Tektronix®

# Radar
# Plug-in Application

## Printable Help Document

077-1355-01

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www.tek.com
077-1355-01

Supports the Radar Plug-in Version 3.1.x and above.

Help part number: 076–0410–01

PDF of Help system part number: 077–1355–01

## Contacting Tektronix

Tektronix, Inc.
14150 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.
- Worldwide, visit www.tek.com to find contacts in your area.

# Table of Contents

# Welcome

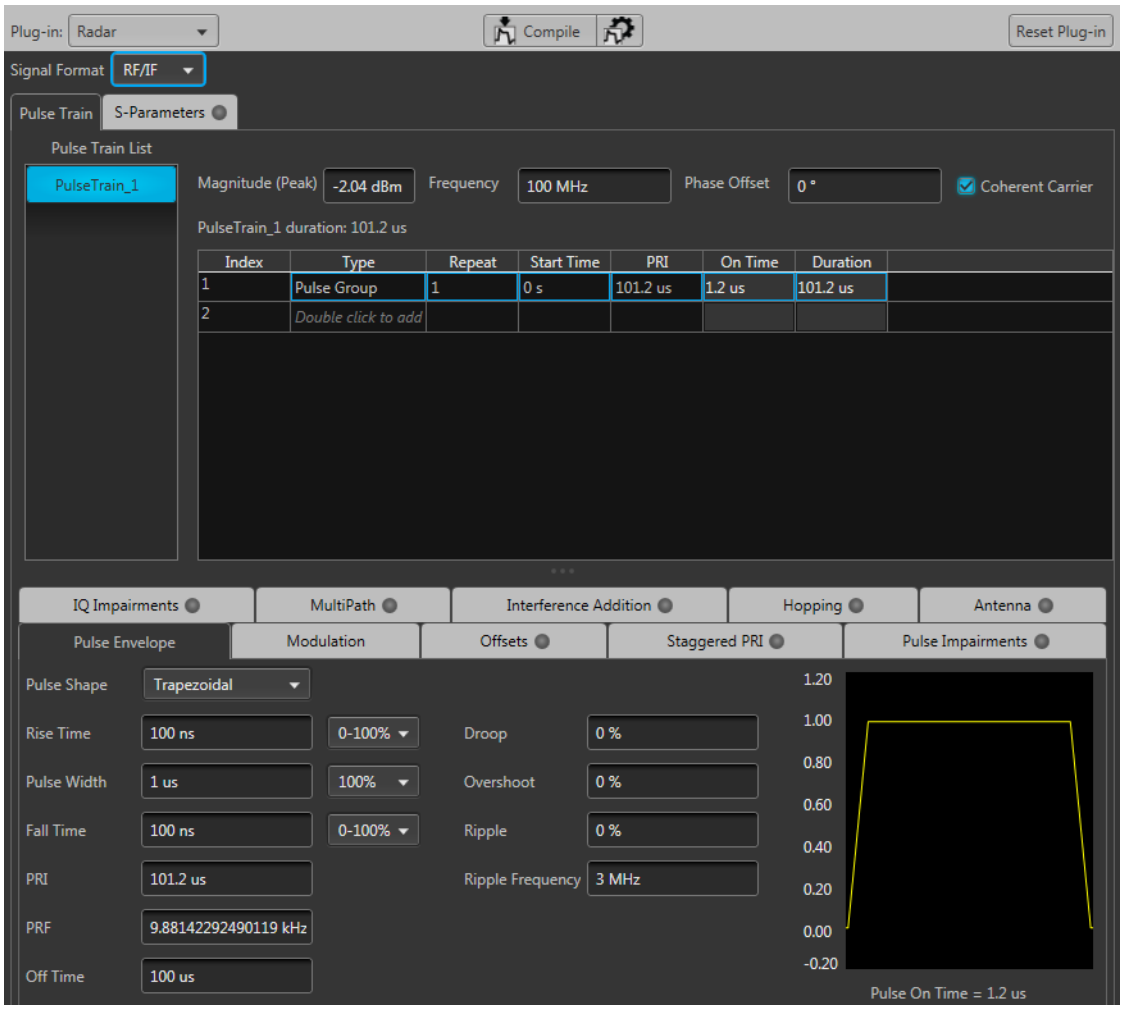
The Radar plug-in is a waveform creation application that is used to create/build pulse(s) and simulate complex test patterns used to test radar receivers. It also allows you to simulate multiple targets.

The Radar plug-in is designed to integrate and operate seamlessly as an enhancement to the following products:

- SourceXpress waveform creation software
- AWG70000 series arbitrary waveform generators
- AWG5200 series arbitrary waveform generators

Once installed, the plug-in becomes available as another waveform plug-in application.

This illustration shows the Radar plug-in viewed from the SourceXpress application. The plug-in interface is identical whether it is used from SourceXpress or installed on a generator.



# Key features

- Define multiple pulse trains that can be assigned to different channels for applications like simulating phase array radars and creating scenarios to test EW receivers.
- Define multiple pulse group(s) or dead time for each pulse train.
- Each pulse group can be independently set up to have different pulse shapes, pulse modulation, offsets, hopping, noise and other features.
- Modulation types supported include LFM, Piecewise LFM, Chirp Sequence, Custom Modulation, Barker codes, and many others.
- Define frequency, phase and amplitude offsets (constant and variable) across pulses in the pulse group.
- Apply noise on entire pulse, including Off time or just on the Pulse On time.
- Define frequency hopping.
- Provide S-parameter emulation of RF and baseband components.

# Documentation

In addition to this application Help system, the following documentation is available for the software.

All documentation is available on the Tektronix Web site (www.tek.com/manual/downloads ).

| To read about | Use these documents |
|---|---|
| Radar plug-in operation and user interface help | Access the plug-in application help from the plug-in Help menu for information on all controls and elements on screen.<br>The Radar plug-in help system is also available in PDF format located in the program's installation folder and also available on the Tektronix web site. |
| Radar plug-in programmer commands | Access the plug-in programmer manual for the syntax of remote commands specific to the plug-in.<br>This is available on the Tektronix web site. |
| SourceXpress operation and user interface help | Access the SourceXpress application help from the Help menu for information on all controls and elements on screen.<br>The SourceXpress help system is also available in PDF format, available on the Tektronix web site. |
| SourceXpress programmer commands | Access the SourceXpress programmer manual for the syntax of remote commands.<br>This document is available in PDF format located in the program's installation folder and also available on the Tektronix web site. |
| Connected instrument operation and user interface help (such as an AWG70000 series generator) | For operation and interface help of a connected instrument, refer to the instrument's documentation.<br>This is available with the instrument or on the Tektronix web site. |
| Connected instrument programmer commands (such as an AWG70000 series generator) | For programming information of a connected instrument, refer to the instrument's documentation. This is available with the instrument or on the Tektronix web site. |

# Support information

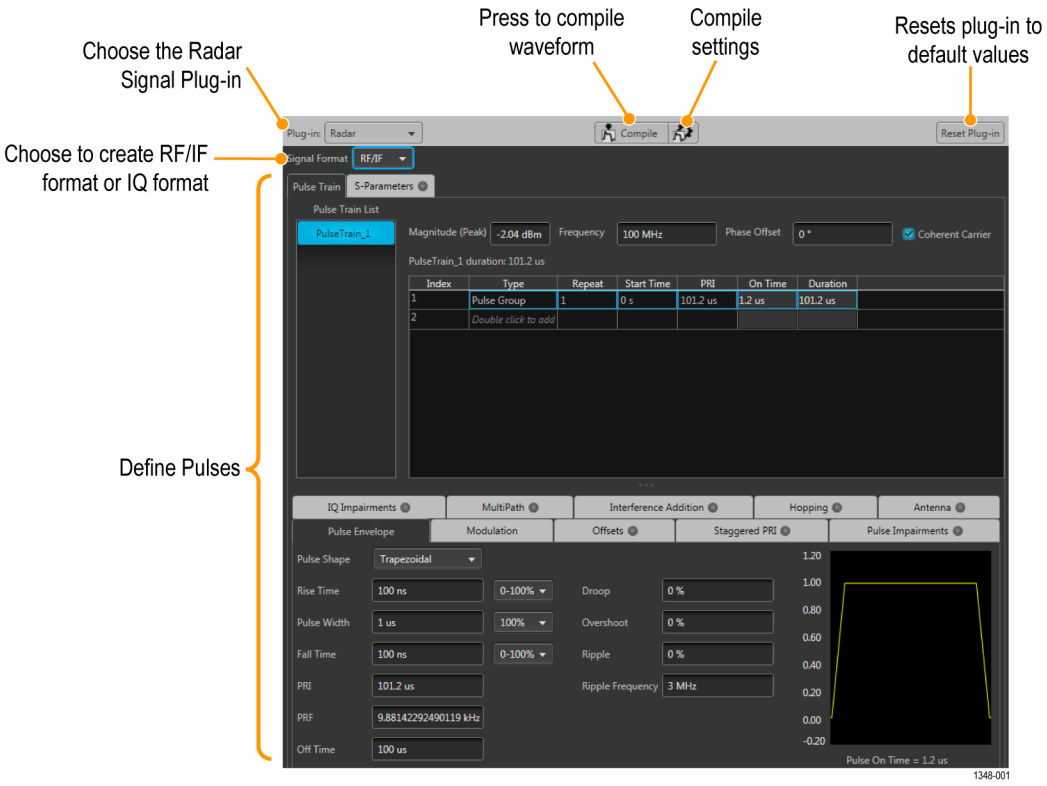
Tektronix offers the following services in support of their products:

- **Technical Support**. For application-related questions about a Tektronix product, contact us by telephone or email ).
- **Service Support**. For service-related questions about a Tektronix product, contact us by telephone or email ).

Tektronix also offers extended warranty and calibration programs as options on many products. Contact your local Tektronix distributor or sales office.

# Elements of the display

The main areas of the application window are shown in the following figure.




# Plug-in selection

Use the Plug-in pull-down menu to select the Radar plug-in application. The plug-in pull-down menu varies depending on the installed applications.

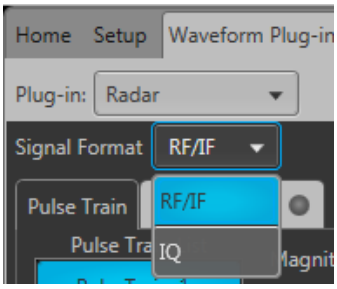
***NOTE.*** *Radar requires a license to create waveforms.*

*Refer to Licensing (see page 65).*

# Signal Format selection

The Radar plug-in supports generation of two signal types (RF/IF and IQ). This allows you to create baseband waveforms (complex signals with I and Q waveforms) and RF/IF waveforms (real signal waveforms).

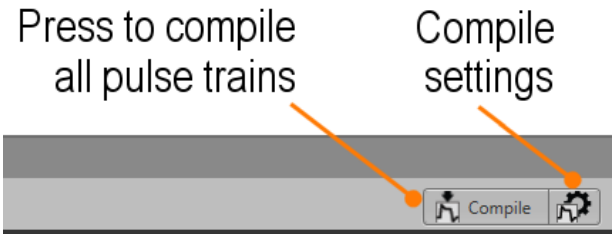
- Baseband signals (IQ format): When the IQ signal format is selected, two baseband waveforms I and Q are generated for each pulse train if the setting is to create a single waveform in the compile settings.
- RF signals (RF/IF format): When the RF signal format is selected, one waveform file is generated for each pulse train if the setting is to create a single waveform in the compile settings.




# Compile button

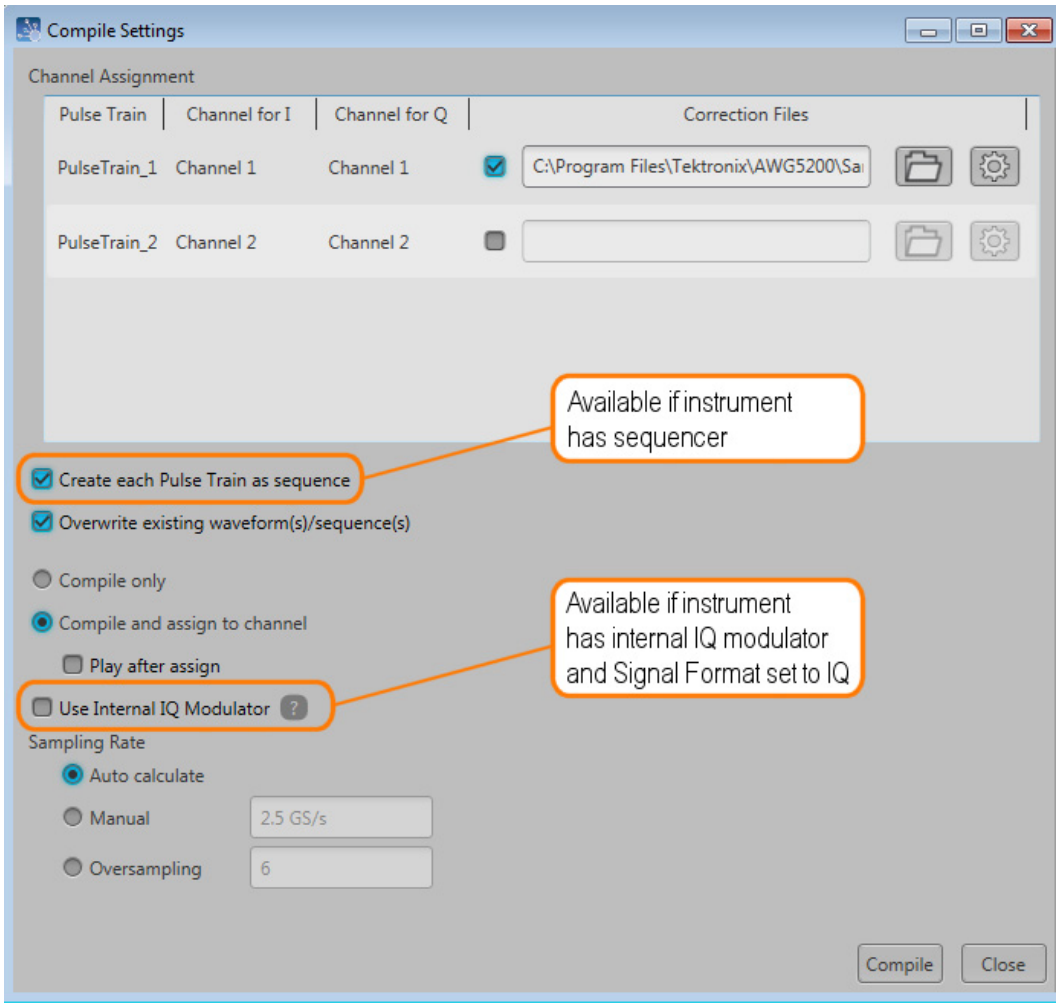
Use the Compile button to compile the currently active pulse train setup and place the pulse trains into the Waveforms list of the host application.

