

Keysight VXT PXI Vector Transceiver

This manual provides documentation for:

Keysight M9410A VXT PXI Vector Transceiver

Keysight M9411A VXT PXI Vector Transceiver

Keysight M9415A VXT PXI Vector Transceiver

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<http://www.keysight.com/find/m9410a>

<http://www.keysight.com/find/m9411a>

<http://www.keysight.com/find/m9415a>

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Information on preventing instrument damage can be found at:

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<http://www.keysight.com/find/techsupport>

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1 Source Overview

The source in this instrument can be operated independently of the transceiver to provide arbitrary waveform generation to test wireless mobile devices. The source can also be used together with the transceiver to simultaneously test both the transmitter and receiver of a wireless device.

“Source Features” on page 10

“Modes of Operation” on page 11

Source Features

- arbitrary I/Q waveform playback up to 375 MSa/s
- SCPI and IVI-COM driver
- user flatness correction
- two output connectors
- with Signal Studio Software, the transceiver 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 transceiver and available from the Keysight Technologies website at:

<http://www.Keysight.com/find/m9410a>

<http://www.Keysight.com/find/m9411a>

<http://www.Keysight.com/find/m9415a>

Modes of Operation

The instrument source provides two basic modes of operation: continuous wave (CW) and digital modulation mode.

Continuous Wave

In this mode, the transceiver produces a CW signal. The transceiver is set to a single frequency and power level, which is set up using the **RF Source** tab menu. To learn more, refer to [Chapter 2, Basic Operation](#).

Digital Modulation

In this mode, an internal baseband generator in the transceiver modulates a CW signal with an arbitrary I/Q waveform (ARB). The ARB waveforms are downloaded through a remote interface into the ARB memory. The ARB waveform setup is accessed using the **RF Source** tab, followed by the **Modulation Setup** key. To learn more, refer to [Chapter 4, Basic Digital Operation](#).


2 Basic Operation

This chapter introduces fundamental front panel operation. For information about remote operation, refer to the **Online Help** or **Programmer's Guide**

- “Viewing Key Descriptions” on page 14
- “Setting RF Source parameters” on page 14
- “Presetting the Source” on page 15
- “Saving and Recalling States” on page 16
- “Selecting Source Output” on page 16
- “Setting Frequency and Power (Amplitude)” on page 17
- “Working with Files” on page 18

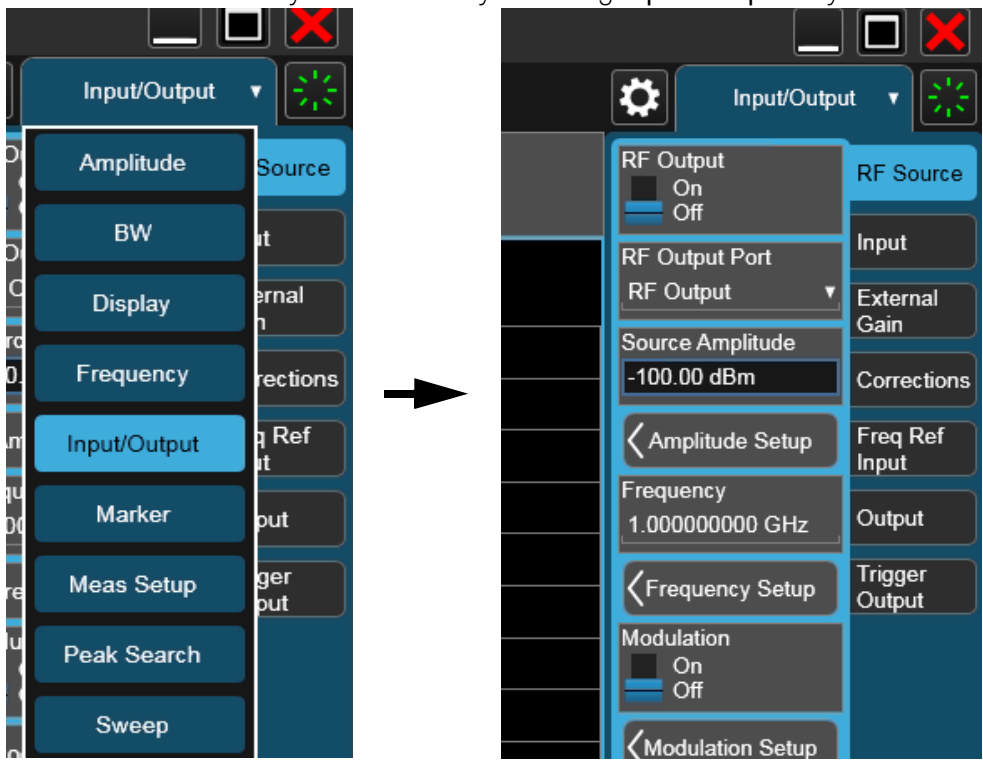
Viewing Key Descriptions

Table 2-1 Online Help Access

	Press the question mark key for comprehensive help information. The online help is context-sensitive (that is, the question mark key opens to a page that is relevant to the last key you pressed). Also, while the help screen is open, press any key, and a page relevant to that key is displayed; the normal key function does not execute. Press ESC to exit the online help.
---	--

Setting RF Source parameters

The source functionality is accessed by selecting **Input/Output** key as below.



Selecting the **Input/Output** key opens up a softkeys menu under the **RF Source** tab on the right side of the application window. These keys allow complete configuration of the corresponding tab's parameters.




Presetting the Source

Presetting the source is a method of restoring all source settings to its default values, after some or all of them have been changed. If you want to be able to return the source settings to the values they had before the preset, save the current state before you preset the source (see **“Saving and Recalling States”** below).

1. Select the **Input/Output** key.
2. Press the **RF Source** Tab (viewed on right of softkey menu).
3. Press **Source Preset** softkey.

Saving and Recalling States

The current state (including both source and analyzer settings) can be saved and later recalled.

1. Click file icon  in the bottom bar, and click  **Save** key to access the file operation window. Select **State** in the left side of this window.
2. Choose a register in which to save the state by pressing one of the **Register** keys. (A register with no state saved in it is in blank; when you save a state in it, the register is labeled with the date and time.)
3. Alternatively, you can save the state to a file rather than to a register. Click the **Save To File** key in the upper-right corner of the window, and use the file-save window to chose a name and location for the file.
4. Recall a saved state by clicking  **Recall** key, followed by the **State** key.
5. Choose a register from which to retrieve a state by Selecting one of the **Register** keys.
6. Alternatively, you can retrieve the state from a file rather than from a register. Click the **Recall From File** key, and chose a name and location for the file.

Selecting Source Output

To select the output port for the source, access the **Input/Output** menu.

7. Click **Input/Output**, **RF Source** tab, **RF Output Port**, **RF Output**.
8. Select from **RF Output**, and **RFIO HD**. If you select **RF Output**, this means that the **RF Output** designated as an output will be used.

Setting Frequency and Power (Amplitude)

NOTE

The M9410A/M9411A transceiver does not have an Automatic Level Control feature; amplitude accuracy is regulated by means of calibration for frequency and temperature variations.

