User's Guide

Agilent Technologies
N5181A/82A MXG Signal Generators

This guide applies to the following signal generator models:

N5181A MXG Analog Signal Generator
N5182A MXG Vector Signal Generator

Because of our continuing efforts to improve our products through firmware and hardware revisions, signal generator design and operation may vary from descriptions in this guide. We recommend that you use the latest revision of this guide to ensure that you have up-to-date product information. Compare the print date of this guide (see bottom of page) with the latest revision, which can be downloaded from the following website:

http://www.agilent.com/find/mxg

Agilent Technologies

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Notice

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[a]Press the **Help** hardkey, and then the key for which you wish help.

1 Signal Generator Overview

Signal Generator Features

- N5181A, analog models: 250 kHz to 1, 3, or 6 GHz

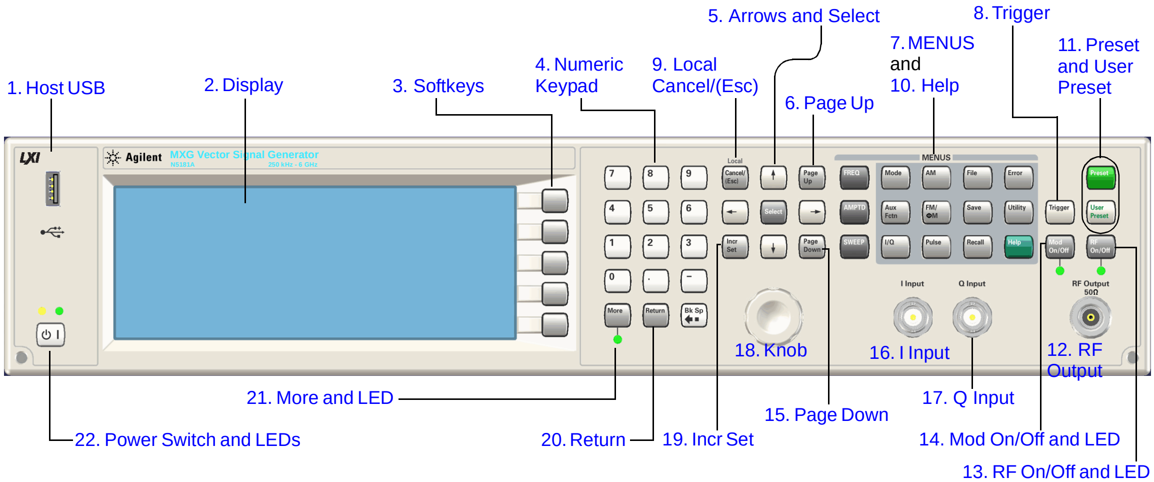
  N5182A, vector models: 250 kHz to 3 or 6 GHz
- electronic attenuator
- step & list sweep of frequency, power, or frequency and power

  vector models can include waveforms in list sweep
- user flatness correction
- automatic leveling control (ALC); power calibration
- 10 MHz reference oscillator with external output
- flexible reference input, 1 – 50 MHz (Option 1ER)
- GPIB, USB 2.0, and 100Base-T LAN interfaces
- analog modulation: AM, FM, and ΦM (Option UNT)
- external AM, FM, and ΦM inputs (Option UNT)
- pulse modulation (Option UNU)
- SCPI and IVI-COM driver
- 8648/ESG code compatible
- LXI Class C compliant
- external analog I/Q inputs (vector models)
- analog differential I/Q outputs (vector models, Option 1EL)
- arbitrary I/Q waveform playback up to 125 MSa/s (vector models, Option 654)
- with Signal Studio Software, vector models can generate 802.11 WLAN, W-CDMA, cdma2000, 1xEV-DO, GSM, EDGE, and more

For more details on hardware, firmware, software, and documentation features and options, refer to the data sheet shipped with the signal generator and available from the Agilent Technologies website.

1. Open: *http://www.agilent.com/find/mxg*
2. Select the desired model number.
3. In the options and price list section, click **price list**.

Front Panel Overview



1. Host USB

Connector Type A

USB Protocol 2.0

Use this universal serial bus (USB) to connect a memory stick for data transfer. You can connect or disconnect a USB device without shutting down or restarting the signal generator. The instrument also has a rear-panel device USB connector (see page 11) used to remotely control the instrument.

2. Display

The LCD screen provides information on the current function. Information can include status indicators, frequency and amplitude settings, and error messages. Labels for the softkeys are located on the right-hand side of the display. See also, “Front Panel Display” on page 7.

3. Softkeys

A softkey activates the function indicated by the displayed label to the left of the key.

4. Numeric Keypad

The numeric keypad comprises the 0 through 9 hardkeys, a decimal point hardkey, a minus sign hardkey, and a backspace hardkey. See “Entering and Editing Numbers and Text” on page 24.

5. Arrows and Select

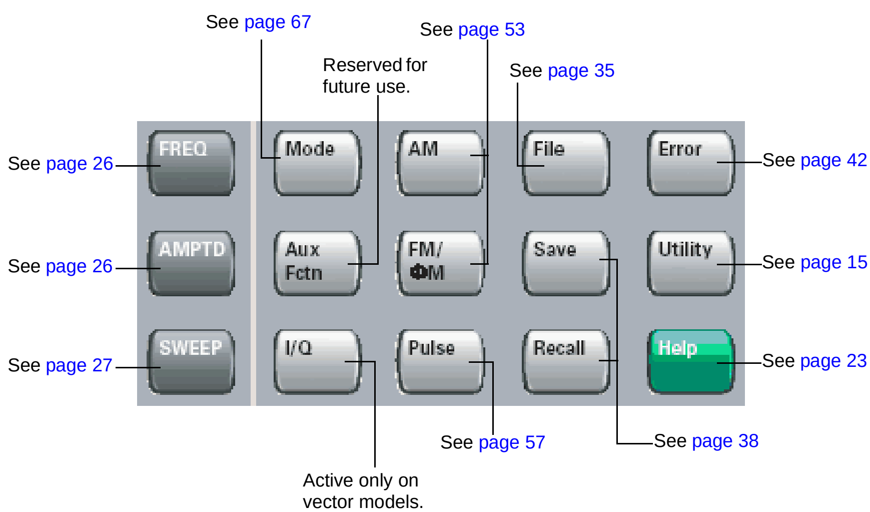
The **Select** and arrow hardkeys enable you to select items on the signal generator’s display for editing. See “Entering and Editing Numbers and Text” on page 24.

6. Page Up

In a table editor, use this hardkey to display a previous page. See “Example: Using a Table Editor” on page 25. When text does not fit on one page in the display area, use this key in conjunction with the Page Down key (page 5) to scroll text.

7. MENUS

These hardkeys open softkey menus that enable you to configure instrument functions or access information.



8. Trigger

When trigger mode is set to **Trigger Key**, this hardkey initiates an immediate trigger event for a function such as a list or step sweep.

9. Local Cancel / (Esc)

This hardkey deactivates remote operation and returns the signal generator to front panel control, cancels an active function entry, and cancels long operations (such an IQ calibration).

10. Help

Use this key to display a description of any hardkey or softkey. See “Viewing Key Descriptions” on page 23.

11. Preset and User Preset

These hardkeys set the signal generator to a known state (factory or user-defined). See “Presetting the Signal Generator” on page 23.

12. RF Output

Connector	Standard:	female Type-N
	Option 1EM:	Rear panel female Type-N
	Impedance:	50Ω
Damage Levels	50Vdc, 2W maximum RF power	

13. RF On/Off and LED

This hardkey toggles the operating state of the RF signal present at the RF OUTPUT connector. The `RF On/Off` LED lights when RF output is enabled.

14. Mod On/Off and LED

This hardkey enables or disables the modulation of the output carrier signal by an active modulation format. This hardkey does not set up or activate a format (see "Modulating the Carrier Signal" on page 34).

The `MOD ON/OFF` LED lights when modulation of the output is enabled.

15. Page Down

In a table editor, use this hardkey to display the next page. See "Example: Using a Table Editor" on page 25. When text does not fit on one page in the display area, use this key in conjunction with the Page Up key (page 4) to scroll text.

16. I Input (vector models only)

Connector	Type: female BNC Impedance: 50Ω
Signal	An externally supplied analog, in-phase component of I/Q modulation.
	The signal level is $\sqrt{I^2+Q^2}$ = 0.5 V_{rms} for a calibrated output level.
Damage Levels	1V_{rms}

See also, "I/Q Modulation" on page 121.

17. Q Input (vector models only)

Connector	Type: female BNC Impedance: 50Ω
Signal	An externally supplied analog, quadrature-phase component of I/Q modulation.
	The signal level is $\sqrt{I^2+Q^2}$ = 0.5 V_{rms} for a calibrated output level.
Damage Levels	1V_{rms}

See also, "I/Q Modulation" on page 121.

18. Knob

Rotating the knob increases or decreases a numeric value, or moves the highlight to the next digit, character, or item in a list. See also, “Front Panel Knob Resolution” on page 17.

19. Incr Set

This hardkey enables you to set the increment value of the currently active function. The increment value also affects how much each turn of the knob changes an active function’s value, according to the knob’s current ratio setting (see “Front Panel Knob Resolution” on page 17).

20. Return

This hardkey enables you to retrace key presses. In a menu with more than one level, the **Return** key returns to the prior menu page.

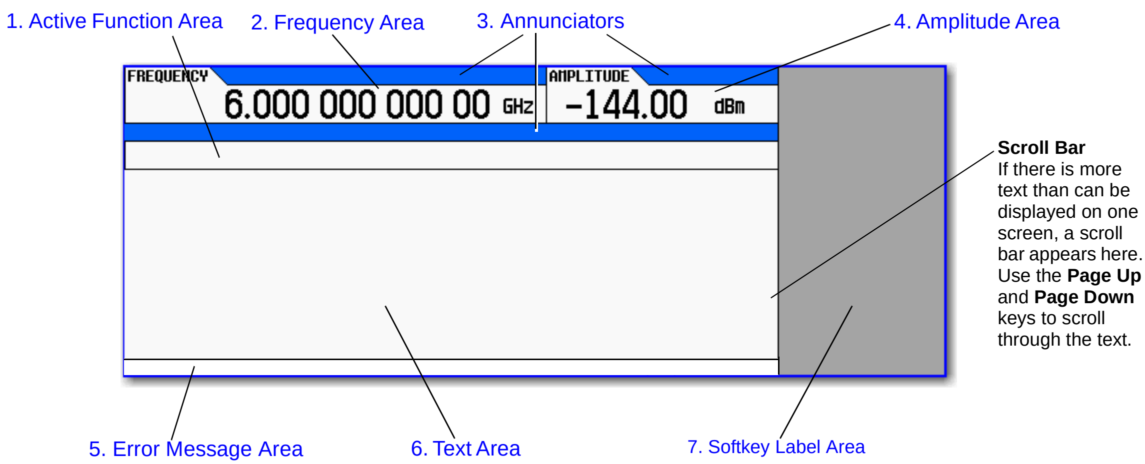
21. More and LED

When a menu contains more softkey labels than can be displayed, the More LED lights and a `More` message displays below the labels. To display the next group of labels, press the **More** hardkey.

22. Power Switch and LEDs

This switch selects the standby mode or the power on mode. In the standby position, the yellow LED lights and all signal generator functions deactivate. The signal generator remains connected to the line power, and some power is consumed by some internal circuits. In the on position, the green LED lights and the signal generator functions activate.

Front Panel Display



1. Active Function Area

This area displays the currently active function. For example, if frequency is the active function, the current frequency setting appears. If the currently active function has an increment value associated with it, that value also appears.

2. Frequency Area

This area displays the current frequency setting.

3. Annunciators

Annunciators show the status of some of the signal generator functions, and indicate error conditions. An annunciator position may be used by more than one annunciator; in this case, only one of the functions sharing a given position can be active at a given time.

This annunciator	appears when . . .
ΦM	Phase modulation is on. If you turn frequency modulation on, the FM annunciator replaces ΦM.
ARB	The ARB generator is on.
ALC OFF	The ALC circuit is disabled. The UNLEVEL annunciator appears in the same position if the ALC is enabled and is unable to maintain the output level.
AM	Amplitude modulation is on.
ARMED	A sweep has been initiated and the signal generator is waiting for the sweep trigger event.
ATTNHOLD	The attenuator hold function is on. When this function is on, the attenuator is held at its current setting.
DETHTR	The ALC detector heater is not up to temperature. To meet ALC specifications the heater must be at temperature.
AWGN	Real Time I/Q Baseband additive white Gaussian noise is on.

This annunciator	appears when . . .
DIGBUS	The digital bus is in use.
ERR	An error message is placed in the error queue. This annunciator does not turn off until you either view all of the error messages or clear the error queue (see "Reading Error Messages" on page 42).
EXTREF	An external frequency reference is applied.
FM	Frequency modulation is on. If you turn phase modulation on, the ΦM annunciator replaces FM.
I/Q	I/Q vector modulation is on.
L	The signal generator is in listener mode and is receiving information or commands over the GPIB, USB, or VXI-11/Sockets (LAN) interface.
MULT	A frequency multiplier is set (see "Setting a Frequency Multiplier" on page 51).
OFFS	An output offset is set (see "Setting an Output Offset" on page 49).
PULSE	Pulse modulation is on.
R	The signal generator is remotely controlled over the GPIB, USB, or VXI-11/Sockets (LAN) interface.
REF	An output reference is set (see "Setting an Output Reference" on page 50).
S	The signal generator has generated a service request (SRQ) over the GPIB, USB, or VXI-11/Sockets (LAN) interface.
SWEEP	The signal generator is currently sweeping in list or step mode.
SWMAN	The signal generator is in manual sweep mode.
T	The signal generator is in talker mode and is transmitting information over the GPIB, USB, or VXI-11/Sockets (LAN) interface.
UNLEVEL	The signal generator is unable to maintain the correct output level. This is not necessarily an indication of instrument failure; unleveled conditions can occur during normal operation. Another annunciator, ALC OFF, appears in the same position when the ALC circuit is disabled (see ALC OFF, above).
UNLOCK	Any of the phase locked loops cannot maintain phase lock. To determine which loop is unlocked, examine the error messages (see "Reading Error Messages" on page 42).
WINIT	The signal generator is waiting for you to initiate a single sweep.

4. Amplitude Area

This area displays the current output power level setting.

5. Error Message Area

This area displays abbreviated error messages. If multiple messages occur, only the most recent message remains displayed. See "Reading Error Messages" on page 42.

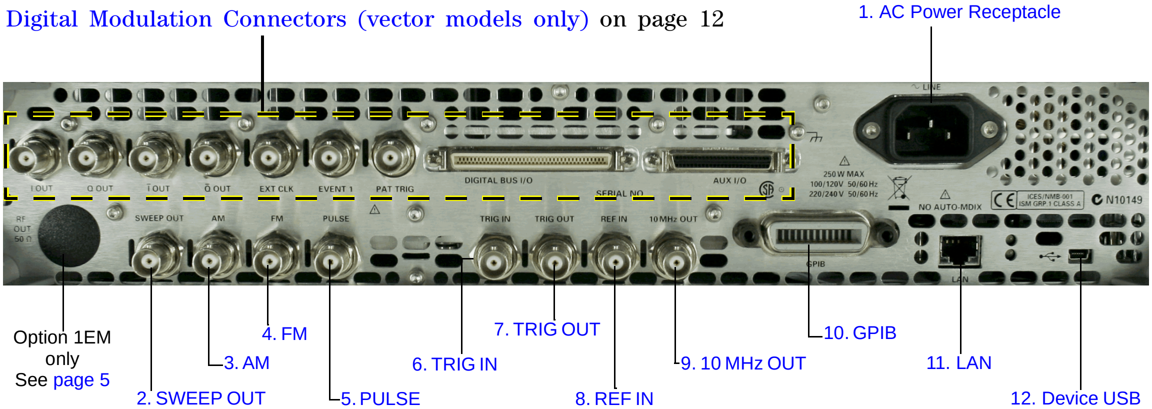
6. Text Area

This area displays signal generator status information, such as the modulation status, and other information such as sweep lists and file catalogs. This area also enables you to perform functions such as managing information (entering information, and displaying or deleting files).

7. Softkey Label Area

This area displays labels that define the function of the softkeys located immediately to the right of the display. Softkey labels change, depending on the function selected.

Rear Panel Overview



1. AC Power Receptacle

The AC power cord receptacle accepts a three-pronged AC power cord that is supplied with the signal generator. For details on line setting requirements and the power cord, see the *Installation Guide*.

2. SWEEP OUT

Connector female BNC Impedance <1Ω
Can drive 2 kΩ.

Signal Voltage range: 0 to +10V, regardless of sweep width
In swept mode: beginning of sweep = 0V; end of sweep = +10V
In CW mode: no output

This is a multiple use connector. For signal routing selections, see pages 33 and 57.

3. AM

Connector female BNC Impedance nominally 50Ω

Signal An externally supplied ±1V_p signal that produces the indicated depth.

Damage Levels 5V_{rms} and 10V_p

4. FM

Connector female BNC Impedance nominally 50Ω

Signal An externally supplied ±1V_p signal that produces the indicated deviation

Damage Levels 5V_{rms} and 10V_p

5. PULSE

Connector female BNC Impedance nominally 50Ω

Signal Externally supplied: +1V = on; 0V = off

Damage Levels 5V_{rms} and 10V_p

6. TRIG IN

Connector female BNC Impedance high Z

Signal An externally supplied TTL or CMOS signal for triggering operations, such as point-to-point in manual sweep mode or an LF sweep in external sweep mode. Triggering can occur on either the positive or negative edge.

Damage Levels ≤ –0.5V and ≥ +5.5V

7. TRIG OUT

Connector female BNC Impedance nominally 50Ω

Signal A TTL signal that is high at the start of a dwell sequence, or when waiting for the point trigger in manual sweep mode.
It is low when the dwell is over, or when the point trigger is received.
The logic polarity can be reversed.

This is a multiple use connector. For signal routing selections, see pages 33 and 57.

8. REF IN

Connector female BNC Impedance nominally 50Ω

Signal An externally supplied –3.5 to +20 dBm signal from a timebase reference that is within ±1 ppm.

In its factory default mode, the signal generator can detect a valid reference signal at this connector and automatically switch from internal to external reference operation. See “Presetting the Signal Generator” on page 23. With Option 1ER (flexible reference input), you must explicitly tell the signal generator the external reference frequency you wish to use; enter the information through the front panel or over the remote interface.

9. 10 MHz OUT

Connector	female BNC Impedance nominally 50Ω
Signal	A nominal signal level greater than 4 dBm.

10. GPIB

This connector enables communication with compatible devices such as external controllers, and is one of three connectors available to remotely control the signal generator (see also 11. LAN and 12. Device USB).

11. LAN

The signal generator supports local area network (LAN) based communication through this connector, which enables a LAN-connected computer to remotely program the signal generator. The LAN interface is LXI class C compliant; it does not support auto–MDIX. The signal generator is limited to 100 meters on a single cable (100Base-T). For more information on the LAN, refer to the *Programming Guide*.

12. Device USB

Connector	Mini-B
USB Protocol	Version 2.0

Use this universal serial bus (USB) connector to connect a PC to remotely control the signal generator.

Digital Modulation Connectors (vector models only)

I OUT, QOUT, $\overline{I}$ OUT, $\overline{Q}$ OUT

Connector Type: female BNC Impedance: 50Ω
DC-coupled

Signal

I OUT The analog, in-phase component of I/Q modulation from the internal baseband generator.

Q OUT The analog, quadrature-phase component of I/Q modulation from the internal baseband generator.

$\overline{I}$ OUT Used in conjunction with the I OUT connector to provide a balanced[a] baseband stimulus.

$\overline{Q}$ OUT Used in conjunction with the Q OUT connector to provide a balanced[a] baseband stimulus.

Damage Levels > 1 Vrms **DC Origin Offset** typically <10 mV

Output Signal Levels into a 50Ω Load

- $0.5V_{pk}$, typical, corresponds to one unit length of the I/Q vector
- $0.69V_{pk}$ (2.84 dB), typical, maximum crest factor for peaks for π/4 DQPSK, alpha = 0.5
- $0.71V_{pk}$ (3.08 dB), typical, maximum crest factor for peaks for π/4 DQPSK, alpha = 0.35
- Typically $1V_{p-p}$ maximum

[a]Balanced signals are signals present in two separate conductors that are symmetrical relative to ground, and are opposite in polarity (180 degrees out of phase).

EXT CLOCK

Connector female BNC Impedance nominally 50Ω

Signal An externally supplied TTL or CMOS bit clock signal where the rising edge aligns with the beginning data bit.
The falling edge is used to clock external signals.
This signal is used with digital modulation applications.

Damage Levels > +8 and < –4V **Maximum Clock Rate** 50 MHz

EVENT 1

Connector female BNC Impedance: nominally 50Ω

Signal A pulse that can be used to trigger the start of a data pattern, frame, or timeslot.
Adjustable to ± one timeslot; resolution = one bit
Markers
Each Arb-based waveform point has a marker on/off condition associated with it.
Marker 1 level = +3.3V CMOS high (positive polarity selected); –3.3V CMOS low (negative polarity selected).
Output on this connector occurs whenever Marker 1 is on in an Arb-based waveform (see "Using Waveform Markers" on page 82).

Damage Levels >+8 and <–4V

PAT TRIG IN

Connector female BNC Impedance: nominally 50Ω

Signal A TTL/CMOS low to TTL/CMOS high, or TTL/CMOS high to TTL/CMOS low edge trigger.
The input to this connector triggers the internal digital modulation pattern generator to start a single pattern output or to stop and re-synchronize a pattern that is being continuously output.
To synchronize the trigger with the data bit clock, the trigger edge is latched, then sampled during the falling edge of the internal data bit clock.
This is the external trigger for all ARB waveform generator triggers.

Minimum Trigger Input Pulse Width (high or low) = 100 ns

Minimum Trigger Delay (trigger edge to first bit of frame) = 1.5 to 2.5 bit clock periods

Damage Levels > +8 and < –4V

DIGITAL BUS I/O

This is a proprietary bus used by Agilent Technologies signal creation software. This connector is not operational for general purpose use. Signals are present only when a signal creation software option is installed (for details, refer to *http://www.agilent.com/find/signalcreation*).

AUX I/O

Pin 1 = Event 1
Pin 2 = Event 2
Pin 3 = Event 3
Pin 4 = Event 4
Pin 5 = Sample Rate Clock Out
Pin 6 = Patt Trig In 2

Pins 7–25 = Reserved*

Pins 26–50 = Ground

*Future Capability

Event 1, 2, 3, and 4 (pins 1 – 4)
A pulse that can be used to trigger the start of a data pattern, frame, or timeslot.
Adjustable to ± one timeslot; resolution = one bit

Markers
Each Arb-based waveform point has a marker on/off condition associated with it.
Marker level = +3.3V CMOS high (positive polarity selected); –3.3V CMOS low (negative polarity selected).

Output on these pins occurs whenever the corresponding marker is on in an Arb-based waveform (see “Using Waveform Markers” on page 82).

Sample Rate Clock Out (pin 5)
This output is used with an internal baseband generator. This pin relays a CMOS bit clock signal for synchronizing serial data.
Damage levels: > +5.5 and < –0.5V.

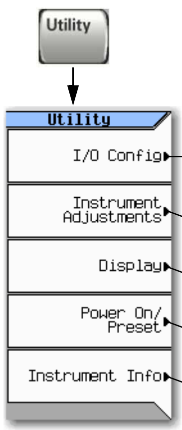
Patt Trig In 2 (pin 6)
A TTL/CMOS low to TTL/CMOS high, or TTL/CMOS high to TTL/CMOS low edge trigger.
The input to this connector triggers the internal digital modulation pattern generator to start a single pattern output or to stop and re-synchronize a pattern that is being continuously output.

To synchronize the trigger with the data bit clock, the trigger edge is latched, then sampled during the falling edge of the internal data bit clock.

This is an external trigger for all ARB waveform generator triggers. Minimum pulse width = 100 ns. Damage levels: > +5.5 and < –0.5V.

2 Setting Preferences & Enabling Options

The Utility menu provides access to both user and remote operation preferences, and to the menus in which you can enable instrument options.



Remote Operation

Configuring the GPIB Interface on page 19

Configuring the LAN Interface on page 20

Enabling LAN Services: Browser, Sockets, and VXI-11 on page 20

User Preferences

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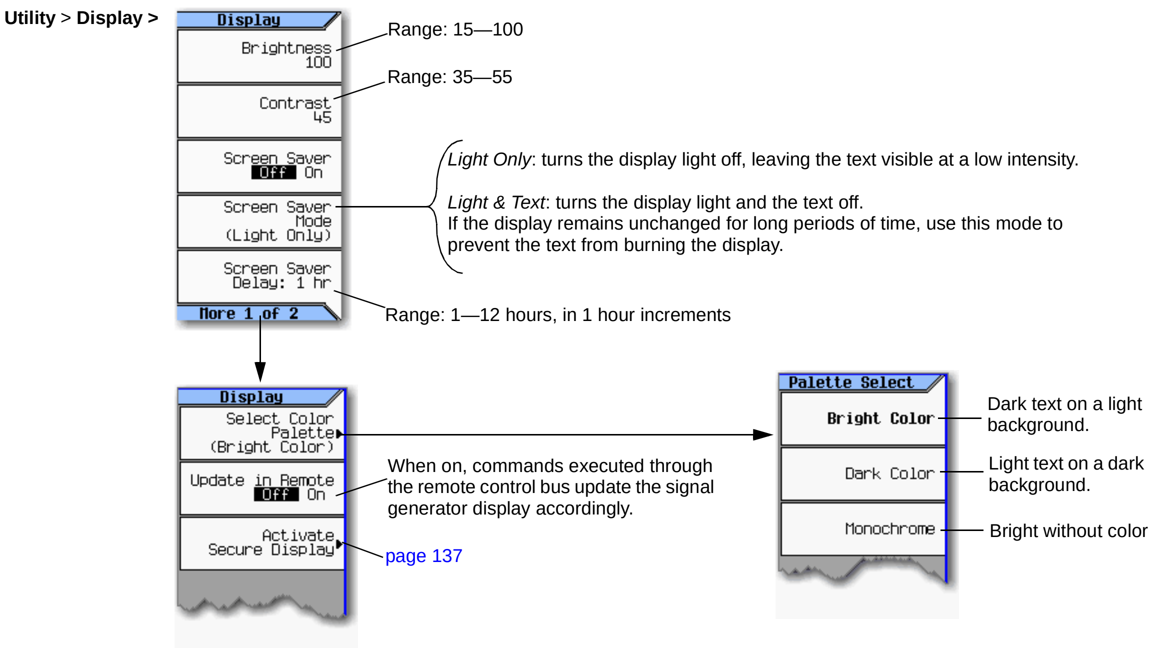
User Preferences

From the Utility menu, you can set the following user preferences:

- Display Settings, below
- Power On and Preset on page 17
- Front Panel Knob Resolution on page 17

Display Settings

See also, Using the Secure Display (Option 006 Only) on page

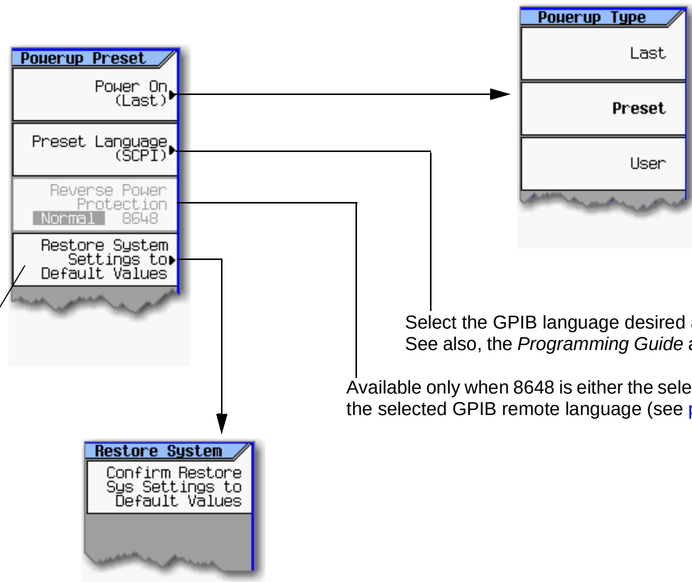


For details on each key, use key help as described on page 23.

NOTE With both brightness and contrast set to minimum, the display may be too dark to see the softkeys. If this happens, use the figure above to locate the brightness and contrast softkeys and adjust their values so that you can see the display.

Power On and Preset

Utility > **Power On/Preset >**



Restores persistent settings (those unaffected by a power cycle, preset, or recall)

Select the GPIB language desired after a preset.
See also, the *Programming Guide* and the *SCPI Reference*.

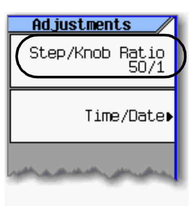
Available only when 8648 is either the selected preset language, or the selected GPIB remote language (see page 19).

Note
To define a user preset, set the instrument up as desired and press **User Preset** > **Save User Preset**.

Front Panel Knob Resolution

Makes the increment value of the current function the active entry.

Utility >
Instrument Adjustments >



The increment value and the step/knob ratio determine how much each turn of the knob changes the active function value.

For example, if the increment value of the active function is 10 dB and the step/knob ratio is 50 to 1, each turn of the knob changes the active function by 0.2 dB (1/50th of 10 dB).

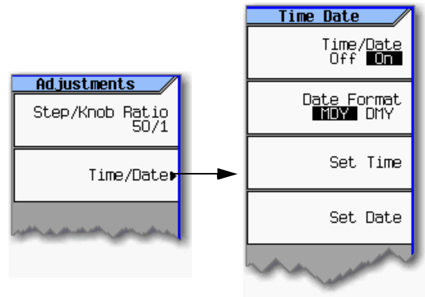
To change the amount for each turn of the knob, modify the increment value, the step/knob ratio, or both.

For details on each key, use key help as described on page 23.

Setting Time and Date

CAUTION Changing the time or date can adversely affect the signal generator’s ability to use time–based licenses, even if a time–based license is not installed when you change the time or date.

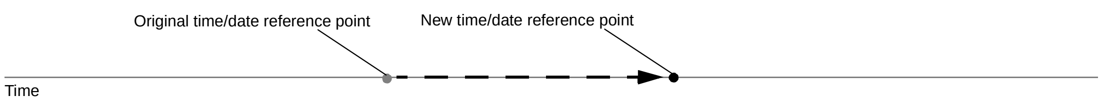
Utility > **Instrument Adjustments** >



The signal generator’s firmware tracks the time and date, and uses the *latest* date and time that has been set as its time/date reference point.

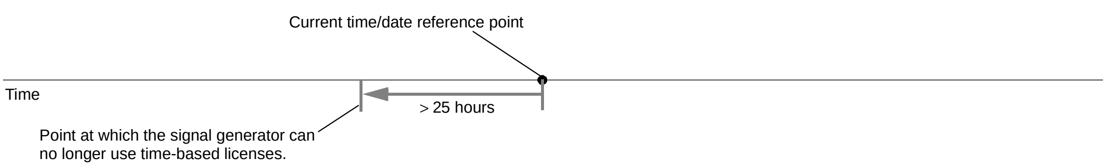
Setting the Time or Date Forward

If you set the time or date forward, be aware that you are using up any installed time-based licenses, and that you are *resetting the signal generator’s time/date reference point*. When you set a new time or date that is later than the signal generator’s current reference point, that date becomes the new reference point. If you then set the date back, you run the risk described in the next section.



Setting the Time or Date Backward

When you set the time back, the signal generator notes that the time has moved back from the reference point (the latest date that has been set). If you set the time back more than approximately 25 hours, you disable the signal generator’s ability to use time-based licenses, even if there is no license installed at the time that you set the time back. In this case, you can reenable the signal generator’s ability to use time-based licenses by returning the date to within 25 hours prior to the the reference point, or to anytime after the reference point.



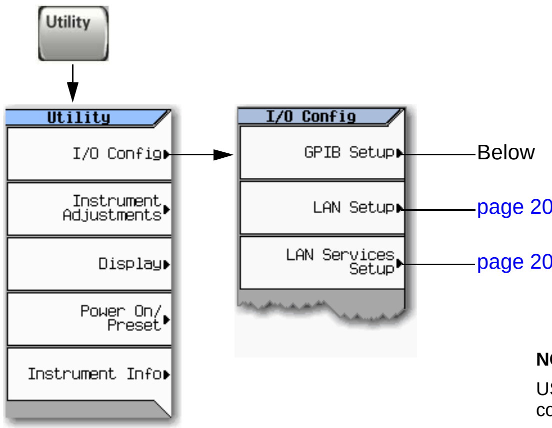
If you find you must set the date backward more than approximately 25 hours (when, for example, the time is mistakenly set ahead) and you wish to use time-based licenses, you must contact Agilent Technologies for assistance (see page 151).

Upgrading Firmware

For information on new firmware releases, go to *http://www.agilent.com/find/upgradeassistant*.

Remote Operation Preferences

For details on operating the signal generator remotely, refer to the *Programming Guide*.



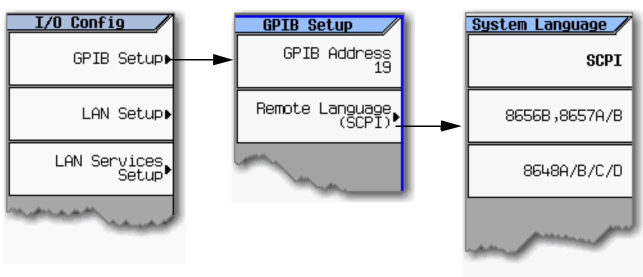
NOTES

USB is also available. It is not shown in the menu because it requires no configuration.

For details on using the instrument remotely, see the *Programming Guide*.

Configuring the GPIB Interface

Utility > **I/O Config >**

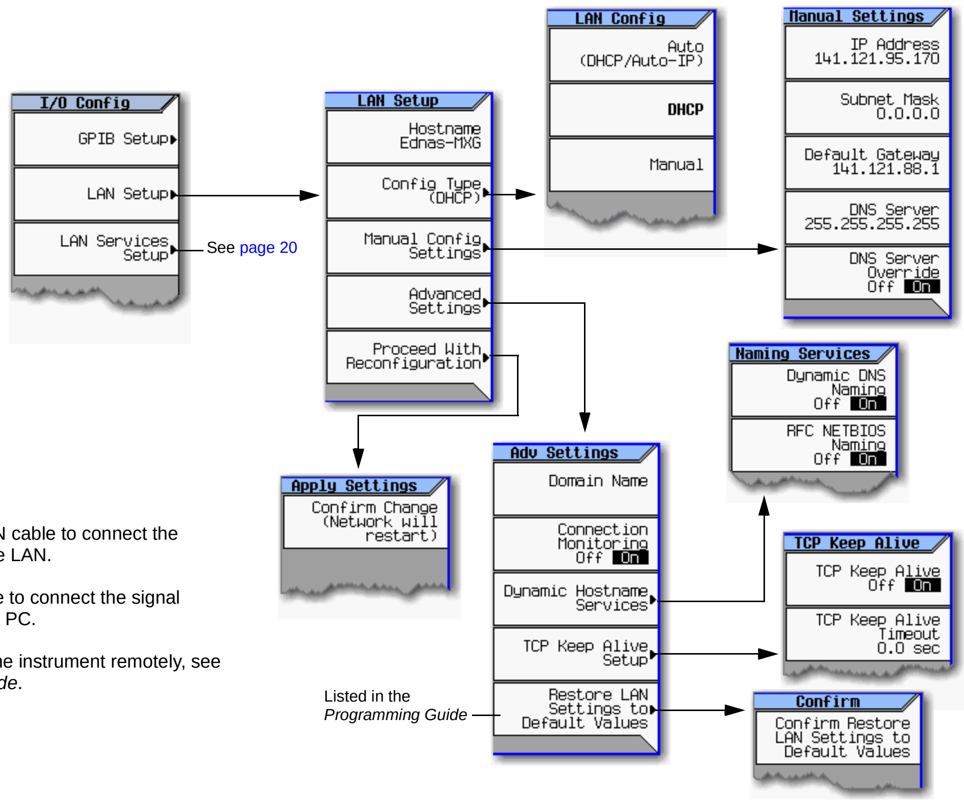


Select the desired GPIB language.

For details on each key, use key help as described on page 23.

Configuring the LAN Interface

Utility > **I/O Config** >



NOTES

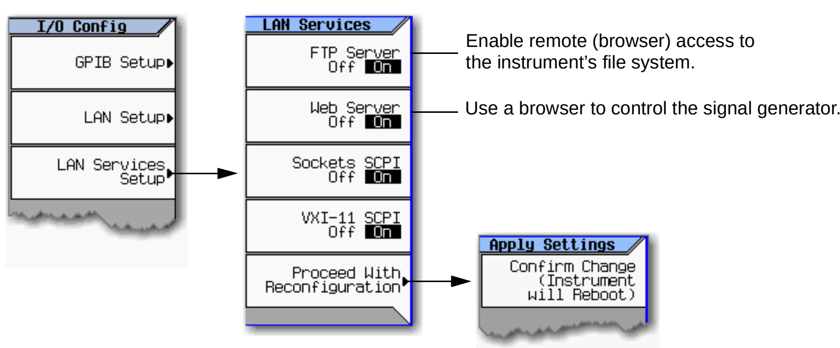
Use a 100Base-T LAN cable to connect the signal generator to the LAN.

Use a crossover cable to connect the signal generator directly to a PC.

For details on using the instrument remotely, see the *Programming Guide*.