Use the Compile settings button to edit the compilation settings.

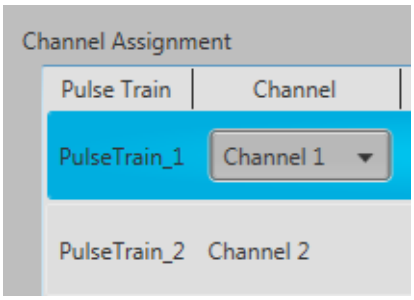
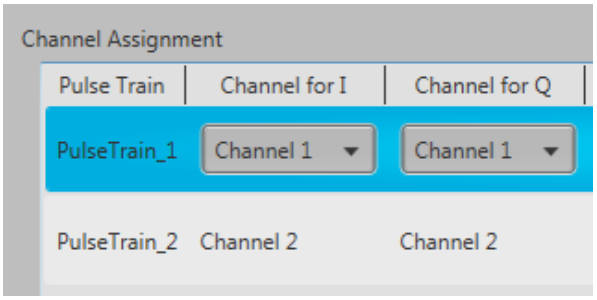
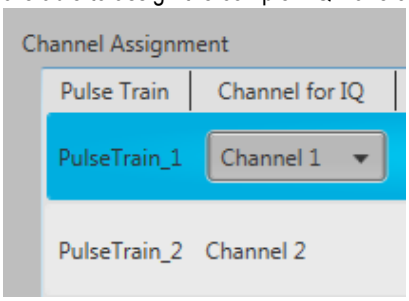


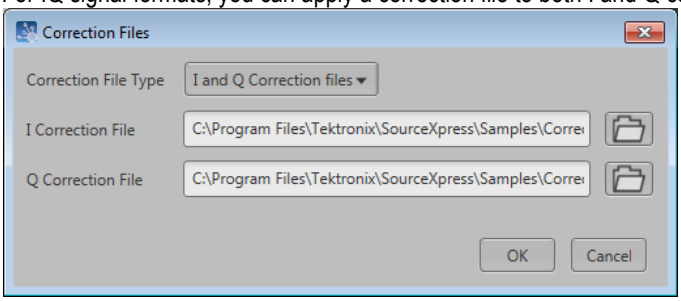
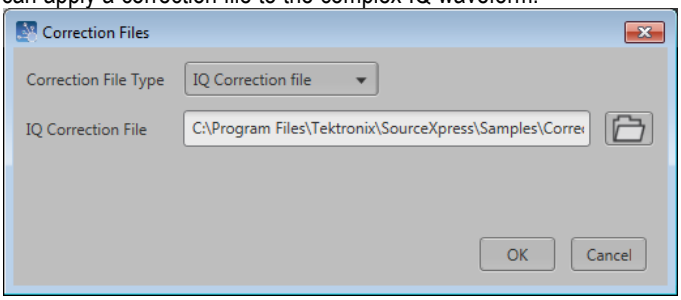

***NOTE.*** *When compiling, all pulse trains are compiled.*

## Compile settings




| Item | Description |
|---|---|
| Channel Assignment | The channel assignment area changes based on these factors:<br>■ Signal Format selection (RF/IF verses IQ).<br>■ Generator capabilities (IQ modulator to create IQ waveforms). |
| Pulse Train | The Pulse Trains listed are based on the trains created in the Pulse Train List. |

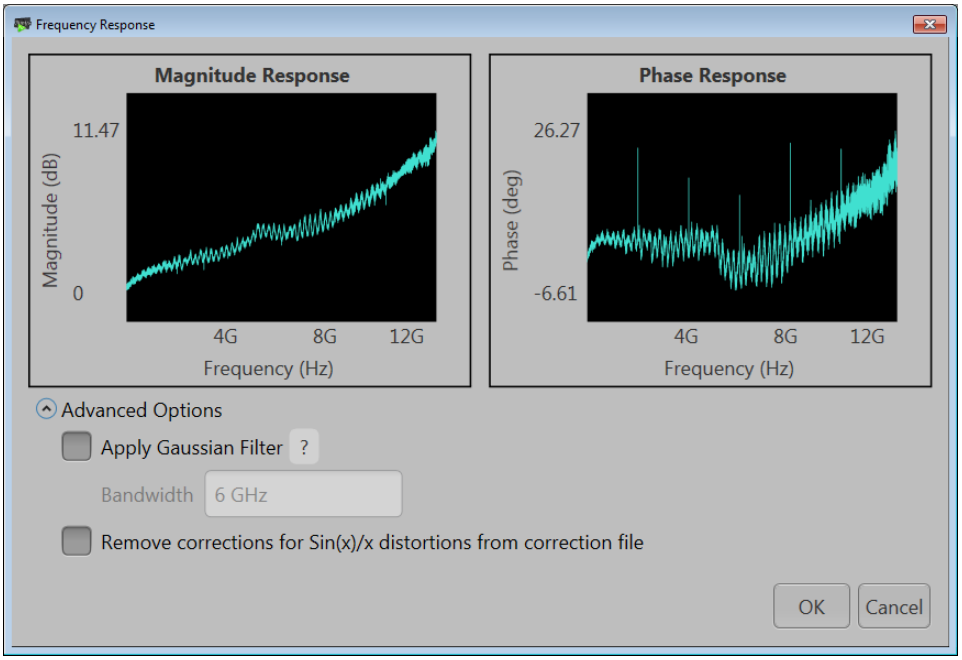
| Item | Description |
|---|---|
| RF channel assignment |  <br>Choose the channel to associate with the compiled RF waveform. The selected channel is also used to define the amplitude ranges. |
| I and Q channel assignment |  <br>Choose the channels to associate with the compiled I and Q waveforms. The selected channel is also used to define the amplitude ranges.<br>See the information about the “Use Internal IQ Modulator” selection. |
| IQ channel assignment | If the generator has IQ modulator capabilities (digital up converter) and is enabled, you are able to assign the complex IQ waveform to a channel.<br>  <br>Choose the channel to associate with the compiled IQ waveform. The selected channel is also used to define the amplitude ranges.<br>See the information about the “Use Internal IQ Modulator” selection. |

| Item | Description |
|---|---|
| Correction Files | Check the box to apply a correction file directly to the pulse train when compiling.<br>Use the browse folder icon to navigate to a saved correction file.<br>Once a valid file path is entered, the Correction Settings icon is enabled. Select to display the Frequency Response screen.<br>For RF signal formats, you apply a single correction file to the pulse train.<br>For IQ signal formats, you can apply a correction file to both I and Q components.<br>  <br>If the instrument has an internal IQ modulator, and it is selected to use during compile, you can apply a correction file to the complex IQ waveform.<br>  |
| Create each Pulse Train as sequence | If checked, each pulse train will be compiled as a sequence in addition to the waveforms.<br>If unchecked, each pulse train is created as one single waveform, which may take more memory to compile, depending on the settings.<br>This check box is not shown if the instrument does not have the sequence option. |
| Use Internal IQ Modulator | If checked, a complex IQ Waveform is created which can be used with the internal IQ modulator. Sampling Rate and interpolation rates will be calculated based on the Baseband parameters.<br>This setting is not shown if the generator does not have an internal IQ modulator. |
| Overwrite existing waveform(s)/sequence(s) | If checked, a pulse train with the same name (in the Pulse Train list) is overwritten with no warnings. |
| Compile only | The compiled pulse trains are entered into the Waveforms and Sequences lists. |
| Compile and assign to channel | The compiled pulse trains are automatically assigned to the selected channel.<br>The pulse trains are compiled and listed in the waveform and sequence lists depending on the state of the "Create each Pulse Train as sequence" setting. |
| Play after assign | If checked, the pulse trains start to play out immediately after compiling. |
| Sampling Rate | |
| Auto calculate | This is the default method to set the sampling rate. The application creates a sampling rate based on the settings chosen. |

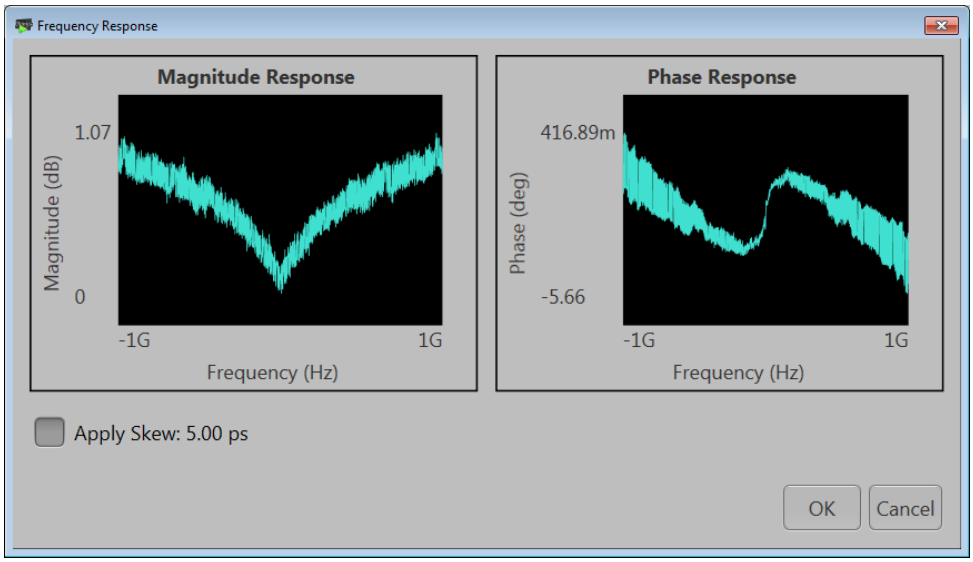
| Item | Description |
|---|---|
| Manual | Select to enter a specific sampling rate. |
| Compile | Compiles the pulse trains.<br>When compiling, all pulse trains in the Pulse Train list are compiled. |

### Correction file frequency response

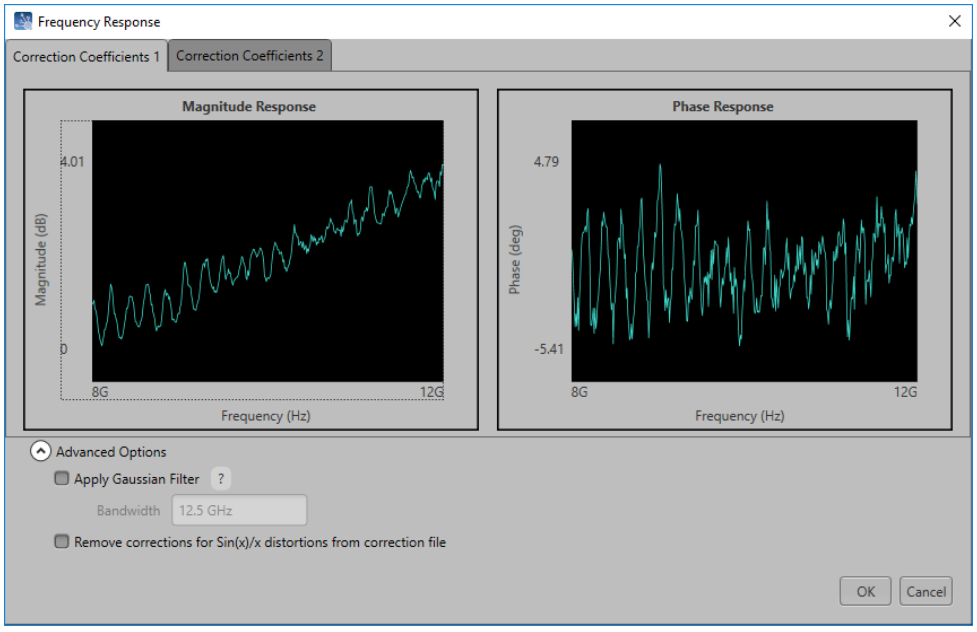
If applying an RF correction file, the Frequency Response screen shows plot information and provides Advanced options to apply a Gaussian filter or remove Sin(x)/x distortions.




If applying an I/Q correction file (to a pair of I and Q waveforms), the Frequency Response screen shows plot information and provides Advanced options to apply a skew.




When applying an I/Q correction file you can choose either a single IQ correction file or correction files for I and Q. The Frequency Response screen shows plot information and provides Advanced Options to apply a Gaussian filter or remove Sin(x)/x distortions. When selecting I and Q correction files, separate files for I and Q are shown in the Frequency Response window.



## Reset Plug-in button

Returns all plug-in settings to their default values.

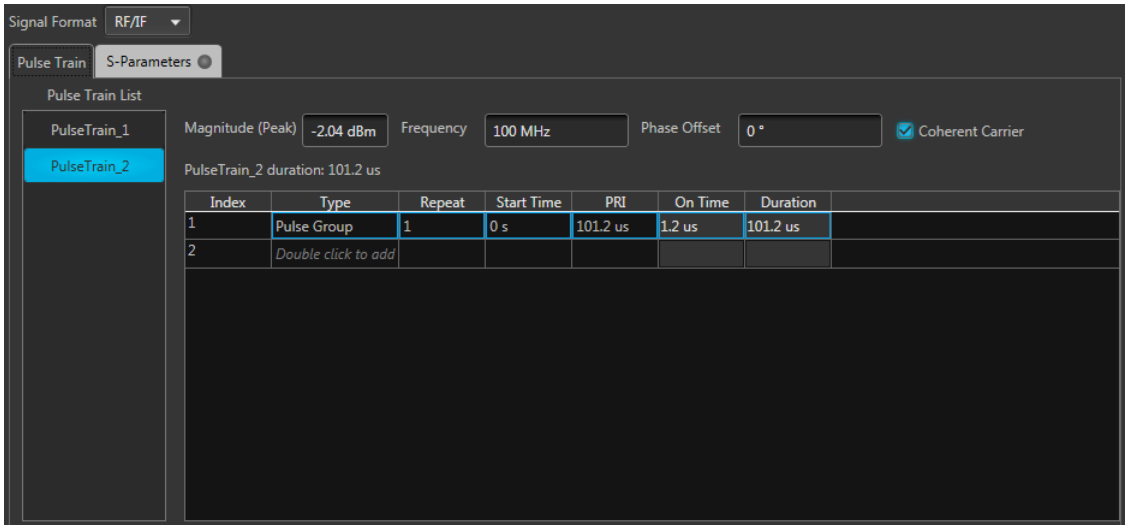
## Help button

This button is located at the top right of the display. Click on it to open the plug-in Help file, which provides information about the plug-in application.