To set the frequency and power of the source output proceed as follows:

1. Select **Input/Output, RF Source, Amplitude, Source Amplitude**.
2. Use the numeric keypad to set a value for power. Press the appropriate units key to complete the entry.
3. Select **Frequency**.
4. Use the numeric keypad to set a value for frequency. Press the appropriate units key to complete the entry.
5. Turn the **RF Output** key to **On**.

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

1. Preset the source by **Input/Output, RF Source, Source Preset**.
2. Select **Input/Output, RF Source, Frequency** key. Press **700** on the keypad and select the **MHz** key.
3. Click **Amplitude** key. Press **20** on keypad and select the **-dBm** key.
4. Turn the **RF Output** to **On**.
5. Press **Input/Output, RF Output Port, RF Output**.

The 700 MHz, –20 dBm CW signal is available at the RF OUTPUT port (to select the output port see [“Selecting Source Output” on page 16](#)).



Working with Files

- “**Viewing a List of Stored Files**” on page 18
- “**Loading (Recalling) a Stored File**” on page 19

The transceiver recognizes several types of files, such as state files, license files, and correction files. Files are stored in the controller internal storage. This section provides an overview of how to navigate the file menus, and how to view, store, load, and move files.

See also: “**Storing, Loading, and Playing a Waveform Segment**” on page 29.

Viewing a List of Stored Files

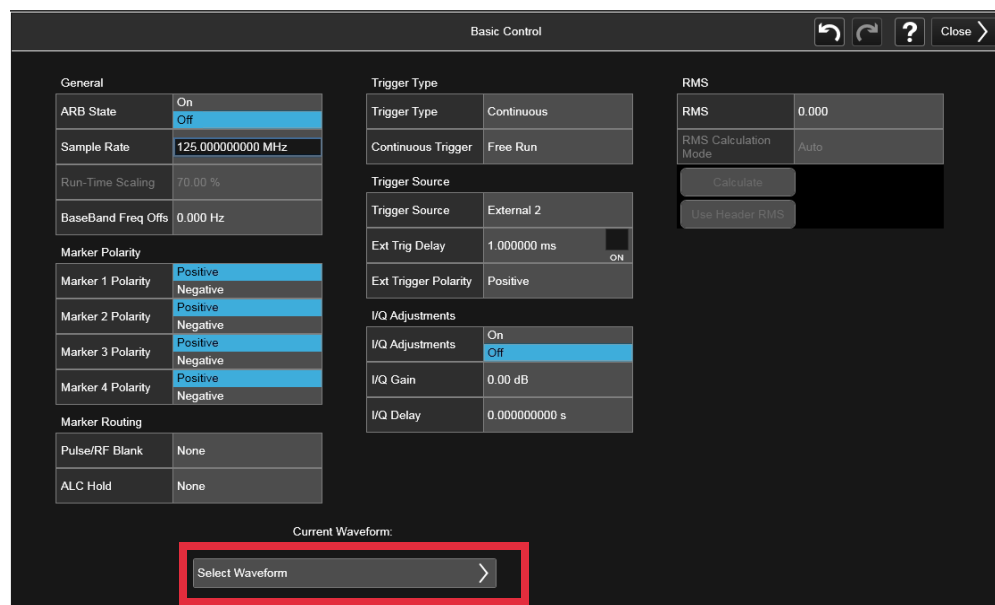
The arbitrary waveform generator (ARB) files that have been created on the transceiver can be viewed using the Waveform Selection screen.

Viewing a List of Files Stored on the transceiver

1. Select **Input/Output** key and **RF Source** tab.
2. Press **Modulation Setup, ARB Setup**.
3. Press **Select Waveform**.

The files listed are identified as either waveform sequences or waveform segments. A sequence is made up of two or more segments.

Use mouse to highlight a waveform for selection. Once the desired file is highlighted, use the **Select Waveform** key to select the waveform to be output.



Storing a File


To store a file that you have set up, use the  **Save** key as described in

“Storing, Loading, and Playing a Waveform Segment” on page 29.

To store a transceiver state that you have set up and may want to re-use, use the **Save key** and select **State** from the sub-menu and select a register in which to store the state.

For more information about the Save function see the online help.

Loading (Recalling) a Stored File

To recall a file that you have previously saved, use the  **Recall** key. For transceiver state recalls, select **State** from the sub-menu and select the required register.

For more information about the Recall function see the online help.

3 Optimizing Performance

Before using this information, you should be familiar with the basic operation of the transceiver source. If you are not comfortable with functions such as setting the power level and frequency, refer to **Chapter 2, Basic Operation** and familiarize yourself with the information in that chapter.

- **“Using an Output Offset and Reference” on page 22**
- **“Using Amplitude Corrections” on page 24**

Using an Output Offset and Reference

Setting an Output Offset

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

$$\text{RF Output} = \text{entered value} - \text{offset value}$$

$$\text{Displayed Value} = \text{output frequency (or power)} + \text{offset value}$$

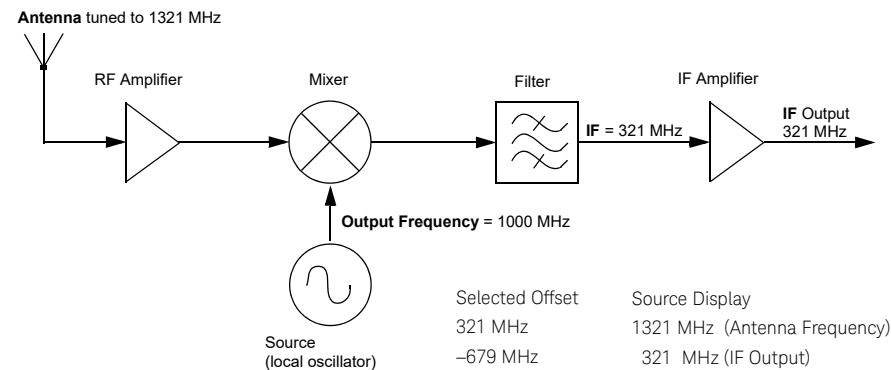
To set an offset:

- **Frequency:** Click **Input/Output, RF Source, Frequency Setup, Freq Offset > offset value > frequency unit** keys.
- **Amplitude:** Click **Input/Output, RF Source, Amplitude Setup, Amptd Offset > offset value > dB** keys.

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 source alerts you if the output frequency or amplitude is out of range.

When using the source 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 source 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 **Input/Output, RF Source, Frequency Setup, Set Reference Frequency**. 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 **Input/Output, RF Source, Amplitude Setup, Set Reference Power**.

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.

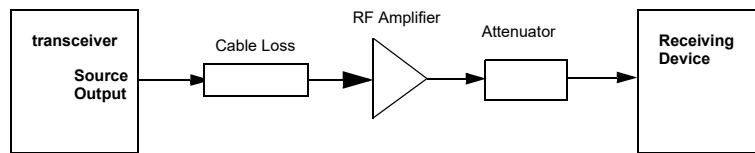
Examples

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 source 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.

Using Amplitude Corrections

Amplitude corrections can be applied to both source and analyzer ports on the transceiver. The Amplitude Corrections arrays can be entered by the user, sent over SCPI or loaded from a file. They allow a user to correct the response of the transceiver for variations in signal paths external to the transceiver. For example if you have a test system with a frequency dependent path due to cable, amplifier or attenuator non-linearities, similar to path illustrated below, then provided you can quantify the frequency variations, you can apply a frequency dependent correction to the transceiver source output. In this way the signal appearing at the receiving device can appear to have the spectral characteristics associated with a flat path.



