mode 3, the procedure is similar. If these measurements are to be repeated in the future for this or other HP 8644A generators, it will be advantageous to record the test file entries for each carrier frequency; these test files can be recalled as needed later on instead of having to re-enter them each time.

5. On the HP 3048A press the Define Msrmnt softkey to obtain the Measurement Definition menu. Refer to figure 3-7.

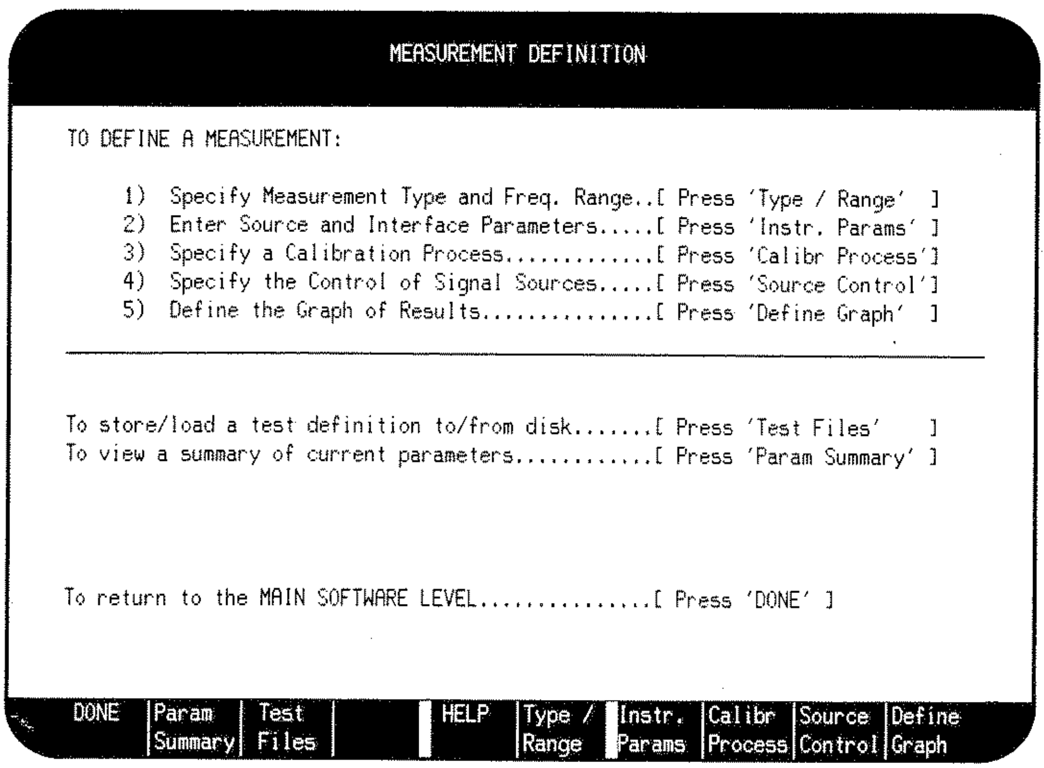


Figure 3-7. *Measurement Definition Menu*

6. On the HP 3048A press the [Type / Range] softkey to obtain the Measurement Type and Frequency Range Specification menu. Set the measurement type and offset frequency range as shown in figure 3-8. When done, press the [DONE] softkey.

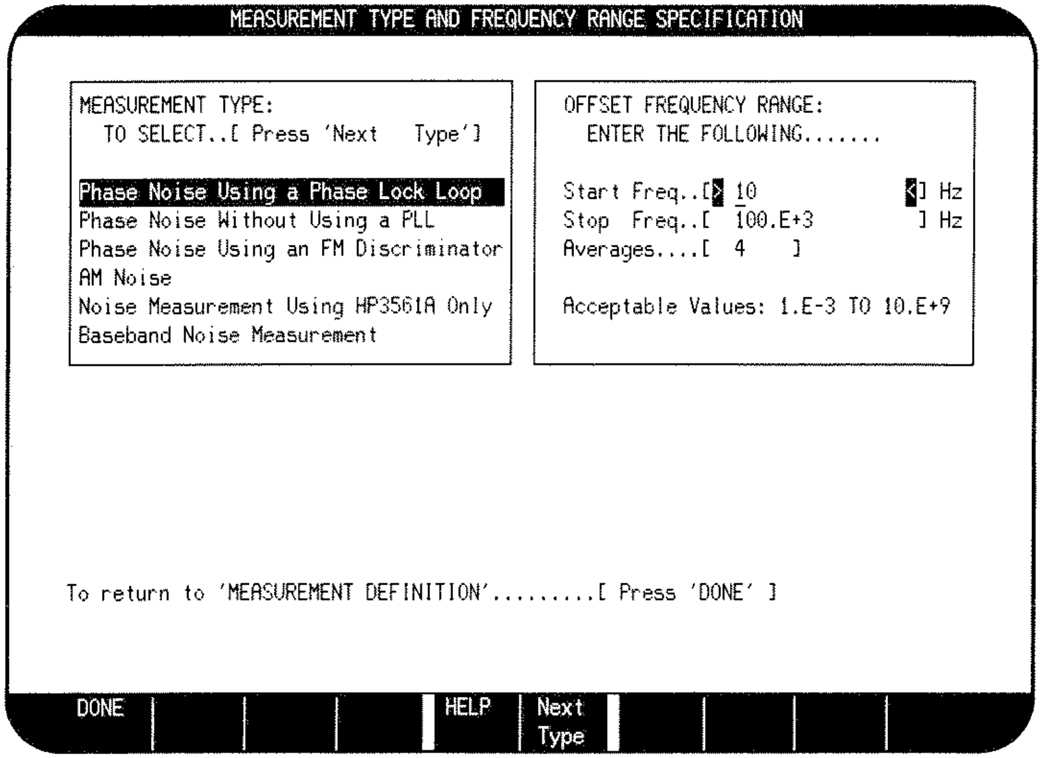


Figure 3–8. Measurement Type and Frequency Range Specification Menu

7. On the HP 3048A press the `Instr. Params` softkey to obtain the Source and Interface Parameter Entry menu. Set the parameters and phase detector as shown in figure 3-9. When done, press the `DONE` softkey.

```
SOURCE AND INTERFACE PARAMETER ENTRY

ENTER THE FOLLOWING PARAMETERS:

     Carrier Frequency.............................[> 550.E+6     <] Hz
     Detector/Discr. Input Frequency...............[  550.E+6      ] Hz
     VCO Tuning Constant...........................[  128          ] Hz/Volt
     Center Voltage of VCO Tuning Curve............[  0            ] Volts
     Voltage Tuning Range of VCO.............. +/- [  10           ] Volts
     VCO Tune-port Input Resistance................[  600          ] Ohms

     Acceptable Values: 1 TO 110.E+9

SELECT A PHASE DETECTOR............................[ Press 'Select Detect.' ]
      Internal Phase Detector: 5 MHz to 1600 MHz
      Internal Phase Detector: 1.2 GHz to 18 GHz
      External Phase/AM Detector

To return to 'MEASUREMENT DEFINITION'................[ Press 'DONE' ]

 DONE |    |    |    | HELP |    | Select  |    |
      |    |    |    |      |    | Detect. |    |
```

Figure 3-9. Source and Interface Parameter Entry Menu

8. On the HP 3048A press the [Calibr Process] softkey to obtain the Determination of Phase Detector Constant and VCO Tuning Constant menu. Set the method of determining the phase detector and VCO tuning constants and the verification of the phase lock loop suppression as shown in figure 3-10. (The displayed Computed Constant may by be quite different from the one in figure 3-10. It will be updated later.) When done, press the [DONE] softkey.

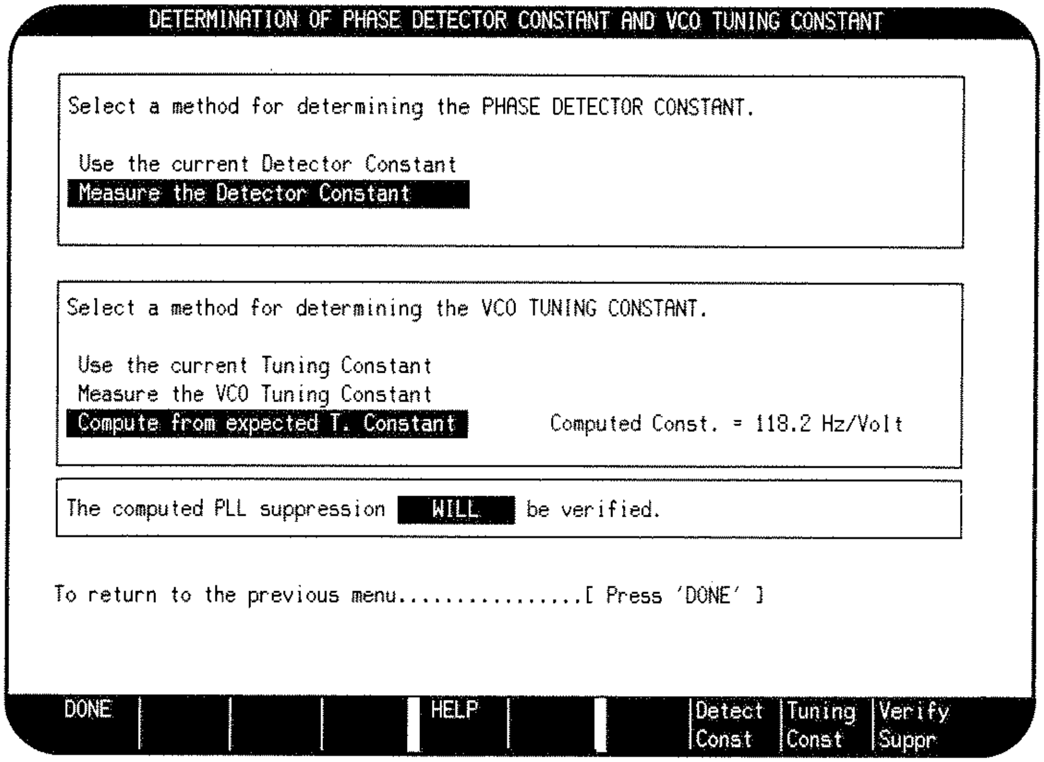


Figure 3-10. Determination of Phase Detector and VCO Tuning Constant Menu

9. On the HP 3048A press the [Source Control] softkey to obtain the Source Control for Measurement Using a Phase Lock Loop menu. Set the various devices in the system as shown in figure 3–11. When done, press the [DONE] softkey.

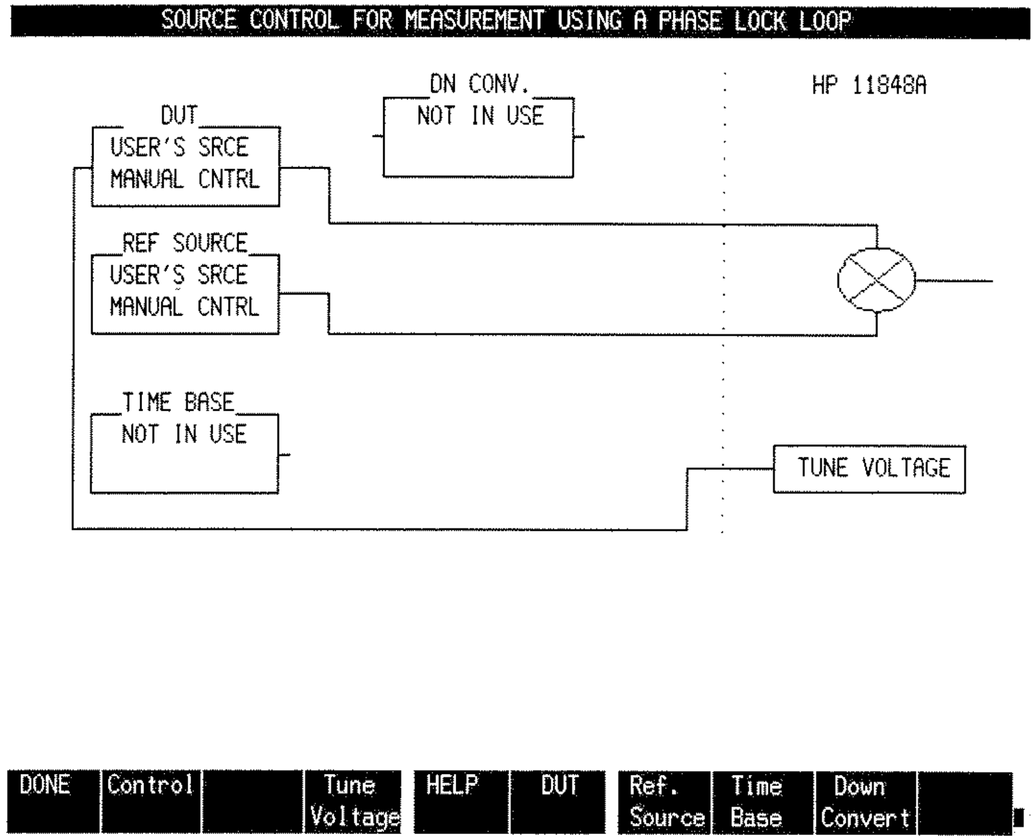


Figure 3–11. *Source Control for Measurement Using a Phase Lock Loop Menu*

```
                              GRAPH DEFINITION
ENTER THE FOLLOWING PARAMETERS:

    Title..[ HP 8644A in MODE 2 (S/N 2825A00110) vs HP 8644A           ]
    Minimum X coordinate........................[  10          Hz ]
    Maximum X coordinate........................[  100.E+3     Hz ]
    Minimum Y coordinate........................[  -170           ]
    Maximum Y coordinate........................[  0              ]


SELECT A GRAPH TYPE.............................[ Press 'Graph Type' ]
    Single Sideband Phase Noise (dBc/Hz)
    Phase Modulation Spectral Density (dB/Hz)
    FM Spectral Density (Hz/SQR(Hz))
    Spectral Density of Fractional Freq. Fluctuations (1/SQR(Hz))
________________________________________________________________

To return to 'MEASUREMENT DEFINITION'...........[ Press 'DONE'      ]

 DONE |  | Spec  |  | HELP |  |  |  |  | Graph
      |  | Lines |  |      |  |  |  |  | Type
```