# Pulse Train tab

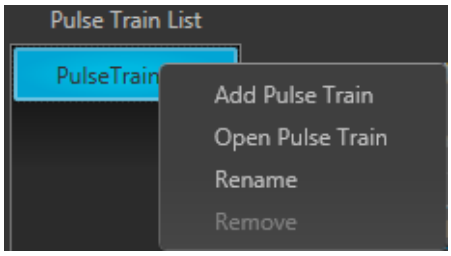
The Pulse Train tab provides all the basic parameters for each pulse train. As you highlight pulse trains in the Pulse Train List, the Pulse Train tab changes to match the highlighted pulse train.

***NOTE.*** *When adding a pulse train (with the Add Pulse Train menu option (see page 13)), the new pulse train is created with default settings. After the new pulse train is created, you can then change its associated parameters.*




# Pulse Train list and menu

Initially, the Radar plug-in contains one default pulse train in the Pulse Train List. Right-clicking on the Pulse Train in the Pulse Train List opens a menu with the following options:



- **Add Pulse Train**: Creates an additional pulse train. The new pulse train is placed at the bottom of the list of existing pulse trains. All features and parameters of the new pulse train are set to their default values.
- **Rename**: Allows you to rename the selected pulse train.
- **Remove**: Deletes the selected Pulse Train. (This menu item is not selectable if the selected pulse train is the only pulse train in the list.)
- **Open Pulse Train**: Allows you to select and open an existing .csv file and adds the new pulse train to the list. The .cvs file must meet the specific format described in the Open Pulse Train file format requirements (see page 14) topic.

The maximum number of pulse trains you can have in the table is 10. Each row in the list corresponds to one pulse train. Each Pulse Train can be compiled and assigned to a channel in Compile Settings.

Each pulse train has a basic set of adjustable parameters. When the Signal Format is set to RF/IF, they are Magnitude (Peak), Frequency, Phase Offset, and choice to create the carrier coherently or not. When the Signal Format is set to IQ, they are Amplitude, Baseband Offset, and Phase Offset.

Each Pulse Train has a corresponding Pulse Train Table that allows you to set up pulses and dead time.

### Open Pulse Train file format requirements

- The pulse train name will be autogenererated if you do not specify the name in the .csv file.
- A sample .csv file (pt10.csv) is attached to the PDF of this Help file, which can be downloaded from www.tek.com/manuals. This same sample .csv file is also provided with the software and can be found by navigating to the Samples directory of the product you are using. For instance, the default installation path for the AWG70000 series sample directory would be *C:\Program Files\Tektronix\AWG70000\Samples*.
- The value of header parameters not specified will be set to default on restore.
- The following header parameters are supported:
  - PulseShape
  - RiseTime
  - FallTime
  - PulseWidth
  - RiseTimeType
  - FallTimeType
  - Droop
  - Overshoot
  - Ripple
  - RippleFrequency
  - OffTime

- A valid csv file must have the following format:

  PULSE_TRAIN_NAME,<pulse_train_name>

  PULSE_HEADER_BEGIN

  PulseShape,RiseTime,FallTime,PulseWidth,RiseTimeType,FallTimeType,Droop,Overshoot,Ripple,RippleFrequency,OffTime

  PULSE_HEADER_END

  PULSE_ITEMS_BEGIN

  <pulse_Shape_1>,<rise_time_1>,<fall_Time_1>,<pulse_Width_1>,<rise_Time_Type1>,

  <fall_Time_1>,<droop_1>,<overShoot_1>,<ripple_1>,<ripple_Freuency_1>,<off_Time_1>

  <pulse_Shape2>,<<rise_time_2>,<fall_Time_2>,<pulse_Width_2>,<rise_Time_Type2>,

  <fall_Time_2>,<droop_2>,<overShoot_2>,<ripple_2>,<ripple_Freuency_2>,<off_Time_2>

  <pulse_Shape_3>,<rise_time_3>,<fall_Time_3>,<pulse_Width_3>,<rise_Time_Type3>,

  <fall_Time_3>,<droop_3>,<overShoot_3>,<ripple_3>,<ripple_Freuency_3>,<off_Time_3>

  .....

  .....

  .....

  <pulse_Shape_n>,<rise_time_n>,<fall_Time_n>,<pulse_Width_n>,<rise_Time_Typen>,

  <fall_Time_n>,<droop_n>,<overShoot_n>,<ripple_n>,<ripple_Freuency_n>,<off_Time_n>

  PULSE_ITEMS_END

- You do not need to specify a value for a particular parameter. For instance, the rise time (second parameter for Trapezoidal shape line 1) is not specified in the following example. The value is blank and is shown as a double comma (,,).

  PULSE_HEADER_BEGIN

  PulseShape,RiseTime,FallTime

  PULSE_HEADER_END

  PULSE_ITEMS_BEGIN

  RaisedCosine,120E-09,130E-09

  Trapezoidal,,110E-09

  Trapezoidal,140E-09,150E-09

PULSE_ITEMS_END

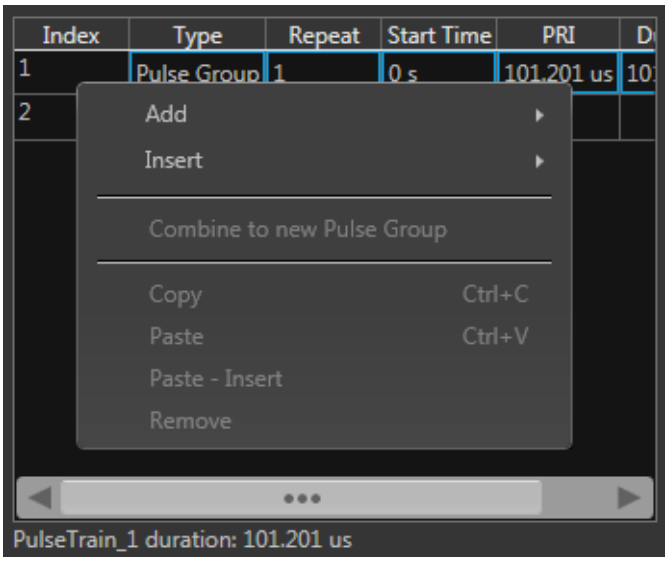
- An error will be reported if any of the following occur:
  - If you attempt to open a pulse train when the total number of pulse trains exceeds the maximum supported
  - If the .csv file contains more pulse definitions than the one supported in the configuration
  - If you set values that are not supported by that particular parameter
  - If you enter a header parameter that is not allowed
  - If a pulse train with a given name already exists

# Pulse train table

The Pulse Train table can have multiple Pulse Groups along with Dead Time. You can set the PRI, Start Time, and Repeat by double clicking in the cell related to that parameter in the table. Duration and On Time are read only. The Duration is calculated by Repeat * PRI. If the type is Dead Time, then only Duration is displayed.

## Menu operations

With any Pulse Group selected, a right-mouse click in the table displays a menu of operations.




| Item | Description |
|---|---|
| Add | Select to add either Pulse Group, Dead Time, or Combined Pulse Group to the table. |
| Insert | Select to insert either Pulse Group, Dead Time, or Combined Pulse Group at the selected index. |

| Item | Description |
|---|---|
| Combine to new pulse group | Select to combine the selected pulse groups to a new combined pulse group. This action super imposes multiple pulse groups and plays out simultaneously. |
| Copy | Copies the selected pulse group in preparation to paste into the Pulse Train table.<br>Pulse groups can only be selected in a contiguous manner. |
| Paste | Select the pulse group to replace with the copied pulse group.<br>If pasting multiple pulse groups, the selected pulse group is replaced and the remaining pulse groups are inserted below. |
| Paste-Insert | The copied pulse groups are inserted at the selected index. |
| Remove | The selected pulse groups are deleted.<br>You can also press Delete on the keyboard.<br>To select multiple pulse groups, left-mouse click on a pulse group, continue to hold the left-mouse button and slide the selection either up or down to highlight the pulse groups. You can also select multiple pulse groups by highlighting a pulse group, hold the Shift key, and scroll up or down to the next pulse group you want to select.<br>Pulse groups can only be selected in a contiguous manner. |

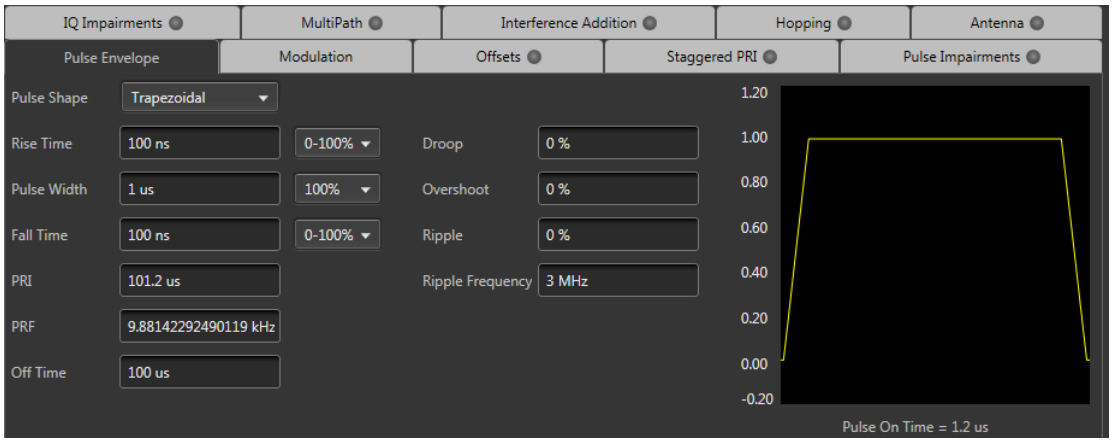
# Common parameters

The following tabs appear in the lower portion of the Pulse Train panel when a Pulse Group is selected in the table. These tabs include parameters specific to the selected pulse group of the selected pulse train.

| Item | Description |
|---|---|
| Pulse Envelope | The Pulse Envelope tab provides settings to define the pulse envelope. For details, refer to the following topic:<br>Pulse Envelope (see page 19) |
| Modulation | The Modulation tab provides settings for modulation type and related parameters. For details, refer to the following topics:<br>Modulation tab (see page 23)<br>Modulation settings (see page 23) |
| Offsets | Offsets for Amplitude, Frequency, and Phase.<br>For details, see the Offsets (see page 35) topic. |
| Staggered PRI | The Staggered PRI tab allows you to create multiple PRIs and define pulse-to-pulse staggering.<br>For details, see the Staggered PRI (see page 37) topic. |
| Pulse Impairments | The Pulse Impairments tab allows you to set the impairments for the selected pulse.<br>For details, see the Pulse Impairments (see page 41) topic. |
| IQ Impairments | The IQ Impairments tab allows you to set IQ impairments for the selected pulse.<br>For details, see the IQ Impairments (see page 43) topic. |
| MultiPath | The Multipath tab allows you to set mulitpath parameters for a signal.<br>For details, see the Multipath (see page 45) topic. |
| Interference Addition | The Interference Addition tab allows you to add Additive Noise to the signal.<br>For details, see the Interference Addition (see page 47) topic. |
| Hopping | The Hopping tab allows you to define the hopping pattern from pulse-to-pulse.<br>For details, see the Hopping (see page 49) topic. |
| Antenna | The Antenna tab allows you to apply Circular and Custom antenna beam pattern settings to the selected pulse group.<br>For details, see the Antenna (see page 53) topic. |

# Pulse Envelope tab

This tab has controls that define the envelope of a selected pulse group. Pulse Envelope parameters define the Pulse Shape, Rise Time, Pulse Width, Fall Time, and Off Time. When you select Dead Time, only Dead Time (Toff) is available.




***NOTE.*** *The available Pulse Envelope parameters will depend on the selected pulse shape. Not all parameters are available for a selected pulse shape.*

| Item | Description | Range, Default value |
|---|---|---|
| Pulse Shape | Select the pulse shape from the following: Rectangular, Trapezoidal, Raised Cosine, Exponential, Saw tooth, Gaussian, and Custom. | Trapezoidal |
| Rise Time | Enter the rise time for the pulse. Define the rise time between 0–100%, 10–90% or 20–80% of the voltage level. Available only for Trapezoidal, Raised Cosine, Exponential, and Saw Tooth pulse shapes. | The range depends on the instrument and options installed.<br>The default values will change based on the pulse shape. |
| Fall Time | Enter the fall time for the pulse. Define the fall time between 0–100%, 10–90% or 20–80% of the voltage level. Available for all pulse shapes except Saw Tooth, Gaussian, and Custom. | |
| Pulse Width | Enter the pulse width. Define the width at 50% or 100% voltage. Available for all pulse shapes except Saw Tooth and Custom. | |
| Off Time (dead time) | Enter the off time after the fall time. | |
| Sampling Rate | Available only when the pulse shape is Custom. Enter the sampling rate at which the custom pulse has been generated in KHz, MHz, GHz, or Hz. | |
| PRI | The Pulse Repetition Interval (PRI) value is automatically generated based on the pulse envelope parameters and is displayed as seconds. The PRI value is updated whenever the values of any of the pulse envelope parameters are changed.<br>Changing the PRI updates the off time without changing the other parameters of the pulse. | |
| PRF | The Pulse Repetition Frequency (PRF) is 1/PRI and the value is automatically generated based on the pulse envelope parameters.<br>The PRF value is updated whenever the values of any of the pulse envelope parameters are changed. | NA |
| Droop | Enter the droop in percentage of voltage.<br>Available for all pulse shapes except Saw Tooth, Gaussian, and Custom. | 0 to 50%, 0 |
| Overshoot | Enter the overshoot in percentage of voltage.<br>Available for all pulse shapes except Saw Tooth, Gaussian, and Custom. | 0 to 50%, 0 |
| Ripple | Enter the ripple in percentage of voltage.<br>Available for all pulse shapes except Saw Tooth, Gaussian, and Custom. | 0 to 50%, 0 |
| Ripple Frequency | Enter the ripple frequency in Hz, KHz, MHz, or GHz.<br>Available for all pulse shapes except Saw Tooth, Gaussian, and Custom. | Based on the instrument and the options installed, 3 MHz |

## Create a custom pulse

Selecting Custom from the pulse Shape menu allows you to define a custom pulse shape. The custom file must meet the following conditions:

- Input files are ASCII files (.txt) or MATLAB files (.mat).
- Only positive numbers are allowed. All other characters are invalid (including tab and space). The application stops reading data when it encounters invalid data.
- The maximum length of the file is 1M samples.
- In case of an ASCII file, the data should be in floating point and the values should be arranged in a single column and several rows with one value in each row.
- The variable name in the .mat file should be "SamplePoints". The .mat file should be saved with the v7.3 option.
- Here is an example of MATLAB command for saving a file: save('SamplePulseEnvelope.mat','SamplePoints', '-v7.3');
- A MATLAB file should contain a variable with ‘n’ sample points or values of the format 1 x n or n x 1. For example,

  SamplePoints = [ 0.5 0.3 0.2 0.7 ….]