Enabling LAN Services: Browser, Sockets, and VXI-11

Utility > **I/O Config** >



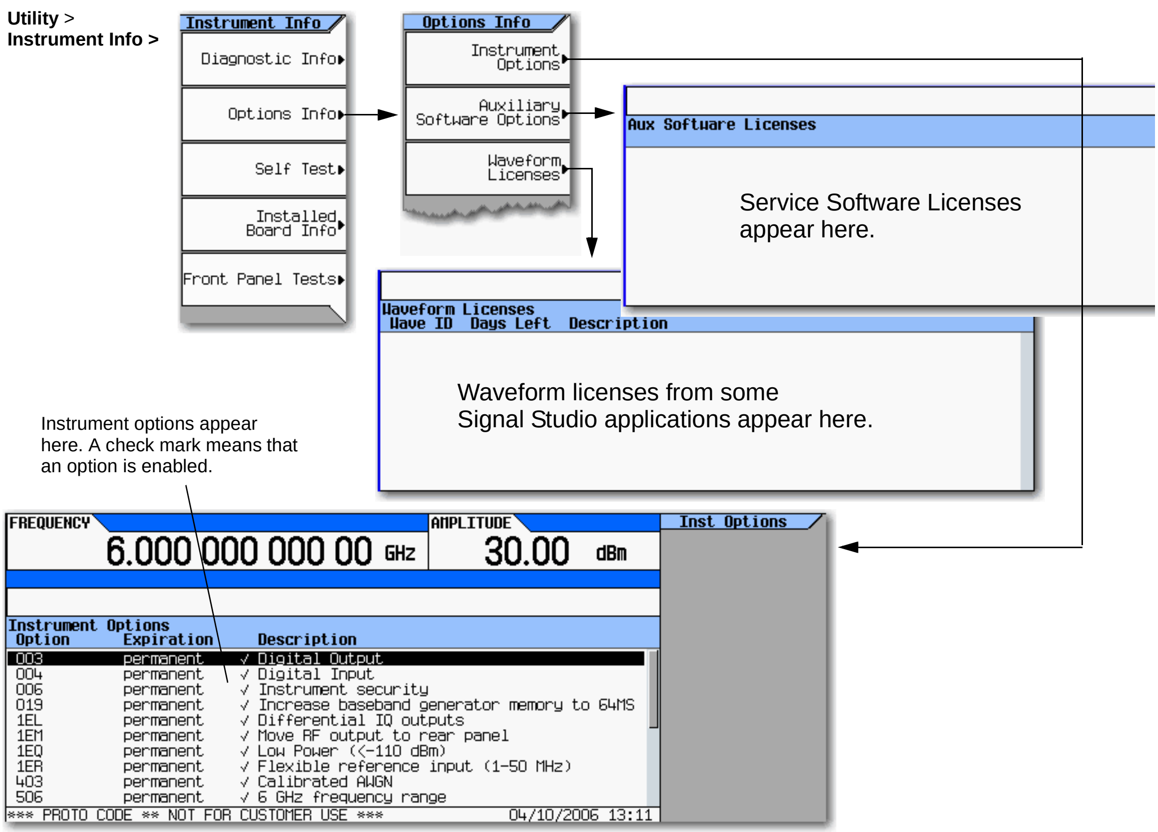
For details on each key, use key help as described on page 23.

Enabling an Option

There are two ways to enable an option:

- Use the License Manager software utility:
  1. Download the utility from *www.agilent.com/find/LicenseManager*
  2. Run the utility and follow the prompts.
- Use SCPI commands, as described in the *Programming Guide*.

Viewing Options and Licenses

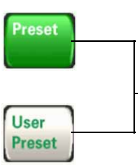


For details on each key, use key help as described on page 23.

3 Basic Operation

This chapter introduces fundamental front panel operation. For information on remote operation, refer to the *Programming Guide*.

Presetting the Signal Generator



To return the signal generator to a known state, press either **Preset** or **User Preset**.

Preset is the factory preset; *User Preset* is a custom preset* (see also, page 17).

To reset persistent settings (those unaffected by preset, user preset, or power cycle), press: **Utility** > **Power On/Preset** > **Restore System Defaults**.

*You can create more than one user preset by giving each saved state file a different name (see Figure 3-6 on page 40).

Viewing Key Descriptions

The Help hardkey enables you to display a description of any hardkey or softkey.

To display help text:

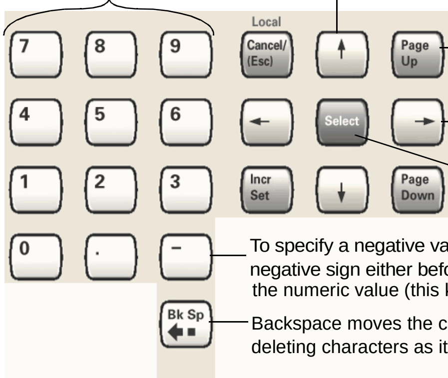
1. Press **Help**.
2. Press the desired key.
   The help displays and the key’s normal function does not execute.

Entering and Editing Numbers and Text

Entering Numbers and Moving the Cursor

Use the number keys and decimal point to enter numeric data.

Up/down arrow keys increase/decrease a selected (highlighted) numeric value, and move the cursor vertically.



Page up/down keys move tables of data up and down within the display area.

Left/right arrow keys move the cursor horizontally.

Use the **Select** hardkey to choose part of an entry, as when entering alpha characters. In some menus, the **Select** key also acts as a terminator, and is equivalent to the **Enter** softkey.

To specify a negative value, enter the negative sign either before or after the numeric value (this key is a toggle).

Backspace moves the cursor to the left, deleting characters as it goes.

Note: Rotating the knob increases or decreases a numeric value, changes a highlighted digit or character, or steps through lists or items in a row.

See also, Front Panel Knob Resolution on page 19

For details on each key, see page 23.

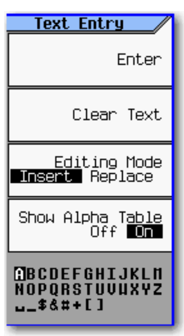
Entering Alpha Characters

Note: File names are limited to 25 characters.

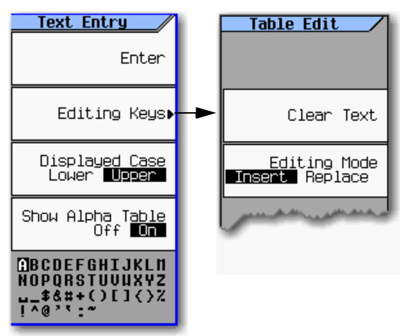
Data entry softkeys appear in various menus. If their meaning is not clear in context, use the help key (described on page 23) to display an explanation. Use the softkey next to the alpha table for help on the table.

Selecting data that accepts alpha characters, displays one of the menus shown at right.

Use the arrow keys or knob to highlight the desired letter, then press the **Select** hardkey (or the softkey next to the alpha table). To correct errors, use **Bk Sp** or **Clear Text**.



to move the cursor within the active value rather than within the alpha table, turn the alpha table off.



Add/edit comments for saved instrument state files (see page 38).

To terminate the entry, press the **Enter** softkey.

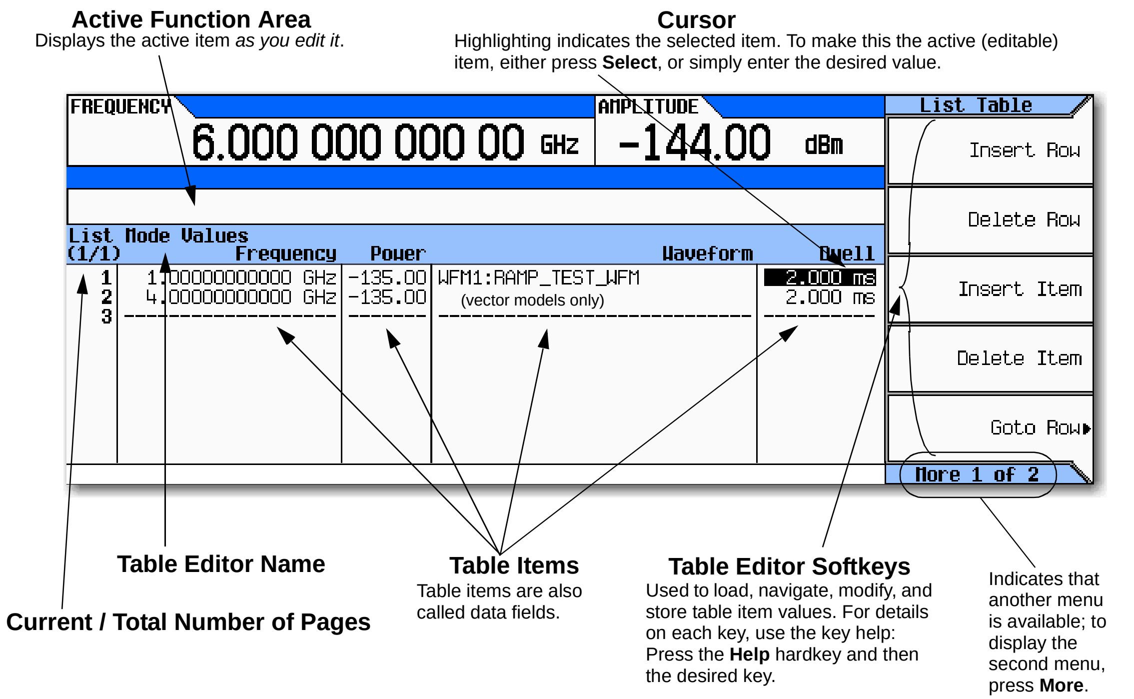
A subset of this menu appears for hexadecimal characters. The character menu displays only the letters A through F (use the numeric keypad for other values).

Example: Using a Table Editor

Table editors simplify configuration tasks. The following procedure describes basic table editor functionality using the List Mode Values table editor.

1. Preset the signal generator: Press **Preset**.
2. Open the table editor: Press **Sweep** > **More** > **Configure List Sweep**.

   The signal generator displays the editor shown in the following figure.

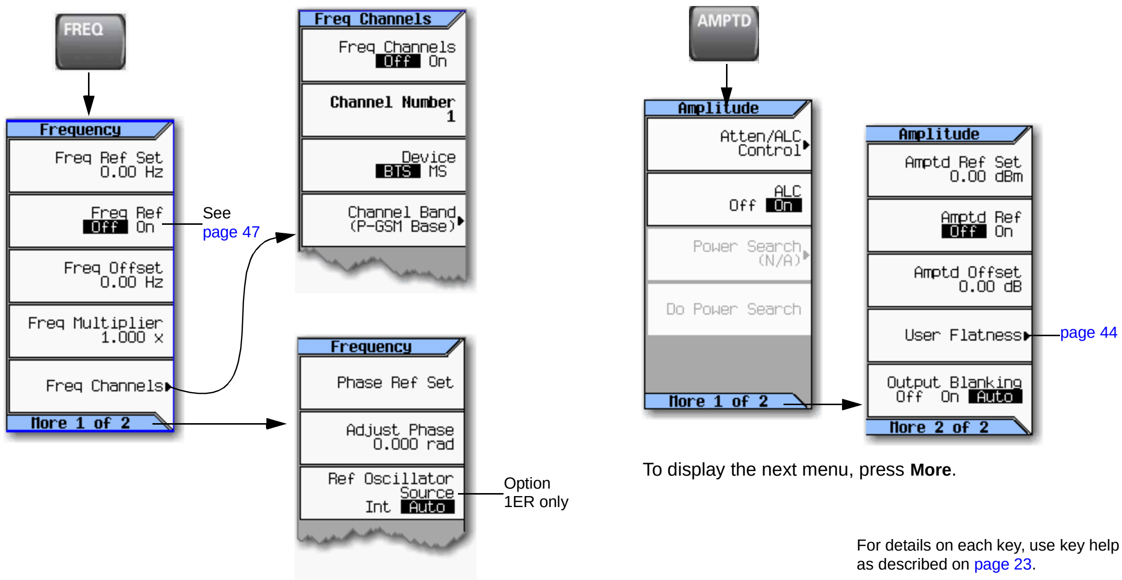


3. Highlight the desired item: use the arrow keys or the knob to move the cursor.
4. (Optional) Display the selected item in the active function area: Press **Select**.
5. Modify the value:
   - If the value is displayed in the active function area, use the knob, arrow keys, or numeric keypad to modify the value.
   - If the value is not displayed in the active function area, use the numeric keypad to enter the desired value (which then appears in the active function area).
6. Terminate the entry:
   - If available, press the desired units.
   - If units are not displayed, press either **Enter** (if available) or **Select**.

   The modified item is displayed in the table.

Setting Frequency and Power (Amplitude)

Figure 3-1 Frequency and Amplitude Softkeys



Example: Configuring a 700 MHz, –20 dBm Continuous Wave Output

1. Preset the signal generator.

   The signal generator displays its maximum specified frequency and minimum power level (the front panel display areas are shown on page 7).

2. Set the frequency to 700 MHz: Press **Freq** > **700** > **MHz**.

   The signal generator displays 700 MHz in both the FREQUENCY area of the display and the active entry area.

3. Set the amplitude to –20 dBm: Press **Amptd** > **–20** > **dBm**.

   The display changes to –20 dBm in the AMPLITUDE area of the display, and the amplitude value becomes the active entry. Amplitude remains the active function until you press another function key.

4. Turn on the RF Output: Press **RF On/Off**.

   The RF Output LED lights, and a 700 MHz, –20 dBm CW signal is available at the RF OUTPUT connector.

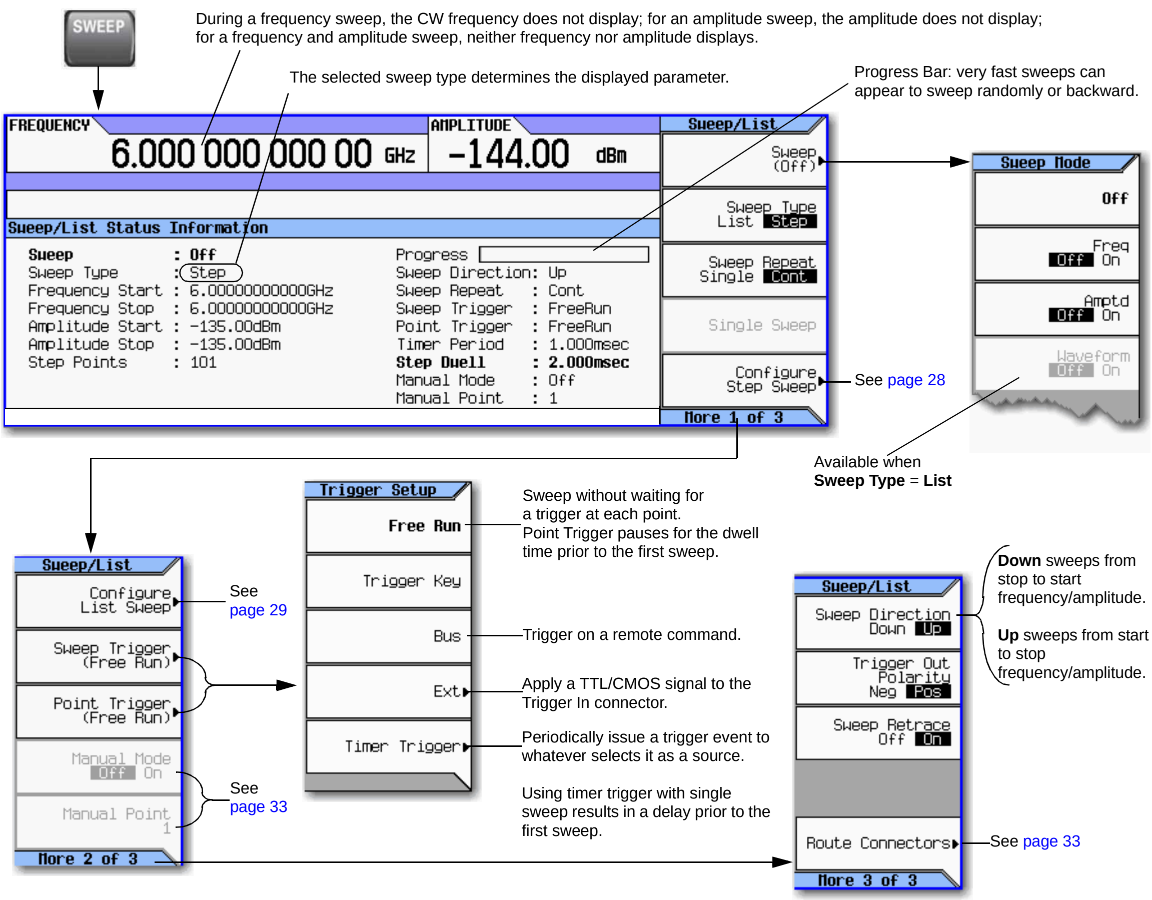
Configuring a Swept Output

The signal generator has two methods of sweeping through a set of frequency and amplitude points:

Step sweep (page 28) provides a linear or logarithmic progression from one selected frequency, or amplitude, or both to another, pausing at linearly or logarithmically spaced points (steps) along the sweep. The sweep can progress forward, backward, or manually.

List sweep (page 29) enables you to enter frequencies and amplitudes at unequal intervals, in nonlinear ascending, descending, or random order. List sweep also enables you to copy the current step sweep values, include an Arb waveform in a sweep (on a vector instrument), and save list sweep data in the file catalog (page 37).

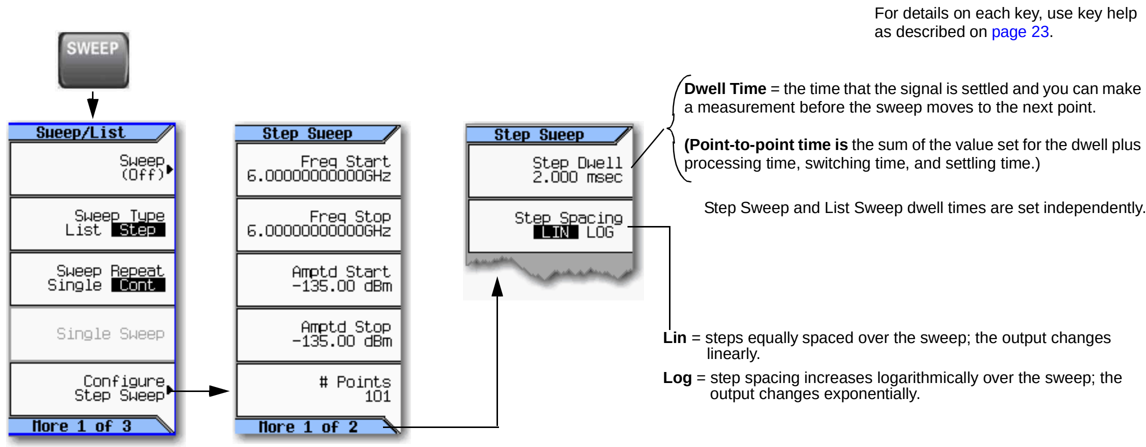
Figure 3-2 Sweep Softkeys



For details on each key, use key help as described on page 23.

Step Sweep

Step sweep provides a linear or logarithmic progression from one selected frequency, or amplitude, or both, to another, pausing at linearly or logarithmically spaced points (steps) along the sweep. The sweep can progress forward, backward, or manually.



Example: Configuring a Continuous, Linear Step Sweep

Output: A signal that continuously sweeps from 500 to 600 MHz and from –20 to 0 dBm, with a dwell time of 500 ms at each of six equally–spaced points.

1. Preset the instrument and open the Sweep/List menu: Press **Preset** > **SWEEP**.

   Because continuous is the default sweep repeat selection, and linear is the default step spacing selection, you do not need to set these parameters.

2. Open the step sweep menu: Press **Configure Step Sweep.**

3. Set the following parameters:

Start frequency 500 MHz:	Press **Freq Start** > **500** > **MHz**
Stop frequency 600 MHz:	Press **Freq Stop** > **600** > **MHz**
Amplitude at the beginning of the sweep, –20 dBm:	Press **Amptd Start** > **–20** > **dBm**
Amplitude at the end of the sweep, 0 dBm:	Press **Amptd Stop** > **0** > **dBm**.
6 sweep points:	Press **# Points** > **6** > **Enter**
Dwell time at each point, 500 milliseconds:	Press **More** > **Step Dwell** > **500** > **msec**

4. Sweep both frequency and amplitude: Press **Return** > **Return** > **Sweep** > **Freq Off On** > **Amptd Off On**.

   A continuous sweep begins, from the start frequency/amplitude to the stop frequency/amplitude. The SWEEP annunciator displays, both the CW frequency and the amplitude display blank (indicating that both are sweeping), and the progress bar shows the sweep progress.

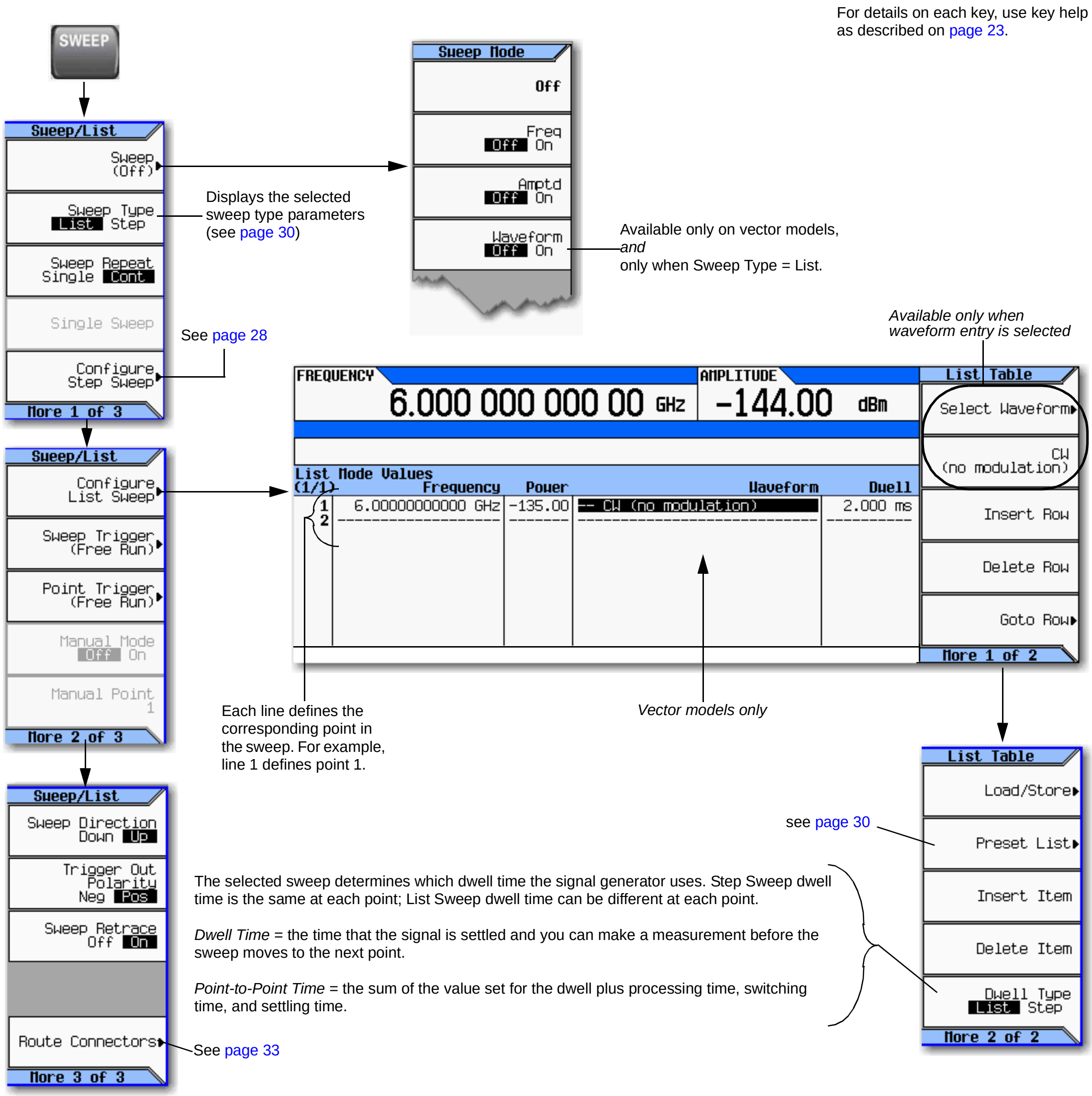
5. Turn the RF output on: Press **RF On/Off**.

   The RF LED lights, and the continuous sweep is available at the RF Output connector.

List Sweep

List sweep enables you to enter frequencies and amplitudes at unequal intervals in nonlinear ascending, descending, or random order. List sweep also enables you to copy the current step sweep values, include a waveform in a sweep (on a vector instrument), and save list sweep data in the file catalog (page 37). Dwell time is editable at each point.

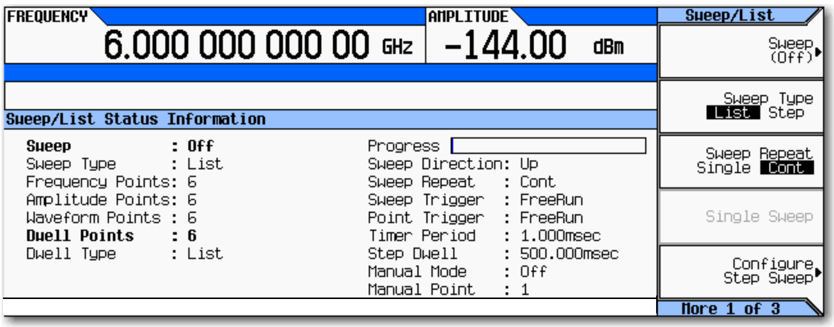
Figure 3-3 List Sweep Configuration Softkeys and Display



Example: Configuring a List Sweep Using Step Sweep Data

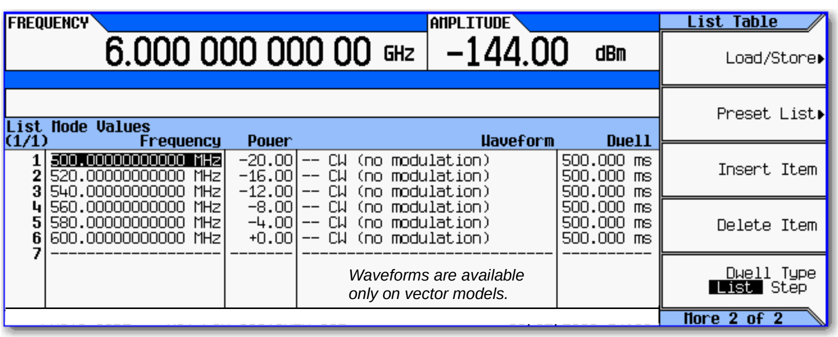
1. Set up the desired step sweep, but do not turn the sweep on. This example uses the step sweep configured on page 28.
2. In the SWEEP menu, change the sweep type to list:
   Press **SWEEP** > **Sweep Type List Step** to highlight List.

   The display shows sweep list parameters, as shown below.



3. Open the List Sweep menu: Press **More** > **Configure List Sweep**.
4. Clear any previously set values from the menu and load the points defined in the step sweep into the list: Press **More** > **Preset List** > **Preset with Step Sweep** > **Confirm Preset**.

   The display updates with the values loaded from the step sweep, as shown.



Vector Models:

Presetting the list clears any previously selected waveforms.

For information on selecting a list sweep waveform, see Example: Editing List Sweep Points on page 31.

5. Sweep frequency and amplitude: Press **SWEEP** (hardkey) > **Sweep** > **Freq Off On** > **Amptd Off On**.

   Setting the sweep turns on the sweep function; a continuous sweep begins. On the display, the SWEEP annunciator appears, and the progress bar shows the progression of the sweep.
6. If not already on, turn the RF output on: Press **RF On/Off**.
   The RF Output LED lights, and a continuous sweep is available at the RF OUTPUT connector.

Example: Editing List Sweep Points

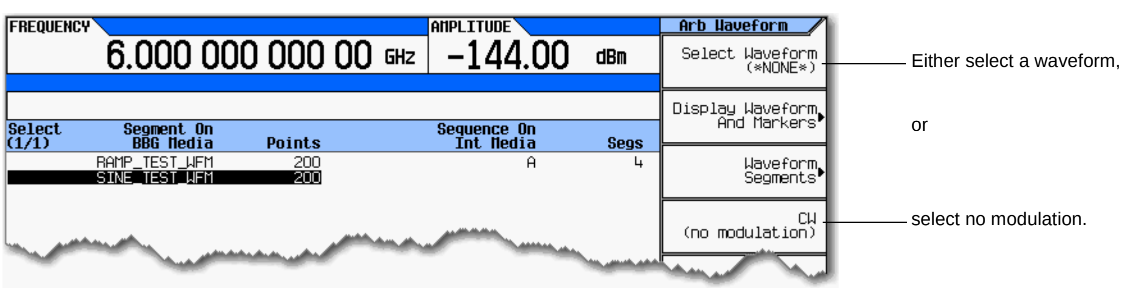
If you are not familiar with table editors, refer to page 25.

1. Create the desired list sweep. This example uses the list sweep created in the previous example.
2. If sweep is on, turn it off. Editing list sweep parameters with sweep on can generate an error.
3. Set the sweep type to list: Press **SWEEP** > **Sweep Type List Step** to highlight List.
4. In the List Mode Values table editor, change the point 1 dwell time (defined in row 1) to 100 ms:
   a. Press **More** > **Configure List Sweep**.
   b. Highlight the point 1 dwell time.
   c. Press **100** > **msec**.

   The next item in the table (the frequency value for point 2) highlights.
5. Change the selected frequency value to 445 MHz: Press **445** > **MHz**.
6. Add a new point between points 4 and 5: Highlight any entry in row 4 and press **Insert Row**.

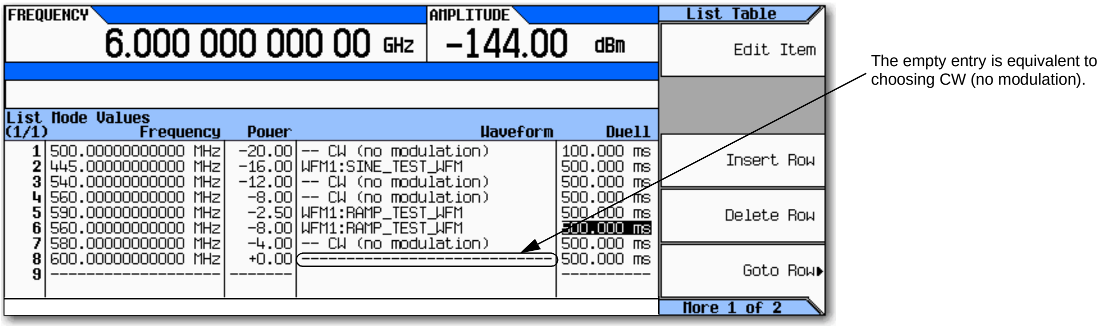
   This places a copy of row 4 below row 4, creating a new point 5, and renumbers subsequent rows.
7. Shift frequency values down one row, beginning at point 5: Highlight the frequency entry in row 5, then press **More** > **Insert Item**.

   This shifts the original frequency values for rows 5 and 6 down one row, and creates an entry for row 8 that contains only a frequency value (the power and dwell time entries do not shift down).
8. Change the still-active frequency value in row 5 to 590 MHz: Press **590** > **MHz**. The power in row 5 is now the active parameter.
9. Insert a new power value (–2.5 dBm) for point 5, and shift down the original power values for points 5 and 6 by one row: Press **Insert Item** > **–2.5** > **dBm**.
10. To complete the entry for point 8, insert a duplicate of the point 7 dwell time by shifting a copy of the existing value down: Highlight the dwell time in row 7 and press **Insert Item**.
11. *For an analog instrument, go to step* 14. For a vector instrument, continue with step 12.
12. Select a waveform for point 2:
   a. Highlight the waveform entry for point 2 and press the **More** > **Select Waveform**.
   The signal generator displays the available waveforms, as shown in the following example.



   b. Highlight the desired waveform (in this example, SINE_TEST) and press either the **Select** hardkey or the **Select Waveform** softkey.

13. As desired, repeat step 12 for the remaining points for which you want to select a waveform. The following figure shows an example of how this might look.



14. Turn sweep on:
    Press **Return** > **Return** > **Return** > **Sweep** > **Freq Off On** > **Amptd Off On** > **Waveform Off On**.

15. If it is not already on, turn the RF output on:
    Press **RF On/Off**.

    The SWEEP annunciator appears on the display, indicating that the signal generator is sweeping, and the progress bar shows the progression of the sweep.

Example: Using a Single Sweep

1. Set up either a step sweep (page 28) or a list sweep (page 30).
2. In the List/Sweep menu, set the sweep repeat to single:
   Press **Sweep Repeat Single Cont** to highlight Single.

   Sweep does not occur until you trigger it.

   Note that the WINIT annunciator appears on the display, indicating that the sweep is waiting to be initiated.
3. If not already on, turn the RF output on: Press **RF On/Off**.
4. Initiate the sweep: Press **Single Sweep**.

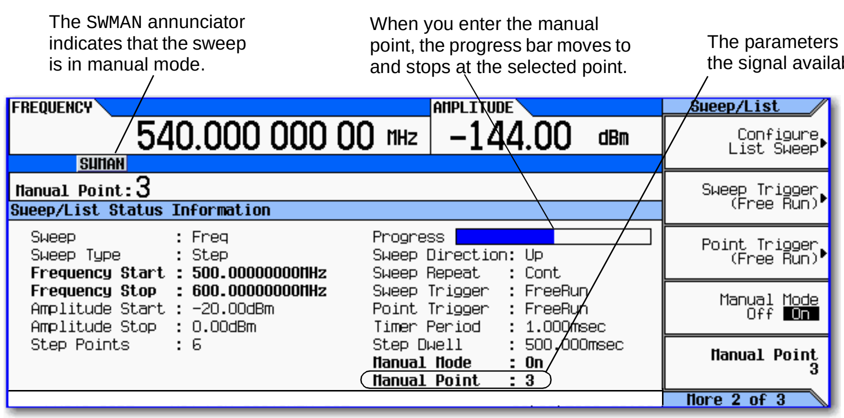
   A single repetition of the configured sweep is available at the RF Output connector.

   As the signal generator sweeps, the SWEEP annunciator replaces WINIT on the display, and the progress bar shows the progression of the sweep.

   At the end of the single sweep, there is no progress bar, and the WINIT annunciator replaces SWEEP.

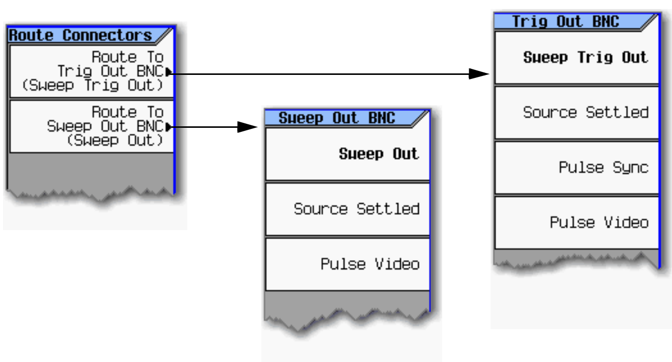
Example: Manual Control of Sweep

1. Set up either a step sweep (page 28) or a list sweep (page 30).
2. In the Sweep/List menu, select a parameter to sweep: Press **Sweep** > *parameter*.
3. Select manual mode: Press **Return** > **More** > **Manual Mode Off On**.
4. If it is not already on, turn the RF output on: Press **RF On/Off**.
5. Select the point to output: Press **Manual Point** > *number* > **Enter**.
6. Use the knob or arrow keys to move from point to point.



Routing Signals

Sweep > **More** > **More** > **Route Connectors** >



Select the signal that you want routed to each output connector.

For details on each key, use key help as described on page 23.

Modulating the Carrier Signal

To modulate the carrier signal, you must have both

- an active modulation format
  and
- modulation of the RF output enabled

Example

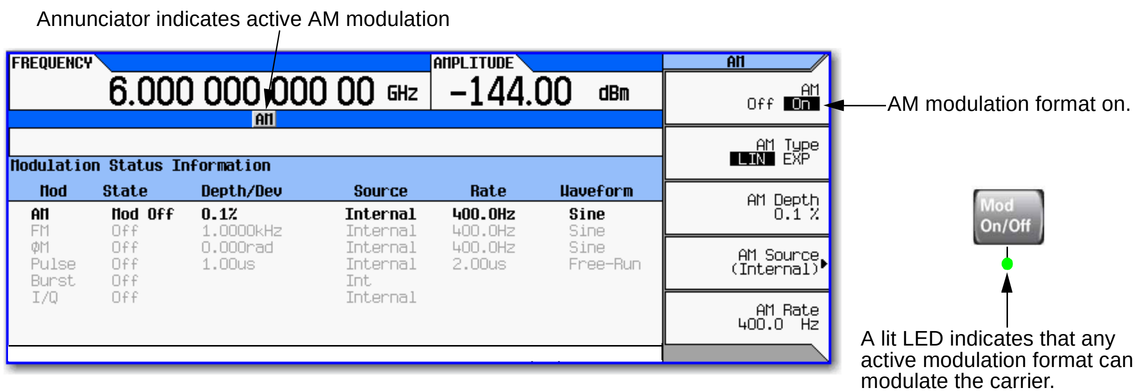
1. Preset the signal generator.
2. Turn on AM modulation: Press **AM** > **AM Off On** (requires Option UNT).

   You can turn on the modulation format before or after setting signal parameters.

   The modulation format generates, but does not yet modulate the carrier signal.

   Once the signal generates, an annunciator showing the name of the format appears, indicating that a modulation format is active.
3. Enable modulation of the RF output: Press the **Mod On/Off** key until the LED lights.

   If you enable modulation without an active modulation format, the carrier signal does not modulate until you subsequently turn on a modulation format.



NOTE To turn modulation *off*, press the **Mod On/Off** key until the LED turns off.

When the **Mod On/Off** key is off, the carrier signal is not modulated, even with an active modulation format.

4. To make the modulated carrier available at the RF output connector, press the **RF On/Off** key until the LED lights.

See also: "Using Analog Modulation (Option UNT Only)" on page 53
"Using Pulse Modulation (Option UNU)" on page 57
"I/Q Modulation" on page 121

Viewing, Saving, and Recalling Data

The signal generator enables you to store data as files and view those files in a file catalog. From the File Catalog (shown in Figure 3-4), you can delete, copy, or rename a stored file.

