SigIQPro

User Manual

EN01C

SIGLENT TECHNOLOGIES CO., LTD.

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SigIQPro Overview

The SigIQPro is a PC software for IQ waveform generation produced by SIGLENT, which can create rich IQ protocol signals with optimized performance. It supports Bluetooth, IOT, Custom OFDM, Custom IQ, 5G NR, LTE, WLAN and DFS Radar, meeting the requirements of the Internet of Things, short-range communications, wireless cellular communications, satellite communications and radar.

Supported protocols:

- Bluetooth BR/EDR (version: 5.0);
- Bluetooth Low Energy (version: 5.2);
- IEEE 802.15.4 O-QPSK BPSK(ZigBee) (version: IEEE Std 802.15.4 -2020);
- IEEE 802.15.4 SUN FSK (version: IEEE Std 802.15.4 -2020);
- IEEE 802.15.4 SUN OFDM (version: IEEE Std 802.15.4 -2020);
- ITU-T G.9959 (Z-WAVE) (version: IEEE Std 802.15.4 -2020);
- IEEE 802.15.4 HRP UWB (version: IEEE Std 802.15.4 -2024);
- Custom OFDM;
- Custom IQ;
- 5G NR (version: 3GPP TS38 V17.3.0);
- LTE TDD/FDD (version: 3GPP TS36 V17.3.0);
- WLAN_802_11a/b/g/n/ac (version: IEEE Std 802.11-2020);
- WLAN_802_11ax (version: IEEE Std 802.11ax-2021);
- WLAN_802_11be (version: IEEE P802.11be/D7.0-2024)。

Contents

1 Installation

To install the SiglQPro software, please do the following:

1. System Requirements;
2. Download and Install SiglQPro Software;
3. Equipment Setup and Connection;
4. Testing Connections.

1.1 System Requirements

To generate signals using SiglQPro software, you must have a properly configured PC and a properly configured instrument, as described below.

1.1.1 PC Requirements

- 200 GB HDD with 1 GB free disk space at runtime (2 GB or higher recommended)
- 1280 x 768 screen resolution
- Windows 7 or Windows 10
- 1 GHz or faster 64-bit processor
- 2 GB of memory minimum
- This software requires the installation of NI-VISA, which can be downloaded from http://www.ni.com/visa.

1.1.2 Hardware Requirements

You can download and play IQ waveforms generated by SiglQPro software through the following SIGLENT instruments.

- SSG5000X-V
- SDG7000A

Proper firmware and options will be required on above instruments.

Instruments	Requirements	
SSG5000X-V	Firmware:	Version V2.1.2.4.1 or later
	Required options:	SiglQPro -BT (support Bluetooth)
		SiglQPro -IOT(support IOT)
		SiglQPro -OFDM (support Custom OFDM)

SSG6082A-V	Firmware：	V1.0.0.7.2 及以上
	Required options：	SiglQPro -BT (support Bluetooth)
		SiglQPro -IOT(support IOT)
		SiglQPro -OFDM (support Custom OFDM)
		SiglQPro -5G NR
		SiglQPro -LTE FDD
		SiglQPro -LTE TDD
		SiglQPro -IEEE.802.11.ax
		SiglQPro -IEEE.802.11.be SiglQPro -IEEE.802.11.a/b/g/n/ac
SDG7000A	Firmware：	V1.1.1.33R1 及以上
	Required options：	SiglQPro -BT (support Bluetooth)
		SiglQPro -IOT(support IOT)
		SiglQPro -OFDM (support Custom OFDM)
		SiglQPro -5G NR
		SiglQPro -LTE FDD
		SiglQPro -LTE TDD
SDG8000A	Firmware：	V1.1.1.7R9 及以上
	Required options：	SiglQPro -BT (support Bluetooth)
		SiglQPro -IOT(support IOT)
		SiglQPro -OFDM (support Custom OFDM)
		SiglQPro -5G NR
		SiglQPro -LTE FDD
		SiglQPro -LTE TDD
		SiglQPro -IEEE.802.11.ax
		SiglQPro -IEEE.802.11.be
		SiglQPro -IEEE.802.11.a/b/g/n/ac

1.2 Download and Install SiglQPro Software

Please visit https://www.siglent.com/download/software/ to download and install.

1.3 Equipment Setup and Connection

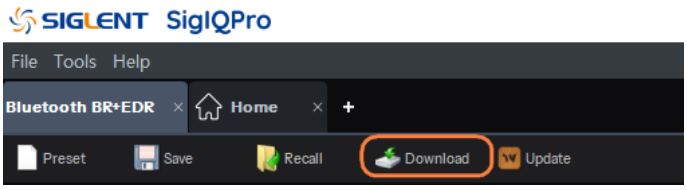
To connect to a Signal Generator, you should do the following:

1. Ensure the signal generator is turned on.
2. Connect the signal generator to the computer using one of the following methods for instrument control:
   - LAN Network -- connect both the signal generator and the computer to an external LAN network using standard LAN cables.
   - Crossover LAN -- connect the signal generator directly to the computer using a crossover LAN cable (You will need to configure your PC).
   - GPIB -- connect the signal generator directly to the computer using a GPIB cable.
   - USB -- connect the signal generator directly to the computer using a USB cable.

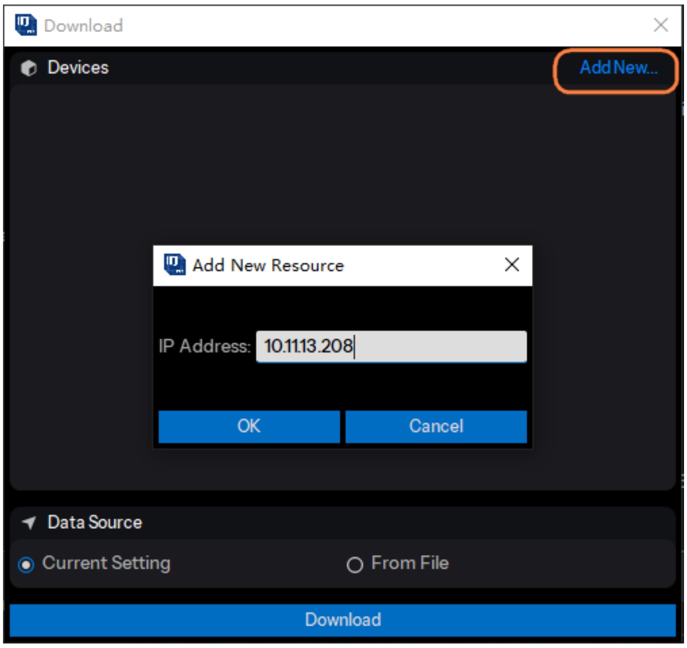
1.4 Testing Connections

Please follow below steps to test connections between the signal generator and the SiglQPro software.

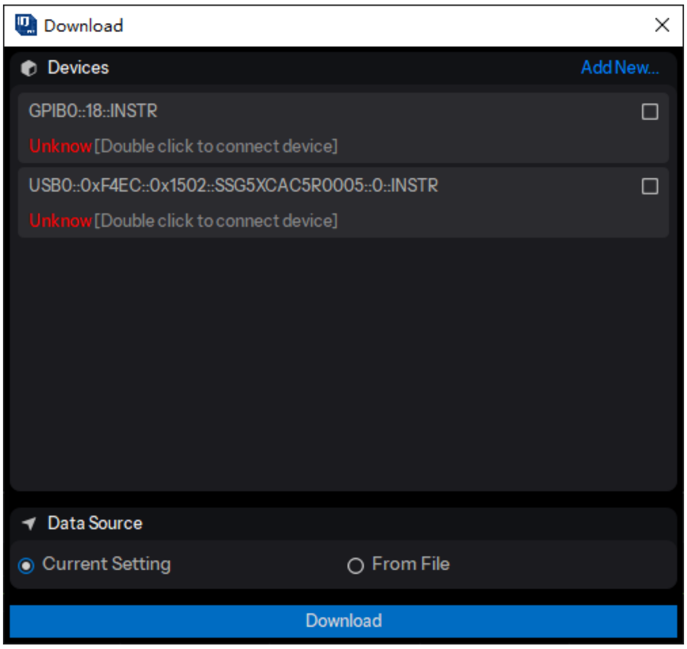
1. Turn on the signal generator and the computer.
2. Start the SiglQPro software.
3. Establish communications between the software and the instrument.
   1) Firstly, click the download button of the SiglQPro software, and then a download dialog will pop up.



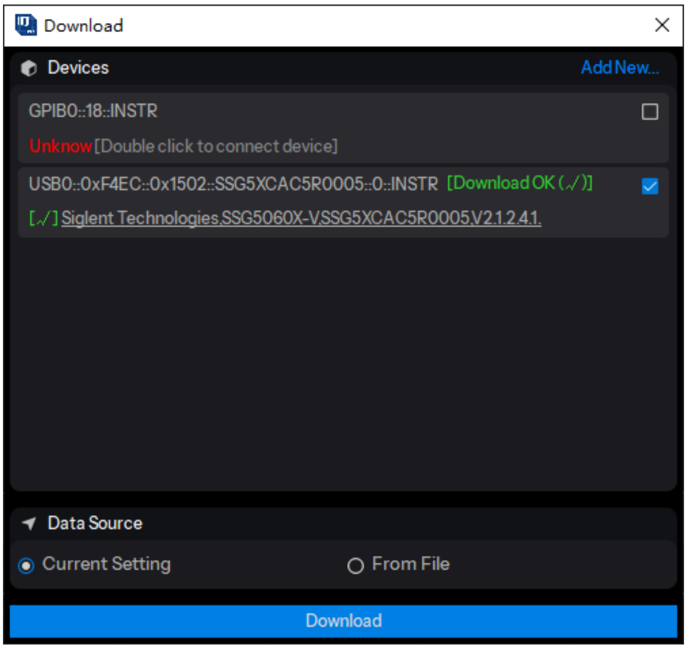
   2) If the signal generator is connected to the PC through LAN, click “Add New…” and enter the IP address of the signal generator to add new resource.



3) If the signal generator is connected to the PC through USB or GPIB, the resource name will be in the device list when the download dialog is opened. You can double-click the resource name to connect to the device.



4. Download a waveform to the signal generator. When the download is successful, it will prompt "Download OK".

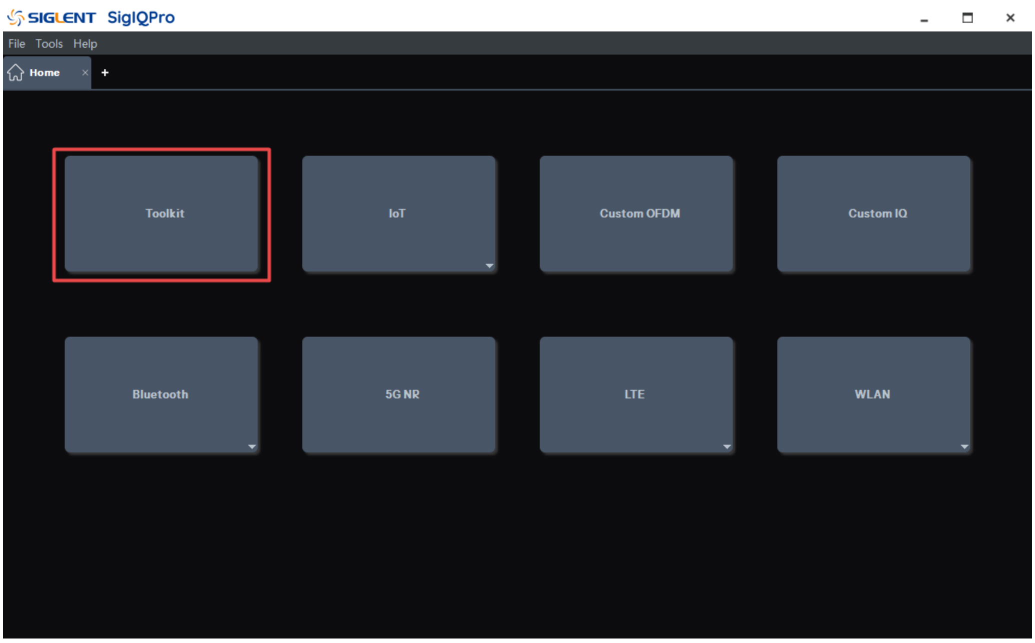

Download
Devices
Add New...
GPIB0::18::INSTR
Unknow [Double click to connect device]
USB0::0xF4EC::0x1502::SSG5XCAC5R0005::0::INSTR [Download OK (√)]
[√] Siglent Technologies,SSG5060X-V,SSG5XCAC5R0005,V2.1.2.4.1.
Data Source
Current Setting
From File
Download

2 Application Examples

2.1 Use Toolkit to Convert the File Format to ARB

The Toolkit can convert waveform files in specific formats, such as MAT files, TXT files, DAT files and CSV files, into ARB files that can be played by SIGLENT signal generators.

Click **Toolkit** on the homepage, or select **Tools** -> **Toolkit** in the menu bar, to enter the Toolkit setting interface.



2.1.1 Convert MAT Files

Step1. Selecting a waveform

1. In the Waveform Import area, select the file type as Mat-File 5 in the **Source File Type** field.
2. In the **Source File** field, click and select the original MAT file.
3. Select the correct **I Data** and **Q Data**.
4. Check if the number of waveform points is correct in the **Number of Points** field.
5. Set the **Sample Rate** of the waveform.

Step2. Set the parameters of the target file

1. In the Waveform Download area, set the name of the target file in the **Waveform Name** field.
2. Set the **Mirror Spectrum** state.
3. Set the **Oversampling Ratio** .

Step3. Update and download the target file

1. Click **Update** in the toolbar to generate the target file.
2. Click **Download** in the toolbar to download the target file to SIGLENT signal generator.

2.1.2 Convert ASCII Files

Step1. Selecting a waveform

1. In the Waveform Import area, select the file type as ASCII/CSV/DAT in the **Source File Type** field.
2. In the **Source File** field, click and select the original file. You can select TXT, CSV or DAT files.
3. If you want to use a separate file for Q data, you should set **Use Separate Q File** as "Yes", and then click and select the Q source file you want to import in the **Q Source File** field.
4. In the **Data Type** field, select the data type of the source file.
5. If the data type of the source file is Hexadecimal, you should select big or little endian for HEX data in the **Big / Little Endian** filed.
6. If the data type of the source file is Hexadecimal, you select signed or unsigned type for HEX data in the **Signed / Unsigned Number** field.
7. Set swap IQ flag in the **Swap IQ** field.
8. Check if the number of waveform points is correct in the **Number of Points** field.
9. Set the **Sample Rate** of the waveform.

Step2. Set the parameters of the target file

1. In the Waveform Download area, set the name of the target file in the **Waveform Name** field.
2. Set the **Mirror Spectrum** state.
3. Set the **Oversampling Ratio**.

Step3. Update and download the target file

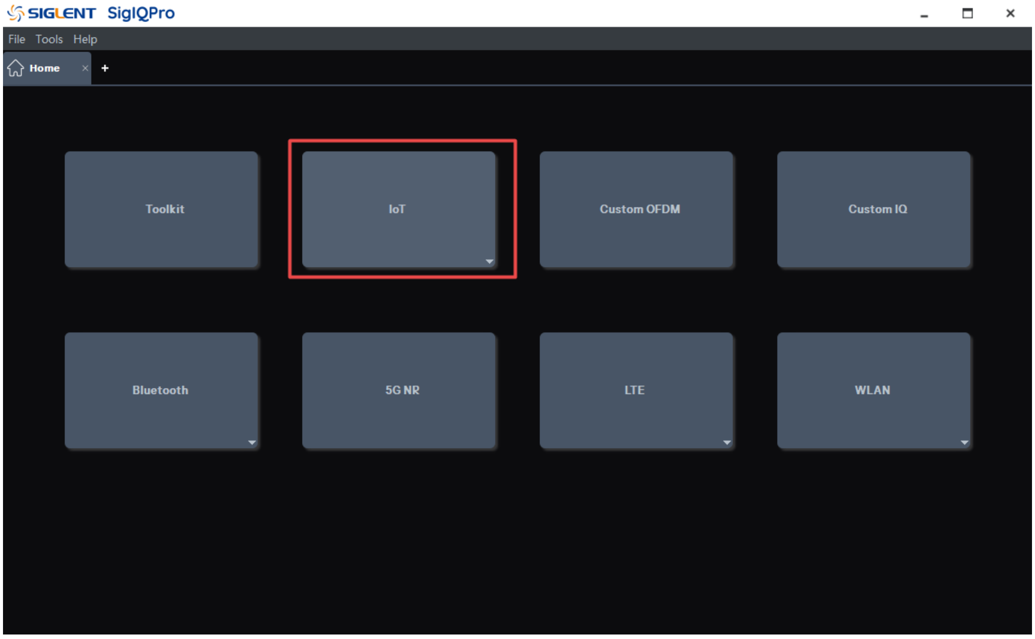
1. Click **Update** in the toolbar to generate the target file.
2. Click **Download** in the toolbar to download the target file to SIGLENT signal generator.

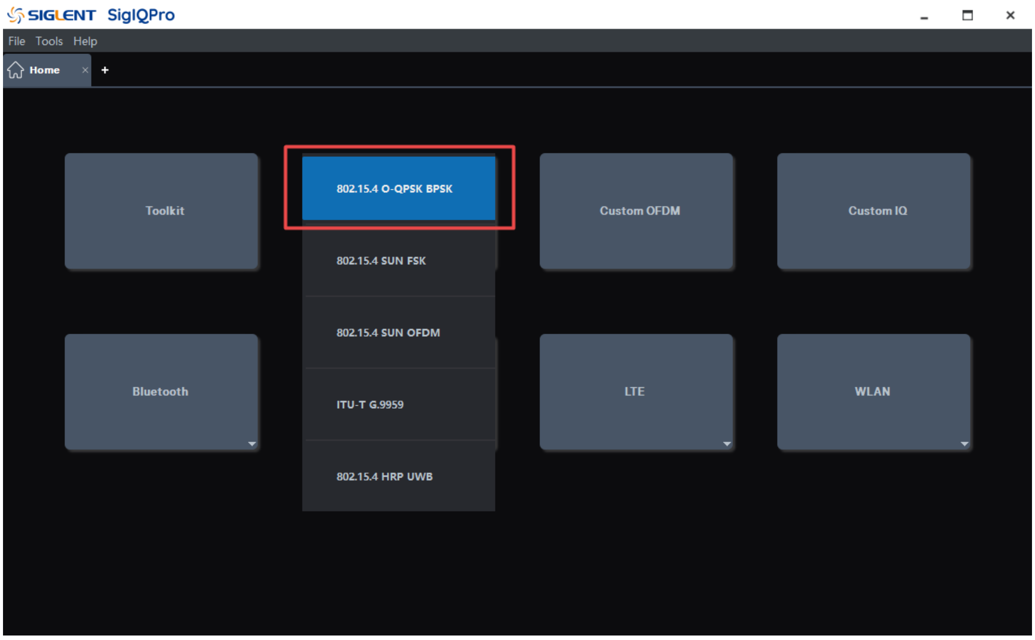
2.2 Creating and Playing IEEE 802.15.4 O-QPSK BPSK Waveform Files

The following example demonstrates how to create and play IEEE 802.15.4 O-QPSK BPSK band waveforms. First, configure the waveform parameters in SigIQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.2.1 Configure waveform parameters

1. Click IoT -> 802.15.4 O-QPSK BPSK on the homepage to enter the 802.15.4 O-QPSK BPSK setting interface.

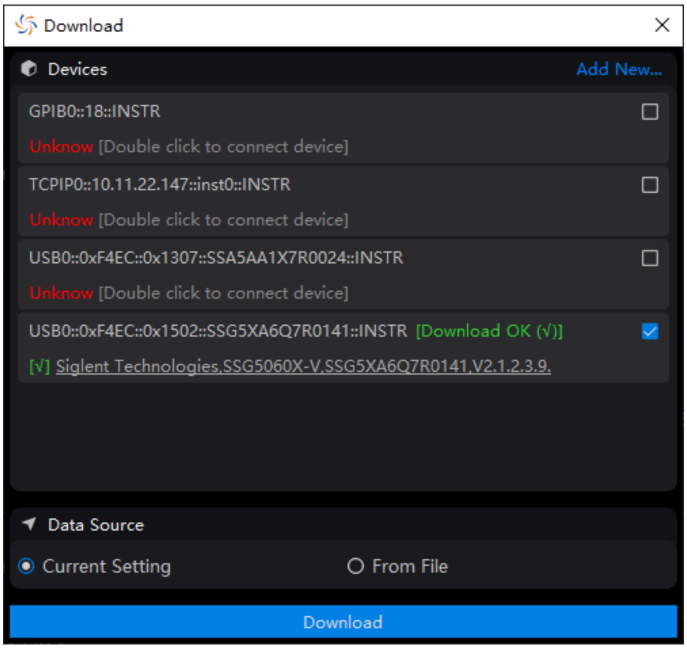




2. Click the **Packet** node in the tree view on the left side of the window to enter parameter settings.
   1) Set **PHY Scheme** as “O-QPSK”.
   2) Set **Frequency Band** as “868 MHz”.
   3) Keep other parameters at their default settings.
3. Click the **Parameters Setup** node in the tree view on the left side of the window to enter parameter settings.
   1) Set **Waveform Name** as “zigbee_868”.
   2) Set **OverSampling Ratio** as “8”.
   3) Keep other parameters at their default settings.

2.2.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
   1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
   2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
   3) Then click the Download button in the Download sub-window.
   4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



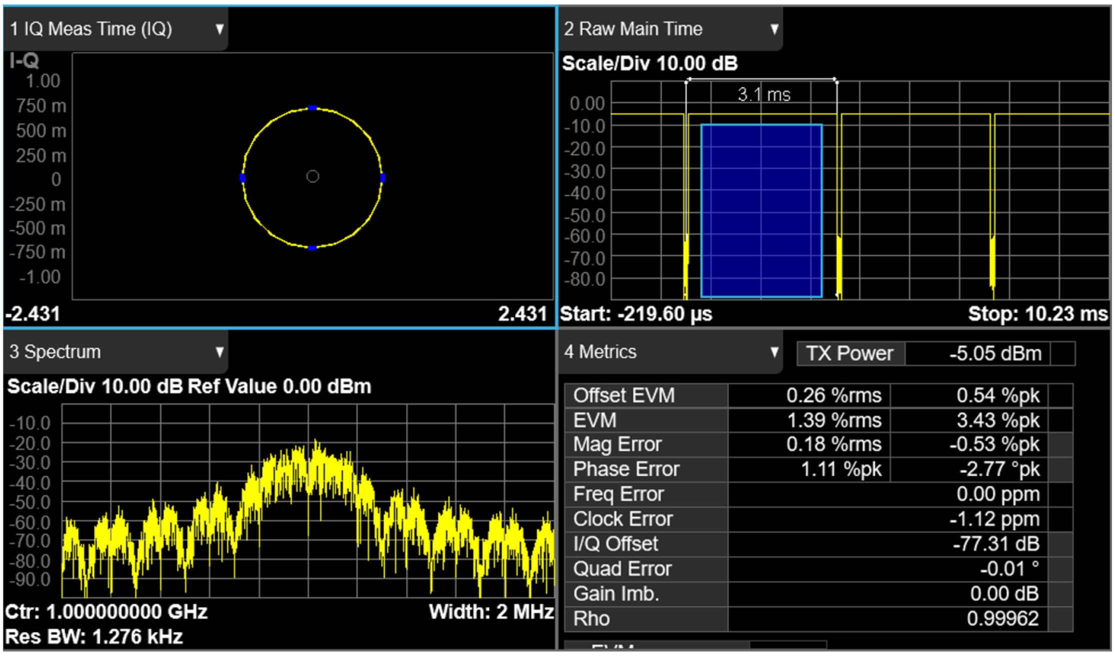
2.2.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing zigbee_868.
2. Set the RF carrier to 1 GHz, -5 dBm.
3. Turn on modulation and RF output.
   1) Press the RF ON/OFF front panel button to turn on the RF output.
   2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.2.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

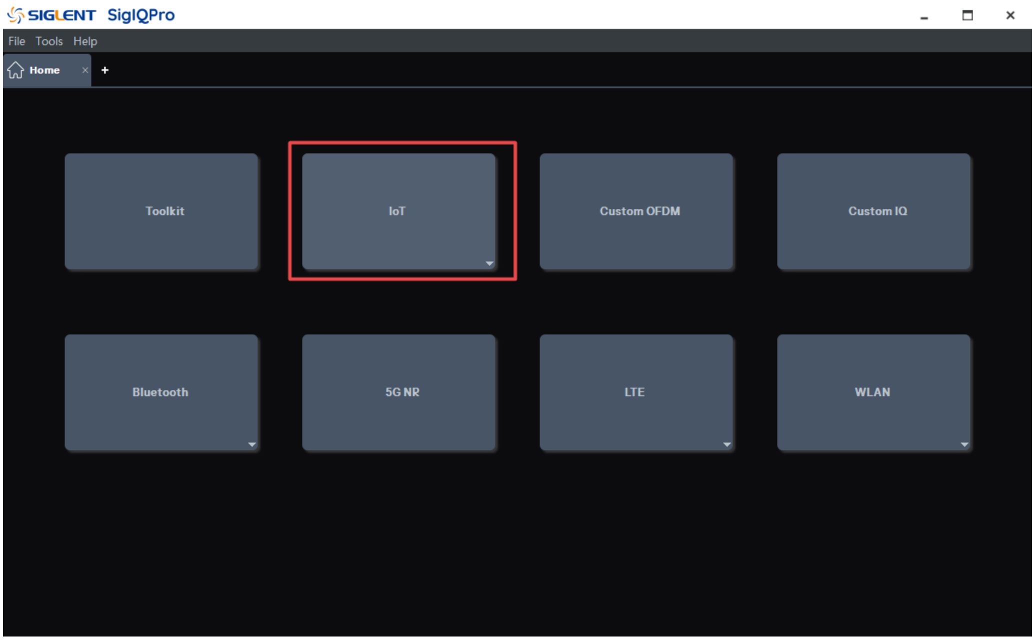

1 IQ Meas Time (IQ)
I-Q
1.00
750 m
500 m
250 m
0
-250 m
-500 m
-750 m
-1.00
-2.431
2.431
2 Raw Main Time
Scale/Div 10.00 dB
3.1 ms
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
Start: -219.60 µs
Stop: 10.23 ms
3 Spectrum
Scale/Div 10.00 dB Ref Value 0.00 dBm
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
Ctr: 1.000000000 GHz
Width: 2 MHz
Res BW: 1.276 kHz
4 Metrics
TX Power -5.05 dBm
Offset EVM 0.26 %rms 0.54 %pk
EVM 1.39 %rms 3.43 %pk
Mag Error 0.18 %rms -0.53 %pk
Phase Error 1.11 %pk -2.77 °pk
Freq Error 0.00 ppm
Clock Error -1.12 ppm
I/Q Offset -77.31 dB
Quad Error -0.01 °
Gain Imb. 0.00 dB
Rho 0.99962

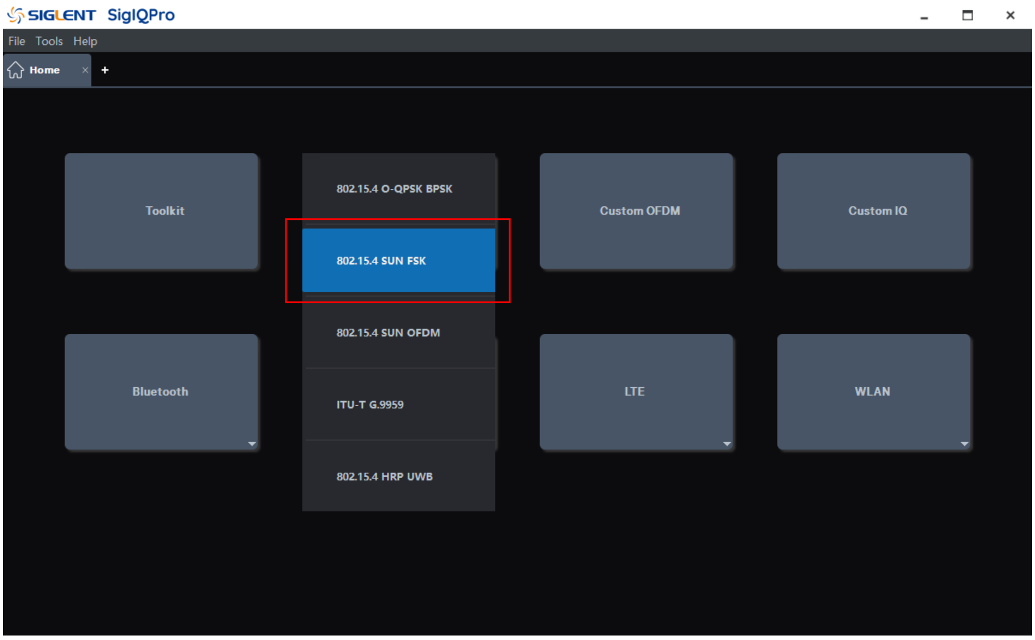
2.3 Creating and Playing IEEE 802.15.4 SUN FSK Waveform Files

The following example demonstrates how to create and play IEEE 802.15.4 SUN FSK waveforms. First, configure the waveform parameters in SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.3.1 Configuring Waveform Parameters

1. On the home page, click **IoT** → **802.15.4 SUN FSK** to enter the IEEE 802.15.4 SUN FSK configuration interface.

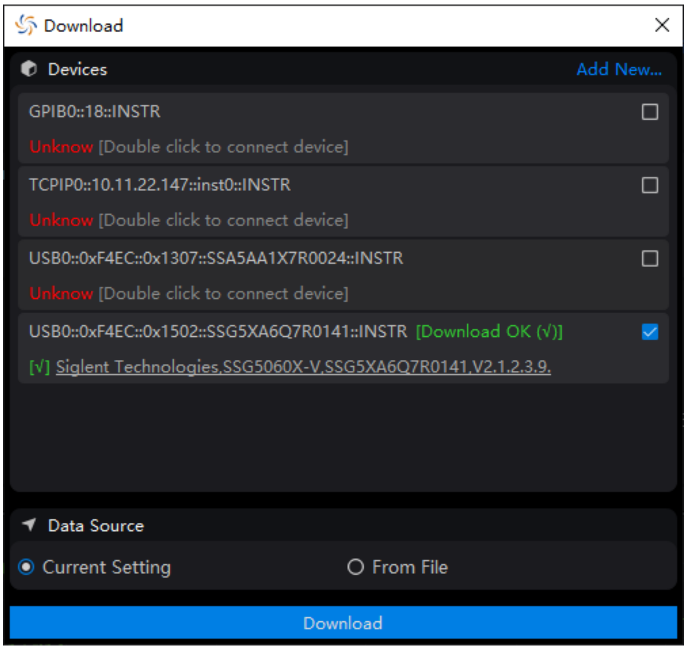




2. Keep the other parameters at their default settings.

2.3.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
    1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
    2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
    3) Then click the Download button in the Download sub-window.
    4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



2.3.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing zigbee_868.
2. Set the RF carrier to 1 GHz, -5 dBm.
3. Turn on modulation and RF output.

1) Press the RF ON/OFF front panel button to turn on the RF output.

2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.3.4 Demodulation Result

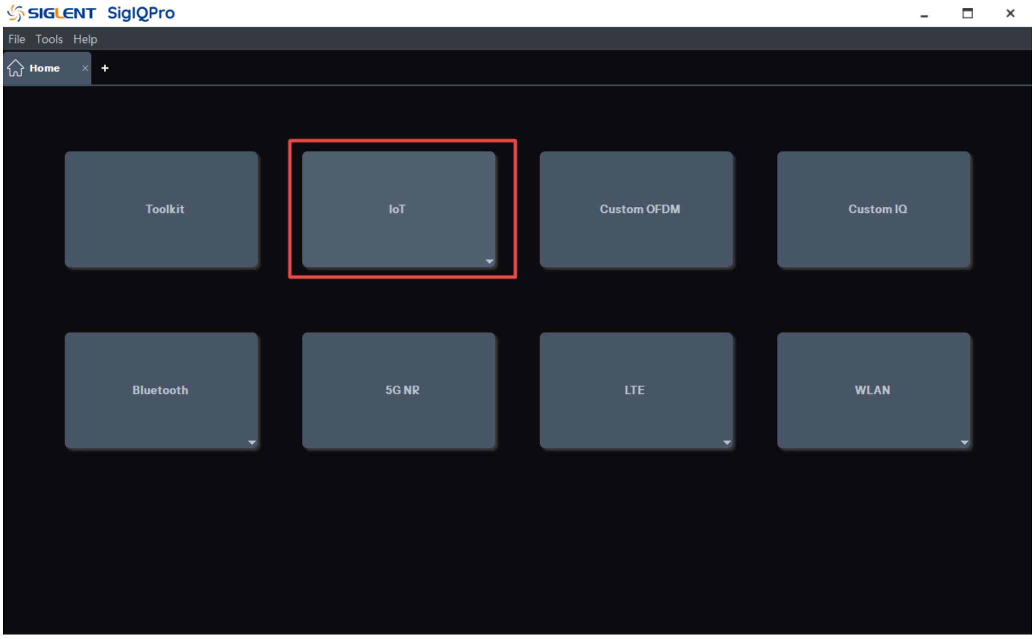
View the demodulation results in the spectrum analyzer:

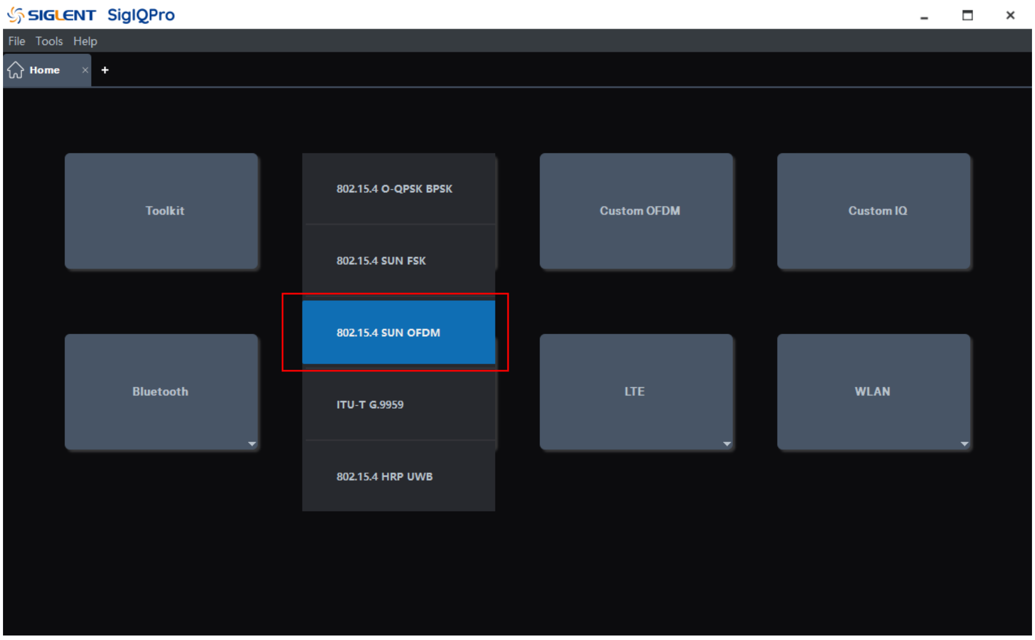
2.4 Creating and Playing IEEE 802.15.4 SUN OFDM Waveform Files

The following example demonstrates how to create and play IEEE 802.15.4 SUN OFDM waveforms. First, configure the waveform parameters in SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.4.1 Configuring Waveform Parameters

1. On the home page, click IoT → 802.15.4 SUN OFDM to enter the IEEE 802.15.4 SUN OFDM configuration interface.

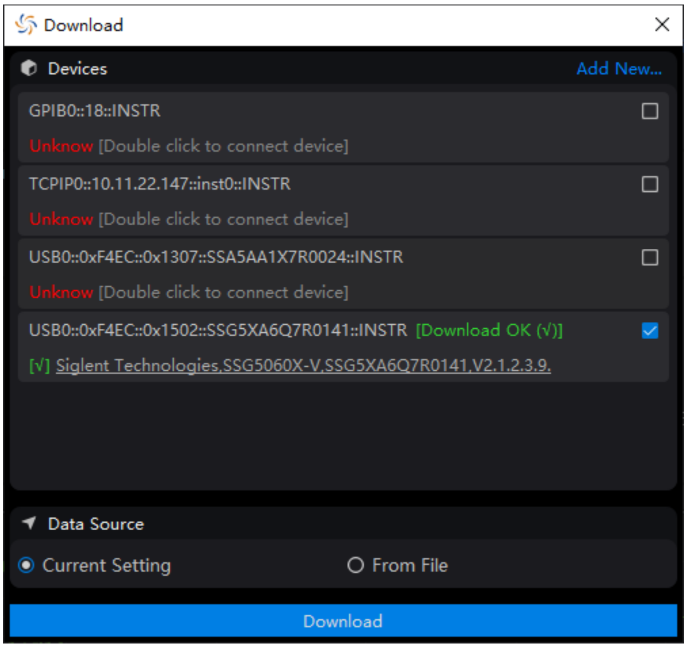




2. Keep the other parameters at their default settings.

2.4.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
   1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
   2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
   3) Then click the Download button in the Download sub-window.
   4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



2.4.3 Play the Waveform in Signal Source

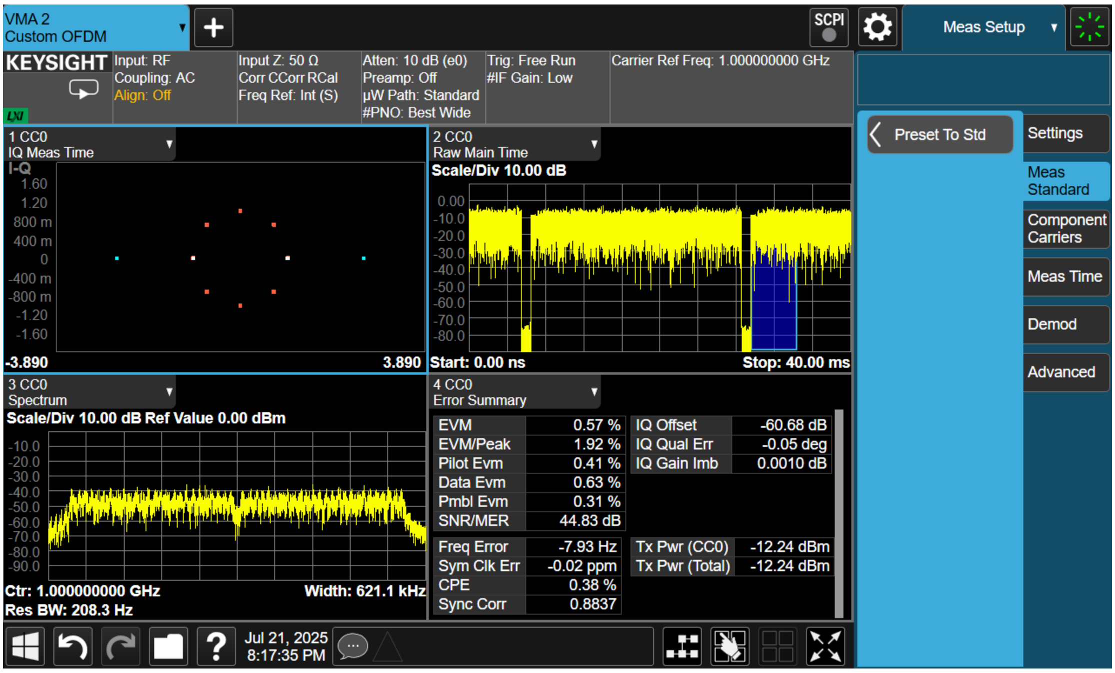
1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing zigbee_868.
2. Set the RF carrier to 1 GHz, -5 dBm.
3. Turn on modulation and RF output.