# Modulation tab

The Modulation tab allows you to provide different modulation schemes that can be applied to the pulse width for a selected pulse. The available modulation schemes are shown in the following table. See the links in the following table to view detailed information about these modulation types. You can also view the Modulation Settings (see page 23) topic.

***NOTE.*** *The No Modulation setting is the same as continuous modulation. No Modulation is the default setting.*

| Modulation category | Modulation type |
|---|---|
| No modulation | |
| Frequency | Linear frequency modulation (LFM) |
| | Chirp Sequence |
| | Up-Down Chirp |
| | Piece-wise LFM |
| | Step Frequency |
| | User Defined Step FM AM |
| | Non Linear FM |
| Phase | Barker Code |
| | Frank Code |
| | Polyphase Codes |
| | P1 Polyphase Codes |
| | P2 Polyphase Codes |
| | P3 Polyphase Codes |
| | P4 Polyphase Codes |
| | User Defined Step PM AM |
| Digital Modulation | BPSK |
| | QPSK |
| Custom Modulation | You can select a custom pulse shape file from a directory. |

# Modulation settings

Linear Frequency Modulation (LFM)

In LFM or Chirp Modulation, the frequency is swept linearly across the pulse width. The sweep can be Low to High (upward) or High to Low (downward). LFM is used to achieve higher bandwidths in pulse compression RADARS.

**Table 1: Linear frequency modulation parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Sweep Range | Enter the sweep range in Hz, kHz, MHz, or GHz. | Range is dependent on the instrument, 10 MHz |
| Frequency Sweep | Enter the frequency sweep: High to Low, or Low to High. | Low to High |

### Chirp Sequence Modulation

Chirp Sequence modulation allows you to define multiple LFMs. This modulation is mainly used in automobile RADAR.

**Table 2: Chirp Sequence parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Sweep Range | Enter the sweep range in Hz, kHz, MHz, or GHz. | Range is dependent on the instrument, 10 MHz |
| Frequency Sweep | Enter the frequency sweep: High to Low, or Low to High. | Low to High |
| Number of chirps | Enter the number of chirps in the modulation. | 1 to 100, 4 |

### Up-Down Chirp Modulation

Up-Down Chirp modulation varies the frequency of the carrier from –Sweep Range/2 to +SweepRange/2 and then again from +Sweep Range/2 to –Sweep Range/2.

**Table 3: Up-down chirp modulation parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Sweep Range | Enter the sweep range in Hz, kHz, MHz, or GHz. | Range is dependent on the instrument, 10 MHz |
| Number of Up-Downs | Enter the number of peaks (ups) and troughs (downs) in the modulation.<br>If the number of Up-downs = 1, then the pulse width is divided into two. The first half of the pulse will have linear chirp from –Sweep/2 to +Sweep/2 and the second half of the pulse will have linear chirp from +Sweep/2 to –Sweep/2.<br>If the number of Up-downs is greater than 1 (n>1), then the modulation shall create multiple (n) number of 'V's or Inverted 'V's. The subpulse width of each V is equal to PulseWidth/n. | 1 to 12, 1 |
| Invert | Check the box to create Down-Up chirp, which creates a 'V' shaped frequency profile.<br>When unchecked, an inverted 'V' shaped frequency profile is created. | Unchecked |

### Piecewise LFM Modulation

Piecewise LFM modulation allows you to define LFM for each subpulse.

**Table 4: Piecewise LFM parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Initial Offset | Enter the initial offset in Hz, kHz, MHz, or GHz. | Range is dependent on the instrument, 10 MHz |
| Add steps button | Enter the number of steps to add and then click the Add button. The added step(s) will appear in the table.<br>If there are no entries in the table and the Add button is clicked, then the duration of each sub pulse = pulse width / number of steps. | 1 to 10, 1 |
| Table settings: | | |
| Duration (s) | Enter the duration of the subpulse width in s. | Cannot be greater than the pulse On Time |
| Duration (%) | Automatically calculated based on the pulse width and the duration of the subpulse. | N/A |
| Sweep Range | Enter the sweep range in Hz, kHz, MHz, or GHz. | Range is dependent on the instrument, 10 MHz |
| Frequency Sweep | Enter the frequency sweep: High to Low, or Low to High. | Low to High |

## Step Frequency Modulation

Step Frequency modulation allows you to divide the pulse width to equal subpulses and to assign different frequencies to each subpulse.

**Table 5: Step Frequency parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Step Count | Enter the number of steps. | 1 to 200, 4 |
| Initial Offset | Enter the initial offset in Hz, kHz, MHz, or GHz. | Range is dependent on the instrument, 10 MHz |
| Frequency Offset | Enter the frequency offset in Hz, kHz, MHz, or GHz. | Range is dependent on the instrument, 10 MHz |
| Ramp Function | Select Linear or Cosine to set how the transition from one subpulse to another occurs. | Linear |
| Ramp Duration (%) | Enter the desired ramp duration. | Up to 100%, 0% |

## User-defined Step FM AM Modulation

User Defined Step FM AM modulation allows you to define the number of subpulses and to set frequency offset and amplitude values for each subpulse.

**Table 6: User-defined Step FM AM parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Ramp Function | Select Linear or Cosine to set how the transition from one subpulse to another occurs. | Linear |
| Ramp Duration | Enter the desired ramp duration (%). | Up to 100%, 0% |

| Selection | Description | Range, default value |
|---|---|---|
| Add steps button | Enter the number of steps to add and then click the Add button. The added step(s) will appear in the table.<br>If there are no entries in the table and the Add button is clicked, then the duration of each sub pulse = pulse width / number of steps. | 1 to 10, 1 |
| Table settings: | | |
| Duration (s) | Enter the duration of the subpulse width in s. | Cannot be greater than the pulse On Time |
| Duration (%) | Automatically calculated based on the pulse On Time and the duration of the subpulse. | N/A |
| Frequency Offset | Enter the frequency offset in Hz for the subpulse. | Range is dependent on the instrument, 10 MHz |
| Amplitude (dB) | Enter the amplitude in dB for the subpulse. | -100 dB to 0 dB, 0 dB |

***NOTE.*** *Duration in percentage is calculated automatically up to three decimal places. This can cause rounding of the actual duration entered.*

Nonlinear Frequency Modulation

Nonlinear FM can be used to define a frequency modulation that can have a nonlinear profile, unlike with Linear FM.

**Nonlinear FM uses the coefficients to create the instantaneous frequencies for modulation.** F(t) = 2*pi*C(t)*t, where C(t) is the instantaneous frequency

Instantaneous frequency C(t) can be defined by the following polynomial:

C(t) = c0+c1*t+c2*t*t +c3*t*t*t..., where c0, c1, and c2 and others are the coefficients with order 0, 1, 2, and others.

Curves can be defined/drawn (curve fitting) with polynomials. In the following, $a_n$ and $a_0$ are the coefficients.

$$Y(t) = a_n * x^n + a_{n-1} * x^{n-1} + a_{n-2} * x^{n-2} + ....+ a_0$$

The equation is based on what the you want to fit. Examples are available in Radar books for different types of nonlinear profiles.

**Nonlinear FM profiles.** When Nonlinear FM is the chosen Modulation, you can select from the following three profiles. When one of the Taylor Weighted profiles is selected, a control for Bandwidth is also available. When User Defined Coefficients is selected, click on the folder icon that appears to provide a file path.

- Taylor Weighted Non symmetrical (default)
- Taylor Weighted Symmetrical
- User Defined Coefficients

Taylor Weighted Nonlinear FM signals are created using the following equation:

$$f(t) = BW\left(\frac{t}{PW} + \sum_{n=1}^{7} K_n \sin\frac{2\pi nt}{PW}\right)$$

Where

BW = bandwidth

PW = pulse on time

$K_1$ = –0.1145

$K_2$ = 0.0396

$K_3$ = –0.0202

$K_4$ = 0.0118

$K_5$ = 0.0082

$K_6$ = 0.0055

$K_7$ = –0.0040

**User defined coefficients file requirements.** A User defined coefficients file must meet the following conditions:

- Input files are ASCII files (.txt) or MATLAB (.mat).
- The maximum length of the file is 100 coefficients.
- When ASCII file is chosen, the data should be in floating point format and the values should be arranged in a single column and several rows with one value in each row.
- The variable name in the .mat file should be "NLFMCoefficients". The .mat file should be saved with the v7.3 option.
- Here is an example of MATLAB command for saving a file: save('Coefficients.mat','NLFMCoefficients', '-v7.3');
- A MATLAB file should contain a variable with ‘n’ coefficients or values of the format 1 x n or n x 1. For example,

  NLFMCoefficients = [ 0.5 0.3 0.2 0.7 ….]

Barker Code

With the Barker Code (a bi-phase coded pulse), the phase is switched between 0 and 180 degrees. The number of subpulses is defined by the Barker Code number. For example, Barker 11 has eleven subpulses. The Barker codes are predefined.

**Table 7: Barker code parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Code Length | Enter the length of the Barker code. The options are: 2, 3, 4, 5, 7, 11, and 13. | 2 |

Frank Code

Frank Code is a type of Polyphase code where the pulse width is divided into subpulses and the phase of the subpulse is changed.

The phase value for each subpulse changes based on the following formula, where subpulse = Code Length * Code Length and p=0, 1, 2,…..code length–1 and q=0, 1, 2…code length–1.

Phase(p,q) = 2*pi*p*q/Code length

**Table 8: Frank code parameter**

| Selection | Description | Range, default value |
|---|---|---|
| Code Length | Enter the length of the code. | 1 to 10, 1 |

Polyphase Codes

Polyphase codes are a type of phase-coded pulse waveform.

**Table 9: Polyphase codes parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Number of Steps | Enter the number of phase entries. | 1 to 200, 4 |
| Initial Offset | Enter the initial offset in degrees. | –180° to +180°, 45° |
| Phase Offset | Enter the phase offset in degrees. | –180° to +180°, 90° |
| Ramp Function | Select Linear or Cosine to set how the transition from one subpulse to another occurs. | Linear |
| Ramp Duration | Enter the desired ramp duration (%). | Up to 100%, 0% |

P1 Polyphase Code

P1 Polyphase code is a type of Polyphase code.

**Table 10: P1 polyphase code parameter**

| Selection | Description | Range, default value |
|---|---|---|
| Code Length | Enter the length of the code. | 1 to 10, 1 |

The phase for each of the subpulses is derived as follows:

Phase(p,q) = –180/Codelength*(Codelength–(2*p–1))*[(p–1)*Codelength)+(q–1))]; where p=1, 2…code length and q=1, 2, …code length

Where:

Number of subpulses = Codelength * Codelength

P2 Polyphase Code

P2 Polyphase code is a type of Polyphase code.

**Table 11: P2 polyphase code parameter**

| Selection | Description | Range, default value |
|---|---|---|
| Code Length | Enter the length of the code. | 1 to 10, 1 |

The phase for each of the subpulses is derived as follows:

Phase(p,q)=[((90/Codelength )*((Codelength –1)/ Codelength))–((180/ Codelength)*(p–1))]*[ Codelength+1–(2*q)] ; where p=1, 2, … code length and q=1, 2, .. code length

Where:

Number of subpulses = Codelength * Codelength

P3 Polyphase Code

P3 Polyphase code is a type of Polyphase code.

**Table 12: P3 polyphase code parameter**

| Selection | Description | Range, default value |
|---|---|---|
| Code Length | Enter the length of the code. | 1 to 100, 1 |

The phase for each of the subpulses is derived as follows:

Phase(p)=(180*(p–1)*(p-1))/ code length; where p=1, 2, …..Codelength

Where:

Number of subpulses = Codelength

P4 Polyphase Code

P4 Polyphase code is a type of Polyphase code.

**Table 13: P4 polyphase code parameter**

| Selection | Description | Range, default value |
|---|---|---|
| Code Length | Enter the length of the code. | 1 to 100, 1 |

The phase for each of the subpulses is derived as follows:

Phase(p)=[180*(p–1)2/ code length]–[180*(p–1)]

Where:

Number of subpulses = Codelength

User Defined Step PM AM

User Defined Step PM AM allows you to define the number of subpulses and phase and amplitude values for each subpulse.