- Viewing a Stored File on page 36
- Saving and Recalling Data on page 37

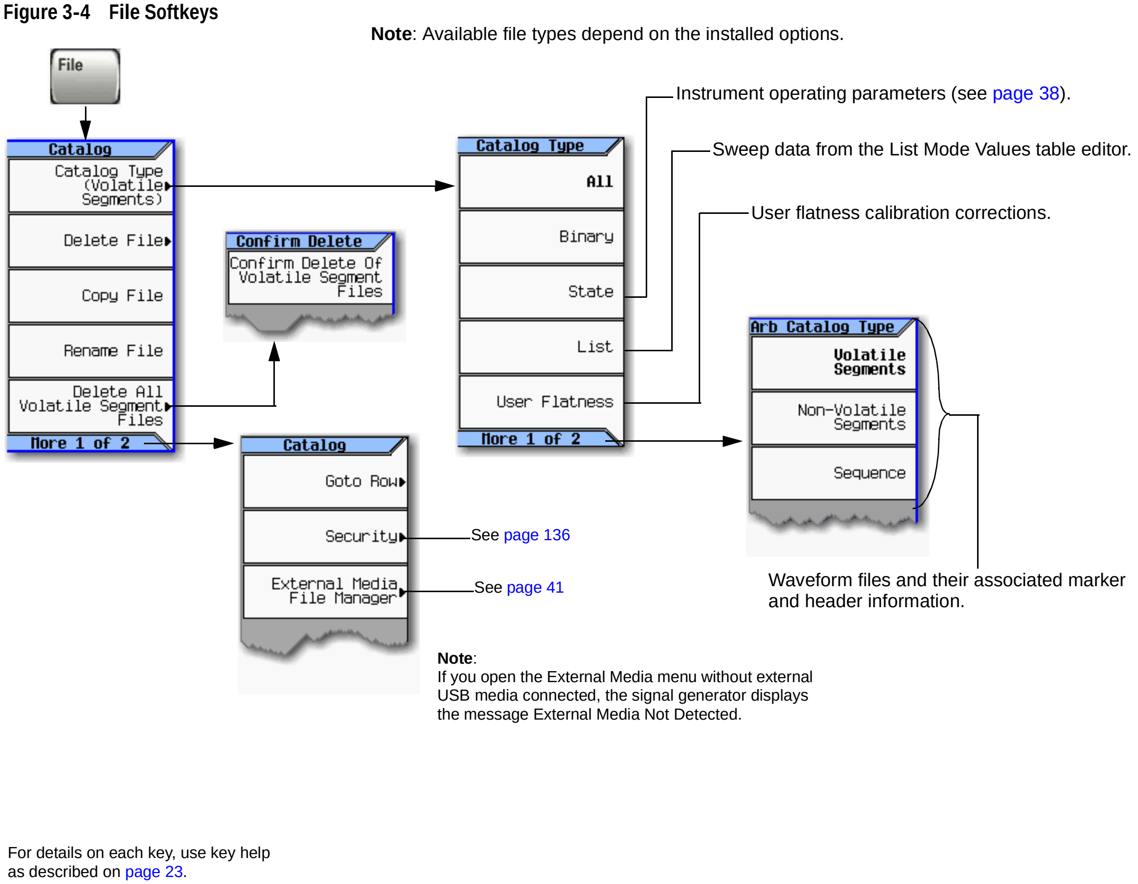
See also:

Working with Instrument State Files on page 38

Selecting Internal or External Media on page 41

Storing, Loading, and Playing a Waveform Segment on page 70.

Figure 3-4 File Softkeys



Viewing a Stored File

Files Stored in the Signal Generator

1. Press **File** > **Catalog Type** > *desired catalog*.

   The files in the catalog appear in alphabetical order. File information includes the file:

   - name
   - type
   - size
   - modification date and time

Files Stored on External Media

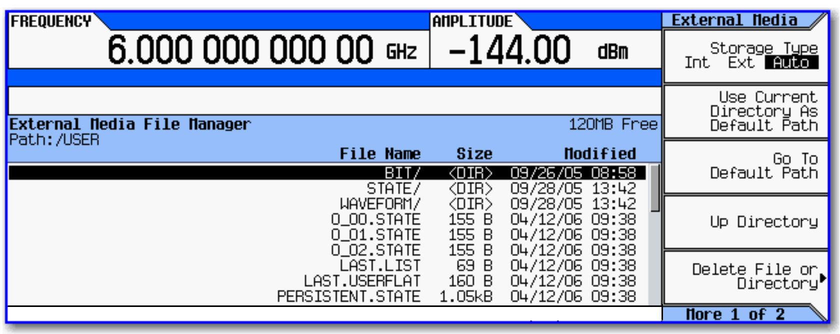
1. Connect the external media.

   The instrument displays the External Media directory.

2. Highlight the USER directory and press **Select**.

   The file directories on the external media appear in alphabetical order, as shown in the following figure.

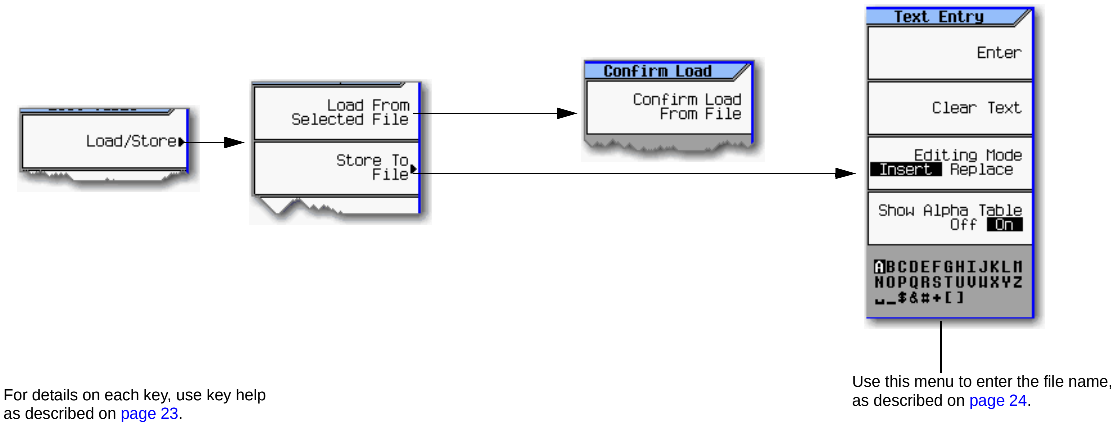
Use the **Page Up** and **Page Down** keys to see the contents of the USER directory.



Saving and Recalling Data

The method of storing and recalling data depends on the data.

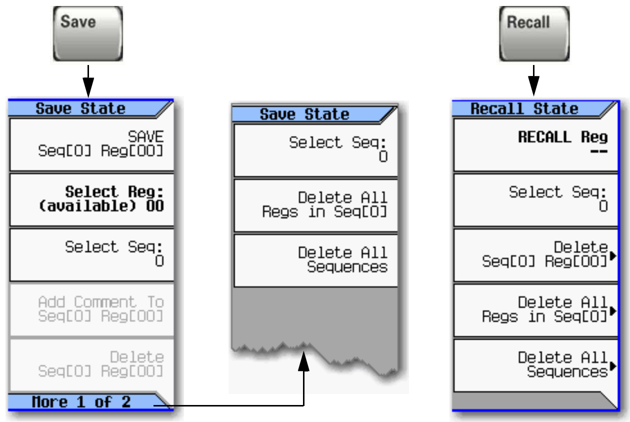
- An instrument state file contains instrument settings. For this type of file, use the **Save** and **Recall** hardkeys, shown in Figure 3-5 on page 38.
- For other types of data, use the **Load/Store** softkeys (shown below) that are available through the menu used to create the file.



NOTE File names are limited to 25 characters.

Working with Instrument State Files

Figure 3-5 Save and Recall Softkeys



For details on each key, use key help as described on page 23.

Instrument settings (states) save to instrument state memory, which is divided into 10 sequences (0 through 9); each sequence comprises 100 registers (00 through 99).

Delete softkeys in the **Save** and **Recall** menus enable you to delete the contents of a specific register, or the contents of all sequences in the state file catalog.

The signal generator requires that you confirm a deletion.

The following information is *not* stored in a state file:

System Security Level	List Mode Freq	Hostname	Remote Language	FM Deviation
System Security Level Display	List Mode Power	IP Address	FTP Server	PM Deviation
System Security Level State	List Mode Dwell	Subnet Mask	Manual DHCP	MAC
Web Server (HTTP)	List Mode Sequence	Default Gateway	VXI-11 SCPI	User Power Correction
Sockets SCPI (TELNET)	Display State On/Off	ARB Files	List Files	I/Q Calibration Data

Example: Saving an Instrument State

1. Preset the signal generator and set the following:
   - Frequency: 800 MHz
   - Amplitude: 0 dBm
   - RF: on
2. (Optional, vector models only) Associate a waveform file with these settings:
   a. Press **Mode** > **Dual ARB** > **Select Waveform**.
   b. Highlight the desired file and press **Select Waveform**. If the file is not listed, you must first move it from internal or external media to BBG media, see page 71.
3. Select the desired memory sequence (for this example, 1): Press **Save** > **Select Seq** > **1** > **Enter**.
4. Select the desired register (in this example, 01): Press **Select Reg** > **1** > **Save Reg**.

   If a waveform is currently selected, saving the instrument state also saves the waveform file *name*.
5. Add a descriptive comment to sequence 1 register 01:

   Press **Add Comment to Seq[1] Reg[01]**, enter the comment and press **Enter**. The comment appears in the Saved States list when you press **Recall**. If the instrument state has an associated waveform, entering the waveform name makes it easy to identify which instrument state applies to which waveform.

Example: Recalling an Instrument State

1. Preset the signal generator.
2. Press **Recall**.

   The **Select Seq** softkey shows the last sequence used, and the display lists any states stored in the registers in that sequence; **RECALL Reg** is the active entry.
3. Select the desired instrument state:

   If the desired state is listed in the currently selected sequence, press *desired number* > **Enter**. If not, press Press **Select Seq** > *desired number* > **Enter** > **RECALL Reg** > *desired number* > **Enter**.

Example: Recalling an Instrument State and Associated Waveform File

1. Recall the desired instrument state (see previous example).
2. View the waveform file name recalled with the instrument state: press **Mode** > **Dual ARB**.

   The name is displayed as the selected waveform. Recalling the instrument state recalls only the waveform *name*. It does not recreate the waveform file if it was deleted, or load the file into BBG media if it is in internal or external media.
3. Ensure that the desired waveform file exists, and that it is in BBG media (page 71). If the waveform file is not in BBG media, performing the next step generates an error.
4. Turn on the waveform file: Press **Mode** > **Dual ARB** > **ARB Off On**.

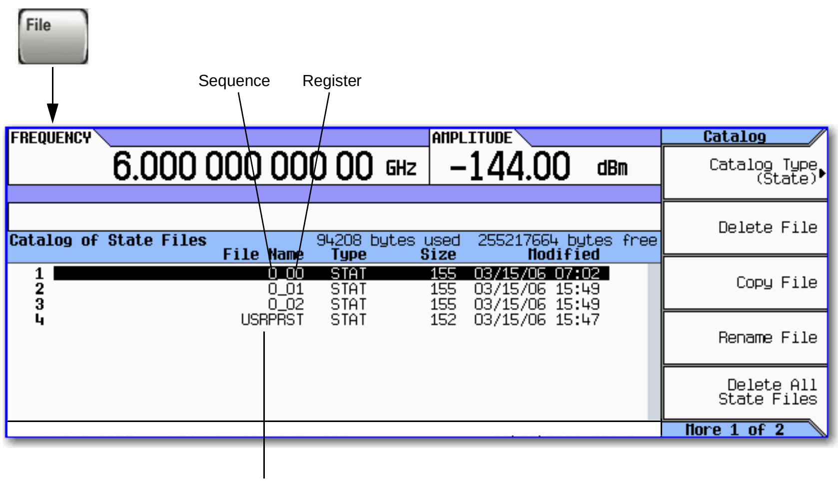
Example: Recalling an Instrument State and Associated List File

Recalling an instrument state recalls only the list sweep setup. It does not recall the frequency and/or amplitude values. Because you must load the list file from the file catalog, when you store a list file, be sure to give it a descriptive name (up to 25 characters).

1. Recall the desired instrument state (see previous example).
2. Recall the desired list file:
   a. Press **Sweep** > **More** > **Configure List Sweep** > **More** > **Load / Store**.
   b. Highlight the desired file and press **Load From Selected File** > **Confirm Load From File**.

Moving or Copying a Stored Instrument State

Figure 3-6 Instrument State File Catalog



A user-created state file's default name is its memory location.

To move the file, rename it to the desired sequence and register.

You can not give a file the same name as an existing file.

Caution
If you rename a state file to something other than a valid sequence/register name, the file does not appear in either the Save or Recall menu.

User Preset Information
If you rename this file, the signal generator no longer recognizes it as user preset information.

Defining a User Preset
Set up the instrument as desired, then press **User** > **Save User Preset**.

Creating More than One User Preset
Set up several preset conditions under different names; give the one you wish to use the name USRPRST. To use a different file, rename the current USRPRST, then give the desired file the name USRPRST.

Note
To define a user preset, set up the instrument as desired and press **User** > **Save User Preset**.

To change a comment on a saved instrument state:

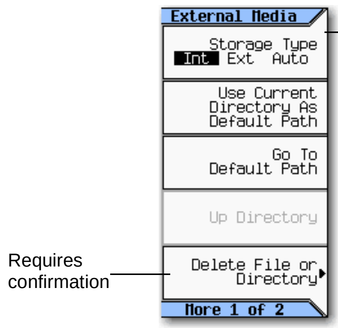
1. Press **Save**
2. Highlight the desired register
3. Press **Edit Comment In Seq[n] Reg [nn]**.
4. Press **Re-SAVE Seq[n] Reg[nn]**.

This overwrites previously saved instrument state settings with the new comment.

Selecting Internal or External Media

In the External Media menu (shown below), select the desired storage type.

File > **More** >
External Media File Manager >



Non-Volatile Storage

Int = Internal

Ext = External; if a memory stick is not connected, non-volatile storage is not available.

Auto = External if present, otherwise internal is used.

File Length (including extension)

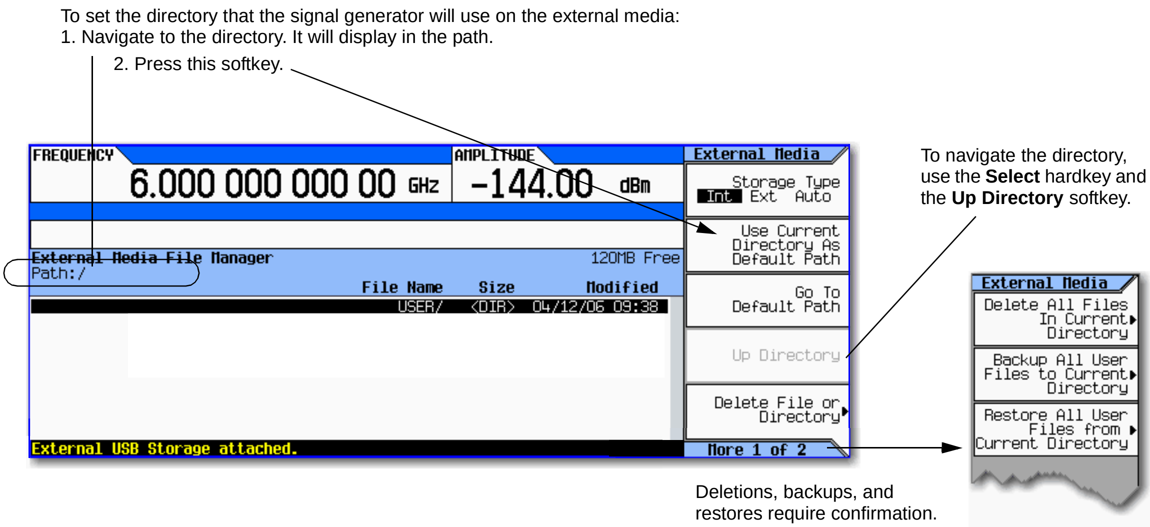
Internal Media: 25 characters

External Media: 39 characters

File Type	Extension	Save From	Pressing Select with file highlighted...
List	.list	Sweep menu	loads list and starts sweep
State	.state	Save menu	load instrument state
Waveform	.waveform	Mode menu	loads and plays waveform
User Flatness	.uflat	Amplitude menu	loads and applies user flatness
User Preset	.uprst	User Preset menu	loads and executes user preset
License	.lic	Agilent purchase	installs purchased license

Using External Media

When you connect storage media to the front panel USB connector, the signal generator displays the menu shown in the figure below, and the message `External USB Storage attached`. When you disconnect the USB media, the message `External USB Storage detached` displays. When you open the External Media menu without USB media connected, the signal generator displays the message `External Media Not Detected`.



The signal generator does not format external media, create directories, or change file permissions. Use a computer to perform these operations.

Reading Error Messages

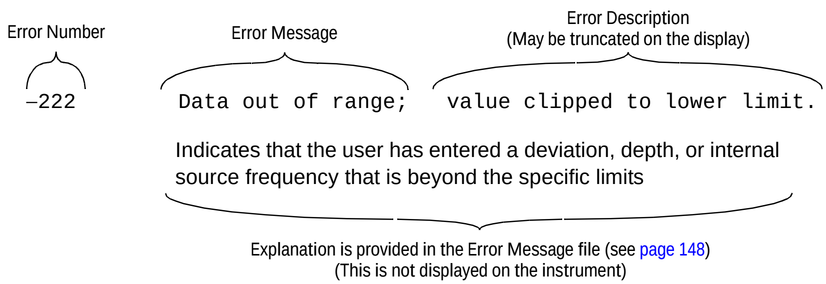
If an error condition occurs, the signal generator reports it to both the front panel display error queue and the SCPI (remote interface) error queue. These two queues are viewed and managed separately; for information on the SCPI error queue, refer to the *Programming Guide*.

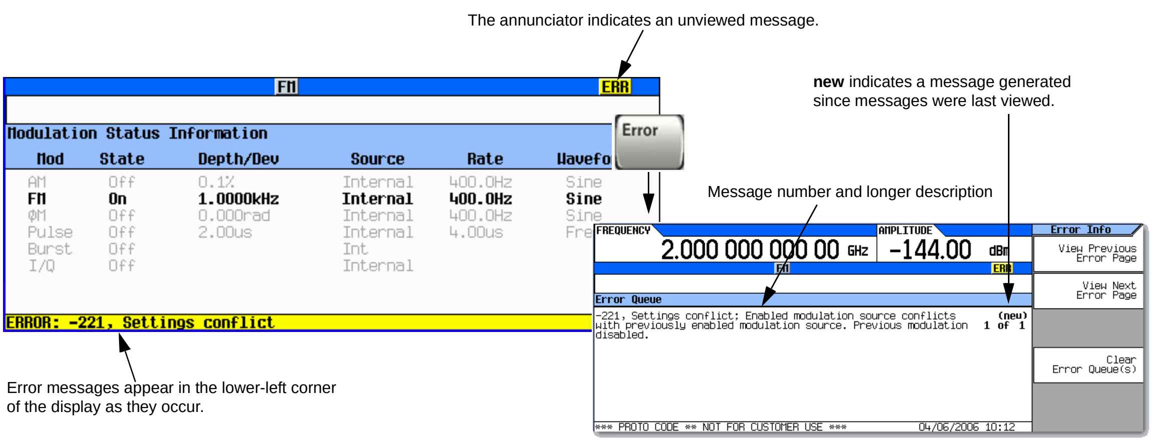
Characteristic	Front Panel Display Error Queue
Capacity (#errors)	30
Overflow Handling	Drops the oldest error as each new error comes in.
Viewing Entries	Press: **Error** > **View Next** (or **Previous**) **Error Page**
Clearing the Queue	Press: **Error** > **Clear Error Queue(s)**
Unresolved Errors[a]	Re-reported after queue is cleared.
No Errors	When the queue is empty (every error in the queue has been read, or the queue is cleared), the following message appears in the queue: `No Error Message(s) in Queue    0 of  0`

[a]Errors that must be resolved. For example, unlock.

Error Message Format

In the front panel display error queue, error messages display on an enumerated (“1 of N”) basis.





4 Optimizing Performance

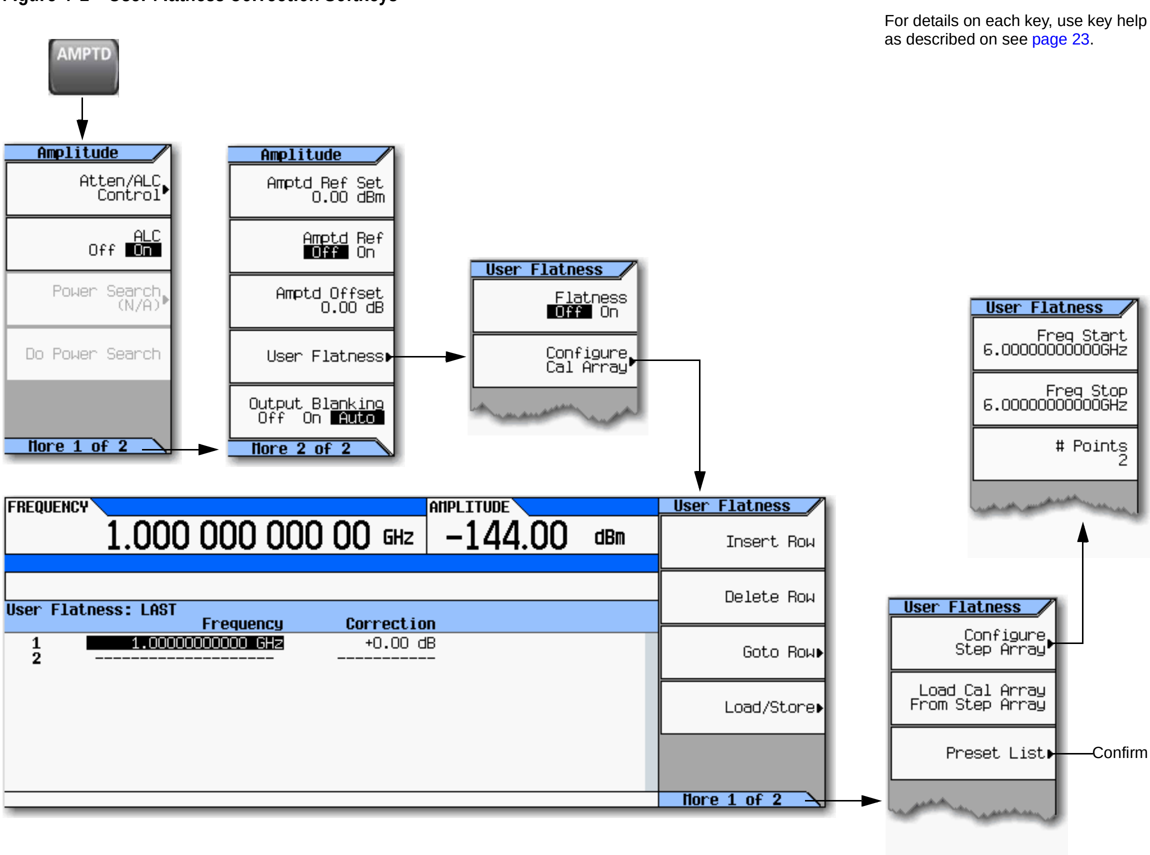
Before using this information, you should be familiar with the basic operation of the signal generator. If you are not comfortable with functions such as setting the power level and frequency, refer to Chapter 3, “Basic Operation,” on page 23 and familiarize yourself with the information in that chapter.

Using User Flatness Correction

User flatness correction enables you to adjust the RF output amplitude for up to 1601 sequential linearly or arbitrarily spaced frequency points to compensate for external losses in cables, switches, or other devices.

You can create and save individual user flatness correction tables, which enables you to recall different correction arrays for various test setups or frequency ranges (see page 46).

Figure 4-1 User Flatness Correction Softkeys



Basic Procedure

1. Create a user flatness array: Enter the user flatness correction values.
2. Optionally, save the user flatness correction data.
3. Apply user flatness correction to the RF Output.

Example: A 500 MHz to 1 GHz Flatness Correction Array with 10 Correction Values

Create the User Flatness Array

1. Configure the signal generator:
   a. Preset the signal generator.
   b. Open the User Flatness table editor and preset the cal array:
   Press **Amptd** > **More** > **User Flatness** > **Configure Cal Array** > **More** > **Preset List** > **Confirm Preset**.
   c. In the Step Array menu, enter the desired flatness-corrected frequencies:

   Press **Configure Step Array** >

   Freq Start > **500** > **MHz** >

   Freq Stop > **1** > **GHz** >

   # of Points > **10** > **Enter**

   d. Populate the user flatness correction array with the step array configured in the previous step:

   Press **Return** > **Load Cal Array From Step Array** > **Confirm Load From Step Data**.
   e. Set the output amplitude to 0 dBm.
   f. Turn on the RF output.
2. Connect the power meter to the RF output and manually enter the correction values:
   a. Open the User Flatness table editor and highlight the frequency value in row 1:
   Press **More** > **User Flatness** > **Configure Cal Array**.

   The RF output changes to the frequency value of the table row containing the cursor.
   b. Note the value measured by the power meter.
   c. Subtract the measured value from 0 dBm
   d. Highlight the correction value in row 1.
   e. Press **Select** > *the difference calculated in step c* > **Enter**.

   The signal generator adjusts the output amplitude based on the correction value entered.
   f. If the power meter does not read 0 dBm, adjust the value in step e until it does.
   g. Highlight the frequency value in the next row.
   h. Repeat steps b through g for this and the remaining rows.

   The user flatness correction array title displays `User Flatness:`, without a name, indicating that the current user flatness correction array data has not been saved to the file catalog.

Optional: Save the User Flatness Correction Data

1. Press **Load / Store** > **Store to File**.
2. Enter a file name (for this example, FLATCAL1) and press **Enter**.

   The user flatness correction array file is now stored in the file catalog as a UFLT file. Any user flatness correction files saved to the catalog can be recalled, loaded into the correction array, and applied to the RF output to satisfy specific RF output flatness requirements.
3. Press **Return**.

Enable the Flatness Correction at the RF Output

- Press **Return** > **Flatness Off On**.

  The UF annunciator appears in the AMPLITUDE area of the display, and the correction data in the array is applied to the RF output.

Recalling and Applying a User Flatness Correction Array

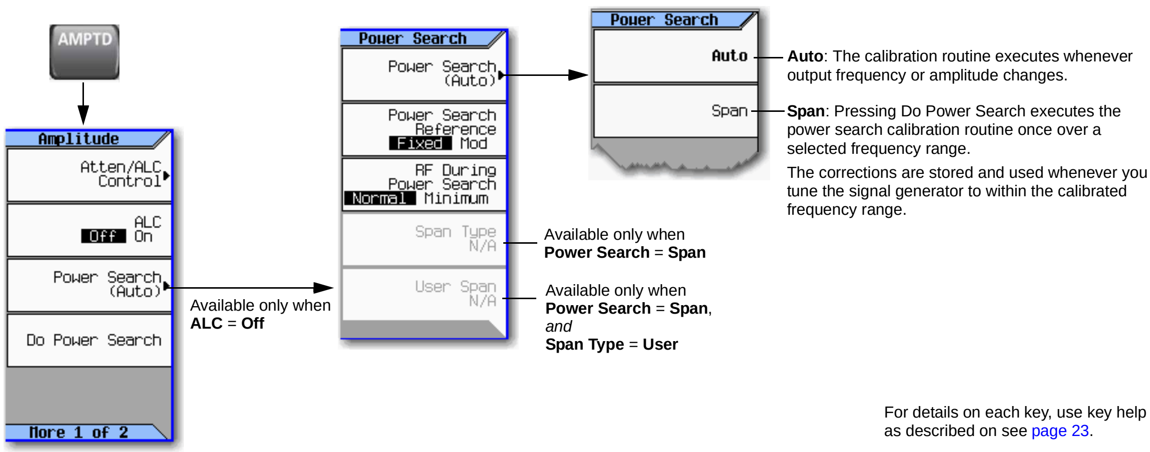
The following example assumes that a user flatness correction array has been created and stored. If not, perform the Example: A 500 MHz to 1 GHz Flatness Correction Array with 10 Correction Values on page 45.

1. Preset the signal generator.
2. Recall the desired User Flatness Correction file:
   a. Press **AMPTD** > **More** > **User Flatness** > **Configure Cal Array** > **More** > **Preset List** > **Confirm Preset**.
   b. Press **More** > **Load / Store**.
   c. Highlight the desired file.
   d. Populate the user flatness correction array with the data contained in the selected file: Press **Load From Selected File** > **Confirm Load From File**.

      The user flatness correction array title displays User Flatness: *Name of File*.
3. Apply the correction data in the array to the RF output: Press **Return** > **Flatness Off On**.

Using Unleveled Operating Modes

Figure 4-2 Power Search and ALC Off Softkeys



ALC Off Mode

Turning ALC off deactivates the signal generator's automatic leveling circuitry, enabling you to measure the output at a specific point in a test setup and adjust as required for the desired power level at that point. Turning ALC off is useful when the modulation consists of very narrow pulses that are below the pulse width specification of the ALC, or when the modulation consists of slow amplitude variations that the automatic leveling would remove.

1. Preset the signal generator.
2. Set the desired frequency.
3. Set the desired amplitude.
4. Connect the power meter to the point at which you want a specific power level.
5. Turn the RF output on.
6. Deactivate the signal generator's automatic leveling control: Press **AMPTD** > **ALC Off On** to highlight Off.
7. Adjust the signal generator's amplitude until the power meter measures the desired level.

Power Search Mode

Refer to Figure 4-2 on page 47. Power search executes a routine that temporarily activates the ALC, calibrates the power of the current RF output, and then disconnects the ALC circuitry.

NOTE For the power search routine to execute, RF must be on and ALC must be off.

Example: Automatic Power Search

1. Preset the signal generator.
2. Set the desired frequency.
3. Set the desired amplitude.
4. Turn the RF output on.
5. Deactivate the signal generator’s automatic leveling control:

   Press **AMPTD** > **ALC Off On** to highlight Off

   Deactivating the signal generator’s automatic leveling control is a significant instrument change that automatically initiates a power search.

When set to Auto, power search automatically executes when a significant instrument setting changes. The Do Power Search feature enables you to execute a power search to compensate for other changes, such as temperature drift or a change in the external input.

Using an Output Offset, Reference, or Multiplier

Setting an Output Offset

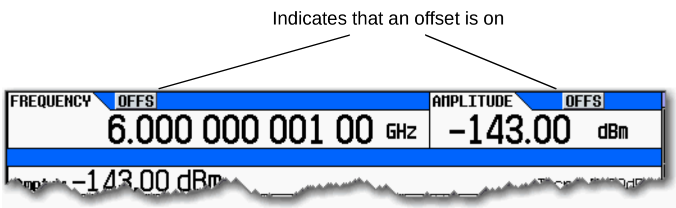
Using an output offset, the signal generator can output a frequency or amplitude that is offset (positive or negative) *from* the entered value.

RF Output = entered value – offset value

Displayed Value = output frequency + offset value

To set an offset:

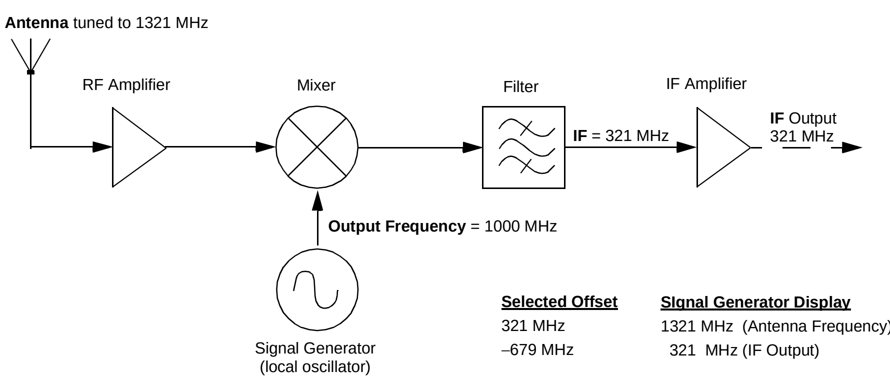
- *Frequency*: Press **Freq** > **Freq Offset** > *offset value* > *frequency unit*.
- *Amplitude*: Press **Amptd** > **More** > **Amptd Offset** > *offset value* > **dB**.



Examples

Parameter	Example #1	Example #2	Example #3	Comments
Entered (and displayed) Value:	300 MHz	300 MHz	2 GHz	The entered value must be positive.
Offset:	50 MHz	–50 MHz	–1 GHz	An offset value can be positive or negative.
Output Frequency:	250 MHz	350 MHz	3 GHz	The signal generator alerts you if the output frequency or amplitude is out of range.

When using the signal generator as a local oscillator (LO), you can use the offset to display the frequency of interest, as illustrated below:



Setting an Output Reference

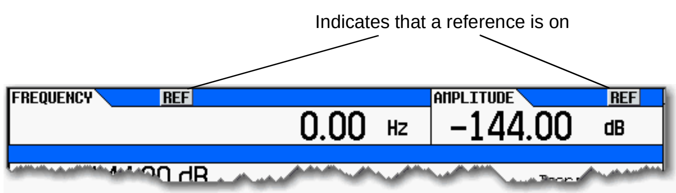
Using an output reference, the signal generator can output a frequency or amplitude that is offset (positive or negative) *by* the entered value *from* a chosen reference value.

RF Output = reference value + entered value

To set a reference:

1. Set the frequency or amplitude to the value you want as the output reference level.
2. *Frequency*: Press **Frequency** > **Freq Ref Set**
   The frequency displays 0.00 Hz, indicating that this is the RF output frequency “zero level.” All frequencies entered are interpreted as being relative to this reference frequency.

   Amplitude: Press **Amptd** > **More** > **Amptd Ref Set**
   The amplitude displays 0.00 dB, indicating that this is the RF output amplitude “zero level.” All amplitudes entered are interpreted as being relative to this reference amplitude.



Examples

Parameter	Example #1	Example #2	Example #3	Comments
Reference:	50 MHz	50 MHz	2 GHz	A reference value must be positive.
Entered (and displayed) Value:	2 MHz	–2 MHz	–1 GHz	The entered value can be positive or negative.
Output Frequency:	52 MHz	48 MHz	1 GHz	The signal generator alerts you if the output frequency or amplitude is out of range.

To set a new frequency or amplitude reference, turn the frequency reference off, and then follow the steps above.

Setting a Frequency Multiplier

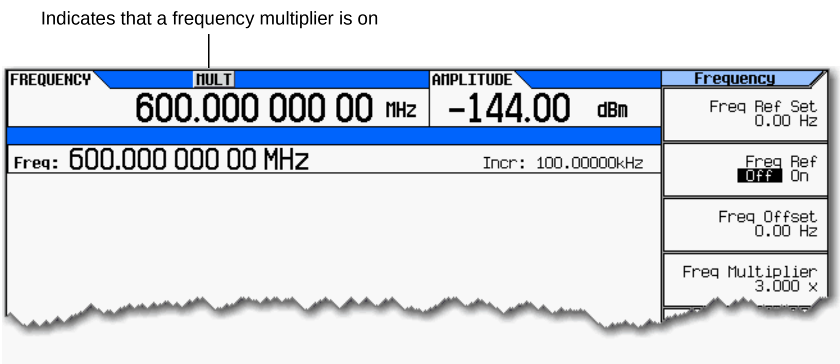
Using a frequency multiplier, the signal generator can display a frequency that is the multiple (positive or negative) of the output value.

Displayed Value = multiplier value × output frequency

Output Frequency = displayed value ÷ multiplier value

To set a frequency multiplier:

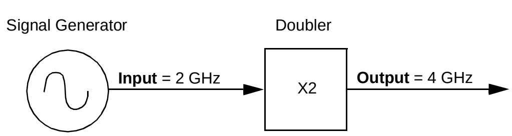
1. Press **Frequency** > **Freq Multiplier** > *multiplier value* > **x**.
2. Set the desired frequency.
   The display equals the output frequency times the multiplier value.



Examples

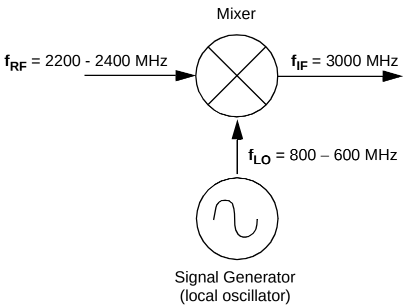
Parameter	Example #1	Example #2	Example #3	Comments
Frequency Multiplier:	3	–3	4	A multiplier value can be positive or negative.
Entered (and displayed) Value:	600 MHz	–600 MHz	8 GHz	
Output Frequency:	200 MHz	200 MHz	2 GHz	The signal generator alerts you if the output frequency is out of range.

When using the signal generator as the input to a system, you can set the frequency multiplier so that the signal generator displays the output of the system, as illustrated below using a doubler:



Selected Multiplier	Entered/Displayed Frequency	Signal Generator Output
2	4 GHz	2 GHz

When measuring mixers, the frequency multiplier and frequency offset are often used together. In the upconverter example below, the multiplier is set to −1 and the offset is set to 3 GHz so that the signal generator displays f_{RF}.



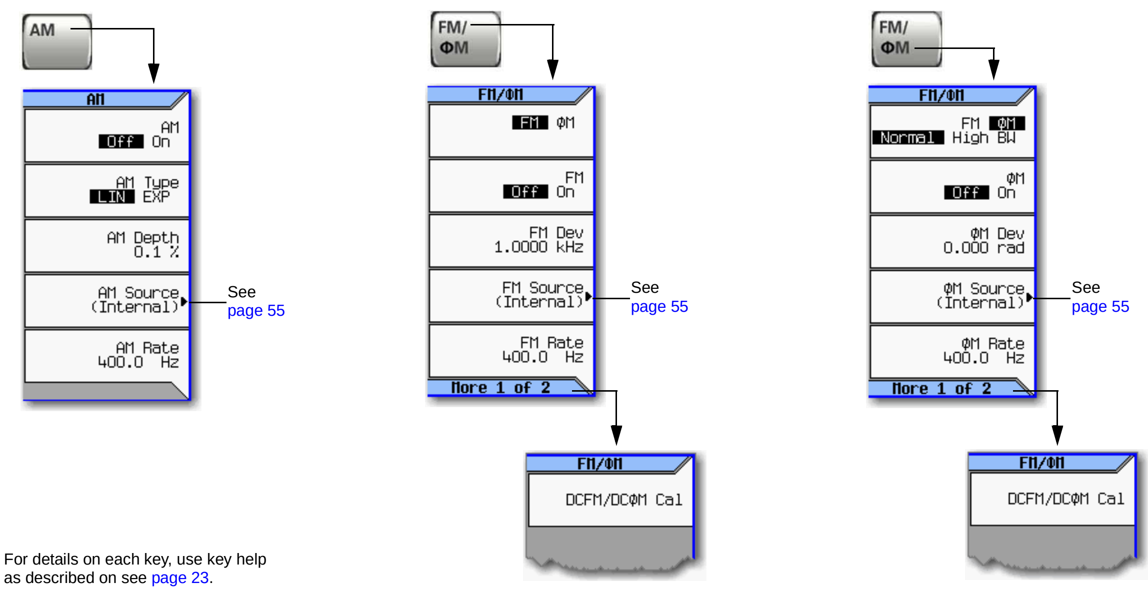
Selected Multiplier	Selected Offset	Entered/Displayed Frequency (f_{RF})	Signal Generator Output (f_{LO})
–1	3000 MHz	2200 MHz	800 MHz
–1	3000 MHz	2400 MHz	600 MHz

5 Using Analog Modulation (Option UNT Only)

Before using this information, you should be familiar with the basic operation of the signal generator. If you are not comfortable with functions such as setting the power level and frequency, refer to Chapter 3, “Basic Operation,” on page 23 and familiarize yourself with the information in that chapter.