1) Press the RF ON/OFF front panel button to turn on the RF output.
2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.4.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

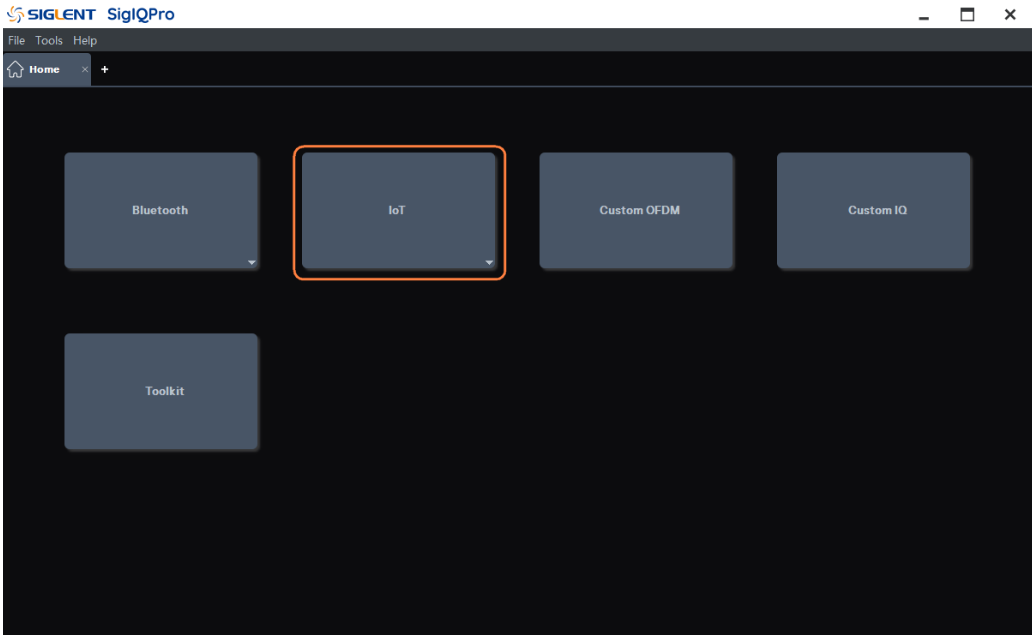


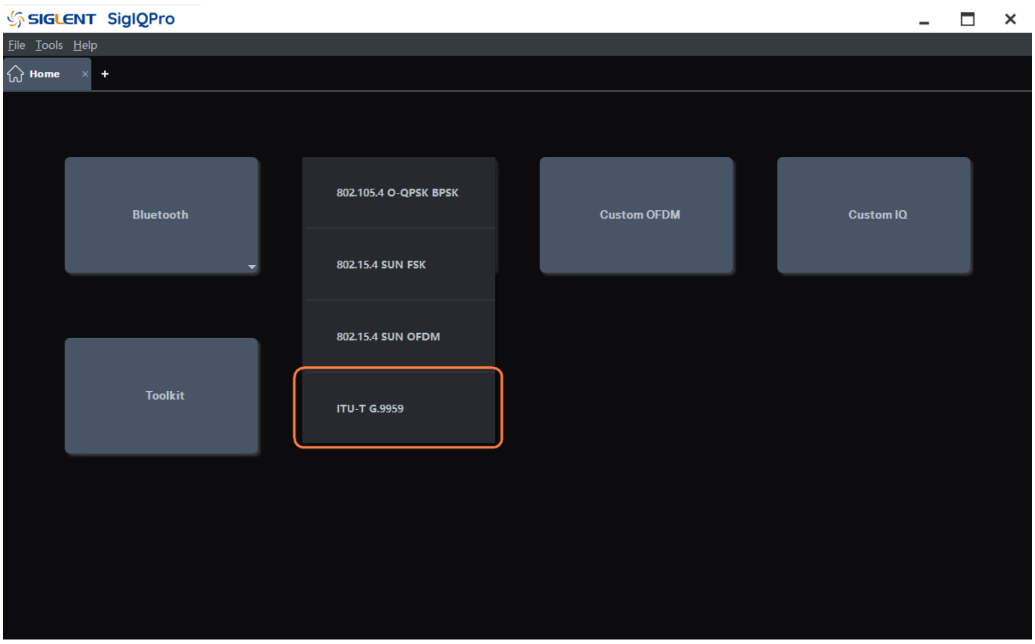
2.5 Create and Play ITU-T G.9959 Waveforms

An example of how to create and play a ITU-T G.9959 waveform with data rate R2 is given below. First configure the waveform parameters on SiglQPro, then download the waveform to SSG5000X-V, and finally play the waveform on SSG5000X-V.

2.5.1 Configure waveform parameters

1. Click IoT -> ITU-T G.9959 on the homepage to enter the ITU-T G.9959 setting interface.





2. Click the Packet node in the tree view on the left side of the window to enter parameter

settings.

1) Set **Data Rate as** "R2-40kbps".

2) Keep other parameters at their default settings.

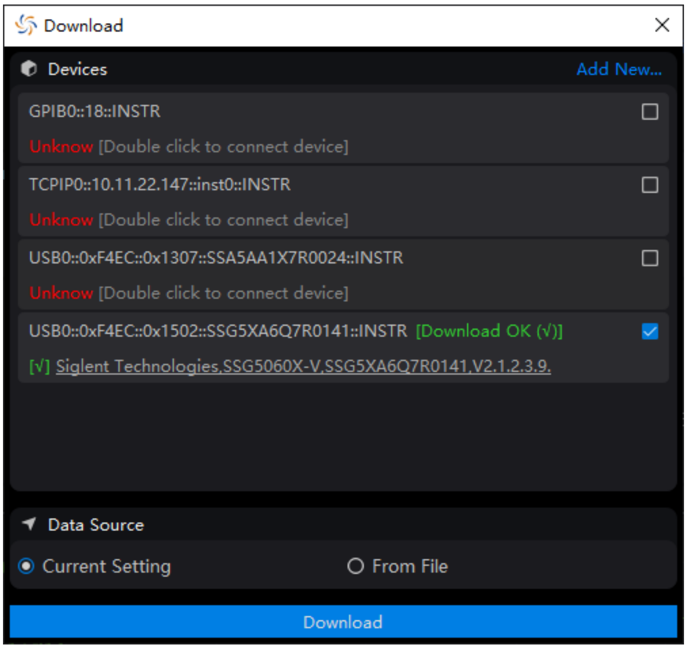
3. Click the **Waveform Setup** node in the tree view on the left side of the window to enter parameter settings.

1) Set **Waveform Name** as "zwave_r2".

2) Keep other parameters at their default settings.

2.5.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
   1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
   2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
   3) Then click the Download button in the Download sub-window.
   4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



2.5.3 Play the Waveform in Signal Source

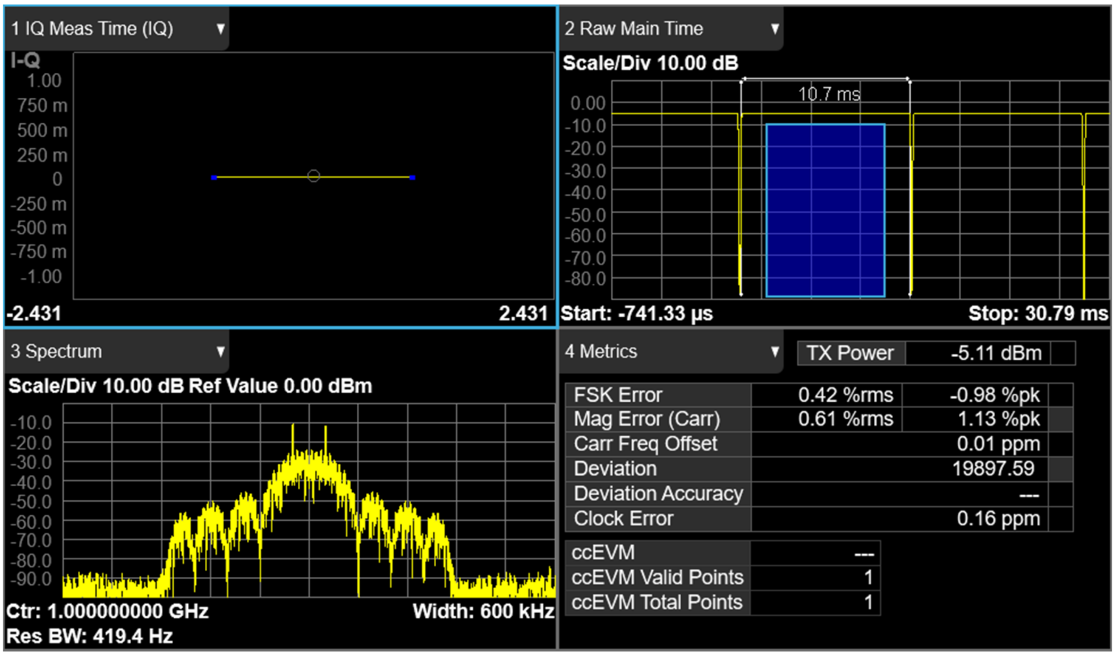
1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing zwave_r2.

2. Set the RF carrier to 1 GHz, -5 dBm.
3. Turn on modulation and RF output.
   1) Press the **RF ON/OFF** front panel button to turn on the RF output.
   2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main switch.

2.5.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

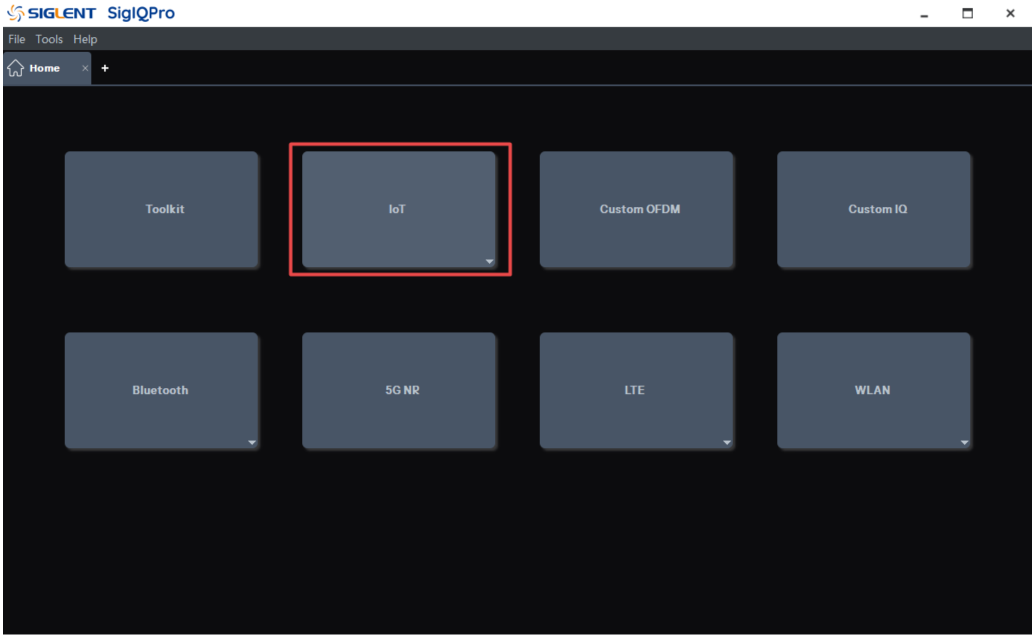


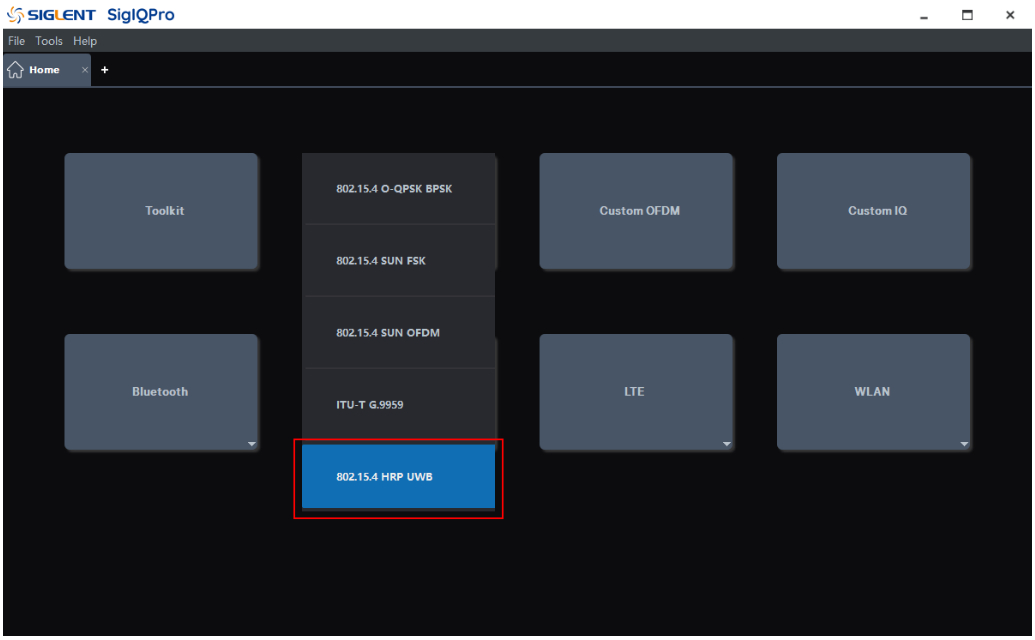
2.6 Creating and Playing IEEE 802.15.4 HRP UWB Waveform Files

The following example demonstrates how to create and play IEEE 802.15.4 HRP UWB waveforms in 802_15_4A mode. First, configure the waveform parameters in SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.6.1 Configuring Waveform Parameters

1. On the home page, click IoT → 802.15.4 HRP UWB to enter the IEEE 802.15.4 HRP UWB configuration interface.

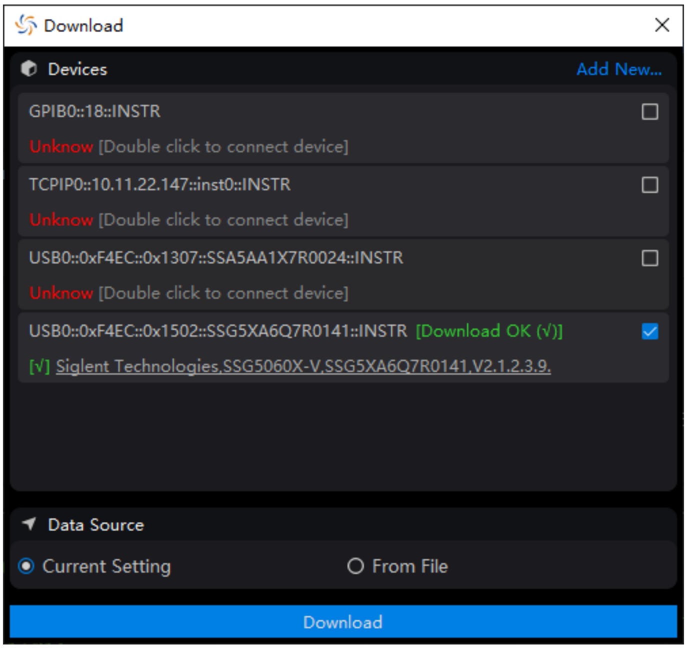




2. Click on the **Packet** node in the left-side tree view to access parameter settings:
   1) Set General -> Mode to 802_15_4A;
   2) Keep all other parameters at their default values.

2.6.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
   1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
   2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
   3) Then click the Download button in the Download sub-window.
   4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



2.6.3 Play the Waveform in Signal Source

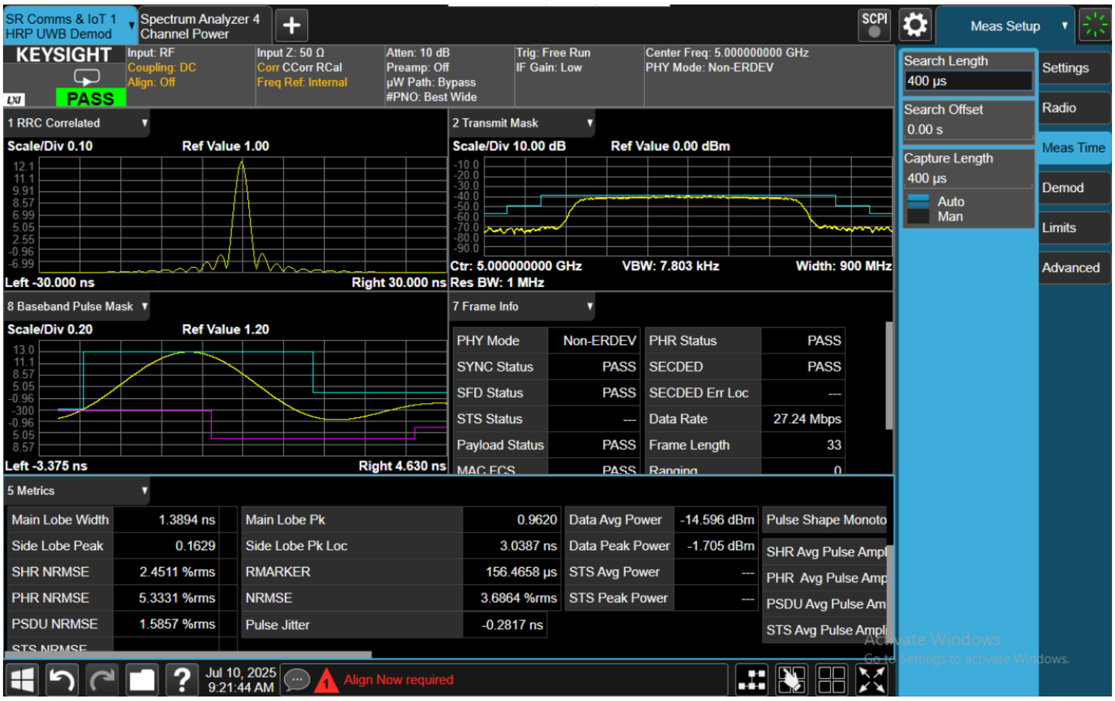
1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing zwave_r2.

2. Set the RF carrier to 1 GHz, -5 dBm.
3. Turn on modulation and RF output.
   1) Press the **RF ON/OFF** front panel button to turn on the RF output.
   2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main switch.

2.6.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

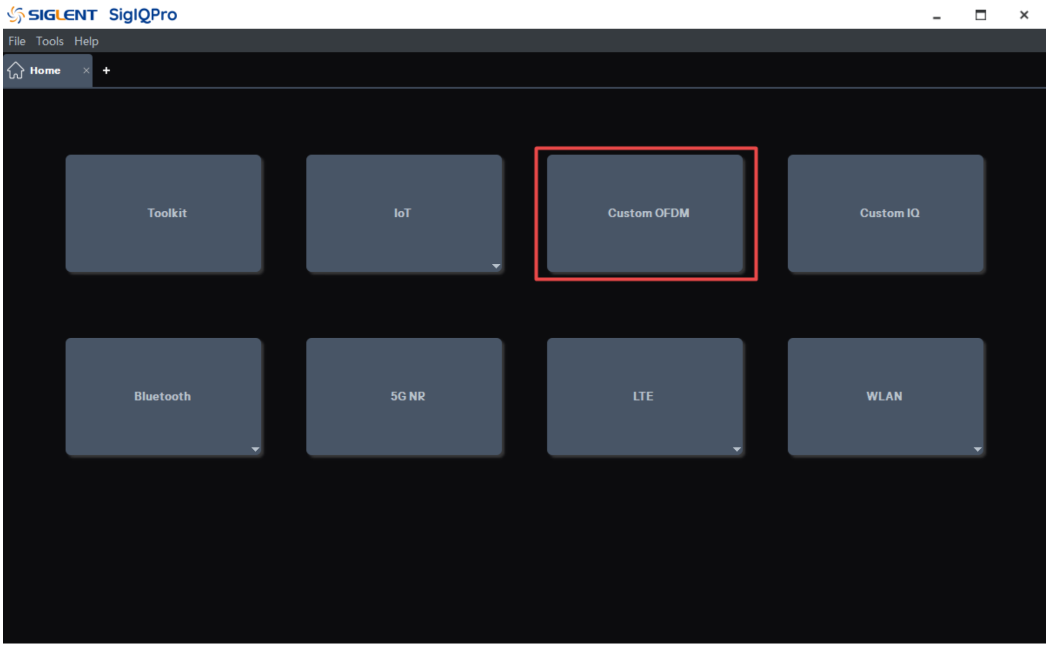


2.7 Create and Play WLAN Custom OFDM Waveforms

An example of how to create and play a WLAN Custom OFDM waveform is given below. First configure the waveform parameters on SiglQPro, then download the waveform to SSG5000X-V, and finally play the waveform on SSG5000X-V.

2.7.1 Configure waveform parameters

1. Click **Custom OFDM** on the homepage to enter the Custom OFDM setting interface.

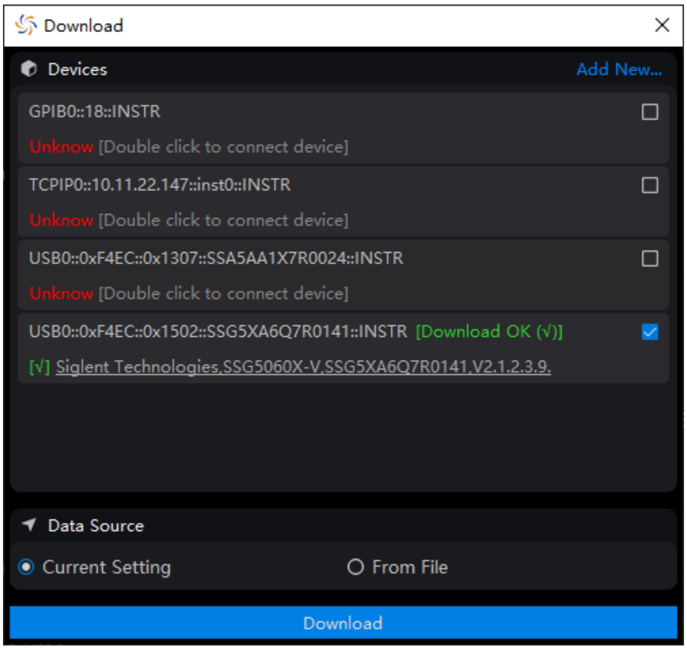


2. Click Quick Setups on the toolbar and select WLAN: IEEE 802.11a.
3. Click the **Waveform Setup** node in the tree view on the left side of the window to enter parameter settings.
   1) Set **Waveform Name** as "WLAN_Custom_OFDM".
   2) Set **OverSampling Ratio** as "8".
   3) Keep other parameters at their default settings.

2.7.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
   1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.

2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
3) Then click the Download button in the Download sub-window.
4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



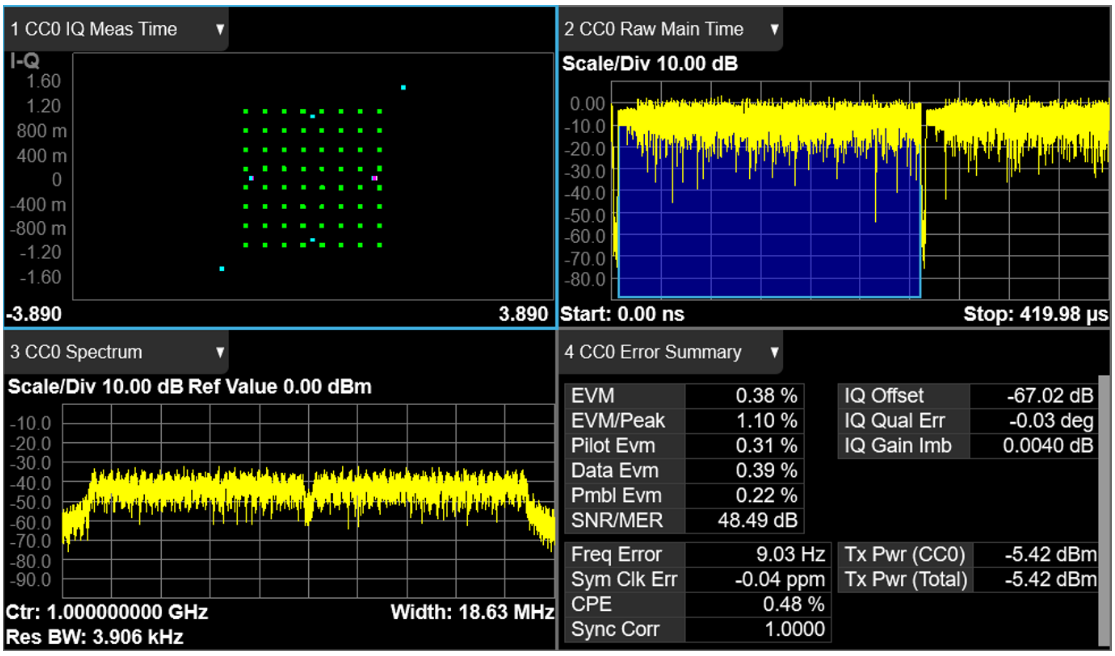
2.7.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing WLAN_Custom_OFDM.
2. Set the RF carrier to 1 GHz, -5 dBm.
3. Turn on modulation and RF output.
   1) Press the **RF ON/OFF** front panel button to turn on the RF output.
   2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main switch.

2.7.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

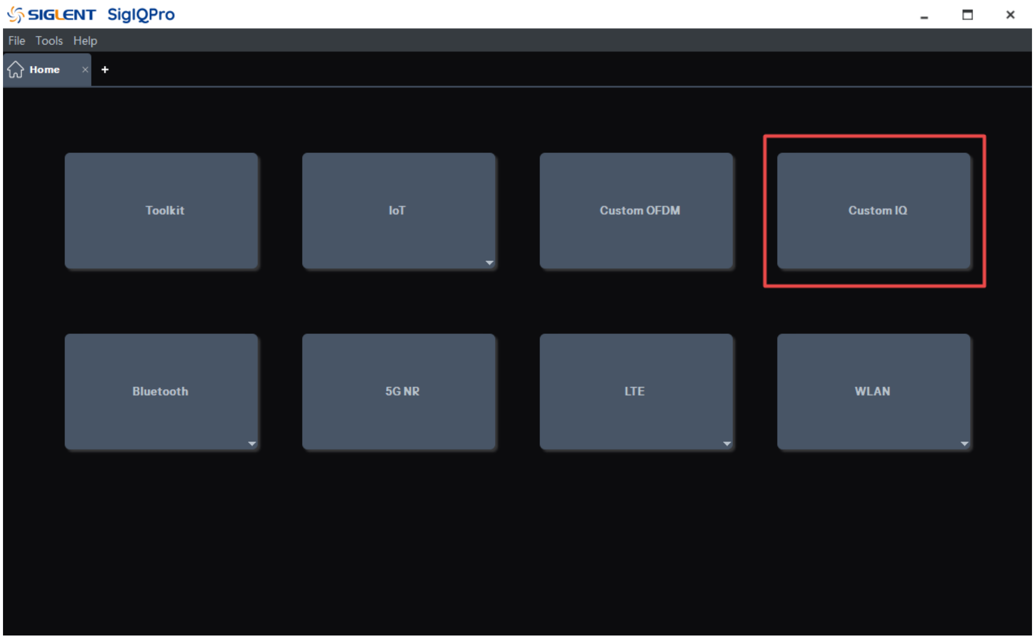

1 CC0 IQ Meas Time
I-Q
1.60
1.20
800 m
400 m
0
-400 m
-800 m
-1.20
-1.60
-3.890
3.890
2 CC0 Raw Main Time
Scale/Div 10.00 dB
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
Start: 0.00 ns
Stop: 419.98 µs
3 CC0 Spectrum
Scale/Div 10.00 dB Ref Value 0.00 dBm
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
Ctr: 1.000000000 GHz
Width: 18.63 MHz
Res BW: 3.906 kHz
4 CC0 Error Summary
EVM 0.38 %
EVM/Peak 1.10 %
Pilot Evm 0.31 %
Data Evm 0.39 %
Pmbl Evm 0.22 %
SNR/MER 48.49 dB
IQ Offset -67.02 dB
IQ Qual Err -0.03 deg
IQ Gain Imb 0.0040 dB
Freq Error 9.03 Hz
Sym Clk Err -0.04 ppm
CPE 0.48 %
Sync Corr 1.0000
Tx Pwr (CC0) -5.42 dBm
Tx Pwr (Total) -5.42 dBm

2.8 Create and Play Custom IQ Waveforms

An example of how to create and play a Custom IQ 16QAM waveform is given below. First configure the waveform parameters on SiglQPro, then download the waveform to SSG5000X-V, and finally play the waveform on SSG5000X-V.

2.8.1 Configure waveform parameters

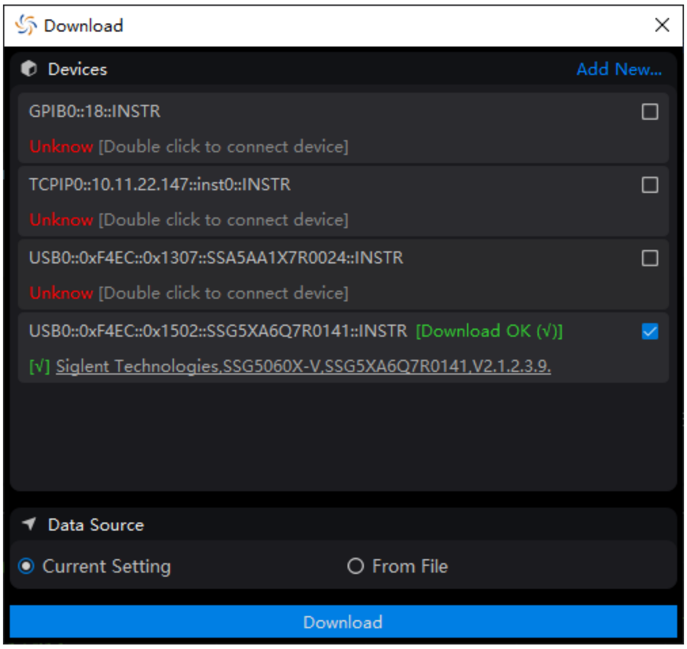
1. Click **Custom IQ** on the homepage to enter the Custom IQ setting interface.



2. Keep the parameters at their default settings.

2.8.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
    1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
    2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
    3) Then click the Download button in the Download sub-window.
    4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



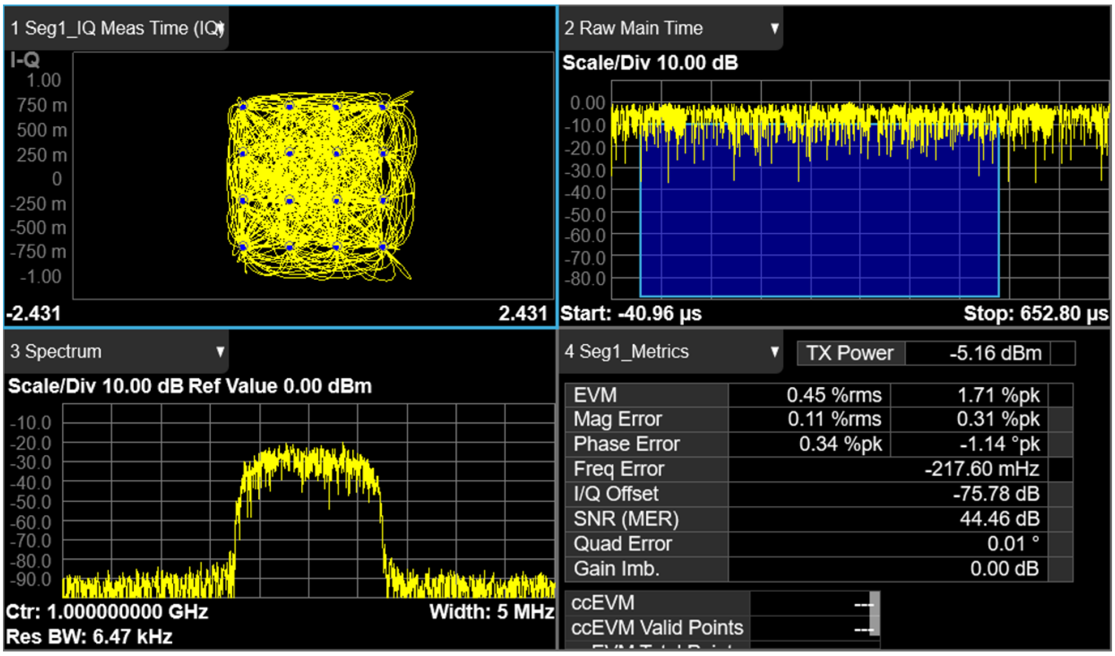
2.8.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing UserIQ_1 (When Waveform Name is not set, SSG5000X-V automatically names the waveform).
2. Set the RF carrier to 1 GHz, -5 dBm.
3. Turn on modulation and RF output.
   1) Press the RF ON/OFF front panel button to turn on the RF output.
   2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.8.4 Demodulation Result

View the demodulation results in the spectrum analyzer:



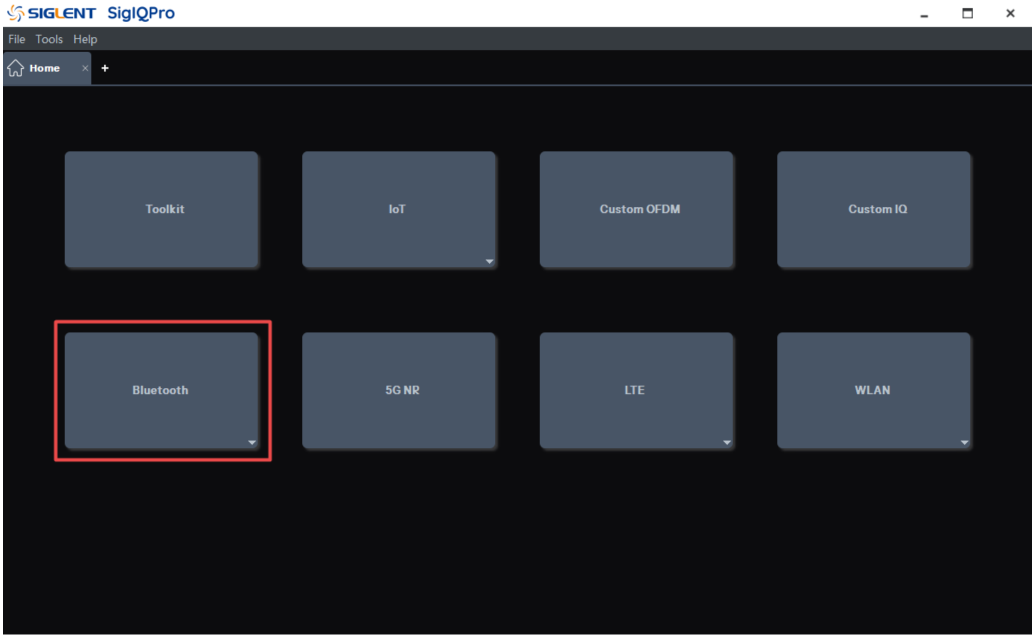
1 Seg1_IQ Meas Time (IQ)
I-Q
1.00
750 m
500 m
250 m
0
-250 m
-500 m
-750 m
-1.00
-2.431
2.431
2 Raw Main Time
Scale/Div 10.00 dB
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
Start: -40.96 µs
Stop: 652.80 µs
3 Spectrum
Scale/Div 10.00 dB Ref Value 0.00 dBm
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
Ctr: 1.000000000 GHz
Width: 5 MHz
Res BW: 6.47 kHz
4 Seg1_Metrics
TX Power -5.16 dBm
EVM 0.45 %rms 1.71 %pk
Mag Error 0.11 %rms 0.31 %pk
Phase Error 0.34 %pk -1.14 °pk
Freq Error -217.60 mHz
I/Q Offset -75.78 dB
SNR (MER) 44.46 dB
Quad Error 0.01 °
Gain Imb. 0.00 dB
ccEVM ---
ccEVM Valid Points ---

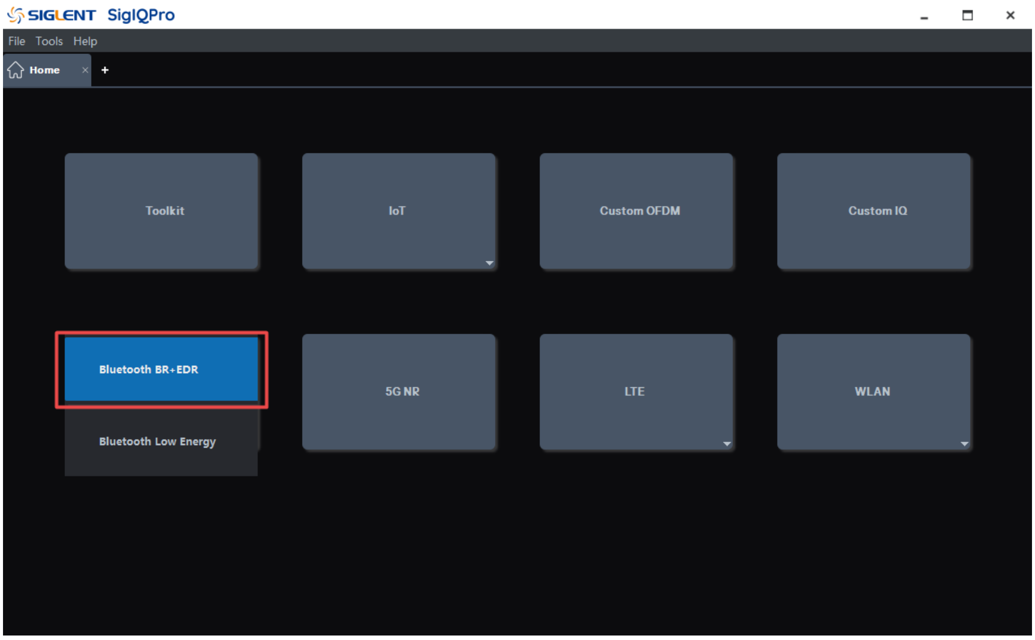
2.9 Create and Play Bluetooth EDR Waveforms

An example of how to create and play Bluetooth EDR waveforms with package type DM1 is given below. First configure the waveform parameters on SiglQPro, then download the waveform to SSG5000X-V, and finally play the waveform on SSG5000X-V.