**Table 14: User-defined step PM AM parameters**

| Selection | Description | Range, default value |
|---|---|---|
| Ramp Function | Select Linear or Cosine to set how the transition from one subpulse to another occurs. | Linear |
| Ramp Duration | Enter the desired ramp duration (%). | Up to 100%, 0% |
| Add step button | Enter the number of steps to add and then click the Add button. The added step(s) will appear in the table.<br>If there are no entries in the table and the Add button is clicked, then the duration of each sub pulse = pulse width / number of steps. | 1 to 10, 1 |
| Duration (s) | Enter the duration of the subpulse width. | Cannot be greater than the pulse On Time |
| Duration (%) | Automatically calculated based on the pulse On Time and the duration of the subpulse. | N/A |
| Phase Offset (deg) | Enter the phase offset in degrees for the subpulse. | –180° to +180°, 90° |
| Amplitude (dB) | Enter the amplitude in dB for the subpulse. | -60 dB to 0 dB, 0 dB |

***NOTE.*** *Duration in percentage is calculated automatically up to three decimal places. This can cause rounding of the actual duration entered.*

BPSK and QPSK Modulation

Enter the number of symbols for the pulse. Check the option “Use same symbols for all pulses” to have the same number of symbols for all the pulses in the pulse group.

| Item | Description |
|---|---|
| Modulation | Select BPSK or QPSK. |
| Number of Symbols | Enter the number of symbols in the pulse.<br>Range: 1 to 200<br>Default: 4 |
| Use same symbols for all pulses | Check (enable) to use the same number of symbols for all the pulses in the modulation. This option is available only when the Repeat parameter (in the Pulse Train table for the selected Pulse Group) is greater than 1.<br>Default: Unchecked |
| **Data** | |
| Pattern | Select the data source: |
| All Zero | Sends a sequence of binary 0 symbols. |
| All One | Sends a sequence of binary 1 symbols. |

| | |
|---|---|
| **Data** | |
| PRBS | Select the PRBS type from the following: 7, 9, 15, 16, 20, 21, 23, 29, 31, and User Defined.<br>To edit the bit sequence, select User Defined. This displays the PRBS Editor icon  . Select to display the PRBS Editor (see page 33) dialog screen. |
| Pattern | Enter a pattern of 0s and 1s up to a maximum of 80 digits in the text field that appears. |
| File | Select the base data file to be used by entering the path or browsing to the file. The supported formats are .txt. |
| **Filter** | |
| Filter | Select the filter from the following options: Rectangular, Raised Cosine, and Root Raised Cosine. |
| Alpha | Specify a value for the alpha factor.<br>Range: 0 to 1<br>Default: 0.35 |
| Pre/Post Pattern | Set the bit pattern for the initial (pre) and final (post) values of the filter. Select Wrap Around, Zeros, or Pattern. |

Custom Modulation

Custom modulation allows you to specify a custom pulse modulation using an external file of the MATLAB format or .txt format. This file should contain Time versus Phase values in the specified format. Phase values should be in degrees.

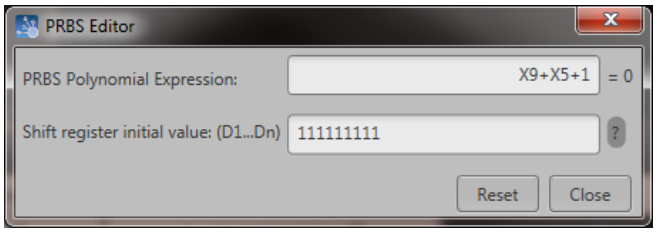
A custom modulation file must meet the following conditions:

- Input files are ASCII files (.txt) or MATLAB (.mat).
- Both positive and negative numbers are allowed. All other characters are invalid (including tab and space). The application stops reading data when it encounters invalid data.
- The maximum length of the file is 1M samples.
- When ASCII file is chosen, the data should be in floating point format and the values should be arranged in a single column and several rows with one value in each row.
- The variable name in the .mat file should be "CustomPhaseProfile". The .mat file should be saved with the v7.3 option.
- Here is an example of MATLAB command for saving a file: save('SamplePhaseProfile.mat','Custom-PhaseProfile', '-v7.3');
- A MATLAB file should contain a variable with ‘n’ phase points or values of the format 1 x n or n x 1. For example,

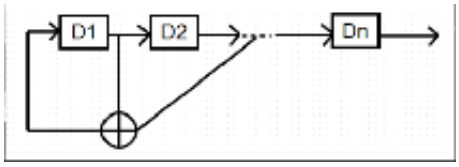
  CustomPhaseProfile = [ 0.5 0.3 0.2 0.7 ….]

# PRBS Editor

The Hopping tab and the Modulation tab both provide access to this dialog box when User Defined is selected as the PRBS Pattern. Clicking on the icon that appears next to the PRBS Pattern setting opens this dialog box.

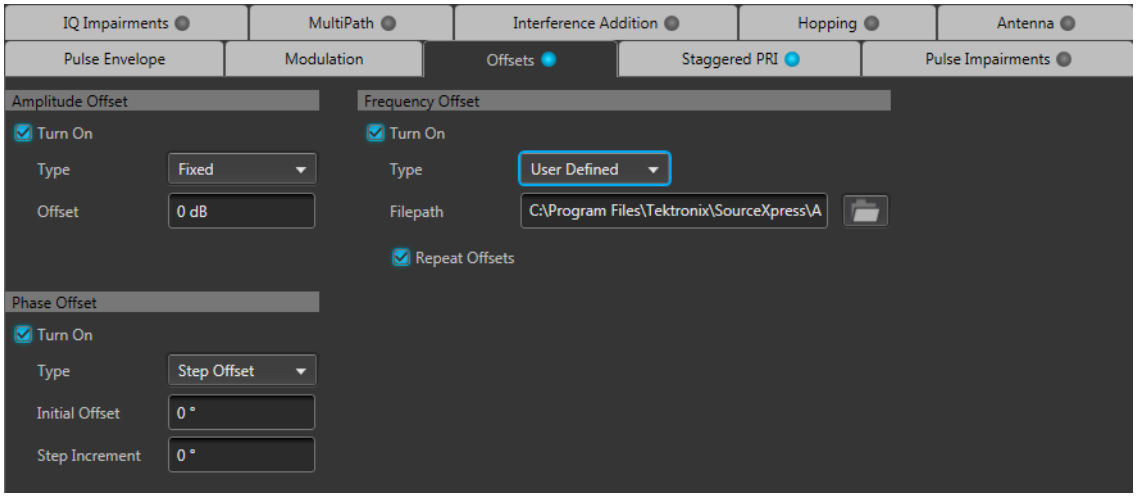



PRBS sequences are generated by a feedback shift register. The number (#) following PRBS indicates the length of the generating shift register. For instance, a shift register with 16 memory cells is required to generate a PRBS 16 sequence. The pseudo-random sequence of a PRBS generator is determined by the number of registers and the feedback.



# Offsets tab

This tab allows you to set Amplitude, Frequency, and Phase offset from pulse to pulse in the selected Pulse Group. Amplitude hopping can be used to create different swirling models. Frequency and Phase offsets can be used to create Frequency and Phase agile signals used in EW countermeasures.




| Item | Description |
|---|---|
| Turn On | Check a box to activate the associated offset. You can select Amplitude Offset, Phase Offset, and Frequency Offset. |
| Type | Choose Fixed, Step Offset, or User Defined as the offset type. |
| Offset | This setting is available when Fixed is the selected offset type.<br>Set the offset in Hz (for Frequency), dB (for Amplitude), or degrees (for Phase). Default setting is 0. |
| Initial Offset | This setting is available when Step Offset is the selected offset type.<br>Set the initial offset in Hz (for Frequency), dB (for Amplitude), or degrees (for phase). Default setting is 0. |
| Step Increment | This setting is available when Step Offset is the selected offset type.<br>The step increments sets the offset to the pulses in the pulse group if the repeat is more than 1.<br>Set the step increment in Hz (for Frequency), dB (for Amplitude), or degrees (for phase). Default setting is 0. |
| File Path | This setting is available when User Defined is the selected offset type.<br>Select a file to apply as frequency, phase, or amplitude offset. |
| Repeat Offsets | Check the box to repeat offsets. Default setting is unchecked (off).<br>If the Pulse Group has a greater repeat count than the offsets listed in the file, then checking this option repeats the offsets in the file for the rest of the pulses.<br>This selection only applies when User Defined is the selected offset type. |

### File format conditions

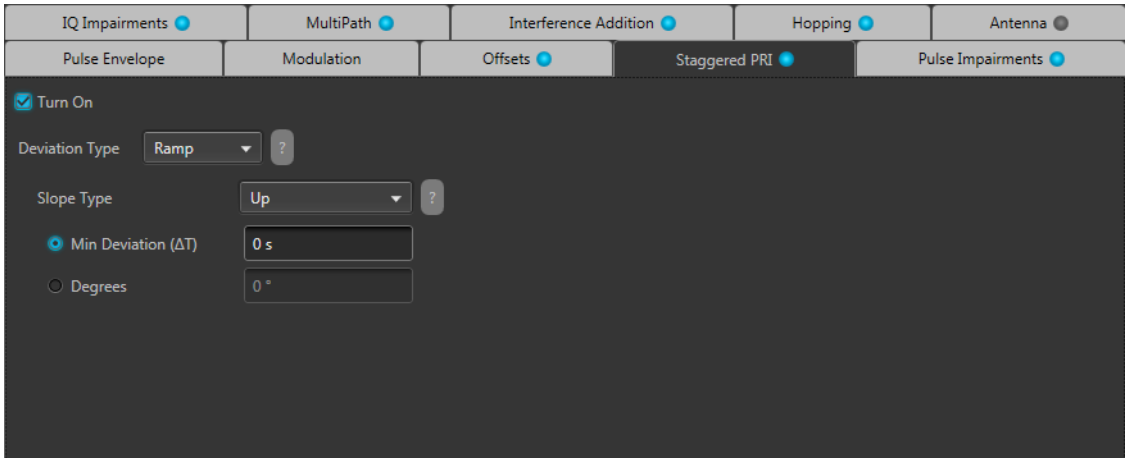
A deviation file must meet the following conditions:

- Input files are ASCII files (.txt) or MATLAB (.mat).
- Both positive and negative numbers are allowed. All other characters are invalid (including tab and space). The application stops reading data when it encounters invalid data.
- The maximum length of the file is 1M samples.
- When ASCII file is chosen, the data should be in floating point format and the values should be arranged in a single column and several rows with one value in each row. The values are frequency values in Hz for Frequency Offset, in dB for Amplitude Offset, and in degrees for Phase Offset.
- The .mat file should be saved with the v7.3 option. The variable name in the .mat file should be:
  - "AmplitudeOffsets" for Amplitude Offset file.
  - "FrequencyOffsets" for Frequency Offset file.
  - "PhaseOffsets" for Phase Offset file.
- Here is an example of MATLAB command for saving a file: save('SampleOffsets.mat','Amplitude-Offsets', '-v7.3');
- A MATLAB file should contain a variable with ‘n’ sample points or values of the format 1 x n or n x 1. For example,

  PhaseOffsets = [ 0.5 0.3 0.2 0.7 ….]

# Staggered PRI tab

Use the Staggered PRI tab to create multiple PRIs and define pulse-to-pulse staggering.




Follow these steps to specify multiple PRIs for a pulse group:

1. Check the Turn On box to enable and access parameter settings. Default setting is off (unchecked).
2. Set the following parameters for the selected pulse.

**Table 15: PRI/PRF parameters**

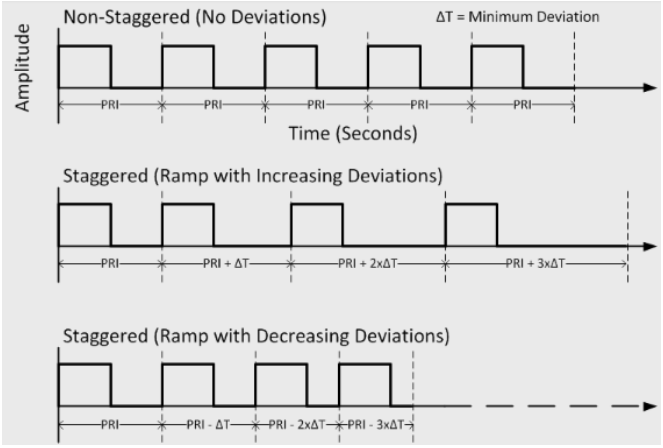
| Item | Description | Range, default value |
|---|---|---|
| Deviation Type | Select from Ramp, File, and Table. | Ramp |
| Ramp | Select the Slope type (Up, Down, Up Down, Down Up).<br>Default is Up.<br>The Ramp deviation type is:<br>  <br> | |

**Table 15: PRI/PRF parameters (cont.)**

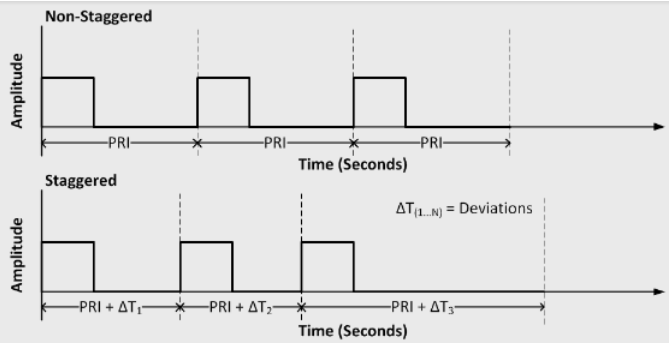
| Item | Description | Range, default value |
|---|---|---|
| File | Click the folder icon to select a file path to an ASCII file (.txt) or MATLAB (.mat) file format. Files must meet the conditions described in the File format conditions (see page 40) topic below.<br>The File deviation type is:<br>  <br> | |

**Table 15: PRI/PRF parameters (cont.)**

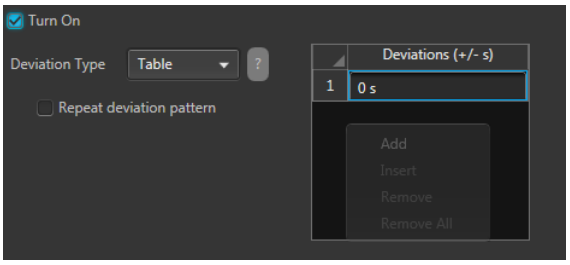
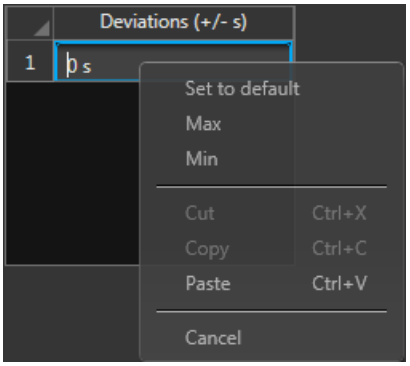
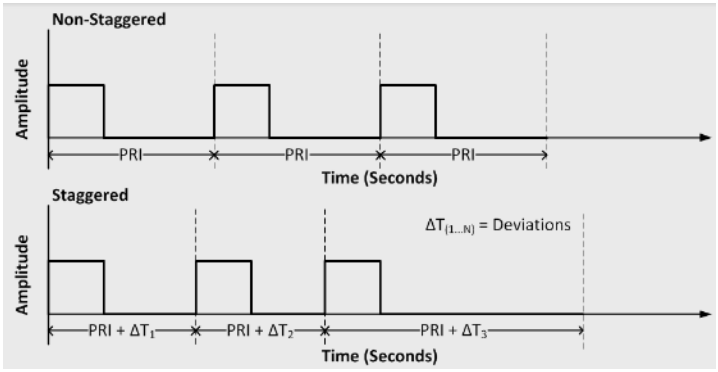
| Item | Description | Range, default value |
|---|---|---|
| Table | Enter the PRI deviation for each pulse group in the table.<br>Right-click on the blank area in the table to access the menu to add and remove items in the table.<br>  <br>Right-click on the deviation value cell access the menu to set deviation.<br>  <br>The table deviation type is:<br>  | |
| Slope Type (degrees)<br>(Available only when the Ramp is the selected deviation type.) | Enter the deviation slope in degrees or as the minimum deviation.<br>Slope = ΔT/PRI = tan(angle) = Peak Deviation/ (Repeat*PRI)<br>Peak Deviation = Repeat * ΔT | |
| Min Deviation (ΔT) | Deviation slope as the minimum deviation. | 0 to PRI, 0 s |

