

**RFXpress RFX100**  
**Advanced RF/IF/IQ Waveform Creation and Editing Software for**  
**the AWG5000 & AWG7000 Series Generators**  
**Quick Start User Manual**

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## **Contacting Tektronix**

Tektronix, Inc.  
14200 SW Karl Braun Drive  
P.O. Box 500  
Beaverton, OR 97077  
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
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# General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

*Only qualified personnel should perform service procedures.*

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

## To Avoid Fire or Personal Injury

**Connect and Disconnect Properly.** Do not connect or disconnect probes or test leads while they are connected to a voltage source.

**Ground the Product.** This product is indirectly grounded through the grounding conductor of the mainframe power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

**Observe All Terminal Ratings.** To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

**Power Disconnect.** The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

**Do Not Operate Without Covers.** Do not operate this product with covers or panels removed.

**Do Not Operate With Suspected Failures.** If you suspect that there is damage to this product, have it inspected by qualified service personnel.

**Avoid Exposed Circuitry.** Do not touch exposed connections and components when power is present.

### Terms in this Manual

These terms may appear in this manual:



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**WARNING.** *Warning statements identify conditions or practices that could result in injury or loss of life.*

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**CAUTION.** *Caution statements identify conditions or practices that could result in damage to this product or other property.*

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## Preface

The RFXpress RFX100 is a software product that allows you to create digitally modulated baseband, IF, and RF signals that can be generated through arbitrary waveform generators (AWG). This software runs as an integral part of AWG5000 and AWG7000 series arbitrary waveform generators and can also run from an external PC.

You can use RFXpress to:

- Design, debug, and develop wideband wireless communications receivers
- Generate UWB-WiMedia compliant and custom signals
- Generate general purpose digitally modulated IQ, IF, and RF signals

## Key Features

- Define baseband I and Q signals using various modulation schemes
- Create single- and multi-carrier signals where each carrier is independently defined
- Apply impairments such as quadrature error and imbalance or non-linear impairments
- Add interferences during waveform creation
- Remotely connect to Tektronix oscilloscopes and to an Agilent Performance Signal Generator (PSG®)
- Remotely configure a Tektronix oscilloscope and an Agilent Performance Signal Generator (PSG®)

### UWB-WiMedia

- Direct RF generation of WiMedia BG1 and BG2 waveforms
- Ability to generate IQ and IF waveforms including band hopping for all band groups
- User-defined IF frequency including TFC pattern
- Comprehensive WiMedia signal generation support for MAC and PHY layers
- Ability to create UWB-WiMedia correction files, which can be automatically applied as compensation to accurately generate signals
- Ability to use Gated Noise to define noise profiles for each section of the UWB packet
- Create tone nulling with intermediate values (–40 dB to +20 dB) for OFDM carrier mapping

## Documentation

RFXpress RFX100 Online Help, English	Tektronix part number 076-0081-XX
RFXpress RFX100 User Manual, English, (PDF)	Tektronix part number 077-0045-XX
RFXpress RFX100 Quick Start User Manual, English (PDF)	Tektronix part number 071-2167-XX
RFXpress RFX100 Installation Manual, English	Tektronix part number 071-2166-XX

## Conventions Used in This Manual

When steps require a sequence of selections using the software interface, the ">" delimiter marks each transition between a menu and an option. For example, File > Save.

The document MultiBand OFDM Physical Layer Specification version 1.2 (Draft) by WiMedia Alliance is referred to as the "WiMedia standard" or "WiMedia specification".

The term "DUT" refers to a device under test.

The terms "signal" and "waveform" are used interchangeably in this manual.

# Installation

For information on how to install this software, refer to the *RFXpress Installation Manual*, Tektronix part number 071-2166-XX.

## Starting the Software

Start the software in either of the following ways:

- From Start > Program Files > Tektronix RFXpress, click RFXpress.
- Double-click the RFXpress icon on your desktop.

## Closing the Software

Click File > Exit to close the software.

## Software Upgrades

Periodic software upgrades may become available. The software is operational only if you have a valid option key for the specific instrument model and serial number.

To check for upgrades:

1. Go to [www.tektronix.com/software](http://www.tektronix.com/software).
2. Enter the product name (RFXpress).



## Using the Software

This section covers the following information:

- Getting acquainted with the software
- Generating a signal
- Adding impairments to the signal
- Compiling a signal
- Graphing a signal

## Getting Acquainted with the Software

### Using the Software Interface

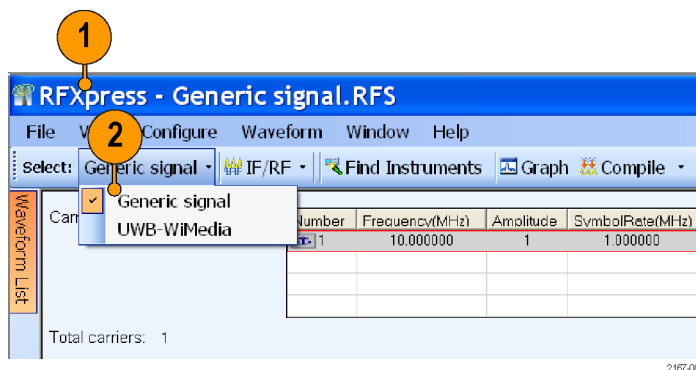
Use the keyboard or mouse to make selections in the software.

Use menus, toolbars, check boxes, and on-screen buttons to control the software functions. Use Microsoft Windows techniques to navigate menus and select or clear check boxes.

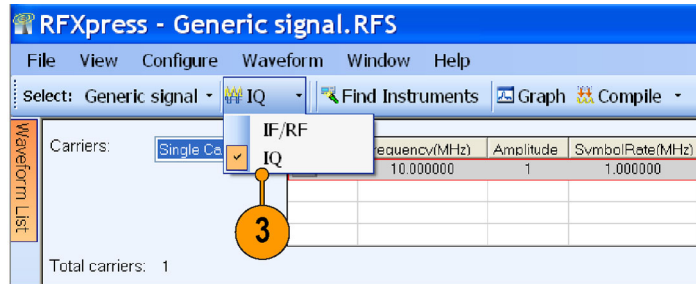
## Generating a Single Carrier Signal

This section shows you a step-by-step procedure for creating a single carrier QPSK baseband signal.

1. Start RFXpress.
2. From the toolbar, click **Select > Generic Signal**.



- Set the signal type to **IQ**.



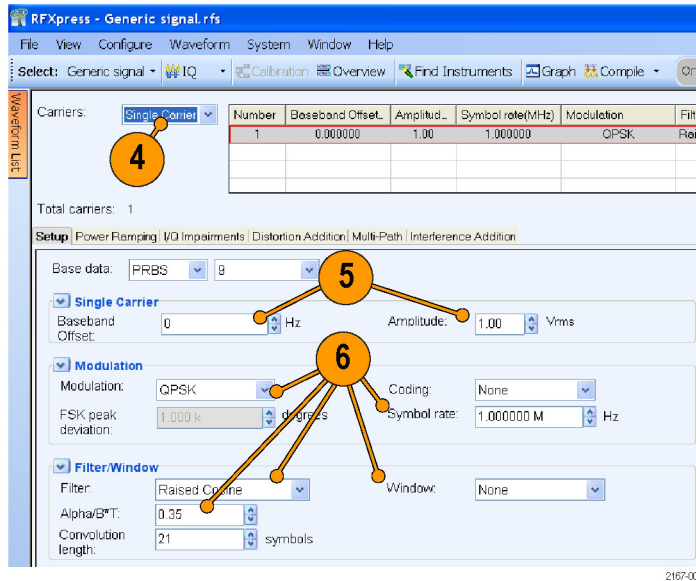
- Click **Carriers > Single Carrier**.

- Select the carrier and set the following:

- **Baseband Offset** to 0 Hz
- **Amplitude** to 1 Vrms

- Ensure that the following parameters are set:

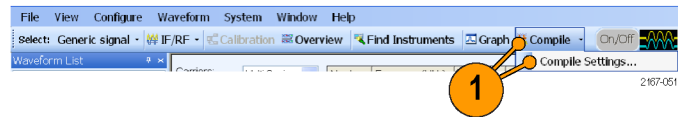
- **Modulation** is QPSK
- **Filter** is Raised Cosine
- **Symbol rate** is 1 MHz
- **Alpha/B\*T** is 0.35
- **Window** is None



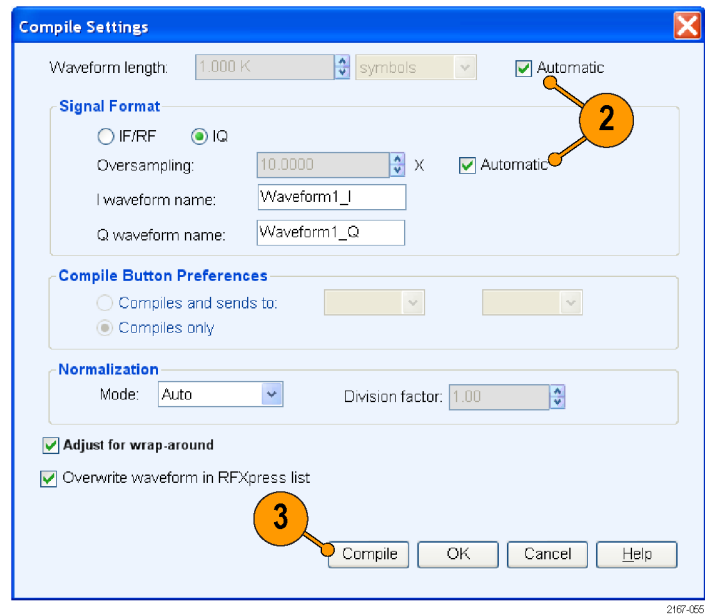
## Compiling a Signal

Follow these steps to compile and generate a signal using the parameters that you just defined.

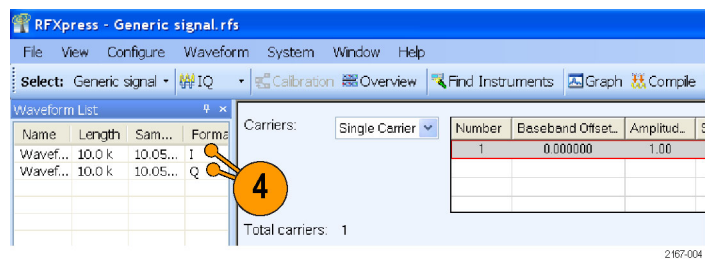
1. From the toolbar, click **Compile > Compile Settings**.