Figure 3–12. *Graph Definition Menu*

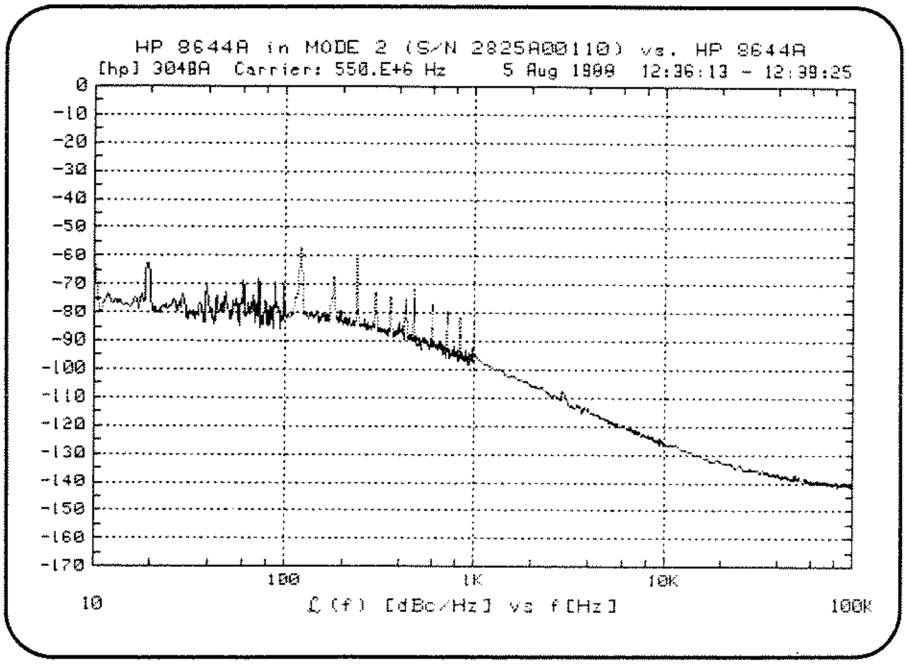
10. On the HP 3048A press the [Define Graph] softkey to obtain the Graph Definition menu. Set the graph parameters and graph type as shown in figure 3–12. Change the title as appropriate for your particular setup. (You may wish to include the serial number of the device under test for example. Note that date, time, and carrier frequency information will automatically appear on the measurement result graph.) When done, press the [DONE] softkey.
11. On the HP 3048A press the [DONE] softkey again to obtain the Main Software Level menu.
12. On the HP 3048A press the [New Msrmnt] softkey then press the [Yes, Proceed] softkey.
13. When the connect diagram appears on the display, verify that the instrument connections are properly made then press the [Proceed] softkey. The phase noise measurement should proceed without error and the phase noise plot should appear as in figure 3–13. Ignoring spurious signals, the phase noise ($\mathcal{L}(f)$) should be less than –88 dBc at a 1 kHz offset frequency, less than –128 dBc at 20 kHz, and less than –138 dBc at 100 kHz. Spurious signals for offset frequencies greater than 20 kHz should be down more than 100 dBc.

SSB phase noise, 1 kHz offset:	________	–88 dBc
SSB phase noise, 20 kHz offset:	________	–128 dBc
SSB phase noise, 100 kHz offset:	________	–138 dBc
Non-harmonic spurious signals, >15 kHz offset:	________	–100 dBc

NOTE

Figure 3-13 also shows a listing of measurement parameters. This listing with the graph itself can be printed by holding down the keyboard's SHIFT *key and pressing the* `Hard Copy` *softkey.*

If you intend to make measurements of this same type frequently, the setup information (carrier frequency, tuning constant, source control, etc.) can be easily stored as test files, then loaded as needed. Refer to the HP 3048A Reference Manual *on storing and loading test files.*



PERTINENT MEASUREMENT PARAMETERS

Measurement Type: PHASE LOCKED	K_VCO Method : COMPUTED
Start Offset Freq: 10 Hz	Tuneport Resist. : 600 Ohms
Stop Offset Freq: 100.E+3 Hz	VCO Tune Constant: 118.2 Hz/Volt
Minimum Averages: 4	
	Loop Suppression : VERIFIED
Carrier Frequency: 550.E+6 Hz	Closed Pll Bandw.: 229.9 Hz
Detect. Input Frq: 550.E+6 Hz	Peak Tuning Range: 1.181E+3 Hz
	Assumed Pole : 2.361E+3 Hz
Entered K_VCO : 128 Hz/Volt	
Center Voltage : 0 Volts	Dev. Under Test : USER'S SRCE, MAN
Tune-voltage Rnge: +/- 10 Volts	Reference Source : USER'S SRCE, MAN, VCO
Phase Detector : 5 TO 1600 MHz	Ext. Timebase : NOT IN USE
	Down Converter : NOT IN USE
K_Detector Method: MEASURED	
Detector Constant: 244.7E-3 V/Rad	HP 11848A LNA : IN

Figure 3–13. *Phase Noise Plot and Pertinent Measurement Parameters*

Further Measurements

14. To measure single-sideband phase noise for other carrier frequencies and modes of operation, set the signal generators and phase noise measurement system as outlined in the following table. The phase noise should be within the limits indicated in the table.

    Spurious signals for Mode 2 at offset frequencies greater than 15 kHz should be down more than 100 dBc for carrier frequencies to 1030 MHz and more than 94 dBc at carrier frequencies between 1030 and 2060 MHz (Option 002).

    Spurious signals for Mode 3 (Option 004) at offset frequencies greater than 10 kHz should be down more than 110 dBc for carrier frequencies to 1030 MHz and more than 104 dBc at carrier frequencies between 1030 and 2060 MHz (Option 002).

    Non-harmonic spurious signals,
    Mode 2, >15 kHz offset, 0.25 to 1030 MHz: ________ −100 dBc
    Non-harmonic spurious signals,
    Mode 2, >15 kHz offset, 1030 to 2060 MHz (Option 002): ________ −94 dBc

    Non-harmonic spurious signals,
    Mode 3 (Option 004), >10 kHz offset, 0.25 to 1030 MHz: ________ −105 dBc
    Non-harmonic spurious signals, Mode 3 (Option 004),
    >10 kHz offset, 1030 to 2060 MHz (Option 002): ________ −100 dBc

Carrier Frequency (MHz) (1)	HP 8644A Settings		HP 3048A VCO Tuning (Hz/V)	Phase Noise Limits (dBc)					
				1 kHz Offset		20 kHz Offset		100 kHz Offset	
	Synth. Mode	FM Peak Dev. (Hz)		Actual	Max.	Actual	Max.	Actual	Max.
1100 (2)	2	256	256	______	−81	______	−121	______	−131
1100 (2)	3 (3)	256	256	______	−94	______	−130	______	−136
550	3 (3)	128	128	______	−100	______	−136	______	−142
550	2	128	128	______	−88	______	−128	______	−138
300	2	64	64	______	−93	______	−134	______	−141
300	3 (3)	64	64	______	−106	______	−142	______	−145
150	3 (3)	32	32	______	−111	______	−145	______	−145
150	2	32	32	______	−98	______	−138	______	−142
80	2	16	16	______	−103	______	−140	______	−144
80	3 (3)	16	16	______	−116	______	−145	______	−145
40	3 (3)	8	8	______	−121	______	−145	______	−145
40	2	8	8	______	−108	______	−142	______	−145
20	2	4	4	______	−113	______	−144	______	−145
20	3 (3)	4	4	______	−127	______	−145	______	−145
10	3 (3)	2	2	______	−130	______	−145	______	−145
10	2	2	2	______	−118	______	−145	______	−145

(1) Make the carrier frequency change to the following:
a. the HP 8644A under test,
b. the reference signal generator (then increment the frequency by 2 Hz),
c. the HP 3048A Source and Interface Parameter Entry menu (for Carrier Frequency and Detector/Disc. Input Frequency), and
d. the Graph Definition menu (in the Title).
(2) Option 002
(3) Option 004

Performance Test 6

SPECTRAL PURITY TEST (HARMONICS)

Specification

Characteristic	Performance Limits	Conditions
Spectral Purity		
Spurious Signals		
Harmonics	< −30 dBc	output <10 dBm; except Options 002 and 005
	< −30 dBc	output <8 dBm; 0.25 to 1030 MHz carrier; Option 002
	< −25 dBc	output <8 dBm; 1030 to 2060 MHz carrier; Option 002
	< −25 dBc	output <8 dBm; 0.25 to 1030 MHz carrier; Option 005
Subharmonics	none	0.25 to 515 MHz carrier
	< −55 dBc	515 to 1030 MHz carrier
	< −40 dBc	1030 to 2060 MHz carrier; Option 002

Description

Harmonics and subharmonics are observed directly on an RF spectrum analyzer while the Signal Generator is swept slowly over its frequency range.

Equipment

RF Spectrum Analyzer............................HP 8562B or HP 853A/8559A

Procedure

Initial Setup

1. Set the Signal Generator as follows.
   a. Press INSTR PRESET.
   b. Key in AMPTD 10 dBm or if the Signal Generator has Option 002 or 005, key in AMPTD 8 dBm.
   c. Key in SWEEP TIME 10 s.
   d. Press AUTO (in the SWEEP key group). This initiates a continuous, 10s sweep from 0.25 to 1030 MHz (or 2060 MHz for Option 002).

2. Set the spectrum analyzer as follows.
   a. Set the frequency span 0 to 3 GHz (or for Option 002, 0 to 6 GHz) with compatible resolution bandwidth and display smoothing. (If this span width is not available, use the widest span possible and, as the measurement progresses, retune the center frequency as needed to span the complete range in segments.)
   b. Set the vertical scale to 10 dB per division log.
   c. Set the vertical sensitivity and attenuation to view a 10 dBm signal with at least 40 dB of uncompressed range.
3. Connect the Signal Generator's OUTPUTS RF to the spectrum analyzer's input.

Harmonics

4. Set the spectrum analyzer sensitivity so that the peak of the sweeping fundamental is at a convenient horizontal graticule.
5. Observe the second and third harmonics of the signal as the fundamental sweeps over its range. If necessary, change the spectrum analyzer's center frequency to observe the harmonics at higher frequencies. The harmonics should be down more than 30 dBc over the 0.25 to 1030 MHz range, and, if the instrument has Option 002, more than 25 dBc from 1030 to 2060 MHz.

Harmonics (0.25 to 1030 MHz carrier, except Option 005): ________ –30 dBc
Harmonics (0.25 to 1030 MHz carrier, Option 005): ________ –25 dBc
Harmonics (1030 to 2060 MHz carrier, Option 002): ________ –25 dBc

Subharmonics

6. Set the spectrum analyzer to span 0 to 1 GHz (or 0 to 2 GHz for Option 002). Increase the vertical gain, sweep time, resolution bandwidth, and display smoothing as necessary to generate a dynamic range of 70 dB. (A slight compression of the signal is acceptable.)
7. Observe the subharmonics of the signal as the fundamental sweeps over its range. The subharmonics should be unobservable over the fundamental range to 0.25 to 515 MHz, more than 55 dBc from 515 to 1030 MHz range, and, if the instrument has Option 002, more than 40 dBc from 1030 to 2060 MHz.

Subharmonics (0.25 to 515 MHz carrier): ________ unobservable
Subharmonics (515 to 1030 MHz carrier): ________ –55 dBc
Subharmonics (1030 to 2060 MHz carrier, Option 002): ________ –40 dBc

Performance Test 7

PULSE MODULATION TEST

Specification

Characteristic	Performance Limits	Conditions
Pulse Modulation		>10 MHz carrier
On/Off Ratio	< −35 dB < −80 dB	10 to 1030 MHz carrier 1030 to 2060 MHz carrier; Option 002
Rise/Fall Time	<100 ns	10% to 90% points
Maximum Pulse Repetition Rate	1 MHz	
Minimum Pulse Width	500 ns	

Description

For low carrier frequencies, the characteristics of the RF pulses are observed directly on an oscilloscope. For high frequencies, a crystal detector is used to peak-detect the pulse envelope which is then viewed on the oscilloscope. The pulse on/off ratio is measured statically on a spectrum analyzer by setting a CW reference then noting how far the amplitude drops when the Signal Generator is switched to the pulse modulation mode with no pulse input.