- The Basic Procedure on page 54
- Using an External Modulation Source on page 55
- Removing a DC Offset on page 55

Figure 5-1 Analog Modulation Softkeys



The Basic Procedure

1. Preset the signal generator.
2. Set the carrier (RF) frequency.
3. Set the RF amplitude.
4. Configure the modulation:

AM	FM	ΦM
a. Press **AM**	a. Press **FM / ΦM**	a. Press **FM / ΦM** > **FM ΦM**
b. Set the AM type (linear or exponential): **AM Type** to highlight desired type	b. Set the deviation: **FM Dev** > *value* > *frequency unit*	b. Set the BW (normal or high): **FM ΦM** to highlight desired type
c. Set the depth: **AM Depth** > *value* > **%**	c. Set the rate: **FM Rate** > *value* > *frequency unit*	c. Set the deviation: **ΦM Dev** > *value* > **pi rad**
d. Set the rate: **AM Rate** > *value* > *frequency unit*		d. Set the rate: **ΦM Rate** > *value* > *frequency unit*

5. Turn on the modulation:

AM	FM	ΦM
AM Off On softkey to On	**FM Off On** softkey to On	**ΦM Off On** softkey to On

The appropriate modulation annunciator displays, indicating that you enabled modulation.

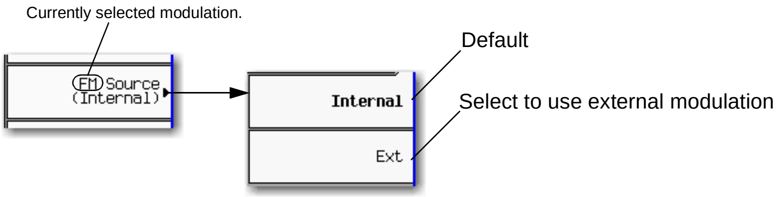
6. Turn on the RF output.

The RF output LED lights, indicating that the signal is transmitting from the RF output connector.

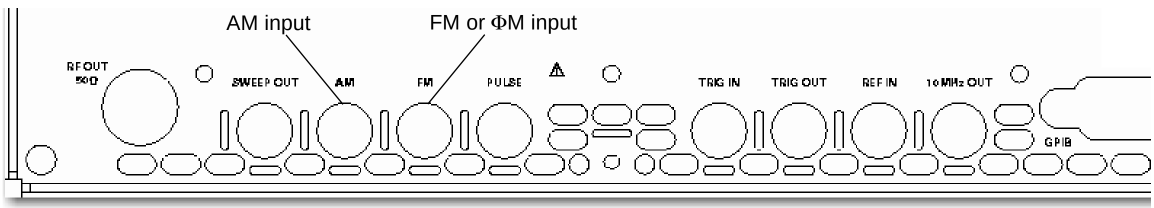
If the modulation does not seem to be working properly, refer to "No Modulation at the RF Output" on page 143.

See also "Modulating the Carrier Signal" on page 34.

Using an External Modulation Source



Rear panel inputs are described on page 9



Removing a DC Offset

To eliminate an offset in an externally applied FM or ΦM signal, perform a DCFM or DCΦM Calibration.

NOTE You can perform this calibration for internally generated signals, but DC offset is not usually a characteristic of an internally generated signal.

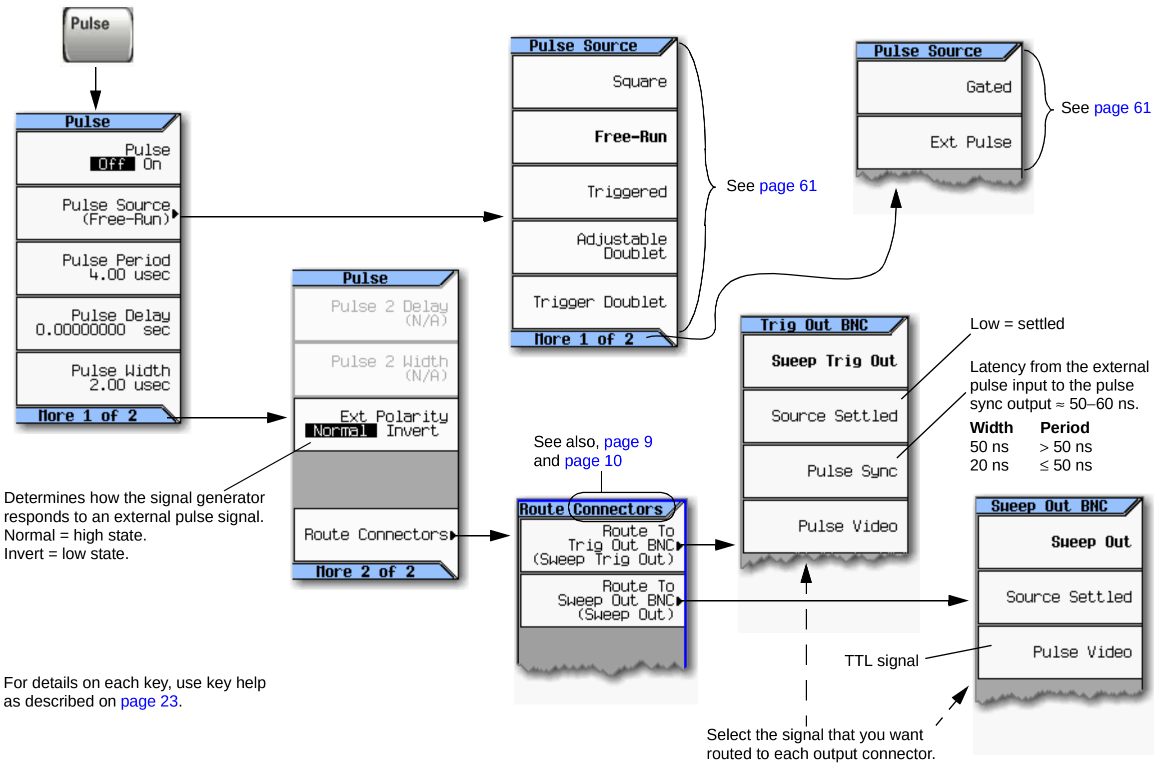
1. Set up and turn on the desired modulation.
2. Press **FM / ΦM** > **More** > **DCFM / DCΦM Cal**.

Performing the calibration with a DC signal applied removes any deviation caused by the DC signal, and the applied DC level becomes the new zero reference point. When you disconnect the DC signal, perform the calibration again to reset the carrier to the correct zero reference.

6 Using Pulse Modulation (Option UNU)

Before using this information, you should be familiar with the basic operation of the signal generator. If you are not comfortable with functions such as setting the power level and frequency, refer to Chapter 3, “Basic Operation,” on page 23 and familiarize yourself with the information in that chapter.

Figure 6-1 Pulse Softkeys



Pulse Characteristics

NOTE When using very narrow pulses that are below the signal generator's ALC pulse width specification, or leveled pulses with an unusually long duty cycle, it is often useful to turn ALC off (see page 47).

Pulse Source	Type	Period[a]	Width & Delay[a]	Uses Trigger Event[b]
Square	Internal free run pulse train with 50% duty cycle.	Determined by user defined rate.	—	—
Free Run (default)	Internal free run pulse train	User Defined	User Defined	—
Triggered	Internal pulse train	—	User Defined	✓
Adjustable Doublet	Two internal pulse trains for each trigger event.	—	User Defined: First pulse is relative to the rising edge of trigger signal. Second pulse is relative to the rising edge of first pulse. See Figure 6-2 on page 60	✓
Trigger Doublet	Two internal pulse trains for each trigger event.	—	The first pulse follows the trigger signal. Second pulse is user defined. See Figure 6-3 on page 60	✓
Gated	Internal gated pulse train	—	User Defined	✓
External	External pulse signal at the rear panel Pulse connector	—	—	—

[a]All delays, widths, and periods have a resolution of 10 ns.
[b]A signal at the rear panel pulse connector must be held high for at least 20 ns to trigger an internally generated pulse.

Rear panel inputs are described on page 9

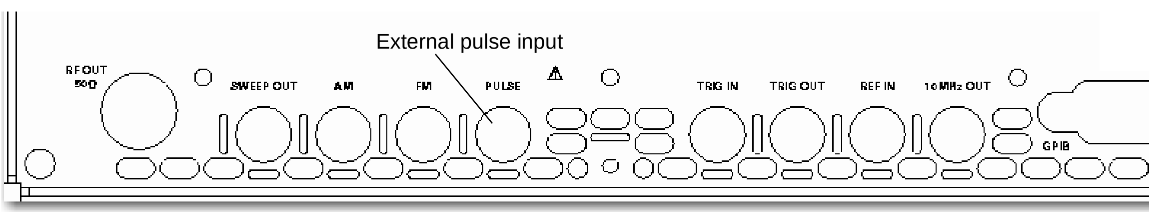


Figure 6-2 Adjustable Doublet

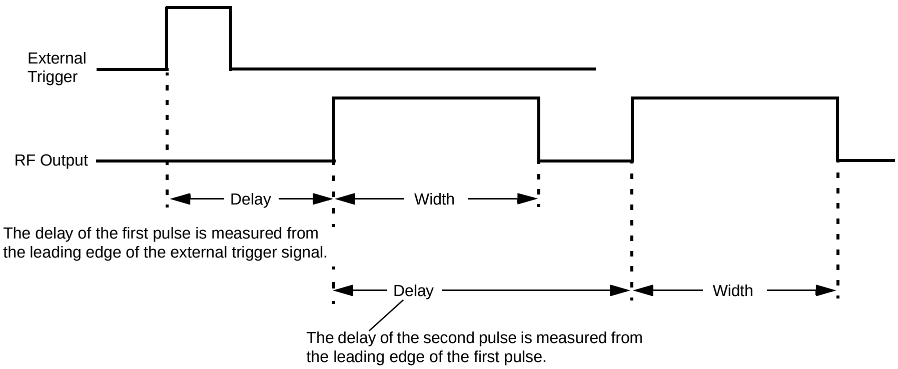
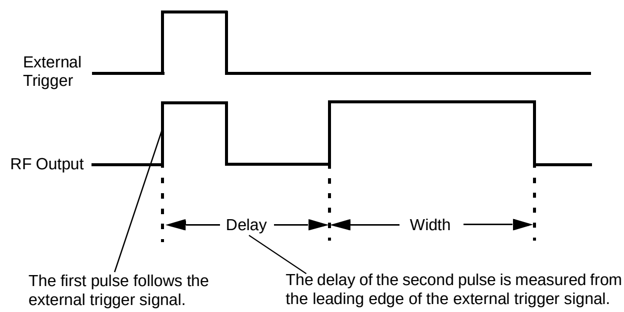


Figure 6-3 Trigger Doublet



The Basic Procedure

1. Preset the signal generator.
2. Set the carrier (RF) frequency.
3. Set the RF amplitude.
4. Configure the modulation:
   a. Set the pulse source: Press **Pulse** > **Pulse Source** > *selection*
   b. Set the parameters for the selected pulse source:

Square	Free Run (default)	Triggered	Adjustable Doublet	Trigger Doublet	Gated	External
Pulse Rate	—	—	—	—	—	—
—	Pulse Period	—	—	—	Pulse Period	—
—	Pulse Delay	Pulse Delay	Pulse Delay	Pulse Delay	—	—
—	Pulse Width	Pulse Width	Pulse Width	Pulse Width	Pulse Width	—
—	—	—	Pulse 2 Delay	—	—	—
—	—	—	Pulse 2 Width	—	—	—

5. Turn on the modulation: **Pulse Off On** softkey to On.
   The the PULSE annunciator lights, indicating that you enabled modulation.
6. Output the modulated signal from the signal generator: Press the front panel **RF On Off** key.

The RF output LED lights, indicating that the signal is transmitting from the RF output connector.

See also, "Modulating the Carrier Signal" on page 34.

Example

The following example uses the factory preset pulse source and delay.

Output: A 2 GHz, 0 dBm carrier modulated by a 24 µs pulse that has a period of 100 µs.

1. Preset the signal generator.
2. Set the frequency to 2 GHz.
3. Set the amplitude to 0 dBm.
4. Set the pulse period to 100 microseconds: Press **Pulse** > **Pulse Period** > **100** > **usec**.
5. Set the pulse width to 24 microseconds: Press **Pulse** > **Pulse Width** > **24** > **usec**
6. Turn on both the pulse modulation and the RF output.
   The PULSE annunciator displays and the RF output LED lights.

If the modulation does not seem to be working properly, refer to "No Modulation at the RF Output" on page 143.

7 Basic Digital Operation—No BBG Option Installed

Before using this information, you should be familiar with the basic operation of the signal generator. If you are not comfortable with functions such as setting power level and frequency, refer to Chapter 3, “Basic Operation,” on page 23 and familiarize yourself with the information in that chapter.

See Also: “Adding Real-Time Noise to a Dual ARB Waveform” on page 130

I/Q Modulation

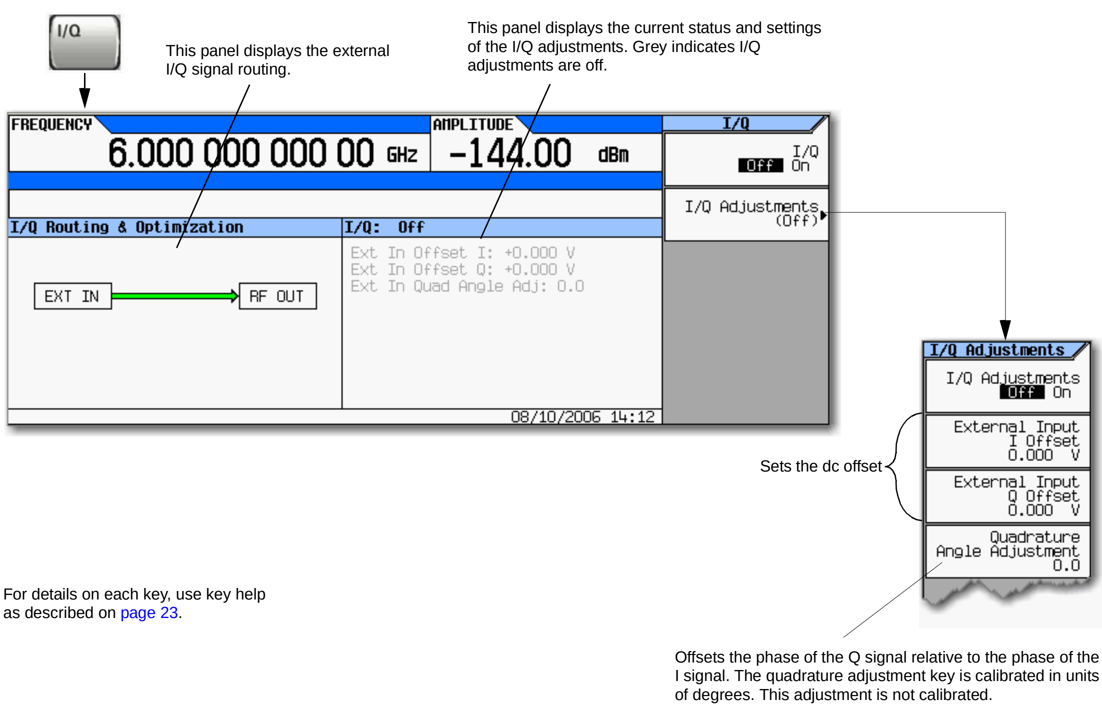
The following factors contribute to the error vector magnitude:

- Differences in amplitude, phase, and delay between the I and Q channels
- DC offsets

The I/Q menu provides adjustments to compensate for some of the differences in the I and Q signals or to add impairments.

See also, "Modulating the Carrier Signal" on page 34.

Figure 7-1 I/Q Display and Softkeys



The following table shows common uses for the adjustments.

Table 7-1 I/Q Adjustments Uses

I/Q Adjustment	Effect	Impairment
Offset	Carrier Feedthrough	dc offset
Quadrature Angle	EVM error	phase skew
	I/Q Images	I/Q path delay

Configuring the Front Panel Inputs

The Agilent MXG accepts externally supplied analog I and Q signals through the front-panel I Input and Q Input for modulating onto the carrier.

1. Connect I and Q signals to the front panel connectors.
   a. Connect an analog I signal to the signal generator's front-panel I Input.
   b. Connect an analog Q signal to the signal generator's front-panel Q Input.
2. Turn on the I/Q modulator: Press **I/Q Off On** to On.
3. Configure the RF output:
   a. Set the carrier frequency.
   b. Set the carrier amplitude.
   c. Turn the RF output on.
4. Make adjustments to the I/Q signals (page 64) as needed.

8 Basic Digital Operation (Option 651 / 652 / 654)

Before using this information, you should be familiar with the basic operation of the signal generator. If you are not comfortable with functions such as setting power level and frequency, refer to Chapter 3, “Basic Operation,” on page 23 and familiarize yourself with the information in that chapter.

The features described in this chapter are available only in vector signal generators with Option 651, 652, or 654.

See Also: “Adding Real-Time Noise to a Dual ARB Waveform” on page 130

Waveform File Basics

There are two types of waveform files:

- A *segment* is a waveform file that you download to the signal generator.

  For information on creating and downloading waveform files, refer to the *Programming Guide*.

- A *sequence* is a file you create in the signal generator that contains pointers to one or more waveform files (segments, other sequences, or both).

  For information on creating sequences, see page 74.

Signal Generator Memory

The signal generator has two types of memory:

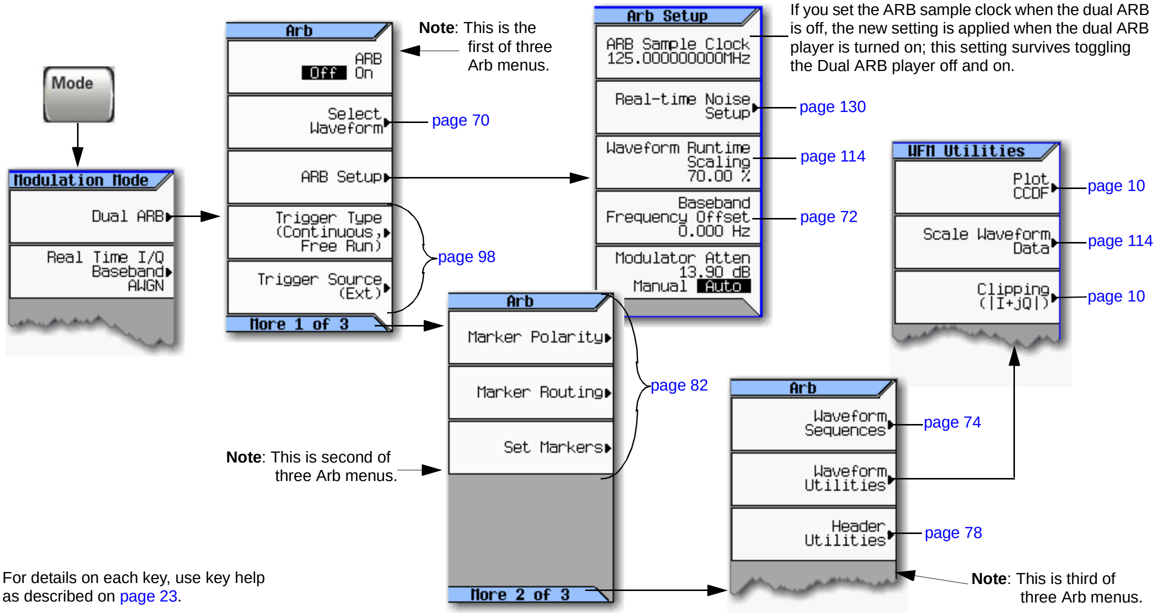
- *Volatile* memory, baseband generator (BBG) media, where waveform files are played from or edited.
- *Non-volatile* memory, either internal (int) or external (USB) media, where waveform files are stored.

Dual ARB Player

The dual ARB waveform player enables you to play, rename, delete, store, and load waveform files in addition to building waveform sequences. The dual ARB waveform player also provides markers (page 82), triggering (page 98), clipping (page 105), and scaling (page 114) capabilities.

Most procedures in this section start from the Dual ARB menu, shown below.

Figure 8-1 Dual ARB Softkeys

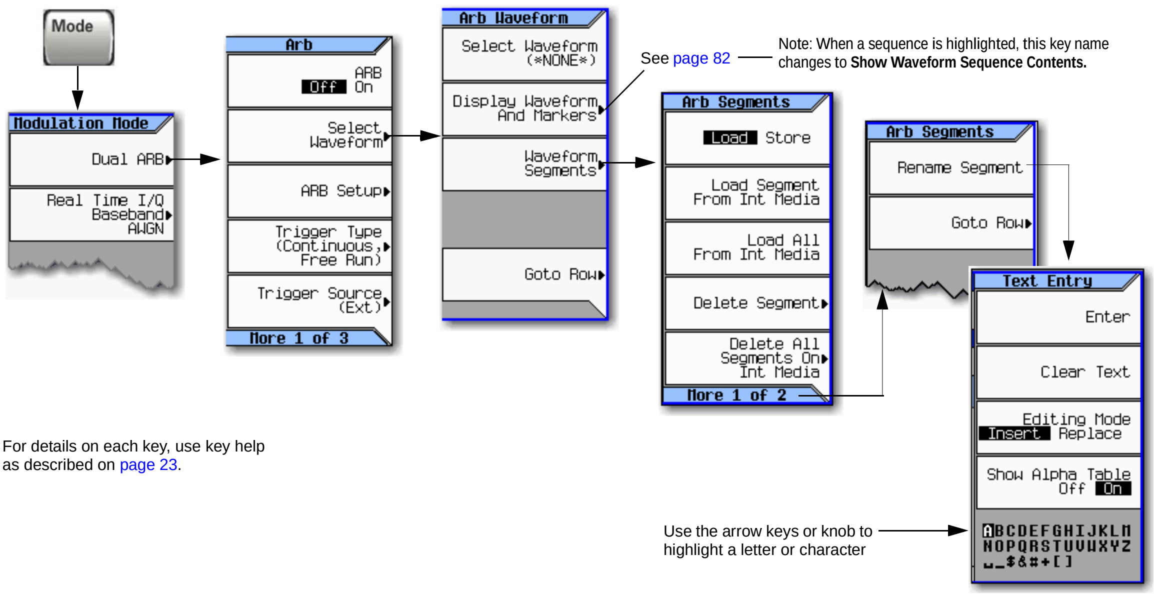


For details on each key, use key help as described on page 23.

Storing, Loading, and Playing a Waveform Segment

See also, Viewing, Saving, and Recalling Data on page 35.

Figure 8-2 Waveform Segment Softkeys



Storing/Renaming a Waveform Segment to Non-Volatile Memory (Internal or External Media)

Use the following steps to store a copy of a file in BBG memory to the currently selected media (page 41). If you have not downloaded a waveform segment, either refer to the *Programming Guide*, or use one of the factory-supplied segments.

1. Press **Mode** > **Dual ARB** > **Select Waveform** > **Waveform Segments**.
2. In the `Segment On BBG Media` column, highlight any waveform segment.
3. Press **Load Store** to highlight Store.
4. Highlight the waveform segment you want to store.
5. Optionally rename the segment.

   If there is already a copy of this segment in the currently selected media and you do not want to overwrite it, rename the waveform segment before you store it:

   a. Press **More** > **Rename Segment** > **Clear Text**.
   b. Enter a name for the waveform segment.
   c. Press **Enter** > **More**.
   d. Highlight the waveform segment that was renamed.

6. Press **Store Segment to** *currently selected* **Media**.

7. Repeat Step 4 through Step 6 for all segments that you want to store.

   To save *all* segments from BBG media to the currently selected media, press **Store All to** *currently selected* **Media**.

Loading a Waveform Segment into BBG Media (Volatile Memory)

Waveform segments must reside in BBG media before they can be played, edited, or included in a sequence. Cycling power or rebooting the signal generator deletes the files in BBG media.

NOTE Each time the instrument powers up, two factory-supplied segments are automatically created in BBG media: RAMP_TEST_WFM and SINE_TEST_WFM.

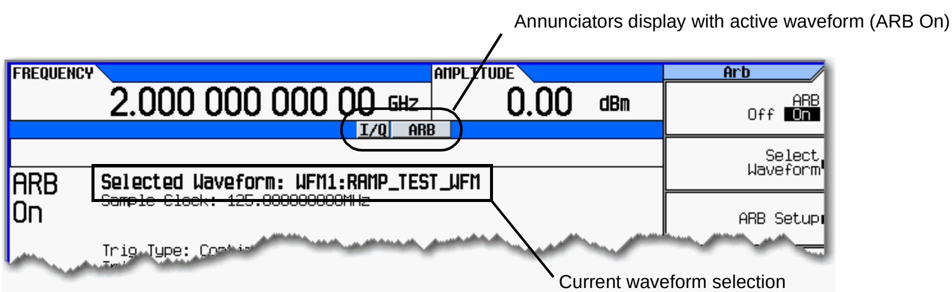
1. Press **Mode** > **Dual ARB** > **Select Waveform** > **Waveform Segments**.
2. Press **Load Store** to highlight Load.
3. Highlight the waveform segment you want to load.
4. If there is already a copy of this segment in the currently selected media and you do not want to overwrite it, rename the waveform segment before you load it (refer to the previous procedure).
5. Press **Load Segment From** *currently selected* **Media**.

   To load *all* files from the currently selected media into BBG media, press **Load All From** *currently selected* **Media**.

Playing a Waveform Segment

1. Press **Mode** > **Dual ARB** > **Select Waveform**.
2. In the Segment on BBG Media column, highlight the waveform segment you want to play.
3. Press **Select Waveform** > **ARB Off On** to On.

   This plays the selected waveform segment. During the waveform segment generation, both the I/Q and ARB annunciators turn on, and the waveform modulates the RF carrier.



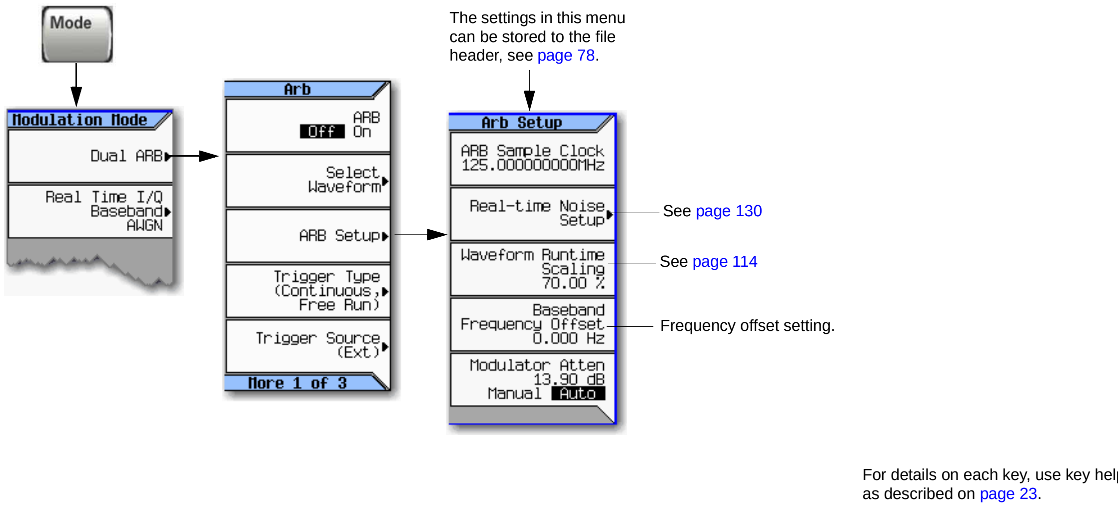
4. Configure the RF Output:

   a. Set the RF carrier frequency.
   b. Set the RF output amplitude.
   c. Turn on the RF output.

   The waveform segment is now available at the signal generator’s RF OUTPUT connector.

Setting the Baseband Frequency Offset

Figure 8-3 Baseband Frequency Offset Softkey



The baseband frequency offset enables you to shift the baseband frequency up to ±50 MHz within the BBG 100 MHz signal bandwidth, depending on the signal generator's baseband generator option. Common uses for the offset feature include:

- offsetting the carrier from any LO feedthrough (carrier signal spur at the carrier frequency)
- sum the baseband signal with external I and Q inputs to create a multicarrier signal
- use the signal generator's I/Q signal as an IF

NOTE Changing the baseband frequency offset may cause a DAC over range condition that generates error `628, Baseband Generator DAC over range`. When this occurs, reduce the waveform runtime scaling value (page 114).

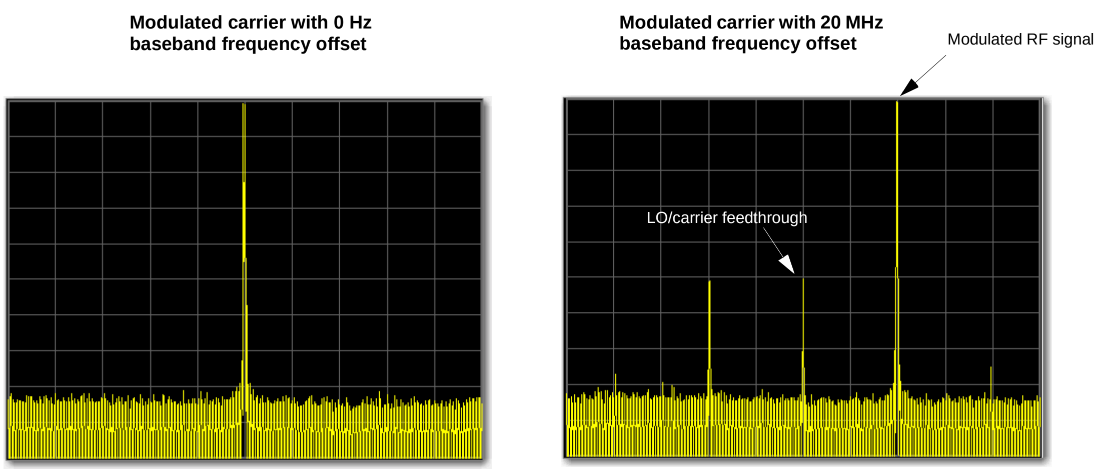
The baseband frequency offset value is one of the file header parameters (page 78), which means you can store this value with the waveform. When you select a waveform with a stored frequency offset value, the signal generator changes the current value to match the stored file header value. If there is no stored baseband offset frequency value for the current waveform, the signal generator uses the last set frequency offset value.

You can also use the Save function (page 35) to store this value as part of the signal generator setup. When you Recall a setup stored with the Save function, the baseband frequency offset value becomes the current instrument setting value, disregarding the stored file header value.

Use the following steps to offset the carrier from LO/carrier feedthrough. This example uses the factory supplied waveform, `SINE_TEST_WFM`. To view the output for this example, connect the RF OUTPUT of the signal generator to the input of a spectrum analyzer.

1. Select and play the waveform.
   a. Press **Mode** > **Dual ARB** > **Select Waveform**.
   b. In the `Segment On BBG Media` column, select `SINE_TEST_WFM`.
   c. Press **Select Waveform**.
2. Generate the waveform: Press **ARB Off On** to On.
3. Configure the carrier signal:
   a. Set the carrier signal to 1 GHz.
   b. Set the amplitude to 0 dBm.
   c. Turn on the RF OUTPUT.
4. Press **ARB Setup** > **Baseband Frequency Offset > 20 MHz.**

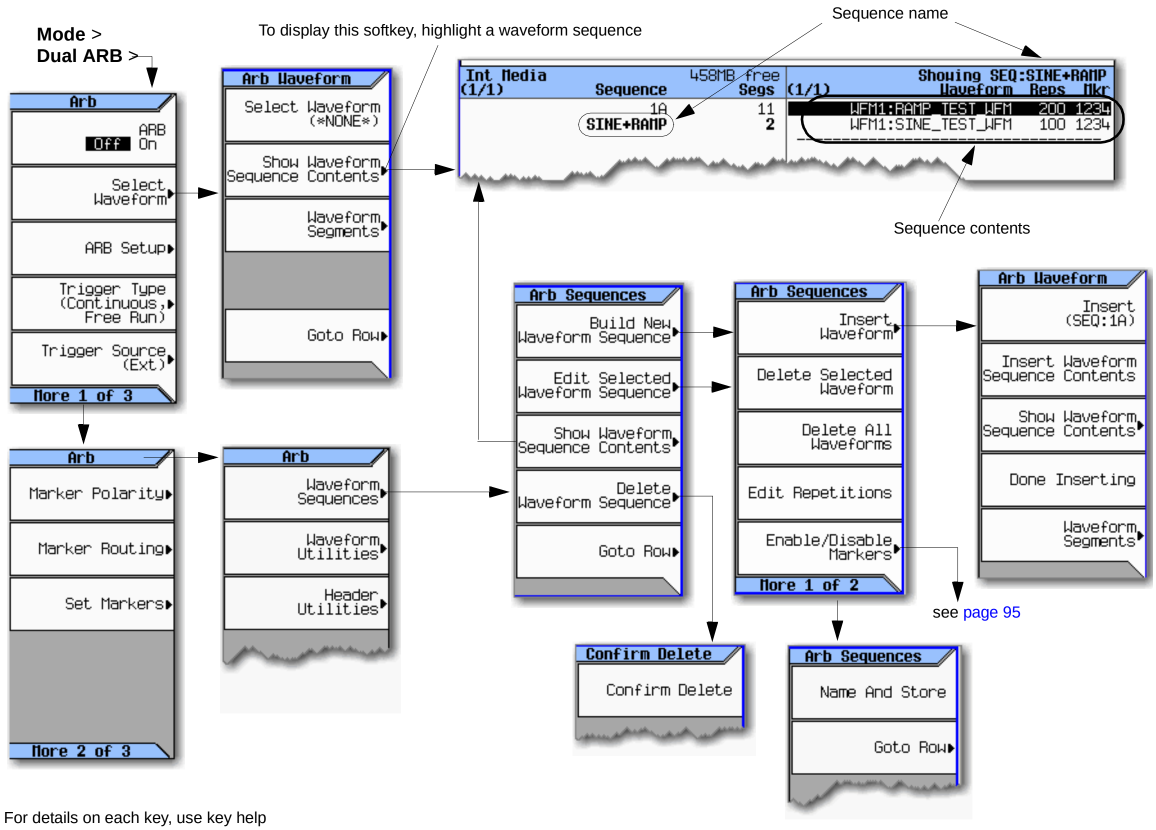
   The modulated RF signal is now offset from the carrier frequency by 20 MHz as shown in the following figures.



Spectrum analyzer set to a span of 100 MHz

Waveform Sequences

Figure 8-4 Waveform Sequence Softkeys



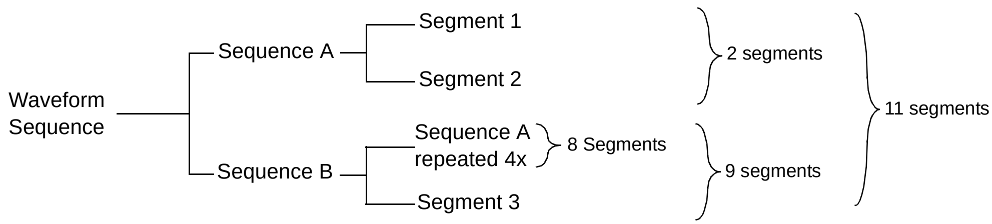
For details on each key, use key help as described on page 23.

A waveform sequence is a file that contains pointers to one or more waveform segments or other waveform sequences, or both. This lets the signal generator play multiple waveform segments, or other sequences, or both thereby eliminating the need to stop waveform playback just to select another waveform.

The segments that a waveform sequence points to are *not* automatically stored when you store the sequence; you must also store the individual segments or they are lost when you turn off or reboot the signal generator. If the segments are located in internal/external media, you must load them into BBG media prior to selecting a waveform sequence. If you attempt to play a sequence without the segments loaded into BBG media, the signal generator reports: `ERROR: 629, File format invalid`. If this happens and the segments are not stored in internal/external media, you must recreate the segments using the same file names that the sequence points to before you can play the sequence.

Creating a Sequence

A waveform sequence can contain up to 1,024 segments and have both segments and other sequences (nested sequences). The signal generator lets you set the number of times the segments and nested sequences repeat during play back. But there is a difference between repeating a segment versus repeating a nested sequence. Each segment can repeat up to 65,535 times, but no matter how many times a segment repeats, it counts as a single segment. However each repetition of a nested sequence counts as additional segments.



The maximum number of times that a nested sequence can repeat is based on the number of segments in the nested sequence and the remaining number of allowed segments (1,024). For example, with a sequence that contains 24 segments and one nested sequence with 4 segments, the nested sequence is limited to 250 repetitions:

$24 + (4 \times 250) = 1{,}024$ maximum number of segments per sequence

Even though there is a limiting factor on the maximum number of times that a nested sequence can repeat, each segment within the nested sequence can repeat up to 65,535 times.

Example

Use the following procedure to create and store a waveform sequence using one repetition each of two different segments.

Assumption: The waveform segments are in BBG media (volatile memory). For information on loading waveform segments into BBG media, see page 71.

1. Select the first segment:
   a. Press **Mode** > **Dual ARB** > **More** > **More** > **Waveform Sequences** > **Build New Waveform Sequence** > **Insert Waveform**.
   b. Highlight the desired waveform segment and press **Insert**.
2. Select the second segment:
   a. Highlight the next desired waveform segment and press **Insert**.
   b. Press **Done Inserting**
3. Name and store the waveform sequence to the Seq file catalog:
   a. Press **More** > **Name and Store**.
   b. Enter a file name and press **Enter**.

See also, "Viewing the Contents of a Sequence" on page 76 and "Setting Marker Points in a Waveform Segment" on page 89.

Viewing the Contents of a Sequence

There are two ways to view the contents of a waveform sequence, through the **Waveform Sequences** softkey or the **Select Waveform** softkey:

Waveform Sequences Softkey

1. Press **Mode** > **Dual ARB** > **More** > **More** > **Waveform Sequences**.
2. Highlight the desired sequence.
3. Press **Show Waveform Sequence Contents.**

Waveform Select Softkey

1. Press **Mode** > **Dual ARB** > **Select Waveform**.
2. In the `Sequence On` column, highlight the desired waveform sequence.
3. Press **Show Waveform Sequence Contents.**

Editing a Sequence

When editing a waveform sequence, you can:

- change the number of times each segment or nested sequence plays
- delete segments or nested sequences from the sequence
- add segments or nested sequences to the sequence
- toggle markers on and off (described on page 95)
- save changes either to the current waveform sequence or as a new sequence
  If you exit the sequence editing menu before saving changes, the changes are lost.
  Sequences save to the `Seq` file catalog.