**Table 15: PRI/PRF parameters (cont.)**

| Item | Description | Range, default value |
|---|---|---|
| Degrees | Deviation slope in degrees. | –180° to +180°, 0° |
| Repeat deviation pattern<br>(Available only when File or Table is the selected deviation type.) | When checked, the application repeats the PRI deviation values for all the pulses. When unchecked, PRI deviation values are used for only those pulses and 0 is used for the number of deviations listed in the file. | Unchecked |

***NOTE.*** *If the Deviation Type is Ramp, the deviation ΔT is calculated as follows:*

*ΔT=(y*PRI*(i-1)), where y=tan(slope) in radians and i=1 to Repeat value*

3. If you have selected Table, right-click and select Add to add a row to the table. Edit the deviation values directly in the table. The number of rows in the table is limited to the value in the Repeat pulse envelope parameter

## File format conditions

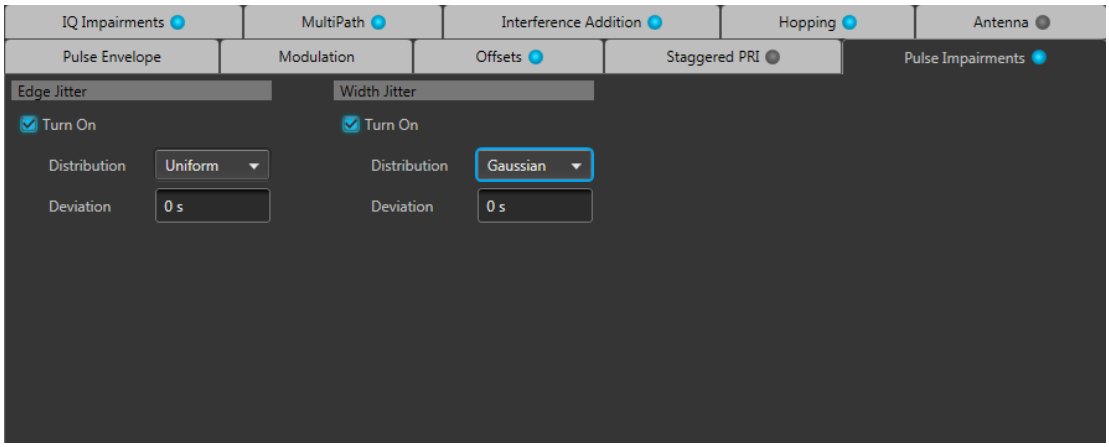
A staggered PRI deviation file must meet the following conditions:

- Input files are ASCII files (.txt) or MATLAB (.mat).
- Both positive and negative numbers are allowed. All other characters are invalid (including tab and space). The application stops reading data when it encounters invalid data.
- The maximum length of the file is 1M samples.
- When ASCII file is chosen, the data should be in floating point format and the values should be arranged in a single column and several rows with one value in each row.
- The variable name in the .mat file should be "StaggeredPRIDeviations". The .mat file should be saved with the v7.3 option.
- Here is an example of MATLAB command for saving a file: save('SamplePRIDeviations.mat','StaggeredPRIDeviations', '-v7.3');
- A MATLAB file should contain a variable with ‘n’ deviations or values of the format 1 x n or n x 1. For example,

  StaggeredPRIDeviations = [ 0.5 0.3 0.2 0.7 ….]

# Pulse Impairments tab

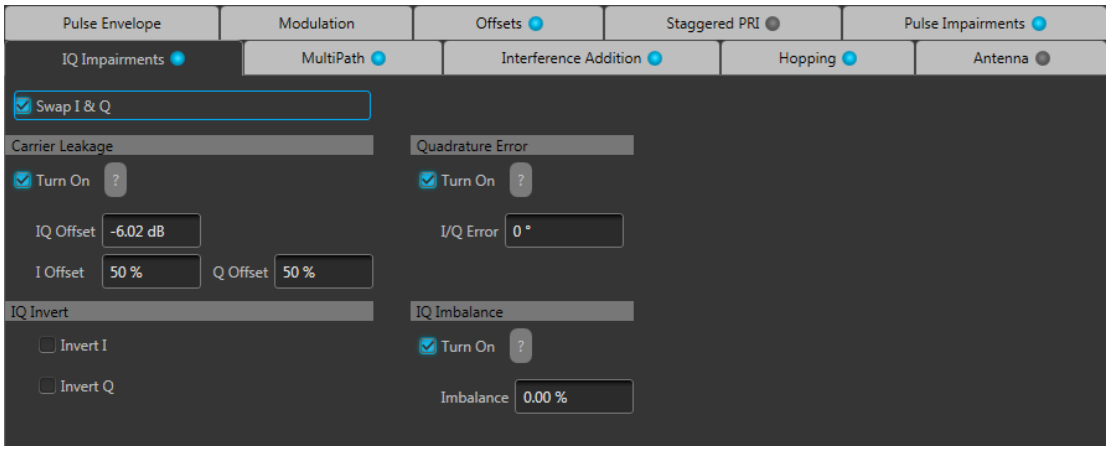
This tab allows you to set the impairments for the selected pulse.




| Item | Description |
|---|---|
| Turn On | Check box to add either Edge Jitter and/or Width Jitter to the carrier. |
| **Edge Jitter** | |
| Adds jitter to the PRI of the pulses. The pulse PRI is changed according to the user defined distribution. | |
| Distribution | Choose Gaussian or Uniform distribution of edge jitter to the selected Pulse Group. |
| Deviation | Adjust the deviation of the edge jitter in time. |
| **Width Jitter** | |
| Adds jitter to the Pulse On time of the Pulse Group. | |
| Distribution | Choose Gaussian or Uniform distribution of width jitter to the carrier. |
| Deviation | Adjust the deviation of the edge jitter in time. |

# IQ Impairments tab

This tab allows you to set IQ impairments for the selected pulse.

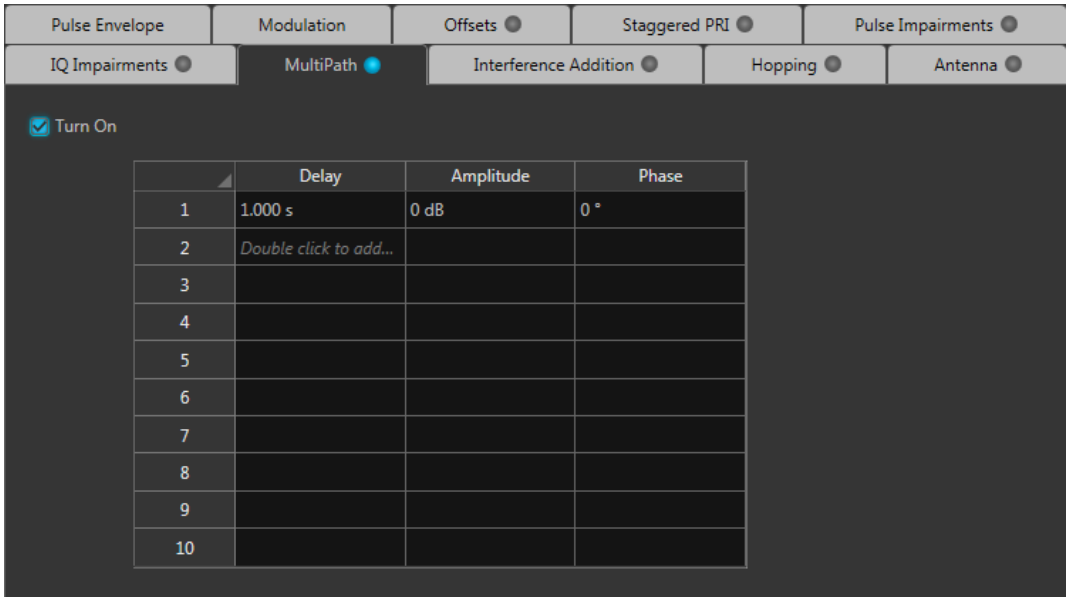



| Item | Description |
|---|---|
| Swap I & Q | Select to interchange I and Q signal outputs. |
| **Carrier Leakage** | |
| Turn on | Select to add carrier leakage (I and Q) impairments to the carrier. |
| IQ Offset | Adds equal offset to I and Q signals based on the dB value provided. |
| I Offset<br>Q Offset | Adjust the percentage of offset for I and Q based on the IQ Offset dB value. |
| **IQ Invert** | |
| Invert I | Select to invert the phase of the I signal. |
| Invert Q | Select to invert the phase of the Q signal. |
| **Quadrature Error** | |
| Turn on | Select to add quadrature error to the carrier. |
| I/Q Error | Enter the phase angle between the I and Q signals.<br>Range: –30° to +30°. |
| **IQ Imbalance** | |
| Turn on | Select to add IQ imbalance to the carrier. |
| Imbalance | Enter the imbalance between the I and Q signals.<br>Range: –30% to 30% (–2.28 dB to 3.1 dB). |

# Multipath tab

Multipath simulates reflected signals which arrive with different delays.

This tab allows you to set mulitpath parameters for a signal as follows.




1. Check the Turn On box to enable and access parameter settings to define the paths. Default setting is off (unchecked).
2. Double click on any cell in a parameter column to add a row.
3. Edit or set the following parameters in the table.

**Table 16: Multipath parameters**

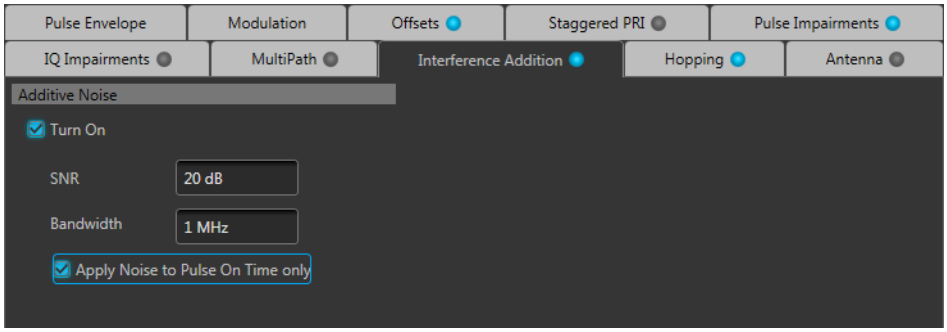
| Item | Description | Range, default value |
|---|---|---|
| Delay (s) | Enter the delay in seconds from the reference path. The delay can be positive or negative. The delay values cannot be repeated. | –1 to +1 s, 0 s |
| Amplitude (dB) | Enter the amplitude in dB from the reference path. The amplitude is always negative. | –100 to 0 dB, 0 dB |
| Phase (deg) | Enter the phase in degrees from the reference path. The phase can be positive or negative. | –180 to +180 degrees, 0 degrees |

4. Right click on any cell of any row to view a menu allowing you to Add, Remove, or Remove All rows.
   - **Add** adds a single row.
   - **Remove** removes the selected row.
   - **Remove All** clears the entire table.

A maximum of ten multipaths is allowed. No two paths can have the same delay value.

# Interference Addition tab

The Interference Addition tab allows you to add Additive Noise interference to the signal.



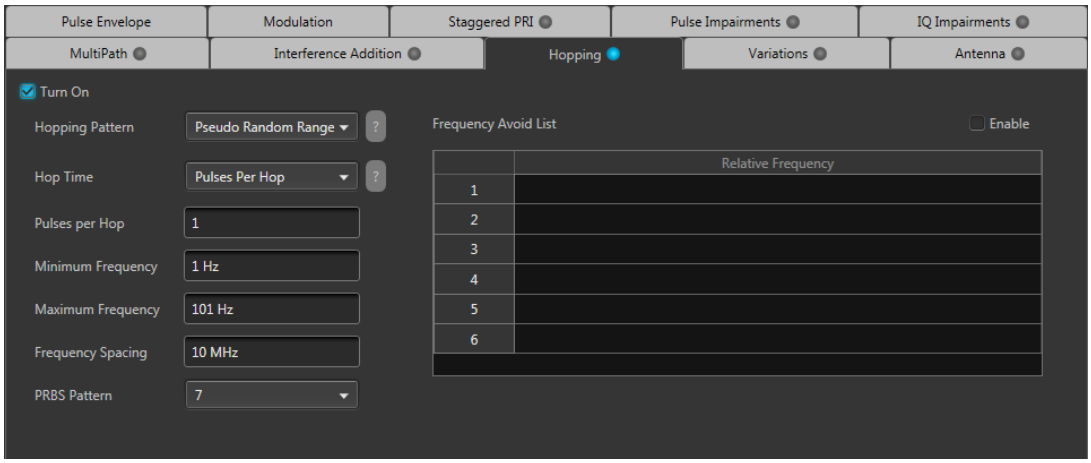

| Item | Description | Range, Default |
|---|---|---|
| Turn On | Check the box to simulate additive Gaussian noise. | N/A |
| SNR | Define the noise with Signal to Noise Ratio (SNR). | –80.00 dB to 80 dB, 20 dB |
| Bandwidth | Enter the bandwidth of the noise to be added. A rectangular filter of bandwidth is applied on the noise signal. | 1 Hz to the maximum supported by the active instrument, 10 MHz |
| Apply Noise to Pulse On Time only | Check the box to apply the noise to the On time only. When unchecked (off), the noise is applied to the on and Off time (the duration) of the pulse. | Unchecked (off) |

# Hopping tab

This tab allows you to define the hopping pattern from pulse-to-pulse. You can provide frequency offset and amplitude deviation.