2. Retain the default values as they are. Ensure that the **Automatic** options are selected.
3. Click **Compile**.



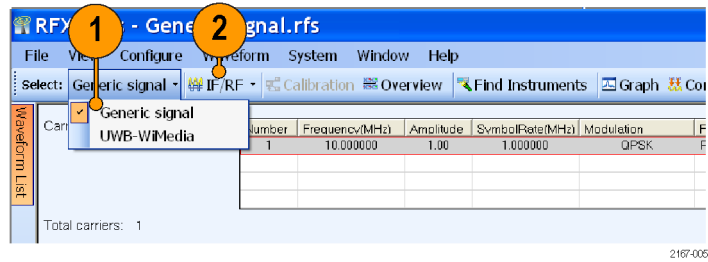
4. The compiled waveform is displayed in the waveform list.



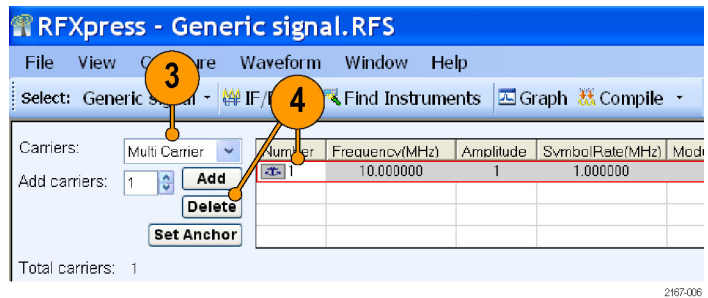
**NOTE.** If the waveform list is not visible, click **Window > Waveform List** to view it.

## Generating a Multi-Carrier RF Signal

1. From the toolbar, click **Select > Generic Signal**.
2. Select the signal type as **IF/RF**.
3. Select **Multi Carrier**.



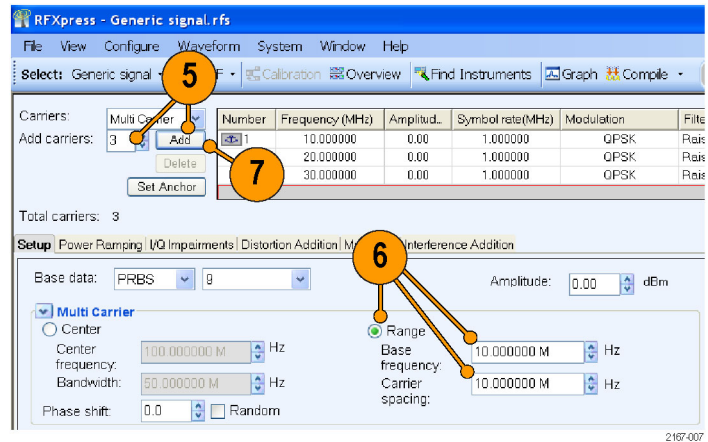
4. You can either add carriers directly or delete the existing carrier and add new ones. Select the carrier in the table and click **Delete**.



5. Click **Add Carriers** and type 3.

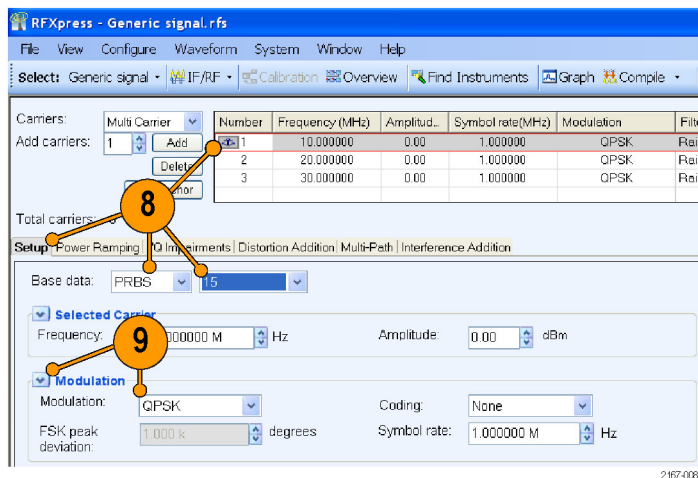
6. Click **Range**. Set the **Base Frequency** to 10 M and the **Carrier Spacing** to 10 M.

7. Click **Add**.



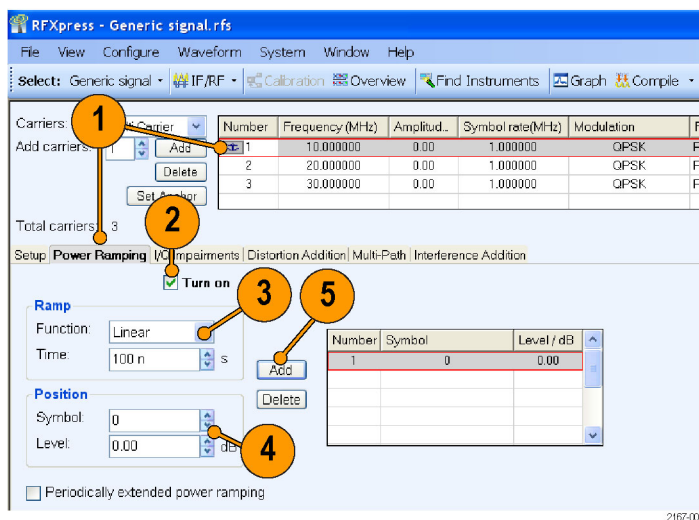


8. Select the first carrier from the table. In the **Setup** tab, set the **Base Data** to PRBS and select 15 from the adjacent field.
9. Set the **Modulation** for the carrier to QPSK.
10. Repeat steps 8 and 9 for the remaining carriers, setting the **Base Data** to PRBS 21 and PRBS 7, and **Modulation** to QPSK.



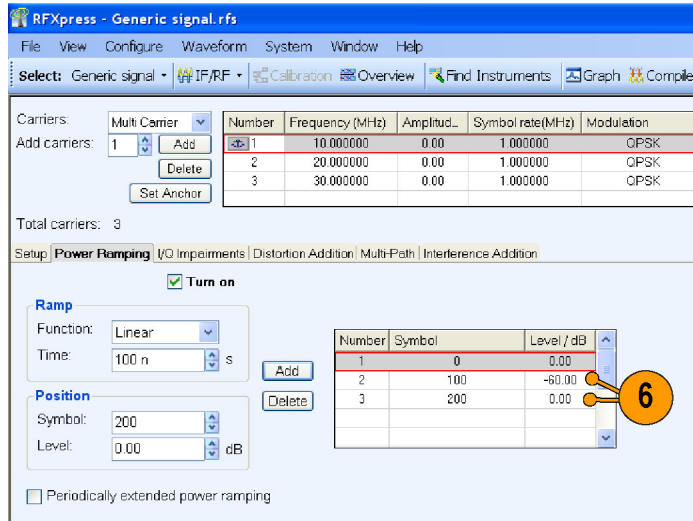
## Adding Power Ramping, I/Q Impairments, and Interference

1. Select the first carrier from the table. Select the **Power Ramping** tab.
2. Select **Turn On**.
3. Set the Ramp parameters:
  - **Function** to Linear
  - **Time** to 100 nsec
4. Set the Position parameters:
  - **Symbol** to 0
  - **Level** to 0.00
5. Click **Add**.



6. Repeat steps 4 and 5 two more times, adding these parameters:

- Symbol = 100
- Level = -60 dB
- and
- Symbol = 200
- Level = 0 dB

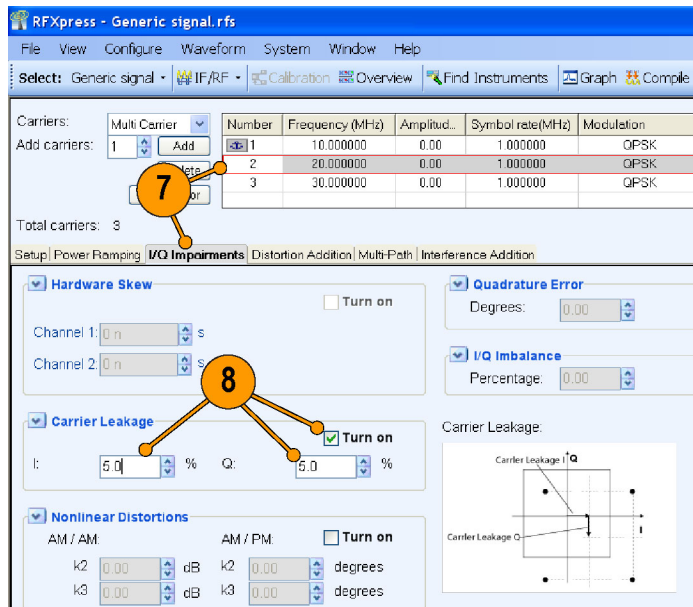


2167-049

7. Select the second carrier from the table. Select the **I/Q Impairments** tab.

8. In the Carrier Leakage group, select **Turn On**. Set the following parameters:

- I to 5.0
- Q to 5.0



2167-010

9. Select the third carrier from the table. Select the **Interference Addition** tab.
10. In the Offset group, select **Turn On**. Set the **Frequency** to 10 M.

The screenshot displays the RFXpress software interface for configuring a signal. The main window is titled "RFXpress - Generic signal.rfs". The menu bar includes File, View, Configure, Waveform, System, Window, and Help. The toolbar contains icons for Select, Generic signal, IF/RF, Calibration, Overview, Find Instruments, Graph, and Complete.

The "Carriers" section shows a table with three carriers. A red circle with the number "9" highlights the third carrier (Number 3, Frequency 30.000000 MHz, Symbol rate 1.000000 MHz, Modulation QPSK). The table is as follows:

Number	Frequency (MHz)	Symbol rate (MHz)	Modulation
1	10.000000	1.000000	QPSK
2	20.000000	1.000000	QPSK
3	30.000000	1.000000	QPSK

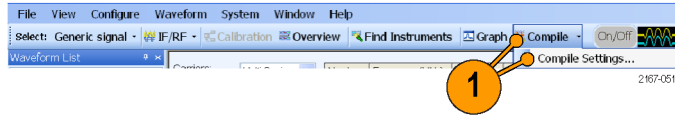
The "Interference Addition" tab is selected. The "Signal Addition" section has "Format" set to "IQ" and "Turn on" is checked. The "Add Interference via" section has "Software" selected. The "Offset" section has "Turn on" checked and "Frequency" set to "10.000000 M Hz". A red circle with the number "10" highlights the "Turn on" checkbox in the Offset section.