Equipment

Crystal Detector .... HP 423B
600 Ω Feed Thru Termination .... HP 11095A
Oscilloscope .... HP 1740A or Tektronix 2245
Pulse Generator .... HP 8116A
Spectrum Analyzer .... HP 8562A or HP 853A/8559A

Procedure

Initial Setup

1. Connect the equipment as shown in figure 3-14.
2. Set the oscilloscope as follows.
   a. Set the input coupling to dc with 50 Ω input impedance.
   b. Set the vertical scale to view a 2 V (p-p) signal.
   c. Set the time sweep to 200 ns per division.
   d. Set the triggering to trigger on the rising transition of the pulse generator's trigger output.

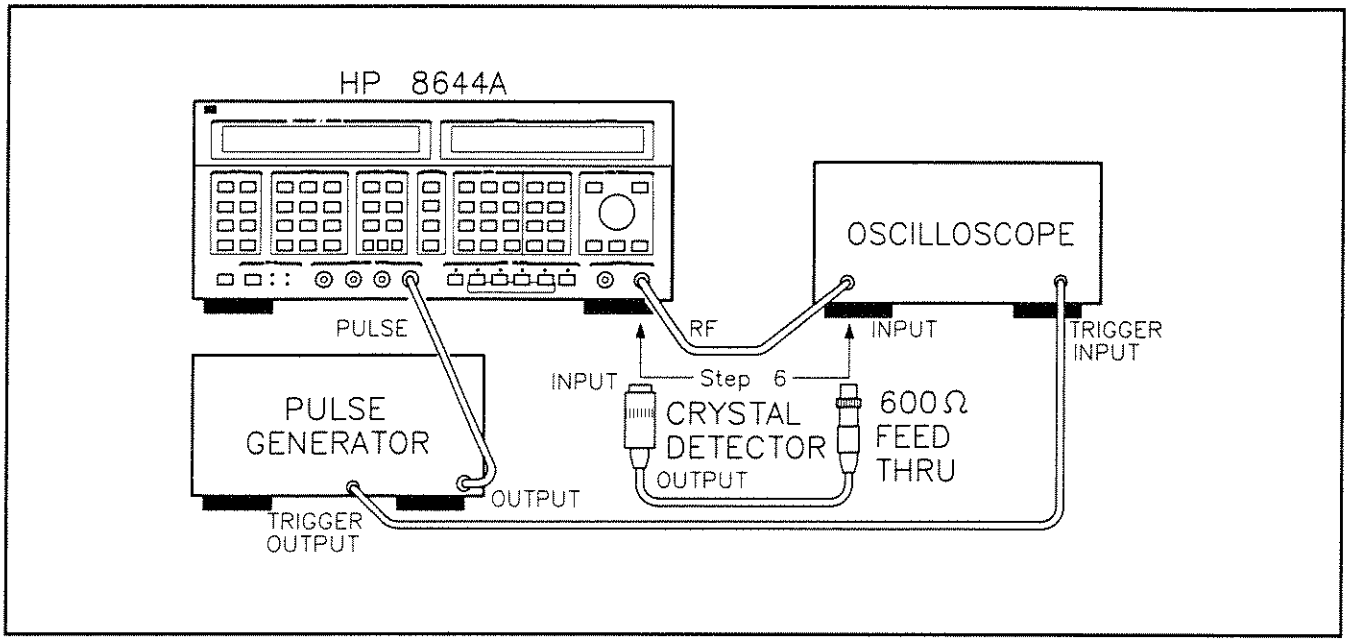


Figure 3–14. Pulse Modulation Test Setup

3. Set the pulse generator as follows.
   a. Set the frequency (rate) to 100 kHz.
   b. Set the pulse width to 1 μs.
   c. Set the amplitude to switch from 0 V to 4 V.
4. Set the Signal Generator as follows.
   a. Press INSTR PRESET.
   b. Key in AMPTD 10 dBm.
   c. Key in FREQ 10 MHz.
   d. Key in PULSE ON.

Risetime and Falltime (Using an Oscilloscope)

5. Set the equipment as indicated in the following table. For each step, observe the 10% to 90% risetime and falltime of the RF burst relative to its steady-state value. (Refer to figure 3–15 for details.) The risetime and falltime should be within the limits shown in the table.

NOTE

Figure 3-15 shows the RF burst envelope as displayed on a digitizing oscilloscope. The X and O markers are at the approximate 10 and 90% points on the envelope. The reading for ΔT is the approximate risetime.

If the oscilloscope does not have bandwidth adequate to measure the pulse waveforms at the carrier frequencies shown in the table, use the technique that begins with step 6.

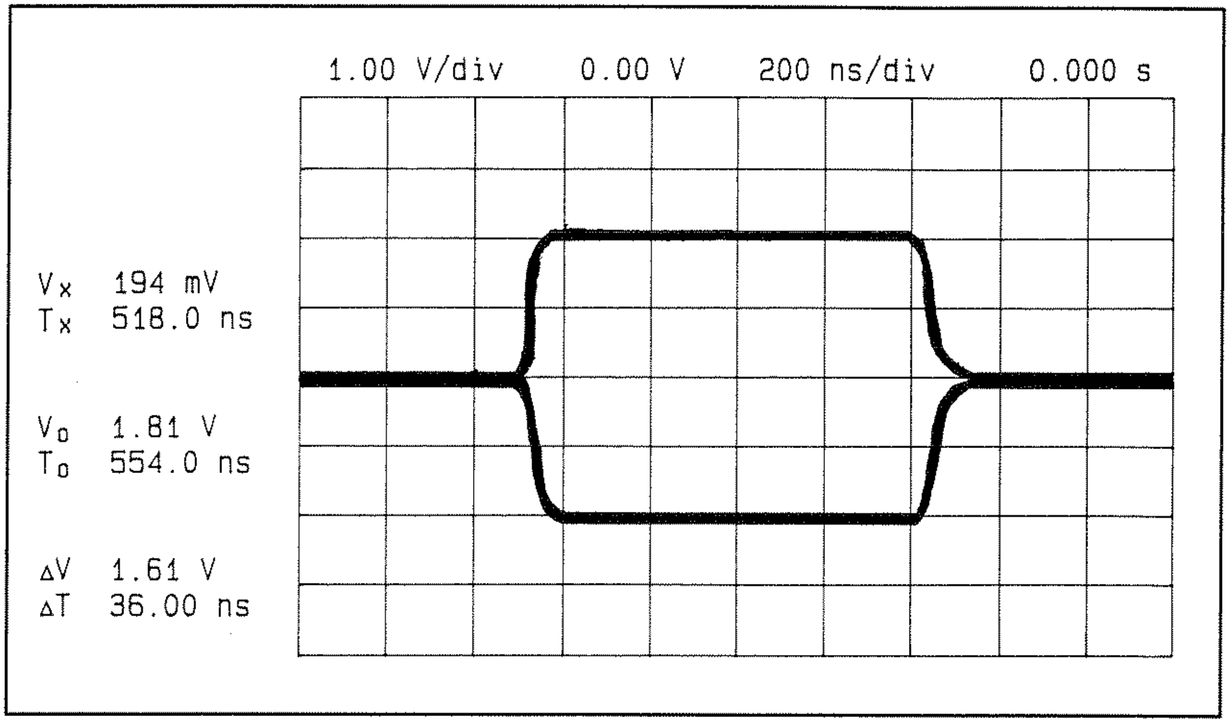


Figure 3–15. *Pulse Modulation Envelope Waveform*

Carrier Frequency (MHz)	Risetime Limits (ns)		Falltime Limits (ns)	
	Actual	Maximum	Actual	Maximum
10	________	100	________	100
20	________	100	________	100
50	________	100	________	100

Risetime (Using a Crystal Detector)

6. Connect the the crystal detector input to the Signal Generator's OUTPUT connector. Connect the feed-thru termination to the output of the detector then connect the output of the 600 Ω feed-thru to the oscilloscope's input. (Refer to figure 3-14.)
7. Set the oscilloscope to high impedance, dc coupled.
8. Set the Signal Generator's carrier frequency as indicated in the following table. For each setting, observe the 10% to 90% risetime and falltime of the RF burst relative to its steady-state value as in step 5. Notice, however, that the waveform on the oscilloscope is now the peak-detected envelope (which may be negative). The risetime and falltime should be within the limits shown in the table.

NOTE

If there is RF feedthrough from the detector, measure the envelope of it.

Carrier Frequency (MHz)	Risetime Limits (ns)		Falltime Limits (ns)	
	Actual	Maximum	Actual	Maximum
100	______	100	______	100
200	______	100	______	100
500	______	100	______	100
1000	______	100	______	100
2000 (1)	______	100	______	100
(1) Option 002				

Pulse On/Off Ratio

9. Set the Signal Generator as follows.
   a. Key in AMPTD 0 dBm.
   b. Key in FREQ 100 MHz.
10. Remove the crystal detector from the Signal Generator's OUTPUTS RF and connect the OUTPUTS RF to the spectrum analyzer's input. (The spectrum analyzer is not shown in figure 3-14.)
11. Set the pulse generator to produce a 0.5 Hz squarewave.
12. Set the spectrum analyzer as follows.
   a. Set the center frequency to 100 MHz.
   b. Set the vertical gain and the input attenuation to view the 0 dBm signal without compression.
   c. Set a span suitable for viewing the RF signal which is switching on and off at a 0.5 Hz rate.
13. Set the Signal Generator's carrier frequency and the spectrum analyzer's center frequency as indicated in the following table. For each carrier frequency, observe the change in amplitude as the Signal Generator is pulsed on and off. The amplitude should drop at least 35 dB between pulse on and pulse off (or 80 dB for 2 GHz carrier frequency, Option 002).

Carrier Frequency (MHz)	On/Off Ratio (dB)	
	Minimum	Actual
100	35	______
200	35	______
500	35	______
1000	35	______
2000 (1)	80	______
(1) Option 002		

Performance Test 8

INTERNAL AUDIO OSCILLATOR TEST

Specification

Characteristic	Performance Limits	Conditions
Internal Modulation Source		
Frequency Accuracy	±5% same as reference oscillator	except Option 007 Option 007
Distortion	<0.2% <0.2%	except Option 007 Option 007; output 1V peak; rate <15 kHz

Description

The frequency and distortion of the internal modulation source are measured directly on a distortion analyzer.

Equipment

Distortion Analyzer.................................... HP 8903B or HP 8903E

Procedure

1. Connect the input of the distortion analyzer directly to the Signal Generator's OUTPUTS AUDIO connector.
2. Set the distortion analyzer to measure distortion. Set its low-pass filter to 50 kHz or greater.
3. On the Signal Generator press INSTR PRESET. If the Signal Generator has Option 007 (Synthesized Audio Oscillator), proceed with step 5.

Fixed Audio Oscillator Test

4. On the Signal Generator, key in the audio frequency as listed in the following table. For each setting measure the audio frequency and distortion. The frequency and distortion should be within the limits indicated.

Audio Frequency Setting (Hz)	Frequency Limits (Hz)			Distortion Limits (%)	
	Minimum	Actual	Maximum	Actual	Maximum
300	285	______	315	______	0.2
400	380	______	420	______	0.2
1000	950	______	1050	______	0.2
3000	2850	______	3150	______	0.2

NOTE

This completes the test for Signal Generators without Option 007.

Synthesized Audio Oscillator (Option 007) Test

5. For Signal Generators with Option 007, key in the audio frequency as listed in the following table. For each setting measure the audio distortion. The distortion should be within the limits indicated.

Audio Frequency Setting (Hz)	Distortion Limits (%)	
	Actual	Maximum
20	______	0.2
100	______	0.2
1 000	______	0.2
10 000	______	0.2
15 000	______	0.2

Performance Test 9

AVIONICS PARAMETERS TEST (OPTION 009)

Specification

Characteristic	Performance Limits	Conditions
VOR		**108 to 118 MHz**
Bearing Accuracy	0.1 degrees	
Frequency Accuracy		Set by timebase
AM		60% AM; 30 Hz and 9960 kHz rates
Accuracy	5% of setting	
Distortion	2%	
FM Accuracy	±1.5 Hz	9960 Hz carrier; 480 Hz Deviation; 30 Hz rate
ILS: Localizer/Glideslope		**108 to 112 MHz/329.3 MHz to 335 MHz**
AM		40 and 80% AM; 90 and 150 Hz rates
Accuracy	±5% of setting	
Distortion	2%	
DDM Resolution		
Localizer	0.0002	
Glideslope	0.0004	
DDM Accuracy		
Localizer	±0.0004 5% of DDM	
Glideslope	±0.0008 5% of DDM	
Marker Beacon		**75 MHz**
AM		95% AM; 400, 1300 and 3000 Hz rates
Accuracy	±5% of setting + 1 %	
Distortion	5%	

Description

The AM accuracy and distortion are measured directly using a modulation analyzer and distortion analyzer. Bearing accuracy is verified by measuring the phase shift of AM modulation at a 10 kHz rate.