CAUTION If you edit and resave a segment used in a sequence, the sequence does not automatically update the RMS value in its header. You must select and update the sequence header information (page 78).

Use the following steps to edit a sequence that has two different segments so that the first segment repeats 100 times and the second segment repeats 200 times, then save the changes.

Assumption: A waveform sequence that has two different segments has been created and stored (see previous example on page 75).

1. Select the sequence:
   Press **Mode** > **Dual ARB** > **More** > **More** > **Waveform Sequences** > *highlight the desired sequence* > **Edit Selected Waveform Sequence**.

2. Change the first segment so that it repeats 100 times:
   Highlight the first segment entry and press **Edit Repetitions > 100 > Enter**.

   The cursor moves to the next entry.

3. Change the repetition for the selected entry to 200:
   Press **Edit Repetitions > 200 > Enter**.

4. Save the changes made in the previous steps:
   Press **More** > **Name and Store** > **Enter**.

   To save the changes as a *new* sequence:

a. Press **More** > **Name and Store** > **Clear Text**.
b. Enter a file name (for example, SINE100+RMP200).
c. Press **Enter**.

The edited sequence saves as a new waveform sequence.

Playing a Sequence

If you have not created a waveform sequence, refer to “Creating a Sequence” on page 75.

NOTE To play a waveform segment individually or as part of a waveform sequence, the segment must reside in BBG media. See also, “Loading a Waveform Segment into BBG Media (Volatile Memory)” on page 71.

---

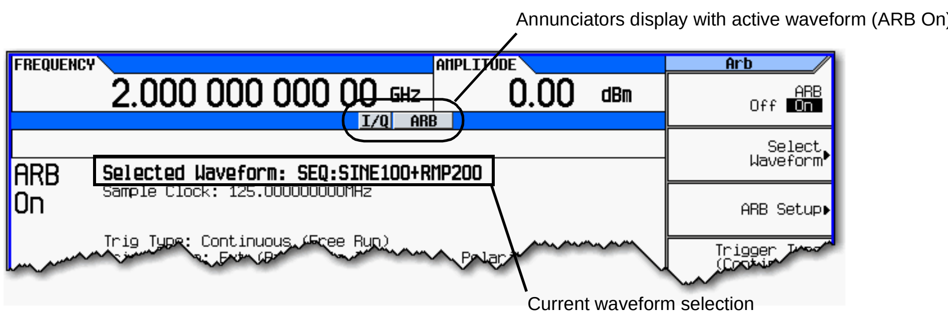
1. Select a waveform sequence:

   a. Press **Mode** > **Dual ARB** > **Select Waveform**.

   b. Highlight a waveform sequence (for this example, SINE100+RMP200) from the `Sequence On` column.

   c. Press **Select Waveform**.

   The display shows the currently selected waveform (for example, `Selected Waveform: SEQ:SINE100+RMP200`).



2. Generate the waveform:
   Press **ARB Off On** to On.

   This plays the selected waveform sequence. During the waveform sequence generation, both the `I/Q` and `ARB` annunciators turn on, and the waveform modulates the RF carrier.

3. Configure the RF output:

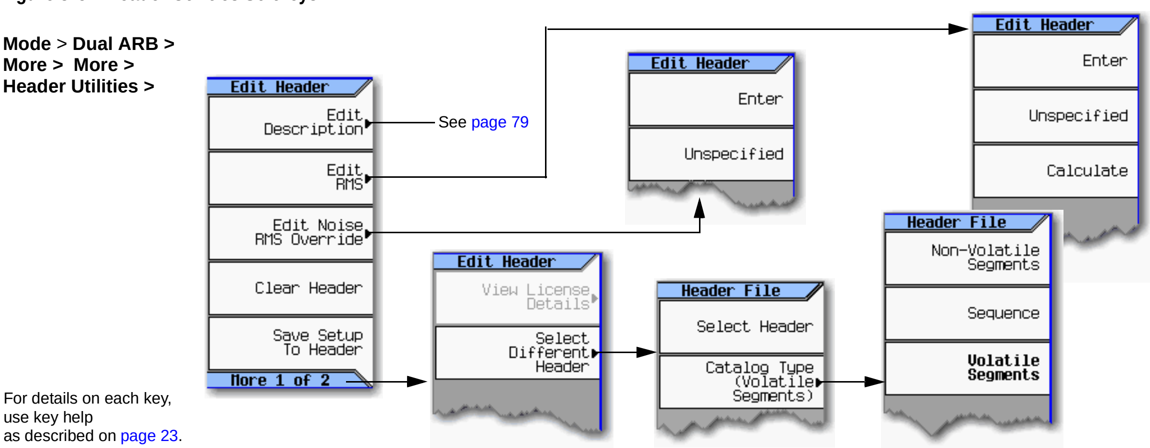
   a. Set the RF carrier frequency.
   b. Set the RF output amplitude.
   c. Turn on the RF output.

   The waveform sequence is now available at the signal generator’s RF OUTPUT connector.

Saving a Waveform’s Settings & Parameters

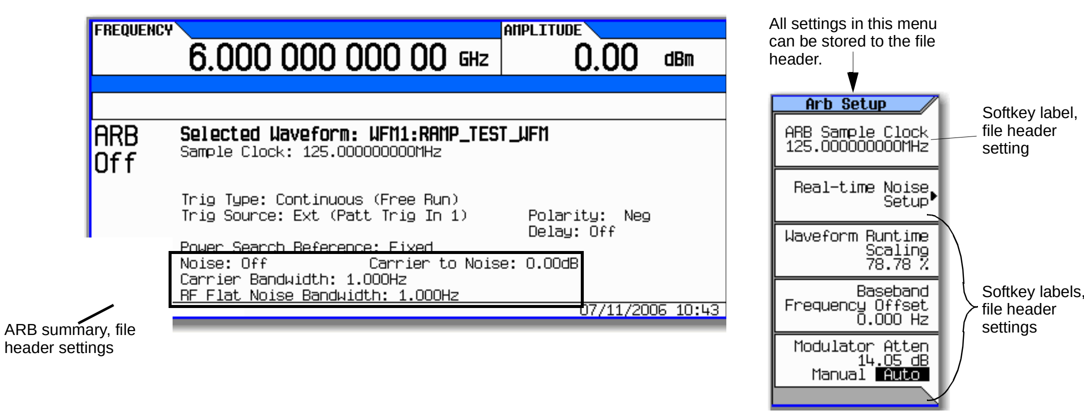
This section describes how to edit and save a file header. When you download only a waveform file (I/Q data, which the signal generator treats as a waveform segment), the signal generator automatically generates a file header and a marker file with the same name as the waveform file. Initially the file header has no signal generator settings saved to it, and the marker file consists of all zeros. For a given waveform, you can save signal generator settings and parameters in its file header and marker settings in its marker file (page 82); when you load a stored waveform file into BBG media, the file header and marker file settings automatically apply to the signal generator so that the dual ARB player sets up the same way each time the waveform file plays.

Figure 8-5 Header Utilities Softkeys



When you create a waveform sequence (as described on page 75), the signal generator automatically creates a waveform sequence header that takes priority over the individual waveform segment headers. During a waveform sequence playback, the segment headers are ignored, except to verify that all required options are installed. Storing a waveform sequence also stores its file header.

Some of the current signal generator settings shown in the file header, appear as part of the softkey labels and others appear in the dual ARB summary display, shown in the following example.



Viewing and Modifying Header Information

The following example uses the factory-supplied waveform file RAMP_TEST_WFM.

1. From BBG media, select the waveform RAMP_TEST_WFM:
   a. Press **Mode** > **Dual ARB** > **Select Waveform**.
   b. In the Segment On column, highlight the waveform RAMP_TEST_WFM.
   c. Press **Select Waveform**.
2. Open the Header Utilities menu:

   Press **More** > **More** > **Header Utilities**

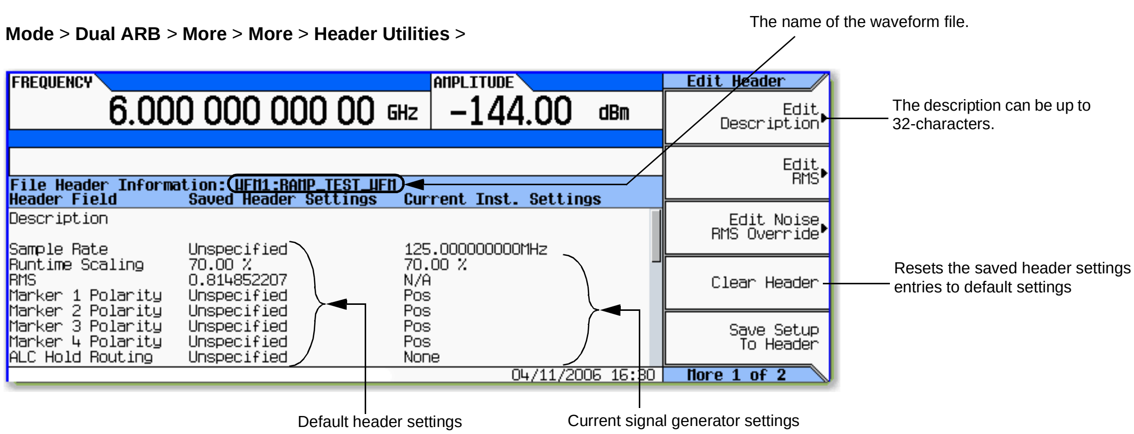
   The Figure 8-6 shows the default file header for the factory-supplied waveform RAMP_TEST_WFM. The Header Field column lists the file header parameters; use the **Page Down** key to see them all.

   The Saved Header Settings column shows that most of the settings are Unspecified. Unspecified means that there is no setting saved for that particular parameter.

   The Current Inst. Settings column shows the current signal generator settings. In this example, these are the settings that you will save to the file header.

NOTE If a setting is unspecified in the file header, the signal generator uses its current value for that setting when you select and play the waveform.

Figure 8-6 Example File Header



3. Save the information in the Current Inst. Settings column to the file header:

   Press **Save Setup To Header**.

   Both the Saved Header Settings column and the Current Inst. Settings column now display the same values; the Saved Header Settings column lists the settings saved in the file header.

4. Edit and Update Settings

   a. Return to the ARB Setup menu:
   Press **Return** > **More** > **ARB Setup**.

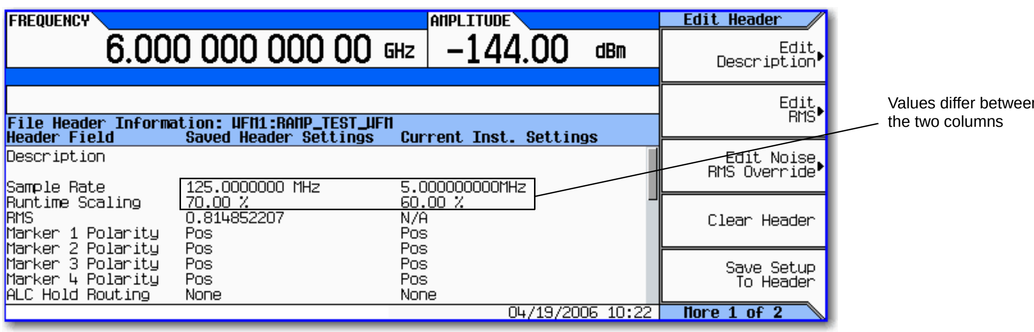
   From this menu you can access some of the signal generator settings that are saved to the file header. Figure 8-1 on page 69 shows the ARB Setup softkeys used in the following steps.

   b. Set the ARB sample clock to 5 MHz:
   Press **ARB Sample Clock** > **5** > **MHz**.

   c. Set waveform runtime scaling to 60%:
   Press **Waveform Runtime Scaling** > **60** > **%**.

   d. Return to the Header Utilities menu:
   Press **Return** > **More** > **More** > **Header Utilities**.

   As shown in the following figure, the `Current Inst. Settings` column now reflects the changes to the current signal generator setup, but the *saved* header values have not changed.



   e. Save the current settings to the file header:
   Press the **Save Setup To Header** softkey.

   The settings from the `Current Inst. Settings` column now appear in the `Saved Header Settings` column. This saves the new current instrument settings to the file header.

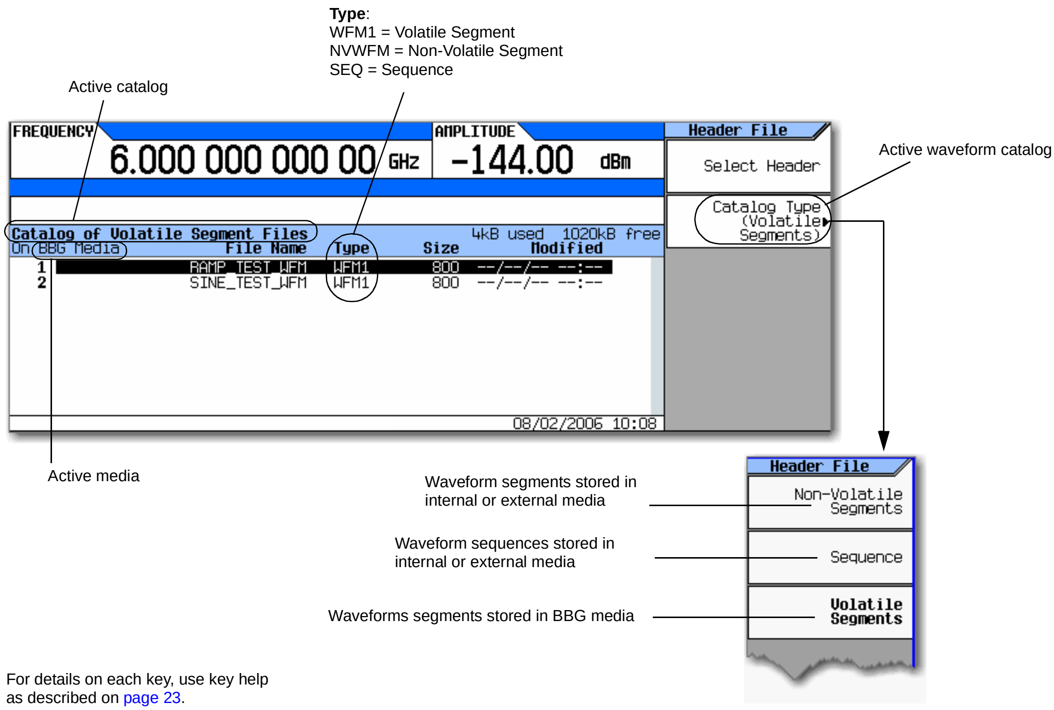
If you change any of the signal generator settings listed in the file header after you select the waveform file, the changed setting(s) appear in the file header's `Current Inst. Settings` column and are used instead of the saved header settings. To reapply the saved header settings, reselect the waveform for playback.

Viewing & Editing a Header without Selecting the Waveform

As described on page 79, you can view and edit a waveform’s header information after you select the waveform; you can also edit waveform header information without selecting a waveform, or for another waveform than the one that is currently selected.

1. Access the file header utilities menu:
   Press **Mode** > **Dual ARB** > **More** > **More** > **Header Utilities** > **More** > **Select Different Header**.

   The signal generator displays an alphabetical list of the waveform files in the media that was last selected. The following figure shows an example of the factory-supplied waveforms in BBG media.



2. If the desired catalog is not displayed, select it.
3. Highlight the desired waveform file and press **Select Header**.

   The signal generator displays the file header for the selected waveform file.
4. To edit the header, press **More**, and proceed as described in Step 4 on page 80 (Viewing and Modifying Header Information section).

Using Waveform Markers

The signal generator provides four waveform markers to mark specific points on a waveform *segment*. When the signal generator encounters an enabled marker, an auxiliary signal is routed to a rear panel event output that corresponds to the marker number.

- Event 1 is available at both the EVENT 1 BNC connector (see page 12), and a pin on the AUXILIARY I/O connector (see page 13).
- Events 2 through 4 are available at pins on the AUXILIARY I/O connector (see page 13).

You can use an auxiliary output signal to synchronize another instrument with the waveform, or as a trigger signal to start a measurement at a given point on a waveform.

You can also configure markers to initiate ALC hold or RF Blanking (which includes ALC hold). Refer to "Using Waveform Markers" on page 82 for details.

When you download a waveform file that does not have a marker file associated with it, the signal generator creates a marker file without any marker points. Factory-supplied segments have a marker point on the first sample for all four markers.

The following procedures demonstrate how to use markers while working in the dual ARB player. These procedures also discuss two types of points: a *marker point* and a sample point. A marker point is a point at which a given marker is set on a waveform; you can set one or more marker points for each marker. A *sample point* is one of the many points that compose a waveform.

There are three basic steps to using waveform markers:

"Clearing Marker Points from a Waveform Segment" on page 88

"Setting Marker Points in a Waveform Segment" on page 89

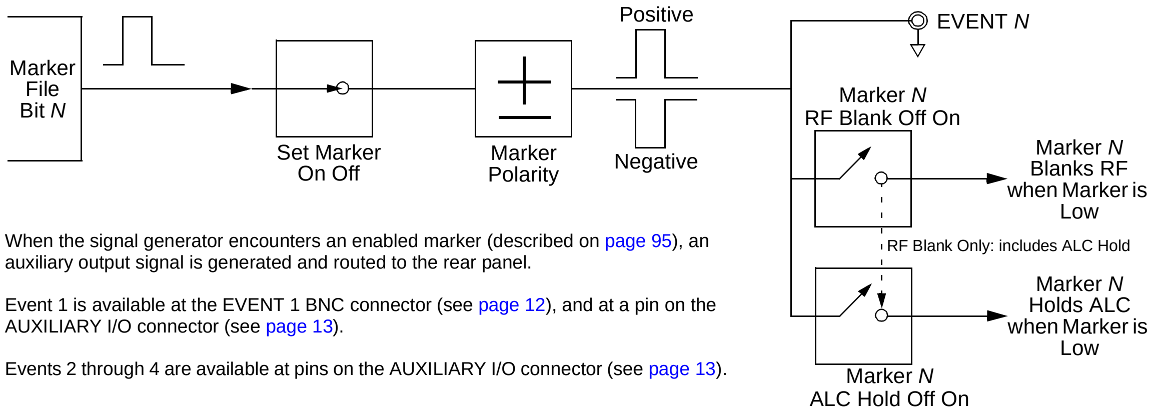
"Controlling Markers in a Waveform Sequence" on page 95

This section also provides the following information:

- "Waveform Marker Concepts" on page 83
- "Accessing Marker Utilities" on page 87
- "Viewing Waveform Segment Markers" on page 88
- "Viewing a Marker Pulse" on page 92
- "Using the RF Blanking Marker Function" on page 93
- "Setting Marker Polarity" on page 94

Waveform Marker Concepts

The signal generator's Dual ARB provides four waveform markers to mark specific points on a waveform segment. You can set each marker's polarity and marker points (on a single sample point or over a range of sample points). Each marker can also perform ALC hold, or RF Blanking and ALC hold.



When the signal generator encounters an enabled marker (described on page 95), an auxiliary output signal is generated and routed to the rear panel.

Event 1 is available at the EVENT 1 BNC connector (see page 12), and at a pin on the AUXILIARY I/O connector (see page 13).

Events 2 through 4 are available at pins on the AUXILIARY I/O connector (see page 13).

Marker Signal Response

The signal generator aligns the marker signals with the I and Q signals at the baseband generator. However some settings such as amplitude, filters, and so forth within the RF output path can create delays between the marker EVENT output signal and the modulated RF output. When using the marker EVENT output signal, observe the signals (marker relative to modulated RF) for any latency, and if needed, reset the marker point positions, include delay (page 125), or both.

Marker File Generation

Downloading a waveform file (as described in the *Programming Guide*) that does not have a marker file associated with it causes the signal generator to automatically create a marker file, but does *not* place any marker points.

Marker Point Edit Requirements

Before you can modify a waveform segment's marker points, the segment must reside in BBG media (see "Loading a Waveform Segment into BBG Media (Volatile Memory)" on page 71).

Saving Marker Polarity and Routing Settings

Marker polarity and routing settings remain until you reconfigure them, preset the signal generator, or cycle power. To ensure that a waveform uses the correct settings when it is played, set the marker polarities or routing (RF Blanking and ALC Hold) and save the information to the file header (page 78).

NOTE When you use a waveform that does not have marker routings and polarity settings stored in the file header, and the previously played waveform used RF Blanking, ensure that you set RF Blanking to **None**. Failure to do so can result in a no RF output condition or a distorted waveform.

ALC Hold Marker Function

While you can set a marker function (described as **Marker Routing** on the softkey label) either before or after you set marker points (page 89), setting a marker function before setting marker points may cause power spikes or loss of power at the RF output.

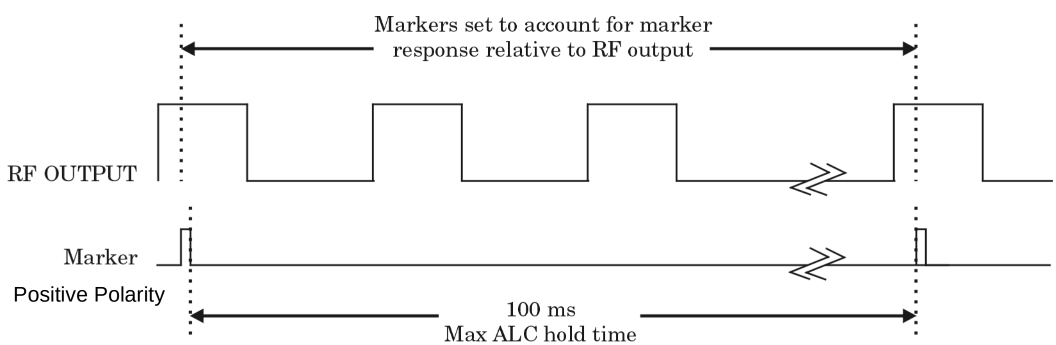
Use the ALC hold function by itself when you have a waveform signal that incorporates idle periods, burst ramps, or when the increased dynamic range encountered with RF blanking (page 93) is not desired.

The ALC hold marker function holds the ALC circuitry at the *average* value of the sampled points set by the marker(s). For both positive and negative marker polarity, the ALC samples the RF output signal (the carrier plus any modulating signal) when the marker signal goes high:

Positive: The signal is sampled during the on marker points.

Negative The signal is sampled during the off marker points.

NOTE Because it can affect the waveform's output amplitude, do not use the ALC hold for longer than 100 ms. For longer time intervals, refer to "Power Search Mode" on page 48.

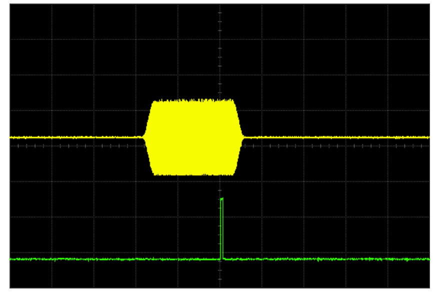


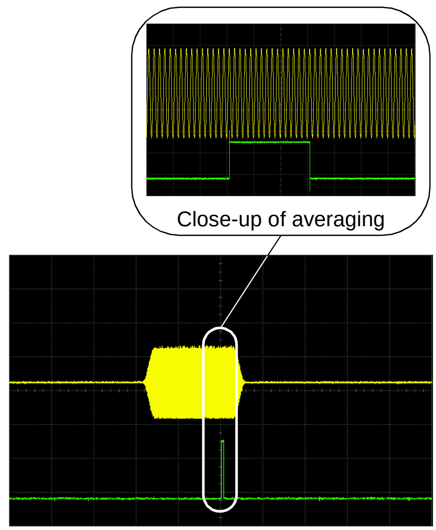
CAUTION Incorrect ALC sampling can create a sudden unleveled condition that may create a spike in the RF output, potentially damaging a DUT or connected instrument. To prevent this condition, ensure that you set markers to let the ALC sample over an amplitude that accounts for the higher power levels encountered within the signal.

Example of Correct Use

Waveform: 1022 points
Marker range: 95-97
Marker polarity: Positive

This example shows a marker set to sample the waveform's area of highest amplitude. Note that the marker is set well before the waveform's area of lowest amplitude. This takes into account any response difference between the marker and the waveform signal.





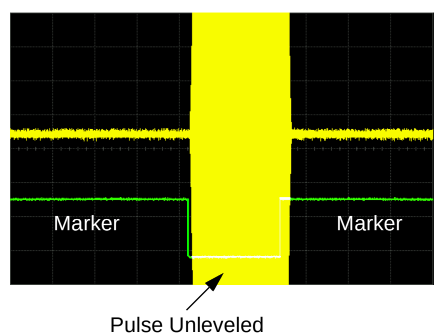
The ALC samples the waveform when the marker signal goes high, and uses the average of the sampled waveform to set the ALC circuitry.

Here the ALC samples during the *on* marker points (positive polarity).

Example of Incorrect Use

Waveform: 1022 points
Marker range: 110-1022
Marker polarity: Positive

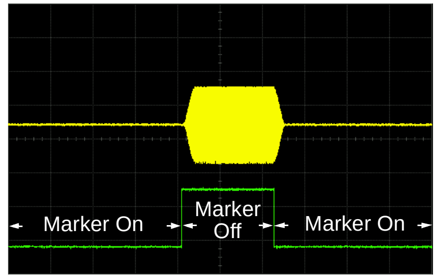
This example shows a marker set to sample the low part of the same waveform, which sets the ALC modulator circuitry for that level; this usually results in an unleveled condition for the signal generator when it encounters the high amplitude of the pulse.



Example of Incorrect Use

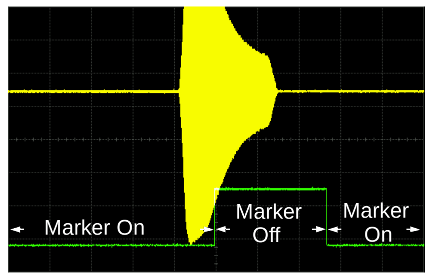
Waveform: 1022 points
Marker range: 110-1022
Marker polarity: Negative

This figure shows that a negative polarity marker goes low during the marker *on* points; the marker signal goes high during the *off* points. The ALC samples the waveform during the *off* marker points.



Sample range begins on first point of signal

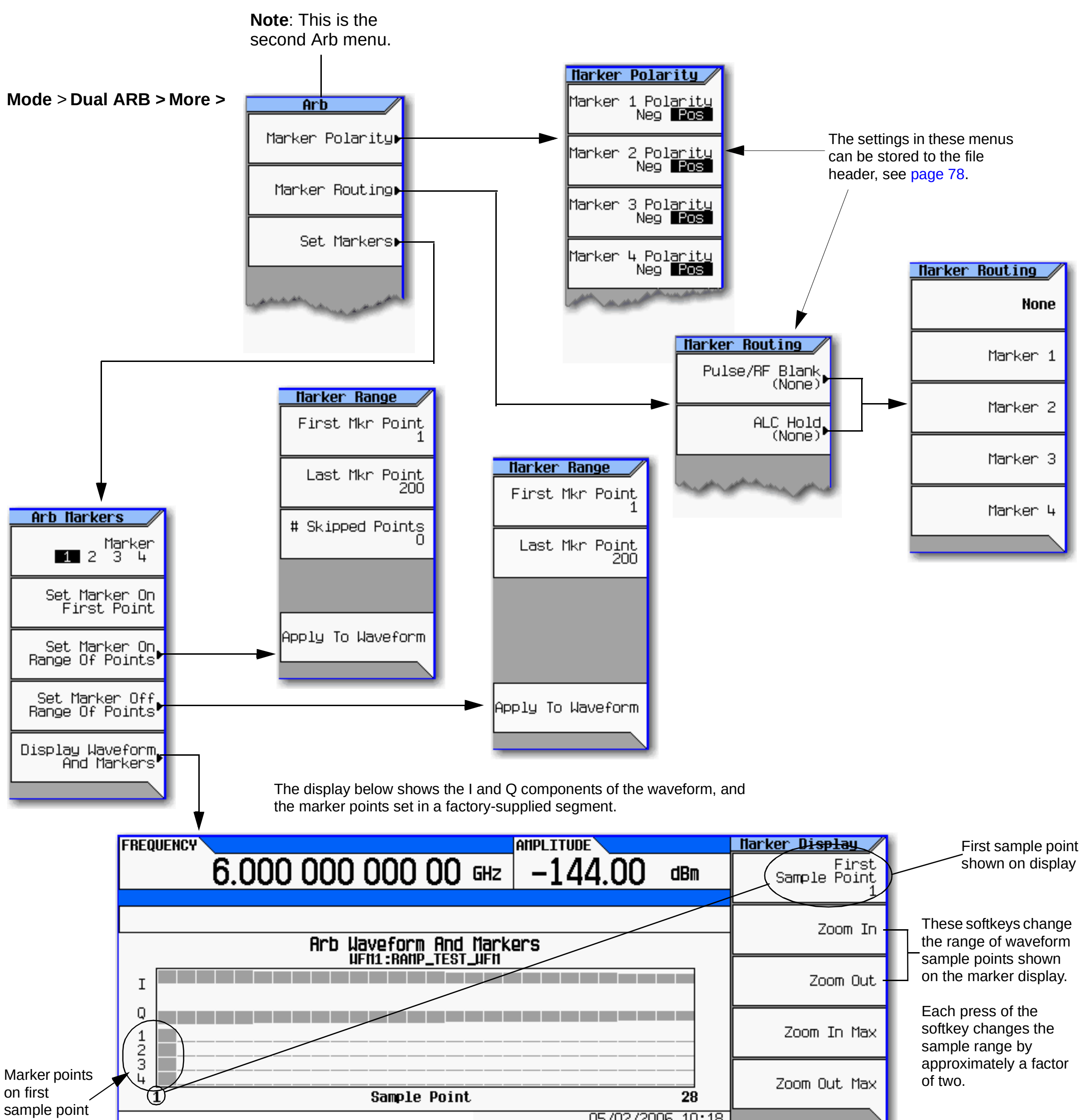
Sampling both on and off time sets the modulator circuitry incorrectly for higher signal levels. Note the increased amplitude at the beginning of the pulse.



Negative range set between signal and off time

Accessing Marker Utilities

For details on each key, use key help as described on page 23.



Viewing Waveform Segment Markers

Markers are applied to waveform segments. Use the following steps to view the markers set for a segment (this example uses the factory-supplied segment, SINE_TEST_WFM).

1. In the second Arb menu (page 87), press **Set Markers**.
2. Highlight the desired waveform segment (in this example, SINE_TEST_WFM).
3. Press **Display Waveform and Markers** > **Zoom in Max**.
   The maximum zoom in range is 28 points.

Experiment with the Zoom functions to see how they display the markers.

The display can show a maximum of 460 points; displayed waveforms with a sample point range greater than 460 points may not show the marker locations.

Clearing Marker Points from a Waveform Segment

When you set marker points they do not replace points that already exist, but are set *in addition* to existing points. Because markers are cumulative, before you set points, view the segment (page 88) and remove any unwanted points. With all markers cleared, the level of the event output signal is 0V. To clear marker points on a segment, the segment must reside in BBG media (page 71).

Clearing All Marker Points

1. In the second Arb menu (page 87), press **Set Markers**.
2. Highlight the desired waveform segment (in this example, SINE_TEST_WFM).
3. Highlight the desired marker number: Press **Marker 1 2 3 4**.
4. For the selected marker number, remove all marker points in the selected segment:
   a. Press **Set Marker Off Range of Points**.

      Notice that the softkeys for the first and last marker points correspond with the length of the waveform. The factory-supplied waveform (SINE_TEST_WFM) contains 200 samples. To clear all set marker points, the range must equal to the length of the waveform.

   b. Press **Apply To Waveform** > **Return**.
5. Repeat from Step 3 for any remaining marker points that you want to remove from the other markers.

Clearing a Range of Marker Points

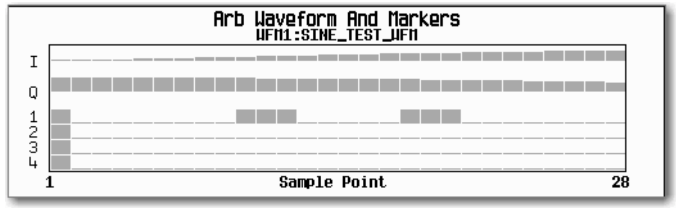
The following example uses a waveform with marker points (Marker 1) set across points 10–20. This makes it easy to see the affected marker points. The same process applies whether the existing points are set over a range or as a single point (page 89).‘

1. In the second Arb menu (page 87), press **Set Markers**, then select Marker 1.
2. Set the first sample point that you want off (for this example, 13):
   Press **Set Marker Off Range Of Points** > **First Mkr Point** > **13** > **Enter**.
3. Set the last marker point in the range that you want off to a value less than or equal to the number of points in the waveform, *and* greater than or equal to the value set in Step 2 (for this example, 17):

Press **Last Mkr Point** > **17** > **Enter** > **Apply To Waveform** > **Return**.

This turns off all marker points for the active marker within the range set in Steps 2 and 3, as shown at right.

How to view markers is described on page 88.



Clearing a Single Marker Point

Use the steps described in "Clearing a Range of Marker Points" on page 88, but set both the first and last marker point to the value of the point you want to clear. For example, if you want to clear a marker on point 5, set both the first and last value to 5.

Setting Marker Points in a Waveform Segment

To set marker points on a segment, the segment must reside in BBG media (page 71).

When you set marker points, they do not replace points that already exist, but are set *in addition* to existing points. Because markers are cumulative, before you set marker points within a segment, view the segment (page 88) and remove any unwanted points (page 88).

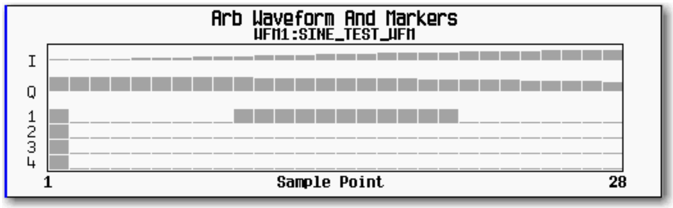
Placing a Marker Across a Range of Points

1. In the second Arb menu (page 87), press **Set Markers**.
2. Highlight the desired waveform segment.
3. Select the desired marker number: Press **Marker 1 2 3 4**
4. Set the first sample point in the range (in this example, 10):

   Press **Set Marker On Range Of Points** > **First Mkr Point** > **10** > **Enter**.
5. Set the last marker point in the range to a value less than or equal to the number of points in the waveform, *and* greater than or equal to the first marker point (in this example, 20):

   Press **Last Mkr Point** > **20** > **Enter**.
6. Press **Apply To Waveform** > **Return**.

This sets a range of waveform marker points. The marker signal starts on sample point 10, and ends on sample point 20, as shown in the following figure.



How to view markers is described on page 88

Placing a Marker on a Single Point

On the First Point

1. In the second Arb menu (page 87), press **Set Markers**.
2. Highlight the desired waveform segment.
3. Select the desired marker number:
   Press **Marker 1 2 3 4**.
4. Press **Set Marker On First Point**.

   This sets a marker on the first point in the segment for the marker number selected in Step 3.

On Any Point

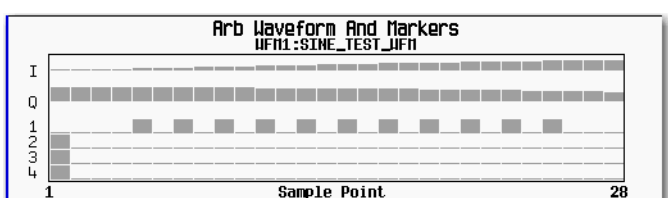
Use the steps described in "Placing a Marker Across a Range of Points" on page 89, but set both the first and last marker point to the value of the point you want to set. For example, if you want to set a marker on point 5, set both the first and last value to 5.

Placing Repetitively Spaced Markers

The following example sets markers across a range of points and specifies the spacing (skipped points) between each marker. You must set the spacing *before* you apply the marker settings; you cannot apply skipped points to a previously set range of points.

1. Remove any existing marker points (page 83).
2. In the second Arb menu (page 87), press **Set Markers**.
3. Highlight the desired waveform segment.
4. Select the desired marker number:
   Press **Marker 1 2 3 4**.
5. Set the first sample point in the range (in this example, 5):
   Press **Set Marker On Range Of Points** > **First Mkr Point** > **5** > **Enter**.
6. Set the last marker point in the range. (The last marker point value must always be less than or equal to the number of points in the waveform, *and* greater than or equal to the first marker point, in this example, 25):
   Press **Last Mkr Point** > **25** > **Enter**.
7. Enter the number of sample points that you want skipped (in this example, 1):
   Press **# Skipped Points** > **1** > **Enter**.
8. Press **Apply To Waveform** > **Return**.

This causes the marker to occur on every other point (one sample point is skipped) within the marker point range, as shown at right.



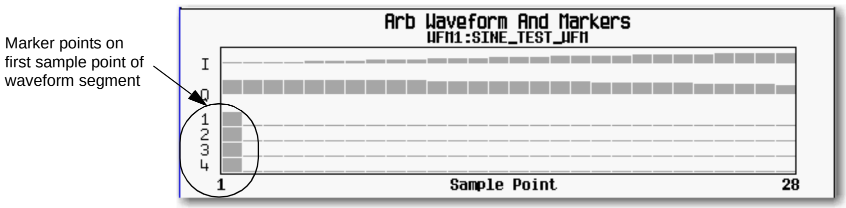
How to view markers is described on page 88.

One application of the skipped point feature is the creation of a clock signal as the EVENT output.

Viewing a Marker Pulse

When a waveform plays (page 77), you can detect a set and enabled marker's pulse at the rear panel event connector/Aux I/O pin that corresponds to that marker number. This example demonstrates how to view a marker pulse generated by a waveform segment that has at least one marker point set (page 89). The process is the same for a waveform sequence.