The "Sinusoidal Interference" section has "Turn on" unchecked, "C/I" set to "20.00 dB", and "Offset from Carrier" set to "0 Hz".

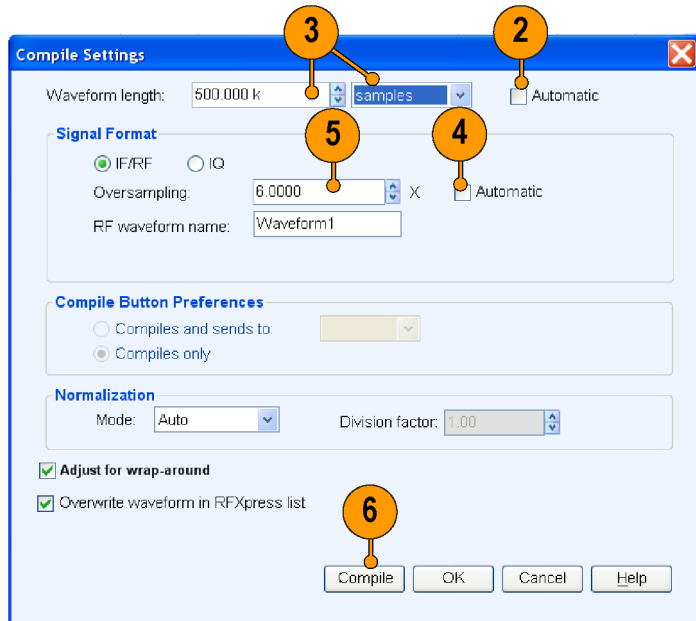
2167-011

## Compile Settings and Compile

1. From the toolbar, click **Compile > Compile Settings**.

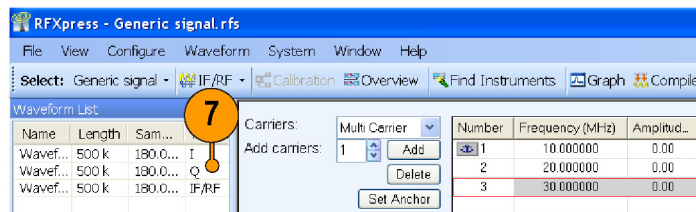


2. Clear **Automatic**.
3. Set the **Waveform Length** to 500K and the units to samples.
4. Clear **Automatic**.
5. Set the **Oversampling** to 6.00.
6. Click **Compile**.



2167-012

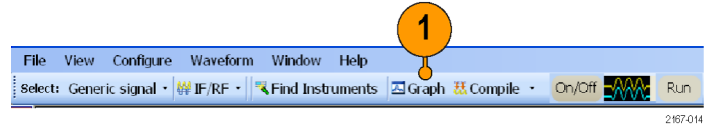
7. The compiled waveform is displayed in the waveform list.



2167-013

## Previewing Graphs

1. From the toolbar, click **Graph**.

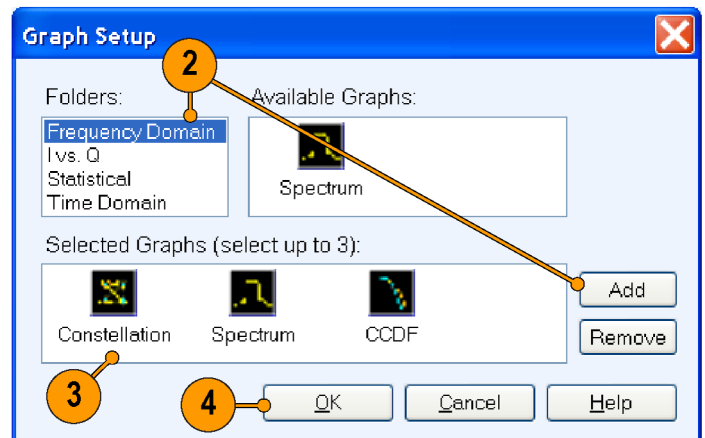


2. In Graph Setup, select the folder and click **Add** to add the following graphs:

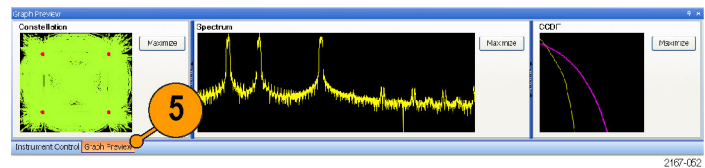
- Frequency Domain: Spectrum
- I Vs Q: Constellation
- Statistical: CCDF

3. The graphs are added to the Selected Graphs.

4. Click **OK**.



5. Click **Graph Preview** at the lower left of the screen to view the graphs.



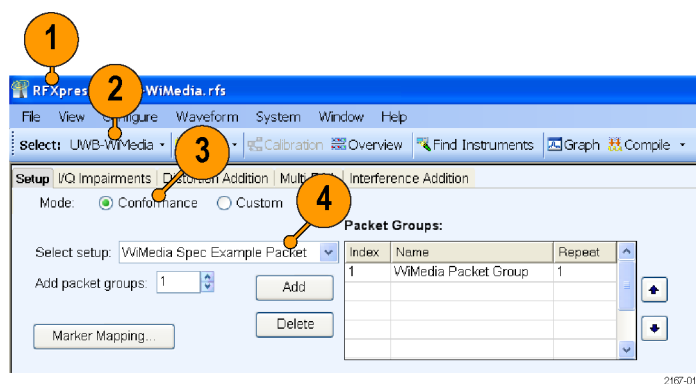


# Application Examples

## Creating a UWB Waveform to Test Your Receivers

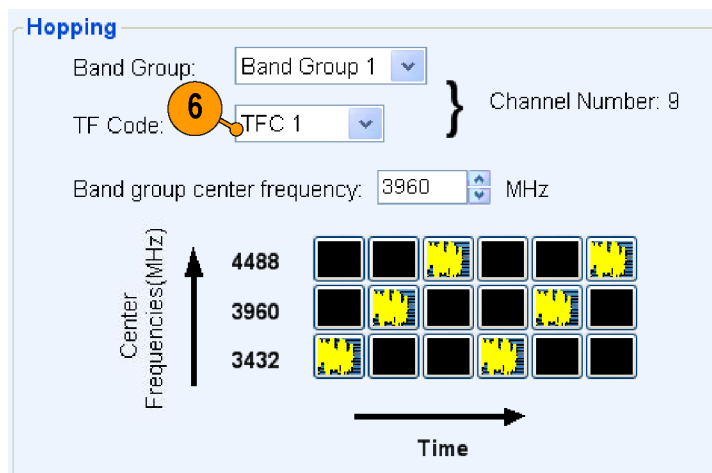
You can create an ideal waveform and use it to test whether your receivers are operating within the WiMedia specifications.

1. Start RFXpress.
2. From the toolbar, click **Select > UWB-WiMedia**.
3. By default, **Conformance** is selected.
4. From the Select Setup, select **WiMedia Spec Example Packet**.



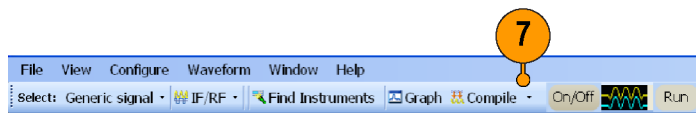
2167-016

5. The **WiMedia Spec Example Packet** settings (according to Annex A of the WiMedia specification document) are displayed in the fields in each tab.
6. Confirm the **Hopping Pattern** for TF Code 1.



2167-017

7. Click **Compile**.

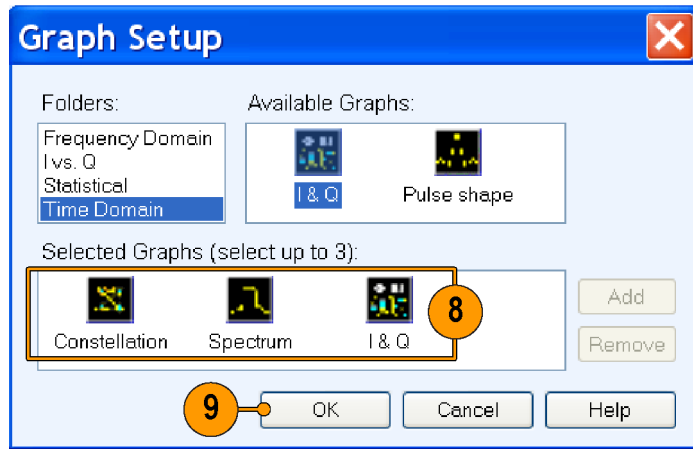


2167-018

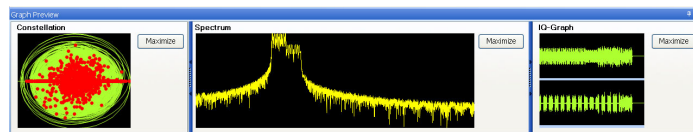
8. Add the following graphs in Graph Setup:

- Frequency Domain: Spectrum
- I Vs Q: Constellation
- Time Domain: I & Q

9. Click **OK**.



10. The graphs are as shown.

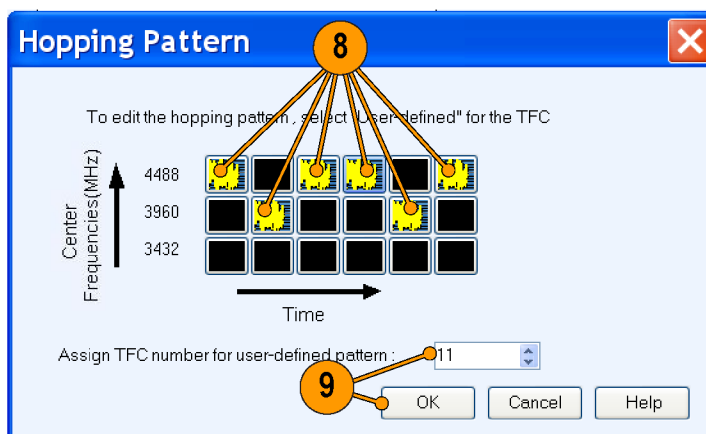
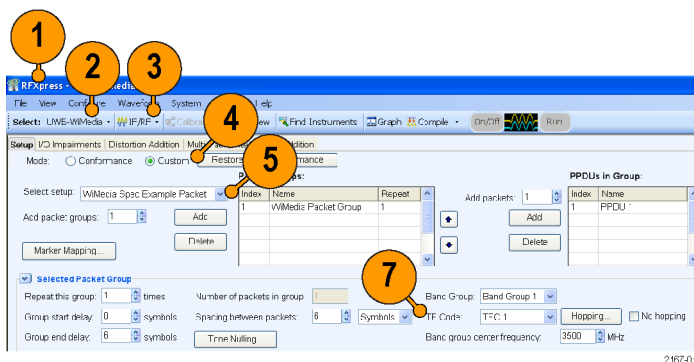


## Characterize Receiver Design for Receiver Verification and Stress Test

You can generate a signal and use it to test your receiver at conditions just outside the boundary values specified by the WiMedia standard.