Equipment

Modulation Analyzer .... HP 8901A
Audio Analyzer .... HP 8903B
Oscilloscope .... HP 54501A
Detector .... HP 423B

Procedure

1. Connect the equipment as shown in figure 3-16.

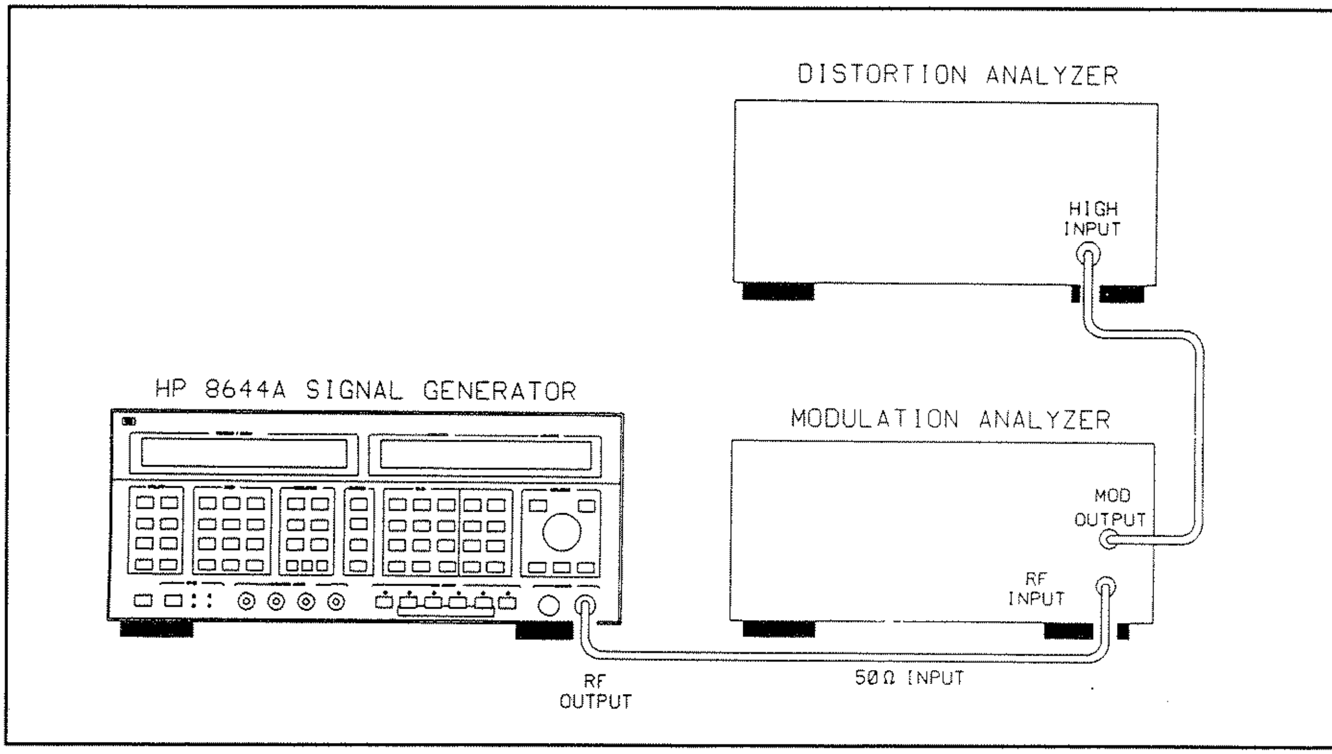


Figure 3-16. *AM Test Setup 1*

2. Press INSTR PRESET on the Signal Generator. Then set as follows:

   Carrier Frequency .... As shown in table
   Modulation AM .... As shown in table
   Modulation Audio Frequency .... As shown in table
   Amplitude (RF Level) .... As shown in table

3. Set the Modulation Analyzer to measure AM. Set the Distortion analyzer to measure distortion in percent.
4. Set the Signal Generator to the settings specified in the first 3 columns of the table. For each setting enter the AM depth and distortion measurements in the table.

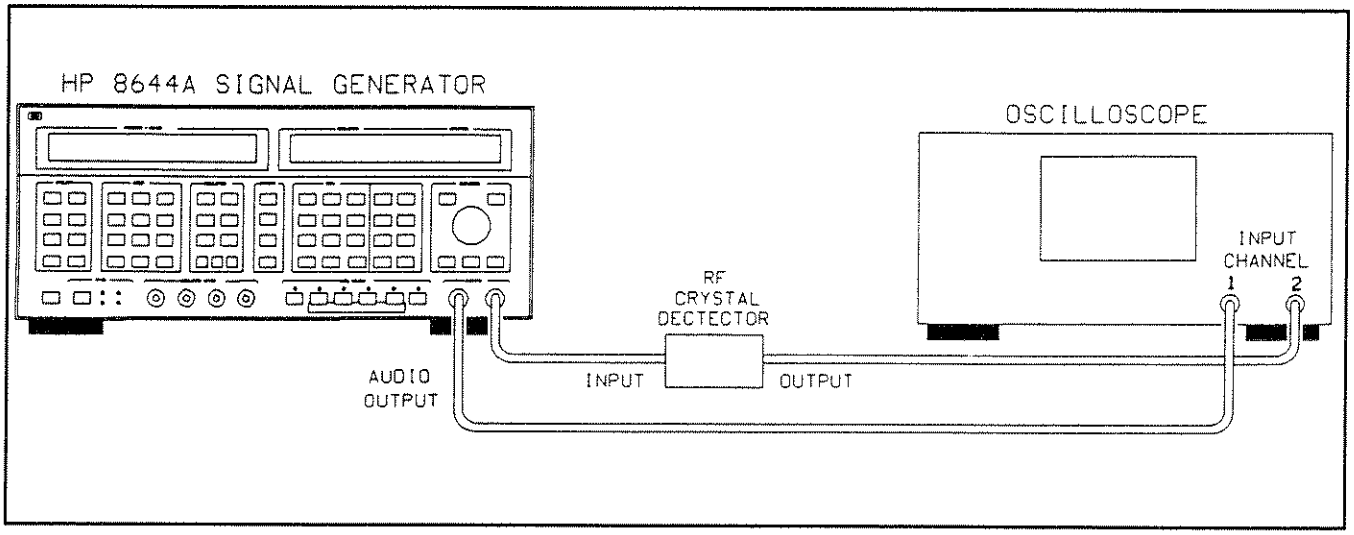


Figure 3–17. *AM Test Setup 2*

5. Connect the equipment as shown in figure 3–17.
6. Press INSTR PRESET on the Signal Generator. Then set as follows:

Carrier Freq	118.0 MHz
Modulation AM	60%
Modulation Audio Frequency	10.0 kHz
Amplitude (RF Level)	0 dBm

7. Set the oscilloscope to display both channels. Set as follows:

CHAN 1

AC coupling

2 V/div

CHAN 2

AC coupling

100 mV/div

TIMEBASE

10 uS/div

TRIGGER

Chan 1

– slope

+1.5 V level

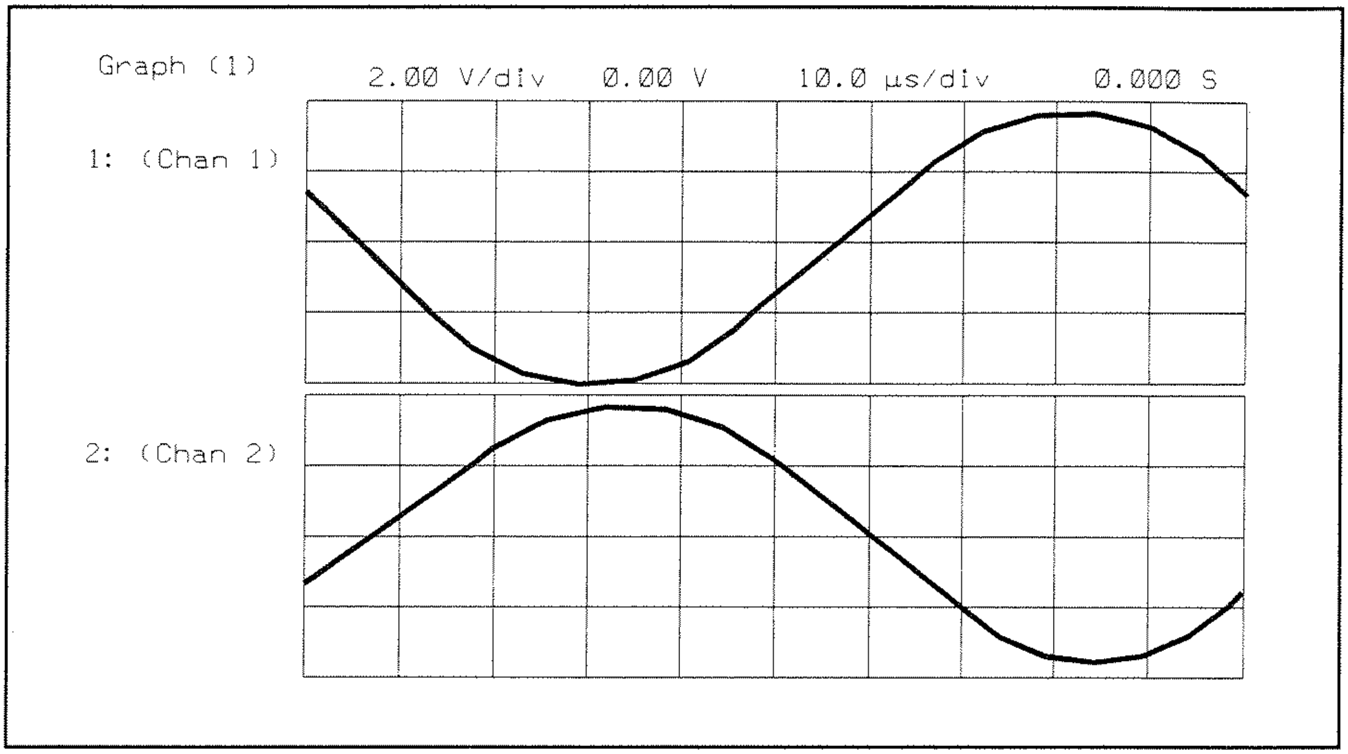


Figure 3–18. *Adjusting Channel 1 Zero Crossing*

8. Both channels should have a sine wave displayed as shown in figure 3–18. Adjust the trigger level so the zero crossing on channel 1 is approximately in the center of the division on the left edge of the display.
9. Change the oscilloscope timebase to 1 μs/div.
10. Decrease the vertical scale (smaller V/div) until the trace has a steep slope as it passes through the zero level. 100 mV/div is about right for channel 1. The top and bottom of the waveform will be off the screen. We are only concerned with the waveform as it passes through zero. Do this on both channels. Figure 3–19 shows how these waveforms should look. Changing the oscilloscope trigger level will move the waveforms to the right or left.

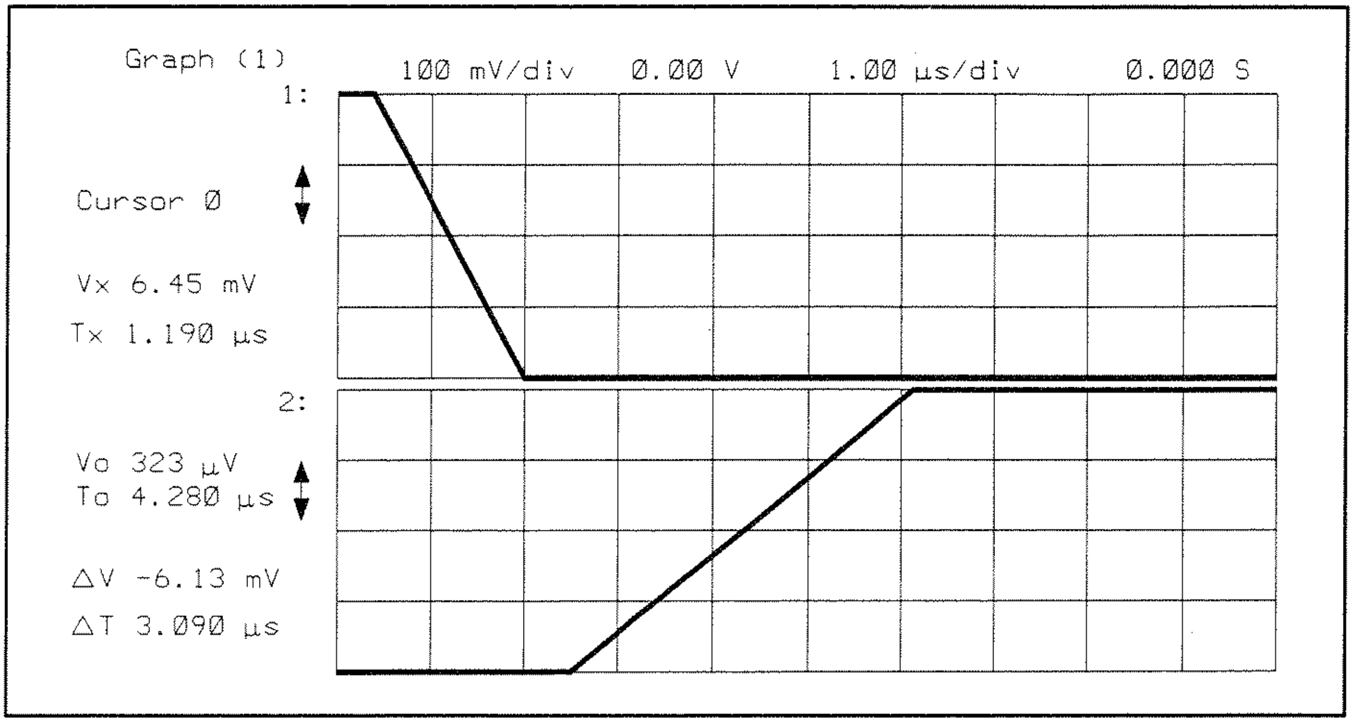


Figure 3–19. *Time Difference at Zero Crossing*

11. The time between the zero crossing on channel 1 and the zero crossing on channel 2 is the phase shift caused by the AM on the Signal Generator. Measure this time using the oscilloscope markers if available.