2.9.1 Configure waveform parameters

1. Click **Bluetooth** -> **Bluetooth BR+EDR** on the homepage to enter the Bluetooth BR/EDR setting interface.

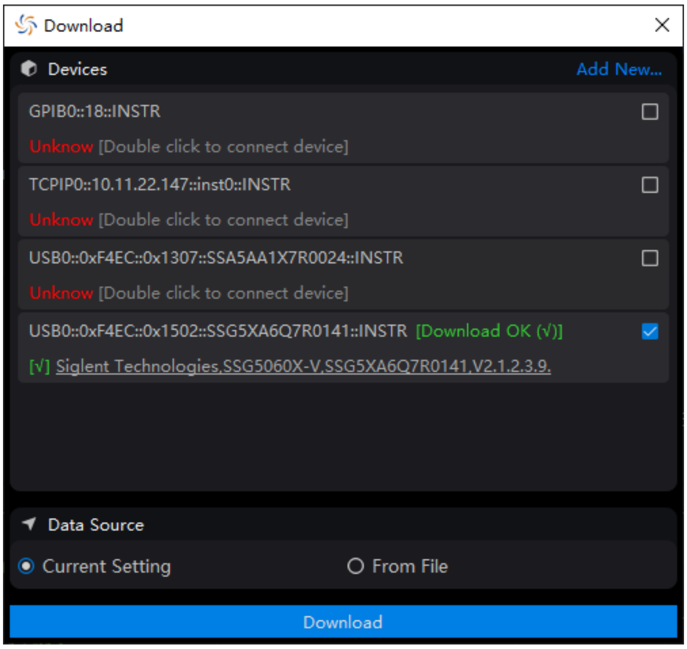




2. Click the **Packet** node in the tree view on the left side of the window to enter parameter settings.
   1) Set **Bluetooth Mode** as “Enhanced Data Rate”.
   2) Set **Transport Mode** as “ACL”.
   3) Set **Packet Type** as “DM1”.
   4) Keep other parameters at their default settings.
3. Click the **Parameters Setup** node in the tree view on the left side of the window to enter parameter settings.
   1) Set **Waveform Name** as “EDR_DM1”.
   2) Keep other parameters at their default settings.

2.9.2 Download the Waveform to Signal Source

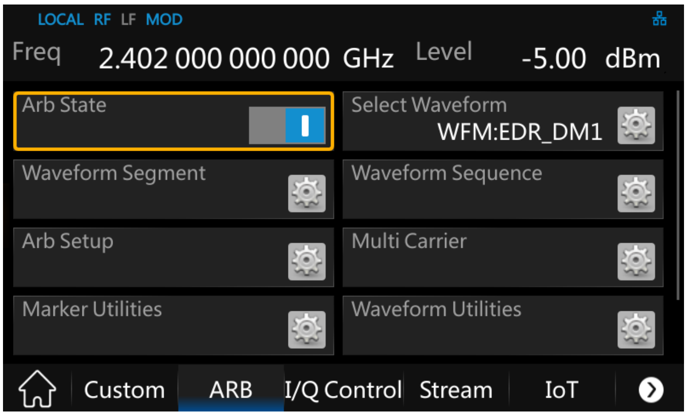
1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
   1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
   2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
   3) Then click the Download button in the Download sub-window.
   4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



2.9.3 Play the Waveform in Signal Source

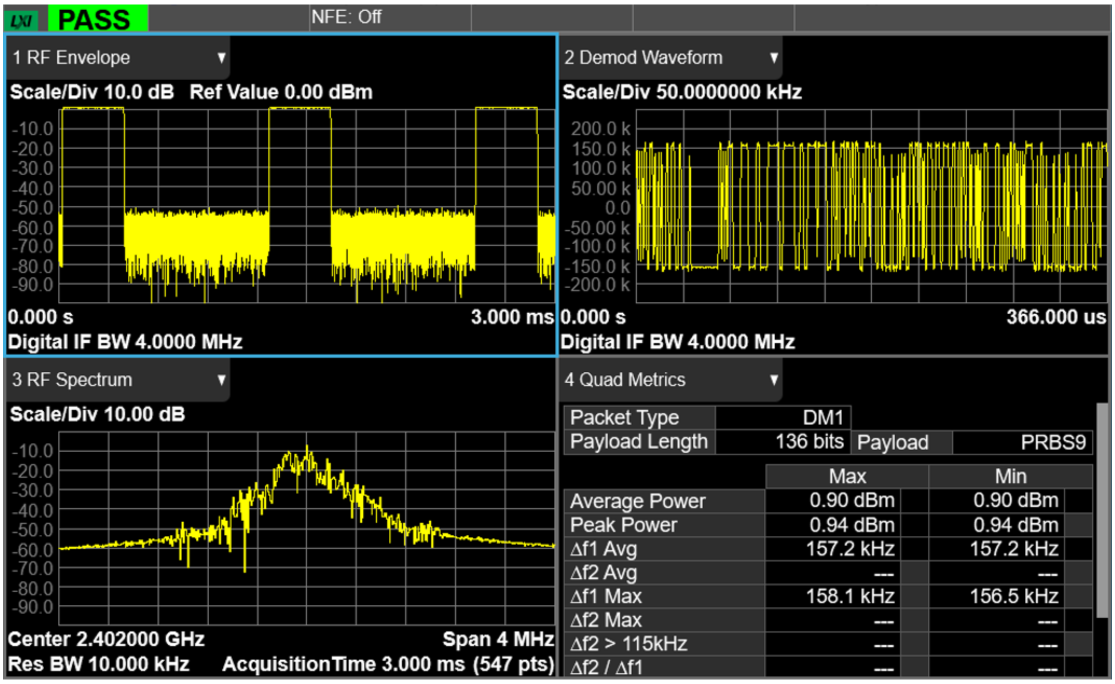
1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing EDR_DM1.
2. Set the RF carrier to 2.402 GHz, -4 dBm.
3. Turn on modulation and RF output.
   1) Press the **RF ON/OFF** front panel button to turn on the RF output.
   2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main switch.



2.9.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

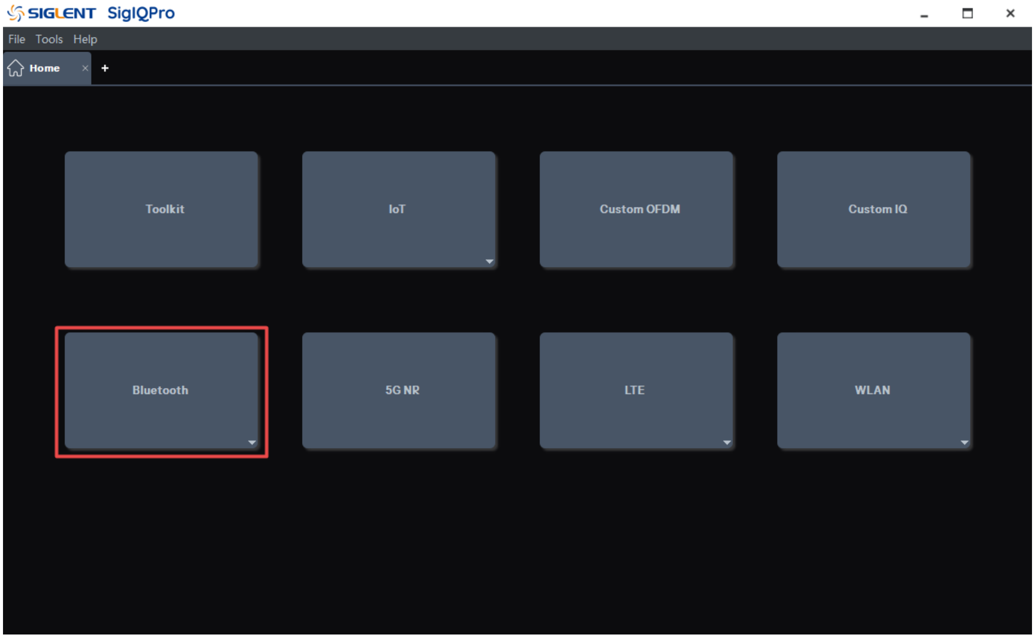


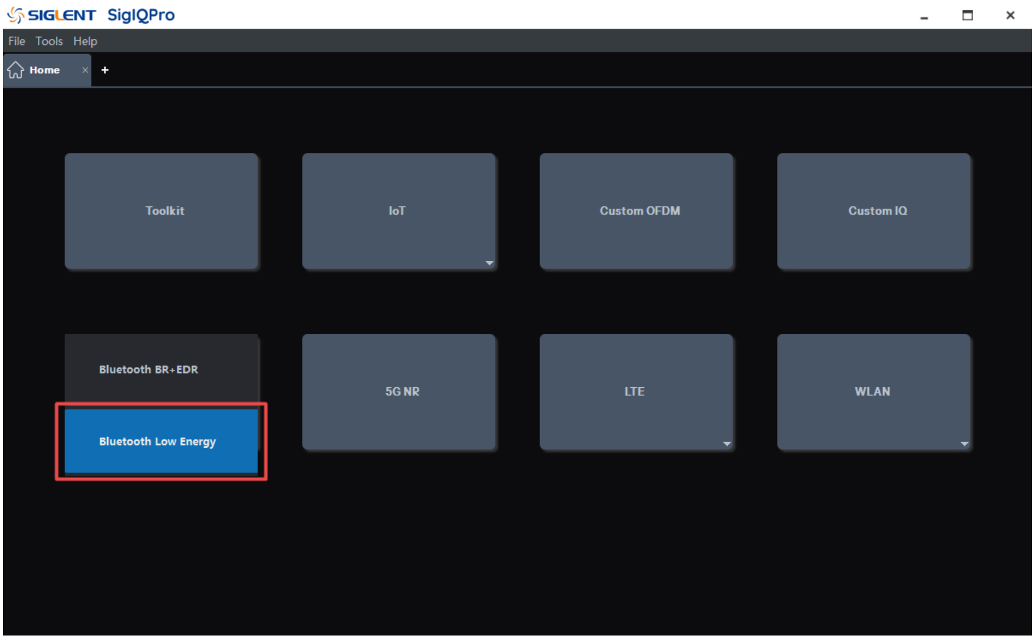
2.10 Create and Play Bluetooth LE Waveforms

An example of how to create and play Bluetooth Low Energy LE 1M test packet waveforms is given below. First configure the waveform parameters on SiglQPro, then download the waveform to SSG5000X-V, and finally play the waveform on SSG5000X-V.

2.10.1 Configure waveform parameters

1. Click Bluetooth -> Bluetooth Low Energy on the homepage to enter the Bluetooth LE setting interface.

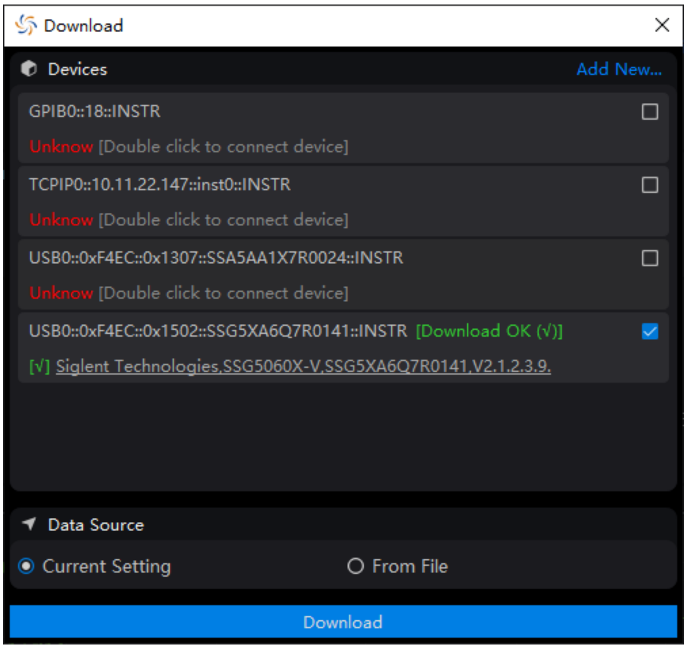




2. Click the **Packet** node in the tree view on the left side of the window to enter parameter settings.
   1) Set **Channel Type** as "Test".
   2) Set **Packet Format** as "LE 1M".
   3) Keep other parameters at their default settings.
3. Click the **Parameters Setup** node in the tree view on the left side of the window to enter parameter settings.
   1) Set **Waveform Name** as "LE_test".
   2) Keep other parameters at their default settings.

2.10.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
   1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
   2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
   3) Then click the Download button in the Download sub-window.
   4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



2.10.3 Play the Waveform in Signal Source

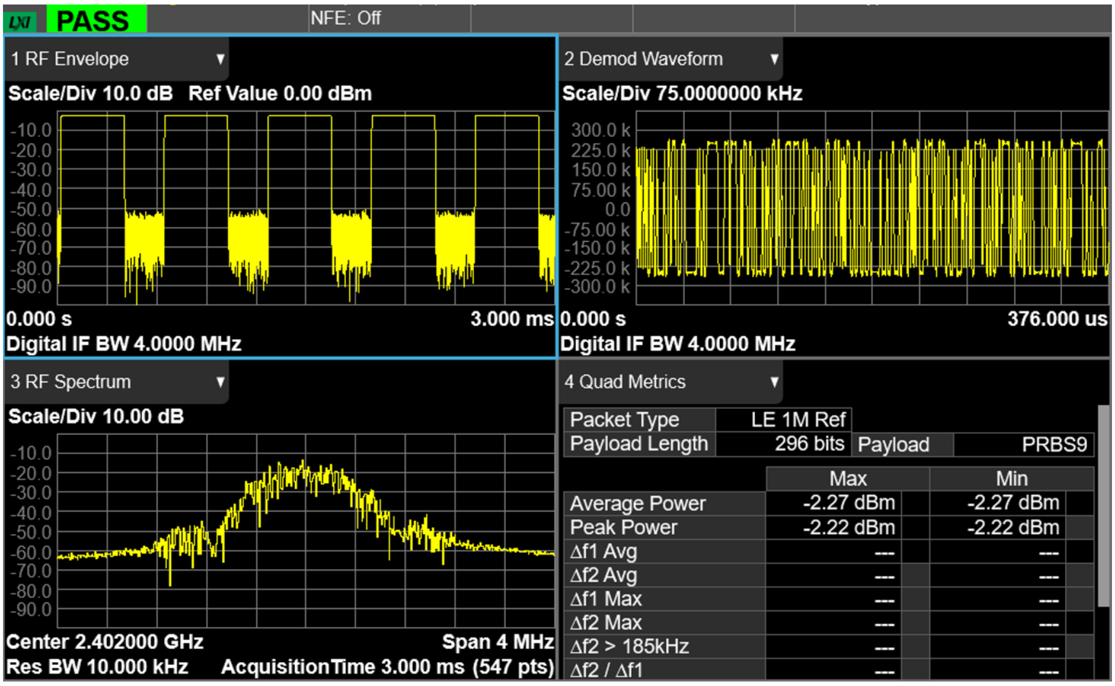
1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing LE_test.

2. Set the RF carrier to 2.402 GHz, -4 dBm.
3. Turn on modulation and RF output.
   1) Press the **RF ON/OFF** front panel button to turn on the RF output.
   2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main switch.

2.10.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

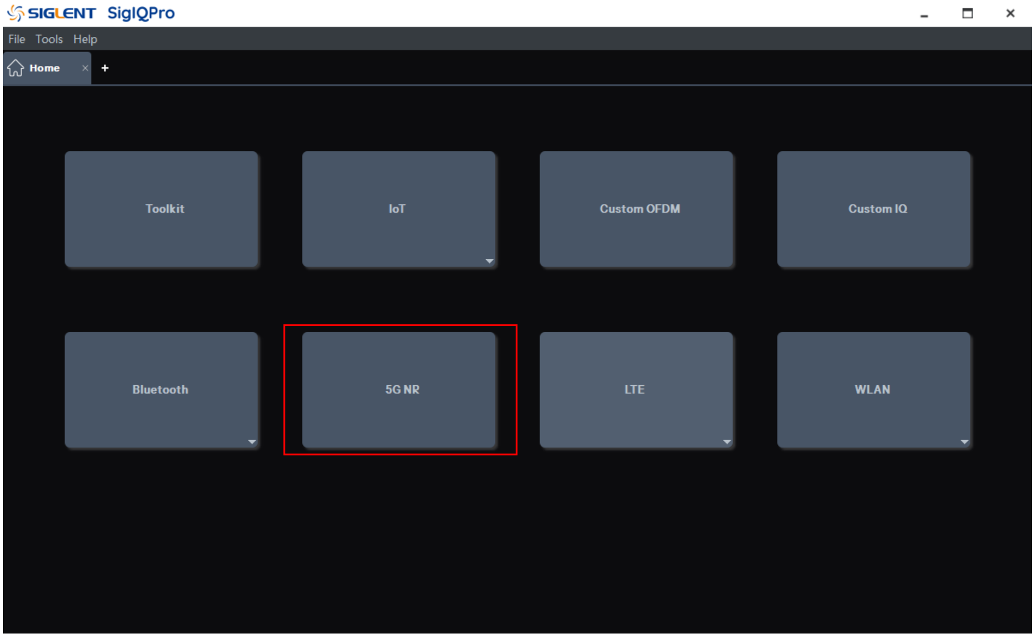


2.11 Creating and Playing NR Waveform Files

The following example demonstrates how to create and play NR TM1.1 waveform. First, configure the waveform parameters in SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.11.1 Configuring Waveform Parameters

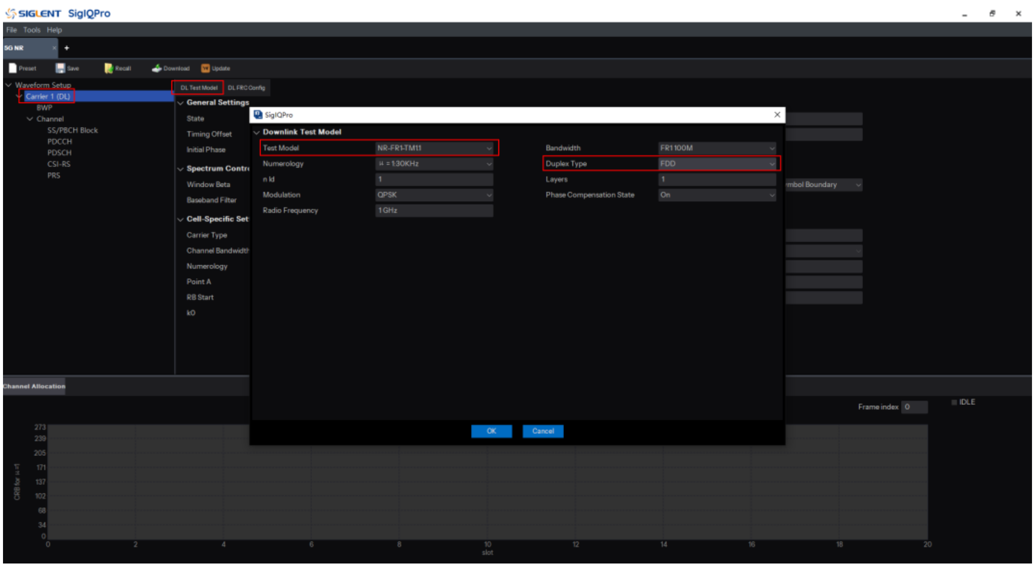
1. On the home page, click 5G NR to enter the 5G NR configuration page.



2. Click the Carrier 1(DL) node in the left-side tree view to access parameter settings.
3. Click the DL Test Model node in the left-side tree view to configure parameters:

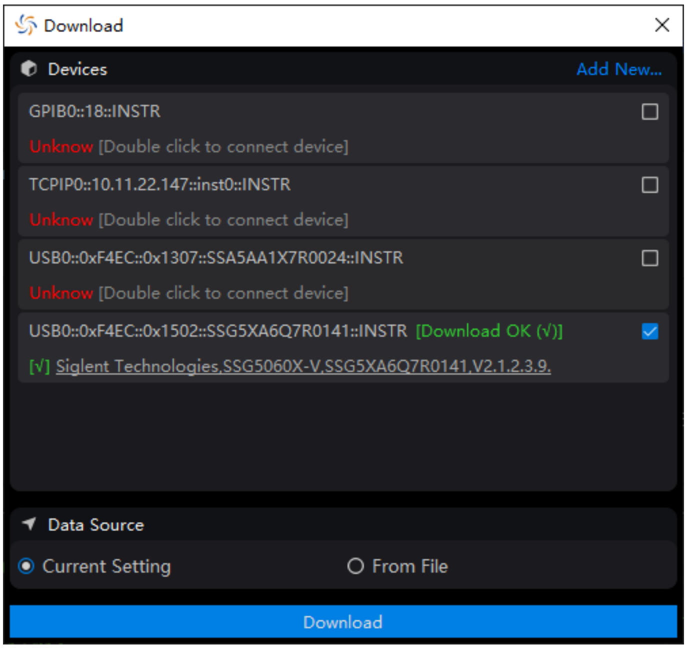
    1) Set Test Model to NR-FR1-TM1.1

    2) Set Duplex Type to FDD, then click OK



2.11.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.
    1) After clicking the Download button, select the instrument to play the waveform in the pop-up Download sub-window.
    2) When the instrument is not connected, please double-click the resource name of the instrument to connect to the instrument as prompted.
    3) Then click the Download button in the Download sub-window.
    4) After the download is successful, a "Download OK" prompt will appear after the name of the downloaded instrument.



2.11.3 Play the Waveform in Signal Source

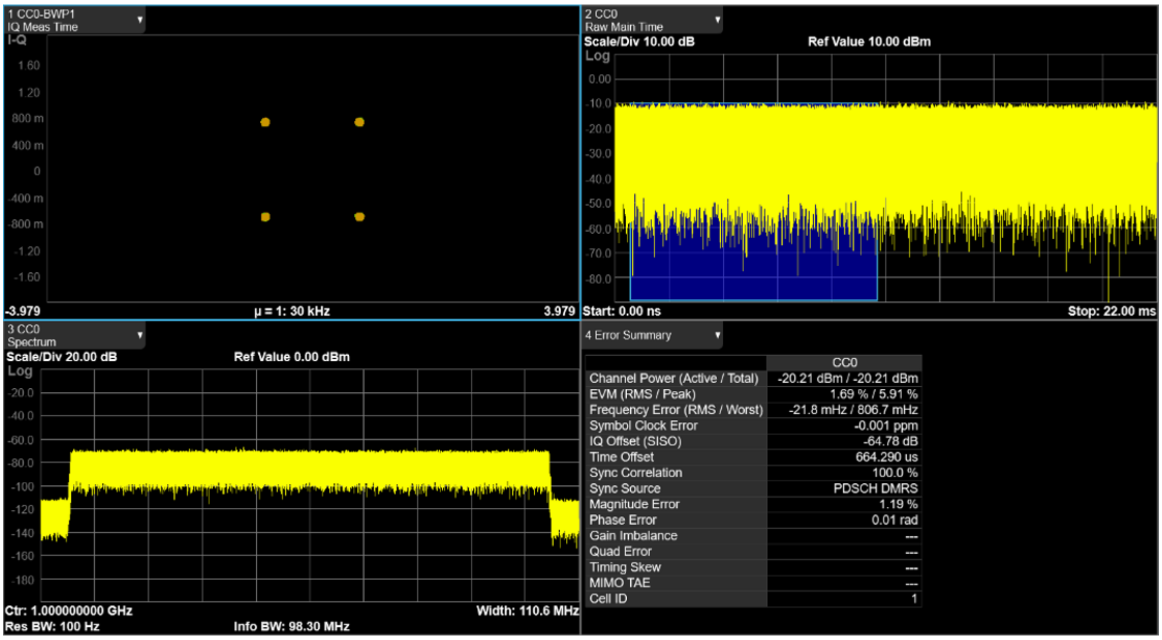
1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing LE_test.
2. Set the RF carrier to 1 GHz, -20 dBm.
3. Turn on modulation and RF output.
    1) Press the **RF ON/OFF** front panel button to turn on the RF output.
    2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main

switch.

2.11.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

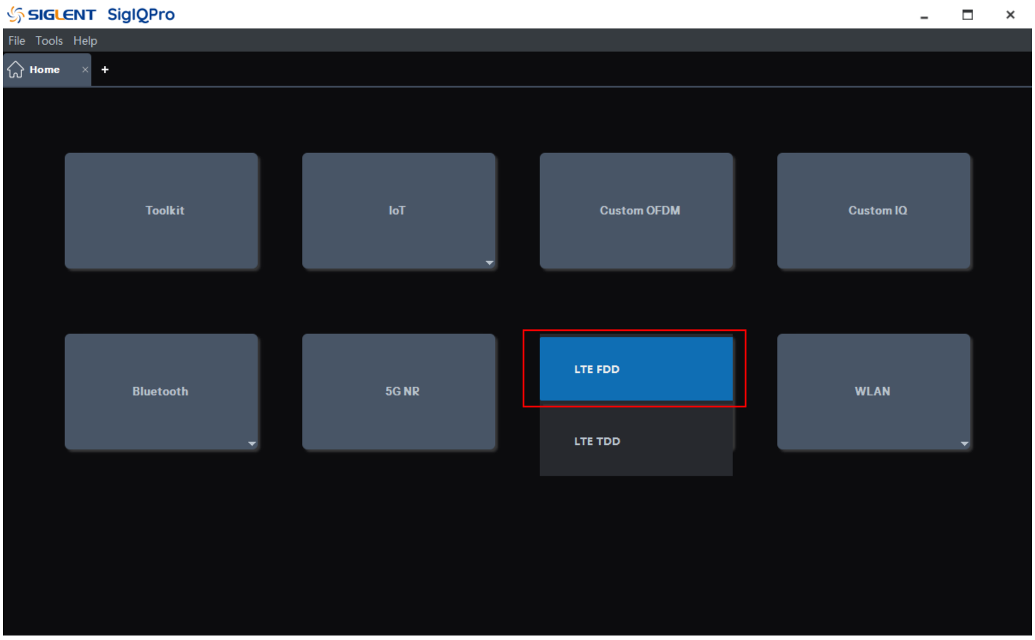


2.12 Creating and Playing LTE Waveform Files

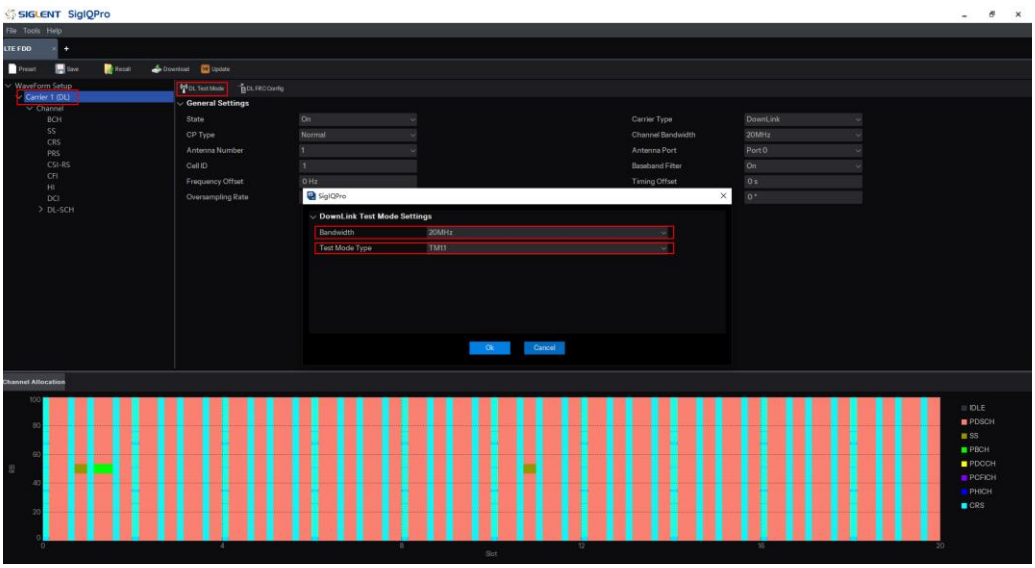
The following example demonstrates how to create and play LTE-FDD TM1.1 waveforms. First, configure the waveform parameters in SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.12.1 Configuring Waveform Parameters

1. On the home page, click **LTE** → **LTE-FDD** to enter the LTE-FDD configuration interface.

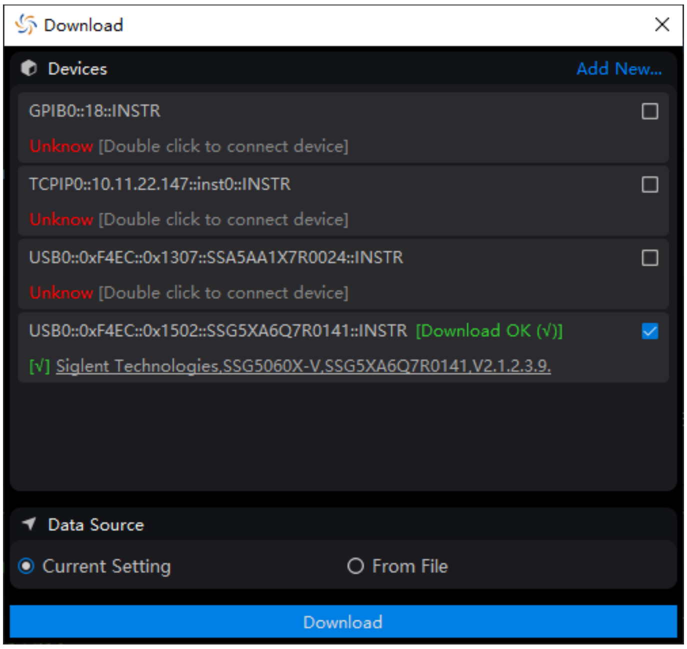


2. Click the **Carrier 1(DL)** node in the left-side tree view to access parameter settings.
3. Click the **DL Test Model** node in the left-side tree view to configure parameters:
   1) Set Bandwidth to 20M
   2) Set Test Model Type to TM1.1, then click OK to confirm



2.12.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.



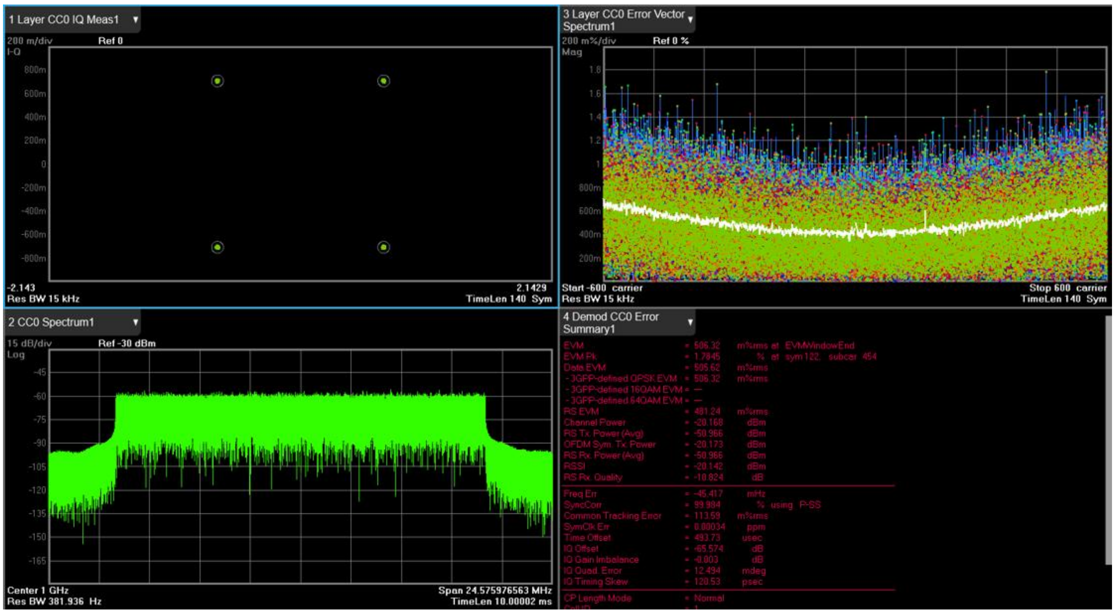
2.12.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing LE_test.
2. Set the RF carrier to 1 GHz, -20 dBm.
3. Turn on modulation and RF output:
   1) Press the RF ON/OFF front panel button to turn on the RF output.
   2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.12.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

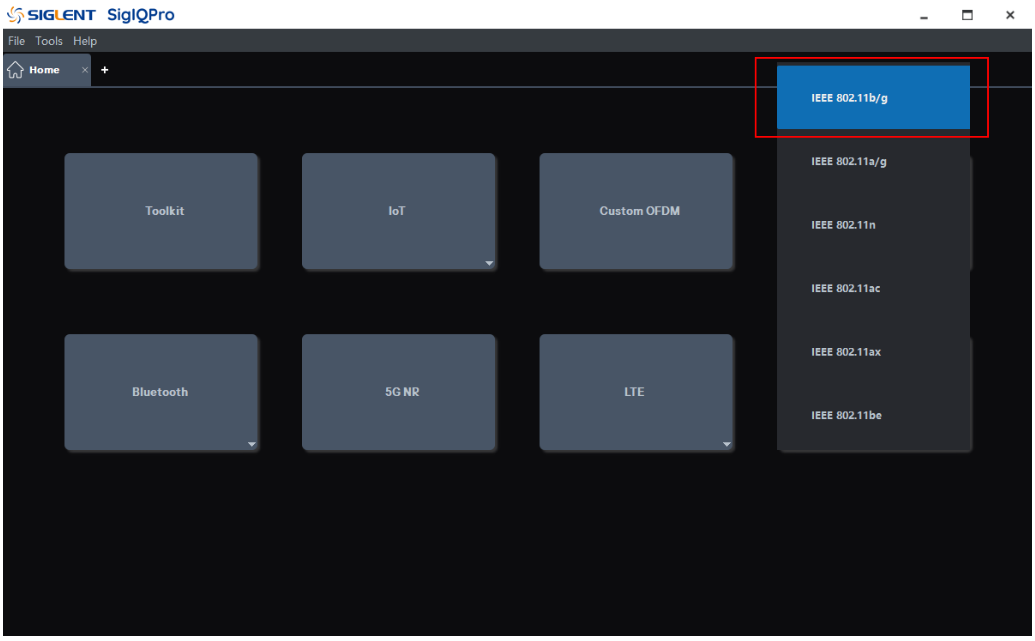

1 Layer CC0 IQ Meas1
200 m/div
Ref 0
I-Q
-2.143
2.1429
Res BW 15 kHz
TimeLen 140 Sym
3 Layer CC0 Error Vector Spectrum1
200 m%/div
Ref 0 %
Mag
Start -600 carrier
Stop 600 carrier
Res BW 15 kHz
TimeLen 140 Sym
2 CC0 Spectrum1
15 dB/div
Ref -30 dBm
Log
Center 1 GHz
Span 24.575976563 MHz
Res BW 381.936 Hz
TimeLen 10.00002 ms
4 Demod CC0 Error Summary1
EVM = 506.32 m%rms at EVMWindowEnd
EVM Pk = 1.7845 % at sym122, subcar 454
Data EVM = 505.62 m%rms
RS EVM = 481.24 m%rms
Channel Power = -20.168 dBm
RS Tx. Power (Avg) = -50.966 dBm
OFDM Sym. Tx Power = -20.173 dBm
RS Rx. Power (Avg) = -50.966 dBm
RSSI = -20.142 dBm
RS Rx. Quality = -10.824 dB
Freq Err = -45.417 mHz
SyncCorr = 99.984 % using P-SS
Common Tracking Error = 113.59 m%rms
SymClk Err = 0.00034 ppm
Time Offset = 493.73 usec
IQ Offset = -65.574 dB
IQ Gain Imbalance = -0.003 dB
IQ Quad. Error = 12.494 mdeg
IQ Timing Skew = 120.53 psec
CP Length Mode = Normal

2.13 Creating and Playing WLAN_802_11b/g Waveform Files

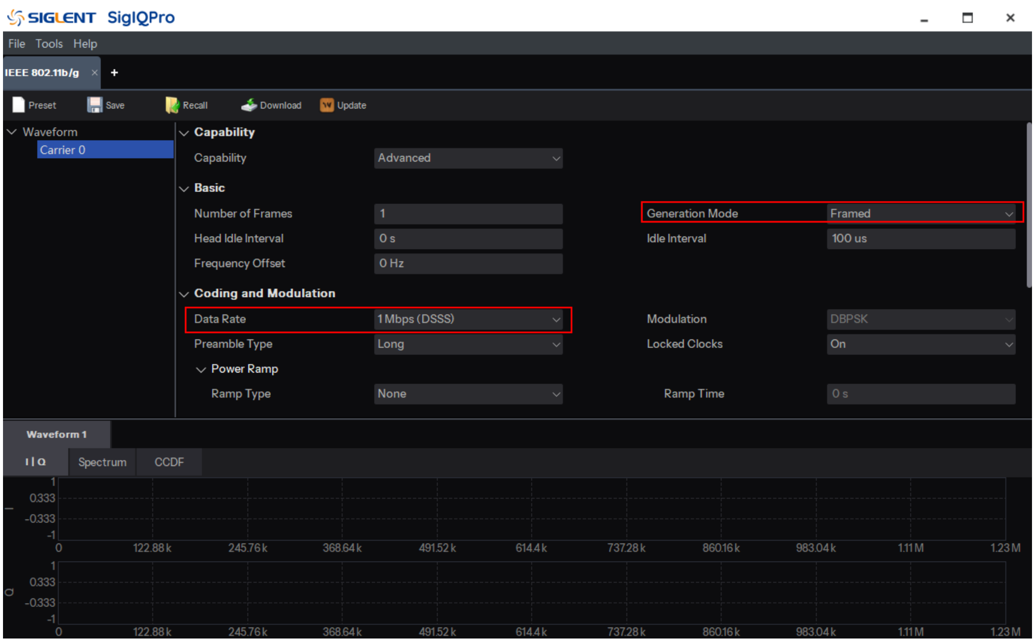
The following example demonstrates how to create and play WLAN_802_11b waveforms at 1Mbps rate. First, configure the waveform parameters in SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.13.1 Configuring Waveform Parameters

1. On the home page, click WLAN → WLAN_802_11b/g to enter the WLAN_802_11b/g configuration interface.

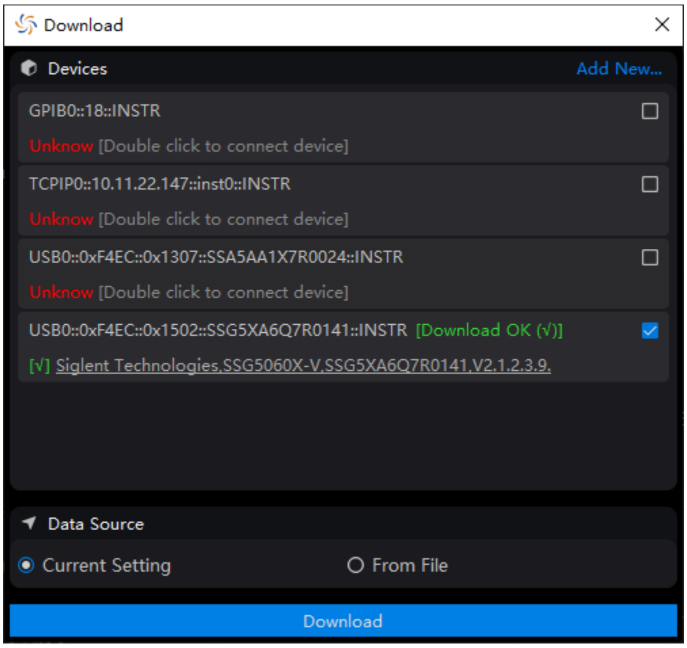


2. Click the Waveform node in the left-side tree view to access parameter settings:
   1) Set Generation Mode to Framed mode
   2) Set Data Rate to 1Mbps (DSSS)



2.13.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.