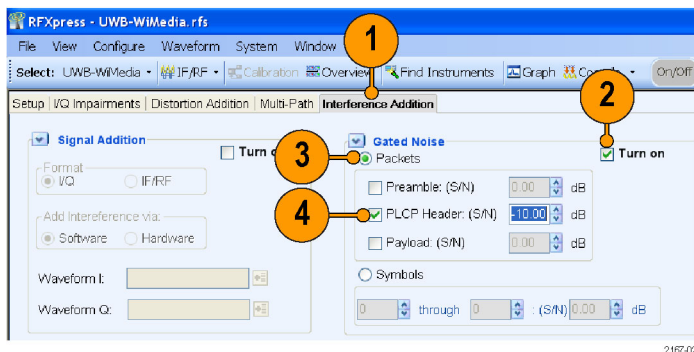


1. Start RFXpress.
2. From the toolbar, click **Select > UWB-WiMedia**.
3. Set the signal type to IF/RF.
4. Click **Custom**.
5. From the Select Setup, select **WiMedia Spec Example Packet**.
6. The default values for the selected setup and packet are shown graphically.
7. For the selected packet group, set **TF Code** to User Defined.
8. To define a hopping pattern: In each column, click the frequency that you want to use. Set the hopping pattern to: 323323.
9. Assign a TFC number for the pattern that you defined and click **OK**.

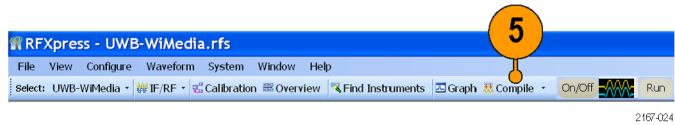


### Adding Interference

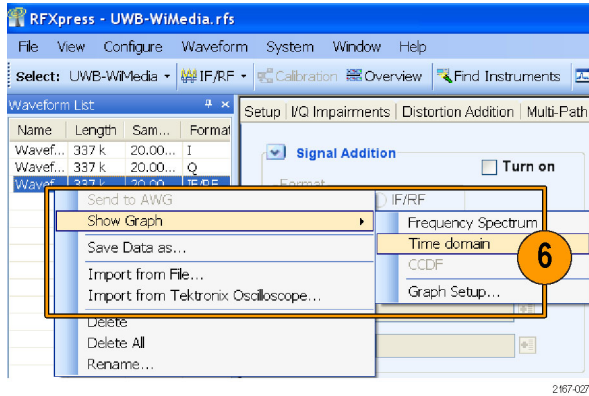
1. Click **Interference Addition**.
2. In the Gated Noise group, select **Turn On**.
3. Click **Packets**.
4. Click **PLCP Header** and set it to **-10.0**.



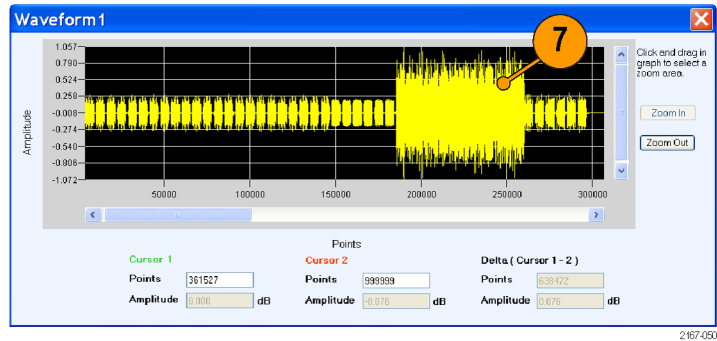
- From the standard toolbar, click **Compile**.



- In the Waveform List, select the IF/RF waveform and right-click. Select **Show Graph > Time Domain**.



- Observe the noise in the header. The noise of 10 dB is greater than the signal.

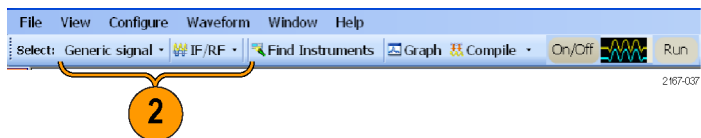


## Replay a Captured Waveform to Test Receivers

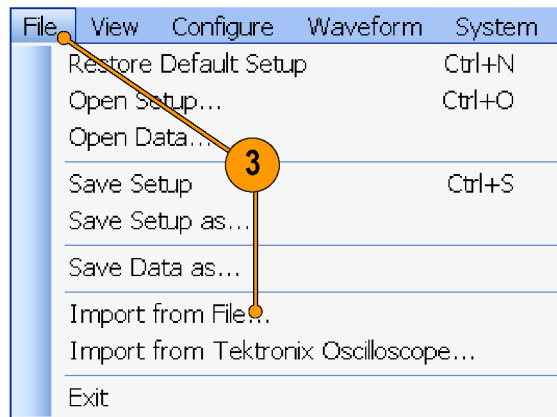
You can capture a real-world signal in a real-time spectrum analyzer and play it back in multiple locations to test your DUTs.

### Import an RTSA File

- Start RFXpress.
- Ensure that the selected application is set to **Generic Signal** and the signal type is **IF/RF**.

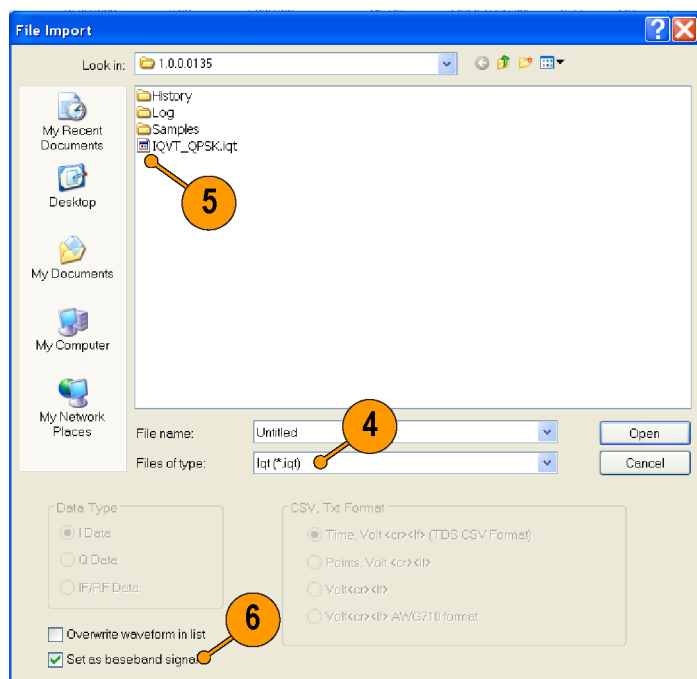


- From the menu, click **File > Import from File**.



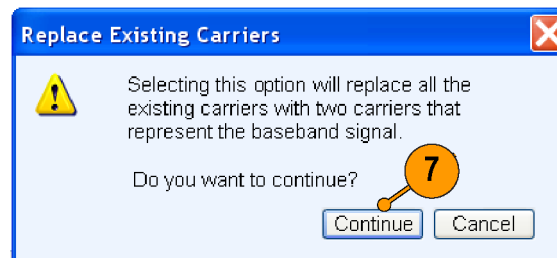
2167-026

- Select **iq1** in the **Files of type** field.
- Select an **iq1** file.
- Select **Set as baseband signal**.



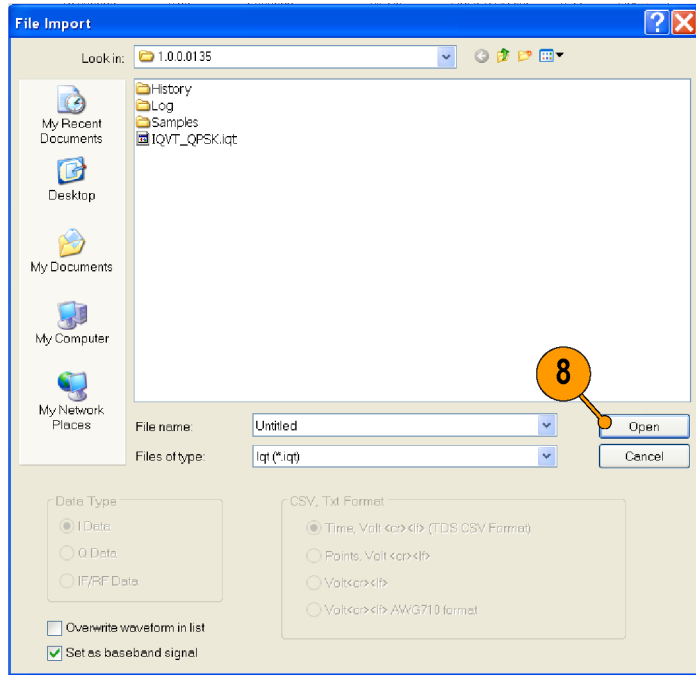
2167-056

- A message appears. Click **Continue**.