The corrections are applied as a table of x and y parameters with the x specifying the frequency and y specifying the correction to be applied at the frequency, x. There are four sets of corrections and each may be individually enabled or disabled. All of the enabled corrections are added together to give the resultant correction. In the instrument, each port can have four different corrections applied to it, but two different ports cannot have the same set of corrections applied to both.

To access the Amplitude Corrections menu press the **Input/Output** key. Select the **Corrections** Tab.

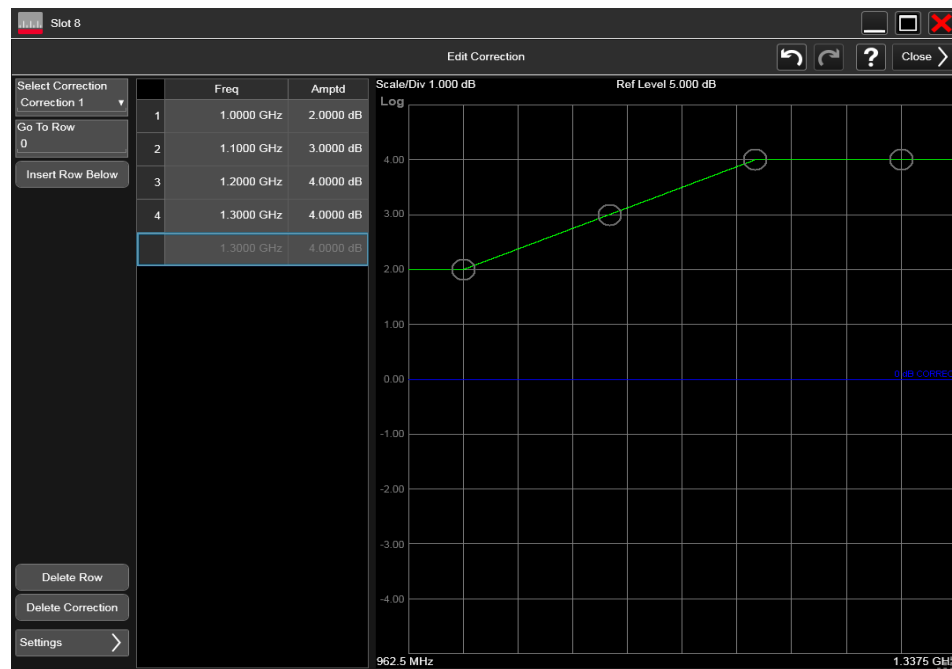
Selecting a port

You can select whether you want to apply the corrections to one of the ports. In the case of the dual purpose ports, the corrections can be applied to the input, output or RFIO HD.

To select the port, from the **Corrections** tab, select **Correction Port**. You can select one of the three ports to which the selected corrections apply.

Setting up a corrections table

To set up the corrections table using the front panel, from the Corrections tab, select **Edit Correction**. Click **Insert Row Below** to start the editing. The **Frequency** and **Amplitude** keys allow you to enter a frequency and the correction in dB that you require at that frequency. As you enter values the actual entries are displayed in tabular format on the left of the display and also, the entered values appear on the graticule as a graph. Because of the large number of possible entries in the corrections table, the **Navigate** key allows you to select an entry by row number to quickly access and edit a particular row.



For more detailed information about the correction data keys and the remote control commands see the online help, accessible by pressing the Help button on the front panel (or the *User's and Programmer's Reference*).

Optimizing Performance
Using Amplitude Corrections

4 Basic Digital Operation

Before using this information, you should be familiar with the basic operation of the transceiver source. If you are not comfortable with functions such as setting power level and frequency, refer to **Chapter 2** and familiarize yourself with the information in that chapter.

- “Waveform File Basics” on page 28
- “Storing, Loading, and Playing a Waveform Segment” on page 29
- “Saving a Waveform Settings & Parameters” on page 31
- “Using Waveform Markers” on page 34
- “Triggering a Waveform” on page 39
- “Licensing” on page 42

Waveform File Basics

There are two types of waveform files:

- A **segment** is a waveform file that you download to the transceiver.
- A **sequence** is a file you create in the transceiver source that contains pointers to one or more waveform files. The current M9410A/M9411A software only supports waveform segment operation and the waveform sequence operation will be supported in future.

Instrument Memory

The instrument has two types of memory:

- **Volatile** memory, baseband generator (ARB) media, where waveform files are played from or edited.
- **Non-volatile** memory, the controller internal hard disk, where waveform files are stored.

Dual ARB Player

The dual ARB waveform player enables you to play, rename, delete, store, and load (external or internal) waveform files. The dual ARB waveform player also provides markers ([page 34](#)) and triggering ([page 39](#)) capabilities.



Storing, Loading, and Playing a Waveform Segment

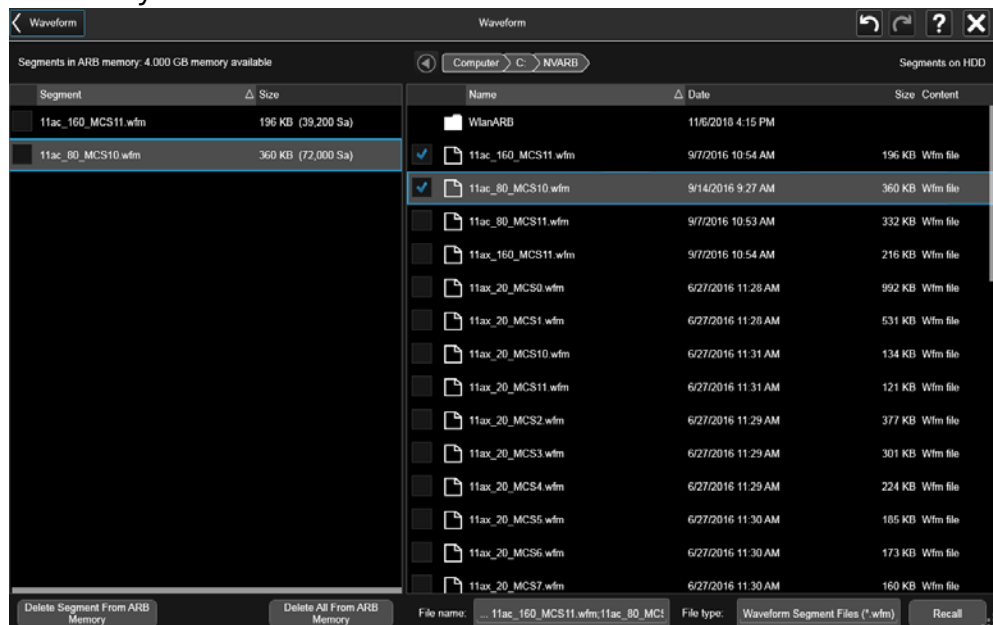
Before using this information, you should be familiar with the source file menus. If you are not, refer to **“Working with Files” on page 18** and familiarize yourself with that information.