2.13.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-

V IQ MOD -> ARB:

You can see that ARB mode is playing LE_test.

2. Set the RF carrier to 2.412 GHz, -5 dBm.
3. Turn on modulation and RF output:
   1) Press the RF ON/OFF front panel button to turn on the RF output.
   2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.13.4 Demodulation Result

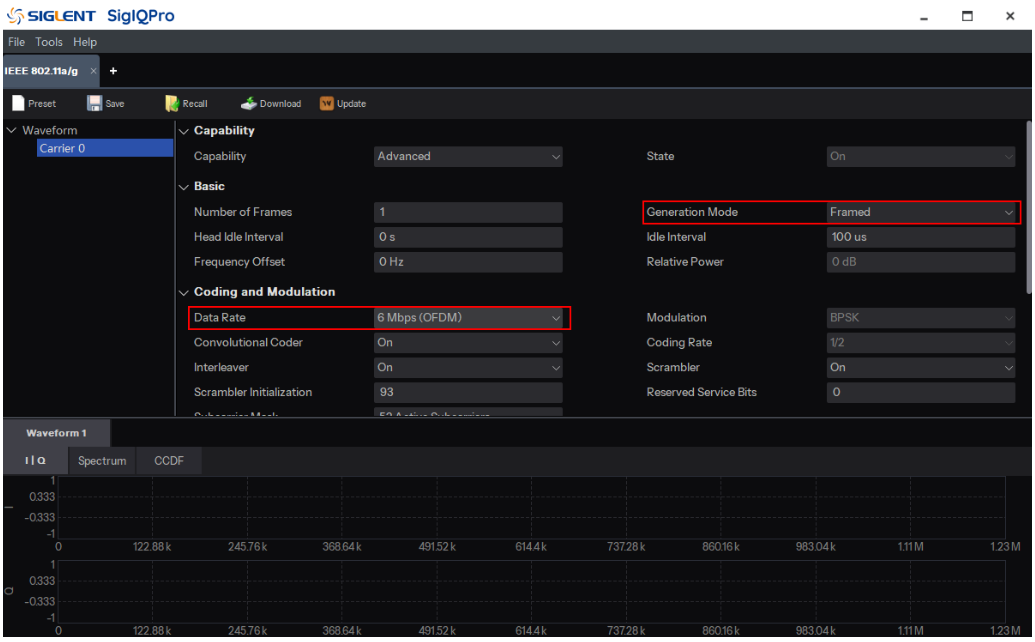
View the demodulation results in the spectrum analyzer:

2.14 Creating and Playing WLAN_802_11a/g Waveform Files

The following example demonstrates how to create and play WLAN_802_11a waveforms at 6Mbps (OFDM). First, configure the waveform parameters in SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

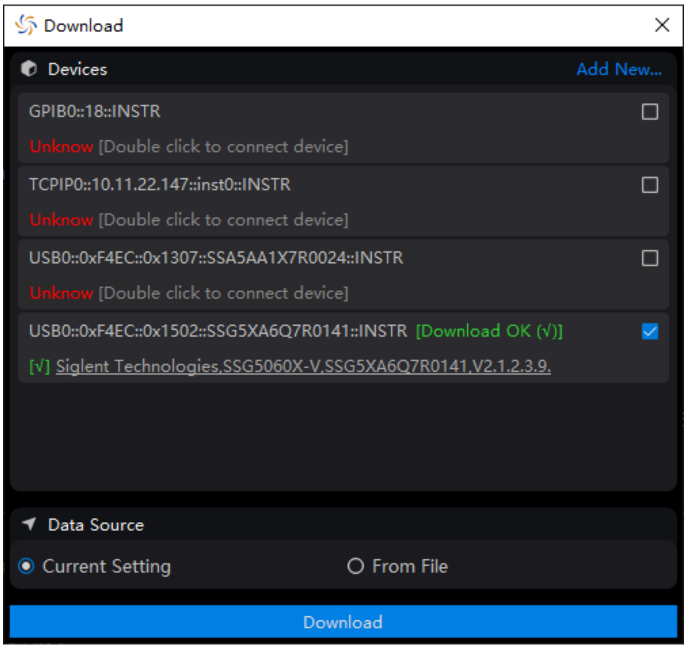
2.14.1 Configuring Waveform Parameters

1. On the home page, click WLAN → WLAN_802_11a/g to enter the WLAN_802_11a/g configuration interface.
2. Click the Waveform node in the left-side tree view to access parameter settings:
   1) Set Generation Mode to Framed mode
   2) Set Data Rate to 6Mbps (OFDM)



2.14.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.



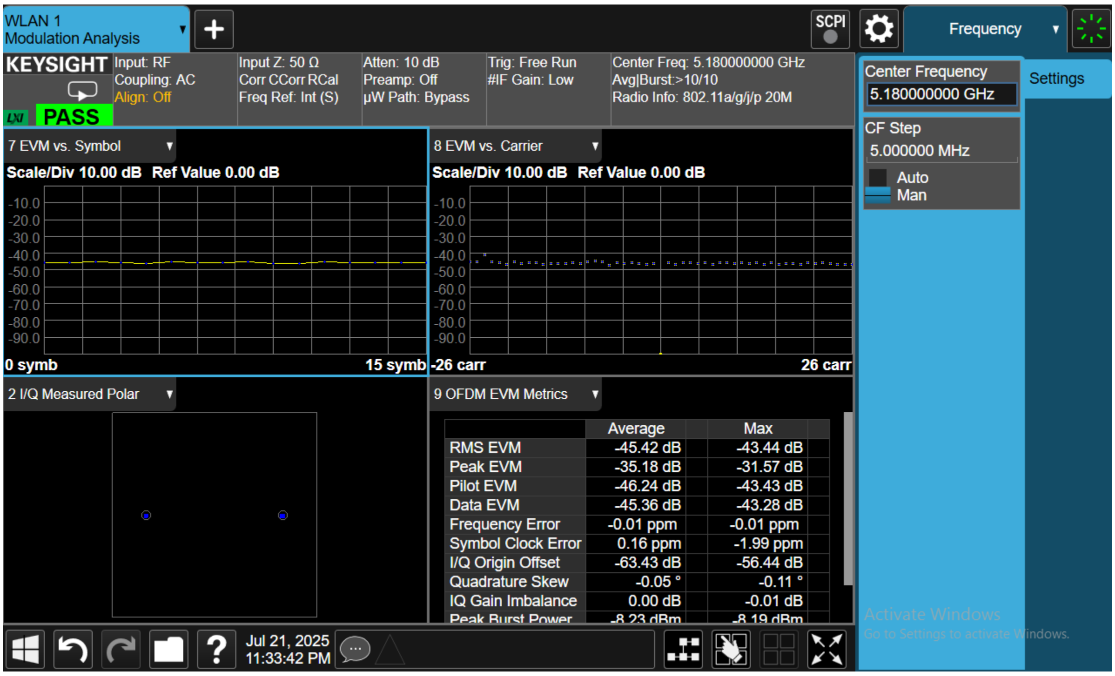
2.14.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-V IQ MOD -> ARB:

   You can see that ARB mode is playing LE_test.
2. Set the RF carrier to 2.412 GHz, -5 dBm.
3. Turn on modulation and RF output:
   1) Press the **RF ON/OFF** front panel button to turn on the RF output.
   2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main switch.

2.14.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

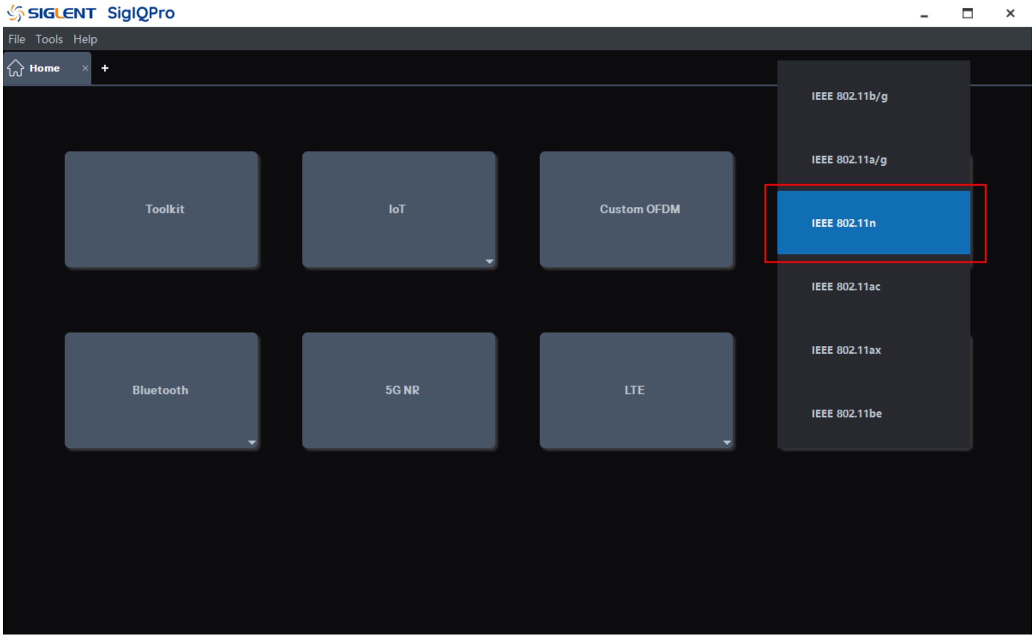

WLAN 1
Modulation Analysis
SCPI
Frequency
KEYSIGHT
Input: RF
Coupling: AC
Align: Off
PASS
Input Z: 50 Ω
Corr CCorr RCal
Freq Ref: Int (S)
Atten: 10 dB
Preamp: Off
µW Path: Bypass
Trig: Free Run
#IF Gain: Low
Center Freq: 5.180000000 GHz
Avg|Burst:>10/10
Radio Info: 802.11a/g/j/p 20M
Center Frequency
5.180000000 GHz
Settings
CF Step
5.000000 MHz
Auto
Man
7 EVM vs. Symbol
Scale/Div 10.00 dB Ref Value 0.00 dB
0 symb
15 symb
8 EVM vs. Carrier
Scale/Div 10.00 dB Ref Value 0.00 dB
-26 carr
26 carr
2 I/Q Measured Polar
9 OFDM EVM Metrics
Average
Max
RMS EVM -45.42 dB -43.44 dB
Peak EVM -35.18 dB -31.57 dB
Pilot EVM -46.24 dB -43.43 dB
Data EVM -45.36 dB -43.28 dB
Frequency Error -0.01 ppm -0.01 ppm
Symbol Clock Error 0.16 ppm -1.99 ppm
I/Q Origin Offset -63.43 dB -56.44 dB
Quadrature Skew -0.05 ° -0.11 °
IQ Gain Imbalance 0.00 dB -0.01 dB
Jul 21, 2025
11:33:42 PM

2.15 Creating and Playing WLAN_802_11n Waveform Files

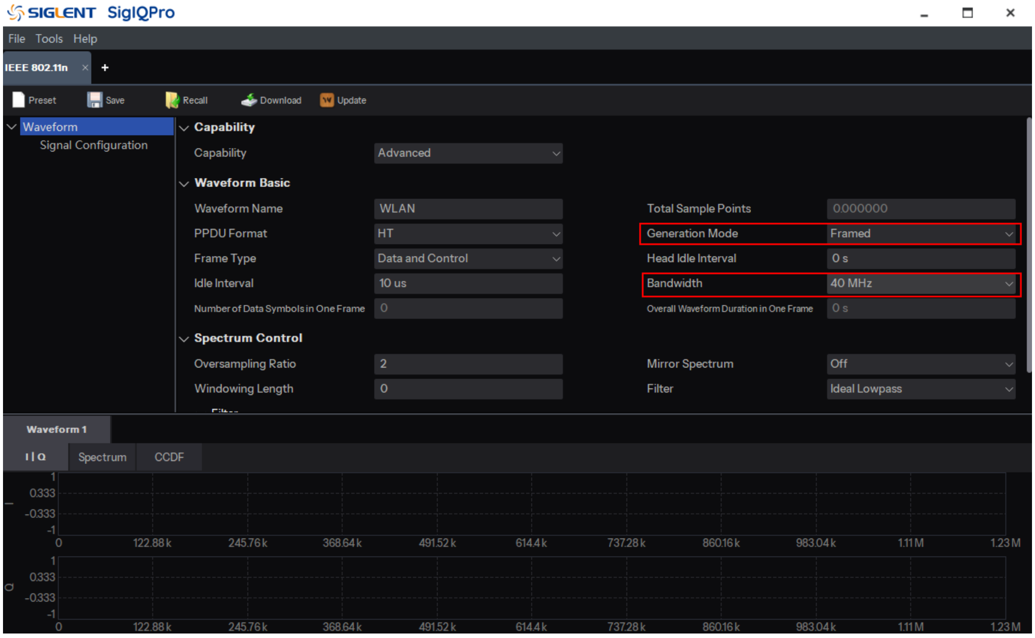
The following example demonstrates how to create and play a WLAN_802_11n waveform with a bandwidth of 40M. First, configure the waveform parameters on SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.15.1 Configuring Waveform Parameters

1. On the homepage, click WLAN -> WLAN_802_11n to enter the WLAN_802_11n settings interface.

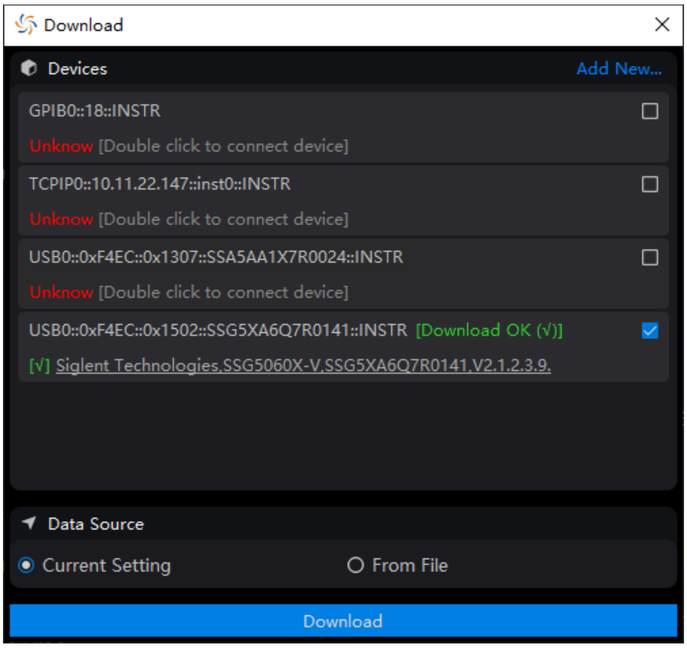


2. Click the Waveform node in the tree view on the left side of the window to access the parameter settings:
   1) Set Generation Mode to Framed mode.
   2) Set BandWidth to 40M.



2.15.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.



2.15.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-

V IQ MOD -> ARB:

You can see that ARB mode is playing LE_test.

2. Set the RF carrier to 2.412 GHz, -5 dBm.

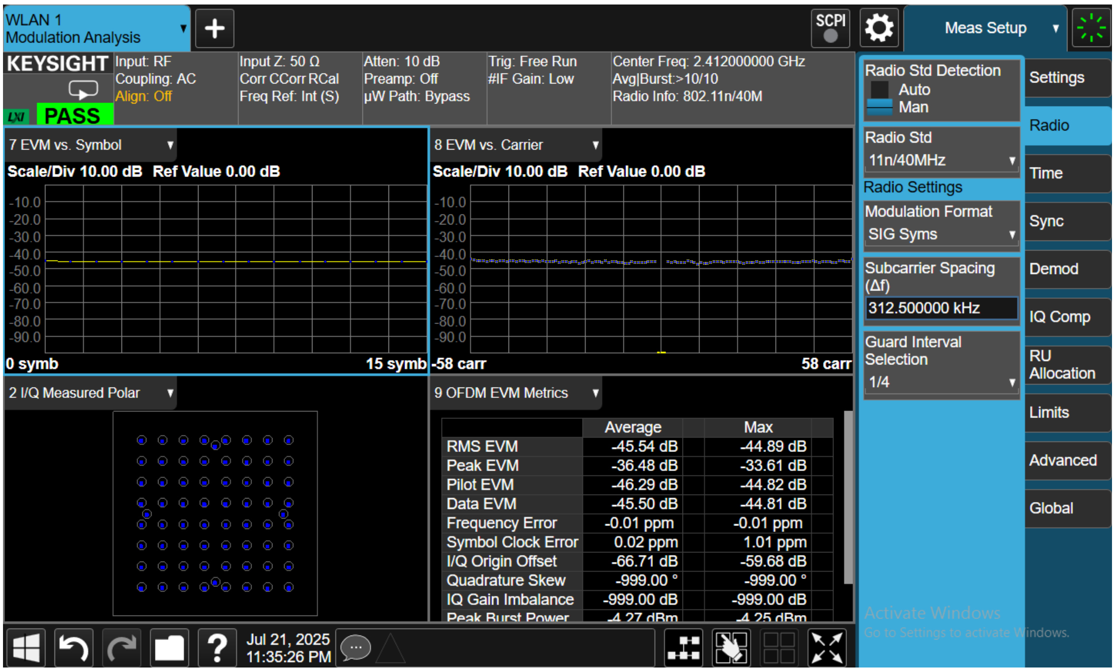
3. Turn on modulation and RF output:

   1) Press the RF ON/OFF front panel button to turn on the RF output.

   2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.15.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

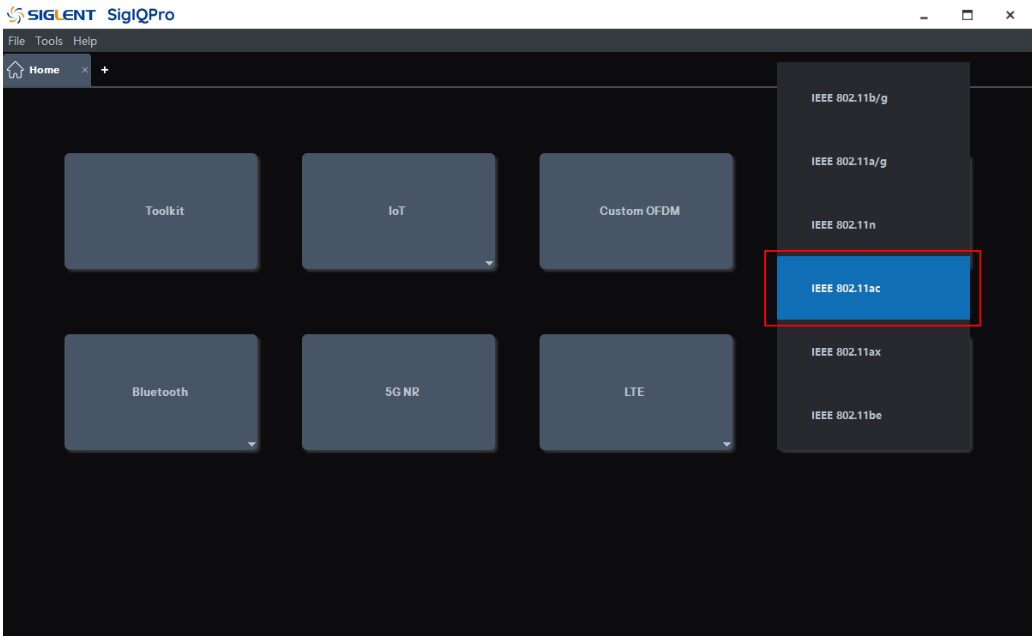


2.16 Creating and Playing WLAN_802_11ac Waveform Files

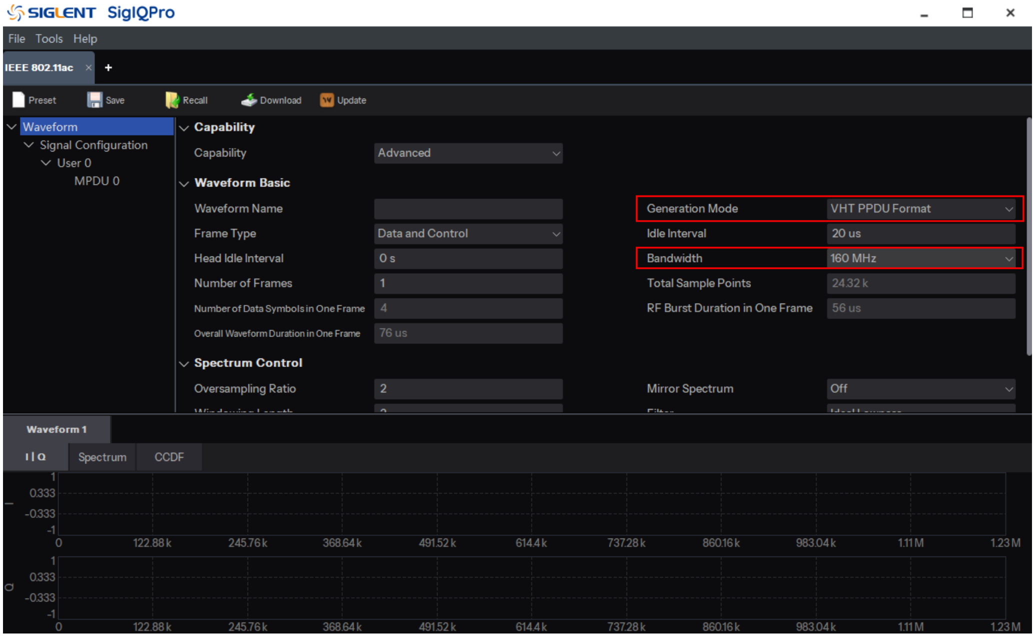
The following example demonstrates how to create and play a WLAN_802_11ac waveform with a bandwidth of 160M. First, configure the waveform parameters on SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.16.1 Configuring Waveform Parameters

1. On the homepage, click WLAN -> WLAN_802_11ac to enter the WLAN_802_11ac settings interface.

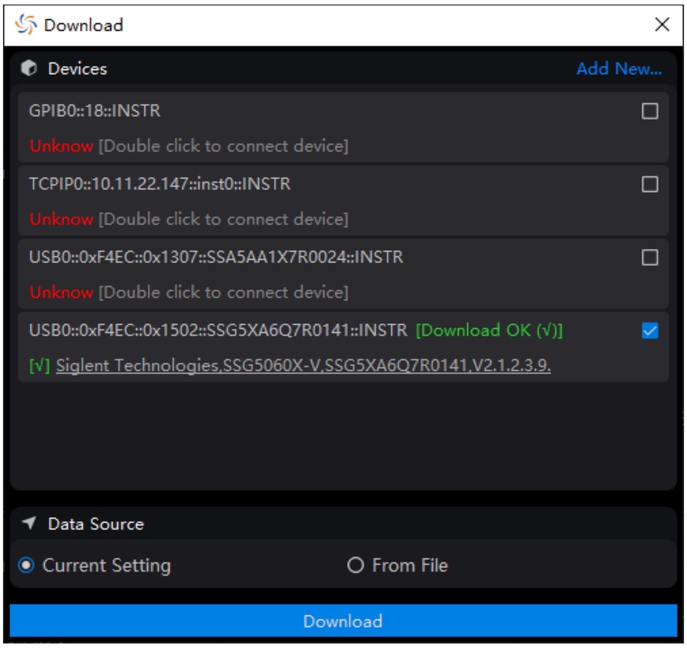


2. Click the Waveform node in the tree view on the left side of the window to access the parameter settings:
   1) Set Generation Mode to VHT PPDU Format mode.
   2) Set BandWidth to 160M.



2.16.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.



2.16.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-

V IQ MOD -> ARB:

You can see that ARB mode is playing LE_test.

2. Set the RF carrier to 2.412 GHz, -5 dBm.

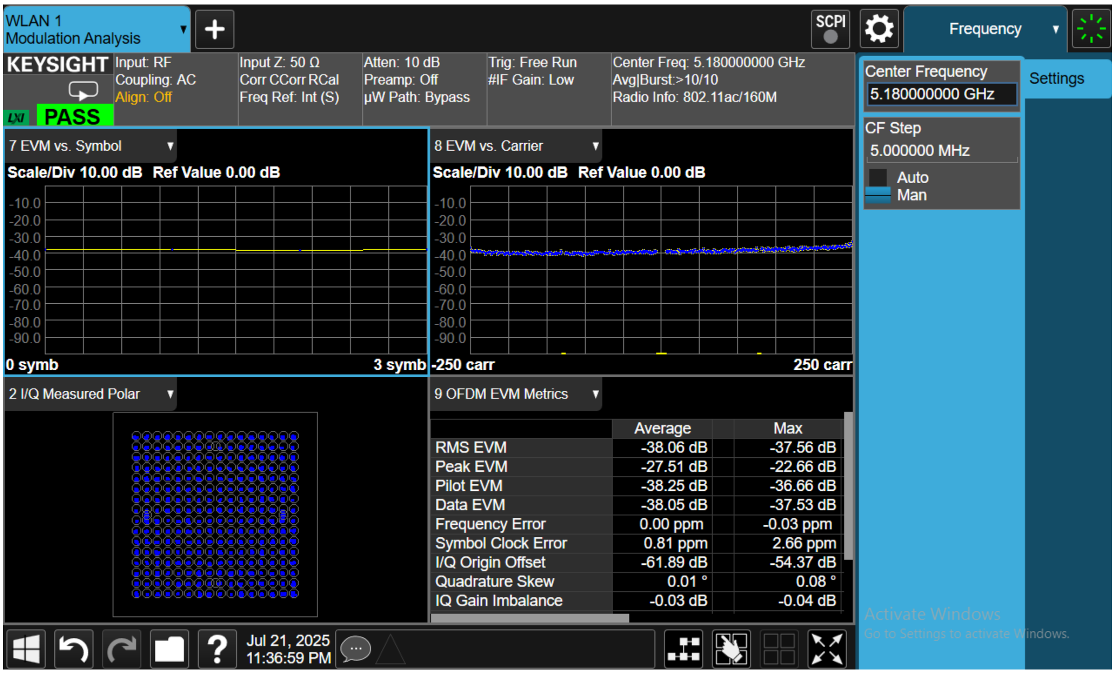
3. Turn on modulation and RF output:

   1) Press the **RF ON/OFF** front panel button to turn on the RF output.

   2) Press the **MOD ON/OFF** front panel button to turn on the IQ Mod modulation main switch.

2.16.4 Demodulation Result

View the demodulation results in the spectrum analyzer:

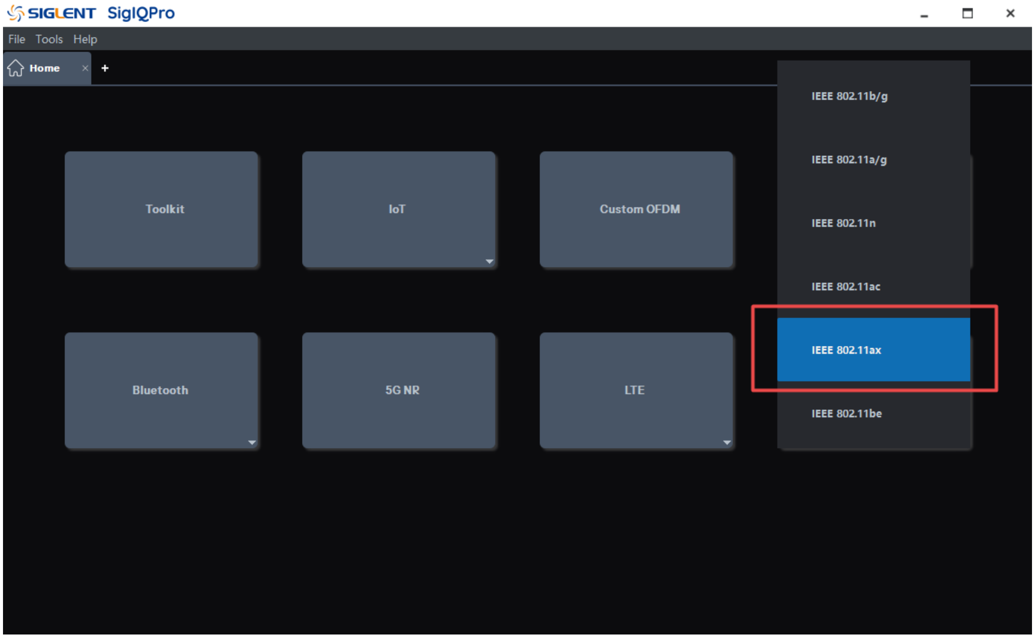


2.17 Creating and Playing WLAN_802_11ax Waveform Files

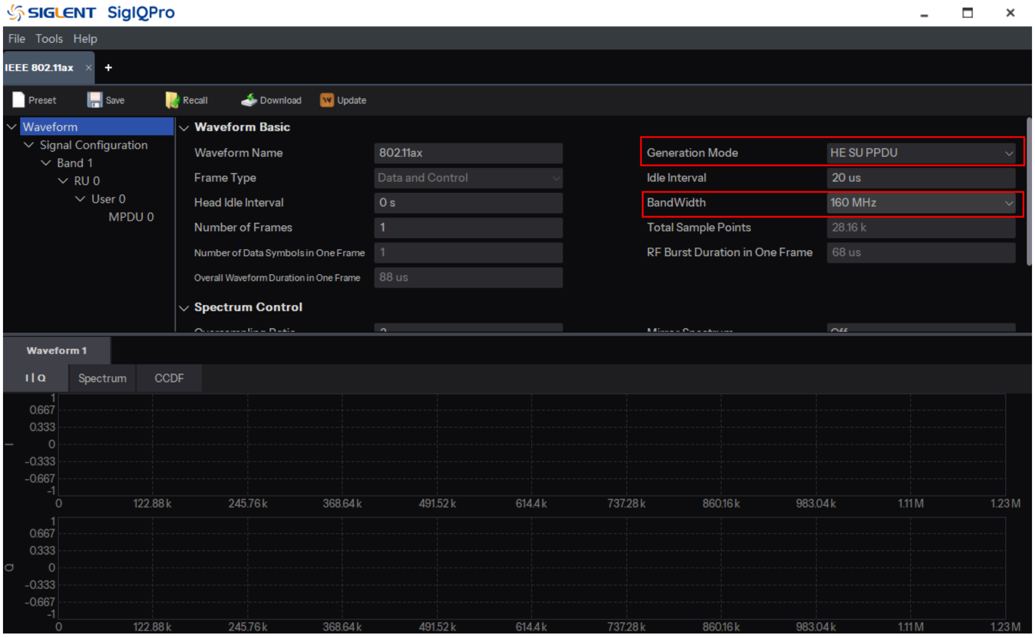
The following example demonstrates how to create and play a WLAN_802_11ax-HE SU PPDU-160M waveform. First, configure the waveform parameters on SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.17.1 Configuring Waveform Parameters

1. On the homepage, click WLAN -> WLAN_802_11ax to enter the WLAN_802_11ax settings interface.

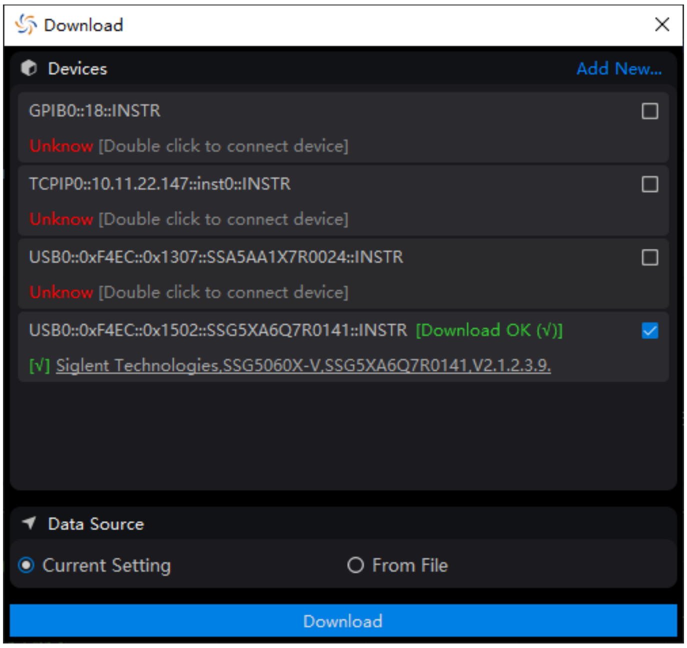


2. Click the Waveform node in the tree view on the left side of the window to access the parameter settings:
   1) Set Generation Mode to HE SU PPDU mode.
   2) Set BandWidth to 160M.



2.17.2 Download the Waveform to Signal Source

1. Click the Update button on the toolbar to update the I/Q waveform and spectrum display at the bottom of the software UI.
2. Click the Download button on the toolbar to download the waveform to SSG5000X-V.



2.17.3 Play the Waveform in Signal Source

1. After successfully downloading the waveform, check whether there is a waveform in SSG5000X-

V IQ MOD -> ARB:

You can see that ARB mode is playing LE_test.

2. Set the RF carrier to 2.412 GHz, -5 dBm.
3. Turn on modulation and RF output:
   1) Press the RF ON/OFF front panel button to turn on the RF output.
   2) Press the MOD ON/OFF front panel button to turn on the IQ Mod modulation main switch.

2.17.4 Demodulation Result

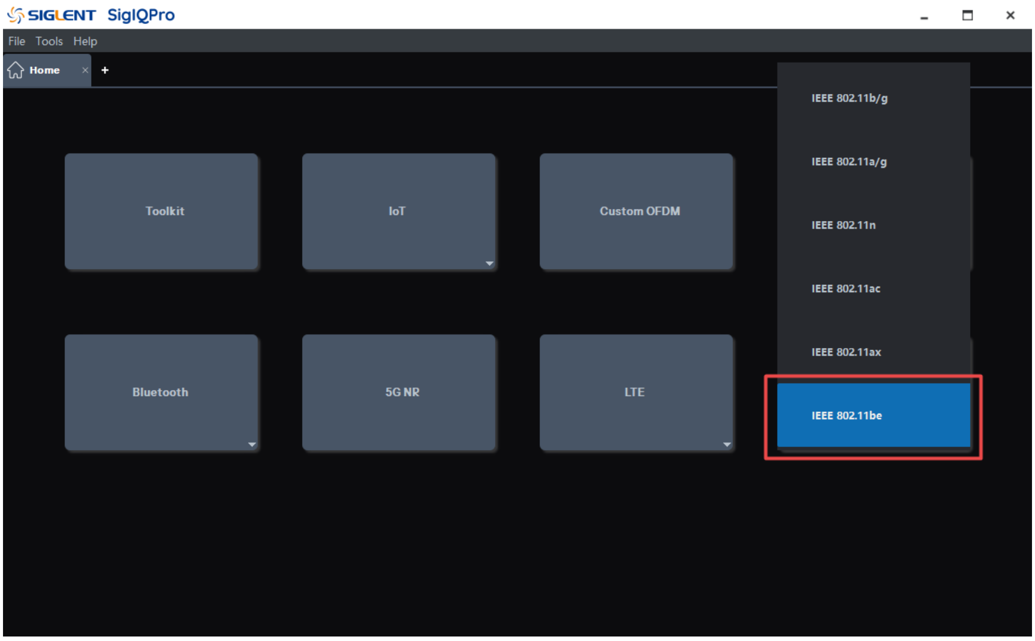
View the demodulation results in the spectrum analyzer:

2.18 Creating and Playing WLAN_802_11be Waveform Files

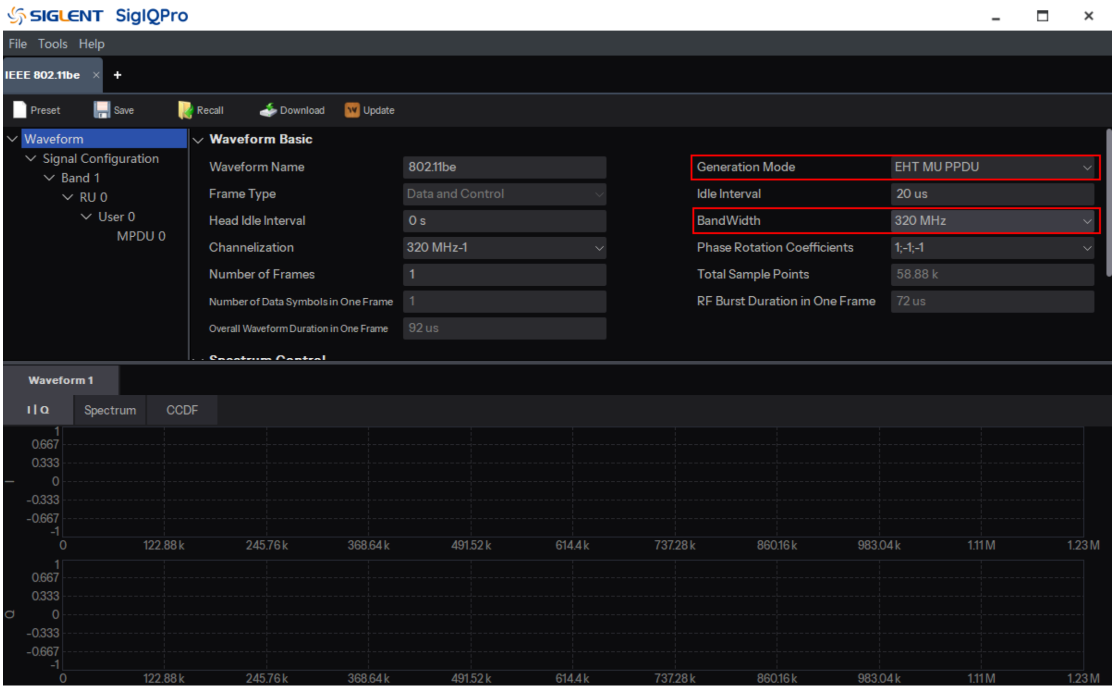
The following example demonstrates how to create and play a WLAN_802_11be-EHT MU PPDU-320M waveform. First, configure the waveform parameters on SiglQPro, then download the waveform to the SSG5000X-V, and finally play the waveform on the SSG5000X-V.