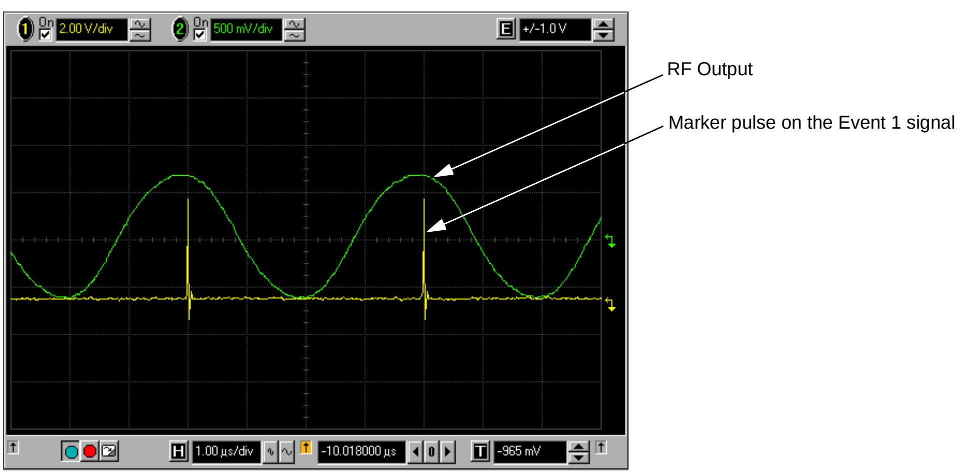
This example uses the factory-supplied segment, SINE_TEST_WFM in the dual ARB Player. Factory-supplied segments have a marker point on the first sample point for all four markers, as shown.



How to view markers is described on page 88

1. In the first Arb menu (page 69), press **Select Waveform**.
2. Highlight the SINE_TEST_WFM segment and press **Select Waveform**.
3. Press **ARB Off On** to On.
4. Connect the Agilent MXG's rear-panel Q OUT output to the oscilloscope's channel 1 input.
5. Connect the signal generator's rear-panel EVENT 1 output to the oscilloscope's channel 2 input.

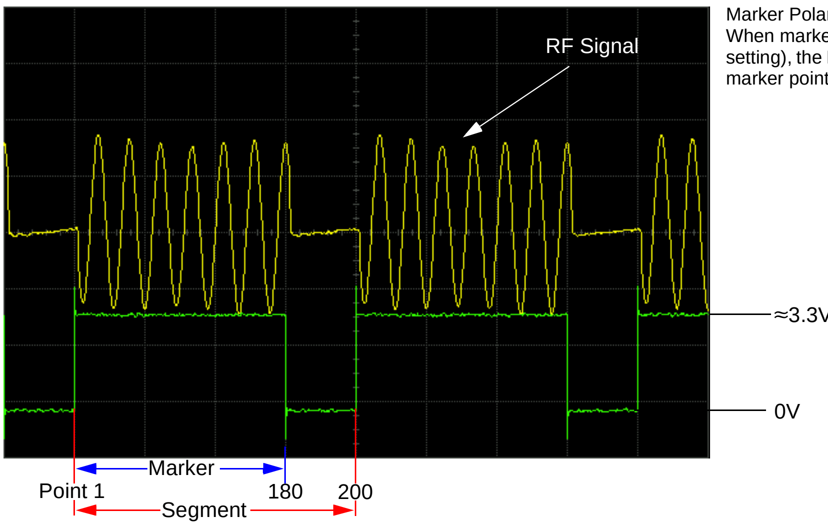
   When marker 1 is present, the Agilent MXG outputs a signal through EVENT 1 as shown in the following example.



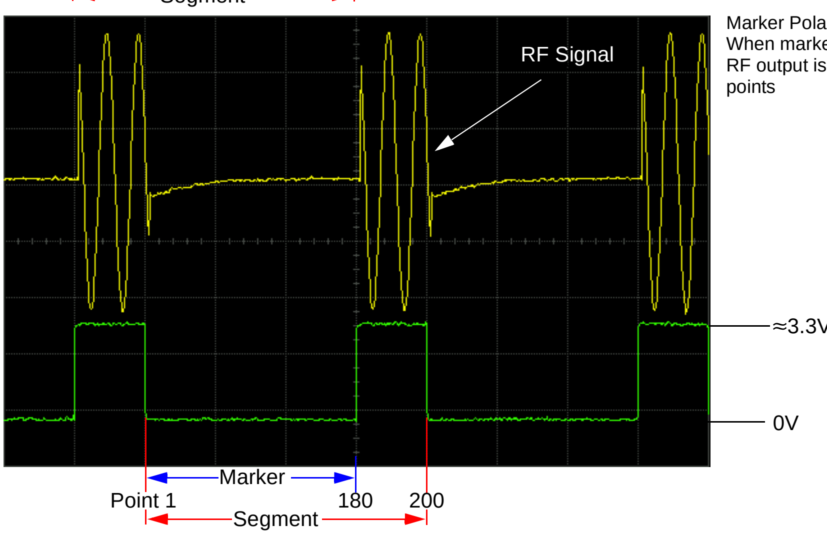
Using the RF Blanking Marker Function

While you can set a marker function (described as **Marker Routing** on the softkey label in the second Arb menu) either before or after setting the marker points (page 89), setting a marker function before you set marker points may change the RF output. RF Blanking includes ALC hold (described on page 84, note Caution regarding unleveled power). The signal generator blanks the RF output when the marker signal goes low. This example is a continuation of the previous example, Viewing a Marker Pulse.

1. Using the factory-supplied segment SINE_TEST_WFM, set Marker 1 across points 1–180 (page 89).
2. From the **Marker Routing** softkey menu, assign RF Blanking to Marker 1:
   In the second Arb menu (page 87), press **Marker Routing** > **Pulse/RF Blank** > **Marker 1**.



Marker Polarity = Positive
When marker polarity is positive (the default setting), the RF output is blanked during the *off* marker points.



Marker Polarity = Negative
When marker polarity is negative, the RF output is blanked during the *on* marker points

Setting Marker Polarity

Setting a negative marker polarity inverts the marker signal.

1. In second Arb menu (page 87), press **Marker Polarity**.
2. For each marker, set the marker polarity as desired.
   - The default marker polarity is positive.
   - Each marker polarity is set independently.

See also, “Saving Marker Polarity and Routing Settings” on page 83.

As shown on page 93:

Positive Polarity: *On* marker points are high (≈3.3V).

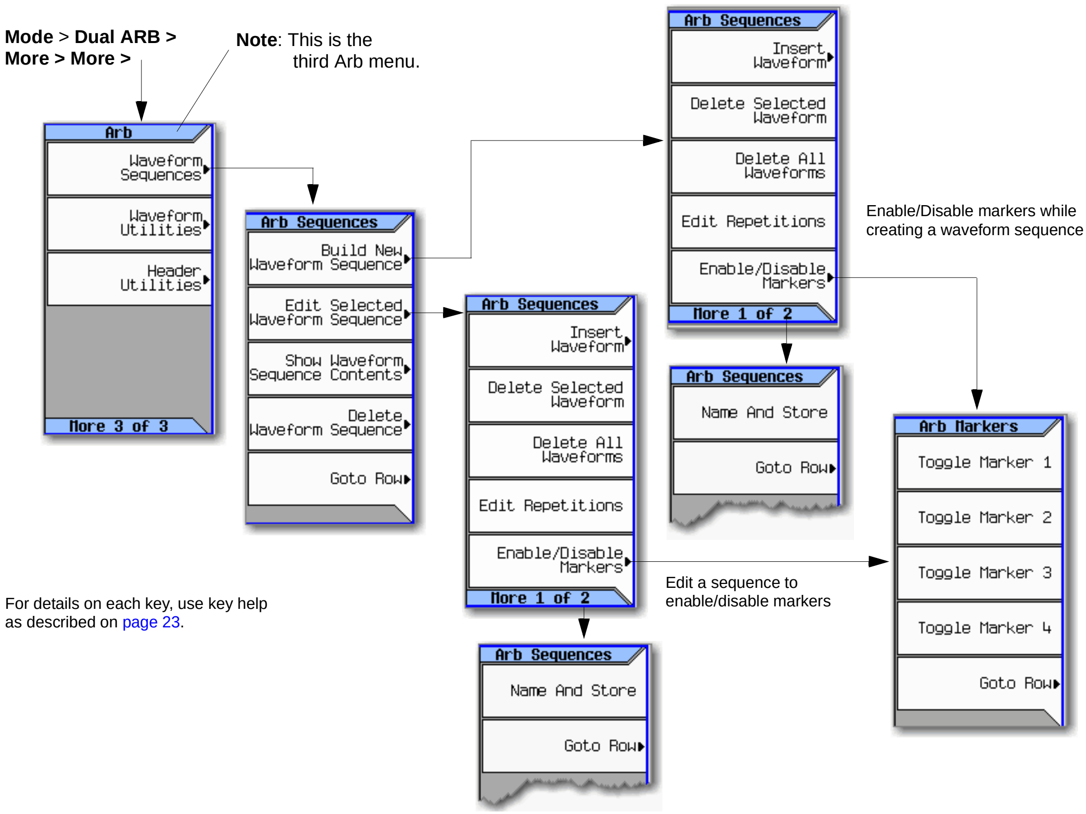
Negative Polarity: *On* marker points are low (0V).

RF blanking always occurs on the low part of the signal regardless of the polarity setting.

Controlling Markers in a Waveform Sequence

In a waveform segment, an enabled marker point generates an auxiliary output signal that is routed to the rear-panel EVENT output (described in “Rear Panel Overview” on page 9) corresponding to that marker number. For a waveform sequence, you enable or disable markers on a segment-by-segment basis; this enables you to output markers for some segments in a sequence, but not for others. Unless you change the sequence marker settings or cycle the power, the marker setting for the last segment edited in the sequence applies to all segments in the next sequence that you build. For information on building a waveform sequence, see “Creating a Sequence” on page 75.

Figure 8-7 Waveform Sequence Menus for Enabling / Disabling Segment Markers



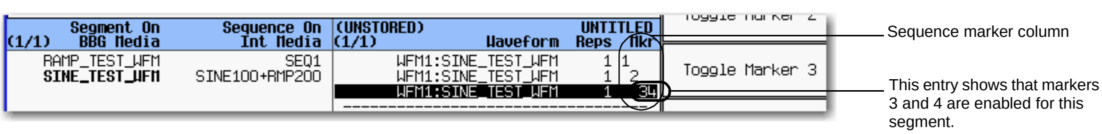
Enabling and Disabling Markers in a Waveform Sequence

Select the waveform segments within a waveform sequence to enable or disable each segment’s markers independently. You can enable or disable the markers either at the time of creating the sequence or after the sequence has been created and stored. If the sequence has already been stored, you must store the sequence again after making any changes. Enabling a marker that has no marker points has no effect on the auxiliary outputs. To set marker points on a segment, see “Setting Marker Points in a Waveform Segment” on page 89. This example assumes that a waveform sequence exists.

1. Ensure that all waveform segments for the sequence reside in BBG media (see page 71).
2. From the third Arb menu, press **Waveform Sequences**.
3. Highlight the desired waveform sequence.
4. Press **Edit Selected Waveform Sequence** > **Enable/Disable Markers**.
5. Toggle the markers:
   a. Highlight the first waveform segment.
   b. As desired, press **Toggle Marker 1**, **Toggle Marker 2**, **Toggle Marker 3**, and **Toggle Marker 4**.
      An entry in the `Mkr` column (see figure below) indicates that the marker is enabled for that segment; no entry in the column means that all markers are disabled for that segment.
   c. In turn, highlight each of the remaining segments and repeat Step b.
6. Press **Return** > **More** > **Name and Store**.
7. Either rename the sequence using the text entry keys (see page 70) or just press **Enter** to save the sequence with the existing name.

The markers are enabled or disabled per the selections, and the changes saved to the sequence file.

The following figure shows a sequence built using one of the factory-supplied waveform segments; a factory-supplied segment has a marker point on the first sample for all four markers. In this example, marker 1 is enabled for the first segment, marker 2 is enable for the second segment, and markers 3 and 4 are enabled for the third segment.

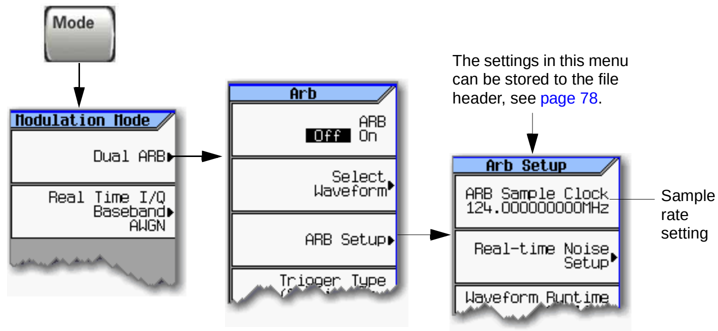


For each segment, only the markers enabled for that segment produce a rear-panel auxiliary output signal. In this example, the marker 1 auxiliary signal appears only for the first segment, because it is disabled for the remaining segments. The marker 2 auxiliary signal appears only for the second segment, and the marker 3 and 4 auxiliary signals appear only for the third segment.

Using the EVENT Output Signal as an Instrument Trigger

For details on each key, use key help as described on page 23.

One of the uses for the EVENT output signal (marker signal) is to trigger a measurement instrument. You can set up the markers to start the measurement at the beginning of the waveform, at any single point in the waveform, or on multiple points in the waveform. To optimize the use of the EVENT signal for measurements, you may also need to adjust the sample rate. The location of the sample rate setting is shown in the figure at right.



The EVENT output signal can exhibit jitter of up to ±4 ns on the rising and falling edge. This jitter can be minimized in either of two ways.

Method 1: Use a sample clock of 125 MHz/N where N is a positive integer and where 125 MHz/N can be represented exactly on the display.
For example: 125 MHz, 62.5 MHz, 31.25 MHz, 25 MHz, and so on.

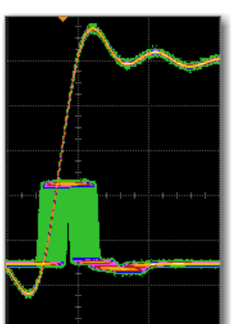
If the result cannot be represented exactly on the display, jitter will be present.

For example: N = 6 will result in jitter, because $125 \text{ MHz} / 6 = 20.83\bar{3}$ MHz, which is truncated when displayed.

Method 2: Select a sample clock and waveform length that spaces the markers by a multiple of 8 ns. For example: A 200 point waveform with a marker on the first point and a sample clock of 50 MHz provides a marker every 4 μs. Because 4 μs is a multiple of 8 ns, the jitter is minimized.

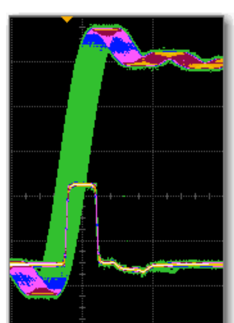
When the EVENT output signal exhibits jitter and it is used as a measurement trigger, it can cause the waveform to falsely appear as having jitter. If this condition occurs, you can adjust the sample rate to a value (see above) that does not cause the jitter appearance. To maintain the integrity of the original waveform with a sample rate change, you will have to also recalculate the sample values. The following figures illustrate the marker signal jitter and its affect on the waveform.

EVENT output signal exhibits jitter due to a non-optimal sample rate



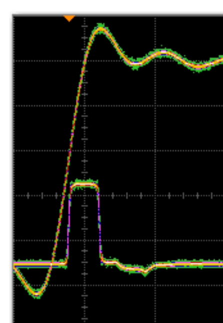
Oscilloscope triggering on waveform

Waveform appears to exhibit jitter when triggered using EVENT signal with jitter.



Oscilloscope triggering on EVENT signal

The jitter is gone with an optimal sample rate

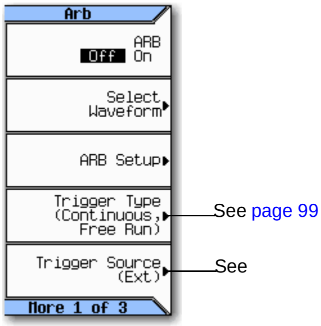


Oscilloscope triggering on EVENT signal

Triggering a Waveform

Figure 8-8 Triggering Softkeys

Mode > **Dual ARB** >



For details on each key, use key help
as described on page 23.

Triggers control data transmission by controlling when the signal generator transmits the modulating signal. You can configure trigger settings so that data transmission occurs once (Single mode), continuously (Continuous mode), or starts and stops repeatedly (Gated and Segment Advance modes).

A trigger signal contains both positive and negative states; you can use either for triggering.

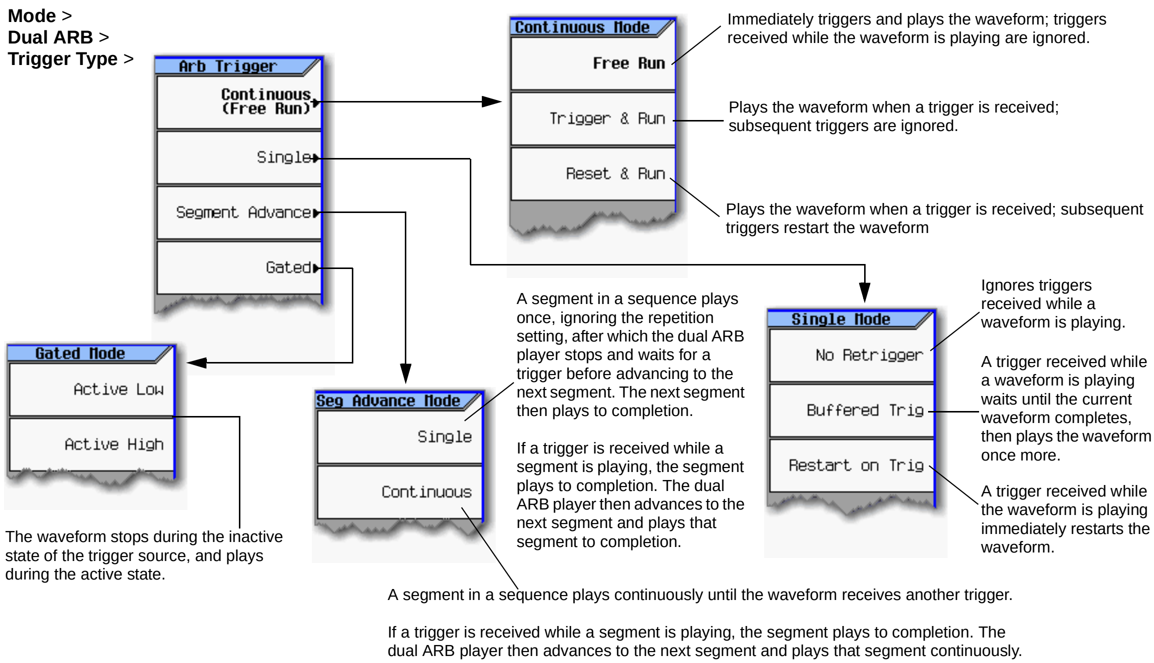
When you initially select a trigger mode or when you change from one triggering mode to another, you may lose the carrier signal at the RF output until the modulating signal is triggered. This is because the signal generator sets the I and Q signals to zero volts prior to the first trigger event. To maintain the carrier signal at the RF output, create a data pattern with the initial I and Q voltages set to values other than zero.

There are two parts to configuring a waveform trigger:

- *Type* determines the behavior of the waveform when it plays (see Trigger Type on page 99).
- *Source* determines how the signal generator receives the trigger that starts the modulating waveform playing (see Trigger Source on page 100).

Trigger Type

Type defines the trigger mode: how the waveform plays when triggered.

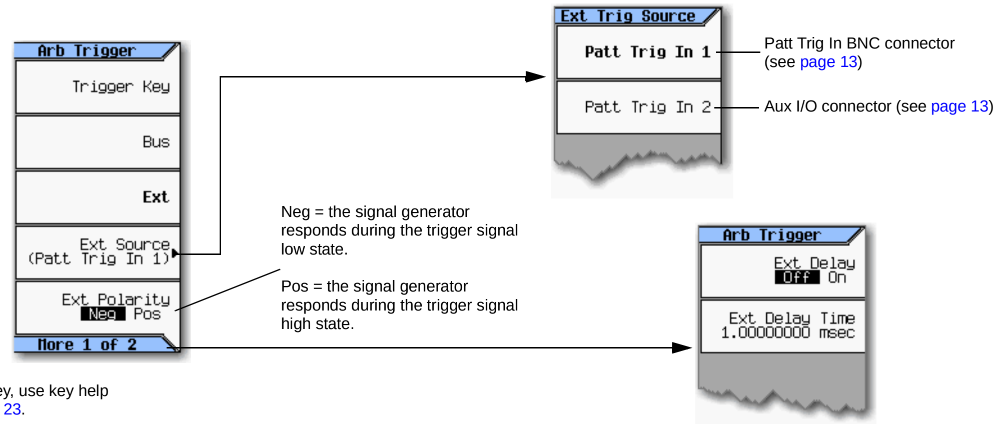


For details on each key, use key help as described on page 23.

- **Continuous** mode repeats the waveform until you turn the signal off or select a different waveform, trigger mode, or response (Free Run, Trigger & Run, Reset & Run).
- **Single** mode plays the waveform once.
- **Segment Advance** mode plays a segment in a sequence only if triggered. The *trigger source* controls segment-to-segment playing (see Example: Segment Advance Triggering on page 101). A trigger received during the last segment loops play to the *first* segment in the sequence.
- **Gated** mode triggers the waveform at the first active triggering state, then repeatedly starts and stops playing the waveform in response to an externally applied gating signal. See Example: Gated Triggering on page 102.

Trigger Source

Mode >
Dual ARB >
Trigger Source >



For details on each key, use key help as described on page 23.

External Trigger Polarity

- In Continuous, Single, and Segment Advance modes, use the **Ext Polarity** softkey to set the external trigger polarity.
- In Gated mode, the **Active Low** and **Active High** softkeys (page 99) determine the external trigger polarity.

Example: Segment Advance Triggering

Segment advance triggering enables you to control the segment playback within a waveform sequence. This type of triggering ignores the repetition value (page 76). For example if a segment has repetition value of 50 and you select Single as the segment advance triggering mode, the segment still plays only once. The following example uses a waveform sequence that has two segments.

If you have not created and stored a waveform sequence, refer to "Creating a Sequence" on page 75.

1. Preset the signal generator.
2. Configure the RF output:
   - Set the desired frequency.
   - Set the desired amplitude.
   - Turn on the RF output.
3. Select a waveform sequence for playback:
   a. Press **Mode** > **Dual ARB** > **Select Waveform**.
   b. In the `Sequence On` column, highlight a waveform sequence file.
   c. Press **Select Waveform**.
4. Set the triggering as follows:
   - Trigger Type: continuous Segment Advance
     Press **Trigger Type** > **Segment Advance** > **Continuous**.
   - Trigger source: Trigger hardkey
     Press **Trigger Source** > **Trigger Key**.
5. Generate the waveform sequence:
   Press **ARB Off On** until On highlights.
6. (Optional) Monitor the waveform:

   Connect the RF OUTPUT of the signal generator to the input of an oscilloscope, and configure the oscilloscope so that you can see the signal.
7. Trigger the first waveform segment to begin playing continuously:
   Press the **Trigger** hardkey.
8. Trigger the second segment:
   Press the **Trigger** hardkey.

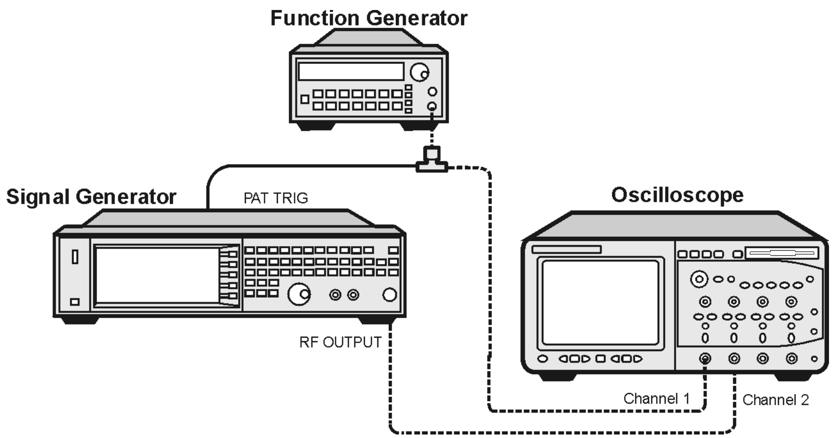
   Pressing the **Trigger** hardkey causes the currently playing segment to finish and the next segment to start.

   If the last segment in the sequence is playing, pressing the **Trigger** hardkey causes the *first* segment in the waveform sequence to start when the last segment finishes.

Example: Gated Triggering

Gated triggering enables you to define the on and off states of a modulating waveform.

1. Connect the output of a function generator to the signal generator's rear-panel PATT TRIG IN connector, as shown in the following figure. This connection is applicable to all external triggering methods. The optional oscilloscope connection enables you to see the effect that the trigger signal has on the RF output.

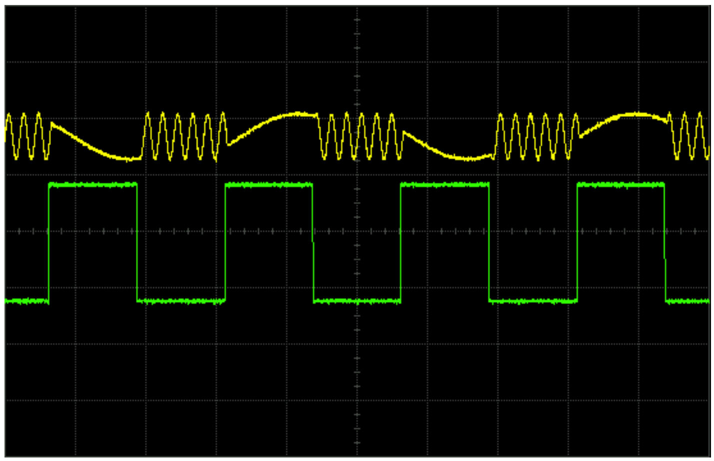


2. Preset the signal generator.
3. Configure the RF output:
   - Set the desired frequency.
   - Set the desired amplitude.
   - Turn on the RF output.
4. Select a waveform for playback (sequence or segment):
   a. Press **Mode** > **Dual ARB** > **Select Waveform**.
   b. In the `Segment On` or `Sequence On` column, highlight a waveform.
   c. Press **Select Waveform**.
5. Set the triggering as follows:
   - Trigger type: Gated
     Press **Trigger Type** > **Gated**.
   - Active state: Low
     Press **Active Low**.
   - Trigger source: External
     Press **Trigger Source** > **Ext**.
   - Input connector: Rear panel Patt Trig In BNC
     Press **Ext Source** > **Patt Trig In 1**.
6. Generate the waveform: Press **Return** > **ARB Off On** until On highlights.

7. On the function generator, configure a TTL signal for the external gating trigger.
8. (Optional) Monitor the waveform:

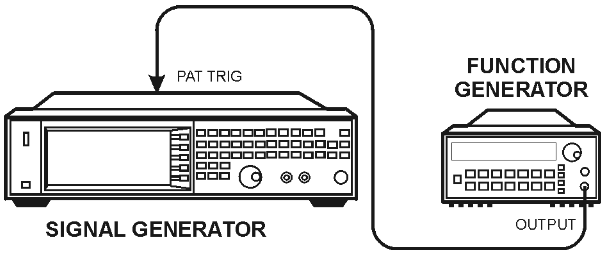
   Configure the oscilloscope to display both the output of the signal generator, and the external triggering signal. You will see the waveform modulating the output during the gate *active* periods (low in this example).

   The following figure shows an example display.



Example: External Triggering

Use the following example to set the signal generator to output a modulated RF signal 100 milliseconds after a change in TTL state from low to high occurs at the PATT TRIG IN rear panel BNC connector



1. Connect the signal generator to the function generator as shown above.
2. Configure the RF output:
   - Set the desired frequency.
   - Set the desired amplitude.
   - Turn on the RF output.
3. Select a waveform for playback (sequence or segment):
   a. Press **Mode** > **Dual ARB** > **Select Waveform**.
   b. In the `Segment On` or `Sequence On` column, highlight a waveform.
   c. Press **Select Waveform**.
4. Generate the waveform:
   Press **ARB Off On** until On highlights.
5. Set the waveform trigger as follows:
   a. Trigger Type: single
   Press **Trigger Type** > **Single** > **No Retrigger**

   b. Trigger Source: external
   Press **Trigger Source** > **Ext**

   c. Input connector: Rear panel Patt Trig In BNC
   Press **Ext Source** > **Patt Trig In 1**.

   d. External Trigger Polarity: positive
   Press **Ext Polarity** until Pos highlights

   e. External Delay: 100 ms
   Press **More** > **Ext Delay** until On highlights
   Press **Ext Delay Time** > **100** > **msec**
6. Configure the Function Generator:
   - Waveform: 0.1 Hz square wave
   - Output Level: 3.5V to 5V.

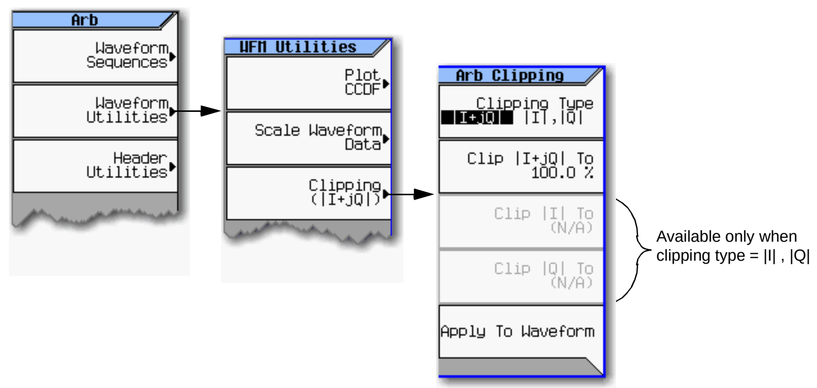
Clipping a Waveform

Digitally modulated signals with high power peaks can cause intermodulation distortion, resulting in spectral regrowth that can interfere with signals in adjacent frequency bands. The clipping function enables you to reduce high power peaks by clipping the I and Q data to a selected percentage of its highest peak, thereby reducing spectral regrowth.

- How Power Peaks Develop on page 106
- How Peaks Cause Spectral Regrowth on page 108
- How Clipping Reduces Peak-to-Average Power on page 109
- Configuring Circular Clipping on page 112
- Configuring Rectangular Clipping on page 113

Figure 8-9 Clipping Softkeys

Mode > **Dual ARB** > **More** > **More** >



For details on each key, use key help as described on page 23.

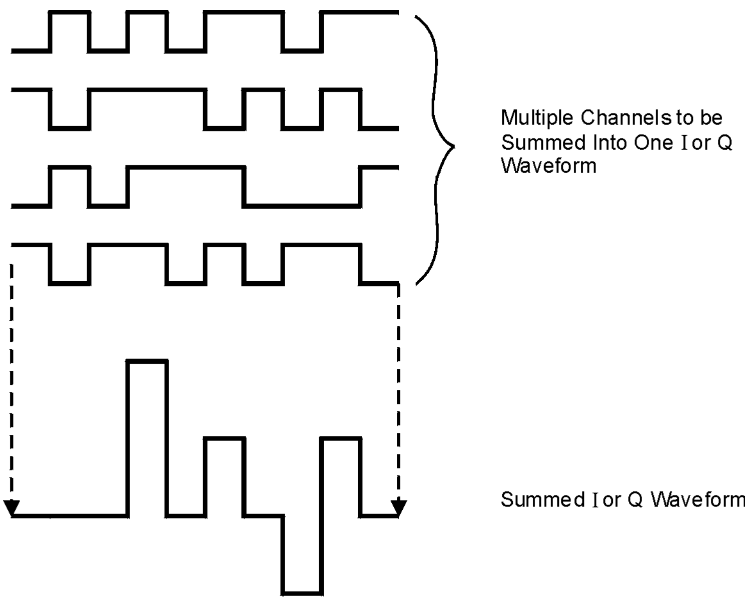
How Power Peaks Develop

To see how clipping reduces high power peaks, it is important to understand how the peaks develop as you construct a signal.

Multiple Channel Summing

I/Q waveforms can be the summation of multiple channels, as shown in the following figure. If a bit in the same state (high or low) occurs simultaneously in several individual channel waveforms, an unusually high power peak (positive or negative) occurs in the summed waveform.

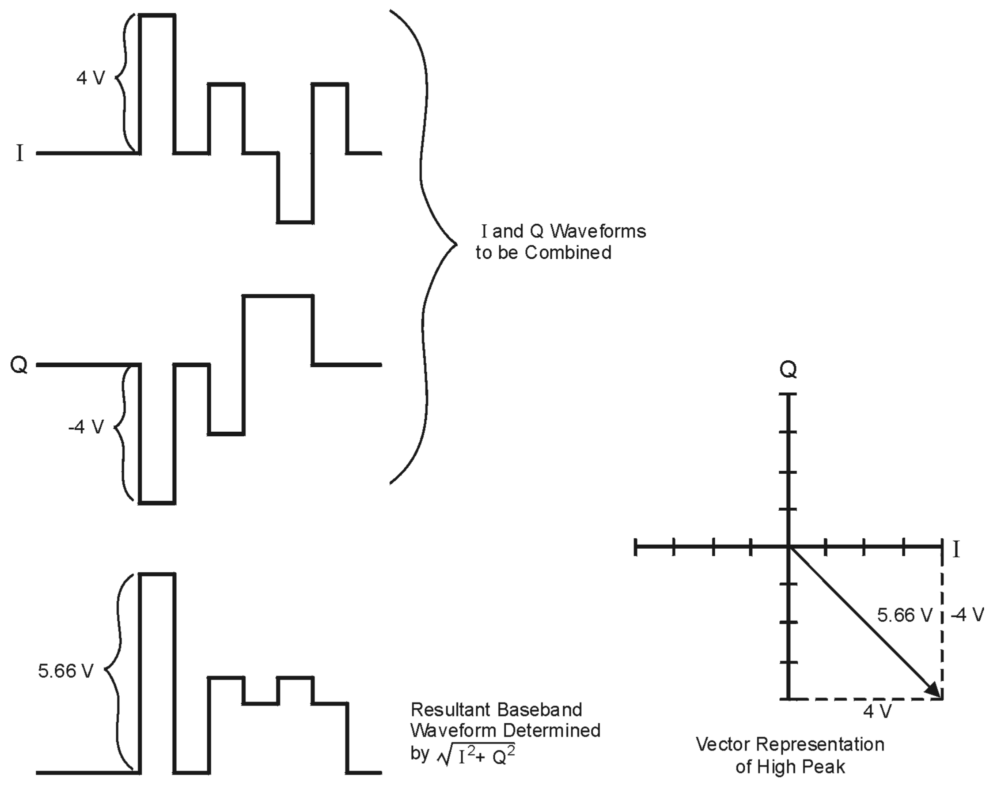
Because the high and low states of the bits in channel waveforms are random and generally result in a cancelling effect, high power peaks occur infrequently with multiple channel summing.



Combining the I and Q Waveforms

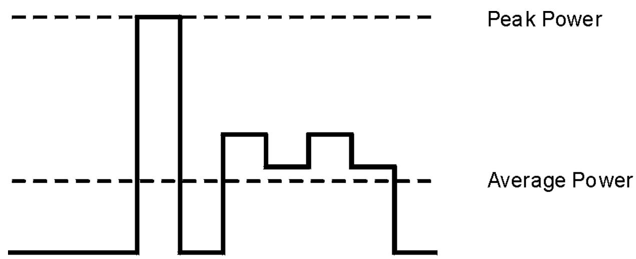
When the I and Q waveforms combine in the I/Q modulator to create an RF waveform, the magnitude of the RF envelope is $\sqrt{I^2+Q^2}$, where the squaring of I and Q always results in a positive value.

As shown in the following figure, simultaneous positive and negative peaks in the I and Q waveforms do not cancel each other, but combine to create an even greater peak.

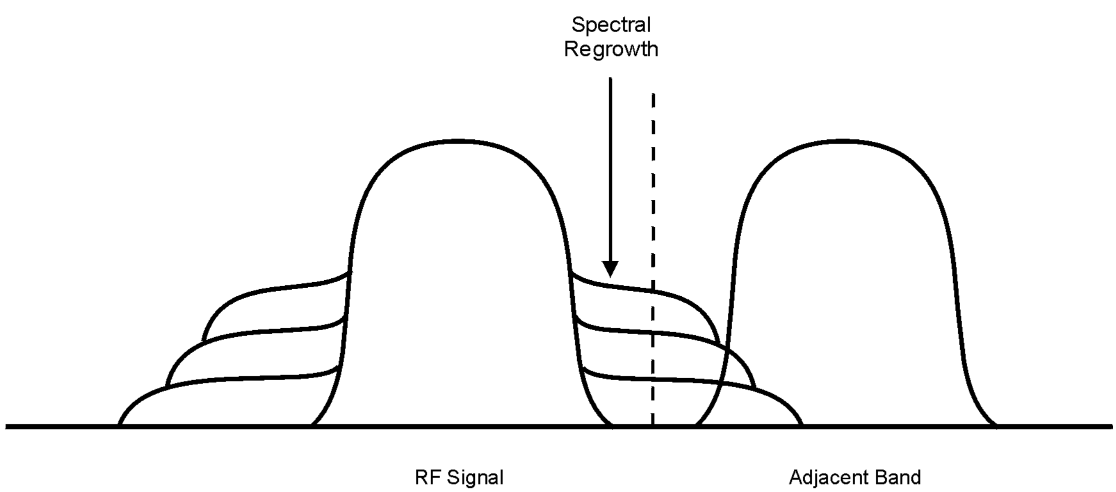


How Peaks Cause Spectral Regrowth

In a waveform, high power peaks that occur infrequently cause the waveform to have a high peak-to-average power ratio, as illustrated in the following figure.



Because the gain of a transmitter's power amplifier is set to provide a specific average power, high peaks can cause the power amplifier to move toward saturation. This causes the intermodulation distortion that generates spectral regrowth. Spectral regrowth is a range of frequencies that develops on each side of the carrier (similar to sidebands) and extends into the adjacent frequency bands (see the following figure). Clipping provides a solution to this problem by reducing the peak-to-average power ratio.



How Clipping Reduces Peak-to-Average Power

You can reduce peak-to-average power, and consequently spectral regrowth, by clipping the waveform. Clipping limits waveform power peaks by clipping the I and Q data to a selected percentage of its highest peak. The Signal Generator provides two methods of clipping:

- *Circular* clipping is applied to the composite I/Q data (I and Q data are equally clipped).

  As shown in Figure 8-10, the clipping level is constant for all phases of the vector and appears as a circle in the vector representation.

- *Rectangular* clipping is independently applied the I and Q data.

  As shown in Figure 8-11 on page 110, the clipping level is different for I and Q, and appears as a rectangle in the vector representation.