12. The upper limit is 15 °. This corresponds to 4.17 µs for a 100.0 kHz sine wave (100 µs period).

Bearing Accuracy Limit: ________ 4.17 µs

Signal Generator Setting			AM Depth Limits (%)			AM Distortion Limits (%)	
Carrier Frequency	Depth AM %	Audio Frequency (Hz)	Minimum	Actual	Maximum	Actual	Maximum
118 MHz	60	30	57	________	63	________	2
		9960	57	________	63	________	2
112 MHz	40	90	38	________	42	________	2
		150	38	________	42	________	2
	80	90	76	________	84	________	2
		150	76	________	84	________	2
334 MHz	40	90	38	________	42	________	2
		150	38	________	42	________	2
	80	90	76	________	84	________	2
		150	76	________	84	________	2
75 MHz	95	400	89.25	________	100.75	________	5
		1300	89.25	________	100.75	________	5
		3000	89.25	________	100.75	________	5

Performance Test 10

OPTION 010 LEAKAGE TEST

Specification

2 μV measured into a resonant dipole 1 inch from the instrument's surface (except rear panel) with output level < 0 dBm and all inputs/outputs properly terminated.

Description

Leakage is measured using a resonate dipole. The output of the antenna is amplified by an RF amplifier and measured on a spectrum analyzer. The calibrated output of the signal generator under test is used to calibrate the amplifier/spectrum analyzer combination.

Equipment

Spectrum Analyzer .... HP 8560A
RF Amplifier .... HP 8447E
Antenna .... HP 8644A/K03
Type N 50 ohm load .... HP 908A
BNC 50 ohm load .... HP 1250-0207

Procedure

Set-Up and Calibration

1. Press the INSTR PRESET key of the signal generator. Then set as follows:

   Frequency .... 1029.1 MHz
   Amplitude .... 2.0 μV

2. Connect the RF Output of the signal generator to the input of the RF Amplifier. Connect the output of the RF Amplifier to the input of the spectrum analyzer.
3. Set the spectrum analyzer center frequency to 1029.1 MHz and input attenuation to 0dB. Set the span so the signal is at least 20 dB above the noise level and the sweep speed is 400 mSec or faster. Try a 100 kHz span as a starting point. Change the reference level so the signal peak in at mid screen. If the spectrum analyzer has display line capability, set a line at the signal peak. This line on the spectrum analyzer display represents a 2 μV signal level from the antenna. All leakage picked up by the antenna must be below this level.
4. Disconnect the cable from the RF Output connector of the signal generator, and connect it to the antenna. Put 50 ohm loads on the RF OUTPUT and all the front panel and rear panel BNC connectors of the signal generator. Set the signal generator RF amplitude to −0.1 dBm.

Measurement

Frequency (MHz)	Length Antenna Element	Max Leakage (dB)[1]
1029.1	5.9 cm (2.30 in)	______
975.1	6.1 cm (2.40 in)	______
925.1	6.5 cm (2.56 in)	______
875.1	7.0 cm (2.74 in)	______
825.1	7.5 cm (2.95 in)	______
775.1	8.1 cm (3.18 in)	______
725.1	8.7 cm (3.44 in)	______
454.1	14.9 cm (5.87 in)	______

[1] Upper limit is 0 dB.

5. For each frequency in the above table do the following:
- Set the signal generator carrier frequency and the spectrum analyzer center frequency to the frequency in the table.
- Set the antenna elements length to the value given in the table. Measure from the outside of the center hub to the tip of the dipole.
- Move the antenna over all the surfaces (except the rear panel) of the signal generator keeping the spacers in contact with the covers. This keeps the actual antenna elements 1 inch away from the surface. Do not allow the antenna elements to get closer than 1 inch to the RF Output connector or any of the front panel BNC connectors.
- Move the antenna slowly. The antenna should move less than one inch per spectrum analyzer sweep cycle.
- Monitor the signal level displayed on the spectrum analyzer. The signal level must stay below the reference line set above for the test to pass. For each frequency note the maximum signal level in relation to the reference line. Write this value in the table. For example if the highest signal level was 5 dB below the reference, enter - 5.0 in the table.

6. To measure leakage at other frequencies use the formula below to determine antenna element length and follow the procedure in step 5.

$$\ell = \frac{7500}{f} - 1.6$$

Where:

ℓ = antenna element length in centimeters
f = frequency in MHz.

Table 3–2. Performance Test Record (1 of 13)

Hewlett-Packard Company
HP 8644A
Synthesized Signal Generator

Tested By ____________________

Serial Number ____________________ **Date** ____________________

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
1	**CARRIER AMPLITUDE PERFORMANCE TEST**			
	Maximum Level			
	Frequency and Amplitude Settings–Standard			
	0.26 MHz; +17 dBm	+16 dBm	______	
	1 MHz; +17 dBm	+16 dBm	______	
	10 MHz; +17 dBm	+16 dBm	______	
	100 MHz; +17 dBm	+16 dBm	______	
	1030 MHz; +17 dBm	+16 dBm	______	
	Frequency and Amplitude Settings–Option 002			
	0.26 MHz; +15 dBm	+14 dBm	______	
	1 MHz; +15 dBm	+14 dBm	______	
	10 MHz; +15 dBm	+14 dBm	______	
	100 MHz; +15 dBm	+14 dBm	______	
	1030 MHz; +15 dBm	+14 dBm	______	
	2060 MHz; +14 dBm	+13 dBm	______	
	Frequency and Amplitude Settings–Option 005			
	0.26 MHz; +14 dBm	+13 dBm	______	
	1 MHz; +14 dBm	+13 dBm	______	
	10 MHz; +14 dBm	+13 dBm	______	
	100 MHz; +14 dBm	+13 dBm	______	
	1030 MHz; +14 dBm	+13 dBm	______	
	High-Amplitude Accuracy			
	Frequency and Amplitude Settings			
	1000 MHz; +6 dBm	+5 dBm	______	+7 dBm
	1000 MHz; +7 dBm	+6 dBm	______	+8 dBm
	1000 MHz; +8 dBm	+7 dBm	______	+9 dBm
	1000 MHz; +9 dBm	+8 dBm	______	+10 dBm
	1000 MHz; +10 dBm	+9 dBm	______	+11 dBm
	1000 MHz; +11 dBm	+10 dBm	______	+12 dBm
	1000 MHz; +12 dBm	+11 dBm	______	+13 dBm
	1000 MHz; +13 dBm	+12 dBm	______	+14 dBm

Table 3–2. Performance Test Record (2 of 13)

Test No.	Test Description	Results Minimum	Actual	Maximum
1	**CARRIER AMPLITUDE PERFORMANCE TEST (Continued)**			
	High-Amplitude Accuracy (continued)			
	Frequency and Amplitude Settings			
	1000 MHz; +14 dBm (except Option 005)	+13 dBm	______	+15 dBm
	1000 MHz; +15 dBm (except Options 002 and 005)	+14 dBm	______	+16 dBm
	1000 MHz; +16 dBm (except Options 002 and 005)	+13 dBm	______	+17 dBm
	0.26 MHz; +16 dBm (except Options 002 and 005)	+15 dBm	______	+17 dBm
	1 MHz; +16 dBm (except Options 002 and 005)	+15 dBm	______	+17 dBm
	10 MHz; +16 dBm (except Options 002 and 005)	+15 dBm	______	+17 dBm
	100 MHz; +16 dBm (except Options 002 and 005)	+15 dBm	______	+17 dBm
	100 MHz; +14 dBm (except Option 005)	+13 dBm	______	+15 dBm
	10 MHz; +14 dBm (except Option 005)	+13 dBm	______	+15 dBm
	1 MHz; +14 dBm (except Option 005)	+13 dBm	______	+15 dBm
	0.26 MHz; +14 dBm (except Option 005)	+13 dBm	______	+15 dBm
	0.26 MHz; +13 dBm	+12 dBm	______	+14 dBm
	1 MHz; +13 dBm	+12 dBm	______	+14 dBm
	10 MHz; +13 dBm	+12 dBm	______	+14 dBm
	100 MHz; +13 dBm	+12 dBm	______	+14 dBm
	2060 MHz; +13 dBm (Option 002)	+12 dBm	______	+14 dBm
	2060 MHz; +10 dBm (Option 002)	+9 dBm	______	+11 dBm
	100 MHz; +10 dBm	+9 dBm	______	+11 dBm
	10 MHz; +10 dBm	+9 dBm	______	+11 dBm
	1 MHz; +10 dBm	+9 dBm	______	+11 dBm
	0.26 MHz; +10 dBm	+9 dBm	______	+11 dBm
	0.26 MHz; +5 dBm	+4 dBm	______	+6 dBm
	1 MHz; +5 dBm	+4 dBm	______	+6 dBm
	10 MHz; +5 dBm	+4 dBm	______	+6 dBm
	100 MHz; +5 dBm	+4 dBm	______	+6 dBm
	1000 MHz; +5 dBm	+4 dBm	______	+6 dBm
	2060 MHz; +5 dBm (Option 002)	+4 dBm	______	+6 dBm
	2060 MHz; +0 dBm (Option 002)	−1 dBm	______	+1 dBm
	1000 MHz; +0 dBm	−1 dBm	______	+1 dBm
	100 MHz; +0 dBm	−1 dBm	______	+1 dBm
	10 MHz; +0 dBm	−1 dBm	______	+1 dBm
	1 MHz; +0 dBm	−1 dBm	______	+1 dBm
	0.26 MHz; +0 dBm	−1 dBm	______	+1 dBm

Table 3-2. Performance Test Record (3 of 13)

Test No.	Test Description	Results Minimum	Results Actual	Results Maximum
1	**CARRIER AMPLITUDE PERFORMANCE TEST (Continued)**			
	Low-Amplitude Accuracy			
	Amplitude Setting			
	−5 dBm	−6 dBm	______	−4 dBm
	−10 dBm	−11 dBm	______	−9 dBm
	−15 dBm	−16 dBm	______	−14 dBm
	−20 dBm	−21 dBm	______	−19 dBm
	−25 dBm	−26 dBm	______	−24 dBm
	−30 dBm	−31 dBm	______	−29 dBm
	−35 dBm	−36 dBm	______	−34 dBm
	−40 dBm	−41 dBm	______	−39 dBm
	−45 dBm	−46 dBm	______	−44 dBm
	−50 dBm	−51 dBm	______	−49 dBm
	−55 dBm	−56 dBm	______	−54 dBm
	−60 dBm	−61 dBm	______	−59 dBm
	−65 dBm	−66 dBm	______	−64 dBm
	−70 dBm	−71 dBm	______	−69 dBm
	−75 dBm	−76 dBm	______	−74 dBm
	−80 dBm	−81 dBm	______	−79 dBm
	−85 dBm	−86 dBm	______	−84 dBm
	−90 dBm	−91 dBm	______	−89 dBm
	−95 dBm	−96 dBm	______	−94 dBm
	−100 dBm	−101 dBm	______	−99 dBm
	−105 dBm	−106 dBm	______	−104 dBm
	−110 dBm	−111 dBm	______	−109 dBm
	−115 dBm	−116 dBm	______	−114 dBm
	−120 dBm	−121 dBm	______	−119 dBm
	−127 dBm	−128 dBm	______	−126 dBm
2	**AM TEST**			
	Residual AM			
	Frequency and Amplitude Settings			
	1000 MHz; +13 dBm		______	0.01%
	1000 MHz; +6 dBm		______	0.01%
	1300 MHz; +6 dBm (Option 002)		______	0.01%
	1300 MHz; +15 dBm (Option 002)		______	0.01%

Table 3-2. Performance Test Record (4 of 13)