2.18.1 Configuring Waveform Parameters

1. On the homepage, click WLAN → WLAN_802_11be to enter the WLAN_802_11be settings interface.



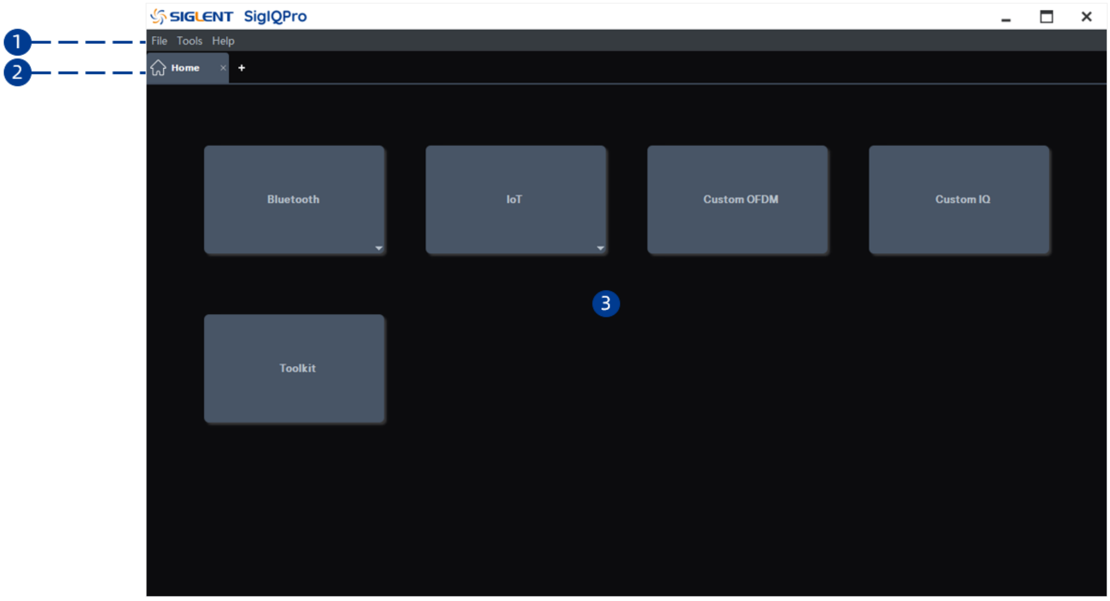
2. Click the Waveform node in the tree view on the left side of the window to access the parameter settings:
   1) Set Generation Mode to EHT MU PPDU mode.
   2) Set BandWidth to 320M.


SIGLENT SiglQPro
File Tools Help
IEEE 802.11be
Preset
Save
Recall
Download
Update
Waveform
Signal Configuration
Band 1
RU 0
User 0
MPDU 0
Waveform Basic
Waveform Name
802.11be
Frame Type
Data and Control
Head Idle Interval
0 s
Channelization
320 MHz-1
Number of Frames
1
Number of Data Symbols in One Frame
1
Overall Waveform Duration in One Frame
92 us
Generation Mode
EHT MU PPDU
Idle Interval
20 us
BandWidth
320 MHz
Phase Rotation Coefficients
1;-1;-1
Total Sample Points
58.88 k
RF Burst Duration in One Frame
72 us
Waveform 1
I | Q
Spectrum
CCDF

3 User Interface Overview

This topic describes the common features of the SiglQPro user interface.

3.1 Home Page



3.1.1 Menu Bar

File

- Recall: Opens a file management window where you can open a previously saved SiglQPro configuration file (*.project) to recall settings.
- Save As: Opens a file management window where you can save your current SiglQPro configuration as a file (*.project) for future use.
- Exit: Exits the SiglQPro software.

Tools

- Toolkit: Launches the Toolkit application.

Help

- Content: Shows the help file.
- Website: Opens company website.
- About: Shows software information.

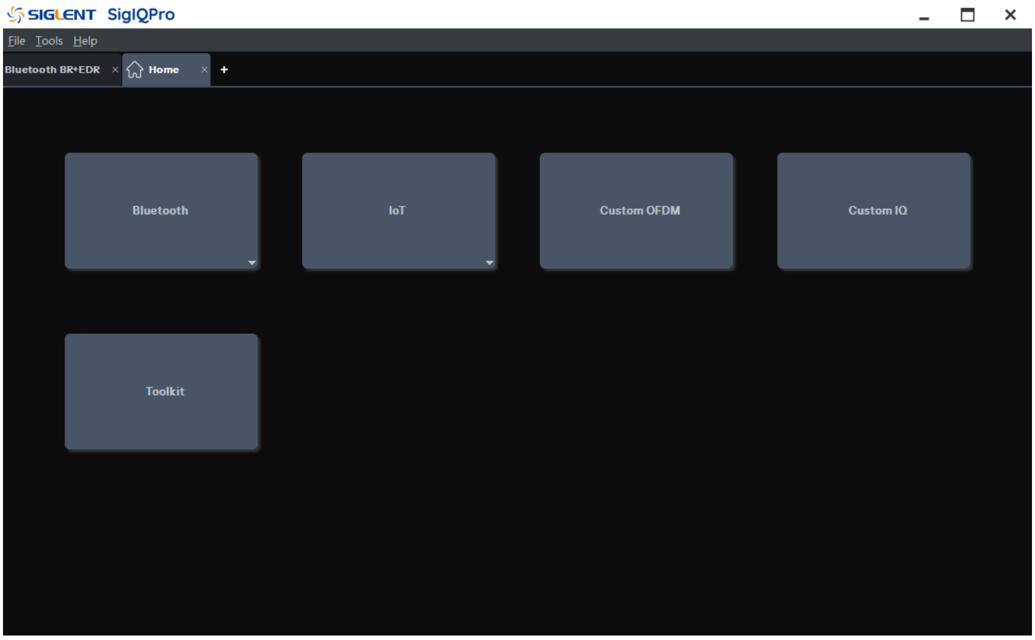
3.1.2 Tab Bar

Displays the Home page and currently running applications. Supports the following operations:

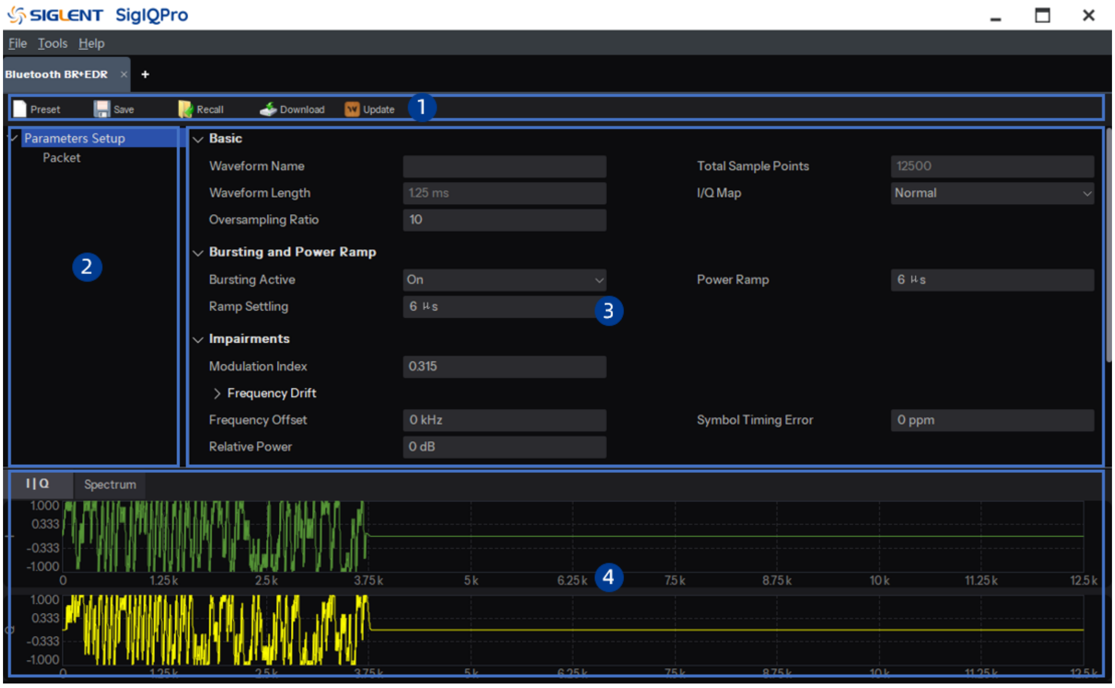
- Clicks the tab to switch to the settings page of the application;
- Clicks "×" on the tab to exit the application;
- Clicks "+" to add a home page.

3.1.3 Protocol Menu

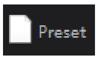
Select the protocol you want and click to open the protocol settings, such as Custom OFDM.



3.2 Parameters Setting Page



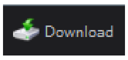
3.2.1 Toolbar



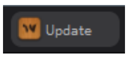
: Resets your current application configuration to default settings.

: Opens a file management window where you can save your current application configuration as a file (*.state) or generated waveform file (*.ARB) for future use.

: Opens a file management window where you can recall a previously saved application configuration file (*.state).



: Opens an instrument connection window where you can download a waveform, based on your application's current configuration or previously saved, to the connected instrument.



: Update the graph view based on your application's current configuration.

3.2.2 Tree View

The left pane of the main window is called the tree view. It is useful for navigating between the waveform setup nodes and packet setup nodes.

3.2.3 Parameter View

The right pane of the main window is called the parameter view. This area enables you to set the waveform parameters. Selecting an item in the tree view enables the related elements in the parameter view.

3.2.4 Graph View

The graph view displays different representations of the generated waveform. Click the tab at the top of the graph view to switch to different waveform graphs. Changes to the waveform configuration will not update the graph until you update the waveform.

3.3 Export or Import Files

SiglQPro supports importing or exporting three types of files.

3.3.1 Project File (*.project)

This file is used to save software configuration, includes the currently launched applications and the current parameter settings of the applications.

Export: Click “File” -> “Save as…” in the menu bar to open a file management window, then click “Save” button to save the project file.

Import: Click “File” -> “Recall…” in the menu bar to open a file management window, then open a previously saved project file (*.project) to recall settings. The software will update the interface display based on the saved configurations in the file.

3.3.2 State File (*.state)

This file is used to save the settings for the current application and can only be imported or exported by current application.

Export: Click “Save” icon in the toolbar of the application to open a file management window, then select save type as “App State Files (*.state)” and click “Save’ to save the state file.

Import: Click “Recall” icon in the toolbar of the application to open a file management window, then open a previously saved state file (*.state) to recall settings for current application.

3.3.3 Waveform File (*.ARB)

This file is used to save an encrypted waveform file (with ARB extension) to your PC. The file contains waveform information of the current application and can then be downloaded and played in licensed instruments.

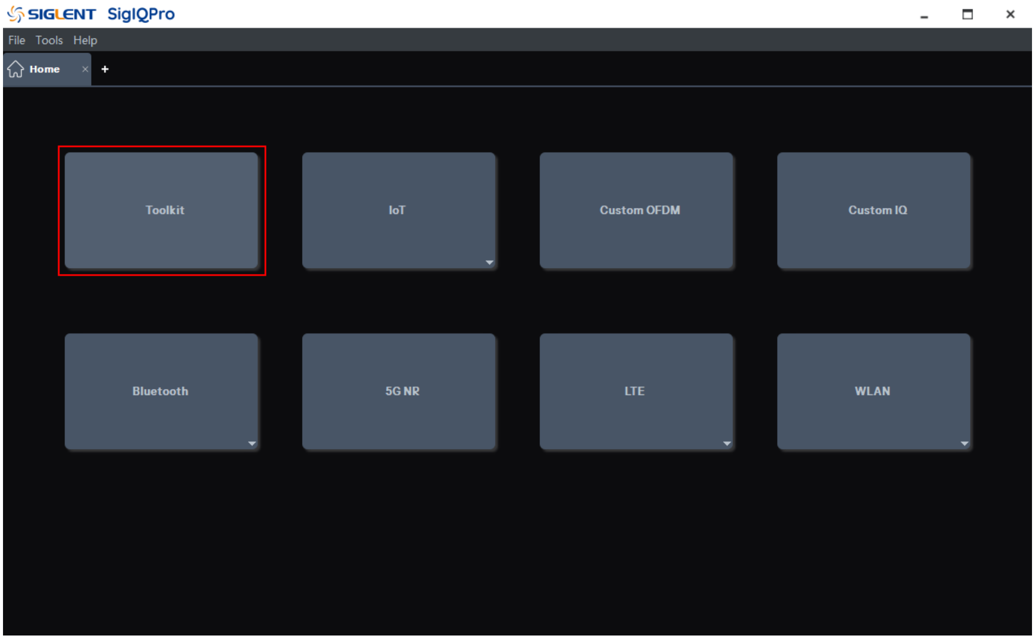
Export: Click “Save” icon in the toolbar of the application to open a file management window, then select save type as “Waveform File (*.ARB)” and click “Save” to save the waveform file.

4 Waveform Setup

4.1 Toolkit

Toolkit is a file conversion tool, which can convert MAT files generated by MATLAB or ASCII files such as TXT files, DAT files or CSV files into files that can be played by SIGLENT instruments. To convert the file format, you need to import the file in "Waveform Import", fill in the information about the exported file in " Waveform Download", and click "Download" in the toolbar to download the target file.

You can click **Toolkit** on the homepage to enter the Toolkit setting interface.



4.1.1 Waveform Import

This function enables you to import a waveform file, with a specific file format, from the PC.

4.1.1.1 Source File Type

Use the drop-down menu to select the source file type.

Properties are displayed. Select one of the file types to navigate to that topic to view the associated waveform properties. MAT-File 5 and TXT/CSV/DAT are supported.

1. MAT-File 5

This format is currently used by MATLAB versions 5, 6, 6.5 and 7.

Mat-File 5 Details and Code Example

The MAT file can contain an I array of data, a Q array of data. The array variables are named by the person saving the data.

- I and Q are two separate arrays. The arrays must be the same size.

```
ilData = 1:10;                  % 10 I data points
qData = iData;                  % 10 Q data points
save('mydata', 'iData', 'qData');       % default format is .mat
```

- I, Q data can be saved as any numeric type supported by MATLAB:
  double precision floating point values -- 8 bytes per sample;
  single precision floating point values -- 4 bytes per sample;
  int32( ) -- 4 bytes per sample;
  int16( ) -- 2 bytes per sample;
  and so on.

- The application will only recognize numeric types and will discard any variable that is contained in a structure, cell or object.
  For example, if the data is placed in a structure and then stored:
  MyData = struct('I', iData, 'Q', qData);
  save 'myfile' MyData

The application will not be able to discover I, Q under this structure.

2. ASCII /CSV/DAT

The ASCII / CSV / DAT file must contain I and Q data, and may also include marker data. The import function searches for markers, so it must know how many markers the file contains.

ASCII Code Example

This is an example of ASCII code from a single file.

I1 Q1

I2 Q2

I3 Q3

4.1.1.2 Source File

To select the source file:

Step1. Click the Source File box to open a dialog window.

Step2. Navigate to the desired file.

Waveform IQ data will finally be transformed into format of 4 bytes per sample to play on signal generator. Hence, Int16 format with 32767 scale is recommended for source file.

4.1.1.3 I Data

This parameter takes effect only when Source File Type is set to MAT-File 5.

The drop-down list enables you to select an I data array from the imported waveform file.

4.1.1.4 Q data

This parameter takes effect only when Source File Type is set to MAT-File 5.

The drop-down list enables you to select a Q data array from the imported waveform file.

4.1.1.5 Use Separate Q File

This parameter takes effect only when Source File Type is set to TXT/CSV/DAT.

Use the drop-down menu to enable or disable the ability to use a separate file for Q data.

If "Yes" is selected, then only I data from the Source file is read.

4.1.1.6 Q Source File

This parameter takes effect only when Source File Type is set to TXT/CSV/DAT.

To select the source file:

Step1. Click the Q Source File box to open a dialog window.

Step2. Navigate to the desired file.

4.1.1.7 Data Type

This parameter takes effect only when Source File Type is set to TXT/CSV/DAT.

Choices: Decimal | Hexadecimal;

Default: Decimal.

Use the drop-down menu to select data type.

4.1.1.8 Big / Little Endian

This parameter takes effect only when Source File Type is set to TXT/CSV/DAT and when the Data Type is set to hexadecimal.

Choices: Big Endian | Little Endian;

Default: Big Endian.

Use the drop-down menu to select big or little endian for HEX data.

Note: When Little Endian is selected, only 2-byte hexadecimal numbers can be parsed.

4.1.1.9 Signed / Unsigned Number

This parameter takes effect only when Source File Type is set to TXT/CSV/DAT and when the Data Type is set to hexadecimal.

Choices: Signed | Unsigned;

Default: Signed.

Use the drop-down menu to select signed or unsigned type for HEX data.

4.1.1.10 Swap IQ

This parameter takes effect only when Source File Type is set to TXT/CSV/DAT.

Choices: Yes | No;

Default: No.

Use the drop-down menu to set the swap IQ flag. If it is set to “Yes”, IQ data will be swapped for waveform generation.

4.1.1.11 Number of Points

Displays the number of points defined by the data files in the selected waveform. Read-only.

4.1.1.12 Sample Rate

Range: 100.0 Hz to 200.0 MHz;

Default: 100.00 MHz.

Enter the waveform sample rate. Instrument Sample Clock is coupled with waveform Sample Rate and Oversampling Ratio.

Sample Clock = Sample Rate * Oversampling Ratio.

4.1.2 Waveform Download

4.1.2.1 Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

4.1.2.2 Mirror Spectrum

Use the drop-down menu to control the Mirror Spectrum state. This feature inverts the Q channel, resulting in a mirrored spectrum. In some systems, as a signal propagates normally through the up-conversion process, the signal spectrum may be inverted. Use this feature to convert the signal back to a non-mirrored spectrum.

4.1.2.3 Oversampling Ratio

Range: 1 - 10 ; Default: 1.

When Oversampling Ratio is set to value other than 1, waveform is re-sampled. A larger Oversampling Ratio results in using more waveform memory. So, set it to 1 if re-sampling is not required.

Instrument Sample Clock is coupled with waveform Sample Rate and Oversampling Ratio.

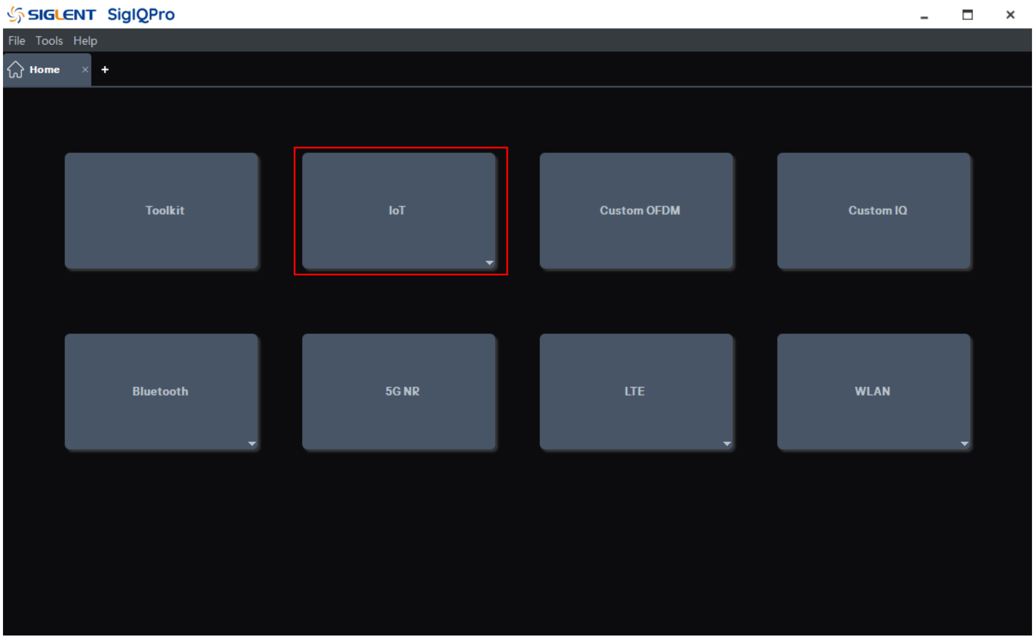
Sample Clock = Sample Rate * Oversampling Ratio.

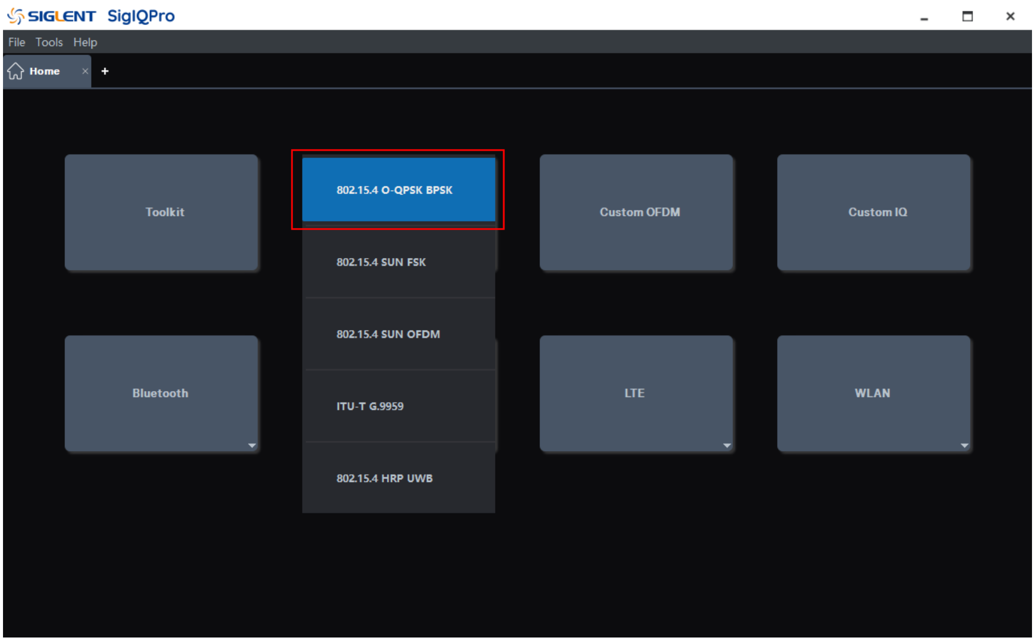
4.2 IEEE 802.15.4 O-QPSK BPSK

O-QPSK PHY and BPSK PHY are physical layer specifications defined in IEEE standard 802.15.4 for low data rate wireless connections.

Protocol version: IEEE Std 802.15.4 -2020

You can click IoT -> 802.15.4 O-QPSK BPSK on the homepage to enter the ZigBee setting interface.





4.2.1 Waveform Setup

Press Waveform Setup in the left window to enter parameter settings.

4.2.1.1 Basic

1. Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

2. Number of Frames

Range: 1 to 2000 ; Default: 1.

Set the number of frames included in the generated waveform.

3. OverSampling Ratio

Range: 2 to 100 ; Default: 10.

Set the number of samples calculated per I/Q symbol.

4. Total Sample Points

Display the generated waveform length (number of points).

Note: This parameter is displayed only and cannot be edited.

5. Waveform Length

Display the generated waveform length (in second).

Note: This parameter is displayed only and cannot be edited.

4.2.1.2 Marker

1. Marker 1 Source

Choice: Waveform Start | Frame Start ; Default: Waveform Start.

Use the drop-down menu to select the type of Mark 1 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start : Set the first point of the waveform to an active marker point.
- Frame Start : Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

2. Marker 2 Source

Choice: Waveform Start | Frame Start ;

Default: Frame Start.

Use the drop-down menu to select the type of Mark 2 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start : Set the first point of the waveform to an active marker point.
- Frame Start : Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

4.2.2 Packet

Press **Packet** in the left window to enter parameter settings.

4.2.2.1 General Setting

1. PHY Scheme

Choices: O-QPSK | BPSK ;

Default: O-QPSK.

Use the drop-down menu to select the 802.15.4 PHY scheme.

2. Idle Interval (us)

Range: 0 – 200000 ; Default: 100.

Set the idle interval in-between frames in microseconds. When idle interval is set to zero, a continuous waveform will be generated.

3. Data Rate

Displays the data rate for current 802.15.4 PHY scheme.

4. Frequency Band

Choices: 780 MHz | 868 MHz | 915 MHz | 2450 MHz ;

Default: 2450 MHz .

Use the drop-down menu to select the frequency band of 802.15.4 PHY scheme.

Note 1: If PHY Scheme is set to BPSK, 780 MHz and 2450 MHz cannot be selected.

Note 2: The selected frequency band does not actually change the center frequency of the signal source.

4.2.2.2 Packet Setting

1. Preamble (Hex)

Displays the Preamble field of PPDU in hexadecimal format.

Note: This parameter is displayed only and cannot be edited.

2. SFD (Hex)

Displays the SFD (Start of Frame Delimiter) field of PPDU in hexadecimal format.

Note: This parameter is displayed only and cannot be edited.

3. PHR (Hex)

Displays the PHR (Payload Header) field of PPDU in hexadecimal format. The value is automatically updated when the PSDU settings are changed.

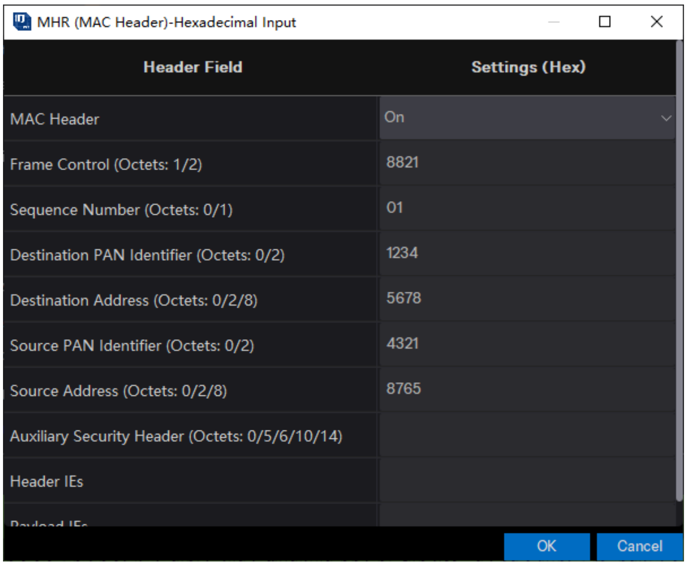
Note: This parameter is displayed only and cannot be edited.

4. PSDU

These are the Settings for the Physical Service Data Unit (PSDU) portion of the frame that contains the payload data.

1) MHR (MAC Header)

Use the drop-down menu to enable or disable the MAC Header filed.



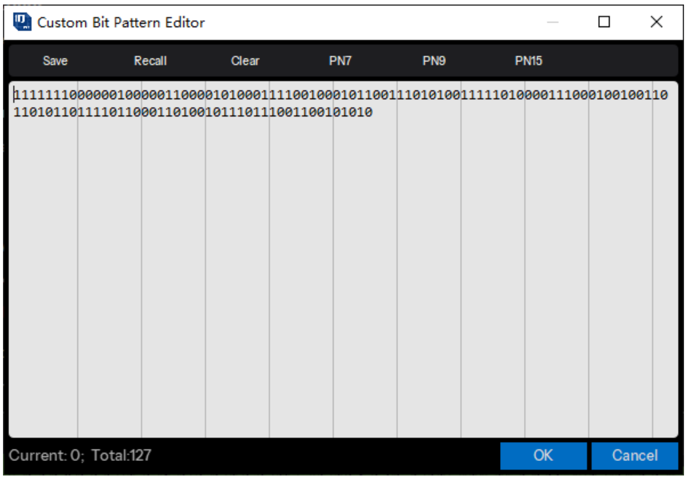
For more information on the MAC header, refer to the IEEE standards 802.15.4.

2) Data Type

Choices: PN9 | PN15 | USER ; Default: PN9.

Use the drop-down menu to set the type of packet payload.

- PN9: A pseudo-random binary sequence of order 9 is used to fill the packet payload
- PN15: A pseudo-random binary sequence of order 15 is used to fill the packet payload
- USER: A user-defined binary sequence is used to fill the packet payload



3) Seed

Set the seed value used to generate the pseudo-random binary sequence.

When Data Type PN9 is selected: Range: 0x0 – 0x1FF ; Default: 0x1FF.

When Data Type PN15 is selected: Range: 0x0 – 0x7FFF ; Default: 0x7FFF.

Note: This parameter can be edited only when the Data Type is PN9 or PN15.

4) Data Length (Octets)

Range: 0 – 127 ; Default: 20.

Set the length of packet payload in octets.

5) Data Mode

Choices: Continuous | Truncated ; Default: Continuous.

For multi-frame signals, select the mode applied to the packet payload. If there is only one frame in the signal, then there is no difference in selection.

- Continuous: packet payload data bits are distributed consecutively across multiple frames
- Truncated: packet payload data bits are the same for all frames, with the data size truncated for one frame

6) MAC FCS

Choices: On | Off ; Default: On.

Use the drop-down menu to enable or disable the MAC FCS (frame check sequence). For more information on the MAC FCS, refer to the IEEE standards 802.15.4.

4.2.2.3 Impairments

1. Symbol Timing Error

Range: -300 to 300ppm ; Default: 0ppm.

Set the shift of standard symbol rate for transmission. This shift varies the symbol rate of the signal. It is used to simulate transmission when the device's sampling clock is slightly off.

2. Frequency Offset

Range: -200 to 200kHz ; Default: 0kHz.

Set the static offset of the carrier frequency. This static offset is used to simulate the device transmitting at a frequency slightly offset from the specified carrier.

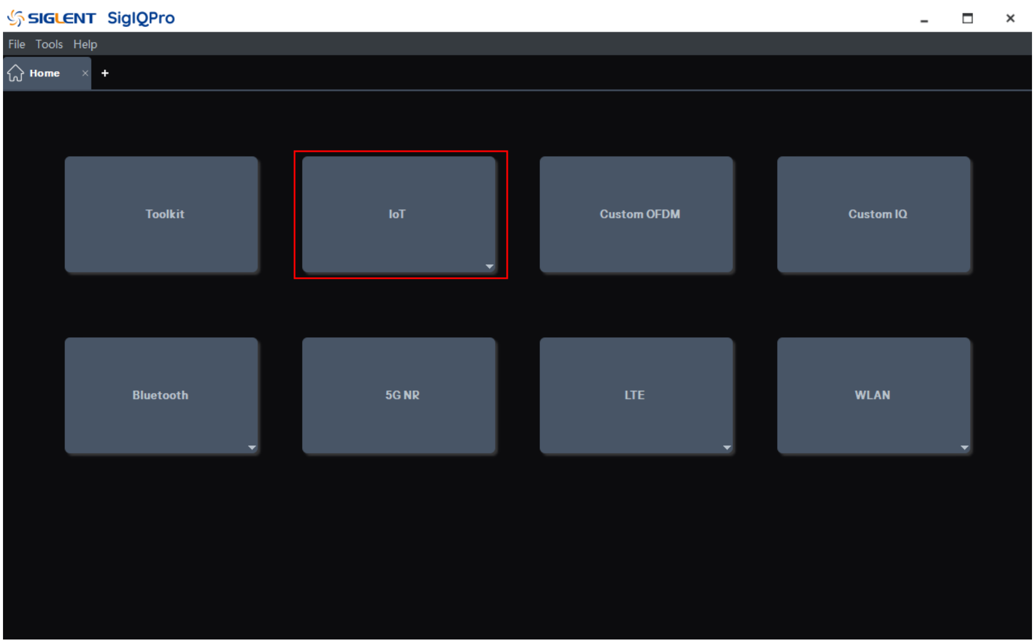
4.3 IEEE 802.15.4 SUN FSK

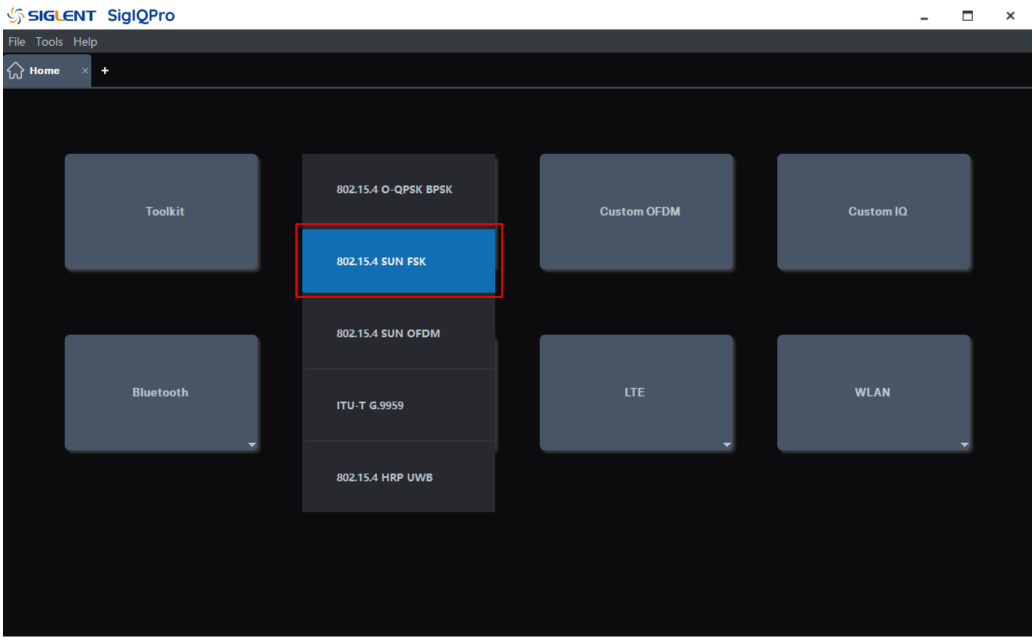
SUNs PHY defined in IEEE standard 802.15.4. The smart utility network is a principally outdoor, low data rate wireless network that supports two-way communications among sensing, measurement, and control devices in the smart grid.

SUNs enable multiple applications to operate over shared network resources, providing monitoring and control of a utility system. SUN devices are designed to operate in very large-scale, low-power wireless applications and often require using the maximum transmit power available under applicable regulations, in order to provide long-range, point-to-point connections. Frequently, SUNs are required to cover geographically widespread areas containing a large number of outdoor devices. In these cases, SUN devices typically employ mesh or peer-to-peer multihop techniques to communicate with an access point.

SUN FSK is one of the physical layers defined in the standard.
Protocol version: IEEE Std 802.15.4 -2020

You can click IoT -> 802.15.4 SUN FSK on the homepage to enter the 802.15.4 SUN FSK setting interface.





4.3.1 Waveform Setup

Press **Waveform Setup** in the left window to enter parameter settings.

4.3.1.1 Basic

1. Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

2. Number of Frames

Range: 1 to 2000 ; Default: 1.

Set the number of frames included in the generated waveform.

3. Oversampling Ratio

Range: 2 to 100 ; Default: 10.

Set the number of samples calculated per I/Q symbol.

4. Total Sample Points

Display the generated waveform length (number of points).

Note: This parameter is displayed only and cannot be edited.

5. **Waveform Length**

Display the generated waveform length (in second).

Note: This parameter is displayed only and cannot be edited.

4.3.1.2 Marker

1. **Marker 1 Source**

Choice: Waveform Start| Frame Start ;

Default: Waveform Start.

Use the drop-down menu to select the type of Mark 1 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start ; Set the first point of the waveform to an active marker point.
- Frame Start ; Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

2. **Marker 2 Source**

Choice: Waveform Start| Frame Start ;

Default: Frame Start.

Use the drop-down menu to select the type of Mark 2 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start : Set the first point of the waveform to an active marker point.
- Frame Start : Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

4.3.2 Packet

Press **Packet** in the left window to enter parameter settings.

4.3.2.1 General Setting

1. Data Rate

Range: 2.4 kb/s – 400 kb/s ; Default: 100 kb/s.

Set the data rate of FSK modulation in kb/s.

For more information on Data Rates, please refer to "Modulation and Coding for SUN FSK" in Section 19.3 of the IEEE Std 802.15.4-2020.

2. Modulation

Choice: 2FSK | 4FSK ; Default: 2FSK.

Use the drop-down menu to select the FSK modulation level.

For more information on the Modulation, please refer to " Modulation and Coding for SUN FSK " in Section 19.3 of the IEEE Std 802.15.4-2020.

3. Modulation Index

Range: 0.33 – 2 ; Default: 1.

Set the modulation index for FSK.

For more information on the Modulation Index, please refer to " Modulation and Coding for SUN FSK " in Section 19.3 of the IEEE Std 802.15.4-2020.

4. Idle Interval

Range: 0 – 200000 us ; Default: 1000 us.

Set the idle interval time in-between frames in microseconds. When idle interval is set to zero, a continuous waveform will be generated.

5. Ramp Symbols

Range: 1 – 10 ; Default: 4.

Set the symbol duration for waveform ramp up and down.

Note: This parameter is visible and configurable only when the idle interval is not zero.

6. Ramp Up/Down Symbol

Choice: First/Last | Center | One | Zero ;

Default: First/Last.

Use the drop-down menu to select the symbol for the period of waveform ramp up and down.

- First/Last: Use the first data symbol value as the ramp up symbol value and the last data symbol value as the ramp down symbol value.
- Center: Set the ramp up/down symbol when frequency deviation is zero.
- One: Set the ramp up/down symbol when frequency deviation is negative.
- Zero: Set the ramp up/down symbol when frequency deviation is positive.

Note: This parameter is visible and configurable only when the idle interval is not zero.

4.3.2.2 SHR (Synchronization Header)

1. Preamble Sequence

Default: 0101 0101.

Set the preamble sequence used by the Synchronization Header. The sequence length should be a multiple of 8 for 2FSK and a multiple of 16 for 4FSK.

Note: The final preamble field will contain several multiples of the preamble sequence.

2. Preamble Length

Range: 32 – 8000 for 2FSK , 64 – 16000 for 4FSK ;

Default: 32.

Set the preamble length in bits in Synchronization Header.

The Preamble Length should be the integer multiple of the length of preamble sequence.

For more information on the preamble, please refer to "PPDU format for SUN FSK" in Section 19.2 of the IEEE Std 802.15.4-2020.

3. SFD Index

Choices: 0 | 1 ; Default: 0.

Set the index of SFD (Start of Frame Delimiter) sequence in Synchronization Header. It corresponds to the PIB attribute *phySunFskSfd* defined in IEEE Std 802.15.4-2020. See section 19.2.3.2 for details.

4. SFD Customized

Choices: On | Off ; Default: Off.

Use the drop-down menu to enable or disable customized SFD.

If SFD Customized is off, the standard SFD sequence is used, and the SFD Sequence is read-only. For more information on the standard SFD sequence, see Section 19.2.3.2 of the IEEE Std 802.15.4-2020.

If SFD Customized is on, the SFD Sequence can be edited, and the custom SFD sequence is used. The SFD Sequence length should be 16 for 2FSK and 32 for 4FSK, otherwise it will be truncated or padded with zeros.