In both circular and rectangular clipping, the objective is to clip the waveform to a level that reduces spectral regrowth but does *not* compromise the integrity of the signal. The two complementary cumulative distribution plots in Figure 8-12 on page 111 show the reduction in peak-to-average power that occurs after applying circular clipping to a waveform.

The lower the clipping value, the lower the peak power that is passed (the more the signal is clipped). The peaks can often be clipped without substantially interfering with the rest of the waveform. In many cases, data that might otherwise be lost in the clipping process is retained because of the error correction inherent in the coded systems. If you apply excessive clipping, however, lost data cannot be recovered. Experiment with clipping settings to find a percentage that reduces spectral regrowth while retaining needed data.

Figure 8-10 Circular Clipping

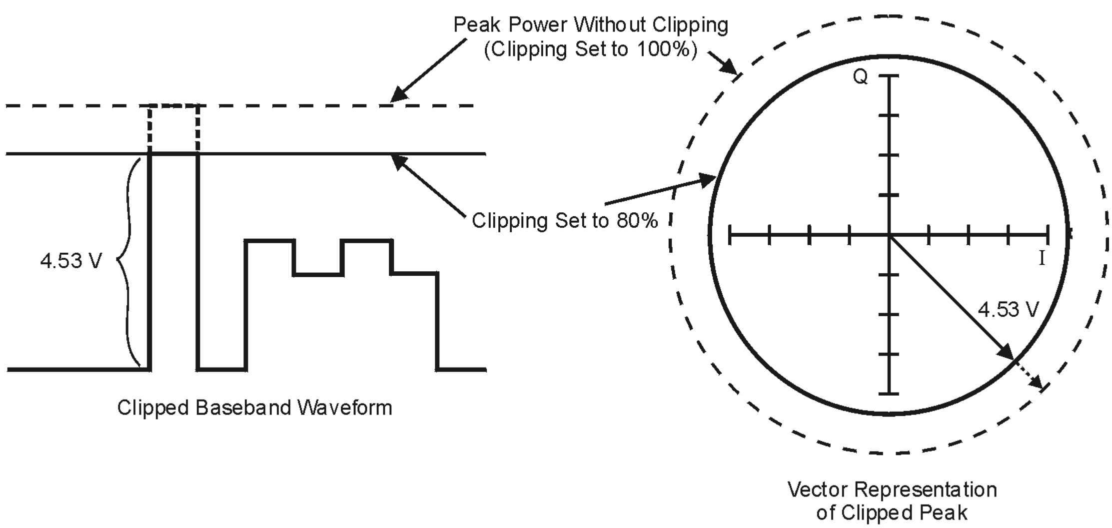


Figure 8-11 Rectangular Clipping

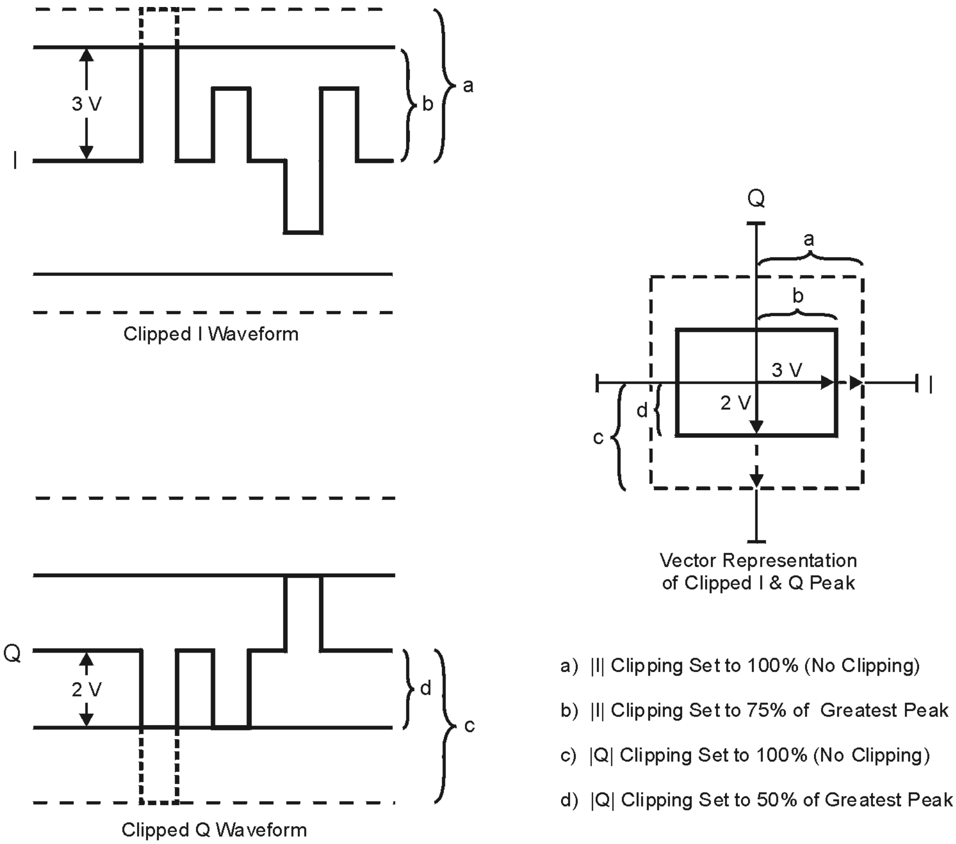
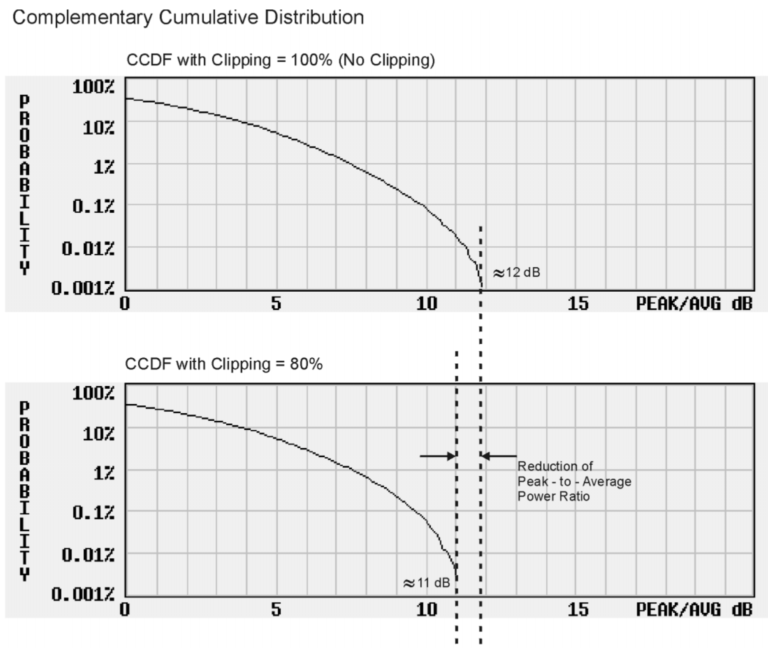


Figure 8-12 Reduction of Peak-to-Average Power



Configuring Circular Clipping

Use this example to configure circular clipping and observe its affect on the peak-to-average power ratio of a waveform. Circular clipping clips the composite I/Q data (I and Q data are clipped equally). For more information about circular clipping, refer to "How Clipping Reduces Peak-to-Average Power" on page 109.

CAUTION Clipping is non-reversible and cumulative. Save a copy of the waveform file before you apply clipping.

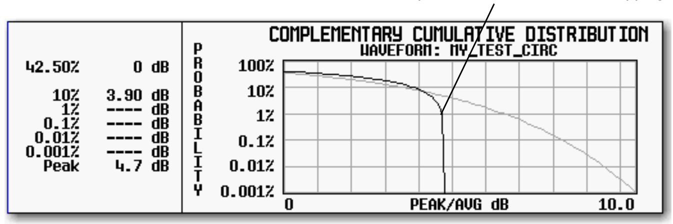
Copy a Waveform File

1. Display the signal generator's files: Press **File** > **Catalog Type** > **More** > **Volatile Segments**.
2. Highlight the waveform `RAMP_TEST_WFM`.
3. Press **Copy File.**
4. Name the copy (in this example, the name is `MY_TEST_CIRC`) and press **Enter**.

Apply Circular Clipping to the Copied Waveform File

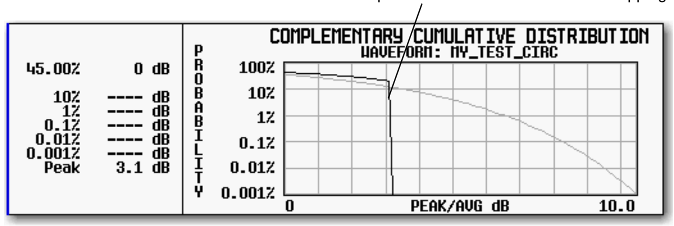
1. Open the DUAL ARB Waveform Utilities menu: Press **Mode** > **Dual ARB** > **More** > **More** > **Waveform Utilities**.
2. In the list of files, highlight the copied file (in this example, `MY_TEST_CIRC`).
3. Create the CCDF plot: Press **Plot CCDF**.
4. Observe the shape and position of the waveform's curve (the dark line in the example at right).

Example waveform curve before clipping



5. Activate circular clipping: Press **Return** > **Clipping** > **Clipping Type** until **|I+jQ|** highlights.
6. Set circular clipping to 80%: Press **Clip |I+jQ| To** > **80** > **%**.
7. Apply 80% clipping to the I and Q data: Press **Apply to Waveform**.
8. Create the CCDF plot (see the example at right): Press **Plot CCDF**.

Example waveform curve after circular clipping



9. Observe the waveform's curve after clipping.

   Note the reduction in peak-to-average power relative to the previous plot.

Configuring Rectangular Clipping

Use this example to configure rectangular clipping. Rectangular clipping clips the I and Q data independently. For more information about rectangular clipping, refer to “How Clipping Reduces Peak-to-Average Power” on page 109.

CAUTION	Clipping is non-reversible and cumulative. Save a copy of the waveform file before you apply clipping.

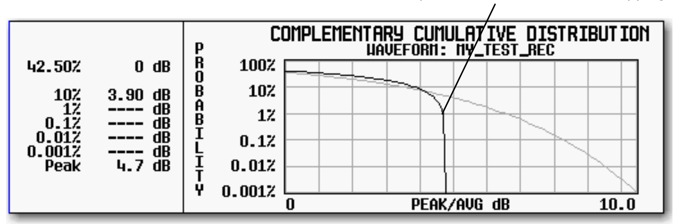
Copy a Waveform File

1. Display the signal generator’s files: Press **File** > **Catalog Type** > **More** > **Volatile Segments**.
2. Highlight the waveform RAMP_TEST_WFM.
3. Press **Copy File.**
4. Name the copy (in this example, the name is MY_TEST_REC) and press **Enter**.

Apply Rectangular Clipping to the Copied Waveform File

1. Open the DUAL ARB Waveform Utilities menu: Press **Mode** > **Dual ARB** > **More** > **More** > **Waveform Utilities**.
2. In the list of files, highlight the copied file (in this example, MY_TEST_REC).
3. Create the CCDF plot: Press **Plot CCDF**.
4. Observe the shape and position of the waveform’s curve (the dark line in the example at right).
5. Activate rectangular clipping: Press **Return** > **Clipping** > **Clipping Type** until **|I|,|Q|** highlights.
6. Set 80% clipping for the I data: Press **Clip |I| To** > **80** > **%**.
7. Set 40% clipping for the Q data: Press **Clip |Q| To** > **40** > **%**.

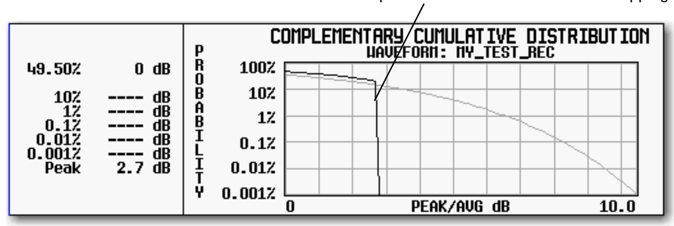
Example waveform curve before clipping



8. Apply the rectangular clipping to the waveform: Press **Apply to Waveform**.
9. Create the CCDF plot (see the example at right): Press **Plot CCDF**.
10. Observe the waveform’s curve after clipping.

    Note the reduction in peak-to-average power relative to the previous plot.

Example waveform curve after circular clipping

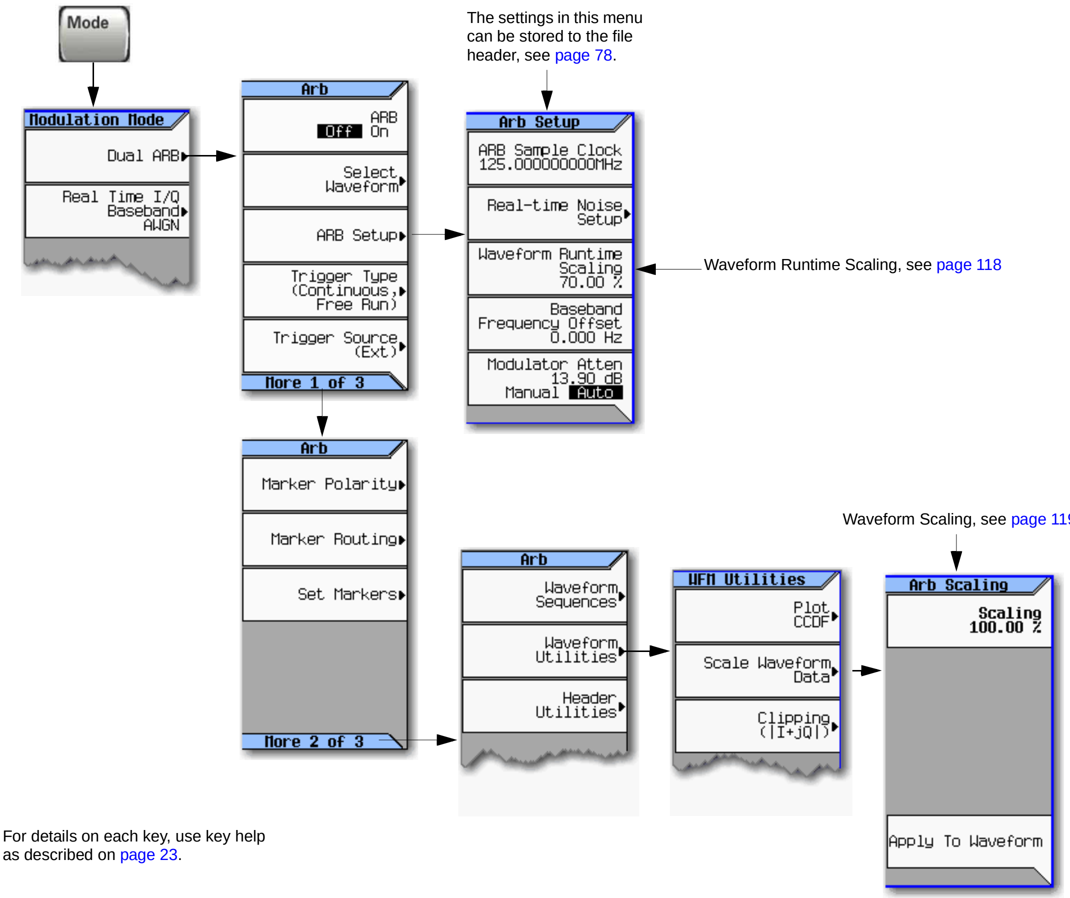


Scaling a Waveform

The signal generator uses an interpolation algorithm (sampling between the I/Q data points) when reconstructing a waveform. For common waveforms, this interpolation can cause overshoots, which may create a DAC over-range error condition. This chapter describes how DAC over-range errors occur and how you can use waveform scaling to eliminate these errors.

- How DAC Over-Range Errors Occur on page 116
- How Scaling Eliminates DAC Over-Range Errors on page 117
- Agilent MXG waveform scaling on page 118 and page 119:
  - Waveform runtime scaling to scale a currently-playing waveform
  - Waveform scaling to permanently scale either the currently playing waveform, or a non-playing waveform file in BBG media

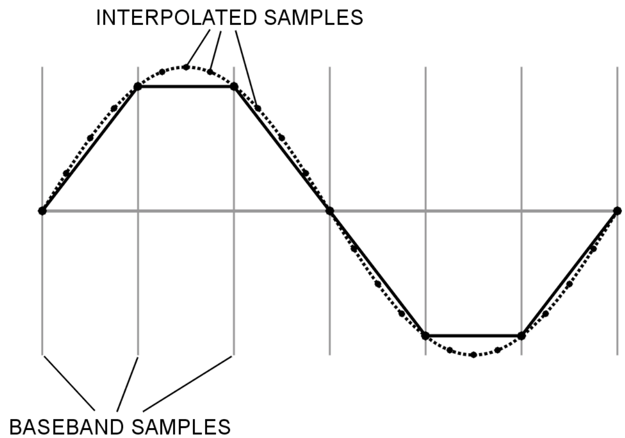
Figure 8-13 Scaling Softkeys



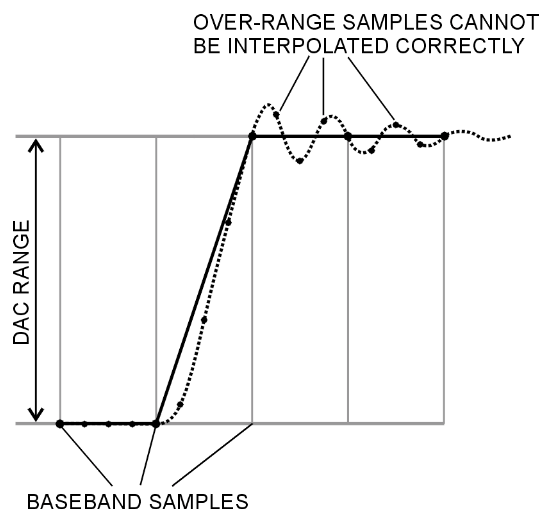
For details on each key, use key help as described on page 23.

How DAC Over-Range Errors Occur

The signal generator uses an interpolator filter when it converts digital I and Q baseband waveforms to analog waveforms. Because the clock rate of the interpolator is four times that of the baseband clock, the interpolator calculates sample points between the incoming baseband samples and smooths the waveform as shown in the figure at the right.



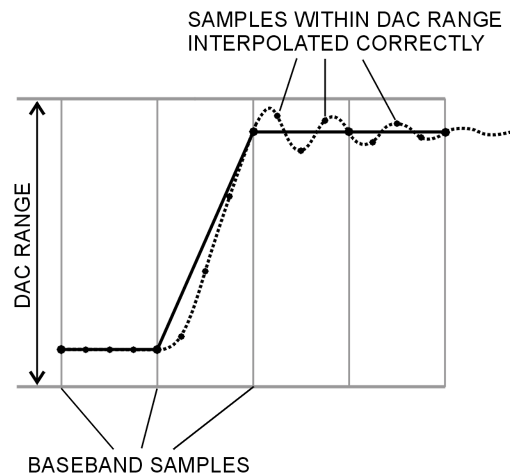
The interpolation filters in the DACs overshoot the baseband waveform. If a baseband waveform has a fast-rising edge, the interpolator filter's overshoot becomes a component of the interpolated baseband waveform. This response causes a ripple or ringing effect at the peak of the rising edge. If this ripple overshoots the upper limit of the DAC range, the interpolator calculates erroneous sample points and is unable to replicate the true form of the ripple (see the figure at the right). As a result, the signal generator reports a DAC over-range error.



How Scaling Eliminates DAC Over-Range Errors

Scaling reduces the amplitude of the baseband waveform while maintaining its basic shape and characteristics, such as peak-to-average power ratio. If the fast-rising baseband waveform is scaled enough to allow an adequate margin for the interpolator filter overshoot, the interpolator filter can calculate sample points that include the ripple effect and eliminate the over-range error (see the figure at the right).

Although scaling maintains the basic shape of the waveform, excessive scaling can compromise waveform integrity. For example, if the bit resolution becomes too low the waveform becomes corrupted with quantization noise. To achieve maximum accuracy and optimize dynamic range, scale the waveform no more than is required to remove the DAC over-range error. Optimum scaling varies with waveform content.



Setting Waveform Runtime Scaling

Runtime scaling scales the waveform data during playback; it does not affect the stored data. You can apply runtime scaling to either a segment or sequence, and set the scaling value either while the ARB is on or off. This type of scaling is well suited for eliminating DAC over-range errors. Runtime scaling adjustments are not cumulative; the scaling value is applied to the original amplitude of the waveform file. There are two ways to save the runtime scaling setting: by using the save function (page 35) and by saving the setting to the file header (page 79). Saving to the file header saves the value with the waveform file, saving with the Save function stores the value as the current instrument setting.

Use this example to learn how to scale the currently selected waveform.

1. Select the waveform to which you want to apply scaling:
   a. Press **Mode** > **Dual ARB** > **Select Waveform**.
   b. Highlight the desired waveform (segment or sequence).
   c. Press **Select Waveform**.
2. Play the selected waveform: Press **ARB Off On** until On highlights.
3. Set the Waveform Runtime Scaling value:
   a. Press **ARB Setup** > **Waveform Runtime Scaling**.
   b. Enter a scaling value.

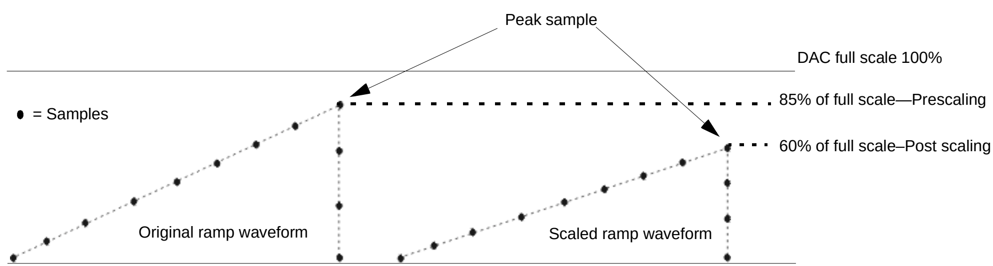
      The signal generator automatically applies the new scaling value to the waveform. There is no single value that is optimal for all waveforms. To achieve the maximum dynamic range, use the largest scaling value that does not result in a DAC over-range error.
   c. Press **Return**.

Setting Waveform Scaling

Waveform scaling differs from waveform runtime scaling in that it permanently affects waveform data and only applies to waveform segments stored in BBG media. You scale the waveform either up or down as a percentage of the DAC full scale (100%). If you scale your waveforms using this method, you may also need to change the waveform runtime scaling value to accommodate this scaling.

When you scale, the signal generator permanently modifies the waveform file's sample values so that they conform to the desired scaling value. When you initiate scaling, the signal generator performs the following actions:

- locates the waveform file's absolute peak sample value
- determines its current percentage of full scale
- calculates the ratio of the desired scale value to the determined absolute peak sample scale value
- multiplies each sample in the waveform file by this ratio



Scaled sample value = scaling ratio × prescale sample val

Scaling ratio = desired scale val / current scale val
= 60 / 85
= 0.70588

Each sample in the waveform is multiplied by 0.70588 to reach the 60% post scaling waveform amplitude.

When you scale a waveform, you can create fractional data, lose data, or both. Fractional data occurs almost every time you reduce or increase the scaling value, and causes quantization errors. Quantization errors are more noticeable when scaling down, since you are closer to the noise floor. You lose data when either the signal generator rounds fractional data down or the scaling value is derived using the results from a power of two. This means that scaling a waveform in half (power of two: $2^1 = 2$) causes each waveform sample to lose one bit. The waveform data modifications are not correctable and may cause waveform distortion. It is always best to make a copy of the original file prior to applying scaling.

Use the following examples to apply waveform scaling to a waveform file. While this process uses the factory-supplied waveform RAMP_TEST_WFM, it is the same for any waveform file.

Copy a Waveform File

1. Display the waveform files in BBG media: Press **File** > **Catalog Type** > **More** > **Volatile Segments**.
2. Highlight the waveform RAMP_TEST_WFM.
3. Press **Copy File.**

4. Name the copy (this example uses the name MY_TEST_SCAL) and press **Enter**.

Apply Scaling to the Copied Waveform File

CAUTION This type of scaling is non-reversible. Any data lost in the scaling operation cannot be restored. Save a copy of the waveform file before scaling.

1. Open the DUAL ARB Waveform Utilities menu:

   Press **Mode** > **Dual ARB** > **More** > **More** > **Waveform Utilities**.
2. In the list of BBG Media segment files, highlight the copied file (in this example, MY_TEST_SCAL).
3. Set and apply a scaling value (in this example 70% scaling is applied):

   Press **Scale Waveform Data** > **Scaling** > **70** > **%** > **Apply to Waveform**.

I / Q Modulation

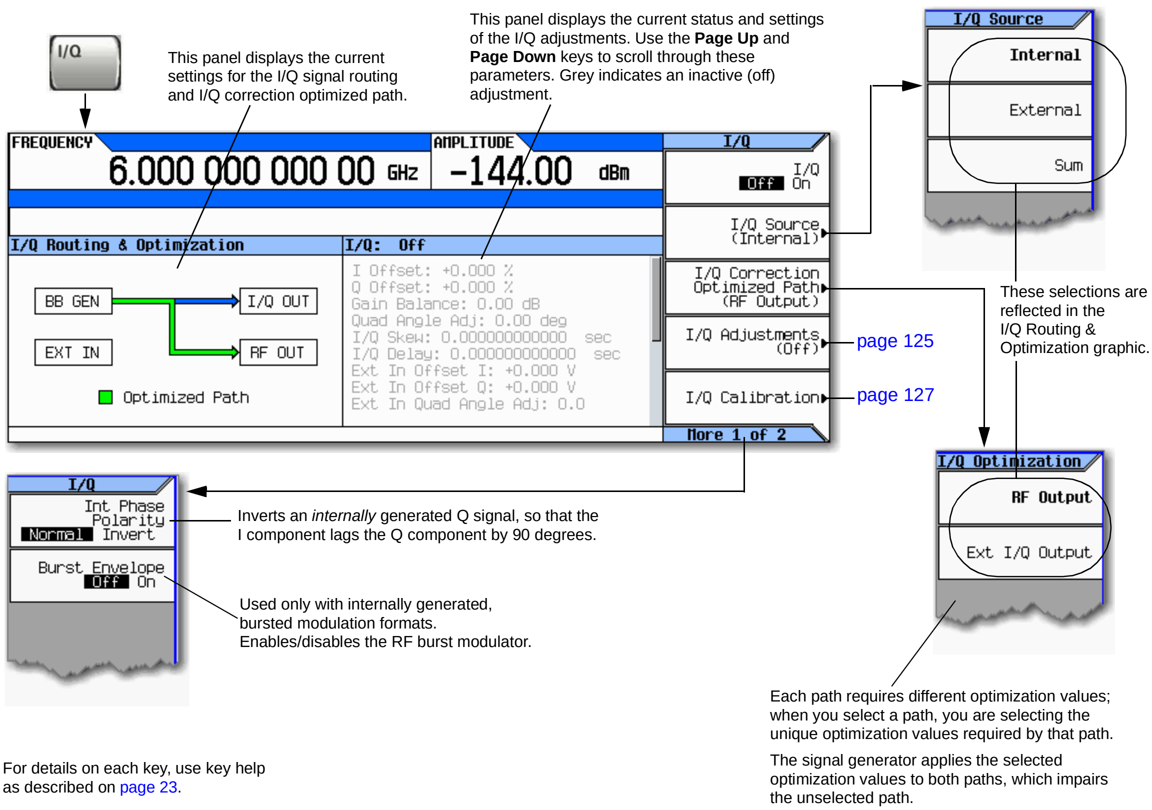
The following factors contribute to the error vector magnitude:

- Differences in amplitude, phase, and delay between the I and Q channels
- DC offsets

The I/Q menu not only enables you to select the I/Q signal source and output, it also provides adjustments and calibrations to compensate for differences in the I and Q signals.

See also, "Modulating the Carrier Signal" on page 34.

Figure 8-14 I / Q Display and Softkeys



Using the Rear Panel I and Q Outputs

NOTE The rear-panel I and Q connectors only output a signal while using the internal BBG.

In addition to modulating the carrier, the signal generator also routes the internally generated I and Q signals to the rear panel I and Q connectors. These output signals are post DAC, so they are in analog form. You can use these rear panel I and Q signals to:

- drive a system's transmitter stage
- test individual analog I and Q components such as an I/Q modulator
- route the I and Q signals into another signal generator

The factory default setting routes the internally generated I and Q signals to the I/Q modulator and the rear panel I and Q output connectors. However to optimize (apply calibration factors) the rear panel signals, you need to select the external I/Q output path.

Select and Play a Waveform

1. Press **Mode** > **Dual ARB** > **Select Waveform**.
2. Highlight the desired waveform.
3. Press **Select Waveform** > **ARB Off On to On**.

Optimize the Signal Path

1. Connect cables from the rear panel I and Q connectors to either a DUT or another signal generator.

   When you turn the ARB on, the signal generator automatically outputs the I and Q signals to the rear panel connectors.

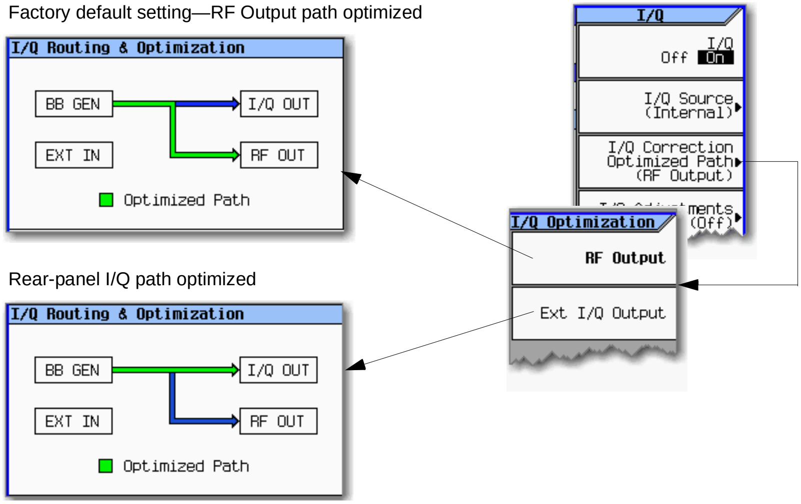
   You can use the rear panel I and Q signals as I and Q inputs to another signal generator. The MXG has front panel connectors, I Input and Q Input, for this purpose.

2. Press **I/Q** > **I/Q Correction Optimized Path** > **Ext I/Q Output**.

When you optimize a path, the path indicator turns green.

Factory default setting—RF Output path optimized

Rear-panel I/Q path optimized



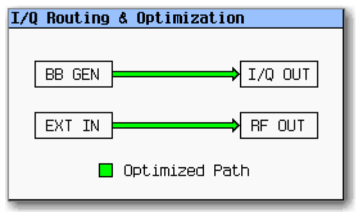
Configuring the Front Panel Inputs

The signal generator accepts externally supplied analog I and Q signals through the front-panel I Input and Q Input. You can use the external signals as the modulating source, or sum the external signals with the internal baseband generator signals.

1. Connect I and Q signals to the front panel connectors.
   a. Connect an analog I signal to the signal generator's front-panel I Input.
   b. Connect an analog Q signal to the signal generator's front-panel Q Input.
2. Set the signal generator to recognize the front-panel input signals:
   - **To Modulate onto the Carrier**

     Press **I/Q** > **I/Q Source** > **External**.

     Signal generator display—both paths calibrated with **I/Q Correction Optimized Path** set to **Ext I/Q Output** (see page 122).

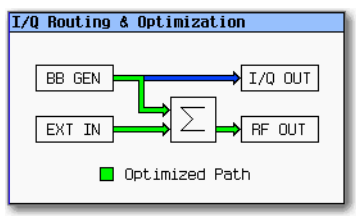
     

   - **To Sum and Modulate onto the Carrier**

     Press **I/Q** > **I/Q Source** > **Sum**.

     To select and play a waveform for the BB GEN path, see page 71.

     Signal generator display—both RF paths calibrated with **I/Q Correction Optimized Path** set to **RF Output** (see page 122).

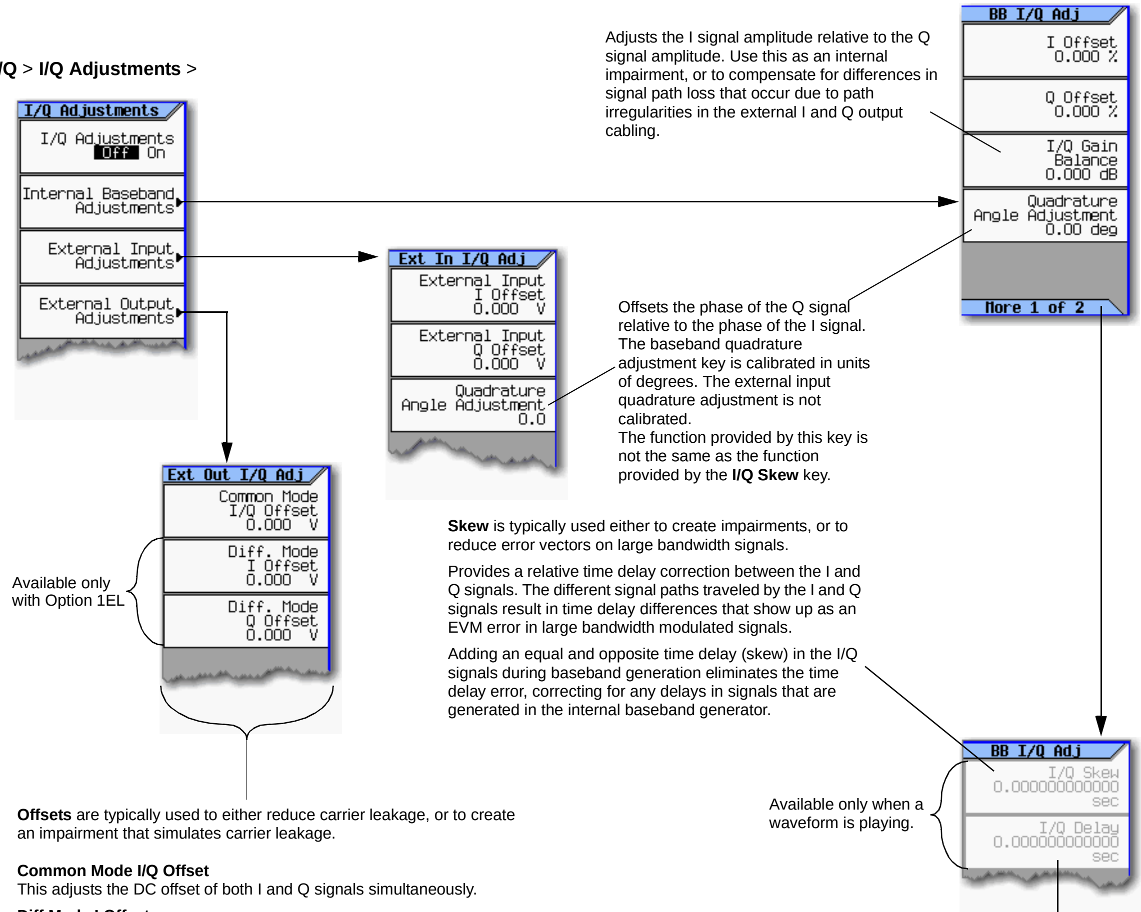
     

   Notice that only the internal BBG (BB GEN) routes I and Q signals to the rear-panel I and Q outputs.
3. If you are using only the external I and Q signals (no summing), turn on the I/Q modulator: Press **I/Q Off On** to On.
4. Configure the RF output:
   a. Set the carrier frequency.
   b. Set the carrier amplitude.
   c. Turn the RF output on.

I/Q Adjustments

Use the I/Q Adjustments to compensate for or add impairments to the I/Q signal.

I/Q > **I/Q Adjustments** >



Adjusts the I signal amplitude relative to the Q signal amplitude. Use this as an internal impairment, or to compensate for differences in signal path loss that occur due to path irregularities in the external I and Q output cabling.

Offsets the phase of the Q signal relative to the phase of the I signal. The baseband quadrature adjustment key is calibrated in units of degrees. The external input quadrature adjustment is not calibrated.
The function provided by this key is not the same as the function provided by the **I/Q Skew** key.

Skew is typically used either to create impairments, or to reduce error vectors on large bandwidth signals.

Provides a relative time delay correction between the I and Q signals. The different signal paths traveled by the I and Q signals result in time delay differences that show up as an EVM error in large bandwidth modulated signals.

Adding an equal and opposite time delay (skew) in the I/Q signals during baseband generation eliminates the time delay error, correcting for any delays in signals that are generated in the internal baseband generator.

Offsets are typically used to either reduce carrier leakage, or to create an impairment that simulates carrier leakage.

Common Mode I/Q Offset
This adjusts the DC offset of both I and Q signals simultaneously.

Diff Mode I Offset
This adjusts the DC offset level of the I and I-bar output signal. I and I-bar cannot be adjusted independently.

Diff Mode Q Offset
This adjusts the DC offset level of the I and I-bar output signal. I and I-bar cannot be adjusted independently.

Changes the absolute phase of both the I and Q signals with respect to triggers and markers.

Positive values add delay and negative values advance the signals. This value affects both the baseband signal modulated onto the RF and the external output signals (I and Q). This setting cannot be used with constant envelope modulation and it does not affect external I and Q inputs.

Table 8-1 I/Q Adjustments Uses

I/Q Adjustment	Effect	Impairment
Offset	Carrier feedthrough	dc offset
Quadrature Angle	EVM error	phase skew
	I/Q Images	I/Q path delay
I/Q Skew	EVM error	high sample rate phase skew or I/Q path delay
I/Q Gain Balance	I/Q amplitude difference	I/Q gain ratio

The I/Q adjustment, I/Q Delay, is not for adding impairments; its function is to compensate for any latency between the EVENT output signals (marker signals) and the RF output.

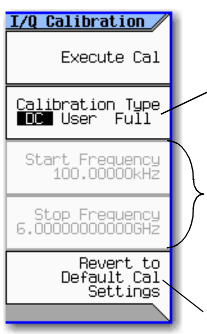
I/Q Calibration

Use the I/Q calibration for I and Q signal corrections. What aspects of the I and Q signal is corrected depends on whether the signal is internally or externally generated.