The source has two types of waveform storage. The waveforms are stored on the controller hard disk which is non-volatile storage. In order to play the files out they must be moved into ARB memory which is volatile storage. ARB memory is also called “working” media, because before you can play, edit, or include a waveform file, the waveform file must be loaded into ARB memory.

Loading a Waveform Segment into ARB memory

Waveforms must reside in ARB memory before they can be played, or edited. Cycling power or rebooting the transceiver deletes the files in ARB memory.



1. Click file icon  in the bottom bar, and click  **Recall** key to access the recall sub-menu.
2. Select **Waveform** in the left column, and click **Recall From File** to display files on the hard disk in **C:\NVARB** and then, highlight the desired waveform segment.
3. Press **Recall** to load this waveform segment from hard disk to ARB memory.





Or you could double click on the file name of desired waveform segment to load it to ARB memory directly.

Deleting a Waveform Segment on Internal Disk

Use the following steps to delete a file on the hard disk.

1. Click file icon  in the bottom bar, and click  **Recall** key to access the recall sub-menu.
2. Select **Waveform** in the left column, and click **Recall From File** to display files on the hard disk in **C:\NVARB** and then, right-click on the file name which you want to delete. A window named "Delete xxx.wfm" will pop up.
3. Press **Delete xxx.wfm** to delete the waveform file immediately.

Deleting a Waveform Segment from ARB memory

1. Click file icon  in the bottom bar, and click  **Recall** key to access the recall sub-menu.
2. Select **Waveform** in the left column, and click **Recall From File** to display files on the hard disk in **C:\NVARB** and then, the waveform segments in ARB memory is listed in the left column of the window.
3. highlight the desired waveform segment which you want to delete.
4. Press **Delete Segment From ARB Memory**.

Alternatively, if you want to clear all ARB memory select **Delete All From ARB Memory**.

Playing a Waveform Segment

Waveforms must reside in ARB memory before they can be played, or edited. Cycling power or rebooting the transceiver deletes the files in ARB memory.

1. Select **Input/Output** key and **RF Source** tab.
2. Press **Modulation Setup, ARB Setup, Select Waveform**.
3. Select a waveform from the list in the display.
4. Press **OK** to execute the waveform.
5. In the **Basic Control** menu, turn **ARB State** to **On** to enable the modulation.
Then the waveform modulates the RF carrier.
6. Configure the RF Output:
Set the RF carrier frequency and amplitude, and turn on the RF output in **Input/Output, RF Source** menu.
The waveform segment is now available at the selected RF Output connector.

Saving a Waveform 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 source treats as a waveform segment), the source automatically generates a file header and a marker file with the same name as the waveform file. Initially the file header has no source settings saved to it, and the marker file consists of all zeros. For a given waveform, you can save source settings and parameters in its file header and marker settings in its marker file ([page 34](#)); when you load a stored waveform file into ARB memory, the file header and marker file settings automatically apply to the source so that the dual ARB player sets up the same way each time the waveform file plays.

Some of the current source settings shown in the file header appear as part of the key labels, and others appear in the dual ARB summary display, shown in the following example. To view the file header:

1. **Select Input/Output key and RF Source tab.**
2. **Press Modulation Setup, ARB Setup keys.** Ensure that a waveform has been selected under the **Select Waveform** key.
3. **Press Header Utilities key** in the ARB Setup column. The header information is shown as below.

Sample Rate	The waveform playback rate. This is the ARB sample clock rate, set in the Arb Setup menu.
Runtime Scaling	The Runtime scaling value is applied in real-time while the waveform is playing. This setting can be changed only for files playing in the dual ARB player.
RMS	When the modulator attenuation setting is set to Auto, this value is used to calculate the I/Q modulator attenuation setting to optimize ACPR. Value: 0 to 1.414213562
Marker 1...4 Polarity	Marker polarity can be positive or negative (described on page 37).
RF Blank Routing	Which marker, if any, implements the Pulse/RF Blanking function (described on page 36) when the marker signal is low. When the marker signal goes high, Pulse/RF Blanking discontinues.
Over Range Protect	Indicated whether DAC Over-Range Protection is on (1) or off (0).
Unique Waveform Id	0 = no Id; once an Id is assigned, it cannot be changed.
License Required	Indicates whether a license is required to play the waveform.

Viewing and Modifying Header Information

1. From ARB memory, select the desired waveform:
 - a. **Select Input/Output key and RF Source tab..**
 - b. **Press Modulation Setup, ARB Setup, Select Waveform.**
 - c. **In the display, select the desired waveform.**
 - d. **Press Select Waveform.**

2. Open the Header Utilities menu:

In the ARB Setup menu, select **Header Utilities**

The Figure below shows the default file header for the desired waveform.

The column with text in gray shows that most of the settings are Unspecified. Unspecified means that there is no setting saved for that particular parameter.

The column with text in white shows the current source settings. These are the settings that are saved to the file header.

NOTE

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

Figure 4-1 Example File Header

Header Utilities					
File Header Information:		11ac160_MCS11.wfm			
Waveform File Description:		---			
Sample Rate	200 MHz	200.000000000 MHz	BB Frequency Offset	0 Hz	0.000 Hz
Runtime Scaling	70 %	70.00 %	AWGN State	0	---
RMS	0.3	0.312	AWGN C/N Ratio	20	---
Marker 1 Polarity	Positive	Positive	AWGN Carrier BW	160000000	---
Marker 2 Polarity	Positive	Positive	AWGN Noise BW	Unspecified	---
Marker 3 Polarity	Positive	Positive	AWGN Carrier RMS	Unspecified	---
Marker 4 Polarity	Positive	Positive	Over Range Protection	Unspecified	---
ALC Hold Rounding	Marker 2	Marker 1	Unique Waveform ID	1202650823	---
RF Blanking Routing	Marker 2	Marker 2	License Required	... licenses installed	---
			Clear Header Save Header		

3. Save the information in the white text column to the file header:

Press **Save Header** key.

Both the gray and white text column now display the same values; the gray text column lists the settings saved in the file header.

4. Edit and update settings

a.Set the ARB sample rate to 5 MHz:
Press **Sample Rate, 5, MHz.**

b.Set waveform runtime scaling to 60%:
Press **Run-time Scaling, 60, Enter.**

The white text column now reflects the changes to the current source setup, but gray text column have not changed.

c. Save the current settings to the file header:
Press the **Save Header** key.

The settings from the white text column now appear in the gray text column. This saves the new current transceiver settings to the file header.

If you change any of the settings listed in the file header after you select the waveform file, the changed setting(s) appear in the file header white text column and are used instead of the saved header settings. To reapply the saved header settings, reselect the waveform for playback.

Using Waveform Markers

The source provides four waveform markers to mark specific points on a **waveform segment**. When the source encounters an enabled marker, an auxiliary signal is routed to a rear panel trigger output. The marker that is routed to the TRIGGER 2 connector is selected using the Input/Output menu.

You can use the output signal to synchronize another transceiver 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 Pulse/RF Blanking.

When you download a waveform file that does not have a marker file associated with it, the source creates a marker file without any marker points.