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
2	**AM TEST (Continued)**			
	Indicator Accuracy			
	AM Depth Setting; standard attenuator			
	30%	26.9%	______	33.1%
	Distortion			
	Carrier Frequency and AM Depth Settings and Option			
	1 GHz; 90%; not Option 002		______	5%
	1 GHz; 70%; not Option 002		______	3%
	1 GHz; 30%; not Option 002		______	2%
	1 GHz; 90%; Option 002		______	8%
	1 GHz; 70%; Option 002		______	5%
	1 GHz; 30%; Option 002		______	5%
	1.3 GHz; 70%; Option 002		______	5%
	1.3 GHz; 90%; Option 002		______	8%
	Incidental Phase Modulation		______	0.2 rad pk
	3 dB Bandwidth			
	Carrier Frequency and AM Rate Settings			
	0.26 MHz; 5 kHz	−3 dB	______	+3 dB
	11 MHz; 50 kHz	−3 dB	______	+3 dB
	129 MHz; 100 kHz	−3 dB	______	+3 dB
	1020 MHz; 100 kHz	−3 dB	______	+3 dB
	1300 MHz; 100 kHz (Option 002)	−3 dB	______	+3 dB

Table 3-2. Performance Test Record (5 of 13)

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
3	**FM TEST (LOW DEVIATIONS AND RATES)**			
	Residual FM			
	Frequency and Bandwidth Settings (Synthesis Mode 2)			
	1000 MHz; 0.3 to 3 kHz		________	2 Hz rms
	1000 MHz; 0.05 to 15 kHz		________	4 Hz rms
	1300 MHz (Option 002); 0.05 to 15 kHz		________	8 Hz rms
	1300 MHz (Option 002); 0.3 to 3 kHz		________	4 Hz rms
	Frequency and Bandwidth Settings (Synthesis Mode 3, Option 004)			
	1300 MHz (Option 002); 0.3 to 3 kHz		________	2 Hz rms
	1300 MHz (Option 002); 0.05 to 15 kHz		________	4 Hz rms
	1000 MHz; 0.05 to 15 kHz		________	2 Hz rms
	1000 MHz; 0.3 to 3 kHz		________	1 Hz rms
	Indicator Accuracy			
	Frequency, Synthesis Mode, FM Rate, and FM Deviation Settings			
	514 MHz; Mode 2; 40 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	514 MHz; Mode 2; 50 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	514 MHz; Mode 2; 60 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	514 MHz; Mode 2; 70 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	514 MHz; Mode 2; 80 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	514 MHz; Mode 2; 90 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	514 MHz; Mode 2; 100 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	514 MHz; Mode 3 (Option 004); 100 kHz; 50 kHz pk	42.5 kHz pk	________	57.5 kHz pk
	258 MHz; Mode 3 (Option 004); 100 kHz; 50 kHz pk	42.5 kHz pk	________	57.5 kHz pk
	258 MHz; Mode 2; 100 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	364.1 MHz; Mode 2; 100 kHz; 360 kHz pk	324 kHz pk	________	396 kHz pk
	257 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	257 MHz; Mode 2; 100 kHz; 250 kHz pk	225 kHz pk	________	275 kHz pk
	257 MHz; Mode 3 (Option 004); 100 kHz; 25 kHz pk	21.25 kHz pk	________	28.75 kHz pk

Table 3-2. Performance Test Record (6 of 13)

Test No.	Test Description	Results Minimum	Results Actual	Results Maximum
3	**FM TEST (LOW DEVIATIONS AND RATES) (Continued)**			
	Indicator Accuracy (Continued)			
	Frequency, Synthesis Mode, FM Rate, and FM Deviation Settings			
	129 MHz; Mode 3 (Option 004); 100 kHz; 25 kHz pk	21.25 kHz pk	________	28.75 kHz pk
	129 MHz; Mode 2; 100 kHz; 250 kHz pk	225 kHz pk	________	275 kHz pk
	129 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	182 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	128 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	128 MHz; Mode 2; 100 kHz; 125 kHz pk	112.5 kHz pk	________	137.5 kHz pk
	128 MHz; Mode 3 (Option 004); 100 kHz; 12.5 kHz pk	10.62 kHz pk	________	14.4 kHz pk
	65 MHz; Mode 3 (Option 004); 100 kHz; 12.5 kHz pk	10.62 kHz pk	________	14.4 kHz pk
	65 MHz; Mode 2; 100 kHz; 125 kHz pk	112.5 kHz pk	________	137.5 kHz pk
	65 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	91.03 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	64 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	64 MHz; Mode 2; 100 kHz; 62.5 kHz pk	56.3 kHz pk	________	68.7 kHz pk
	64 MHz; Mode 3 (Option 004); 100 kHz; 6.25 kHz pk	5.31 kHz pk	________	7.19 kHz pk
	33 MHz; Mode 3 (Option 004); 100 kHz; 6.25 kHz pk	5.31 kHz pk	________	7.19 kHz pk
	33 MHz; Mode 2; 100 kHz; 62.5 kHz pk	56.3 kHz pk	________	68.7 kHz pk
	33 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	45.51 MHz; Mode 1; 100 kHz; 330 kHz pk	264 kHz pk	________	396 kHz pk
	32 MHz; Mode 1; 100 kHz; 312 kHz pk	250 kHz pk	________	374 kHz pk
	32 MHz; Mode 2; 100 kHz; 31.2 kHz pk	28.1 kHz pk	________	34.3 kHz pk
	32 MHz; Mode 3 (Option 004); 100 kHz; 3.12 kHz pk	2.65 kHz pk	________	3.59 kHz pk
	17 MHz; Mode 3 (Option 004); 100 kHz; 3.12 kHz pk	2.65 kHz pk	________	3.59 kHz pk
	17 MHz; Mode 2; 100 kHz; 31.2 kHz pk	28.1 kHz pk	________	34.3 kHz pk
	17 MHz; Mode 1; 100 kHz; 312 kHz pk	250 kHz pk	________	374 kHz pk
	22.75 MHz; Mode 1; 100 kHz; 312 kHz pk	250 kHz pk	________	374 kHz pk
	16 MHz; Mode 1; 100 kHz; 156 kHz pk	124.8 kHz pk	________	187.2 kHz pk
	16 MHz; Mode 2; 100 kHz; 15.6 kHz pk	14.04 kHz pk	________	17.16 kHz pk
	16 MHz; Mode 3 (Option 004); 100 kHz; 1.56 kHz pk	1.32 kHz pk	________	1.80 kHz pk
	11.37 MHz; Mode 1; 100 kHz; 156 kHz pk	124.8 kHz pk	________	187.2 kHz pk

Table 3–2. Performance Test Record (7 of 13)

Test No.	Test Description	Results: Minimum	Results: Actual	Results: Maximum
3	**FM TEST (LOW DEVIATIONS AND RATES) (Continued)**			
	Indicator Accuracy (Continued)			
	Frequency, Synthesis Mode, FM Rate, and FM Deviation Settings			
	514 MHz; Mode 2; 30 kHz; 380 kHz pk	361 kHz pk	________	399 kHz pk
	514 MHz; Mode 3 (Option 004); 30 kHz; 50 kHz pk	47.0 kHz pk	________	53.0 kHz pk
	258 MHz; Mode 3 (Option 004); 30 kHz; 50 kHz pk	47.0 kHz pk	________	53.0 kHz pk
	258 MHz; Mode 2; 30 kHz; 380 kHz pk	361 kHz pk	________	399 kHz pk
	257 MHz; Mode 1; 30 kHz; 350 kHz pk	308 kHz pk	________	392 kHz pk
	257 MHz; Mode 2; 30 kHz; 250 kHz pk	238 kHz pk	________	262 kHz pk
	257 MHz; Mode 3 (Option 004); 30 kHz; 25 kHz pk	23.5 kHz pk	________	26.5 kHz pk
	129 MHz; Mode 3 (Option 004); 30 kHz; 25 kHz pk	23.5 kHz pk	________	26.5 kHz pk
	129 MHz; Mode 2; 30 kHz; 250 kHz pk	238 kHz pk	________	262 kHz pk
	129 MHz; Mode 1; 30 kHz; 350 kHz pk	308 kHz pk	________	392 kHz pk
	128 MHz; Mode 1; 30 kHz; 350 kHz pk	308 kHz pk	________	392 kHz pk
	128 MHz; Mode 2; 30 kHz; 125 kHz pk	118.8 kHz pk	________	131.2 kHz pk
	128 MHz; Mode 3 (Option 004); 30 kHz; 12.5 kHz pk	11.75 kHz pk	________	13.25 kHz pk
	65 MHz; Mode 3 (Option 004); 30 kHz; 12.5 kHz pk	11.75 kHz pk	________	13.25 kHz pk
	65 MHz; Mode 2; 30 kHz; 125 kHz pk	118.8 kHz pk	________	131.2 kHz pk
	65 MHz; Mode 1; 30 kHz; 350 kHz pk	308 kHz pk	________	392 kHz pk
	64 MHz; Mode 1; 30 kHz; 350 kHz pk	308 kHz pk	________	392 kHz pk
	64 MHz; Mode 2; 30 kHz; 62.5 kHz pk	56.3 kHz pk	________	68.7 kHz pk
	64 MHz; Mode 3 (Option 004); 30 kHz; 6.25 kHz pk	5.93 kHz pk	________	6.57 kHz pk
	33 MHz; Mode 3 (Option 004); 30 kHz; 6.25 kHz pk	5.93 kHz pk	________	6.57 kHz pk
	33 MHz; Mode 2; 30 kHz; 62.5 kHz pk	56.3 kHz pk	________	68.7 kHz pk
	33 MHz; Mode 1; 30 kHz; 350 kHz pk	308 kHz pk	________	392 kHz pk
	32 MHz; Mode 1; 30 kHz; 312 kHz pk	275 kHz pk	________	349 kHz pk
	32 MHz; Mode 2; 30 kHz; 31.2 kHz pk	29.7 kHz pk	________	32.7 kHz pk
	32 MHz; Mode 3 (Option 004); 30 kHz; 3.12 kHz pk	2.93 kHz pk	________	3.31 kHz pk
	17 MHz; Mode 3 (Option 004); 30 kHz; 3.12 kHz pk	2.93 kHz pk	________	3.31 kHz pk
	17 MHz; Mode 2; 30 kHz; 31.2 kHz pk	29.7 kHz pk	________	32.7 kHz pk
	17 MHz; Mode 1; 30 kHz; 312 kHz pk	275 kHz pk	________	349 kHz pk
	16 MHz; Mode 1; 30 kHz; 156 kHz pk	137.3 kHz pk	________	174.7 kHz pk
	16 MHz; Mode 2; 30 kHz; 15.6 kHz pk	14.82 kHz pk	________	16.38 kHz pk
	16 MHz; Mode 3 (Option 004); 30 kHz; 1.56 kHz pk	1.46 kHz pk	________	1.66 kHz pk

Table 3-2. Performance Test Record (8 of 13)

Test No.	Test Description	Results Minimum	Actual	Maximum
3	**FM TEST (LOW DEVIATIONS AND RATES) (Continued)**			
	Indicator Accuracy (Continued)			
	Frequency, Synthesis Mode, FM Rate, and FM Deviation Settings			
	8.1 MHz; Mode 3 (Option 004); 10 kHz; 1.56 kHz pk	1.46 kHz pk	______	1.66 kHz pk
	8.1 MHz; Mode 2; 10 kHz; 15.6 kHz pk	14.82 kHz pk	______	16.38 kHz pk
	8.1 MHz; Mode 1; 10 kHz; 35 kHz pk	30.8 kHz pk	______	39.2 kHz pk
	8 MHz; Mode 1; 10 kHz; 35 kHz pk	30.8 kHz pk	______	39.2 kHz pk
	8 MHz; Mode 2; 10 kHz; 7.8 kHz pk	7.41 kHz pk	______	8.19 kHz pk
	8 MHz; Mode 3 (Option 004); 10 kHz; 0.78 kHz pk	0.73 kHz pk	______	0.83 kHz pk
	4.1 MHz; Mode 3 (Option 004); 10 kHz; 0.78 kHz pk	0.73 kHz pk	______	0.83 kHz pk
	4.1 MHz; Mode 2; 10 kHz; 7.8 kHz pk	7.41 kHz pk	______	8.19 kHz pk
	4.1 MHz; Mode 1; 10 kHz; 35 kHz pk	30.8 kHz pk	______	39.2 kHz pk
	5.689 MHz; Mode 1; 10 kHz; 35 kHz pk	30.8 kHz pk	______	39.2 kHz pk
	4 MHz; Mode 1; 10 kHz; 35 kHz pk	30.8 kHz pk	______	39.2 kHz pk
	4 MHz; Mode 2; 10 kHz; 3.9 kHz pk	3.71 kHz pk	______	4.09 kHz pk
	4 MHz; Mode 3 (Option 004); 10 kHz; 0.39 kHz pk	0.36 kHz pk	______	0.42 kHz pk
	2.1 MHz; Mode 3 (Option 004); 10 kHz; 0.39 kHz pk	0.36 kHz pk	______	0.42 kHz pk
	2.1 MHz; Mode 2; 10 kHz; 3.9 kHz pk	3.71 kHz pk	______	4.09 kHz pk
	2.1 MHz; Mode 1; 10 kHz; 35 kHz pk	30.8 kHz pk	______	39.2 kHz pk
	2.844 MHz; Mode 1; 10 kHz; 35 kHz pk	30.8 kHz pk	______	39.2 kHz pk
	2 MHz; Mode 1; 10 kHz; 19.5 kHz pk	17.2 kHz pk	______	21.8 kHz pk
	2 MHz; Mode 2; 10 kHz; 1.95 kHz pk	1.86 kHz pk	______	2.04 kHz pk
	2 MHz; Mode 3 (Option 004); 10 kHz; 0.195 kHz pk	0.18 kHz pk	______	0.21 kHz pk
	1.1 MHz; Mode 3 (Option 004); 10 kHz; 0.195 kHz pk	0.18 kHz pk	______	0.21 kHz pk
	1.1 MHz; Mode 2; 10 kHz; 1.95 kHz pk	1.86 kHz pk	______	2.04 kHz pk
	1.1 MHz; Mode 1; 10 kHz; 19.5 kHz pk	17.2 kHz pk	______	21.8 kHz pk
	1.422 MHz; Mode 1; 10 kHz; 19.5 kHz pk	17.2 kHz pk	______	21.8 kHz pk
	1 MHz; Mode 1; 9.7 kHz; 9.7 kHz pk	8.54 kHz pk	______	10.86 kHz pk
	1 MHz; Mode 2; 9.7 kHz; 0.97 kHz pk	0.922 kHz pk	______	1.018 kHz pk
	0.51 MHz; Mode 2; 9.7 kHz; 0.97 kHz pk	0.922 kHz pk	______	1.018 kHz pk
	0.51 MHz; Mode 1; 9.7 kHz; 9.7 kHz pk	8.54 kHz pk	______	10.86 kHz pk