Correction	Internal I and Q	External I and Q
Offset	X	X
Gain Balance	X	--
Quadrature Error	X	X

When you perform an I/Q calibration, that calibration data takes precedence over the factory-supplied calibration data. The calibration routines improves performance that may degrade over time or due to temperature changes.

I/Q > **I/Q Calibration** >



Available only when Calibration type = User

Deletes any user-generated calibration data and restores the factory–supplied calibration data.

DC optimizes the I/Q performance for the current instrument settings, and typically completes in several seconds. Changing any instrument setting except for I/Q adjustments after performing a DC calibration voids the DC calibration and causes the signal generator to revert to the factory–supplied calibration data.

Presetting the instrument or cycling power is equivalent to pressing **Revert to Default Cal Setting**.

User provides a quicker calibration when a full calibration is not required. You can limit the calibration by specifying the calibration start and stop frequencies.

When you limit the calibration to less than the instrument's full frequency range, the factory–supplied calibration data is used for the rest of the range.

Information is retained through a preset or power cycle.

Full takes 5 minutes, executing measurements over the instrument's entire frequency range.

Information is retained through a preset or power cycle.

For details on each key, use key help as described on page 23.

9 Adding Real Time Noise to a Signal (Option 403)

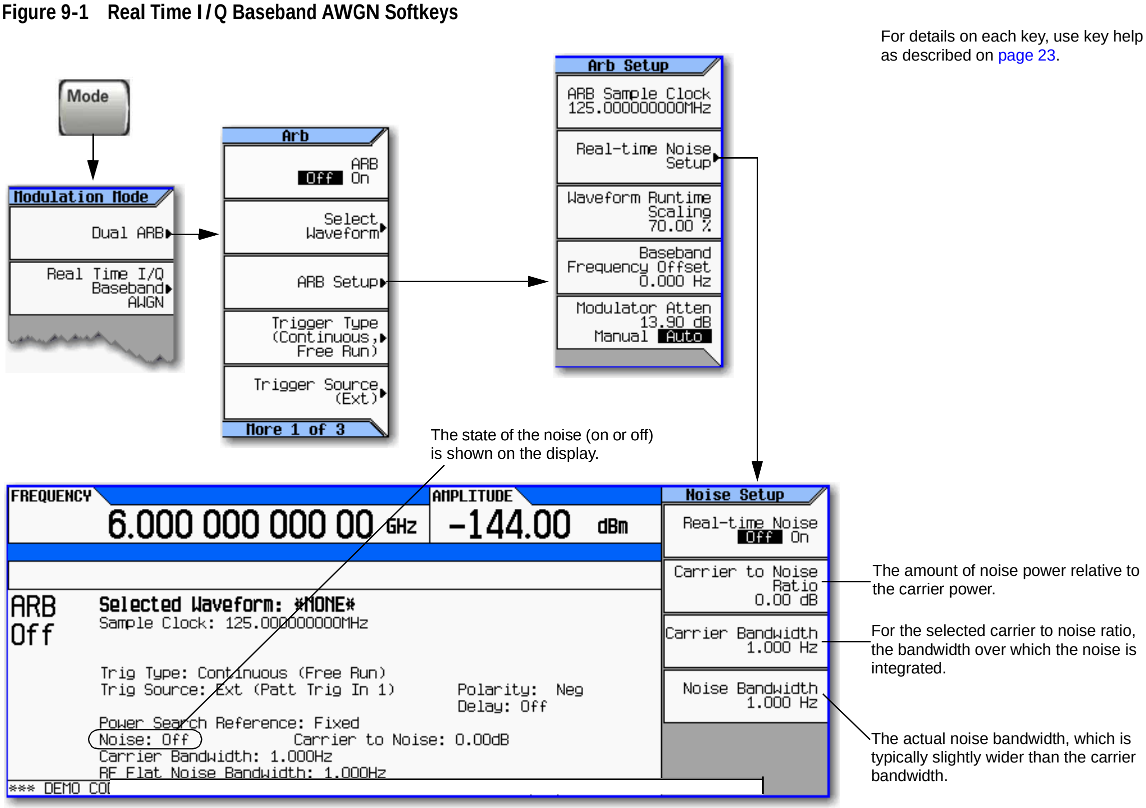
Before using this information, you should be familiar with the basic operation of the signal generator. If you are not comfortable with functions such as setting the power level and frequency, refer to Chapter 3, "Basic Operation," on page 23 and familiarize yourself with the information in that chapter.

This chapter contains examples of using the additive white gaussian noise (AWGN) waveform generator, which is available only in vector signal generators with Option 403.

Adding Real-Time Noise to a Dual ARB Waveform

A vector signal generator with option 403 enables you to apply additive white gaussian noise (AWGN) to a carrier in real time while the modulating waveform plays in the dual ARB waveform player.

Figure 9-1 Real Time I/Q Baseband AWGN Softkeys



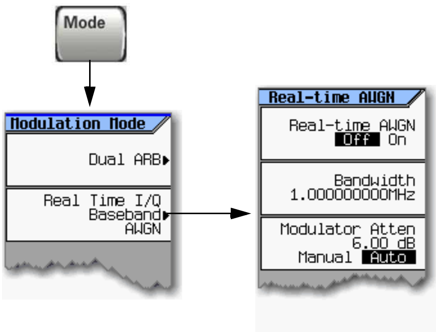
Use the following steps to modulate a 1 GHz, –10 dBm carrier with the factory-supplied waveform SINE_TEST_WFM, and then apply 45 MHz bandwidth noise that has a 30 dB noise power carrier–to–noise ratio across a 40 MHz carrier bandwidth.

1. Preset the signal generator and set the following:
    - Frequency: 1 GHz
    - Amplitude: –10 dBm
    - RF output: on
2. Select the factory-supplied waveform SINE_TEST_WFM:
    a. Press **Mode** > **Dual ARB** > **Select Waveform**.
    b. Highlight SINE_TEST_WFM and press **Select Waveform**.
3. Turn on the dual ARB player: press **ARB Off On** to highlight On.
4. Set the ARB sample clock to 50 MHz: Press **ARB Setup** > **ARB Sample Clock** > **50** > **MHz**.
5. Press **Real-time Noise Setup** and set the following:
    - Carrier to Noise Ratio: 30 dB
    - Carrier Bandwidth: 40 MHz
    - Noise Bandwidth: 45 MHz
    - Real-time Noise: on

The signal generator’s displayed power level (–10 dBm) includes the noise power.

Using Real Time I/Q Baseband AWGN

Figure 9-2 Real Time I/Q Baseband AWGN Softkeys



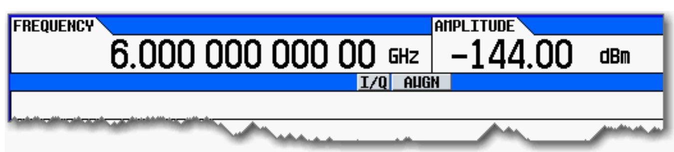
For details on each key, use key help as described on page 23.

Use the following steps to apply 10 MHz bandwidth noise to a 500 MHz, –10 dBm carrier.

1. Configure the noise:
   a. Preset the signal generator.
   b. Press **Mode** > **Real Time I/Q Baseband AWGN**
   c. Press **Bandwidth** > **10** > **MHz**.
2. Generate the noise:

   Press **AWGN Off On** until On highlights.

   During generation, the AWGN and I/Q annunciators activate (as shown at right). AWGN is now available to modulate the RF carrier.



3. Configure the RF output:
   - Frequency: 500 MHz
   - Amplitude: –10 dBm
   - RF output: on

   The carrier with AWGN is now available at the signal generator's RF OUTPUT connector.

10 Working in a Secure Environment

Understanding Memory Types

The signal generator has several memory types, and each is used to store a specific type of data. Before removing sensitive data, you should to understand how each memory type is used. The following tables describe each memory type used in the base instrument, and optional baseband generator.

Table 10-1 Base Instrument Memory

Memory Type and Size	Writable During Normal Operation?	Data Retained When Powered Off?	Purpose/Contents	Data Input Method	Location in Instrument and Remarks
Main Memory (RAM) 32 MB	Yes	No	firmware operating memory no user data	operating system	CPU board
Main Memory (Flash) 8 MB	Yes	Yes	factory calibration/configuration data [a]user file system, which includes flatness calibration, instrument states, and sweep lists	firmware upgrades and user-saved data[a]	CPU board (same chip as firmware memory, but managed separately) Because this memory chip contains 8 MB of user data (described here) and 8 MB of firmware memory, a full-chip erase is not desirable. User data areas are selectively and completely sanitized when you perform the **Erase and Sanitize** function.
Firmware Memory (Flash) 8 MB	No	Yes	main firmware image	factory installed or firmware upgrade	CPU board (same chip as main flash memory, but managed separately) During normal operation, this memory cannot be overwritten. It is only overwritten during the firmware installation or upgrade process. Because this memory chip contains 8 MB of user data and 8 MB of firmware memory (described here), a full-chip erase is not desirable. User data areas are selectively and completely sanitized when you perform the **Erase and Sanitize** function.
Bootrom Memory (EEPROM) 8 kB	No	Yes	CPU bootup parameters no user data	factory programmed	CPU board During normal operation, this memory cannot be overwritten or erased. This read-only data is programmed at the factory.
Calibration Data (Flash) 256 kB	No	Yes	factory calibration/configuration data backup no user data	factory or service only	RF Board
LCD Display Memory (RAM) 160 kB	No	No	display buffer	operating system	RF board

Table 10-1 Base Instrument Memory (Continued)

Memory Type and Size	Writable During Normal Operation?	Data Retained When Powered Off?	Purpose/Contents	Data Input Method	Location in Instrument and Remarks
Front Panel Memory (Flash) 32 kB	No	No	front panel keyboard controller firmware no user data	operating system	Front Panel board

[a]Analog instruments only

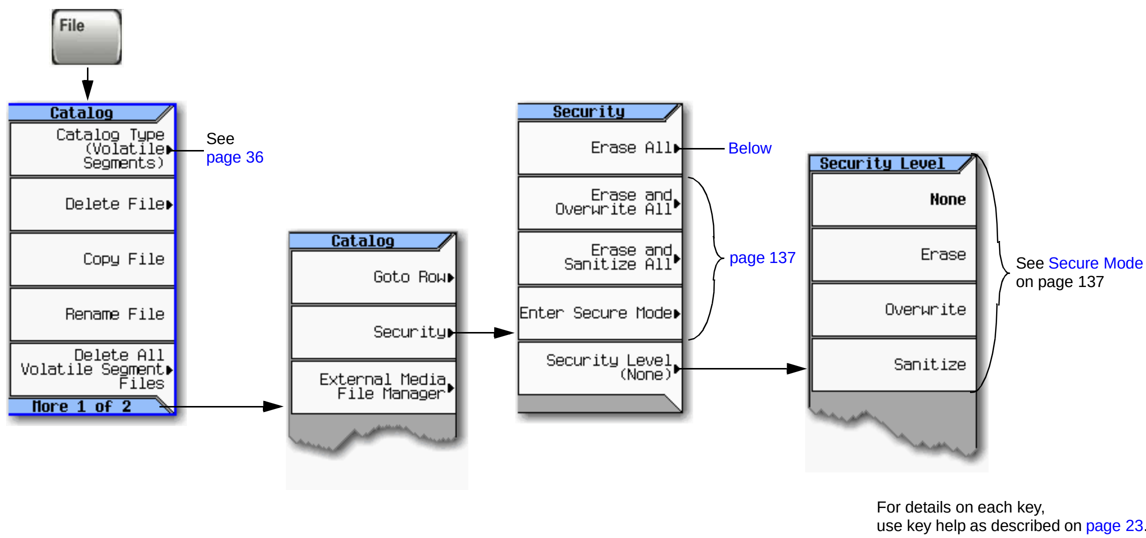
Table 10-2 Baseband Generator Memory (Options 651,652, 654)

Memory Type and Size	Writable During Normal Operation?	Data Retained When Powered Off?	Purpose/Contents	Data Input Method	Remarks
Waveform Memory (RAM) ≤ 320 MB	Yes	No	waveforms (including header and marker data)	normal user operation	User data is completely sanitized when you perform the **Erase and Sanitize** function.
Persistent Memory (Flash) 512 MB	Yes	Yes	all user data		User data is completely sanitized when you perform the **Erase and Sanitize** function.
Calibration Data Memory (Flash) 128 kB	No	Yes	no user data		

Removing Data from Memory (Option 006 Only)

When moving the signal generator from a secure development environment, there are several security functions you can use to remove classified proprietary information from the instrument. Security functions also have equivalent SCPI commands for remote operation (“System Subsystem (:SYSTem)” commands; refer to the *SCPI Command Reference*)

CAUTION The signal generator has several memory types (described in Table 10-1 on page 134, and Table 10-2 on page 135), and each is used to store a specific type of data. Before removing sensitive data, understand how each memory type is used.



Erase All

Removes:	All user files, user flatness calibrations, user I/Q calibrations
Resets:	All table editors with original factory values, ensuring that user data and configurations are not accessible or viewable
Does Not:	Sanitize memory
Time to Erase:	typically < 1 minute, depending on the number of files.
To Start:	Press **File** > **More** > **Security** > **Erase All** > **Confirm Erase**

NOTE This is not **File** > **Delete All Files**, which deletes all user files but does not reset table editors.

Erase and Overwrite All

This performs the same actions as Erase All, plus it clears and overwrites the various memory types in accordance with Department of Defense (DoD) standards, as follows:

CPU Flash	Overwrites all addressable locations with random characters and then erases the flash blocks. This accomplishes the same purpose as a chip erase. System files are restored after erase.
To Start:	Press **File** > **More** > **Security** > **Erase and Overwrite All** > **Confirm Erase**

Erase and Sanitize All

This performs the same actions as Erase and Overwrite All and then adds more overwriting actions. After executing this function, you must manually perform the additional steps described below for the sanitization to comply with Department of Defense (DoD) standards.

CPU Flash	Overwrites all addressable locations with random characters and then erases the flash blocks. This accomplishes the same purpose as a chip erase. System files are restored after erase.
BBG Persistent Memory (Flash)	*(Vector instruments only)* Overwrites all addressable locations with random characters and then erases the flash blocks. This accomplishes the same purpose as a chip erase. System files are restored after erase.
To Start:	Press **File** > **More** > **Security** > **Erase and Sanitize All** > **Confirm Sanitize**

Secure Mode

CAUTION Once you activate secure mode (by pressing **Confirm)**, you cannot deactivate or decrease the security level; the erasure actions for that security level execute at the next power cycle. Once you activate secure mode, you can only increase the security level until you cycle power. For example, you can change **Erase** to **Overwrite**, but not the reverse.

After the power cycle, the security level selection remains the same, but secure mode is not activated.

Secure mode automatically applies the selected **Security Level** action the next time the instrument's power cycles.

To Set the Level: Press **File** > **More** > **Security** > **Security Level** and choose from the following:

– **None** = factory preset, no user information is lost
– **Erase** = Erase All
– **Overwrite** = Erase and Overwrite All
– **Sanitize** = Erase and Sanitize All

To Activate: Press **File** > **More** > **Security** > **Enter Secure Mode** > **Confirm**

The softkey changes to **Secure Mode Activated**.

Securing a Nonfunctioning Instrument

If the instrument is not functioning and you are unable to use the security functions, you must physically remove the processor board and, for vector instruments, the A4 Memory Chip from the instrument. Once these assemblies are removed, choose one of the following options:

- Discard the board (or boards) and send the instrument to a repair facility. A new board (or boards) will be installed and the instrument will be repaired and calibrated. If the instrument is still under warranty, you will not be charged for new boards.
- If you have another working instrument, install the board (or boards) into that instrument and erase the memory. Then reinstall the board (or boards) back into the nonworking instrument and send it to a repair facility for repair and calibration. If you discover that one or both of the boards do not function in the working instrument, discard the nonfunctioning board and note on the repair order that it caused the instrument failure. If the instrument is still under warranty, you will not be charged for new boards.

For instructions on how to remove and replace boards, refer to the *Service Guide*.

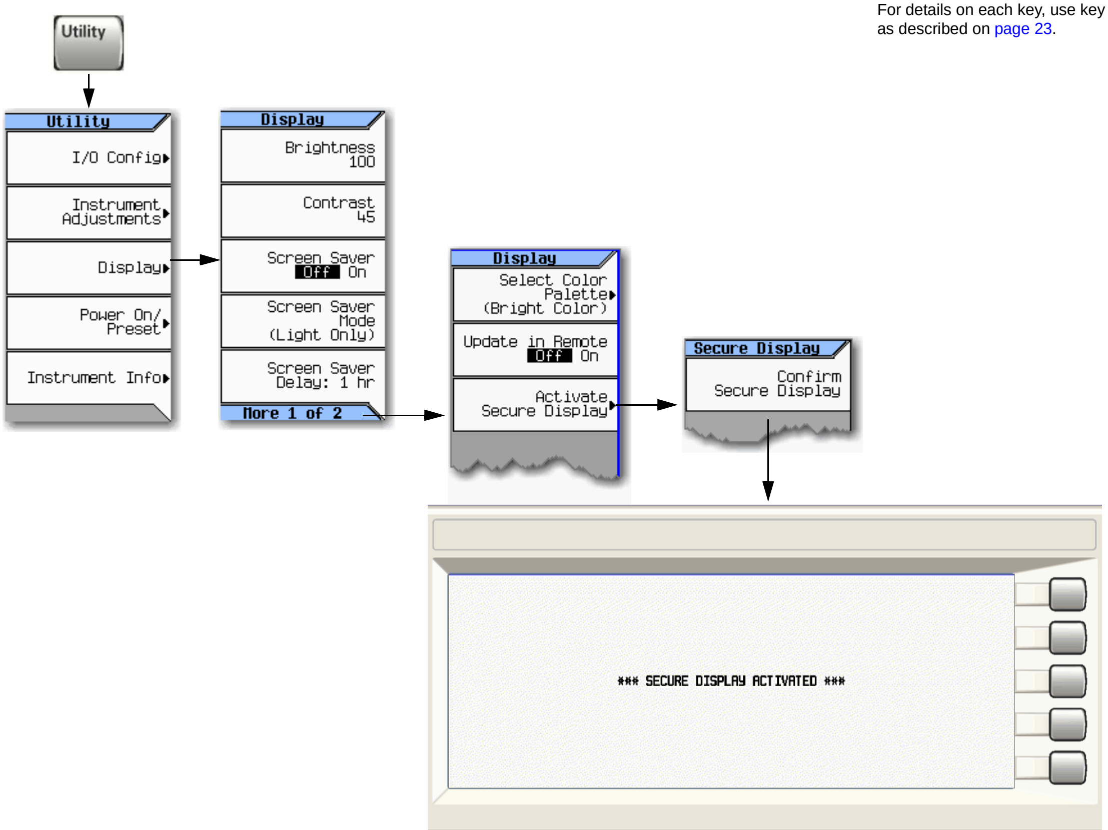
Using the Secure Display (Option 006 Only)

This function prevents unauthorized personnel from reading the instrument display and tampering with the current configuration through the front panel. The display blanks, except for the message shown in the following figure, and the front panel keys are disabled.

To re-enable the display and front panel keys, cycle the power.

Figure 10-1 Secure Display Softkeys

For details on each key, use key help as described on page 23.



11 Troubleshooting

Display

The Display is Too Dark to Read

Both brightness and contrast may be set to minimum. Use the figure in “Display Settings” on page 16 to locate the brightness and contrast softkeys and adjust their values so that you can see the display.

Signal Generator Lock-Up

- Ensure that the signal generator is not in remote mode (the R annunciator shows on the display). To exit remote mode and unlock the front panel, press **Local Cancel / (Esc).**
- Ensure that the signal generator is not in local lockout, which prevents front panel operation. For information on local lockout, refer to the *Programming Guide*.
- If a progress bar appears on the signal generator display, an operation is in progress.
- Preset the signal generator.
- Cycle power on the signal generator.

RF Output

No RF Output

- Check the RF ON/OFF LED (shown on page 3). If it is off, press RF On/Off to turn the output on.
- Ensure that the amplitude is set within the signal generator's range.
- If the instrument is playing a waveform, ensure that marker polarity and routing settings are correct (see "Saving Marker Polarity and Routing Settings" on page 83).

Power Supply Shuts Down

If the power supply does not work, it requires repair or replacement. If you are unable to service the instrument, send the signal generator to an Agilent service center for repair (see page 151).

No Modulation at the RF Output

Check both the Mod On/Off LED and the <*modulation*> Off On softkey, and ensure that both are on. See also, page 34.

For digital modulation on a vector signal generator, ensure that the internal I/Q modulator is on (the I/Q annunciator displays).

If using an external modulation source, ensure that the external source is on and that it is operating within the signal generator's specified limits.

RF Output Power too Low

- If the AMPLITUDE area of the display shows the OFFS indicator, eliminate the offset:

  Press **Amptd** > **More (1 of 2)** > **Amptd Offset** > **0** > **dB**. See also, "Setting an Output Offset" on page 49.
- If the AMPLITUDE area of the display shows the REF indicator, turn off the reference mode:
  1. Press **Amptd** > **More** > **Amptd Ref Off On** until *Off* highlights.
  2. Reset the output power to the desired level.

  See also, "Setting an Output Reference" on page 50.
- If you are using the signal generator with an external mixer, see page 144.
- If you are using the signal generator with a spectrum analyzer, see page 144.
- If pulse modulation is on, turn off the ALC, and check that pulse width is within specifications.

Distortion

If you edit and resave a segment in a waveform sequence, the sequence does not automatically update the RMS value stored in it's header. This can cause distortion on the output signal. Display the sequence header information and recalculate the RMS value (see page 78).

Signal Loss While Working with a Spectrum Analyzer

The effects of reverse power can cause problems with the RF output when you use the signal generator with a spectrum analyzer that does not have preselection. Use an unleveled operating mode (described on page 47).

A spectrum analyzer can have as much as +5 dBm LO feedthrough at its RF input port at some frequencies. If the frequency difference between the LO feedthrough and the RF carrier is less than the ALC bandwidth, the LO's reverse power can amplitude modulate the signal generator's RF output. The rate of the undesired AM equals the difference in frequency between the spectrum analyzer's LO feedthrough and the signal generator's RF carrier.

Reverse power problems can be solved by using one of the unleveled operating modes.

See:

- "ALC Off Mode" on page 47

  and

- "Power Search Mode" on page 48

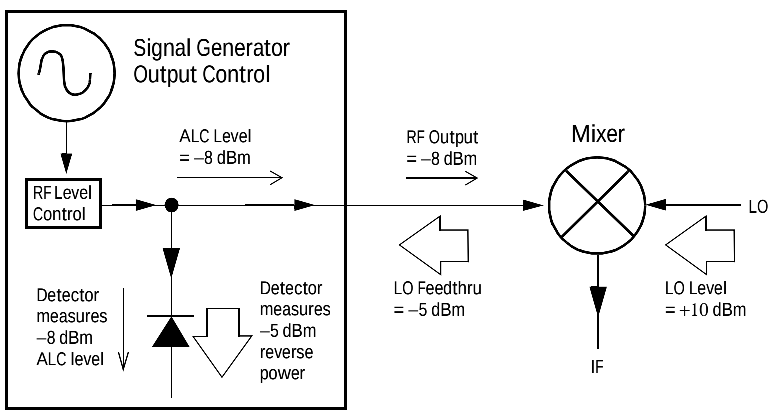
Signal Loss While Working with a Mixer

To fix signal loss at the signal generator's RF output during low-amplitude coupled operation with a mixer, add attenuation and increase the RF output amplitude.

The figure at right shows a configuration in which the signal generator provides a low amplitude signal to a mixer.

The internally leveled signal generator RF output (and ALC level) is –8 dBm. The mixer is driven with an LO of +10 dBm and has an LO-to-RF isolation of 15 dB. The resulting –5 dBm LO feedthrough enters the signal generator's RF output connector and arrives at the internal detector.

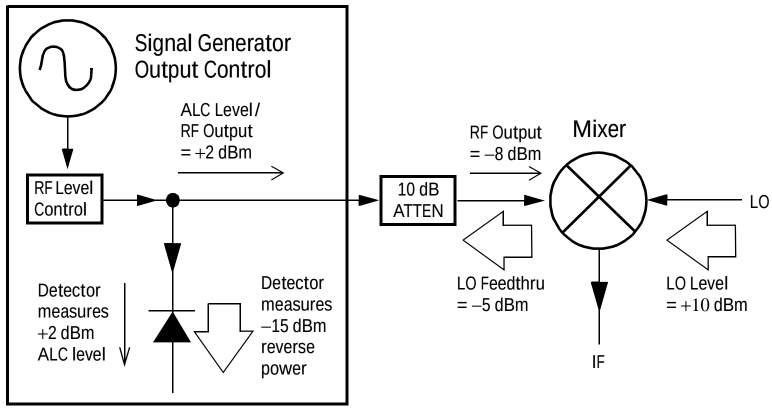
Effects of Reverse Power on ALC



Depending on frequency, it is possible for most of this LO feedthrough energy to enter the detector. Because the detector responds to its total input power regardless of frequency, this excess energy causes the ALC to reduce the RF output. In this example, the reverse power across the detector is actually greater than the ALC level, which can result in loss of signal at the RF output.

The solution at right shows a similar configuration with the addition of a 10 dB attenuator connected between the RF output of the signal generator and the input of the mixer. The signal generator's ALC level increases to +2 dBm and transmits through a 10 dB attenuator to achieve the required –8 dBm amplitude at the mixer input.

Reverse Power Solution



Compared to the original configuration, the ALC level is 10 dB higher while the attenuator reduces the LO feedthrough (and the signal generator's RF output) by 10 dB. Using the attenuated configuration, the detector is exposed to a +2 dBm desired signal versus the –15 dBm undesired LO feedthrough. This 17 dB difference between desired and undesired energy results in a maximum 0.1 dB shift in the signal generator's RF output level.

Sweep

Cannot Turn Off Sweep

Press **Sweep** > **Sweep** > **Off**.

Sweep Appears Stalled

The current status of the sweep is indicated as a shaded rectangle in the progress bar (see "Configuring a Swept Output" on page 27). If the sweep appears to stall, check the following:

1. Turn on the sweep with one of the following key sequences:

   Sweep > **Sweep** > **Freq**
   Sweep > **Sweep** > **Amptd**
   Sweep > **Sweep** > **Waveform** (vector instruments only)

2. If the sweep is in single mode, press the **Single Sweep** softkey.
3. If the sweep trigger (indicated by the **Sweep Trigger** softkey) is *not* set to Free Run, set it to Free Run to determine if a missing sweep trigger is blocking the sweep.
4. If the point trigger (indicated by the **Point Trigger** softkey) is *not* set to Free Run, set it to Free Run to determine if a missing point trigger is blocking the sweep.
5. Set the dwell time to one second to determine if the dwell time was set to a value that was too slow or too fast to see.
6. Ensure that you set at least two points in the step sweep or list sweep.

Incorrect List Sweep Dwell Time

1. Press Sweep > More > Configure List Sweep.
2. Check that the list sweep dwell values are accurate.
3. If the dwell values are incorrect, edit them.
   If the dwell values are correct, continue to the next step.
4. Press **More**, and ensure that the **Dwell Type List Step** softkey is set to List.

   If Step is selected, the signal generator sweeps the list points using the dwell time set for step sweep rather than list sweep.

See also, "Configuring a Swept Output" on page 27.

List Sweep Information is Missing from a Recalled Register

List sweep information is not stored as part of the instrument state in an instrument state register. Only the current list sweep is available to the signal generator. You can store list sweep data in the instrument catalog (see "Saving and Recalling Data" on page 37).

Amplitude Does Not Change in List or Step Sweep

Verify that sweep type is set to amplitude (Amptd); the amplitude does not change when the sweep type is set to frequency (Freq) or waveform.

Internal Media Data Storage

Instrument State Saved but the Register is Empty or Contains the Wrong State

If the register number you intended to use is empty or contains the wrong instrument state, recall register 99. If you selected a register number greater than 99, the signal generator automatically saves the instrument state in register 99.

See also, "Working with Instrument State Files" on page 38.

External Media Data Storage

Instrument Recognizes External Media Connection, but Does Not Display Files

If the external media works on other instruments or computers, it may simply be incompatible with the signal generator; use a different memory stick. See the signal generator data sheet for information on compatible media.

Preset

The Signal Generator Does Not Respond

If the signal generator does not respond to a preset, the instrument may be in remote mode, which locks the keypad.

To exit remote mode and unlock the preset keys, press **Local Cancel / (Esc).**

Pressing Preset Performs a User Preset

This behavior results from the use of a backward-compatible SCPI command. To return the signal generator to normal use, send the command `:SYST:PRESet:TYPE NORM`.

For information on SG–1364/U SCPI commands, refer to the *SCPI Command Reference*.

Error Messages

Error Message Types

Events do not generate more than one type of error. For example, an event that generates a query error does not generate a device-specific, execution, or command error.

Query Errors (–499 to –400) indicate that the instrument's output queue control has detected a problem with the message exchange protocol described in IEEE 488.2, Chapter 6. Errors in this class set the query error bit (bit 2) in the event status register (IEEE 488.2, section 11.5.1). These errors correspond to message exchange protocol errors described in IEEE 488.2, 6.5. In this case:

- Either an attempt is being made to read data from the output queue when no output is either present or pending, or
- data in the output queue has been lost.

Device Specific Errors (–399 to –300, 201 to 703, and 800 to 810) indicate that a device operation did not properly complete, possibly due to an abnormal hardware or firmware condition. These codes are also used for self-test response errors. Errors in this class set the device-specific error bit (bit 3) in the event status register (IEEE 488.2, section 11.5.1).

The <error_message> string for a *positive* error is not defined by SCPI. A positive error indicates that the instrument detected an error within the GPIB system, within the instrument's firmware or hardware, during the transfer of block data, or during calibration.

Execution Errors (–299 to –200) indicate that an error has been detected by the instrument's execution control block. Errors in this class set the execution error bit (bit 4) in the event status register (IEEE 488.2, section 11.5.1). In this case:

- Either a <PROGRAM DATA> element following a header was evaluated by the device as outside of its legal input range or is otherwise inconsistent with the device's capabilities, or
- a valid program message could not be properly executed due to some device condition.

Execution errors are reported *after* rounding and expression evaluation operations are completed. Rounding a numeric data element, for example, is not reported as an execution error.

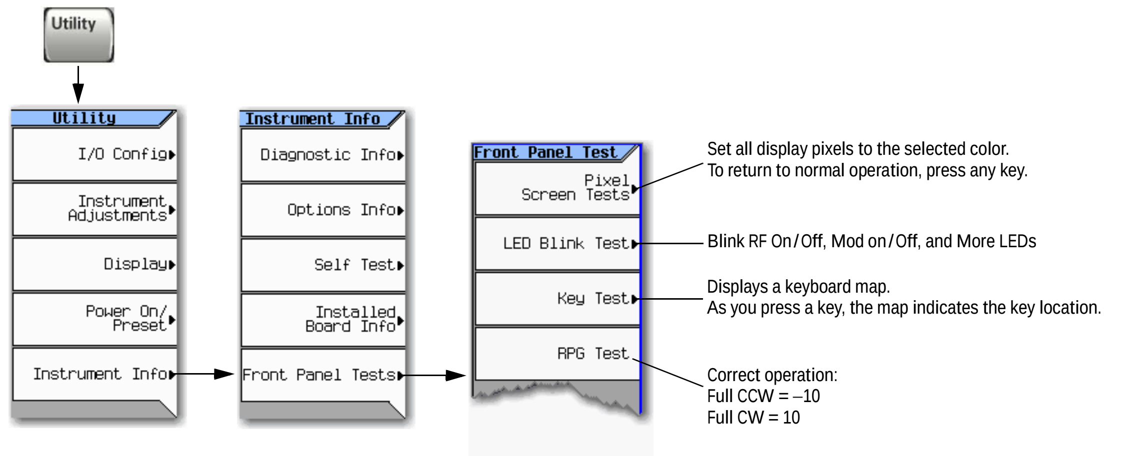
Command Errors (–199 to –100) indicate that the instrument's parser detected an IEEE 488.2 syntax error. Errors in this class set the command error bit (bit 5) in the event status register (IEEE 488.2, section 11.5.1). In this case:

- Either an IEEE 488.2 syntax error has been detected by the parser (a control-to-device message was received that is in violation of the IEEE 488.2 standard. Possible violations include a data element that violates device listening formats or whose type is unacceptable to the device.), or
- an unrecognized header was received. These include incorrect device-specific headers and incorrect or unimplemented IEEE 488.2 common commands.

Error Message File

A complete list of error messages is provided on the CDROM supplied with the instrument. In the error message file, an explanation is generally included with each error to further clarify its meaning. The error messages are listed numerically. In cases where there are multiple listings for the same error number, the messages are in alphabetical order.

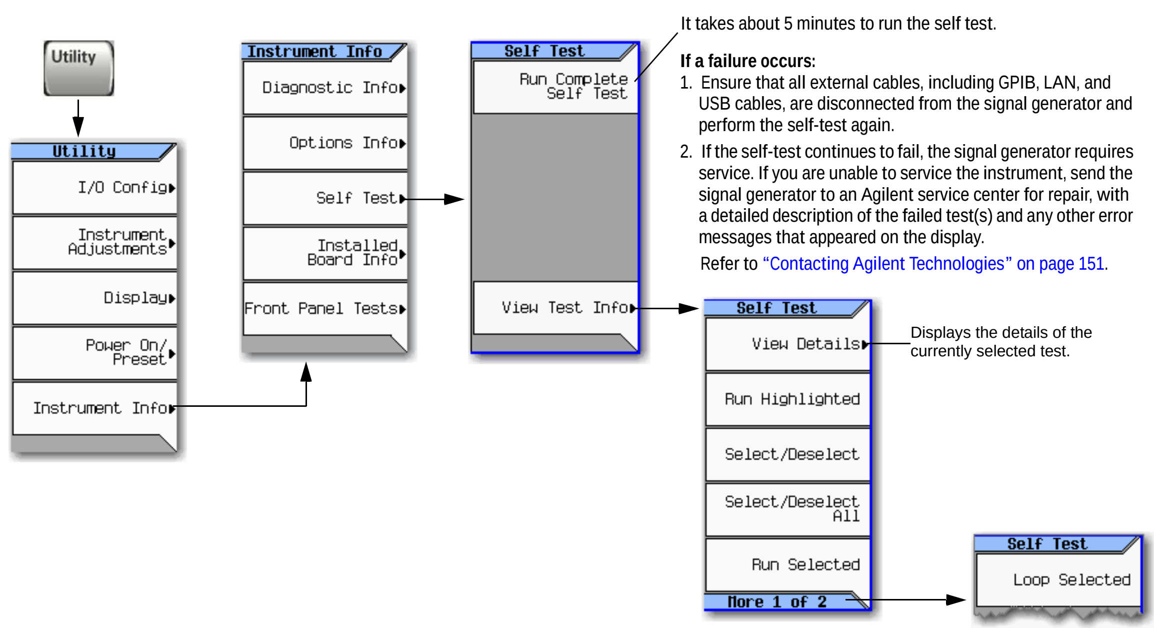
Front Panel Tests



For details on each key, use key help as described on page 23.

Self Test

The self test is a series of internal tests that checks different signal generator functions.



Licenses

A Time-Based License Quits Working

- The instrument’s time or date may have been reset forward causing the time-based license to expire.
- The instrument’s time or date may have been reset backward more than approximately 25 hours, causing the instrument to ignore time-based licenses.

See page 18 for details and cautions on setting time and date.

Cannot Load a Time-Based License

The instrument’s time or date may have been reset backward more than approximately 25 hours, causing the instrument to ignore time-based licenses.

See page 18 for details and cautions on setting time and date.

Contacting Agilent Technologies

- assistance with test and measurements needs, and information on finding a local Agilent office: *http://www.agilent.com/find/assist*
- accessories or documentation: *http://www.agilent.com/find/mxg*
- new firmware releases: *http://www.agilent.com/find/upgradeassistant*.

If you do not have access to the Internet, please contact your field engineer.

NOTE In any correspondence or telephone conversation, refer to the signal generator by its model number and full serial number. With this information, the Agilent representative can determine whether your unit is still within its warranty period.

Returning a Signal Generator to Agilent

Use the following steps to return a signal generator to Agilent Technologies for servicing:

1. Gather as much information as possible regarding the signal generator's problem.
2. Call the phone number listed on the Internet (*http://www.agilent.com/find/assist*) that is specific to your geographic location. If you do not have access to the Internet, contact your Agilent field engineer.

   After sharing information regarding the signal generator and its condition, you will receive information regarding where to ship your signal generator for repair.
3. Ship the signal generator in the original factory packaging materials, if available, or use similar packaging to properly protect the signal generator.

Glossary

A

Active Entry The currently selected, and therefore editable, entry or parameter

ARB Arbitrary waveform generator

AWG Arbitrary waveform generator. Additive white Gaussian noise

B

BBG Media Baseband generator media. Volatile memory, where waveform files are played or edited.

BNC Connector Bayonet Neill-Concelman connector. A type of RF connector used to terminate coaxial cable.

C

CCW Counterclockwise

C/N Carrier-to-noise ratio

CW Continuous wave. Clockwise

D

DHCP Dynamic host communication protocol

Dwell Time In a step sweep (see page 28), the time that the signal is settled and you can make a measurement before the sweep moves to the next point.

E

EVM Error vector magnitude; the magnitude of the vector difference at a given instant between the ideal reference signal and the measured signal.

G

GPIB General purpose interface bus. An 8-bit parallel bus common on test equipment.

H

Hardkey A labeled button on the instrument.

I

IF Intermediate frequency

Int Media Internal media. Non–volatile signal generator memory, where waveform files are stored.

IP Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks.

L

LAN Local area network

LO Local oscillator

LXI LAN extension for instrumentation. An instrumentation platform based on industry standard Ethernet technology designed to provide modularity, flexibility, and performance to small- and medium-sized systems. See also, *http://www.lxistandard.org*

P

Persistent Settings (States) Settings unaffected by preset, user preset, or power cycle.

Point-to-point Time In a step sweep (see page 28), the sum of the dwell time plus processing time, switching time, and settling time.

R

RMS Root mean square. A time-varying signal's effective value (the equivalent DC voltage required to generate the equivalent heat across a given resistor). For a sinewave, RMS = 0.707 x peak value.

S

Softkey A button located along the instrument's display that performs whatever function is shown next to it on that display.

T

TCP Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.

Terminator A unit indicator (such as Hz or dBm) that completes an entry. For example, for the entry 100 Hz, *Hz* is the terminator.

Type-N Connector Threaded RF connector used to join coaxial cables.

U

USB Universal serial bus. See also, *http://www.usb.org*

Symbols

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