5. SFD Sequence

Displays the value of the SFD fields in the Synchronization Header. For more information on the SFD sequence, see Section 19.2.3.2 of the IEEE Std 802.15.4-2020.

Note: This parameter can be edited only when SFD Customized is on.

4.3.2.3 PHR (PHY Header)

1. Mode Switch

Choices: Off | On ; Default: Off.

Use the drop-down menu to enable or disable the Mode Switch PHR.

- On: A mode switch packet is generated. The Mode Switch field of the packet shall be set to one, indicating that a mode switch shall occur.
- Off: A normal packet is generated. The Mode Switch field of the packet shall be set to zero, indicating that the entire packet shall be transmitted at a single data rate and using a single modulation scheme.

It will be included in Mode Switch field of PHR. For more information on the Mode Switch, see Section 19.2.4 and 19.2.5 of the IEEE Std 802.15.4-2020.

2. FCS Type

Choices: 0 = 4-octets | 1 = 2-octets;

Default: 0 = 4-octets.

Use the drop-down menu to select the FCS type. The FCS Type field of PHR indicates the length of the FCS field contained in the MPDU.

It will be included in FCS Type field of PHR. The FCS Type field of PHR shall be set to zero for a 4-octet FCS and shall be set to one for a 2-octet FCS. For more information on the FCS Type, see Section 19.2.4 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible and configurable only when the Mode Switch is off.

3. Data Whitening

Choices: On | Off ; Default: On.

Use the drop-down menu to enable or disable the data whitening of PSDU upon transmission. It will be included in Data Whitening field of PHR. For more information on the Data Whitening, see Section 19.2.4 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible and configurable only when the Mode Switch is off.

4. Frame Length

Display the total number of octets contained in the PSDU (prior to FEC encoding, if enabled). It will be included in Frame Length field of PHR. For more information on the Frame Length, see Section 19.2.4 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible and configurable only when the Mode Switch is off.

5. Mode Switch Parameter

Range: 0 – 3 ; Default: 0.

Set the parameter group used for mode switch. It will be included in Mode Switch Parameter field of PHR. For more information on the Mode Switch Parameter, see Section 19.2.5 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible and configurable only when the Mode Switch is on.

6. New Mode FEC

Choices: On | Off ; Default: Off.

Use the drop-down menu to specify whether the packet following the mode switch PPDU is transmitted using FEC. It will be included in New Mode FEC field of PHR. For more information on the New Mode FEC, see Section 19.2.5 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible and configurable only when the Mode Switch is on.

7. New Mode

1) Page

Range: 0 – 1 ; Default: 0.

Set the Page in New Mode Field of mode switch PHR. The Page field shall be set to zero to indicate channel page nine or set to one to indicate channel page ten.

Note: This parameter is visible and configurable only when the Mode Switch is on.

2) Modulation Scheme

Range: 0 – 3 ; Default: 0.

Set the Modulation Scheme in New Mode Field of mode switch PHR. The Modulation Scheme field indicates the modulation scheme.

Modulation Scheme Field value	Description
0	SUN FSK
1	SUN OFDM
2	SUN O-QPSK
3	Additional modes

Note: This parameter is visible and configurable only when the Mode Switch is on.

3) Mode

Range: 0 – 15 ; Default: 0.

Set the Mode in New Mode field of mode switch PHR. The Mode field specifies the new mode of operation. For more information on the Mode, see Section 19.2.5 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible and configurable only when the Mode Switch is on.

8. Checksum

Display the checksum field in mode switch PHR. This value is read-only and automatically updated with PHR value. For more information on the Checksum, see Section 19.2.5 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible only when the Mode Switch is on.

9. Parity Check

Display the parity check field in mode switch PHR. This value is read-only and automatically updated with PHR value. For more information on the Parity Check, see Section 19.2.5 of the IEEE Std 802.15.4-2020.

Note: This parameter is visible only when the Mode Switch is on.

4.3.2.4 PSDU

These are the settings for the physical service data unit (PSDU) part of the frame when Mode Switch is off.

1. **FEC**

Choices: None | RSC | NRNSC ; Default: None.

Use the drop-down menu to select whether FEC is enabled and what type of FEC is used. For more information on the FEC, see Section 19.3.5 of the IEEE Std 802.15.4-2020.

2. **Interleaving**

Choices: On | Off ; Default: Off.

Use the drop-down menu to select whether interleaving is enabled after FEC. Interleaving is always enabled for NRNSC coding and disabled when FEC is not used. For more information on the interleaving, see Section 19.3.6 of the IEEE Std 802.15.4-2020.

3. **Padding Bits**

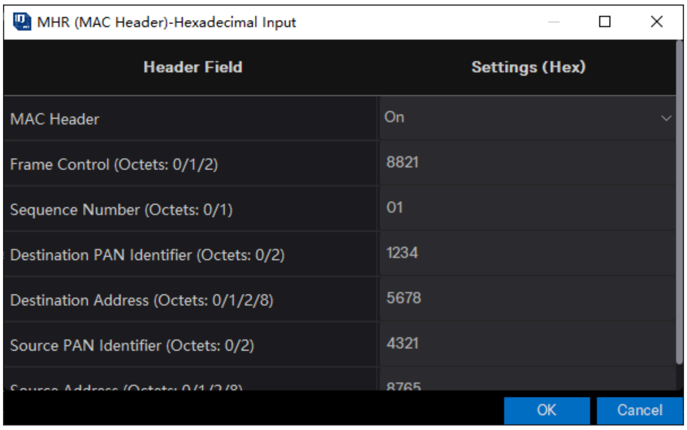
Display the number of padding bits appended to the tail bits, when interleaving is used in conjunction with convolutional coding.

The padding bits are required to fill up the last interleaver buffer completely, and the padding bits length is usually 5 or 13. This value is read-only and automatically updated with PHR and PSDU length. For more information on the padding bits, see Section 19.3.6 of the IEEE Std 802.15.4-2020.

4. **PHY Payload**

1) **MHR (MAC Header)**

Use the drop-down menu to enable or disable the MAC Header filed.



For more information on the MAC header, refer to the IEEE standards 802.15.4.

2) **Data Type**

Choices: PN9 | PN15 | USER ;

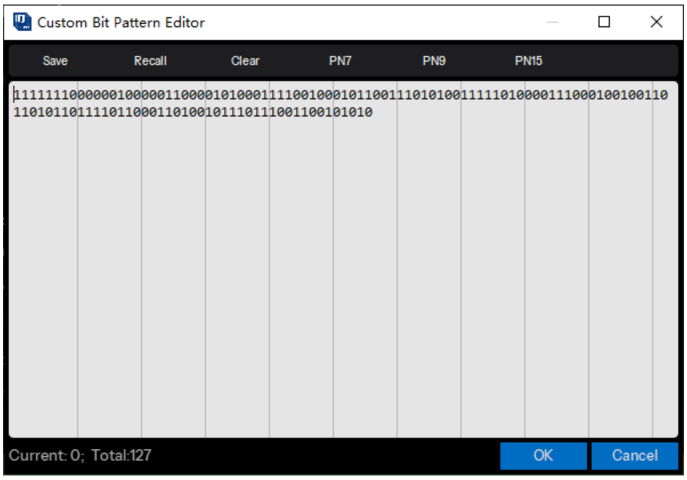
Default: PN9.

Use the drop-down menu to set the type of packet payload.

PN9: A pseudo-random binary sequence of order 9 is used to fill the packet payload

PN15: A pseudo-random binary sequence of order 15 is used to fill the packet payload

USER: A user-defined binary sequence is used to fill the packet payload



3) Seed

Set the seed value used to generate the pseudo-random binary sequence.

When Data Type PN9 is selected: Range: 0x0 – 0x1FF ; Default: 0x1FF.

When Data Type PN15 is selected: Range: 0x0 – 0x7FFF ; Default:0x7FFF.

Note: This parameter can be edited only when the Data Type is PN9 or PN15.

4) Data Length (Octets)

Range: 0 – 2047 ; Default: 1024.

Set the length of MAC payload in octets.

5) Data Mode

Choices: Continuous | Truncated ;

Default: Continuous.

For multi-frame signals, select the mode applied to the packet payload. If there is only one frame in the signal, then there is no difference in selection.

- Continuous: packet payload data bits are distributed consecutively across multiple frames
- Truncated: packet payload data bits are the same for all frames, with the data size truncated for one frame

6) MAC FCS

Choices: On | Off ; Default: On.

Use the drop-down menu to enable or disable the MAC FCS (frame check sequence). For more information on the MAC FCS, refer to the IEEE standards 802.15.4.

4.3.2.5 Encoding

These are the encoding settings when Mode Switch is on.

1. FEC

Choices: None | RSC | NRNSC ;

Default: None.

Use the drop-down menu to select whether FEC is enabled and what type of FEC is used. For more information on the FEC, see Section 19.3.5 of the IEEE Std 802.15.4-2020.

2. Interleaving

Choices: On | Off ; Default: Off.

Use the drop-down menu to select whether interleaving is enabled after FEC. Interleaving is always enabled for NRNSC coding and disabled when FEC is not used. For more information on the interleaving, see Section 19.3.6 of the IEEE Std 802.15.4-2020.

3. Padding Bits

Display the number of padding bits appended to the tail bits, when interleaving is used in conjunction with convolutional coding.

The padding bits are required to fill up the last interleave buffer completely， and the padding bits length is usually 5 or 13. This value is read-only and automatically updated with PHR and PSDU length. For more information on the interleaving, see Section 19.3.6 of the IEEE Std 802.15.4-2020.

4.3.2.6 Impairments

1. Symbol Timing Error

Range: -300 to 300ppm ; Default: 0ppm.

Set the shift of standard symbol rate for transmission. This shift varies the symbol rate of the signal. It is used to simulate transmission when the device's sampling clock is slightly off.

2. Frequency Offset

Range: -200 to 200kHz ;

Default: 0kHz.

Set the static offset of the carrier frequency. This static offset is used to simulate the device transmitting at a frequency slightly offset from the specified carrier.

3. Frequency Deviation Scaling

Range: 50 – 150% ;

Default: 100%.

Set the additional scaling to the nominal FSK frequency deviation. This is equivalent to apply scaling to FSK modulation index.

4. Gaussian BT

Range: 0.1 – 1.0 ;

Default: 0.5.

Set the BT product of the Gaussian filter applied to FSK modulation.

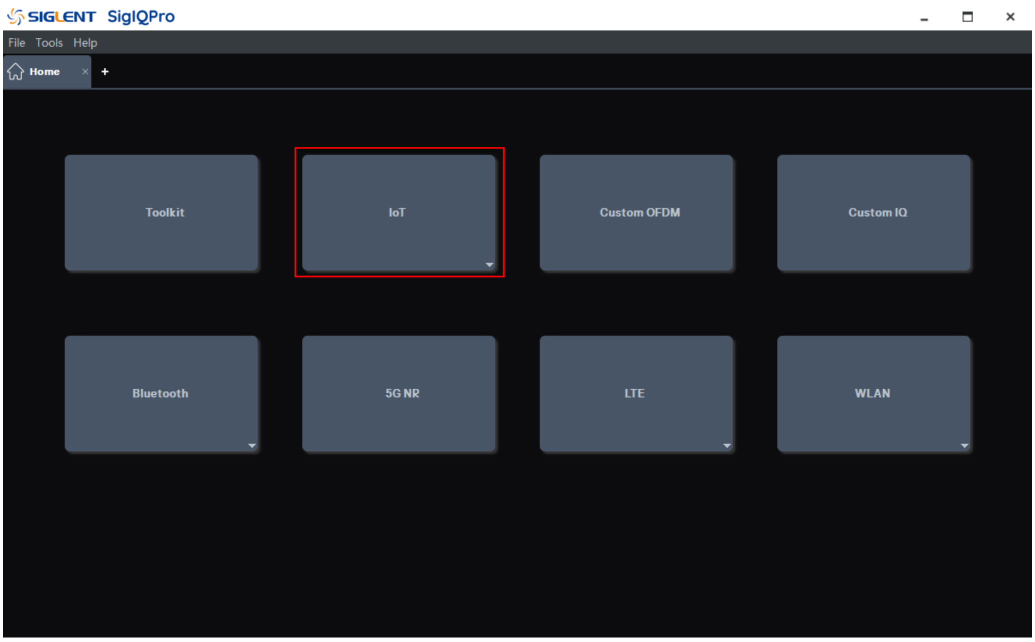
4.4 IEEE 802.15.4 SUN OFDM

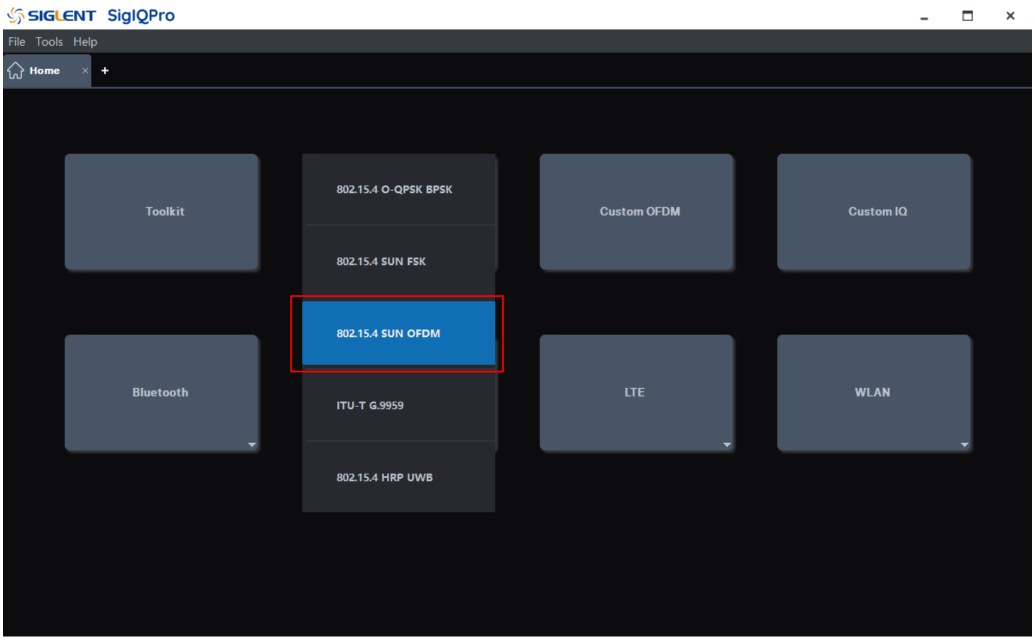
SUNs PHY defined in IEEE standard 802.15.4. The smart utility network is a principally outdoor, low data rate wireless network that supports two-way communications among sensing, measurement, and control devices in the smart grid.
SUNs enable multiple applications to operate over shared network resources, providing monitoring and control of a utility system. SUN devices are designed to operate in very large-scale, low-power wireless applications and often require using the maximum transmit power available under applicable regulations, in order to provide long-range, point-to-point connections. Frequently, SUNs are required to cover geographically widespread areas containing a large number of outdoor devices. In these cases, SUN devices typically employ mesh or peer-to-peer multihop techniques to communicate with an access point.

SUN OFDM is one of the physical layers defined in the standard, which supports data rates ranging from 12.5 kb/s to 2400 kb/s. The subcarrier spacing is constant and is equal to 10416-2/3 Hz. The symbol rate is 8-1/3 kSymbol/s, which corresponds to 120 us per symbol.

Protocol version: IEEE Std 802.15.4 -2020

You can click **IoT** -> **802.15.4 SUN OFDM** on the homepage to enter the 802.15.4 SUN OFDM setting interface.





4.4.1 Waveform Setup

Press **Waveform Setup** in the left window to enter parameter settings.

4.4.1.1 Basic

1. Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

2. Number of Frames

Range: 1 to 2000 ;

Default: 1.

Set the number of frames included in the generated waveform.

3. Oversampling Ratio

Range: 2 to 100 ;

Default: 10.

Set the number of samples calculated per I/Q symbol.

4. Total Sample Points

Display the generated waveform length (number of points).

Note: This parameter is displayed only and cannot be edited.

5. **Waveform Length**

Display the generated waveform length (in second).

Note: This parameter is displayed only and cannot be edited.

4.4.1.2 Marker

1. **Marker 1 Source**

Choice: Waveform Start | Frame Start;

Default: Waveform Start.

Use the drop-down menu to select the type of Mark 1 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start : Set the first point of the waveform to an active marker point.
- Frame Start : Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

2. **Marker 2 Source**

Choice: Waveform Start | Frame Start;

Default: Frame Start.

Use the drop-down menu to select the type of Mark 2 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start : Set the first point of the waveform to an active marker point.
- Frame Start : Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

4.4.2 Packet

Press **Packet** in the left window to enter parameter settings.

4.4.2.1 OFDM Setting

1. Option

Choices: Option 1 | Option 2 | Option 3 | Option 4 ;

Default: Option 2.

Use the drop-down menu to select PHY option. This PHY includes four options, each one being characterized by the number of active tones during the PHR or PSDU. Please refer to Table 20-10 in IEEE Std 802.15.4-2020 for more information.

2. FFT Size

Display the FFT size of selected OFDM option. This value is read-only and automatically updated when Option is changed. Please refer to Table 20-10 in IEEE Std 802.15.4-2020 for more information.

3. Idle Interval

Range: 0 – 200000 us ;

Default: 1000 us.

Set the idle interval time in-between frames in microseconds. When idle interval is set to zero, a continuous waveform will be generated.

4. Windowing Length

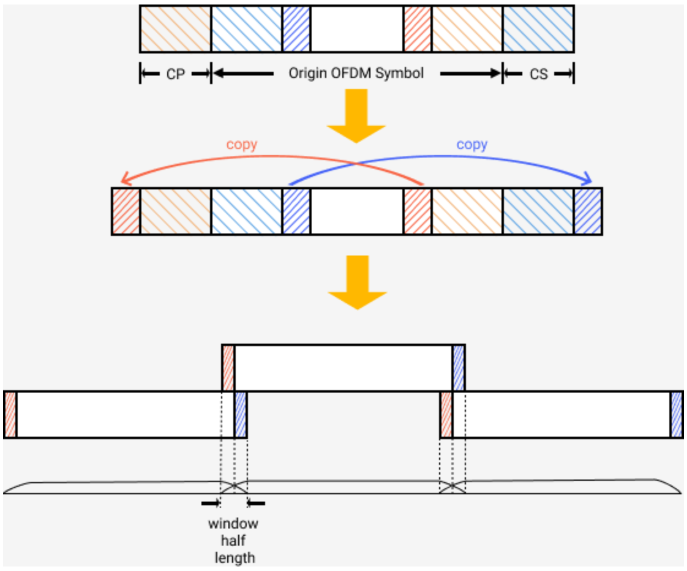
Range: 0 – FFT Size * Oversampling Ratio * 0.5;

Default: 16.

Set the raised cosine window length used to smooth the OFDM symbol transition. The maximum windowing length is limited to avoid exceeding the cyclic prefix (CP) part based on the option of OFDM signal.

To achieve a balance between ACP and EVM test results, it is necessary to set an appropriate windowing length. If you increase the windowing length to enhance the ACP result, the EVM result may deteriorate.

Note: Window length must be even.



5. **Filter for STF Symbols**

Choices: On | Off ; Default: On.

Use the drop-down menu to enable or disable an ideal low pass filter that is applied to STF symbols. This filter will help eliminate the out-of-band spurs that are caused by the negated half of the 4th STF symbol.

6. **Filter**

Choices: None | Gaussian | Root Nyquist | Nyquist ;

Default: None.

Use the drop-down menu to select the pulse shape filter type to be applied to the waveform.

4.4.2.2 PSDU

These are the settings for the physical service data unit (PSDU) part of the frame that includes the payload data.

1. **MCS**

Range:0 – 6 ; Default: 3.

Set the MCS level for PSDU. The MCS level affects the modulation and coding for PSDU. Please refer to Table 20-10 in IEEE Std 802.15.4-2020 for more information.

2. **Modulation and Coding**

Display the modulation and coding scheme under selected MCS level. This value is read-only and automatically updated when MCS is changed. Please refer to Table 20-10 in IEEE Std 802.15.4-2020 for more information.

3. Scrambler

Choices: 00 (Seed 000010111) | 01 (Seed 101110111) | 10 (Seed 000011100) | 11 (Seed 101111100); Default: 00 (Seed 000010111).

Use the drop-down menu to select the seed for scrambling PN sequence generation. It will be included in Scrambler field of PHR. Please refer to section 20.2.4 in IEEE Std 802.15.4-2020 for more information.

4. OFDM Interleaving

Choices: 0 | 1 ; Default: 0.

Set the SUN OFDM interleaving attribute. This value affects the depth of interweaving. It corresponds to the PIB attribute *phyOfdmInterleaving* defined in IEEE Std 802.15.4-2020.

0: The interleaving depth of one symbol

1: The interleaving depth of the number of symbols equal to the frequency domain spreading factor. For more information on the interleaving, see Section 20.4.5 of the IEEE Std 802.15.4-2020.

5. FCS Type

Choices: 0 = 4-octets | 1 = 2-octets;

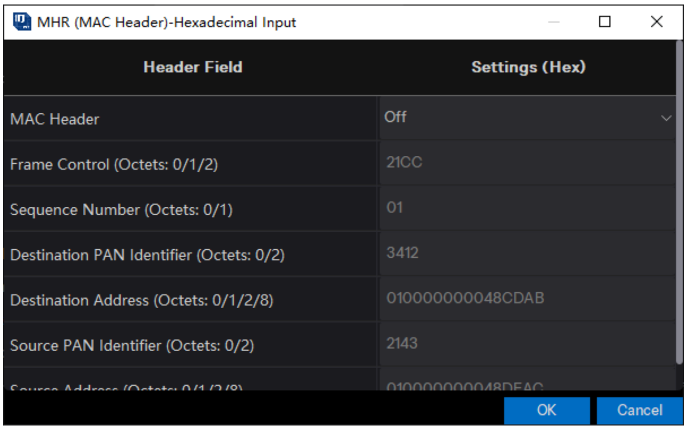
Default: 0 = 4-octets.

Use the drop-down menu to select the FCS type. The FCS Type indicates the length of the FCS field contained in the MPDU.

6. PHY Payload

1) MHR (MAC Header)

Use the drop-down menu to enable or disable the MAC Header filed.



For more information on the MAC header, refer to the IEEE standards 802.15.4.

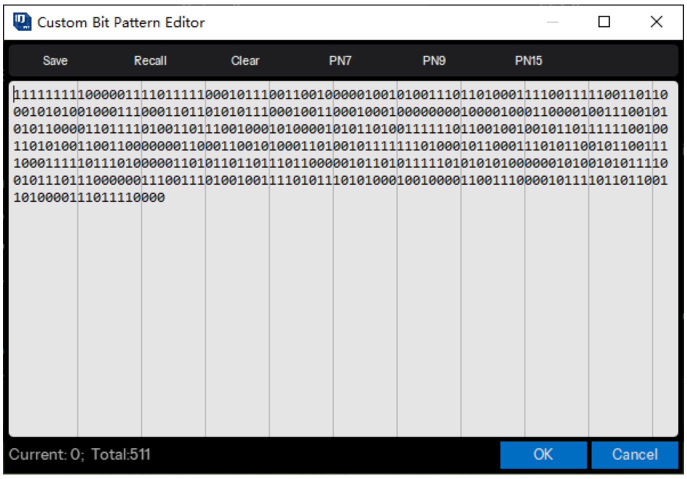
2) Data Type

Choices: PN9 | PN15 | USER ;

Default: PN9.

Use the drop-down menu to set the type of packet payload.

- PN9: A pseudo-random binary sequence of order 9 is used to fill the packet payload.
- PN15: A pseudo-random binary sequence of order 15 is used to fill the packet payload.
- USER: A user-defined binary sequence is used to fill the packet payload.



3) Seed

Set the seed value used to generate the pseudo-random binary sequence.

When Data Type PN9 is selected: Range: 0x0 – 0x1FF ; Default: 0x1FF.

When Data Type PN15 is selected: Range: 0x0 – 0x7FFF ; Default: 0x7FFF.

Note: This parameter can be edited only when the Data Type is PN9 or PN15.

4) Data Length (Octets)

Range: 0 – 2047 ; Default: 1024.

Set the length of MAC payload in octets.

5) Data Mode

Choices: Continuous | Truncated ;

Default: Continuous

For multi-frame signals, select the mode applied to the packet payload. If there is only one frame in the signal, then there is no difference in selection.

- Continuous: packet payload data bits are distributed consecutively across multiple frames
- Truncated: packet payload data bits are the same for all frames, with the data size truncated for one frame

6) MAC FCS

Choices: On | Off ; Default: On.

Use the drop-down menu to enable or disable the MAC FCS (frame check sequence). For more information on the MAC FCS, refer to the IEEE standards 802.15.4.

7. Padding Bits

Display the number of padding bits appended to the tail bits in PSDU. The appended bits in PSDU are set to zeros, and to ensure that the number of bits in the PHY Payload field are multiple of Ncbps. For more information on the padding bits, see Section 20.4.10 of the IEEE Std 802.15.4-2020.

This value is read-only and automatically updated with Option, MCS, Frame Length and OFDM Interleaving.

8. Number of OFDM Symbols

Display the number of OFDM symbols of PSDU. This value is read-only and automatically updated with Option, MCS, OFDM Interleaving and PSDU settings.

4.4.2.3 PHR (PHY Header) Info

These are the settings for PHY Header. All configuration items are read-only and automatically updated with OFDM setting and PSDU settings.

1. MCS

Display the MCS level for PHR. The MCS level affects the modulation and coding for PHR. The PHR

shall be transmitted using the lowest supported MCS level for Option 1 and Option 2. For OFDM option 3 and OFDM Option 4, the PHR shall be transmitted using MCS1 and MCS2 respectively.
This value is read-only and automatically updated when Option is changed. Please refer to Section 20.2.4 in IEEE Std 802.15.4-2020 for more information.

2. Modulation and Coding

Display the modulation and coding scheme under selected MCS level. This value is read-only and automatically updated when MCS is changed. Please refer to Table 20-10 in IEEE Std 802.15.4-2020 for more information.

3. Frame Length

Display the total number of octets contained in the PSDU (prior to FEC encoding). It will be included in Frame Length field of PHR. This value is read-only and automatically updated with PSDU settings. Please refer to Section 20.2.4 in IEEE Std 802.15.4-2020 for more information.

4. HCS

Display the HCS (header check sequence) field of PHR in HEX. The HCS shall be computed using the first 22 bits of the PHR. This value is read-only and automatically updated when any of the PHR filed settings is changed. Please refer to Section 20.2.4 in IEEE Std 802.15.4-2020 for more information.

5. Padding Bits

Display the number of padding bits appended to the tail bits in PHR. The appended bits in PHR are set to zeros, and to ensure that the number of bits in the PHR field are multiple of Ncbps. For more information on the padding bits, see Section 20.4.10 of the IEEE Std 802.15.4-2020.
This value is read-only and automatically updated with Option, MCS, Frame Length and OFDM Interleaving.

6. Number of OFDM Symbols

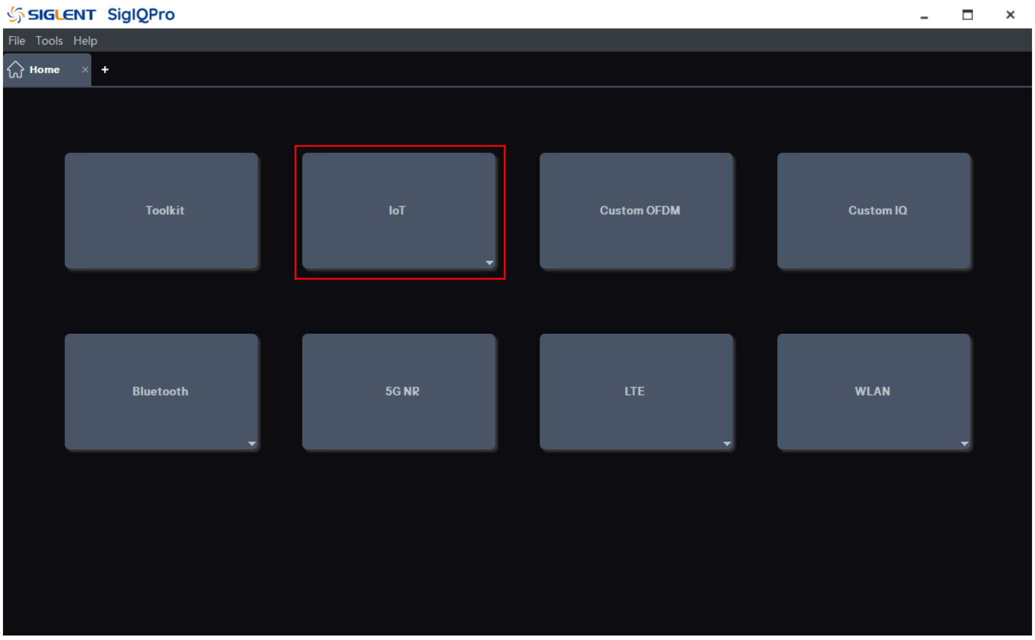
Display the number of OFDM symbols of PHR. This value is read-only and automatically updated with Option, MCS, and OFDM Interleaving.

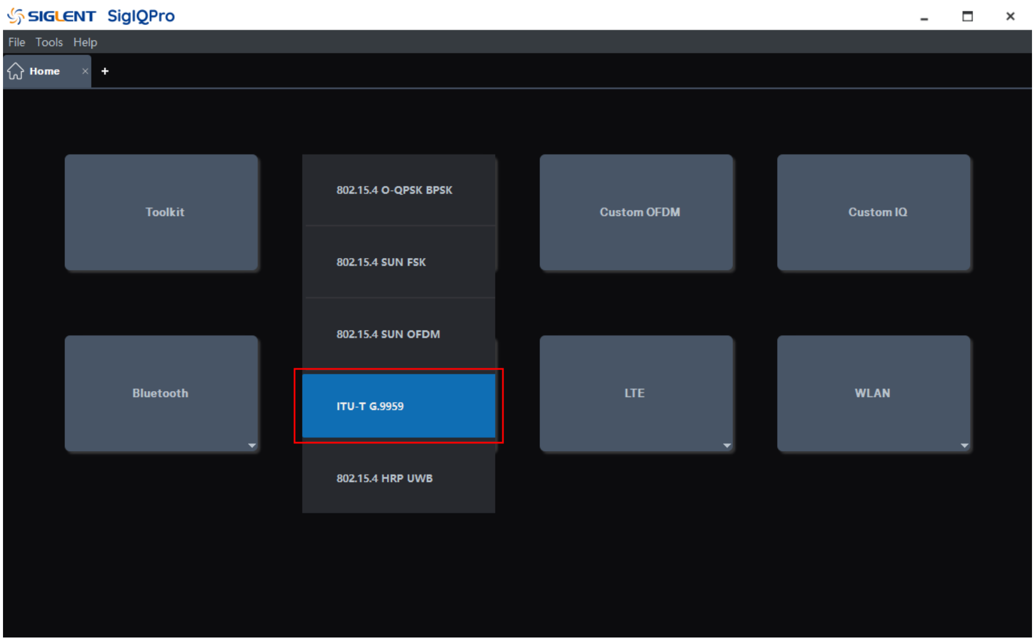
4.5 ITU-T G.9959

ITU-T G.9959 PHY is defined in short range narrow-band digital radiocommunication transceivers – – PHY, MAC, SAR and LLC layer specifications.

Protocol version: IEEE Std 802.15.4 -2020.

You can click **IoT** -> **ITU-T G.9959** on the homepage to enter the ITU-T G.9959 setting interface.





4.5.1 Waveform Setup

Press **Waveform Setup** in the left window to enter parameter settings.

4.5.1.1 Basic

1. Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

2. Number of Frames

Range: 1 to 2000 ; Default: 1.

Set the number of frames included in the generated waveform.

3. Oversampling Ratio

Range: 2 to 100 ; Default: 10.

Set the number of samples calculated per I/Q symbol.

4. Total Sample Points

Display the generated waveform length (number of points).

Note: This parameter is displayed only and cannot be edited.

5. Waveform Length

Display the generated waveform length (in second).

Note: This parameter is displayed only and cannot be edited.

4.5.1.2 Marker

1. Marker 1 Source

Choice: Waveform Start | Frame Start;

Default: Waveform Start.

Use the drop-down menu to select the type of Mark 1 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start : Set the first point of the waveform to an active marker point.
- Frame Start : Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

2. Marker 2 Source

Choice: Waveform Start | Frame Start;

Default: Frame Start.

Use the drop-down menu to select the type of Mark 2 Source to set the active mark points within the waveform. When the signal generator encounters an active mark point, a pulse signal is output via the IQ_EVENT connector on the rear panel. For more information, see the Signal Generator's User guide.

- Waveform Start : Set the first point of the waveform to an active marker point.
- Frame Start : Set the first point of the frame to an active marker point.

Note: A waveform may contain multiple frames.

4.5.2 Packet

Press **Packet** in the left window to enter parameter settings.

4.5.2.1 General Setting

1. Data Rate

Choices: R1 – 9.6 kbps | R2 – 40 kbps | R3 – 100 kbps;

Default: R1 – 9.6 kbps.

Use the drop-down menu to select the data rate type of PHY.

- R1: Data Rate Type 1 (9.6 kbit/s).
- R2: Data Rate Type 2 (40 kbit/s).
- R3: Data Rate Type 3 (100 kbit/s).

For more information on Data Rate, please refer to "Data rates" in Section 7.1.2.2 of the ITU-T G.9959 -2015.

2. Modulation

Choices: FSK | GFSK;

Default: FSK for R1/R2, GFSK for R3.

Use the drop-down menu to select the modulation type for PHY. For more information on Modulation, please refer to "Modulation and encoding" in Section 7.1.2.4 of the ITU-T G.9959 -2015.

3. Coding

Displays the coding type. This value is read-only and automatically updated when Data Rate is changed.

Manchester code shall be used for data symbol encoding at data rate R1 and non-return-to-zero (NRZ) shall be used for data symbol encoding at data rates R2 and R3. Please refer to Section 7.1.2.4 in ITU-T G.9959 -2015 for more information.

4. Separation

Displays the separation of FSK. This value is read-only and automatically updated when Data Rate is changed. Please refer to Table 7-4 in ITU-T G.9959 -2015 for more information.

5. Idle Interval

Range: 0 – 200000 us ; Default: 1000 us.

Set the idle interval time in-between frames in microseconds. When idle interval is set to zero, a continuous waveform will be generated.

6. Ramp Symbols

Range: 1 – 10 ; Default: 4.

Set the symbol duration for waveform ramp up and down.

Note: This parameter is visible and configurable only when the idle interval is not zero.

7. Ramp Up/Down Symbol

Choice: First/Last | Center | One | Zero;

Default: First/Last.

Use the drop-down menu to select the symbol for the period of waveform ramp up and down.

- First/Last : Use the first data symbol value as the ramp up symbol value and the last data symbol value as the ramp down symbol value.
- Center : Set the ramp up/down symbol when frequency deviation is zero.
- One : Set the ramp up/down symbol when frequency deviation is negative.

- Zero : Set the ramp up/down symbol when frequency deviation is positive.

Note: This parameter is visible and configurable only when the idle interval is not zero.

4.5.2.2 PPDU Settings

These are the settings to configure the physical protocol data unit (PPDU) which is the frame.

1. PPDU Length (Octets)

Display the total PPDU length in bytes. This value is read-only and automatically updated with PPDU Settings.

2. Preamble Length (Octets)

Range: 10 – 100 ; Default: 10.

Set the preamble length in bytes in SHR (Synchronization Header). For more information on preamble, please refer to " Preamble field" in Section 7.1.3.2 of the ITU-T G.9959 -2015.

3. Start of Frame Delimiter (Hex)

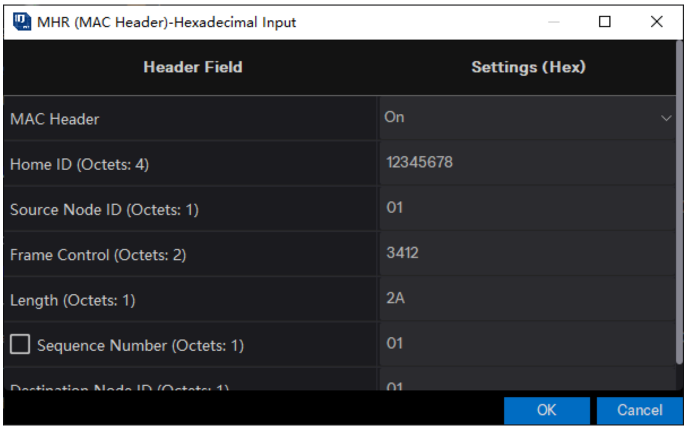
Range: 00 to FF ; Default: F0.

Set the SOF field in hex in SHR (Synchronization Header). The SOF is an 8-bit field terminating the preamble field and the start of the PSDU. For more information on SOF, please refer to "Start of frame (SOF) field " in Section 7.1.3.3 of the ITU-T G.9959 -2015.

4. PSDU

1) MHR (MAC Header)

Use the drop-down menu to enable or disable the MAC Header filed.



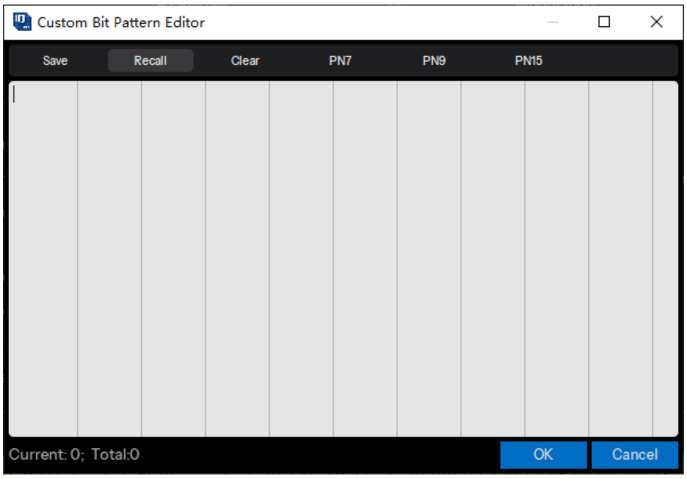
For more information on the MAC header, please refer to " MPDU format " in Section 8.1.3 of the ITU-T G.9959 -2015.

2) Data Type

Choices: PN9 | PN15 | USER ; Default: PN9.

Use the drop-down menu to set the type of packet payload.

- PN9: A pseudo-random binary sequence of order 9 is used to fill the packet payload
- PN15: A pseudo-random binary sequence of order 15 is used to fill the packet payload
- USER: A user-defined binary sequence is used to fill the packet payload



3) Seed

Set the seed value used to generate the pseudo-random binary sequence.

When Data Type PN9 is selected: Range: 0x0 – 0x1FF ; Default:0x1FF.

When Data Type PN15 is selected: Range: 0x0 – 0x7FFF ; Default:0x7FFF.