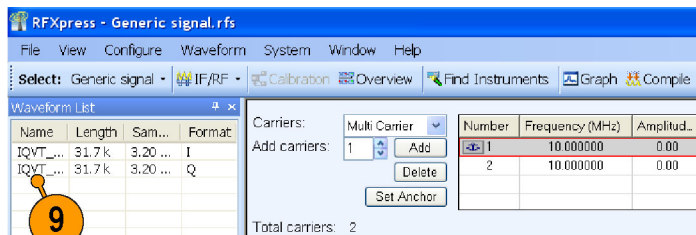
2167-057

8. Click **Open**.



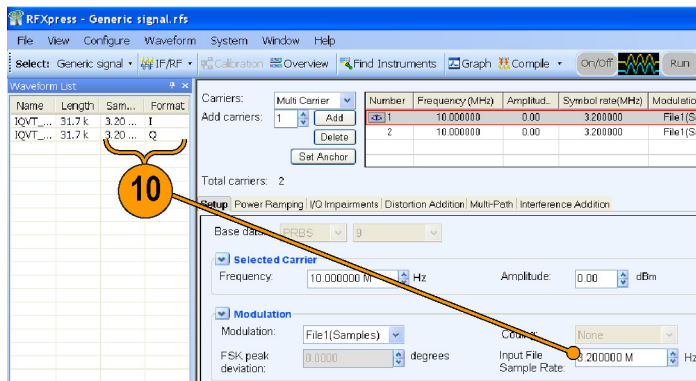
2167-058

9. The waveform list displays the I and Q signals.



2167-060

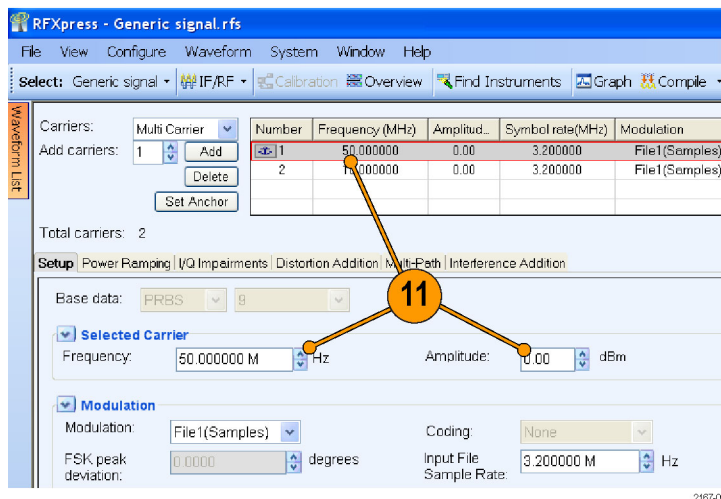
10. Note that the **Input File Sample Rate** automatically takes the value with which the iqt file was created.



2167-039

11. Select the first carrier and set the following:

- **Frequency** to 50 M
- **Amplitude** to 0 dBm

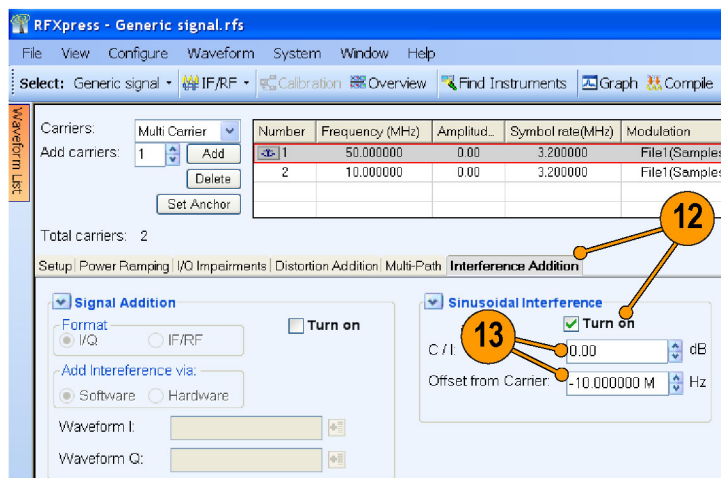


2167-063

12. Click **Interference Addition**. In the Sinusoidal Interference group, select **Turn On**.

13. Set the following:

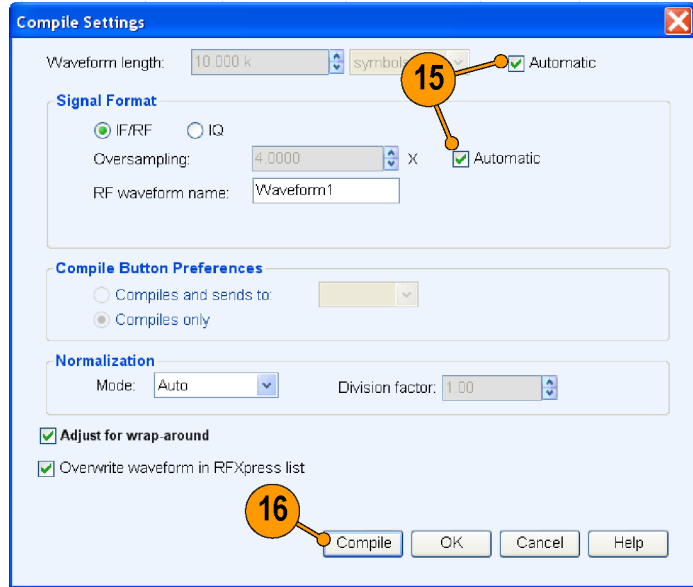
- **C/I** to 0 dB.
- **Offset from Carrier** to -10 M.



2167-064

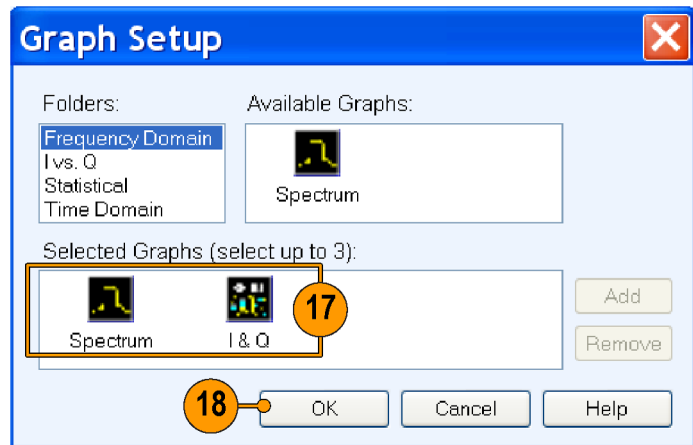
14. Select the second carrier and repeat steps 11 through 13.

15. Click **Compile > Compile Settings**. Ensure that **Automatic** is selected.
16. Click **Compile**. The software uses the default compile settings to generate the waveform.



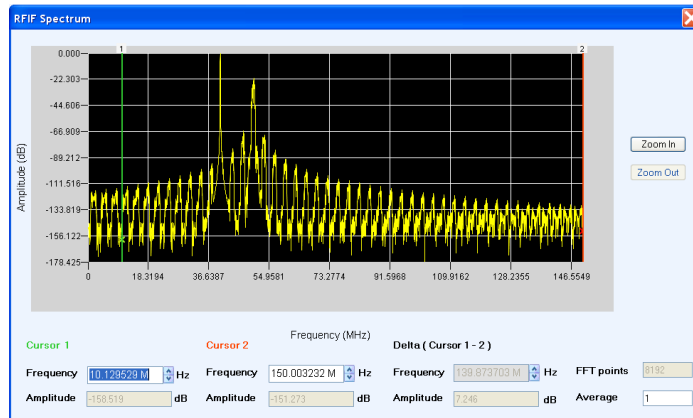
2167-001

17. Add the following graphs in Graph Setup:
  - Frequency Domain: Spectrum
  - Time Domain: I & Q
18. Click **OK**.



2167-040

19. The Spectrum graph is as shown.



## Using Calibration to Increase the Flatness of a UWB Signal Path to the DUT

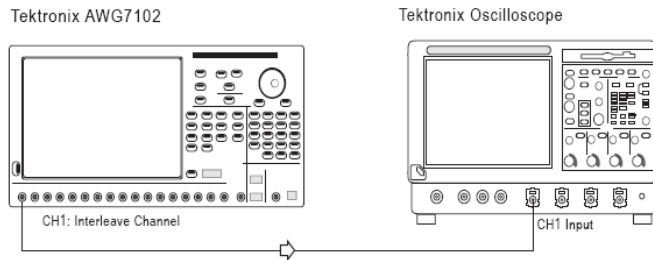
The calibration feature allows you to generate correction files that you can use during compilation to predistort the signal, thereby increasing the flatness of the signal.

1. Set up the instruments as shown. The instruments must be connected over a LAN.

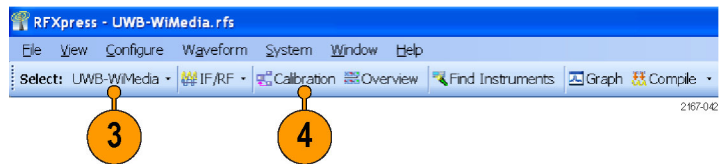
You will need:

- A Tektronix AWG7102 with Option 06 running RFXpress software
- A Tektronix DPO70804 oscilloscope to capture the signal
- Connecting cable

**NOTE.** Ensure that the output of the AWG Interleave channel is connected to Channel 1 of the oscilloscope.



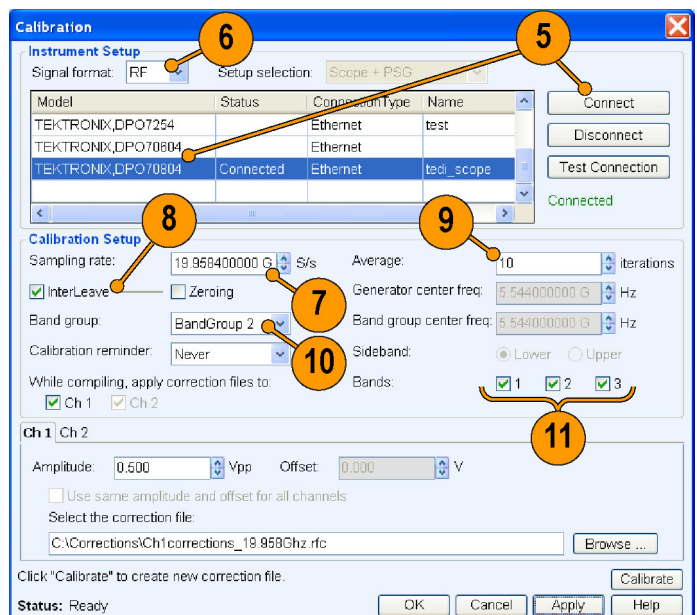
2. Start RFXpress.
3. From the toolbar, click **Select > UWB-WiMedia**.
4. From the toolbar, click **Calibration**.