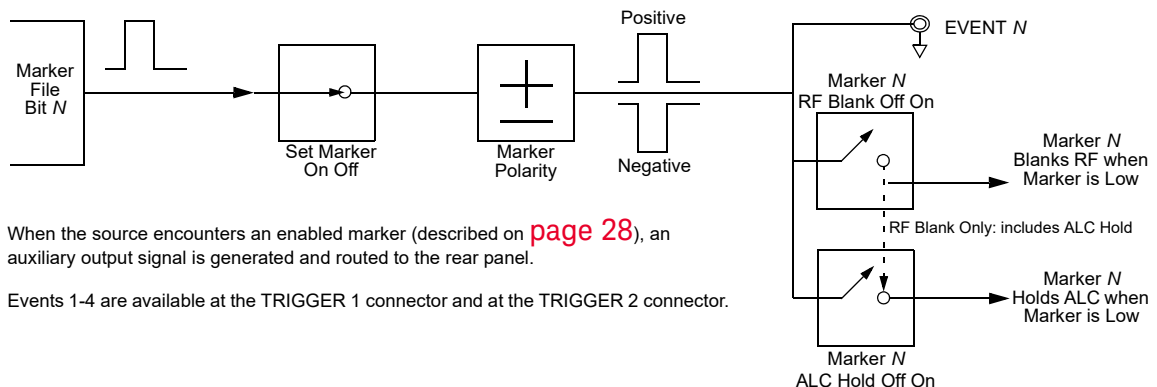
The following procedures demonstrate how to use markers while working with the ARB player. These procedures also discuss two types of points: a **marker point** and a sample point. A marker point is a point at which a given marker is set on a waveform; you can set one or more marker points for each marker.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

This section also provides the following information:

- “Waveform Marker Concepts”
- “Viewing a Marker Pulse” on page 35
- “Using the Pulse/RF Blanking Marker Function” on page 36
- “Setting Marker Polarity” on page 37

Waveform Marker Concepts

The source dual ARB provides four waveform markers for use on a waveform segment. You can set each marker polarity and marker points (on a single sample point or over a range of sample points). Each marker can also perform Pulse/RF Blanking.



Marker Signal Response

The source 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 TRIGGER 2 output signal and the modulated RF output. When using the marker TRIGGER 2 output signal, observe the signals (marker relative to modulated RF) for any latency, and if needed, reset the marker point positions, include delay or both.

Marker File Generation

Downloading a waveform file that does not have a marker file associated with it causes the source to automatically create a marker file, but does **not** place any marker points.

Marker Point Edit Requirements

Before you can modify a waveform segment marker points, the segment must reside in ARB memory (see [“Loading a Waveform Segment into ARB memory” on page 29](#)).

Saving Marker Polarity and Routing Settings

Marker polarity and routing settings remain until you reconfigure them, preset the source, or cycle power. To ensure that a waveform uses the correct settings when it is played, set the marker polarities or routing (Pulse/RF Blanking) and save the information to the file header ([page 31](#)).

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 Pulse/RF Blanking, ensure that you set Pulse/RF Blanking to **None**. Failure to do so can result in no RF output or a distorted waveform.

Selecting which Marker to output

To select which one of the four markers is output at the TRIGGER 2 connector:

1. Select **Input/Output** key and **Trigger Output** tab.
2. Press **Trig 2 Out** keys.
3. Press **Trig 2 Out** key, click **Source Marker 1**, **Source Marker 2**, **Source Marker 3**, or **Source Marker 4** key as required to choose which marker to output.

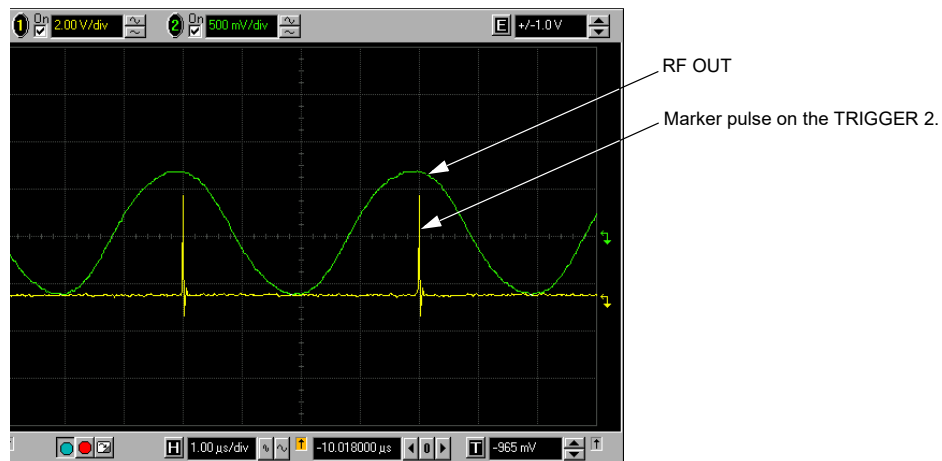
Viewing a Marker Pulse

When a waveform plays, you can detect an enabled marker pulse at the rear panel TRIGGER 2 connector. This example demonstrates how to view a marker pulse generated by a waveform segment that has at least one marker point set. The process is the same for a waveform sequence.

This example uses a sine waveform segment in the dual ARB Player. Factory-supplied segments have a marker point on the first sample point for all four markers.

1. follow the procedure on [page 29](#) to select and load the waveform segment file you need.
2. In the **ARB Setup** menu, Set **ARB State** to **On**.
3. Connect the instrument source output to the oscilloscope channel 1 input.
4. Connect the instrument TRIG 2 output to the oscilloscope channel 2 input.