Frequency hopping can used to create frequency agile waveforms. Frequency is changed from one pulse to another pulse. Frequency hopping is used in electronic counter measures by rapidly switching the frequency of the transmitted energy, and receiving only that frequency during the receiving time window.

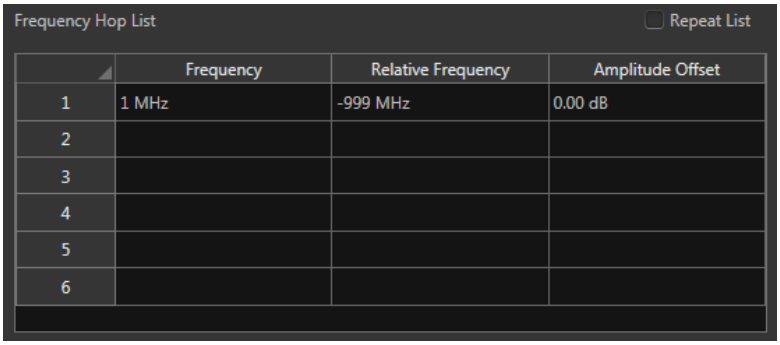
Amplitude hopping can be used to create different amplitudes from one pulse to another. Amplitude hopping can be used to create different swirling models.




| Item | Description |
|---|---|
| Hopping Pattern | Three hopping patterns are available.<br>Custom: Hops are based on the Frequency Hop List.<br>Pseudo Random List: Hops are chosen randomly (based on PRBS selection) from the Frequency Hop List.<br>Pseudo Random Range: Hops are chosen randomly (based on PRBS selection) from frequencies between a minimum and maximum frequency with a minimum frequency spacing. Frequencies included in the Frequency Avoid List will be skipped. |
| **Custom Hopping Pattern** | |
| Hop Time | Select the method to define the Hop Time<br>Pulses Per Hop<br>Pulse Start Index |
| Pulses Per Hop | Pulses per Hop determines how many Pulses occur between each Hop. The value applies to the entire hop list.<br>Range: 1 to 5000000. |

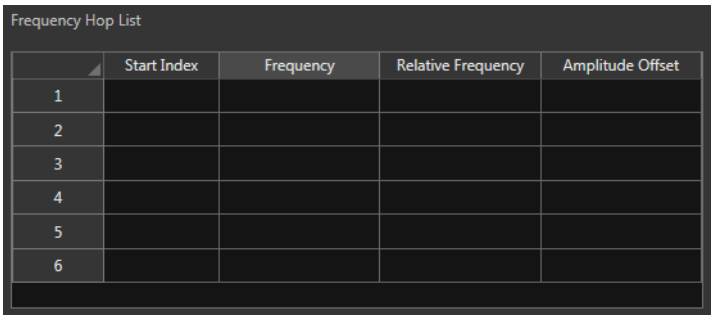
### Custom Hopping Pattern

Use the Frequency Hop List.




| | |
|---|---|
| Pulse Start Index | Defines the index the specific hop starts. Each hop must contain a unique start index. |

Use the Frequency Hop List. Each index indicates the pulse that needs to hop to the specified frequency.

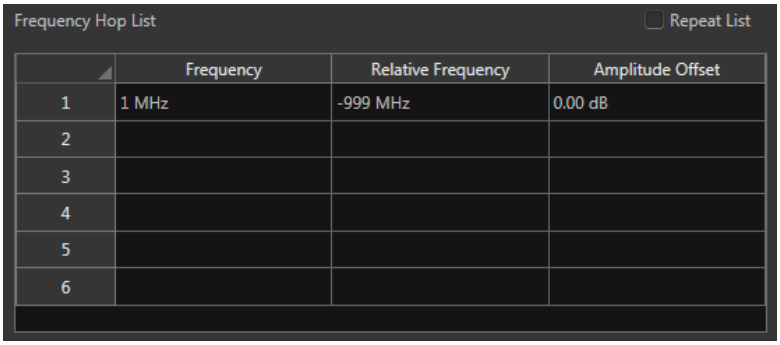



### Pseudo Random List Hopping Pattern

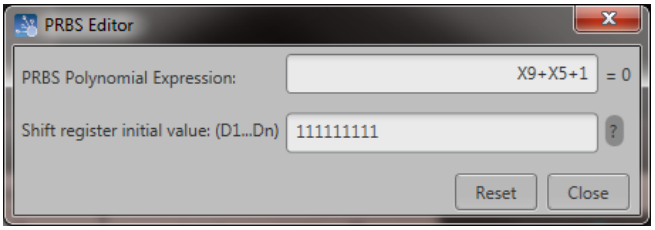
| | |
|---|---|
| Hop Time | Select the method to define the Hop Time<br>Pulses Per Hop |
| Pulses Per Hop | Pulses per Hop determines how many Pulses occur between each Hop. The value applies to the entire hop pattern.<br>Range: 1 to 5000000. |

### Pseudo Random List Hopping Pattern

Use the Frequency Hop List.




| | |
|---|---|
| PRBS Pattern | Select the PRBS pattern for hopping.<br>When User Defined is selected, a settings icon appears that allows you to open the PRBS Editor to enter a pattern. |

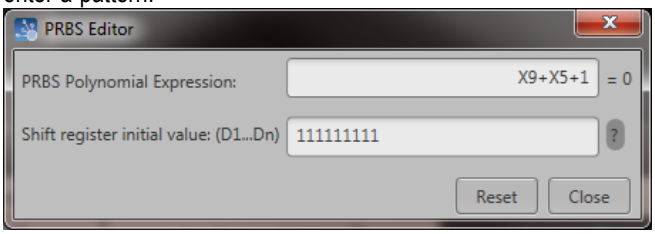
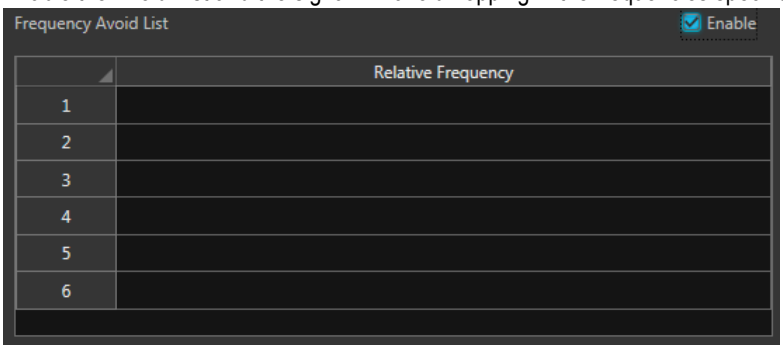



You can read more about the PRBS Editor in the PRBS Editor topic (see page 33).

### Pseudo Random Range Hopping Pattern

| | |
|---|---|
| Hop Time | Select the method to define the Hop Time<br>Pulses Per Hop |
| Pulses Per Hop | Pulses per Hop determines how many Pulses occur between each Hop. The value applies to the entire hop pattern.<br>Range: 1 to 5000000. |
| Minimum Frequency | Enter the frequency range within which to hop. Specify the start frequency for the range. |
| Maximum Frequency | Specify the end frequency for the range. |
| Frequency Spacing | Specify the minimum frequency intervals for hopping. The signal will hop avoiding the frequencies specified in the table in this interval or at multiples of this interval. |

### Pseudo Random Range Hopping Pattern

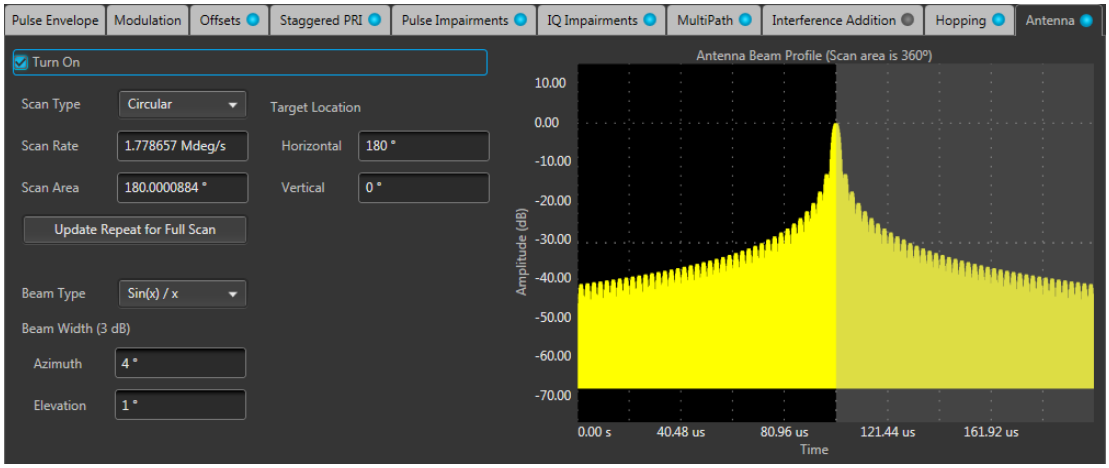
| | |
|---|---|
| PRBS Pattern | Select the PRBS pattern for hopping.<br>When User Defined is selected, a settings icon appears that allows you to open the PRBS Editor to enter a pattern.<br>  <br>You can read more about the PRBS Editor in the PRBS Editor topic (see page 33). |
| Frequency Avoid List | Enable the Avoid List and the signal will avoid hopping in the frequencies specified in the table.<br>  |

# Antenna tab

This tab allows you to apply Circular and Custom antenna scan types to the selected Pulse Group. The settings associated with each scan type are described below.

### Quick links:

- Antenna settings when Circular is the selected Scan Type (see page 53)
- Antenna settings when Custom is the selected Scan Type (see page 54)

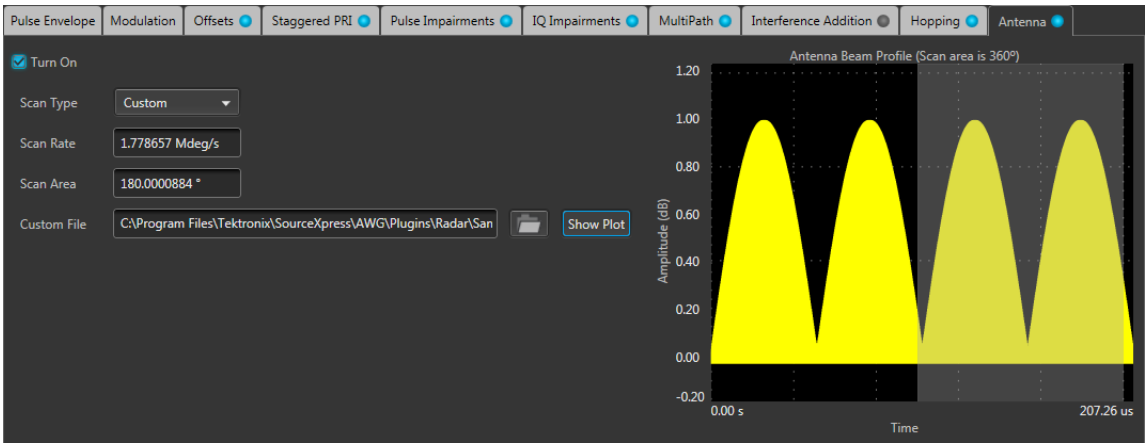



The above image shows settings for the Antenna tab when Circular is the selected Scan Type and Sinc (Sinx/x) is the Beam Type.

## Antenna settings when Circular is the selected Scan Type

| Item | Description |
|---|---|
| Turn On | Check box to apply antenna settings to the pulse train. |
| Scan Type | Choose Circular or Custom scan to apply. |
| Scan Rate | Enter the rate at which the scan takes place (degrees/second). |
| Scan Area | Enter the scanned area (degrees). |
| Target Location | Shows the following coordinates of the target. |
| Horizontal | Enter the horizontal location of the target (degrees). |
| Vertical | Enter the vertical location of the target (degrees). |
| Update Repeat for Full Scan | Click to update the pulse repeat count for one full scan. |
| Beam Type | Select from the following beam types:<br>Sin(x)/x<br>Gaussian |

| | |
|---|---|
| Beam Width (3 dB) | |
| Azimuth | Shows the compass direction of the antenna (azimuth). You can force the azimuth by entering a value.<br>Range: 0° to 360° |
| Elevation | Shows the elevation of the antenna in degrees. You can force the elevation by entering a value. |
| Show Plot | Displays the antenna beam profile on an Amplitude vs Time graph. |




The above image shows settings for the Antenna tab when Custom is the selected Scan Type and Show Plot is selected.

### Antenna settings when Custom is the selected Scan Type

| Item | Description |
|---|---|
| Turn On | Check box to apply antenna settings to the pulse train. |
| Scan Type | Choose Gaussian or Circular scan to apply to the pulse train. |
| Scan Rate | Enter the rate at which the scan takes place (degrees/second). |
| Scan Area | Enter the scanned area (degrees). |
| Custom File | Allows you to apply settings using a custom antenna scan file. See the File format conditions (see page 54) topic for details. |
| Show Plot | Displays the antenna beam profile on an Amplitude vs Time graph. |

### File format conditions

A custom antenna scan file must meet the following conditions:

- Input files are ASCII files (.txt) or MATLAB (.mat).
- Both positive and negative numbers are allowed. All other characters are invalid (including tab and space). The application stops reading data when it encounters invalid data.
- The maximum length of the file is 1M samples.

- When ASCII file is chosen, the data should be in floating point format and the values should be arranged in a single column and several rows with one value in each row.
- The variable name in the .mat file should be "Profile". The .mat file should be saved with the v7.3 option.
- Here is an example of MATLAB command for saving a file: save('Antenna.mat','Profile', '-v7.3');
- A MATLAB file should contain a variable with ‘n’ values of the format 1 x n or n x 1. For example,

  Profile = [ 0.5 0.3 0.2 0.7 ….]

# S-Parameter license

A license is required to use the S-Parameter feature.

S-Parameters is available when a license is detected by the application. With the license installed on the host PC where SourceXpress is installed, S-Parameters is available regardless of connecting to a virtual generator or a real instrument.

Refer to Licensing (see page 65) for information about obtaining a license file.