Table 3-2. Performance Test Record (9 of 13)

Test No.	Test Description	Results Minimum	Results Actual	Results Maximum
3	**FM TEST (LOW DEVIATIONS AND RATES) (Continued)**			
	Indicator Accuracy (Continued)			
	Frequency, Synthesis Mode, FM Rate, and FM Deviation Settings			
	0.711 MHz; Mode 1; 9.7 kHz; 9.7 kHz pk	8.54 kHz pk	_______	10.86 kHz pk
	0.5 MHz; Mode 1; 4.8 kHz; 4.8 kHz pk	4.23 kHz pk	_______	5.37 kHz pk
	0.5 MHz; Mode 2; 4.8 kHz; 0.48 kHz pk	0.456 kHz pk	_______	0.504 kHz pk
	0.26 MHz; Mode 2; 4.8 kHz; 0.48 kHz pk	0.456 kHz pk	_______	0.504 kHz pk
	0.26 MHz; Mode 1; 4.8 kHz; 4.8 kHz pk	4.23 kHz pk	_______	5.37 kHz pk
	0.355 MHz; Mode 1; 4.8 kHz; 4.8 kHz pk	4.23 kHz pk	_______	5.37 kHz pk
	1 MHz; Mode 3 (Option 004); 1.0 kHz; 0.097 kHz pk	0.091 kHz pk	_______	0.103 kHz pk
	0.51 MHz; Mode 3 (Option 004); 1.0 kHz; 0.097 kHz pk	0.091 kHz pk	_______	0.103 kHz pk
	0.5 MHz; Mode 3 (Option 004); 1.0 kHz; 0.048 kHz pk	0.045 kHz pk	_______	0.051 kHz pk
	0.26 MHz; Mode 3 (Option 004); 1.0 kHz; 0.048 kHz pk	0.045 kHz pk	_______	0.051 kHz pk
	Distortion			
	Frequency, Synthesis Mode, and FM Deviation Settings			
	257 MHz, Mode 3 (Option 004), 25 kHz pk		_______	1%
	257 MHz, Mode 2, 125 kHz pk		_______	3%
	257 MHz, Mode 2, 250 kHz pk		_______	5%
	182 MHz, Mode 2, 250 kHz pk		_______	5%
	129 MHz, Mode 2, 250 kHz pk		_______	5%
	129 MHz, Mode 2, 125 kHz pk		_______	3%
	129 MHz, Mode 3 (Option 004), 25 kHz pk		_______	1%
	Incidental AM		_______	0.5%
	Carrier Frequency Accuracy in FM			
	Frequency and FM Deviation Settings			
	10 MHz; 0.15 MHz pk		_______	0.75 kHz
	20 MHz; 0.3 MHz pk		_______	1.5 kHz
	50 MHz; 0.625 MHz pk		_______	3.12 kHz
	100 MHz; 1.25 MHz pk		_______	6.25 kHz
	200 MHz; 2.5 MHz pk		_______	12.5 kHz
	500 MHz; 5 MHz pk		_______	25 kHz
	1000 MHz; 10 MHz pk		_______	50 kHz

Table 3–2. Performance Test Record (10 of 13)

Test No.	Test Description	Results Minimum	Results Actual	Results Maximum
4	**FM TEST (HIGH DEVIATIONS AND RATES)**			
	Indicator Accuracy			
	Synthesis Mode, FM Rate, and FM Deviation Settings			
	Mode 1; 100 kHz; 5000 kHz pk	20.9 dB	________	24.4 dB
	Mode 2; 100 kHz; 500 kHz pk	1.9 dB	________	3.7 dB
	Mode 2; 30 kHz; 500 kHz pk	2.4 dB	________	3.3 dB
	Mode 1; 30 kHz; 5000 kHz pk	21.7 dB	________	23.8 dB
	Distortion			
	Synthesis Mode and FM Deviation Settings			
	Mode 1; 5000 kHz pk		________	−26.0 dB
	Mode 1; 500 kHz pk		________	−26.0 dB
	Mode 2; 500 kHz pk		________	−26.0 dB
	Mode 2; 250 kHz pk		________	−30.5 dB
	Mode 2; 50 kHz pk		________	−30.5 dB
	Mode 3 (Option 004); 50 kHz pk		________	−40.0 dB
5	**SPECTRAL PURITY TEST (SSB PHASE NOISE)**			
	SSB Phase Noise			
	Frequency and Synthesis Mode Settings and Offset			
	1100 MHz (Option 002); Mode 2; 1 kHz		________	−81 dBc
	1100 MHz (Option 002); Mode 2; 20 kHz		________	−121 dBc
	1100 MHz (Option 002); Mode 2; 100 kHz		________	−131 dBc
	1100 MHz (Option 002); Mode 3 (Option 004); 1 kHz		________	−94 dBc
	1100 MHz (Option 002); Mode 3 (Option 004); 20 kHz		________	−130 dBc
	1100 MHz (Option 002); Mode 3 (Option 004); 100 kHz		________	−136 dBc
	550 MHz; Mode 3 (Option 004); 1 kHz		________	−100 dBc
	550 MHz; Mode 3 (Option 004); 20 kHz		________	−136 dBc
	550 MHz; Mode 3 (Option 004); 100 kHz		________	−142 dBc
	550 MHz; Mode 2; 1 kHz		________	−88 dBc
	550 MHz; Mode 2; 20 kHz		________	−128 dBc
	550 MHz; Mode 2; 100 kHz		________	−138 dBc
	300 MHz; Mode 2; 1 kHz		________	−93 dBc
	300 MHz; Mode 2; 20 kHz		________	−134 dBc
	300 MHz; Mode 2; 100 kHz		________	−141 dBc
	300 MHz; Mode 3 (Option 004); 1 kHz		________	−106 dBc
	300 MHz; Mode 3 (Option 004); 20 kHz		________	−142 dBc
	300 MHz; Mode 3 (Option 004); 100 kHz		________	−145 dBc

Table 3–2. Performance Test Record (11 of 13)

Test No.	Test Description	Results: Minimum	Actual	Maximum
5	**SPECTRAL PURITY TEST (SSB PHASE NOISE) (Continued)**			
	SSB Phase Noise (Continued)			
	Frequency and Synthesis Mode Settings and Offset			
	150 MHz; Mode 3 (Option 004); 1 kHz		________	–111 dBc
	150 MHz; Mode 3 (Option 004); 20 kHz		________	–145 dBc
	150 MHz; Mode 3 (Option 004); 100 kHz		________	–145 dBc
	150 MHz; Mode 2; 1 kHz		________	–98 dBc
	150 MHz; Mode 2; 20 kHz		________	–138 dBc
	150 MHz; Mode 2; 100 kHz		________	–142 dBc
	80 MHz; Mode 2; 1 kHz		________	–103 dBc
	80 MHz; Mode 2; 20 kHz		________	–140 dBc
	80 MHz; Mode 2; 100 kHz		________	–144 dBc
	80 MHz; Mode 3 (Option 004); 1 kHz		________	–116 dBc
	80 MHz; Mode 3 (Option 004); 20 kHz		________	–145 dBc
	80 MHz; Mode 3 (Option 004); 100 kHz		________	–145 dBc
	40 MHz; Mode 3 (Option 004); 1 kHz		________	–121 dBc
	40 MHz; Mode 3 (Option 004); 20 kHz		________	–145 dBc
	40 MHz; Mode 3 (Option 004); 100 kHz		________	–145 dBc
	40 MHz; Mode 2; 1 kHz		________	–108 dBc
	40 MHz; Mode 2; 20 kHz		________	–142 dBc
	40 MHz; Mode 2; 100 kHz		________	–145 dBc
	20 MHz; Mode 2; 1 kHz		________	–113 dBc
	20 MHz; Mode 2; 20 kHz		________	–144 dBc
	20 MHz; Mode 2; 100 kHz		________	–145 dBc
	20 MHz; Mode 3 (Option 004); 1 kHz		________	–127 dBc
	20 MHz; Mode 3 (Option 004); 20 kHz		________	–145 dBc
	20 MHz; Mode 3 (Option 004); 100 kHz		________	–145 dBc
	10 MHz; Mode 3 (Option 004); 1 kHz		________	–130 dBc
	10 MHz; Mode 3 (Option 004); 20 kHz		________	–145 dBc
	10 MHz; Mode 3 (Option 004); 100 kHz		________	–145 dBc
	10 MHz; Mode 2; 1 kHz		________	–118 dBc
	10 MHz; Mode 2; 20 kHz		________	–145 dBc
	10 MHz; Mode 2; 100 kHz		________	–145 dBc
	Non-Harmonic Spurious			**worst case**
	Mode 2; >15 kHz offset; 0.25 to 1030 MHz		________	–100 dBc
	Mode 2; >15 kHz offset; 1030 to 2060 MHz (Option 002)		________	–94 dBc
	Mode 3 (Option 004); >10 kHz offset; 0.25 to 1030 MHz		________	–105 dBc
	Mode 3 (Option 004); >10 kHz offset; 1030 to 2060 MHz (Option 002)		________	–100 dBc

Table 3–2. Performance Test Record (12 of 13)

Test No.	Test Description	Results Minimum	Results Actual	Results Maximum
6	**SPECTRAL PURITY TEST (HARMONICS)**			
	Harmonics			
	0.25 to 1030 MHz (except Option 005)		________	–30 dBc
	0.25 to 1030 MHz (Option 005)		________	–25 dBc
	1030 to 2060 MHz (Option 002)		________	–25 dBc
	Subharmonics			
	515 MHz Carrier		________	none
	515 to 1030 MHz Carrier		________	–55 dBc
	1030 to 2060 MHz Carrier (Option 002)		________	–40 dBc
7	**PULSE MODULATION TEST**			
	Rise and Fall Time			
	Frequency Setting and Measurement			
	10 MHz, Risetime		________	100 ns
	10 MHz, Falltime		________	100 ns
	20 MHz, Risetime		________	100 ns
	20 MHz, Falltime		________	100 ns
	50 MHz, Risetime		________	100 ns
	50 MHz, Falltime		________	100 ns
	100 MHz, Risetime		________	100 ns
	100 MHz, Falltime		________	100 ns
	200 MHz, Risetime		________	100 ns
	200 MHz, Falltime		________	100 ns
	500 MHz, Risetime		________	100 ns
	500 MHz, Falltime		________	100 ns
	1000 MHz, Risetime		________	100 ns
	1000 MHz, Falltime		________	100 ns
	2000 MHz, Risetime (Option 002)		________	100 ns
	2000 MHz, Falltime (Option 002)		________	100 ns
	On/Off Ratio			
	Frequency Setting			
	100 MHz	35 dB	________	
	200 MHz	35 dB	________	
	500 MHz	35 dB	________	
	1000 MHz	35 dB	________	
	2000 MHz (Option 002)	80 dB	________	

Table 3–2. Performance Test Record (13 of 13)