Note: This parameter can be edited only when the Data Type is PN9 or PN15.

4) Data Length (Octets)

Range: 0 – 64 for R1 or R2; 0 – 170 for R3 ;

Default: 32.

Set the length of MAC payload in octets.

5) Data Mode

Choices: Continuous | Truncated;

Default: Continuous.

For multi-frame signals, select the mode applied to the packet payload. If there is only one frame in the signal, then there is no difference in selection.

- Continuous: packet payload data bits are distributed consecutively across multiple frames .
- Truncated: packet payload data bits are the same for all frames, with the data size truncated for

one frame.

6) MAC FCS

Choices: On | Off ; Default: On.

Use the drop-down menu to enable or disable the MAC FCS (frame check sequence). For more information on the MAC FCS, refer to Section 8.1.3.8 and Section 8.1.3.9 of the ITU-T G.9959 -2015.

5. End of Frame Delimiter

Choices: On | Off ; Default: On.

Use the drop-down menu to enable or disable EOF in the PPDU. The EOF delimiter field shall be sent only when transmitting at data rate R1. For more information on the EOF, refer to Section 7.1.3.5 of the ITU-T G.9959 -2015.

4.5.2.3 Impairments

1. Symbol Timing Error

Range: -300 to 300ppm ; Default: 0ppm.

Set the shift of standard symbol rate for transmission. This shift varies the symbol rate of the signal. It is used to simulate transmission when the device's sampling clock is slightly off.

2. Frequency Offset

Range: -200 to 200kHz ; Default: 0kHz.

Set the static offset of the carrier frequency. This static offset is used to simulate the device transmitting at a frequency slightly offset from the specified carrier.

3. Frequency Deviation Scaling

Range: 50 – 150% ; Default: 100%.

Set the additional scaling to the nominal FSK frequency deviation. This is equivalent to apply scaling to FSK modulation index.

4. Gaussian BT

Range: 0.1 – 1.0 ; Default: 0.6.

Set the BT product of the Gaussian filter applied to FSK modulation.

Note: This parameter is visible only when the Modulation selection is GFSK.

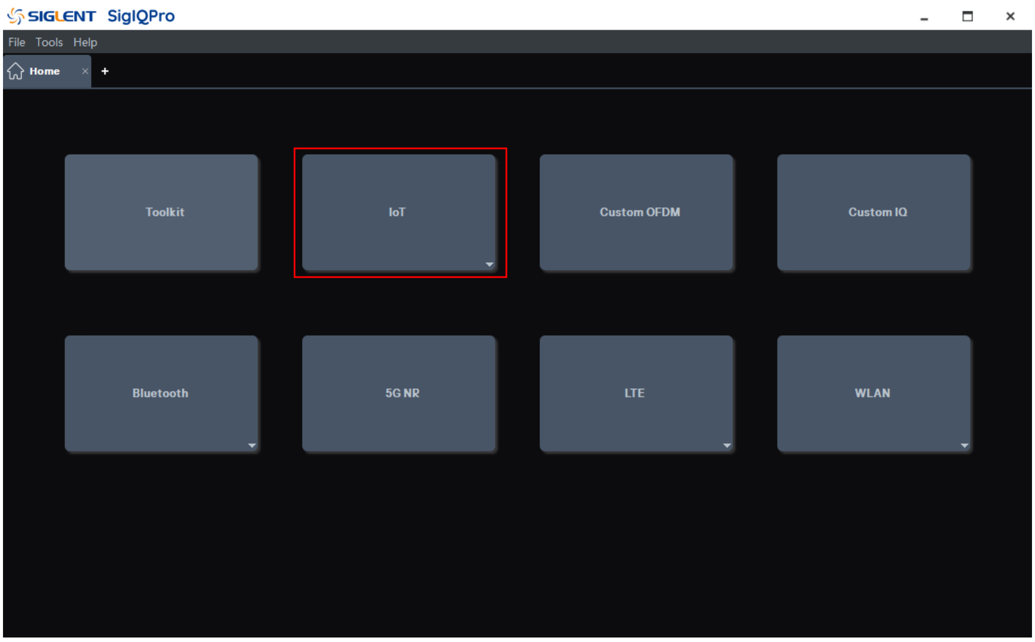
4.6 IEEE 802.15.4 HRP UWB

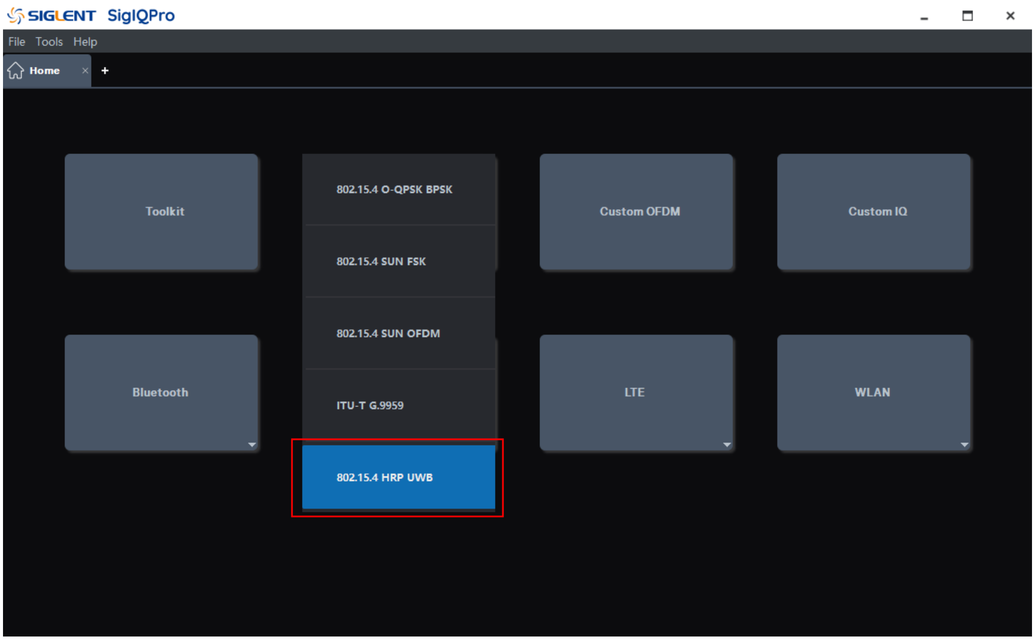
UWB has three major characteristics: carrier-free pulse, ultra-wide spectrum, and low power density. It has centimeter-level positioning accuracy and strong anti-interference ability. It can not only be used for data transmission, but also for radar imaging and ranging positioning, becoming the underlying supporting technology for smart cars, Industry 4.0 and spatial computing.

HRP UWB is based on pulse radio communication, using nanosecond narrow pulses to transmit data. It works in three frequency bands: sub-GHz (249.6~749.6 MHz), low band (3.1~4.8 GHz), high band (6.0~10.6 GHz).

The protocol version implemented by this software is: IEEE Std 802.15.4-2024.

You can click IoT -> 802.15.4 HRP UWB to enter the 802.15.4 HRP UWB settings interface.





4.6.1 Waveform Setup

Click the Waveform Setup node in the tree view on the left side of the window to enter the waveform setup.

4.6.1.1 Basic

1. **Waveform Name**

This parameter is used to define the waveform name displayed when it is downloaded to the signal generator. If it is not defined, the signal generator will automatically assign a unique name to the waveform.

2. **Number of Frames**

Available range: 1 ~ 2000, default value: 1.

Set the number of frames contained in the generated waveform.

4.6.2 Packet

Click the Packet node in the tree view on the left side of the window to enter the parameter settings.

4.6.2.1 Basic

1. **Samples Per Pulse**

Available range: 4 ~ 64 (when Channel is 4, 7, 11 or 15), 2 ~ 64 (when Channel is not 4, 7, 11 or 15), default value: 2.

The number of sampling points for each pulse is an integer multiple of the peak PRF (499.2 MHz).

2. Idle Time

The adjustable range is: 0 ~ 1000000 (unit: us), the default value is: 50 us.

Idle time between frames.

4.6.2.2 General

1. Mode

Possible range: 'HPRF' | 'BPRF' | '802.15.4a' , default value: 'HPRF' .

Set the mode of HRP UWB PHY.

2. STS Packet

Available range: 0~3, default value: 1.

STS packet type configuration, indicating the location of STS in the PPDU.

3. Channel

Available range: 0~15, default value: 9 .

Channel number.

4.6.2.3 Header

1. Code Index

Mode is '802.15.4a', options: 1~24

Mode is 'BPRF', options: 9~24

Mode is 'HPRF', options: 1~32

Default value: 9

The preamble number used by the HRP UWB PHY channel to generate the SYNC segment, which is associated with the Mode and Channel.

2. Preamble Duration

Mode is '802.15.4a' | 'BPRF', options: 16 | 64 | 1024 | 4096

Mode is 'HPRF', options: 16 | 24 | 32 | 48 | 64 | 96 | 128 | 256

The preamble length, that is, the number of symbols in the SYNC segment (or the number of times the preamble symbol is repeated), is associated with the Mode.

3. Delta Length

Mode is '802.15.4a', options: 4 | 16 | 64

Mode is 'BPRF', options: 4

Mode is 'HPRF', options: 4 | 16 | 64

Default value: 4.

The length of the Delta function. The Delta function is used to expand the preamble code into the preamble symbol.

Delta Length is associated with Mode, Channel, and Code Index.

4. SFD Number

Mode is 'BPRF', options: 0 | 2

Mode is 'HPRF', options: 1~4

SFD sequence number, that is, select SFD0~4, and Mode is 'HPRF' | 'BPRF' to take effect.

5. SFD Length (Symbols)

After selecting SFD Number, the corresponding SFD Length value is automatically displayed.

6. Preamble Mean PRF

When Code Index is 1-8, options are: 16.1 | 4.03

When Code Index is 9-24, it is fixed to: 62.89

When Code Index is 25-32, it is fixed to: 111.09

Default value: 62.89

Preamble average pulse repetition frequency, unit: MHz

7. PHR Data Rate (Mb/s)

Only valid when Mode is 'BPRF', options: 0.85 | 6.81

Among them, 0.85 corresponds to DRBM_LP; 6.81 corresponds to DRBM_HP

Default value: 0.85

The (bit) data rate of PHR, in Mb/s.

4.6.2.4 PSDU

1. Mean PRF

When Mode is '802.15.4a', Channel is [0:3 5:6 8:10 12:14], options: 3.9 | 15.6 | 62.4

Channel is {4 7 11 15}, options: 15.6 | 62.4

Mode is 'BPRF', fixed at 62.4

Mode is 'HPRF', options: 124.8 | 249.6

Default value: 249.6

The average pulse repetition frequency of the PSDU part in the frame is related to Mode and Channel.

2. Data Rate (Mb/s)

When Mode is '802.15.4a', options are: 0.11 | 0.85 | 1.7 | 6.81 | 27.24

Mode is 'BPRF', fixed at 6.81

Mode is 'HPRF', options: 6.81 | 7.8 | 27.24 | 31.2

Default value: 6.81

The data rate of the payload (in bits), in Mb/s

3. Constraint Length

Available values: 3 | 7. Default value: 3.

Convolution encoder length, effective when Mode is 'HPRF', and fixed value is 3 for other modes. It is associated with Data Rate.

Data Rate = 6.81 ——> Constraint Length = 3

Data Rate = 27.24 ——> Constraint Length = 3

Data Rate = 7.8 ——> Constraint Length = 7

Data Rate = 31.2 ——> Constraint Length = 7

4. Ranging State

Available options: On | Off

Indicates whether the data frame is used for ranging. It is used to fill the Ranging bit of PHR.

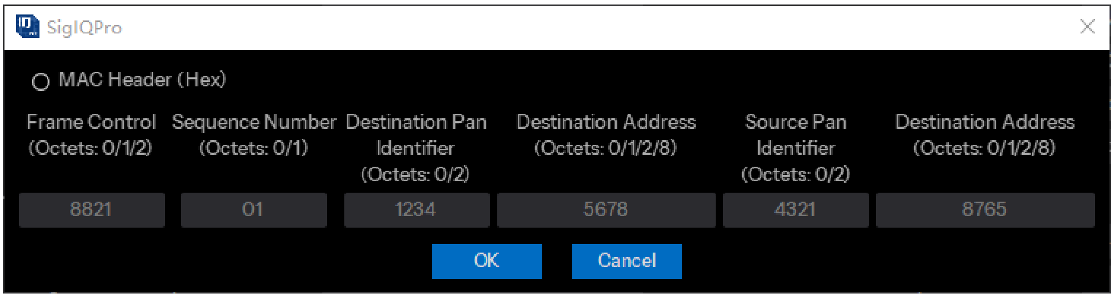
5. Frame Length

Displays the total number of bytes contained in the PSDU. It will be contained in the Frame Length field of the PHR. This parameter is a read-only value and is automatically updated as the Data Length in the Payload changes.

6. Payload

1) MAC Header

Use the pop-up window to configure the MAC Header fields.



For more information about the MAC header, refer to IEEE Std 802.15.4.

2) Data Type

Available options: PN9 | PN15

Default value: PN9

Use the drop-down menu to select the type of message payload.

PN9: Uses a 9th-order pseudo-random binary sequence to fill the message payload.

PN15: Uses a 15th-order pseudo-random binary sequence to fill the message payload.

3) Seed

Sets the seed value used to generate pseudo-random binary sequences.

When the data type is PN9:

Available range: 0x0 ~ 0x1FF

Default value: 0x1FF

When the data type is PN15:

Available range: 0x0~ 0x7FFF

Default value: 0x7FFF

4) Max Data Length (Octets)

Mode is '802.15.4a' | 'BPRF', fixed value is 127, unit: Octets

Mode is 'HPRF', options: 1023 | 2047 | 4095

Set the maximum length of the message payload in bytes.

5) Data Length (Octets)

Available range: 0 ~ (MaxDataLength - length(MAC Header) - length(FCS))

Set the length of the message payload (in bytes).

6) Data Mode

Available options: 'Continuous' | 'Truncated' , default value: 'Continuous' .

For multi-frame signals, select the mode to apply to the message payload. If there is only one frame in the signal, select Make No Difference.

Continuous: The data bits in the packet payload are distributed continuously in multiple frames.

Truncated: The message payload data bits are the same for all frames, and the data length is truncated within a frame.

7) FCS State

Available options: On | Off, Default value: On.

Use the drop-down menu to enable or disable MAC FCS (Frame Check Sequence).

For more information about MAC FCS, refer to IEEE standards 802.15.4.

8) FCS Type

Available options: '2-octets' | '4-octets' , default value: '2-octets'.

If FCS State is On, this option is enabled. Use the drop-down menu to select the FCS type. The FCS type indicates the length of the FCS field contained in the MPDU.

4.6.2.5 STS

1. Number of STS Segments

When Mode is 'HPRF', options are: 1 | 2 | 3 | 4

When Mode is 'BPRF', it is fixed to 1

That is, the number of STS segments.

2. Length of STS Segments

When Mode is 'HPRF', options are: 16 | 32 | 64 | 128 | 256

When Mode is 'BPRF', it is fixed to 64

The length of the STS segment, in units of 512 chips.

3. Length of STS Gap

Options: 0 ~ 127. Default value: 0.

Set the Gap length in units of 4 chips (~8ns).

This option is effective when Mode is 'HPRF' and STSPacket Configuration is 2, and an additional Gap is added between PSDU and STS.

4. Index of STS Gap

Options: 0 | 1 | 2 | 3. Default: 0.

Set the sequence number of the extra STS gap.

This function is effective when Mode is 'HPRF' and STSPacket Configuration is 2, and is used to generate the bit data of (A0, A1) in PHR.

4.6.2.6 Impairments

1. Symbol Time Error

Optional range: -300 ~ 300 ppm

Default value: 0

Sets the symbol timing error (sampling clock offset) of the signal in ppm.

2. Frequency Offset

Selectable range: -500 ~ 500 kHz

Default value: 0

Set carrier frequency deviation, unit: Hz.

4.6.2.7 Filter

1. FilterType

Optional options: 'Root Raised Cosine' | '3-order Butterworth' | '4-order Butterworth'

Default value: 'Root Raised Cosine'.

Use the pull-down menu to select the type of pulse shaping filter to apply to the waveform.

2. Pulse Duration

Filter Type is 'Root Raised Cosine' and takes effect. Unit: ns.

Bound to Channel, only displayed but not editable.

3. Beta

FilterType is 'Root Raised Cosine' and is fixed at 0.5. It is only displayed and cannot be edited.

4.6.2.8 Multipath

Multipath

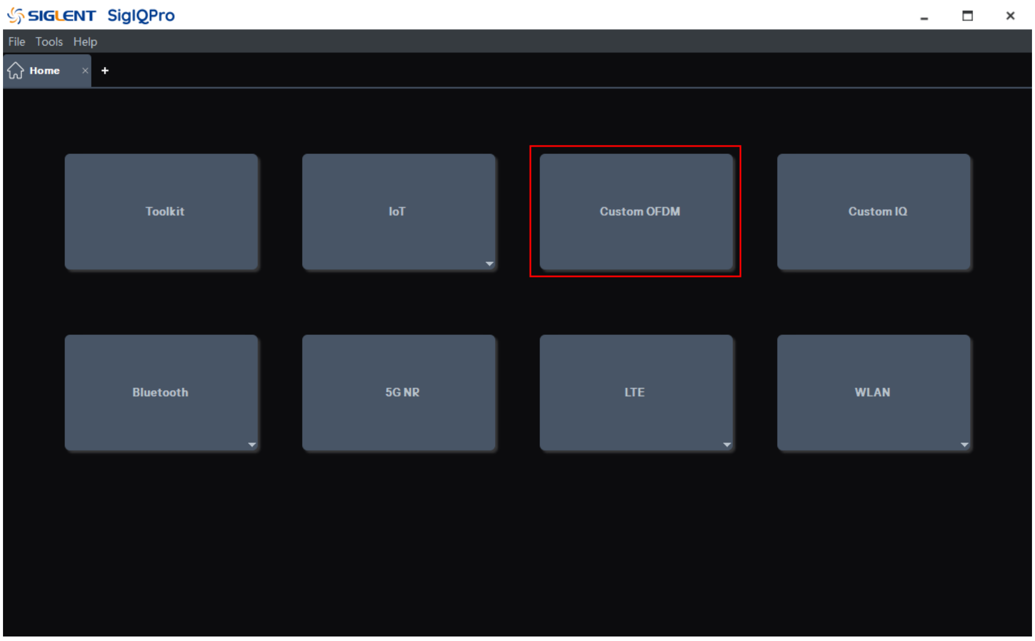
Available Values: On | Off. Default Value: Off.

Multipath channel settings.

4.7 Custom OFDM

Custom OFDM software module supports highly customizable settings based on Orthogonal Frequency Division Multiplexing (OFDM), and generates baseband data for Siglent signal generators to output modulated signals.

You can click **Custom OFDM** on the homepage to enter the Custom OFDM setting interface.



4.7.1 Term Definition

For the purposes of the present document, some terms are applied. IEEE Std 802.11a-1999 provides references for term definitions.

The definitions of these terms are as follow.

4.7.1.1 Frame

In Custom OFDM software module, OFDM baseband signal is divided as frames in the time domain, which is made up of a certain number of OFDM symbols. There is the same number of subcarriers in the frequency domain for every OFDM symbol, each of them can carry a symbol generated by means of linear digital modulation, such as PSK and QAM.

OFDM symbols in frame are numbered, starting from 0.

Subcarriers are also numbered, and the index of center subcarrier is set to 0. Compared to the center subcarrier, the indices of subcarriers at lower frequencies are negative, the other subcarrier indices are positive integers.

4.7.1.2 Resource Unit

Physical Resources in a frame is generally described as two-dimensional grids, whose dimensions are OFDM symbols and subcarriers.
Resource Unit is the smallest unit of physical resources in a frame, referring to the physical resource made up of single subcarrier on a single OFDM symbol.

4.7.1.3 Resource Block

To transmit data effectively by means of OFDM, some known signals is usually transmitted in a frame, which is used to analyze the physical channel parameters in the receiving side. The other signals carry data encoding based on valid transmission information.
Resource Blocks are transmission units of independent signals for different proposes, which is called as Channel in some communication protocols.
Resource Blocks occupy certain resource units to transmission data, which is assigned by resource mapping in OFDM. Transmitted data in resource blocks is encoded into IQ value arrays by linear digital modulation, which is called as Payload.
Payload can be directly given as IQ value arrays, or modulated according to the bit patterns and the linear digital modulation type. The bit pattern can be automatically generated PN codes, or directly given.

Resource Blocks is classified into three types in accordance with the function of transmitted signals: Preamble, Pilot and Data.
Preamble is used to transmit known signals for frame synchronization. The signals might be also used to frequency/phase offset estimation or channel model estimation. It's usually assigned fixed IQ sequences for these resource blocks in the communication protocols.
Pilot is used to transmit known signals for channel model estimation, which is usually widely distributes in OFDM symbols to track time-varying channel parameters. Pilot might be also used to synchronization. It's usually assigned fixed bit sequences for these resource blocks in the communication protocols, and payloads are generated by linear digital modulation.
Data is used to transmit signals carrying the valid transmission information. The information is encoded into binary bit sequences, then modulated into IQ value sequences for resource block payloads.

Resource mapping priority of the resource blocks relates to the resource block type. Preamble has the highest priority, Pilot is the second, Data is the lowest.
Resource Blocks are numbered, the indices start from 1. For resource blocks of the same type, the resource blocks with larger indices have higher priority to resource mapping.

4.7.1.4 Resource Group

To assign resource units occupied by resource blocks clearly, resource groups is introduced to divide occupied resource units into several groups.
Resource units occupied by resource groups are given as OFDM symbol index lists and subcarrier index lists, which respectively assign certain OFDM symbols and subcarriers. For every OFDM symbol assigned, resource unit made up of every subcarrier assigned on the symbol is indicated to be occupied.
Every resource group has a unique group ID, that a non-negative integer to indicate the group. Resource group ID 0 is reserved, and indicates the group is global. The resource group is assigned as 0 by default if not given, its symbol index lists and subcarriers don't assign resource units for itself, but are appended the lists to those of other resource groups to expand physical resource ranges occupied by those groups.

4.7.2 Techniques Explanation

For the purposes of the present document, some techniques used in the software are explained as follow.

4.7.2.1 Cyclic Prefix / Cyclic Suffix

To reduce the effect of multipath transmission on the communication quality, Cyclic Prefix and Cyclic Suffix are frequently applied in the communication protocols based on OFDM.
Cyclic Prefix (CP) means adding certain number of sample points before the origin OFDM symbol sample data. Extra sample points are copied from the same number of sample points at the end of the origin symbol sample data.
Cyclic Suffix works similarly to CP, copying the sample points at the beginning of the origin and adding them into the end of the origin.

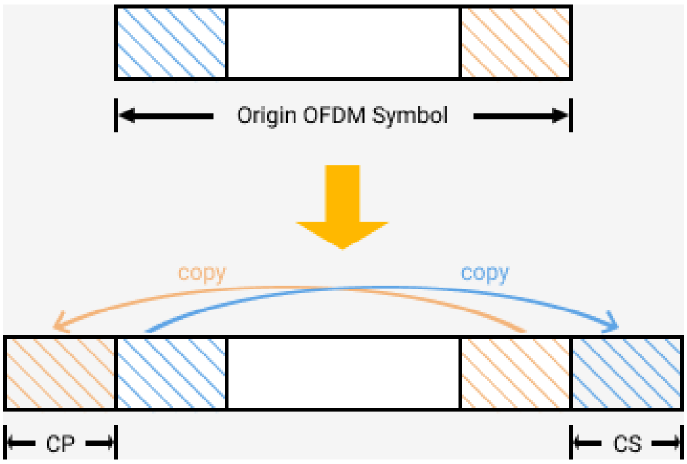


Figure 4-1 Cyclic Prefix and Cyclic Suffix

4.7.2.2 DFT Spread

DFT Spread is a technique to mapping the DFT calculation output sequences of the payload IQ values to physical resources, instead of origin payload sequences. It's introduced to suppress the Inter-Symbol Interference (ISI) and reduce the Peak to Average Power Ratio (PAPR) the spectrum in some communication protocols, like Uplink of LTE and NR.

If DFT spread is enabled for a resource block, the software will execute DFT calculation for payload values of it on every OFDM symbols respectively, and replace the origin data by the calculation results.

4.7.2.3 Windowing

Windowing is a technique to smoothing the transitions between OFDM symbols, in order to reduce the spectrum leakage of OFDM. There are two windowing method supported in the software: Window centered at symbol boundary, or window starting at symbol boundary.

For window centered at symbol boundary, origin OFDM symbol sample data are expanded at the beginning and the end, expanded sample points are copied from the end and the beginning of the origin respectively. For symbol with CP and /or CS, the copy source is before the source of CP and /or after the source of CS respectively. The expand data length is the quarter of the length of window rising / falling edge respectively.

Then, raise cosine window is applied to the expanded symbol data, the center of the rising / falling edge of the window function is aligned with the origin symbol boundary. The process flow is shown in Figure 4-2.

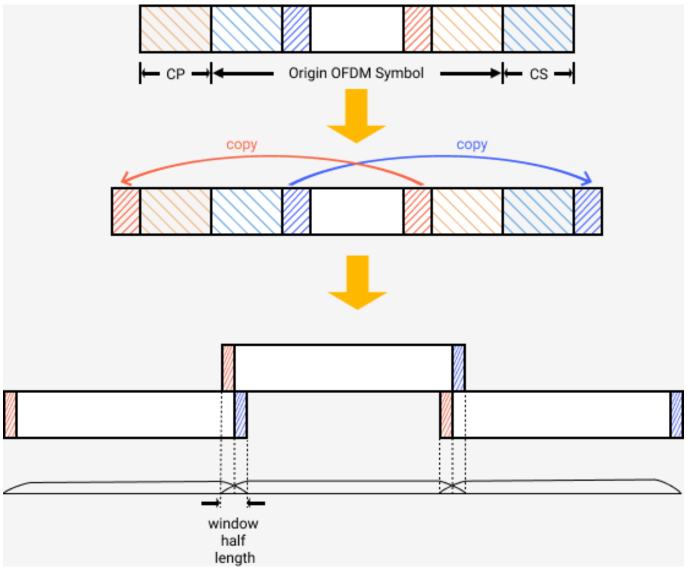


Figure 4-2 Window center aligning with symbol boundary

For window starting at symbol boundary, origin OFDM symbol sample data are expanded at the end only. The expand method is similar to the former method, but the expand length is the half of the window edge length.

Then, raise cosine window is applied, and the starting of window edge is aligned with the origin symbol boundary. The process flow is shown in Figure 4-3.

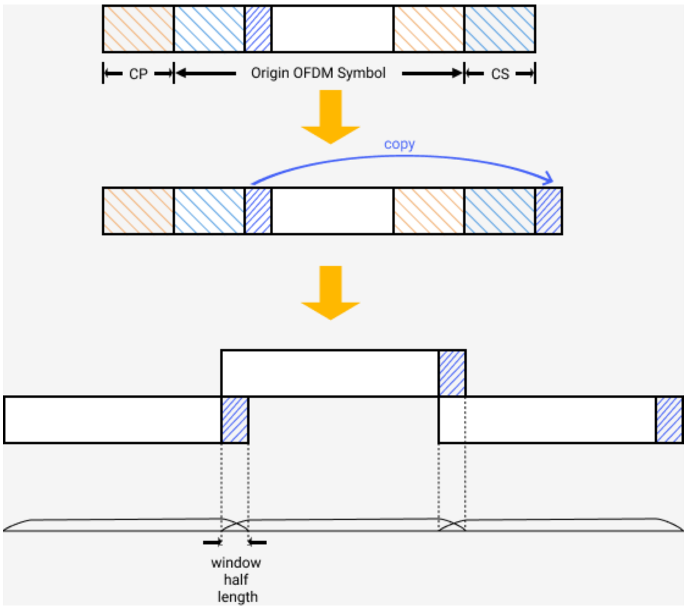


Figure 4-3 Window starting aligning with symbol boundary

4.7.2.4 Crest Factor Reduction

If Peak to Average Power Ratio (PAPR) of the OFDM baseband signal is relatively high, the power amplifier used in the transmission circuit must have wide dynamic range, which usually results in a lower power efficiency. To avoid the problem, it's necessary to reduce the PAPR of the baseband signals, which is called as Crest Factor Reduction (CFR).

There are some mature techniques to implement CFR, such as Clipping and filtering, Peak Windowing and Peak Cancellation. Peak Cancellation is adopted in the software.

If CFR is enabled, the software divides the baseband signal into blocks according to the block size assigned, and execute Peak Cancellation for every block:

For the sample point whose amplitude is highest, if the amplitude is over CFR target PAPR limit, generate the cancellation signal to cut down the over-limited amplitude according to the cancelling percent assigned.

Combine the cancellation signal of all blocks, and filter the combined signal to suppress the spectrum leak, then add the filtered signal to the baseband signal.

Check if the target PAPR value has been achieved, if not achieved and not meeting the max iteration limit, execute above steps iteratively.

4.7.3 Waveform Setup

The section explains the settings in the Waveform Setup Menu. Press **Waveform Setup** in the left window to enter parameter settings.

4.7.3.1 Basic

1. Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

2. Number of Frames

Range: 1 to 300 ; Default: 1.

Set the number of frames in the baseband signal data to download to the devices or export to the files.

3. Oversampling Ratio

Range: 1 to 128 ; Default: 4.

Set oversampling ratio of the baseband signal.

The parameter will increase the actual FFT length during the signal generation, too large parameter value will slow down the processing procedure, even result in out-of-memory failure.

4. Total Sample Points

Display the total number of sample points for the baseband signal according to the current settings.

5. Waveform Length

Display the time length of the baseband signal according to the current settings.

6. Mirror Spectrum

Choice: On | Off ; Default: Off.

Select setting the spectrum of the baseband signal into mirror symmetry or not.

The mirror spectrum is implemented by inversing the Q path of the baseband IQ signal.

4.7.3.2 Crest Factor Reduction

The section introduces the settings of CFR applied to the baseband signal.

1. Crest Factor Reduction

Choice: On | Off ; Default: Off.

Select applying CFR to the baseband signal or not.

If the parameter is set to Off, other settings of Crest Factor Reduction will be hidden.

2. Target PAPR

Range: 3 dB to 100 dB ; Default: 8 dB.

Set the target PAPR value of CFR applied to the baseband signal.

The software tries to reduce the PAPR value to the target assigned by executing CFR iteratively, but the target is NOT guaranteed to be achieved. If Max Iteration or Cancelling Percent is too little, it will be little possible to reduce the PAPR value to the low target value.

3. Max Iteration

Range: 1 to 20 ; Default: 10.

Set the maximum iterations of CFR process for the baseband signal.

The software executes CFR iteratively, and terminate the iteration if the target PAPR value has been achieved or the maximum iterations limit has been met.

4. Cancelling Percent

Range: 0 % to 100 % ; Default: 100 %.

Set the cancelling percent of the generated cancellation signal in the CFR process.

To reduce the PAPR of the blocked signals, cancellation signal amplitude equals to the cancelling percent assigned multiplies the over-limited amplitude of the origin signal. If the cancelling percent is too little, the effect of CFR will become too weak to achieve the target PAPR value.

5. Block Size

Range: 20 to Total Sample Points ; Default: 1000.

Set the block size of the signal segmentation in the CFR process.

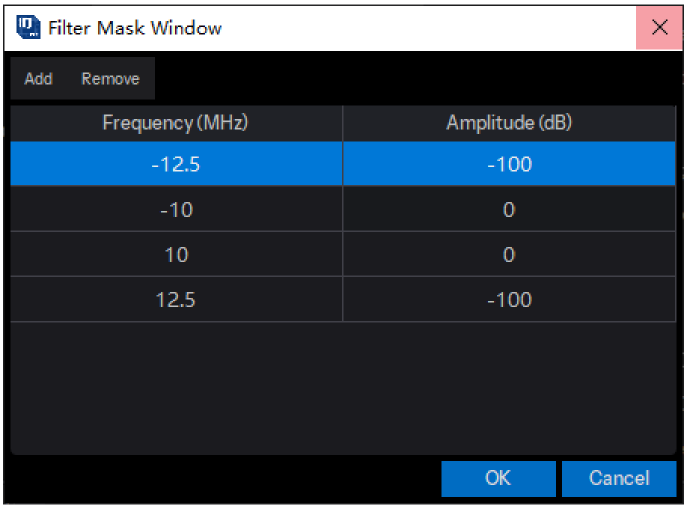
In the CFR process, the baseband signal is divided into blocks to execute Peak cancellation. For every signal block, only one peak will be cancellation in a single iteration. If the block size is too large, it's little possible to cancel all over-limited sample points in the baseband signal, resulting in failing to achieve the target PAPR value.

6. Filter Mask

Set the amplitude-frequency response data of the filter used to suppress the spectrum leak in the CFR process.

The cancellation signal generated in the CFR process will be filtered before add to the baseband signal, the software generates lowpass or bandpass FIR filter according the filter mask data assigned automatically.

If the passband of filter is too broad, the spectrum leak can't be suppressed effectively. If the passband is too narrow, the peak cancellation will be too weak to reduce PAPR value to the target.



4.7.3.3 Multicarrier

The section introduces the settings of multicarrier applied to the baseband signal.

Multicarrier is implemented by mixing the baseband signal to the carrier frequency assigned, and combine all signals on multi-carriers into the final baseband signal data to output to the devices or files.

1. Multicarrier Enabled

Choice: On | Off ; Default: Off.

Select applying multicarrier to the baseband signal or not.

If the parameter is set to Off, other settings of Multicarrier will be hidden.

2. Number of Carriers

Display the number of carriers in the multicarrier process.

3. Carrier Phases

Choice: Fixed | Random ; Default: Random.

Select the initial phases of the carriers to be aligned or random in the multicarrier process.

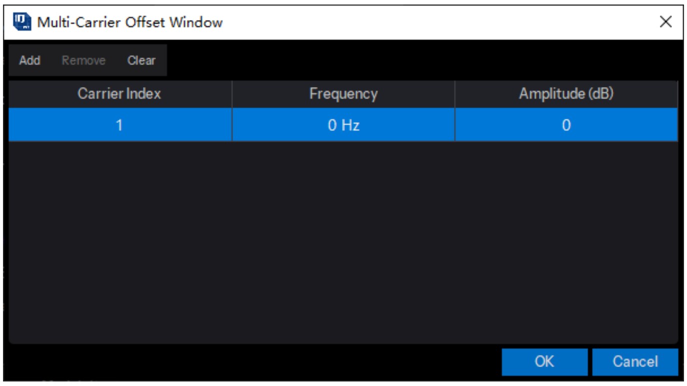
If the parameter is set to Fixed, the initial phases of all the carriers is set to the Initial Phase assigned in the Section 5. If the parameter is set to Random, the initial phases will be given by random numbers.

4. Frequency Offsets & Power Offsets

Click the "Frequency Offsets" or "Power Offsets" box to open the Multi-Carrier Offset Window, set the frequency or Power Offsets of carriers.

The Frequency Offset values larger than the baseband signal bandwidth or the device output bandwidth will result in undefined behaviors.

The Power Offset is limited to be non-positive values, indicating the power attenuation factors of the signal on the carriers.



4.7.4 Custom OFDM

The section explains the settings in the Waveform Setup Menu. Press **Custom OFDM** in the left window to enter parameter settings.

4.7.4.1 General Settings

1. Idle Interval

Range: 0 to 200ms;

Default: 4us (IEEE STD 802.11a-1999).

Set the idle interval length between frames in the baseband signal.

The idle interval is added to the end of the frames, and filled with zero sample data.

2. System Sample Frequency

Range: 1kHz to 250MHz;

Default: 20MHz (IEEE STD 802.11a-1999).

Set the basic sample frequency of the baseband signal.

The actual sample frequency of the baseband signal equals to the System Sample Frequency multiplies the Oversampling Ratio in Section 3. The actual sample frequency over the device bandwidth limit will result in undefined behaviors.

3. Half Subcarrier Offset

Choice: On | Off ; Default: Off.

Select half subcarrier offset applying to the baseband signal or not.

The transmission quality of signal on the DC subcarrier might be low because of the LO leakage in the transmitting and receiving end. Some communication protocol, like LTE Uplink, apply the technique to avoid DC subcarriers working, which shifts the frequency spectrum of the modulated signals from the bandwidth center, usually integer multiples of the half of subcarrier spacing.

If the parameter is set to Off, the parameter "Number of Shifted Half Subcarriers" will be disabled and hidden.

If the parameter is set to On, the parameter "Initial Phase" will be disabled and hidden.

4. Number of Shifted Half Subcarriers

Range: 1 to 16 ; Default: 1.

Set the half subcarrier number of frequency spectrum shifting of the baseband signal.

The parameter will be disabled and hidden, if the parameter "Half Subcarrier Offset" is set to Off.

5. Initial Phase

Range: 0 to 360 degrees ; Default: 0.

Set initial phase of the carrier for the modulated signal.

The parameter will be disabled and hidden, if the parameter "Half Subcarrier Offset" is set to Off.

If the Multicarrier Enabled is set to On, and the parameter "Carrier Phases" is set Random, the parameter will be actually invalid.

4.7.4.2 OFDM Settings

1. FFT Length

Range: 4 to 16384, must be an even number.

Default: 64 (IEEE STD 802.11a-1999).

Set the total subcarrier number of OFDM symbols.

The parameter decides the total subcarrier number of OFDM symbols, but the actual FFT length of the modulation equals to the parameter multiplies the Oversampling Ratio assigned in the Section 3.

The parameter will increase the actual FFT length during the signal generation, too large parameter value will slow down the processing procedure, even result in out-of-memory failure.

The parameter is usually set to the power of 2, or the FFT calculation will be slower.

2. Number of OFDM Symbols

Range: 1 to 2000 ; Default: 64.

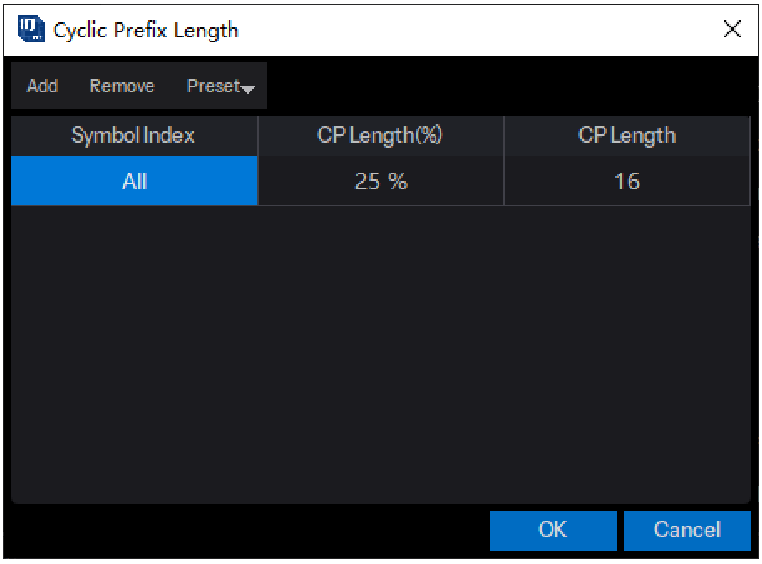
Set the total OFDM symbol number in a frame.