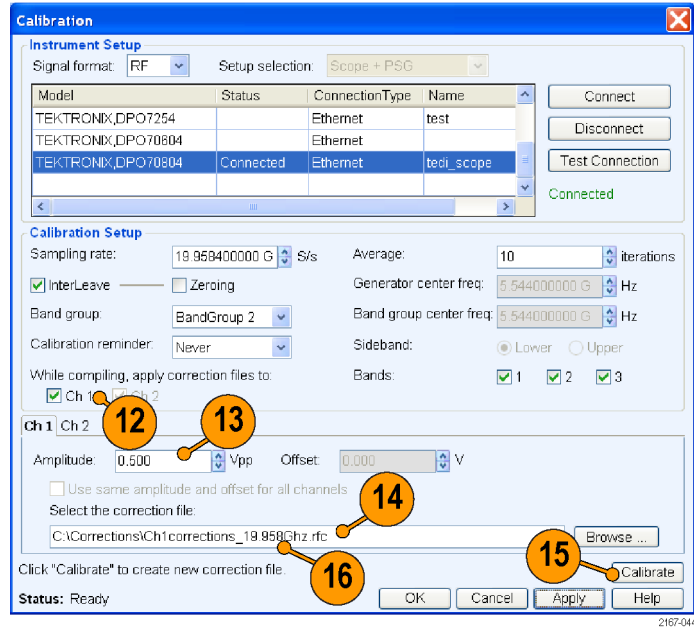
5. The Calibration window displays a table of instruments connected on the network. Select the DPO70804 oscilloscope and click **Connect**. Note that the status changes to Connected.

**NOTE.** You can click **Test Connection** to test the status of the instrument.

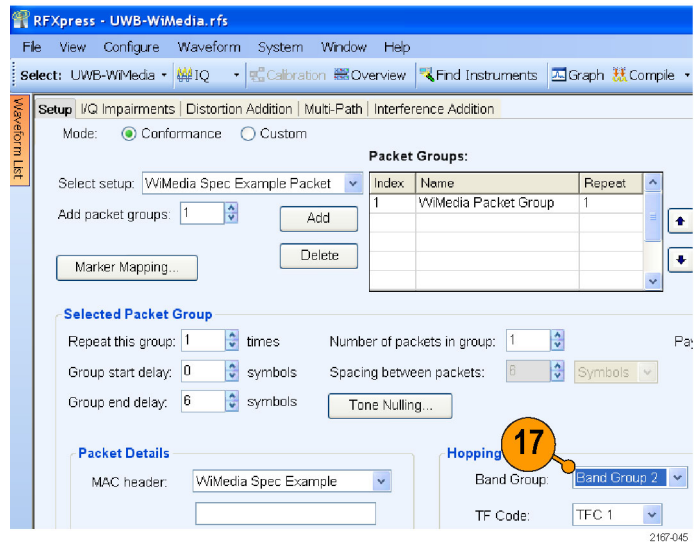
6. Set the **Signal Type** to RF.
7. Set the **Sampling Rate** to 19.996576 GS/s.
8. Select **Interleave**.
9. Set the **Average** to 10.
10. Set the **Band Group** to 2.
11. Select **Bands**: 1, 2, and 3.



12. Set **When compiling, apply correction files to** to Ch1.
13. Set the **Amplitude** for Ch1 to 0.5 Vpp.
14. Set the path for **Select the correction file**.
15. Click **Calibrate** to create the correction file (.rfc). The calibration status is continually updated.
16. Confirm that the correction file that was just generated is selected.

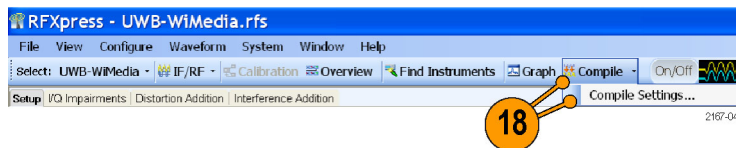


17. Set **Band Group** to BandGroup 2.





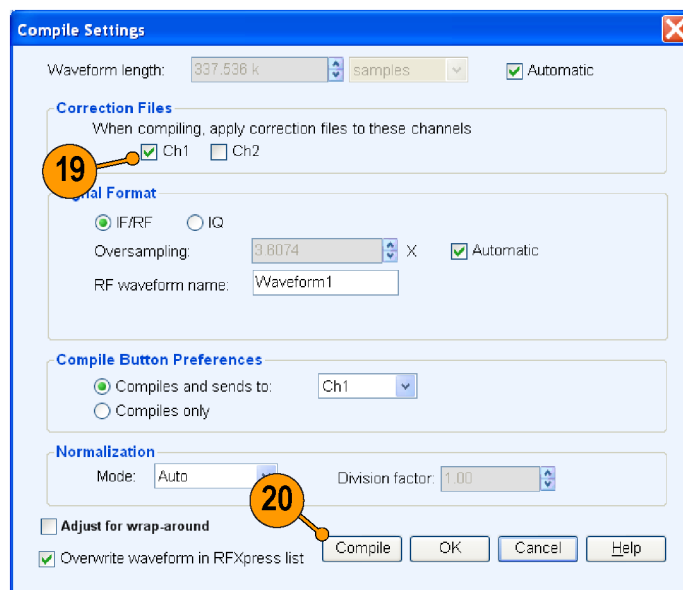
18. From the toolbar, click **Compile > Compile Settings**.



19. Ensure that the correction file created during calibration is applied to Ch1.

**NOTE.** *Oversampling is calculated automatically to achieve a sampling rate of 19.996576 GS/s.*

20. Click **Compile**.

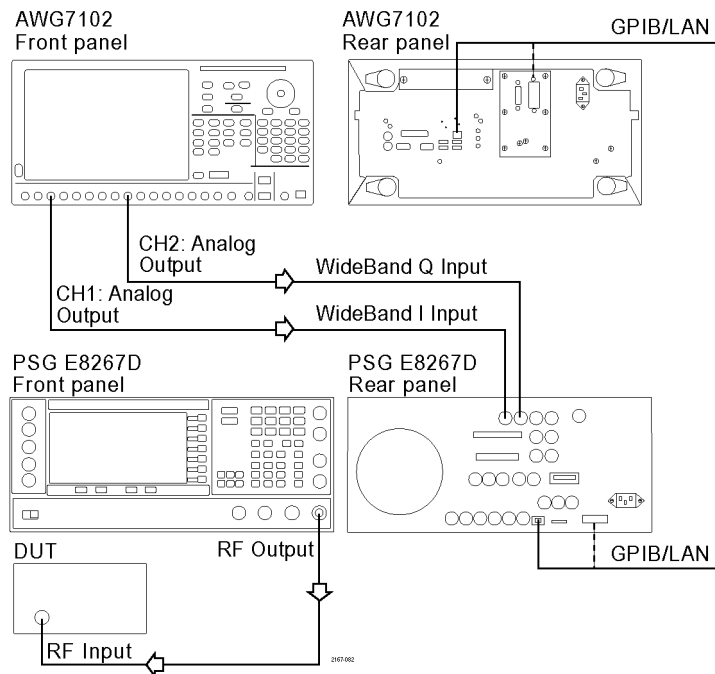


## Creating a Band Group 6 Signal Using an External IQ Modulator

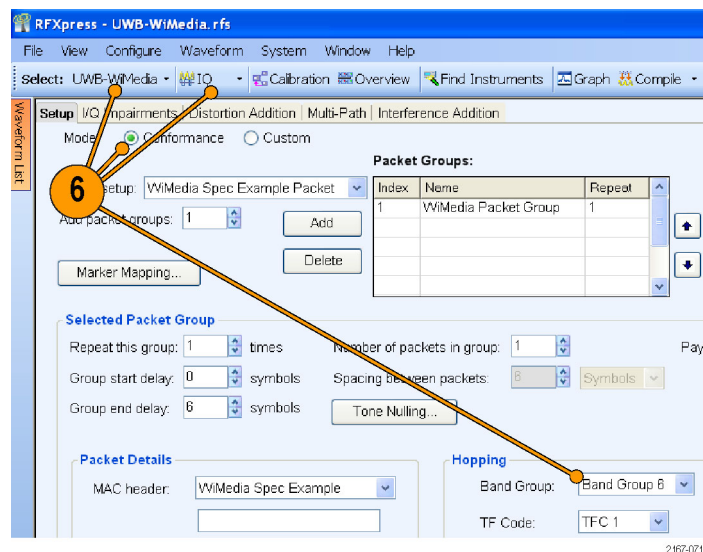
You can create a Band Group 6 WiMedia signal using an AWG7102 and an external IQ modulator like the Agilent PSG®. The AWG7102 is used to generate a hopping baseband signal which will be fed to PSG to modulate it to the desired Band Group 6 center frequency of 8184 MHz. The signal would have to be calibrated to adjust the channel mismatches. Channel mismatches result in images and carrier leakage. Carrier leakage is caused by the offset mismatch between the channels and images by the amplitude and skew mismatches. To eliminate images you must calibrate the signal for all the tones. In this application example, an extreme tone from the center frequency is taken and calibrated.

1. You will need the following equipment, with each piece calibrated:
  - A Tektronix AWG7102 with Option 06 running RFXpress software
  - A Tektronix DSA72004 oscilloscope to capture the signal. The Tektronix Ultra Wideband Spectral Analysis software must be loaded and running on the oscilloscope
  - An Agilent Performance Signal Generator PSG® E8267D with Option 015
  - A Tektronix RSA6114A Real Time Spectrum Analyzer
  - Matched pair connecting cables to connect between the PSG E8267D and the AWG7102

2. Connect the equipment as shown. Either the DSA72004 oscilloscope or the RSA6114A Real Time Spectrum Analyzer can be used as the DUT.