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
8	**INTERNAL AUDIO OSCLLATOR TEST**			
	Fixed Audio Oscillator Frequency Accuracy			
	300 Hz	285 Hz	________	315 Hz
	400 Hz	380 Hz	________	420 Hz
	1000 Hz	950 Hz	________	1050 Hz
	3000 Hz	2850 Hz	________	3150 Hz
	Fixed Audio Oscillator Distortion			
	300 Hz		________	0.2%
	400 Hz		________	0.2%
	1000 Hz		________	0.2%
	3000 Hz		________	0.2%
	Synthesized Audio Oscillator (Option 007) Distortion			
	20 Hz		________	0.2%
	100 Hz		________	0.2%
	1000 Hz		________	0.2%
	10 000 Hz		________	0.2%
	15 000 Hz		________	0.2%
9	**AVIONICS PARAMETERS TEST (OPTION 009)**			
	AM Depth Limits (%)			
	118 MHz, 60%, 30 Hz	57%	________	63%
	9960 Hz	57%	________	63%
	112 MHz, 40%, 90 Hz	38%	________	42%
	150 Hz	38%	________	42%
	80%, 90 Hz	76%	________	84%
	150 Hz	76%	________	84%
	334 MHz, 40%, 90 Hz	38%	________	42%
	150 Hz	38%	________	42%
	80%, 90 Hz	76%	________	84%
	150 Hz	76%	________	84%
	75 MHz, 95%, 400 Hz	89.25%	________	100.75%
	1300 Hz	89.25%	________	100.75%
	3000 Hz	89.25%	________	100.75%

Table 3-2. Performance Test Record

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
9	AVIONICS PARAMETERS TEST (OPTION 009) (cont'd)			
	AM Distortion Limits (%)			
	118 MHz, 60%, 30 Hz		______	2%
	9960 Hz		______	2%
	112 MHz, 40%, 90 Hz		______	2%
	150 Hz		______	2%
	80%, 90 Hz		______	2%
	150 Hz		______	2%
	334 MHz, 40%, 90 Hz		______	2%
	150 Hz		______	2%
	80%, 90 Hz		______	2%
	150 Hz		______	2%
	75 MHz, 95%, 400 Hz		______	5%
	1300 Hz		______	5%
	3000 Hz		______	5%

Test 10 – Leakage Test (Option 010)

Frequency (MHz)	Length Antenna Element	Max Leakage (dB)[1]
1029.1	5.9 cm (2.30 in)	______
975.1	6.1 cm (2.40 in)	______
925:1	6.5 cm (2.56 in)	______
875.1	7.0 cm (2.74 in)	______
825.1	7.5 cm (2.95 in)	______
775.1	8.1 cm (3.18 in)	______
725.1	8.7 cm (3.44 in)	______
454.1	14.9 cm (5.87 in)	______

[1] Upper limit is 0 dB.

Table 3-2. Performance Test Record

Test 11 – Counter Accuracy and Sensitivity Test (Option 011)

Sig Gen Freq (MHz)	Sig Gen Level (dBm)	HP 8644A Counter Range	HP 8644A Counter Display (Hz)		
			Minimum	Actual	Maximum
0.10	+20.0	10 MHz	99,999.99	________	100,000.01
10.00	+20.0	10 MHz	9,999,999.90	________	10,000,000.10
100.00	+20.0	640 MHz	99,999,999.00	________	100,000,001.00
1000.00	+20.0	2 GHz	999,999,990.00	________	1,000,000,010.00
2000.00	+20.0	2 GHz	1,999,999,980.00	________	2,000,000,020.00
0.10	−19.0	10 MHz	99,999.99	________	100,000.01
10.00	−19.0	10 MHz	9,999,999.90	________	10,000,000.10
100.00	−19.0	640 MHz	99,999,999.00	________	100,000,001.00
1000.00	−19.0	2 GHz	999,999,990.00	________	1,000,000,010.00
2000.00	−19.0	2 GHz	1,999,999,980.00	________	2,000,000,020.00

4 Adjustments

Section 4
ADJUSTMENTS

4–1. INTRODUCTION

The procedures in this section will adjust the instrument's electrical performance.

NOTE

Before beginning the adjustments, the Signal Generator should be allowed a 24 hour warm-up period after being connected to the ac power line and a 10 minute warm-up period after turn-on. Line voltage must be within ±10% of nominal if the results of the adjustments are to be considered valid.

Unless otherwise stated, the specifications assume the Signal Generator is operating with its Synthesis Modes set to Auto which automatically optimizes the internal hardware configuration for best performance.

4–2. EQUIPMENT REQUIRED

Equipment required for the Adjustments is listed in table 1–2, *Recommended Test Equipment.* Any equipment that satisfies the critical specifications provided in the table may be substituted for the recommended model(s).

4–3. CALIBRATION CYCLE

This instrument requires periodic adjustments. Depending on the use and environmental conditions, the instrument should be checked and adjusted every three years.

Adjustment 1

SPECIAL 171: RECAL

Description

This special function allows you to recalibrate the entire instrument. A recalibration takes about five minutes. The message **Result Code = 0** appears if the recalibration passes. All error codes are defined in the Service Diagnostics Manual (HP part number 08645-90104).

Equipment: None

Procedure

1. On the Signal Generator, press the [INSTR PRESET] key.
2. Key in the following:

   [SPECIAL] [1] [7] [1] [ENTER] [ON]

NOTE

The "ENTER" and "ON" labels are on the same keypad.

Adjustment 2

SPECIAL 160: STANDARD REFERENCE CALIBRATION

Specification (typical)

	Standard	*Option 001*
Aging:	*± 2 ppm / year after 1 year*	*± 3× 10^{-10} / day after 10 days*
Temperature:	*± 4 ppm, 0 to 55°C*	*± 3 × 10^{-9}, 0 to 55°C*
Line Voltage:	*± 0.1 ppm, ± 10%*	*± 1 × 10^{-10}, ± 10%*

Description

This special function allows you to adjust the frequency of the internal reference oscillator. Values used to adjust the reference frequency are in the range of 0 to 255. A change in the value of "1" corresponds to about a 4 Hz change in the reference frequency. The value required to set the reference to approximately 10 MHz will vary from instrument to instrument. When an instrument preset or power on/off is done, the reference frequency value is returned to its calibrated value. (Activate service Special Function 331 to save the reference calibration value.)

Equipment

Measuring Receiver .... HP 8902A
Sensor Module .... HP 11722A

Procedure

1. Open the instrument and set the service switch, SW1–A, to position 1. See figure 4–1 below.

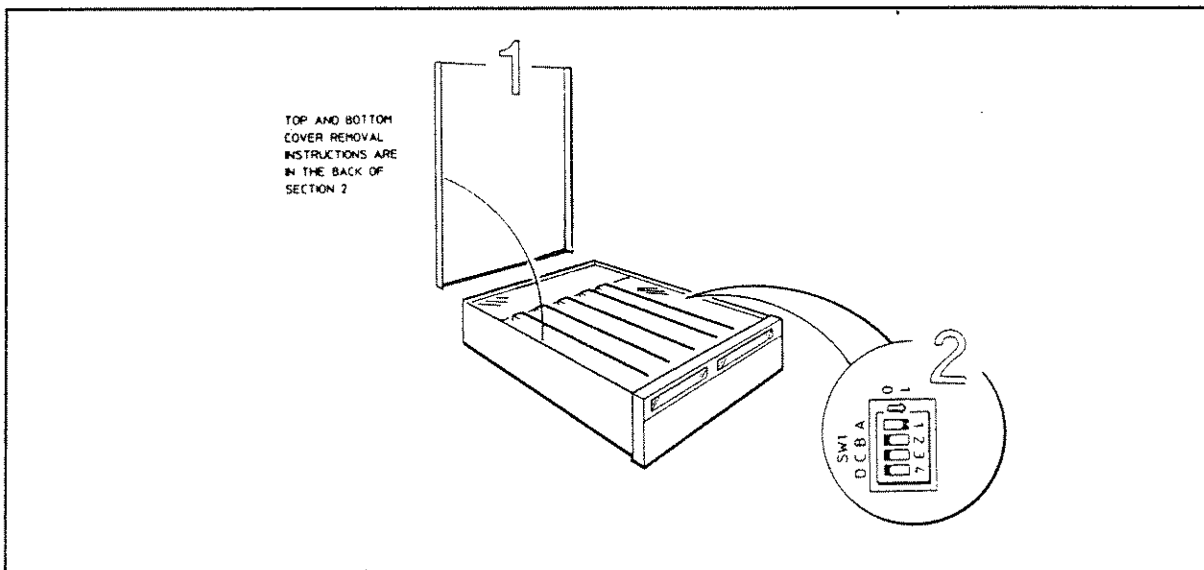


Figure 4–4. Service Switch Location

2. On the Signal Generator, press [INSTR PRESET].
3. Preset the measuring receiver, then select frequency measurement. Key in [7] [•] [4] [SPECIAL] to set the counter resolution to 0.1Hz.
4. Connect the input of the measuring receiver's sensor module directly to the Signal Generator's rear panel at the 10MHz REF OUTPUT connector.
5. If available, the measuring receiver's 10MHz TIMEBASE INPUT should be connected to a 10MHz Reference Standard (House Standard).
6. On the Signal Generator; key in the following:

   [SPECIAL] [1] [6] [0] [ENTER] [ON]

NOTE

The "ENTER" and "ON" labels are on the same keypad.

7. A reference calibration number will appear in the Frequency display. This number can be set to a number between 1 and 255 with the INCR knob. This number is the Reference Calibration Factor.
8. Monitor the measuring receiver frequency reading. Adjust the signal generator Reference Calibration Factor until the measuring receiver's frequency reading is as close to 10.000 000 MHz as possible.
9. On the signal generator; key in the following:

   [SPECIAL] [3] [3] [1] [ENTER] [ON]

   This special function will save the Reference Calibration Factor in the signal generator's memory.
10. Return the signal generator test switch, SW1–A to the 0 position. See figure 4–1. Replace the signal generator's covers.

Adjustment 3

OPTION 001 HIGH STABILITY TIMEBASE

Specification (typical)

	Standard	*Option 001*
Aging:	*± 2 ppm / year after 1 year*	*± 3× 10^{-10} / day after 10 days*
Temperature:	*± 4 ppm, 0 to 55°C*	*± 3 × 10^{-9}, 0 to 55°C*
Line Voltage:	*± 0.1 ppm, ± 10%*	*± 1 × 10^{-10}, ± 10%*

Description

The OVEN REF OUTPUT from the Signal Generator (rear panel) is compared against a frequency standard with a long term stability greater than 1 × 10^{-10}. The frequency of the reference oscillator is fine tuned for minimum drift using the OVEN REF Adjustment.

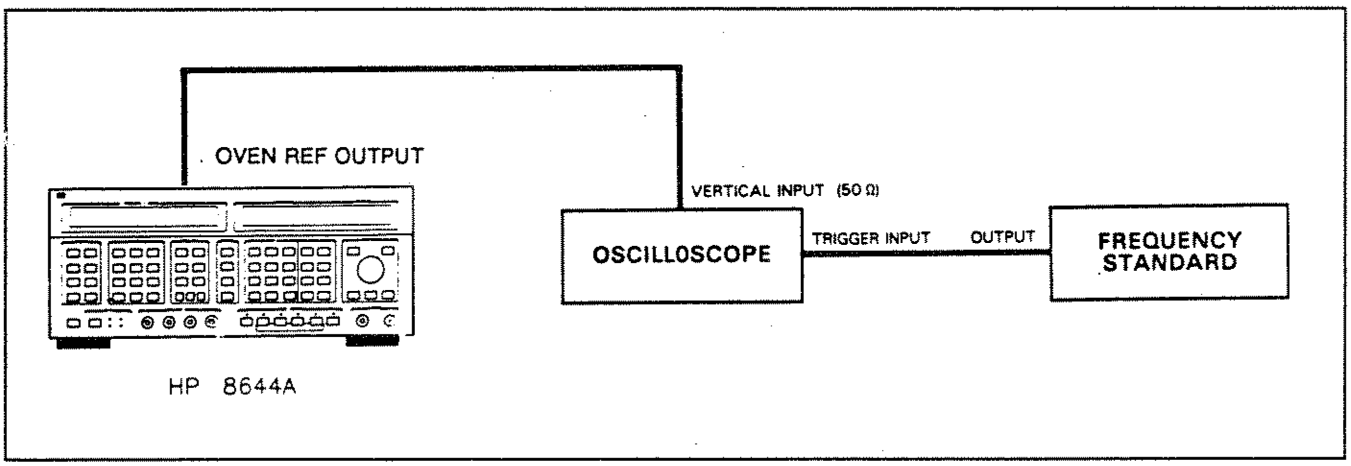


Figure 4-2.

Equipment

Frequency Standard .... HP 5065A
Oscilloscope .... HP 1740A
or Tektronix 2245

Procedure

1. Connect an RF cable from the frequency standard to the vertical input of the oscilloscope.
2. Adjust the oscilloscope so that at least one cycle of the sine waveform can be viewed on the oscilloscope screen.
3. Connect the equipment as shown in figure 4–2.
4. Set the oscilloscope for external triggering input and adjust for synchronized (stable) display.
5. Set the OVEN REF Adjust (rear of the Signal Generator; crystal oscillator assembly) so that the waveform on the oscilloscope does not drift more than one cycle in ten seconds.