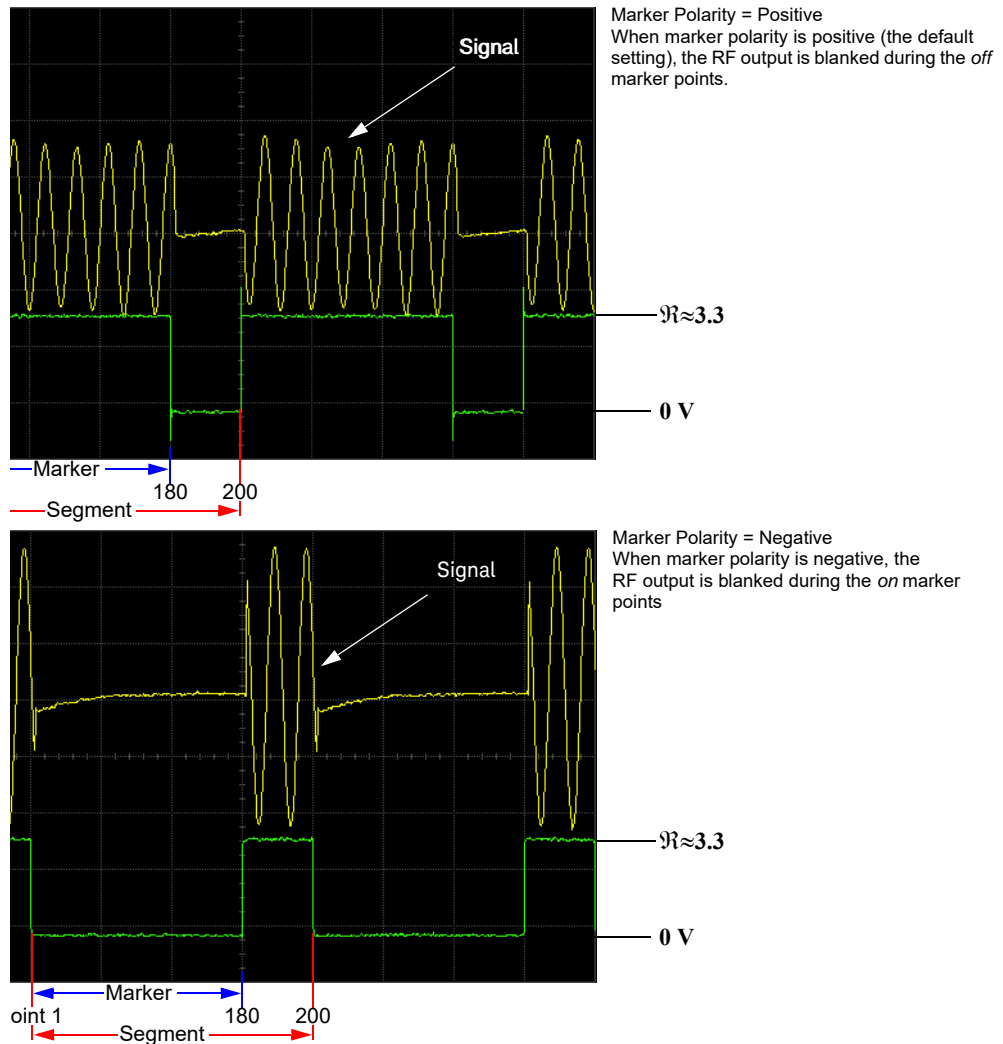
When marker 1 is present, the instrument outputs a signal through TRIG 2 as shown in the following example.



Using the Pulse/RF Blanking Marker Function

While you can set a marker function (described as **Marker Routing** on the key label in the Marker Utilities menu) either before or after setting the marker points, setting a marker function before you set marker points may change the RF output. The source blanks the RF output when the marker signal goes low. This example is a continuation of the previous example, [“Viewing a Marker Pulse” on page 35](#).

1. Using a segment, assume Marker 1 is set across points 1–180.
2. From the **Marker Routing** key menu, assign Pulse/RF Blanking to Marker 1:
In the ARB Setup menu, Click **Basic Control, Pulse/RF Blank, Marker 1**.



Setting Marker Polarity

Setting a negative marker polarity inverts the marker signal.

1. In ARB Setup menu, Click **Marker Polarity** to choose Negative or Positive.
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 35.

As shown on **page 36**:

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

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

Pulse/RF Blanking always occurs on the low part of the signal regardless of the polarity setting.

Using the TRIGGER 2 Signal as a Transceiver Trigger

One of the uses for the TRIGGER 2 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 TRIGGER 2 OUT signal for measurements, you may also need to adjust the sample rate. To change the sample rate setting click **Input/Output, RF Source, Modulation Setup, ARB Setup, Sample Rate** keys.

The TRIGGER 2 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.

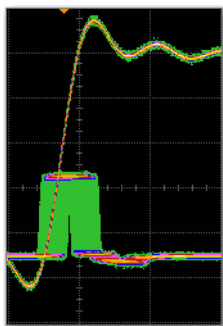
Method 1: Use a sample clock of 200 MHz/N where N is a positive integer and where 200 MHz/N can be represented exactly on the display.
For example: 200 MHz, 100 MHz, 50 MHz, 25 MHz, and so on.

If the result cannot be represented exactly on the display, jitter will be present.
For example: N = 6 will result in jitter, because $200 \text{ MHz}/6 = 33.333 \text{ MHz}$, 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.

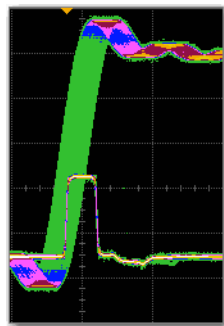
When the TRIGGER 2 signal exhibits jitter and it is used as a measurement trigger, it can cause the waveform to falsely appear as having jitter. If this condition occurs, you can adjust the sample rate to a value (see above) that does not cause the jitter appearance. To maintain the integrity of the 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 effect on the waveform.

TRIGGER 2 signal exhibits jitter
due to a non-optimal sample rate



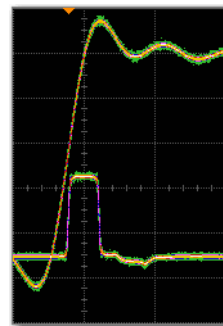
Oscilloscope triggering on waveform

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

Triggers control data transmission by controlling when the transceiver transmits the modulating signal. You can configure trigger settings so that data transmission occurs once (Single mode), or continuously (Continuous mode).

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 source 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.

When you initially turn the Arb State ON or select a trigger mode or when you change from one triggering mode to another, you may temporarily lose the carrier signal for a few tens of milliseconds at the RF output. The Arb will present the idle IQrms value of the next Arb waveform to the IQ modulator. This ensures that the RF carrier output is at the correct amplitude level while the Arb waits for a trigger. When that trigger is received, the Arb begins playing the waveform and the modulated RF carrier exhibits no undesirable transients.

There are two parts to configuring a waveform trigger:

- **Type** determines the behavior of the waveform when it plays (see “**Trigger Type**” on page 39).
- **Source** determines how the source receives the trigger that starts the modulating waveform playing (see “**Trigger Source**” on page 40).

Trigger Type

Type defines the trigger mode: how the waveform plays when triggered. Trigger Type is selected by clicking the **Input/Output** key, followed by the **Modulation Setup, ARB Setup, Basic Control, Trig Type** keys.

- **Continuous** mode repeats the waveform until you turn the signal off or select a different waveform, trigger mode, or response
 - **Free Run** immediately triggers and plays the waveform; triggers received while the waveform is playing are ignored.
 - **Trigger and Run** plays the waveform when a trigger is received; subsequent triggers are ignored.
- **Single** mode plays the waveform once.
 - **No Retrigger** ignores triggers received while a waveform is playing. If a trigger is received early it will be ignored. The gap in your playback is dependent on the trigger period, after which time the RF will start up again where it is expected.

Trigger Source

Trigger Source is selected by pressing the **Input/Output** key, followed by the **Modulation Setup, ARB Setup, Basic Control, Trigger Source** keys.

- **Key** - the waveform is triggered when the **Single** key is pressed
- **Bus** - the waveform is triggered over LAN or USB using the
:SOURce:RADio:ARB:TRIGger:INITitate SCPI command.
- **External 2** - the waveform is triggered by a trigger signal on the TRIGGER 1 port or the TRIGGER 2 port on the transceiver rear panel.

Source Alignment

Use the Alignments menu to provide a manual signal alignment of the source. When you execute an alignment of the source. The transceiver stops any sequence of the source, presets the source, and performs the alignment.

Run the source alignment by pressing the **System** front-panel key, followed by **Alignments, Align Now, Align Source**. A message box appears advising you of the alignment process.

To abort the alignment, click on **Cancel** or press the **Cancel (Esc)** key.