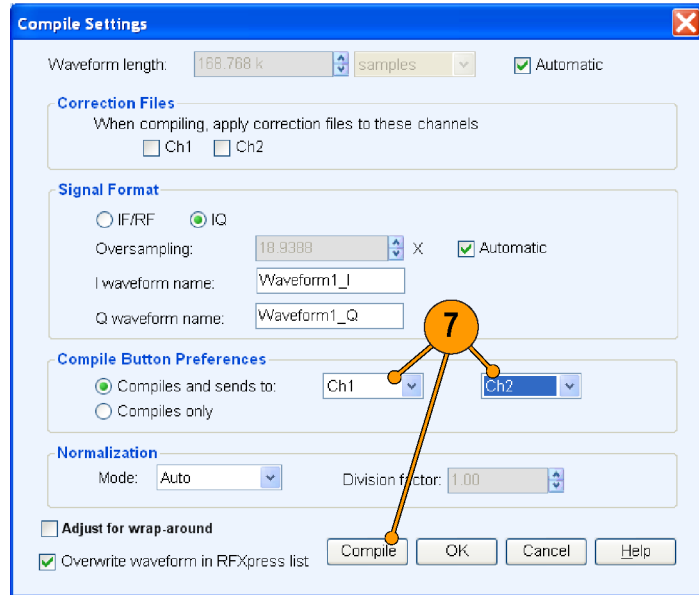


3. On the PSG E8267D, do the following:
  - Set **I/Q** to On.
  - Set **I/Q Path** to Wide.
  - Select **IQ Calibration**. Set **Calibration Type** to Full and execute calibration.
  - Set **Frequency** to 8184 MHz (for BandGroup 6) and **Amplitude** to 0 dBm.
4. Connect the RF output of the PSG E8267D to the oscilloscope (DUT).
5. On the AWG7102, start RFXpress.
6. Set the following:
  - Application to **UWB-WiMedia**
  - Signal type to **IQ**
  - Mode to **Conformance**
  - **BandGroup** to 6



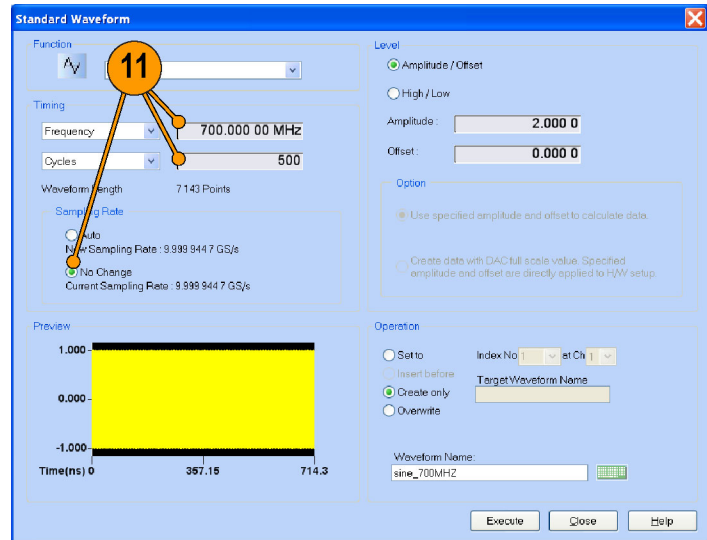
2167-071

7. Click **Compile > Compile Setting**. Ensure that **Compile and Sends to** is set to Ch1 and Ch2. Click **Compile** to generate the signal.



8. On the PSG E8267D, do the following:
  - Set **Modulation** to On.
  - Set **RF** to On.
9. The signal is sent to oscilloscope (DUT); capture and demodulate it using the Tektronix Ultra Wideband Spectral Analysis software. If the software is unable to decode the signal, go to step 10 to proceed with calibrating the signal.
10. Disconnect the oscilloscope and connect the RF output of the PSG E8267D to the RSA6114A (DUT).

- On the AWG7102, using a standard waveform, generate a sine wave with a **Frequency** of 700 MHz, **Cycle** of 500, and the sampling rate set to **No change**.



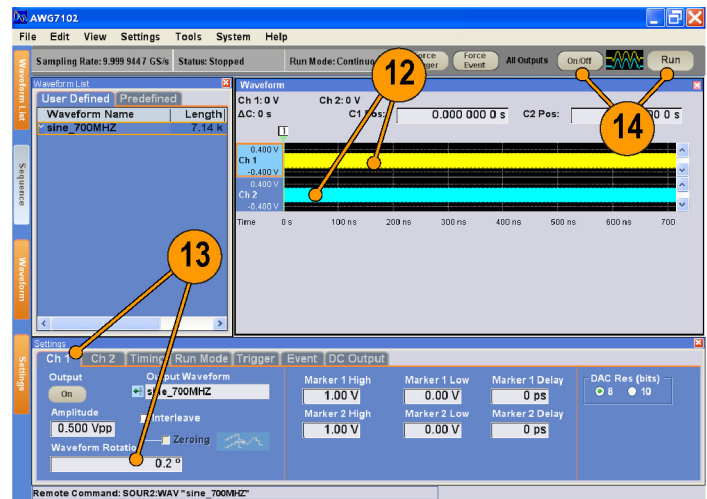
2167-073

- Drag and drop the sine wave (signal) into Ch1 and Ch2.

- Click Ch1 and set **Waveform Rotation** to 0.18 degrees. Leave Ch2 unchanged.

**NOTE.** On the AWG7102, the waveform rotation value will be shown as 0.2°.

- Click **On/Off**. Click **Run**.

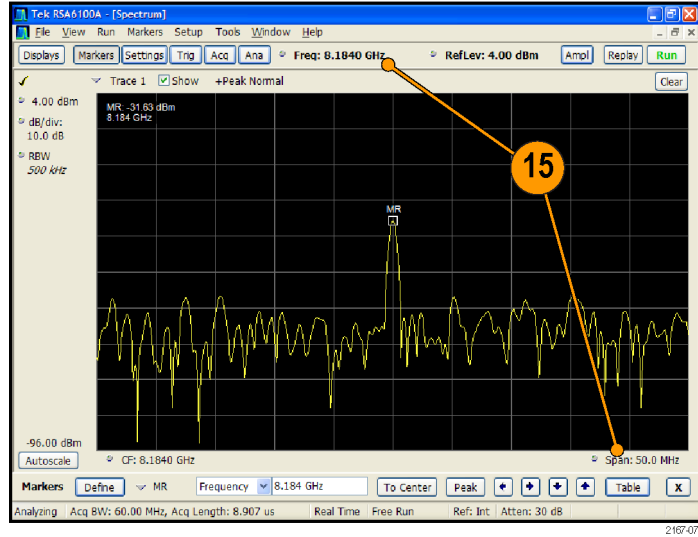


2167-074

15. On the RSA6114A, do the following:

- Set **Frequency** to 8184 MHz.
- Set **Span** to 50 MHz.

Observe whether there is a carrier leakage at 8184 MHz. If you find a frequency component at 8184 MHz, go to step 16.



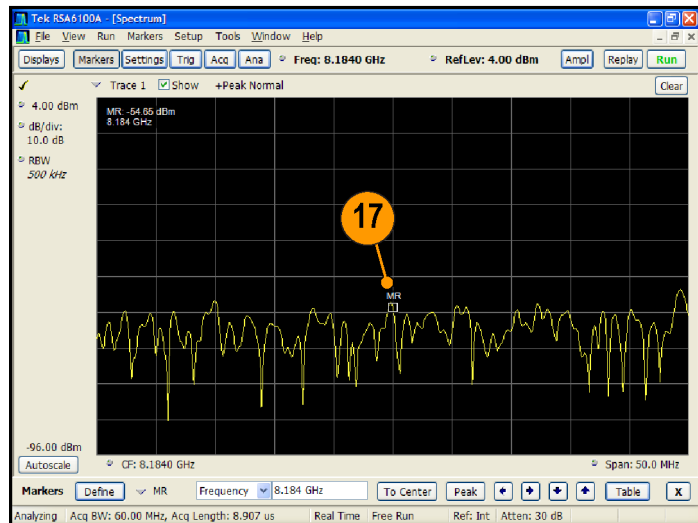
2167-076

16. On the PSG E8267D, do the following:

- Set **I/Q Adjustments** to On.
- Adjust the **I Offset** and **Q Offset** until the carrier leakage reduces to the noise floor.

You may have to adjust the values iteratively.

17. Observe the change in the signal on the RSA6114A.



2167-076

18. On the RSA6114A, do the following:

- Set **Center Frequency** to 8184–700 MHz (that is 7484 MHz).

- Set **Span** to 50 MHz.

Observe whether there is an image at a frequency of 7484 MHz. If there is an image, proceed to calibrate the signal. If there is no image, proceed to step 21.



2167-077

19. On the AWG7102, adjust the **Amplitudes** and **Channel Skews** to reduce the image to the noise floor.

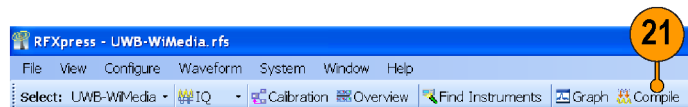
You may have to adjust the values iteratively. Observe the change in the signal on the RSA6114A.