# S-Parameter tab

Enable S-Parameters to apply scattering parameters to the waveform. S-Parameters can be applied to the RF/IF waveform or to the I and Q data, depending on the selected Signal Format.

The S-Parameter parameters can be set independently to each pulse train or applied to all pulse trains.

## S-Parameter parameters

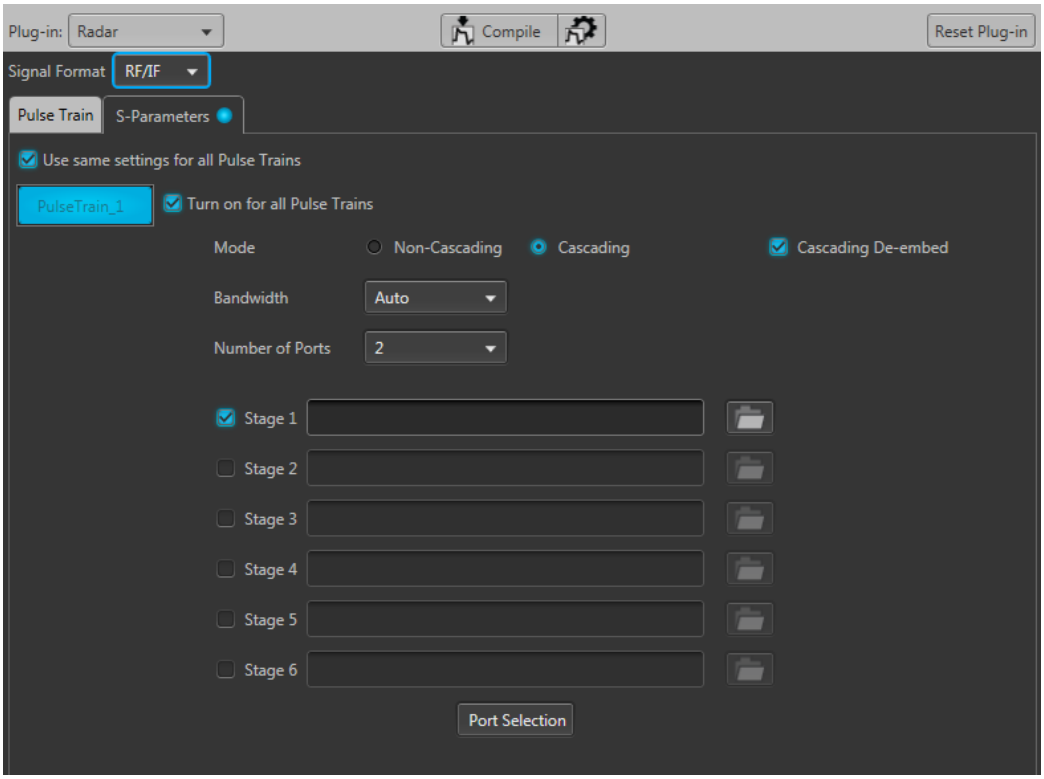
All S-Parameter features apply whether the Signal Format is set to RF/IF or IQ. The only exception is that an additional control is available for the IQ signal format to choose how the S-Parameters are applied to the I and Q components. They can be applied to the individual I and Q components or to the same S-Parameters can be applied to both I and Q.

For the IQ Signal Format, select to apply unique S-Parameters to the individual I and Q components or apply the same S-Parameters to both I and Q.

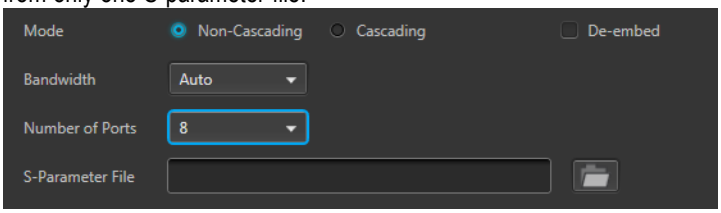
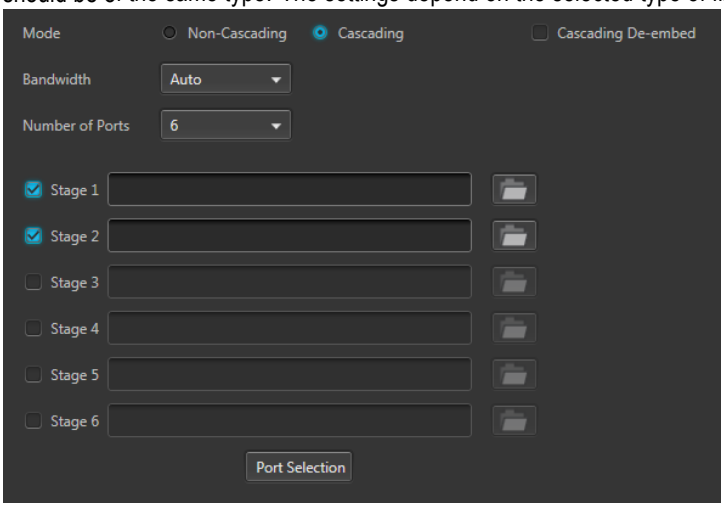
***CAUTION.*** *When selecting Couple Settings (I,Q), the Q parameters are instantly replaced with the I parameters.*

Below is a sample S-Parameter dialog screen with the Number of Ports set to 4. The dialog screen changes to accommodate the Number of Ports selected.

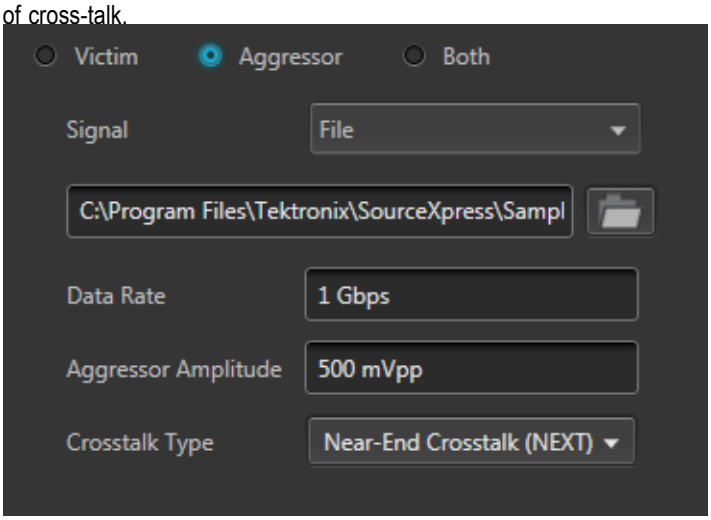
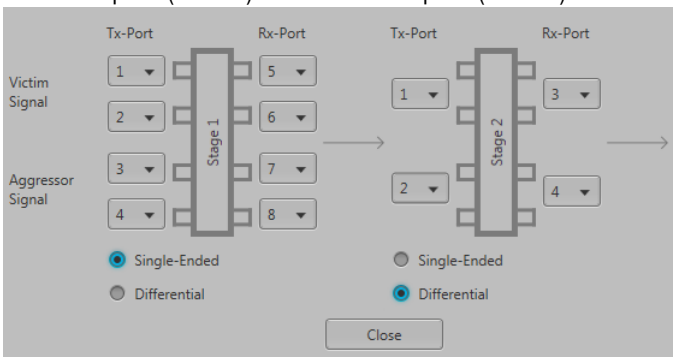
The information provided for S-Parameters applies to both the Non-Cascading and Cascading modes.




| Item | Description |
|---|---|
| Use same settings for all Pulse Trains | Check this box to apply the S-Parameter settings to all the pulse trains. The Pulse Train list is disabled when this box is checked. |
| S-Parameter settings for<br>(Only available when IQ is the selected Signal Format.) | Select I or Q to apply the S-Parameters to just that selection.<br>For example to apply unique parameters to I and Q, select I and set the parameters. Then select Q and set it's parameters. The application retains the settings for both I and Q.<br>  |
| Use same settings for I and Q<br>(Only available when IQ is the selected Signal Format.) | Check this box to apply the same S-Parameters to both I and Q.<br>***CAUTION.*** *When you select this setting, the Q parameters are instantly replaced with the I parameters.* |

| Item | Description |
|---|---|
| Mode | Select Non-Cascading or Cascading S-parameter mode.<br>In the Non-Cascading mode, you apply S-parameter characteristics on the signal from only one S-parameter file.<br>  <br>In the Cascading mode, you can cascade up to six S-parameter files in Stages and apply the characteristics on the signal. You can select the files to apply by turning on or turning off the corresponding Stages shown in the display. All the selected files should be of the same type. The settings depend on the selected type of file.<br>  <br>The files supported are s1p, s2p, s4p, s6p, s8p, and s12p. |
| De-embed<br>(Non-Cascading mode)<br>Cascading De-embed<br>(Cascading mode) | Check the box to invert the S-Parameters from the signal. This removes the effects of the component (for which the S-Parameters were created) from the signal path. |
| Bandwidth | Auto – The bandwidth is defined at the point where the signal rolls off to -60 dB. If this results in a bandwidth greater than the instrument supports, the bandwidth is set to ½ of the waveform's sample rate (i.e. Nyquist Frequency).<br>Full Bandwidth – The bandwidth is set to ½ of the waveform's sample rate (i.e. Nyquist Frequency).<br>Manual – The bandwidth can set by the user from 1 Hz to ½ of the maximum sample rate of the instrument. If the set Bandwidth is greater than the Nyquist (Sample rate of the waveform/2), then the software limits the bandwidth to ½ of the waveform's sample rate. A warning message is provided. |

| Item | Description |
|---|---|
| Number of Ports | Choose the number of ports. The port matrixes supported are 1, 2, 4, 6, 8, and 12.<br>The number of ports selected determines:<br>• The type of S-Parameter file to apply<br>• The Signaling Scheme choice<br>• The port matrixes available |
| S-Parameter File | Navigate to the Touchstone file to apply to the signal. The type of Touchstone files that you are able to open is dependent on the number of ports selected. For instance, only .s4p files can be opened if the Number of Ports is set to 4.<br>The files supported are s1p, s2p, s4p, s6p, s8p, and s12p. |
| Signaling Scheme<br>(Only for 4, 8, and 12 ports) | Single-Ended: If the data is single-ended, you must map the port numbers as used in the file to physical locations in your link.<br>Differential: If the data is differential, you must select the data layout in the file. |
| Selection of the port<br>(No port selection for 1 Port environments) | Use the diagrams to map the ports for the transmitter ports (Tx-Port) and the receiver ports (Rx-Port).<br>When choosing the number of Ports, you are presented with an active diagram of the ports. The diagram presented reflects the Number of Ports selected and the Signalling Scheme (if appropriate for the ports selected). |

| Item | Description |
|---|---|
| Victim<br>Aggressor and Both<br>(Only for 8 and 12 ports) | Victim: The default setting with no cross-talk effects.<br>Aggressor: Select this to activate aggressor signal parameters, adding the effect of cross-talk.<br>  |
| Port Selection | The Port Selection button is available only when in Cascading mode. Press the Port Selection button to display an active dialog screen to map the ports for the transmitter ports (Tx-Port) and the receiver ports (Rx-Port) for each stage.<br>  |

## S-Parameter file descriptions

### 1-port

Files with one port of data contain only one S-parameter file (s1p) so they do not require any further input.

### 2-port

Files with data for two ports contain four S-parameters as a 2x2 matrix. These are Touchstone 2-port files (s2p). A dialog box is created to define the 2-port mapping.

### 4-Port

Files with data for four ports contain 16 S-parameters as a 4x4 matrix. These are Touchstone 4-port files (s4p). They may contain single-ended or differential data. A dialog box is created to define the 4-port mapping for either single-ended or differential data.

- If the data is single-ended, you must map the port numbers as used in the file to physical locations in your link.

  You can select the port for both transmitter and receiver from the drop-down list. Each drop-down list has ports from 1 to 2.

- If the data is differential, you must select the data layout in the file.

### 6-port

Files with data for six ports contain 36 S-parameters as a 6x6 matrix. These are Touchstone 6-port files (s6p). A dialog box is created to define the 6-port mapping.

### 8-Port

Files with data for eight ports contain 64 S-parameters as an 8x8 matrix. These are Touchstone 8-port files (s8p). They may contain single-ended or differential data. A dialog box is created to define the 8-port mapping for either single-ended or differential data.

- If the data is single-ended, you must map the port numbers as used in the file to physical locations in your link.

  You can select the port for both transmitter and receiver from the drop-down list. Each drop-down list has ports from 1 to 4.

- If the data is differential, you must select the data layout in the file.

### 12-Port

Files with data for 12 ports contain 144 S-parameters as an 12x12 matrix. These are Touchstone 12-port files (s12p). They may contain single-ended or differential data. A dialog box is created to define the 12-port mapping for either single-ended or differential data.

- If the data is single-ended, you must map the port numbers as used in the file to physical locations in your link.

  You can select the port for both transmitter and receiver from the drop-down list. Each drop-down list has ports from 1 to 6.

- If the data is differential, you must select the data layout in the file.

## Aggressor signals

8 and 12 port S-parameters allows you to activate aggressor signal parameters and to add the effect of cross-talk. 12 port S-parameters allows 2 Aggressor signal parameters.

Aggressors can be added in either Non-Cascading Mode or Cascading Mode.

The Aggressor signal parameters include:

| Item | Description |
|---|---|
| Signal | Choose the type of aggressor signal with the dropdown list:<br>• Clock: Indicates that the aggressor signal is a clock pattern.<br>• PBRS: Also choose the number of bits<br>• File: Indicates that the aggressor signal is another pattern file. Navigate to the Pattern file<br>• Same as victim: The signal flow of the aggressor is same as the victim. |
| Data Rate | Specify the data rate (in bps) of the signal.<br>This is not available when the Aggressor signal is set to be the same as the victim. |
| Aggressor Amplitude | Enter the signal amplitude.<br>This is not available when the Aggressor signal is set to be the same as the victim. |
| Crosstalk Type | Choose the type of crosstalk of the aggressor signal.<br>• Near-End Crosstalk<br>• Far-End Crosstalk<br>• Both |

# Licensing

A license is required for this plug-in to become operational. The plug-in must be licensed for use with the host application from where you want to use the plug-in.

For example, to use the plug-in from SourceXpress, SourceXpress must have a license. To use the plug-in from an instrument, the instrument must have a license.

Refer to the application help (such as SourceXpress or the host instrument) for information about obtaining and installing license files.

# Index