Licensing

You can create your own signal waveforms to output from the transceiver ARB using a number of methods. One of them is to use Keysight Signal Studio which is a suite of PC-based signal creation software that allows you to create customized signals for multiple radio standards. You can also create your own signals using other signal creation software (such as MATLAB or ADS) and download them to the transceiver hard disk. You can use Signal Studio Toolkit to process your customized files for use on the transceiver, if necessary. The instrument also provides a multi-pack licensing solution, a cost-effective solution that allows you to license individual Signal Studio waveforms rather than purchase the Signal Studio software.

NOTE

Note that the Signal Studio files are encrypted waveforms; they are stored on the hard disk on the transceiver and are moved to the volatile ARB memory for payout. Other waveforms that you create may not be encrypted.

Signal Studio

Signal Studio software allows you to create technology-specific waveforms. It can be downloaded from the Keysight website at:

www.keysight.com/find/signalstudio

To use Signal Studio waveforms on the transceiver, you can either purchase a Signal Studio license or use waveform multi-pack licensing (see the next section). The Signal Studio website allows you to purchase the Signal Studio license and also provides trial licenses. The Signal Studio license is transceiver specific and therefore cannot be used on a transceiver other than the one specified in the purchase agreement. Once you have licensed the required Signal Studio software package, any waveforms that you create using this package can be used on the transceiver.

Waveform multi-pack licensing

Each license gives you certain number of slots for waveforms. For 45 slots, buy nine 5-pack licenses. For 500 slots, buy ten 50-pack licenses. For 545 slots, buy nine 5-pack licenses and ten 50-pack licenses.

Waveform multi-pack licensing (Option 2xx) enables you to create, generate and permanently license multiple Signal Studio waveforms without the need to purchase the full Signal Studio license.

A multi-pack license includes a number of license slots which are used to license waveform segments. The number of license slots varies depending on the multi-pack license option that has been purchased. When a waveform segment is licensed, it is assigned to one of the license slots. Waveform segments licensed with a multi-pack license are perpetual and cannot be exchanged. Once a waveform is licensed, that license is permanent and cannot be revoked or replaced.

Signal Studio waveforms can be downloaded to the instrument and placed into a waveform slot for a 48 hour trial period. This allows you to edit and reuse this slot for 48 hours. After the 48 hour time period the STATUS of this slot will be changed to LOCK REQUIRED. This waveform slot now has been consumed and is no longer available for editing or reuse.

Option 2xx waveform licenses are transceiver specific (i.e. transceiver Host ID / PCSERNO). If the licensed waveform segment is transferred from one instrument to another the segment file must be re-licensed on the new instrument by a multi-pack license on that instrument before it can be played back.

To license additional waveforms that exceed the number permitted by a multi-pack option, you must purchase an additional multi-pack option that you do not already own. For example, if you have Option 221 and need additional waveforms, you should purchase Option 222. Re-purchasing Option 221 for the same transceiver provides no additional multi-pack licenses.

Waveforms licensed with Options 2xx cannot be **exchanged for different waveforms**. Once a waveform is licensed, that license is permanent and cannot be revoked or replaced.

After licensing a waveform, you can make copies of the waveform using different file names for use on the same transceiver and even rename the original file without affecting the waveform license.

You can also use the Option 2xx to license waveforms from N76xxB Signal Studio software downloaded during its 14-day free trial license. All of the N76xxB Signal Studio software products provide a 14-day trial period (trial license). This 14-day trial license lets you download and play back waveforms during the trial period. These waveforms are denoted by the TRL in the status message area of the waveform segment catalog. After the trial period expires, the TRL message is removed but the waveform remains. You can license these waveforms after the TRL message is gone.

To redeem an additional Option 2xx upgrade, refer to the **Entitlement Certificate** that comes with the instrument order.

Installing an Option N7650B–22x/25x Waveform 5/50–Pack Licensing



1. Load a Waveform 5–Pack license, Option N7650B–22x/25x, into the transceiver using License Manager or a USB media. For more information on loading the Waveform 5/50–Pack License, refer to the **N7650B–22x/25x Entitlement Certificate**.

Licensing a Source Waveform File

1. Create the waveform:

- a. Download any of the N76xxB Signal Studio software that interests you. For downloading N76xxB Signal Studio software, refer to the N76xxB Entitlement Certificate or trial website.
- b. Create and download a waveform to the transceiver using any of the N76xxB Signal Studio software. Refer to your **Signal Studio** software Help. You can add the waveform to a license slot for a 48-hour trial period. During the trial period, the waveform can be played and replaced any number of times. When the trial time expires, the slot can no longer be used for playback until the slot is locked for permanent playback capability. The slot status will be changed from "Remaining Trial Time" to "LOCK REQUIRED".

Waveform Licensing Interface

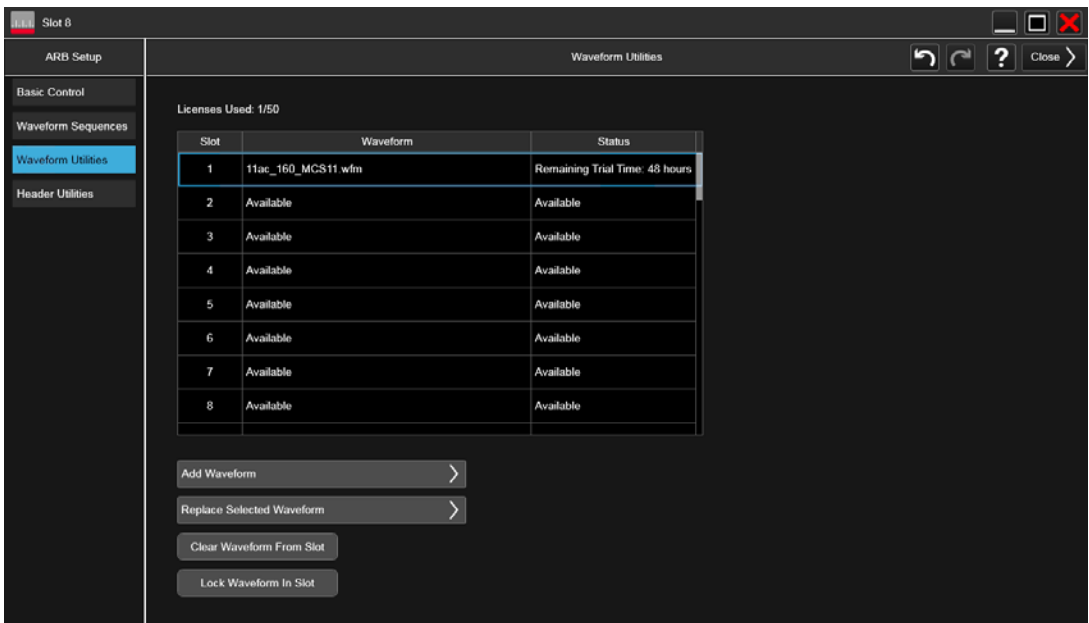
Click file icon  in the bottom bar, and click  **Save** key to access the file type selection menu.

Select **Waveform** in the left column, and click **Recall From File** to display files on the hard disk in **C:\NVARB** and then, highlight the desired waveform segment. Press **Recall** to load this waveform segment from hard disk to ARB memory.

The selected file name appears in the left column once it is loaded.