20. Make a note of the amplitudes and skew values of Ch1 and Ch2.



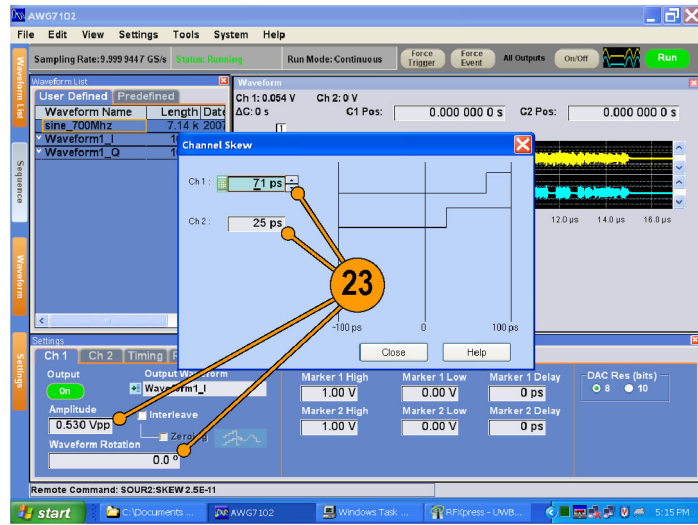
2167-078

21. Go to RFXpress and click **Compile**.



2167-079

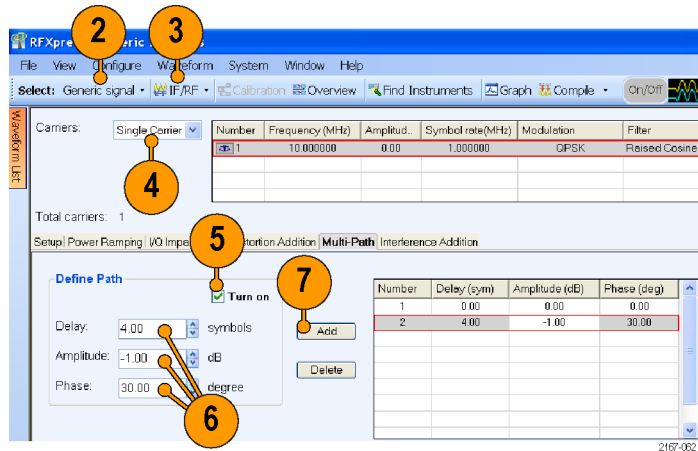
22. Connect the RF output of the PSG E8267D to the oscilloscope (DUT).
23. On the AWG7102, set the values noted in step 20:
  - Amplitudes of Ch1 and Ch2.
  - Skew values of Ch1 and Ch2.
  - Waveform rotation to 0.
24. Observe that the signal is decoded on the oscilloscope.



## Simulating a MultiPath Environment for a Generic Signal

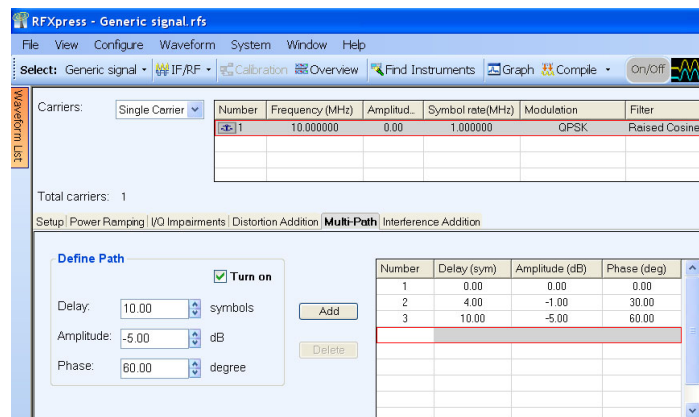
You can simulate multipath to test your receiver's response to multipaths.

1. Start RFXpress.
2. From the toolbar, ensure that **Select > Generic signal** is selected.
3. Ensure that the signal type is set to **IF/RF**.
4. Ensure that **Single Carrier** is selected. Keep the default values for the carrier.
5. Click **Multi-Path** and select **Turn On**.

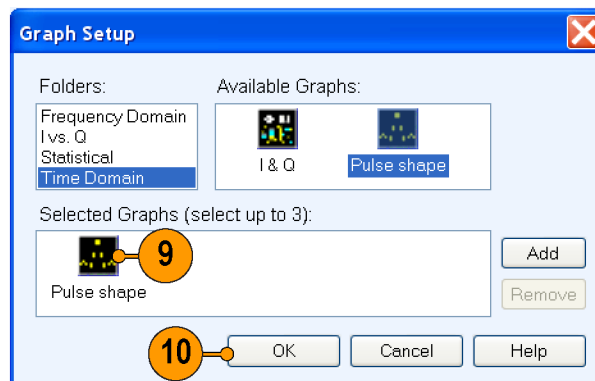




6. Set the following parameters:
  - **Delay** to 4 symbols
  - **Amplitude** to -1 dB
  - **Phase** to 30 degrees
7. Click **Add**.
8. Repeat steps 6 and 7 setting the following parameters:
  - **Delay** to 10 symbols
  - **Amplitude** to -5 dB
  - **Phase** to 60 degrees



9. Add the following graph in Graph Setup:
  - Time Domain: Pulse shape
10. Click **OK**.

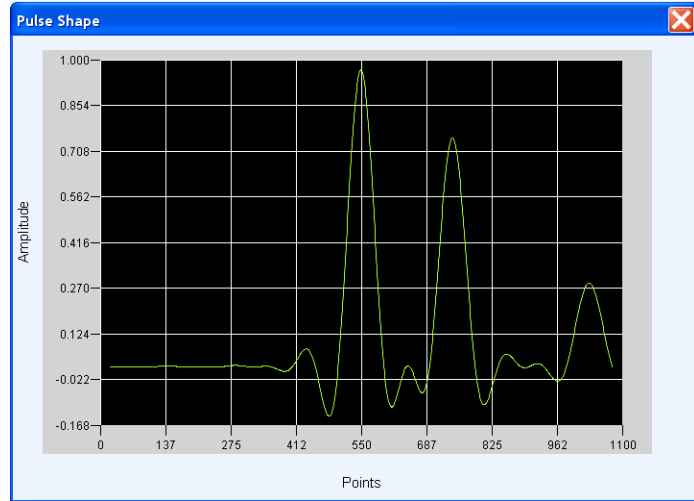


2167-005

- From the toolbar, click **Compile**.



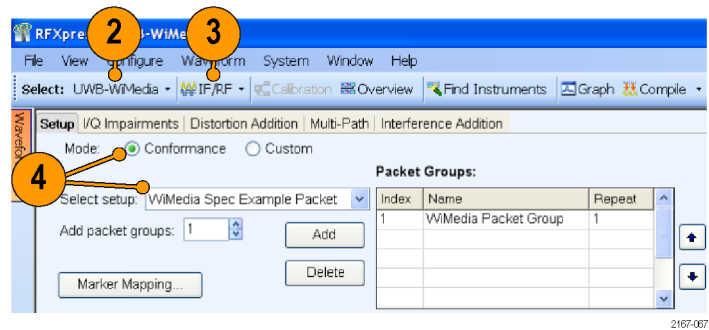
- The pulse shape is as shown.



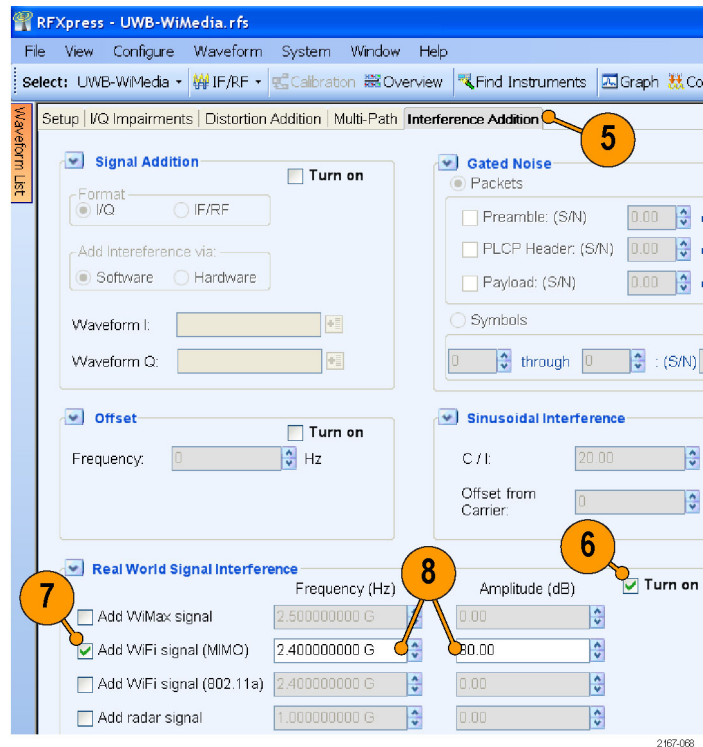
## Introducing Real-World Impairments in a UWB Signal

You can introduce real-world impairments in a UWB signal to test your receiver in a simulated real-world environment.

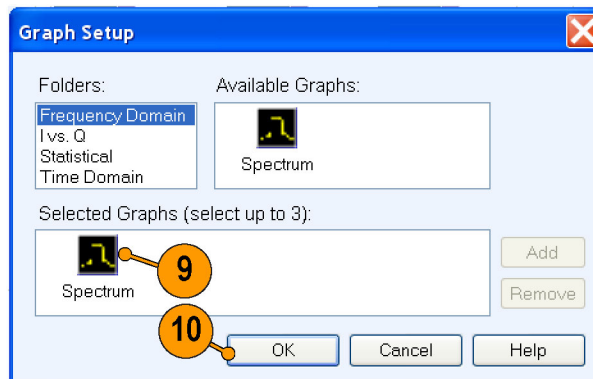
- Start RFXpress.
- From the toolbar, click **Select > UWB-WiMedia**.
- Ensure that the signal type is set to **IF/RF**.
- Ensure that the **Mode** is Conformance and the **Selected setup** is WiMedia Spec Example. Keep the default values for the selected setup.



5. Click **Interference Addition**.
6. In the Real World Signal Interference group box, click **Turn On**.
7. Click **Add WiFi signal (MIMO)**.
8. Set the following parameters:
  - **Frequency** to 2.4 G Hz (default).
  - **Amplitude** to 30 dB.



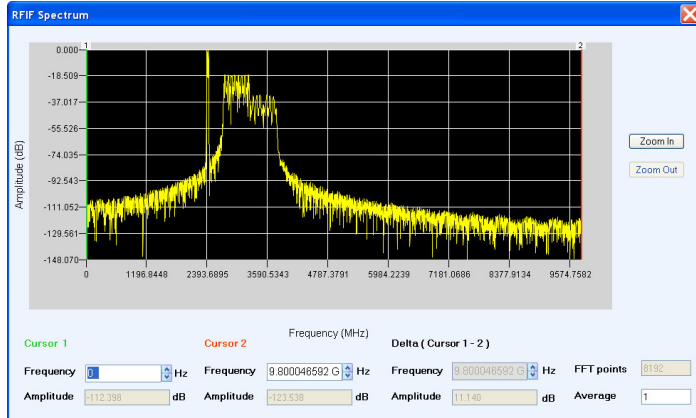
9. Add the following graph in Graph Setup:
  - Frequency Domain: Spectrum
10. Click **OK**.



11. From the toolbar, click **Compile**.



12. The spectrum is as shown.



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