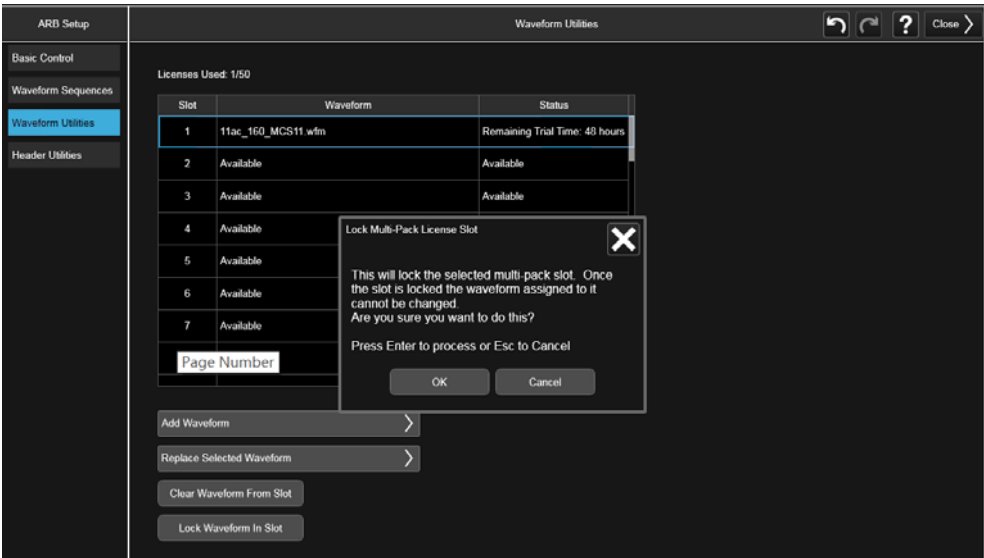
Go back to the **ARB Setup** menu. Click **Waveform Utilities**, **Add Waveform**, select the waveform you want to assign to a slot, and press **OK**.

Figure 4-2 Assigning the waveform to a slot



The loaded waveform will be displayed with a status message of "Remaining Trial Time 48 Hours". Select the desired waveform and press **Lock Waveform In Slot**. A popup window asks you to confirm the lock operation; selecting **OK** will change the status of the waveform to "LOCKED [date]". This indicates that you have successfully licensed the waveform permanently.

Figure 4-3 Locking the waveform to the slot



Waveform Multi-Pack Licensing Status Messages

The following messages appear in the Waveform Multi-Pack license display in the Status column. The table below shows the meaning of the entries in the Status column.

Table 4-1 Waveform Multi-Pack Licensing Status Messages

Status Message	Meaning	Notes
Remaining Trial Time 48 Hours	The waveform can be replaced or modified for the next 48 hours.	Once the 48 hour period has expired, the waveform status message changes to "LOCK REQUIRED".
Multi-Pack Licensed	This waveform is licensed by Option 2xx.	
Multi-Pack License Not Required	This status message applies to: Any free waveforms provided with the instrument Any customer created waveform Any waveforms that have a valid license (e.g. Trial (TRL) licenses, Advanced Design System (ADS), etc.).	Once a Trial (TRL) license expires, the waveform becomes licensable (i.e. the status message for the trial waveform becomes "LOCK REQUIRED").

Other menu functions under Multi-Pack Licenses

- **Replace Waveform:** This key allows you to replace the waveform in the selected slot during the 48 hour trial period.
- **Clear Waveform from Slot:** This key clears the waveform name from a used slot so that the name can be used in another slot. Note that this does not make the original waveform slot reusable, it merely makes the waveform name reusable.

5 Troubleshooting

This chapter identifies some checks you can make if the source in the transceiver is not operating as expected. For information about non-source related problems see the Getting Started Guide.

- “RF Output” on page 50
 - “No RF Output
 - “Power Supply Shuts Down
 - “No Modulation at the RF Output
 - “RF Output Power too Low
- “Error Messages” on page 51
- “Licenses” on page 51
- “Contacting Keysight Technologies” on page 52

RF Output

No RF Output

- Check the **RF Output On/Off** key (In **RF Source** tab). If it is off, turn the **RF Output On** to turn the output on (selection is underlined).
- Ensure that the amplitude is set within the source range.
- If the transceiver is playing a waveform, ensure that marker polarity and routing settings are correct (see [“Saving Marker Polarity and Routing Settings” on page 35](#)).

Power Supply Shuts Down

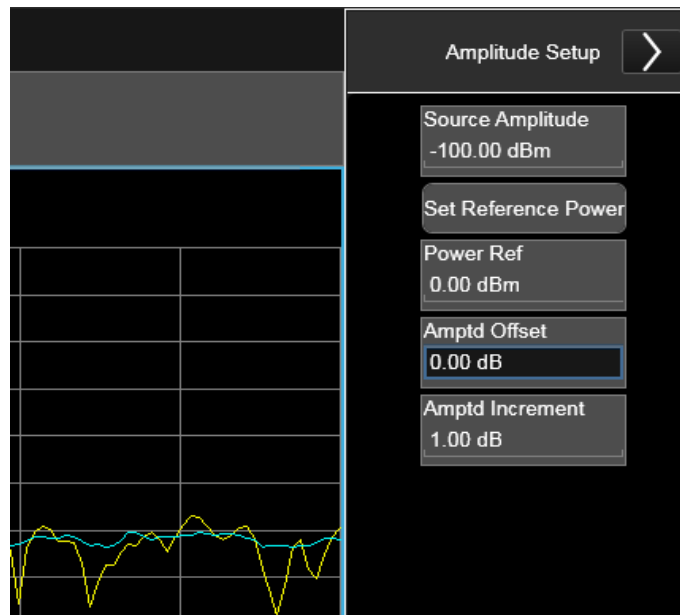
If the power supply does not work, it requires repair or replacement. If you are unable to service the transceiver, send the transceiver to an Keysight service center for repair (see [“Contacting Keysight Technologies” on page 52](#)).

No Modulation at the RF Output

Check the **Modulation On/Off** key, and ensure it is set to on.

RF Output Power too Low

- Check to see if the amplitude offset is set and if necessary, reset to 0 dB:
Choose **Input/Output** from the drop-down panel followed by **Amplitude Setup** key of **RF Source** tab. Set **Amptd Offset** to **0 dB**. See also [“Setting an Output Offset” on page 22](#).



- Check to see if power reference is set and turned on and if necessary, turn off the reference mode
 1. Choose **Input/Output** from the drop-down panel followed by **Amplitude Setup** key of **RF Source** tab. Press **Power Ref** to set to **Off**.
 2. Reset the output power to the desired level.
- See also “**Setting an Output Reference**” on page 23.

Error Messages

A complete list of error messages is provided in PDF format on the transceiver (accessible from the Additional Documentation page of the online help) and also on the Keysight website (www.keysight.com/find/m9410a).

Licenses

A time-based license stops working

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

Cannot load a time-based license

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

Contacting Keysight Technologies

- assistance with test and measurements needs, and information on finding a local Keysight office:

<http://www.Keysight.com/find/assist>

- accessories, documentation, or new firmware releases:

www.keysight.com/find/m9410a

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

NOTE

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