The parameter decides the total symbol number in a frame, and determines the size of the physical resources together with the parameter "FFT Length".

3. Cyclic Prefix Length

Click the "Cyclic Prefix Length" box to open the Cyclic Prefix Length Window, set the cyclic prefix length according to OFDM symbol grouping.

To express which symbols in a group, the symbol index lists is given according to the method presented in the Section 4.7.6.1. The Cyclic Prefix length is given as the length ratio of the sample point number of CP and origin OFDM symbol, whose range is 0 to 1.



4. Cyclic Suffix Length

Set the cyclic prefix applied to the modulated signal, the way to configure is similar to Cyclic Prefix Length in the Section 3.

5. Guard Lower Subcarriers

Range: 0 to the half of the FFT Length assigned in the Section 1 (included).

Default: 6 (IEEE STD 802.11a-1999).

Set the guard subcarrier number at the lower edge of the bandwidth.

To suppress the effect of the spectrum leakage, the subcarriers close to the edge of the bandwidth might be set to reserved or unused. The parameter indicates the number of the unused subcarriers at the lower edge.

6. Guard Upper Subcarriers

Range: 0 to the half of the FFT Length assigned in the Section 1 (not included).

Default: 5 (IEEE STD 802.11a-1999).

To suppress the effect of the spectrum leakage, the subcarriers close to the edge of the bandwidth might be set to reserved or unused. The parameter indicates the number of the unused subcarriers at the upper edge.

To ensure at least one subcarrier to transmit data, the maximum of the guard upper subcarrier is set to the half of the total subcarrier number minus 1.

7. Subcarrier Spacing

Display the spacing frequency between adjacent subcarriers according to the current settings.

8. Actual Signal Bandwidth

Display the actual bandwidth of data transmission according to the current settings, which equals to System Sample Frequency (in the Section 2) minus the bandwidth of guard subcarriers (in the Section 5 and 6).

9. Power Reference Type

Choice: First Symbol | Preamble Symbol(s) | All Symbol(s) | All Burst Symbol(s);

Default: First Symbol.

Select OFDM symbols to participate the RMS power calculation, the RMS power will be downloaded to the device to adjust the actual output power.

The option "Preamble Symbol(s)" indicates that the RMS power of all symbols used by Preamble resource blocks is set to the reference power.

The option "All Symbol(s)" indicates that frame idle intervals participate the power calculation, and the option "All Burst Symbol(s)" excludes the idle intervals.

4.7.4.3 Spectrum Control

1. Baseband Filter

To suppress the adjacent channel interference, the communication protocol usually regulates the spectrum masks to limit the spectrum leakage. It's a widely used solution to design a filter to achieve the requirement, and apply it to the modulated signals.

The software uses window function method to design lowpass FIR filters automatically, according to assigned filter length, cut-off frequency and window function type, and supports apply the FIR filter to the baseband signals generated.

1) Filter Enabled

Choice: On | Off ; Default: Off.

Set the baseband filter applied to the baseband signals or not.

If the parameter is set to Off, other settings of the baseband filter will be hidden.

2) Filter Type

Choice: Rectangle | Hanning | Flat Top | Blackman;

Default: Blackman.

Set the window function type applied to design the baseband filters.

3) Filter Length

Range: 1 to 2048 ; Default: 32.

Set the length of the baseband filter without account of oversampling.

The actual filter length equals to the parameter multiplies the Oversampling Ratio assigned in the Section 3, which determines the order of the filter and the process speed of the baseband filtering.

4) Filter Cutoff Frequency

Range: 0 to the half of the product of the System Sample Frequency times the Oversampling Ratio.

Default: 10MHz (IEEE STD 802.11a-1999).

Set the cut-off frequency of the baseband lowpass filter.

The cut-off frequency is counts from center frequency (DC) and the filter passband width is twice the cut-off frequency because of spectral symmetry.

The cut-off frequency is usually set larger than the half of the System Sample Frequency, or the valid spectrum data will be filtered and lost.

2. Windowing

The section explains the settings about windowing applied to OFDM baseband signals.

1) Window Beta

Range: 0 to 0.5 ; Default: 0.005.

Set the window function length applied in the signal windowing process.

The length of the single edge of the window function equals to the Window Beta multiplies the actual FFT Length.

2) Windowing Method

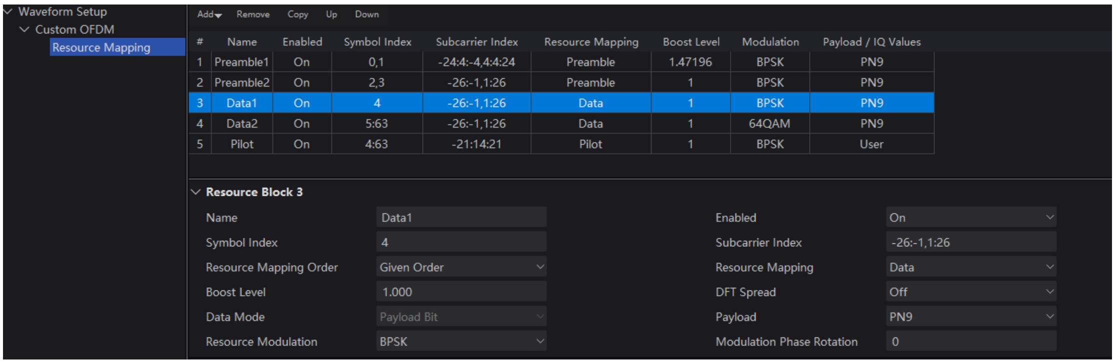
Choice: Centered at Symbol Boundary | Starting at Symbol Boundary

Default: Centered at Symbol Boundary

Set the windowing method applied in the windowing process.

4.7.5 Resource Mapping

The Section explains the settings in the Resource Mapping menu. Press **Resource Mapping** in the left window to enter parameter settings.



4.7.5.1 Resource Block List

To configure the list of resource blocks, use the buttons above the list respectively to:

- Add a new resource block of assigned type at the end of the list.
- Remove the selected resource block.
- Copy the selected resource block and add it at the end of the list.
- Move the selected resource block up one line.
- Move the selected resource block down one line.

The list displays the settings of all resource blocks, and click one to select it and modify the its settings with the edit boxes and buttons below.

4.7.5.2 Name

Set the name of the selected resource block.

4.7.5.3 Enabled

Choice: On | Off ; Default: Off.

Set the resource block is used in the resource mapping and signal modulation or not.

If a resource block is set to disabled, the resource mapping and signal modulation will skip the resource block, other settings in the resource block will be invalid but reserved.

4.7.5.4 Symbol Index

Set the symbols which the payload of selected resource block should be mapped to.

The Symbol Index should be given as resource groups introduced in the Section 4.7.1.4, and in the format given in the Section 4.7.6.2.

The parameter "Symbol Index" together with the parameter "Subcarrier Index" determines the resource units occupied by selected resource block.

4.7.5.5 Subcarrier Index

Set the subcarriers which the payload of selected resource block should be mapped to.

The Subcarrier Index should be given as resource groups introduced in the Section 4.7.1.4, and in the format given in the Section 4.7.6.2.

The parameter "Symbol Index" together with the parameter "Subcarrier Index" determines the resource units occupied by selected resource block.

4.7.5.6 Resource Mapping Order

Choice: Given Order | Resource Order ;

Default: Given Order.

Set the payload mapping order of selected resource block.

The option "Given Order" indicates that the payload IQ value sequence of the resource block is mapping to physical resources according to the order of resource units given in the parameter

"Symbol Index " and "Subcarrier Index".

The option "Resource Order" indicates that the mapping is according to the small-to-large order of the symbol and subcarrier indices of resource units.

Both mapping order is subcarrier-major mapping, meaning filling the subcarriers given in a single symbol first, then fill the subcarriers for next symbols.

4.7.5.7 Resource Mapping

Choice: Preamble | Pilot | Data ;

Set the type of selected resource block.

4.7.5.8 Boost Level

Range: 0.1 to 10 ; Default: 1.0 .

Set the boost level of the payload in selected resource block.

The payload IQ values will be multiplying the Boost Level before mapping to physical resources.

4.7.5.9 DFT Spread

Choice: On | Off ; Default: Off.

Set DFT Spread is enabled or not in selected resource block.

4.7.5.10 Data Mode

Choice: Payload Bit | IQ Values.

Set the payload data mode of selected resource block.

The option "Payload Bit" indicates that the payload IQ values are generated by modulating the payload bit patterns with certain linear digital modulation mode.

The option "IQ Values" indicates that the payload IQ values is directly given in the resource block setting.

4.7.5.11 Payload

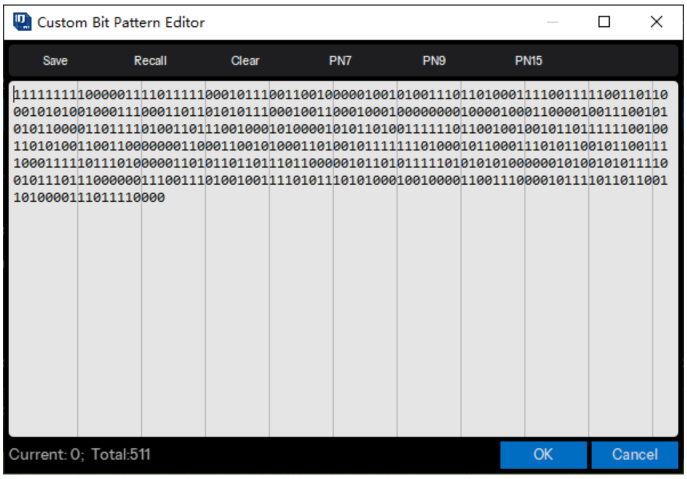
Choice: PN9 | PN15 | PN23 | User ;

Default: PN9.

Set the payload bit pattern type of selected resource block.

PN codes will be generated automatically for following modulation and payload generation, if PN code type is selected. Otherwise, a user-defined bit patterns should be inputted in the Custom Bit Pattern Editor. The Editor will pop up when the option "User" is clicked.

If the parameter "Data Mode" is set to "IQ Values", the parameter will be disabled and hidden.



4.7.5.12 Resource Modulation

Choice: BPSK | QPSK | 8PSK | 16QAM | 32QAM | 64QAM | 128QAM | 256QAM | 512QAM | 1024QAM | 2048QAM | 4096QAM ;

Default: BPSK.

Set the linear digital modulation type is applied to generate payload IQ values from given bit patterns.

If the parameter "Data Mode" is set to "IQ Values", the parameter will be disabled and hidden.

4.7.5.13 Modulation Phase Rotation

Range: 0 to 360 degrees

Default: 0.

Set rotation phase of the modulated IQ values.

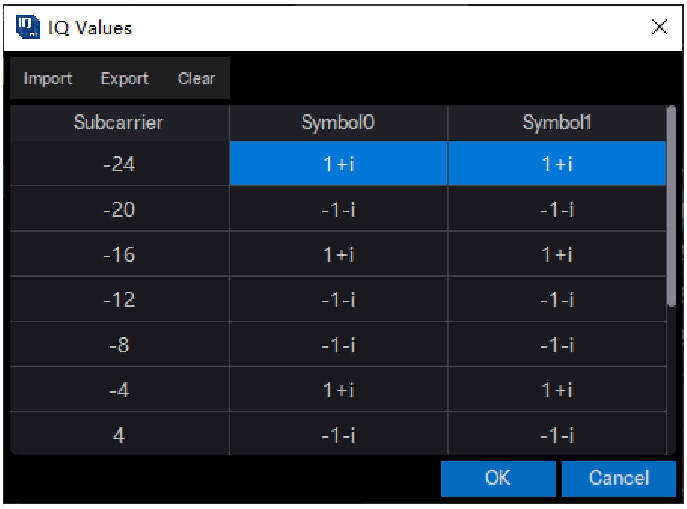
The software will rotate the modulated IQ values before payload mapping to physical resources, if the parameter "Data Mode" is set to "Payload Bit".

If the parameter "Data Mode" is set to "IQ Values", the parameter will be disabled and hidden.

4.7.5.14 IQ Values

Click the "IQ Values" box to open the IQ Values Window, set payload IQ value sequence of selected resource block directly.

If the parameter "Data Mode" is set to "Payload Bit", the parameter will be disabled and hidden.



4.7.6 Appendix

4.7.6.1 Integer Array Expressions

Integer arrays are given as formatted expressions, which is used for assigning symbol index lists and subcarrier index lists of resource groups, or symbols which cyclic prefix / suffix is applied.

The syntax format of formatted expressions supported are as follow:

1. A single integer value, e.g., 0, 1, 2.
2. Two integer values separated by a colon (:), indicating all integer values between the two numbers, including the numbers directly given in the expressions. e.g., −3:2 means −3, −2, −1, 0, 1, 2.
3. Three integer values separated by colons (:), like A:B:C (A, B, C are integer values), indicating the integer values at intervals of the value C from the value A to the value B. e.g., −4:3:8 means −4, −1, 2, 5, 8.

   The value B should have the same sign as the difference between C and A (C−A), or the expressions is considered illegal.

   The value A is guaranteed to be included in the integer array. The value C will NOT be included if the difference between C and A (C−A) is not divisible by the value B.
4. Five integer values separated by colons (:), like A:B:C:D:E (A, B, C, D are integer values, E is 0 or 1).

The expression means the combination of certain numbers of integer arrays, and the number of integer arrays is assigned to be the value D.

The initial integer array is the same as the one parsed from A:B:C, the following array are generated from every element in the former array increment by 1.

The value A must be larger than the value C. The value B and the value D must be positive. The expressions violate the rules will be considered as illegal.

The value E indicates the integer arrays to skip zero or not. It can be omitted, like A:B:C:D. The value E is considered as 0 by default in this case.

For example, to parse the formatted expression -6:3:6:2:1, generate the initial array -6,-3, 0, 3, 6;
Then the number of arrays is assigned to be 2, the following array is generated as -5,-2, 1, 4, 7;
The skip zero flag is assigned to be 1, so skip zero and get array -6, -3, 1, 4, 7and array -5, -2, 2, 5, 8;
At last, combine the arrays to get indicated integer array -6, -5, -3, -2, 1, 2, 4, 5, 7, 8.

Two or more formatted expressions separated by a comma (,) indicate a single integer array, which includes all elements of integer arrays parsed from expressions.

4.7.6.2 Resource Group Expressions

To show resource units occupied by resource blocks, resource group is introduced, and is given by symbol groups and subcarrier groups respectively. To get more information about resource groups, refer to Section 4.7.1.4.

Every resource group is assigned an ID, symbol / subcarrier groups with the same ID will combine into the resource group. The expressions of symbol / subcarrier groups should be separated by commas (,).

The syntax format of symbol / subcarrier groups is as follow:

{n|xxxxx}

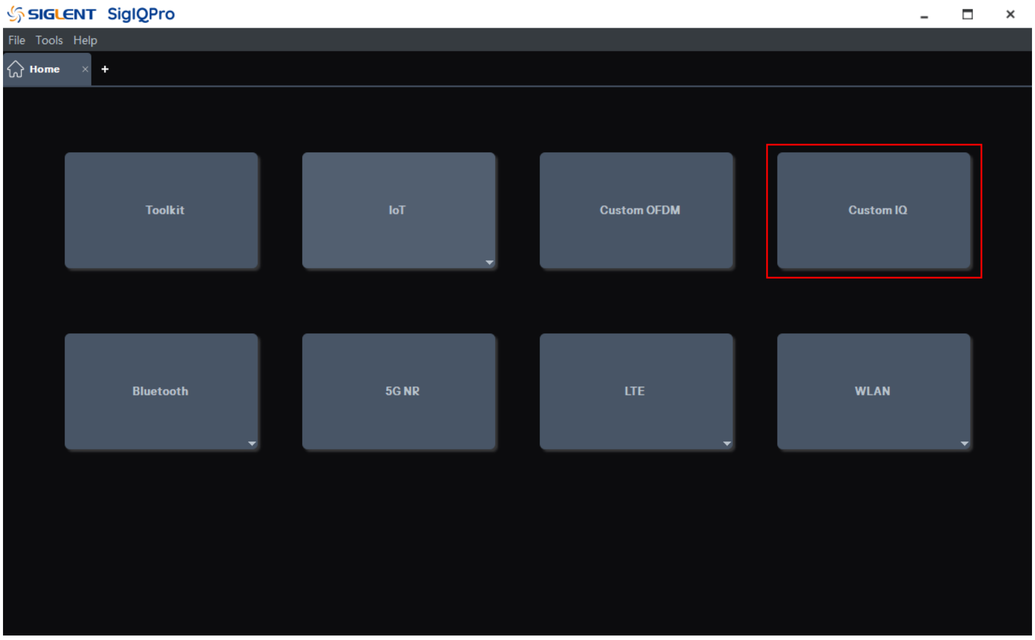
where non-negative integer value n is the group ID, xxxxx is the formatted expressions to indicate symbol / subcarrier index lists, whose syntax format is given in Section 4.7.6.1.

The group ID can be omitted, like {xxxxx} or xxxxx, which is considered as 0 in this case, and the resource group is considered as a global group.

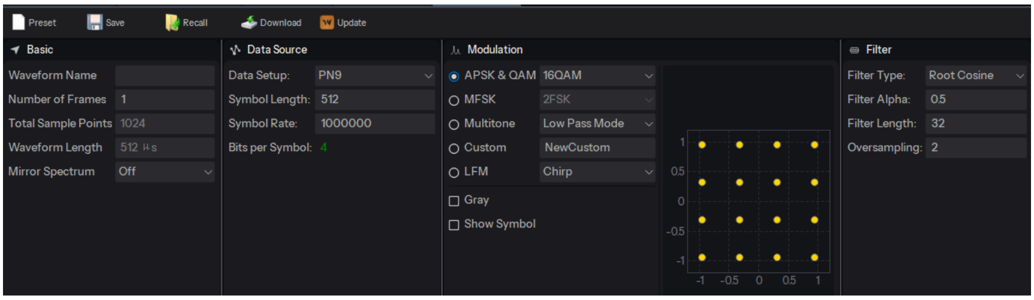
It's allowed to give a single symbol / subcarrier group in two or more expressions separated by commas (,) with the same group ID.

4.8 Custom IQ

Custom IQ includes Digital modulation, Custom modulation, Multitone and LFM sweep. You can click **Custom IQ** on the homepage to enter the Custom IQ setting interface.



Waveform setup panel is used for setting parameters of a waveform, such as Data Source, Modulation and Filter.



4.8.1 Basic

4.8.1.1 Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

4.8.1.2 Number of Frames

Range: 1 to 300 ; Default: 1.

Set the number of frames included in the generated waveform.

4.8.1.3 Total Sample Points

Display the generated waveform length (number of points).

Note: This parameter is displayed only and cannot be edited.

4.8.1.4 Waveform Length

Display the generated waveform length (in second).

Note: This parameter is displayed only and cannot be edited.

4.8.1.5 Mirror Spectrum

Choice: On | Off ; Default: Off.

Select setting the spectrum of the baseband signal into mirror symmetry or not.

The mirror spectrum is implemented by inversing the Q path of the baseband IQ signal.

4.8.2 Data Source

Data Source panel sets parameters for symbol data that to be modulated.

4.8.2.1 Data Setup

Select a data source type for modulation.

Choices: PN7 | PN9 | PN15 | PN23 | PN31 | User File | Custom Bit Pattern ;

Default: PN9.

- PN7 | PN9 | PN15 | PN23 | PN31:

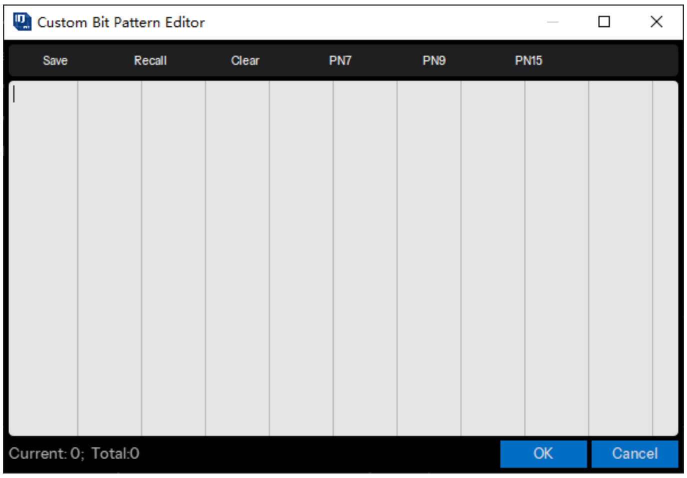
When selecting “PN7 | PN9 | PN15 | PN23 | PN31” as data source type, software generates data source bit automatically.

- User File:

When selecting “User File” as data source type, a file selection dialog box pops up for you to select a TXT (*.txt) file as input data bits. In the user data file, only 0 and 1 is acceptable. If there is any illegal value in it, an error message box will pop up.

- Custom Bit Pattern:

When selecting “Custom Bit Pattern” as data source type, a Pattern Editor window opens for data bits editing. You can input 0|1 in the input box manually or insert PN7|PN9|PN15 data bits by corresponding button, and you can also save the data to a new file and recall data from an existing file. Use “Clear” button to clear the data edit box.



4.8.2.2 Symbol Length

Set the length of modulated symbols.

Range: 100 to 100000;

Default: 512.

4.8.2.3 Symbol Rate

Set the symbol rate (symbols per second) of the waveform.

Range: 250 to (8e+09/Oversampling) Symbol/s;

Default: 1000000 Symbol/s.

4.8.2.4 Bits Per Symbol

Display the number of bits contained in one modulated symbol. It is read-only, not settable.

4.8.3 Modulation

Modulation panel sets parameters for user selected modulation type.

Choices: APSK & QAM | MFSK | Multitone | Custom | LFM;

Default: APSK & QAM.

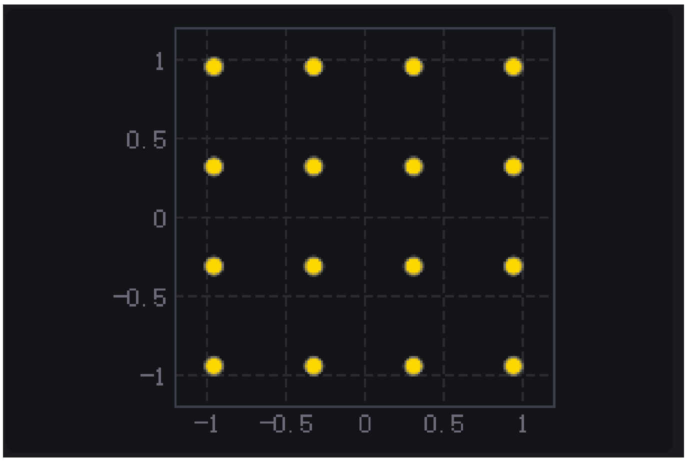
4.8.3.1 APSK & QAM

Select a type in APSK & QAM category for modulation.

Choices: 2ASK | PR-ASK | BPSK | OQPSK | QPSK | 8PSK | DBPSK | DQPSK | PI/4-DQPSK | D8PSK | PI/8-D8PSK | 16APSK | 32APSK | 8QAM | 16QAM | 32QAM | 64QAM | 128QAM | 256QAM | 512QAM | 1024QAM | 2048QAM | 4096QAM;

Default: 16QAM.

After a modulation type is selected, the constellation of current modulation is displayed on right side of the panel:



You can double click on the constellation display to show a zoomed in window of the constellation.

Gray

Turn ON or OFF the Gray code for the constellation data.

Default: OFF.

Show Symbol

Turn ON or OFF the Symbol display of the constellation diagram.

Default: OFF.

4.8.3.2 MFSK

Select a type in MFSK category for modulation.

Choices: 2FSK | 4FSK | 8FSK | 16FSK | MSK;

Default: 2FSK.

- **2FSK | 4FSK | 8FSK | 16FSK**

When selecting 2FSK | 4FSK | 8FSK | 16FSK as current modulation type, FSK Deviation setting is displayed on the bottom of the panel.

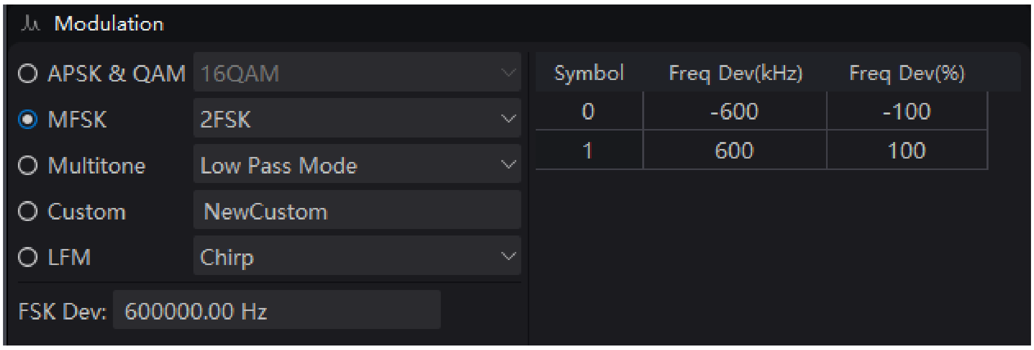
FSK Dev (Hz)

Set frequency deviation for FSK modulation in Hz.

Range: 0 to (0.8 * Symbol Rate * Oversampling) Hz;

Default: 600000 Hz.

The Symbol and FSK deviation table is displayed on the right side of the panel:

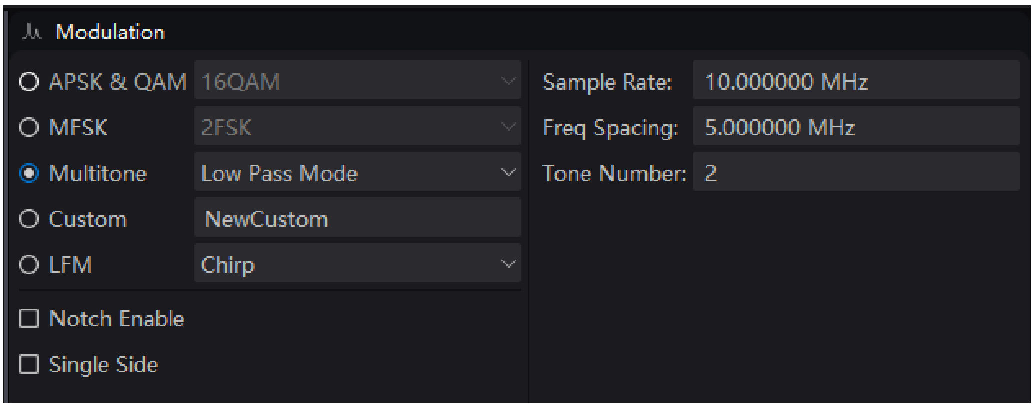


- **MSK**

When selecting MSK as current modulation type, Filter type can only be selected as Gaussian.

4.8.3.3 Multitone

Select Multitone as current modulation type. Filter setting panel is invisible under multitone modulation. The settings for Multitone modulation are displayed on the right side of the panel:



1) **Low Pass Mode**

- **Sample Rate**

Set sample rate of multitone modulation in MHz.

Range: 500 Hz to 4000 MHz;

Default: 10 MHz.

- **Freq Spacing**

Set frequency spacing of multitone modulation in MHz.

Range: 0 to (Sample Rate / 1.28) MHz;

Default: 5 MHz.

- **Tone Number**

Set tones number of multitone modulation.

Range: 1 to 10000;

Default: 2.

2) **Band Mode**

- **Sample Rate**

Set sample rate of multitone modulation in MHz.

Range: 500 Hz to 4000 MHz;

Default: 10 MHz.

- **Start Freq**

Set start frequency of multitone modulation in MHz.

Range: 0 to (Sample Rate / 2.56) MHz;

Default: 2 MHz.

- **Stop Freq**

Set frequency spacing of multitone modulation in MHz.

Range: (start freq) MHz to (Sample Rate / 2.56) MHz;

Default: 2 MHz.

- **Tone Number**

Set tones number of multitone modulation.

Range: 1 to 10000;

Default: 2.

3) Notch Enable

Turn ON or OFF the multitone notch.

Default: OFF.

- **Notch Start**

Set notch start of multitone modulation in MHz.

Range: 0 to (Sample Rate / 2) MHz; Default: 0 MHz.

- **Notch Stop**

Set notch stop of multitone modulation in MHz.

Range: (notch start) to (Sample Rate / 2) MHz; Default: 0 MHz.

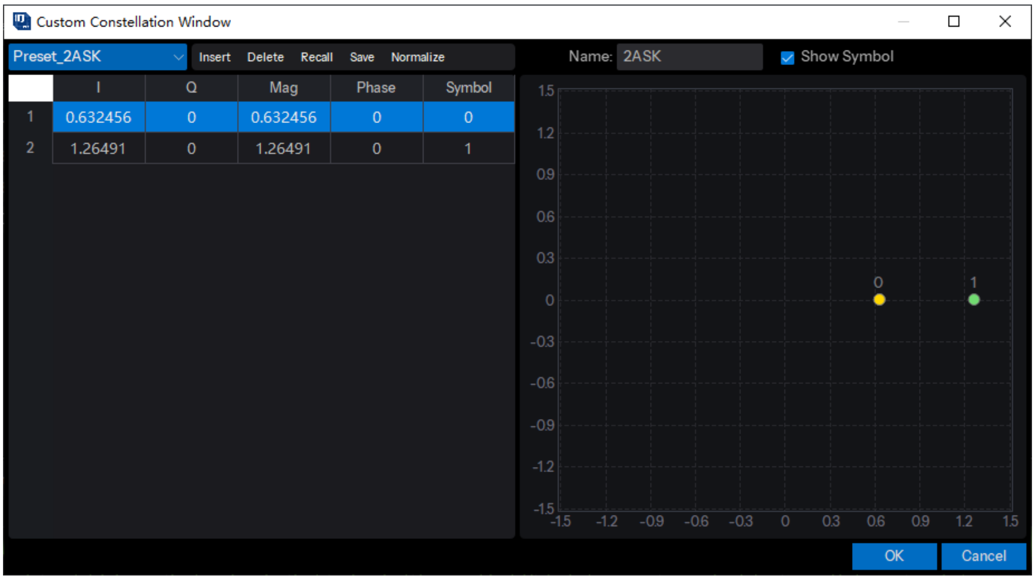
4) Single Side

Turn ON or OFF single side modulation for multitone.

Default: OFF.

4.8.3.4 Custom

Set a custom constellation for modulation. After selecting Custom modulation type, a custom constellation editing window is displayed:



In the custom constellation editing window, you can preset the constellation data to a known modulation type first by pressing 

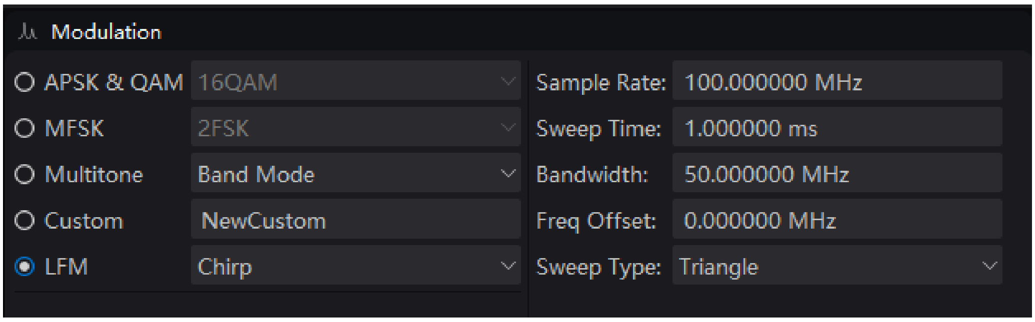
buttons, then you can insert or delete constellation points and edit the IQ data for each constellation point manually. You can also recall constellation data from an existing file and save the edited constellation data to a new file. “Normalize” button is used to normalize all constellation data for RMS value = 1.

On the right side of the window, it shows the constellation display of current editing. You can input a name for the constellation, this name will be displayed beside the “Custom” modulation item after you click “OK” button. You can also turn ON or OFF symbol display on the constellation display by clicking “Show Symbol” button.

Note: When editing the constellation points, the number of points must be a value of power of 2 and the Symbol values cannot be duplicated, otherwise there will be error message when you click “OK” button.

4.8.3.5 LFM

Select LFM as current modulation type. Filter setting panel is invisible under LFM modulation. The settings for LFM modulation are displayed on the right side of the panel:



1) Chirp

Single segment waveform.

- **Sample Rate**

Set sample rate in MHz.

Range: 500 Hz to 12000 MHz; Default: 100 MHz.

- **Sweep Time**

Set sweep time in ms.

Range: 10 ns to 1s; Default: 1 ms.

- **Bandwidth**

Set sweep bandwidth of LFM modulation in MHz.

Range: 100 Hz to (Sample Rate) MHz; Default: 50 MHz.

- **Freq Offset**

Set freq offset of LFM modulation in MHz.

Range: (-bandwidth / 2) MHz to (bandwidth / 2) MHz;

Default: 50 MHz.

- **Sweep Type**

Choices: Triangle | Up | Down;

Default: Triangle.

2) Customized Chirp

Multi-segment waveform.

- **Sample Rate**

Set sample rate of LFM modulation in MHz.

Range: 500 Hz to 12000 MHz;

Default: 100 MHz.

- **Segment**

Enter the number of chirp segments.

Range: 1 to 100; Default: 3.

- **Total Sweep Time**

Display the total sweep time for all the chirp segments.

- **Frequency Start**

Enter the start frequency for current chirp segment.

Range: (– Sample Rate / 2) MHz to (Sample Rate / 2) MHz.

- **Frequency End**

Enter the end frequency for current chirp segment.

Range: (– Sample Rate / 2) MHz to (Sample Rate / 2) MHz.

- **Duration**

Enter the duration for current chirp segment.

Range: 10 ns to 1 s

4.8.4 Filter

Set the filter parameters for current modulation.

4.8.4.1 Filter Type

Set filter type for current modulation.

Choices: None | Gaussian | RaisedCosine | RootCosine | HalfSine;

Default: Gaussian for MSK and RootCosine for all other modulation types.

Note: For MSK modulation, only Gaussian filter type is supported. For HalfSine filter, only OQPSK modulation type is supported.

4.8.4.2 Filter Alpha/BT

Set the Alpha factor of the filter (BT of Gaussian filter).

Alpha Range: 0.01 ~ 1;

BT Range: 0.1 ~ 5;

Default: 0.5 .

4.8.4.3 Filter Length

Set length of filter in symbols.

Range: 1 ~ min (Symbol Length, 512) ;

Default: 32.

4.8.4.4 Oversampling

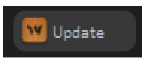
Set the oversampling ratio of the waveform. The waveform Sample Rate is determined based on Symbol Rate and Oversampling ratio.

Range: 2 – 32;

Default: 2.

Notes: For OQPSK modulation, the oversampling must be even. For HalfSine filter, the oversampling must be more than 8.

4.8.5 Waveform Display

After setting all parameters for modulation and click the 

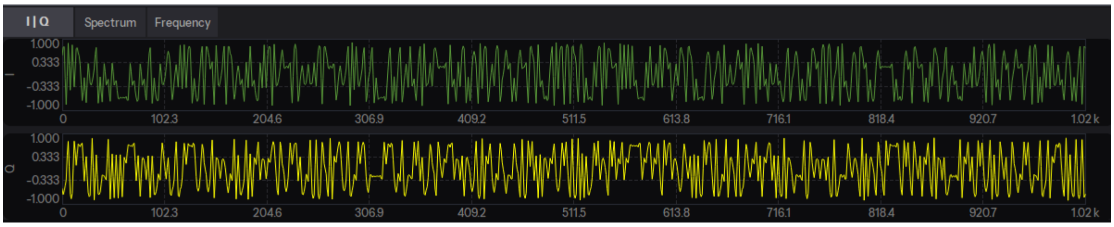
button on the top of the window, the modulated waveform is displayed on the lower half of the main window. You can click

"Spectrum" tab to display the Frequency domain waveform, click "I | Q" tab to display the Time domain waveform alternatively, click "Frequency" tab to display the Frequency waveform.

When the Mouse is on waveform display, you can use the scroll button of your Mouse to zoom in or zoom out the waveform plots. You can also click "Update" button to restore the default display of the plots.

4.8.5.1 IQ Waveform Display

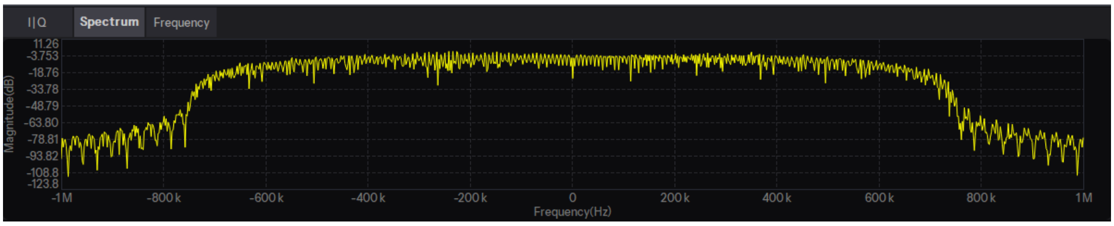
After clicking "I | Q" tab, the time domain plot of modulated IQ data is displayed.



The I/Q data plots are displayed separately in two graphs. The horizontal coordinate shows the symbol values and the vertical coordinate shows the amplitude values of I/Q data.

4.8.5.2 FFT Spectrum Display

After clicking "Spectrum" tab, the frequency domain plot of modulated IQ data by FFT is displayed.

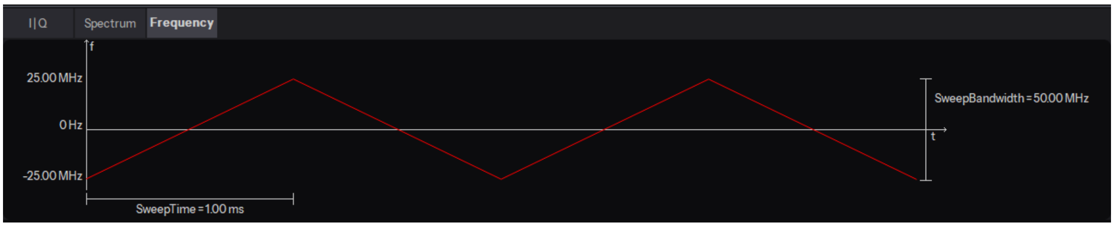


The horizontal coordinate shows the frequency values in Hz and the vertical coordinate shows the Magnitude values in dB.

4.8.5.3 Frequency Diagram

After clicking "Frequency" tab, the frequency diagram is displayed.

This diagram is displayed only when the modulation mode is LFM.



Information such as sweep time, sweep frequency and sweep bandwidth are clearly displayed in the frequency plot.

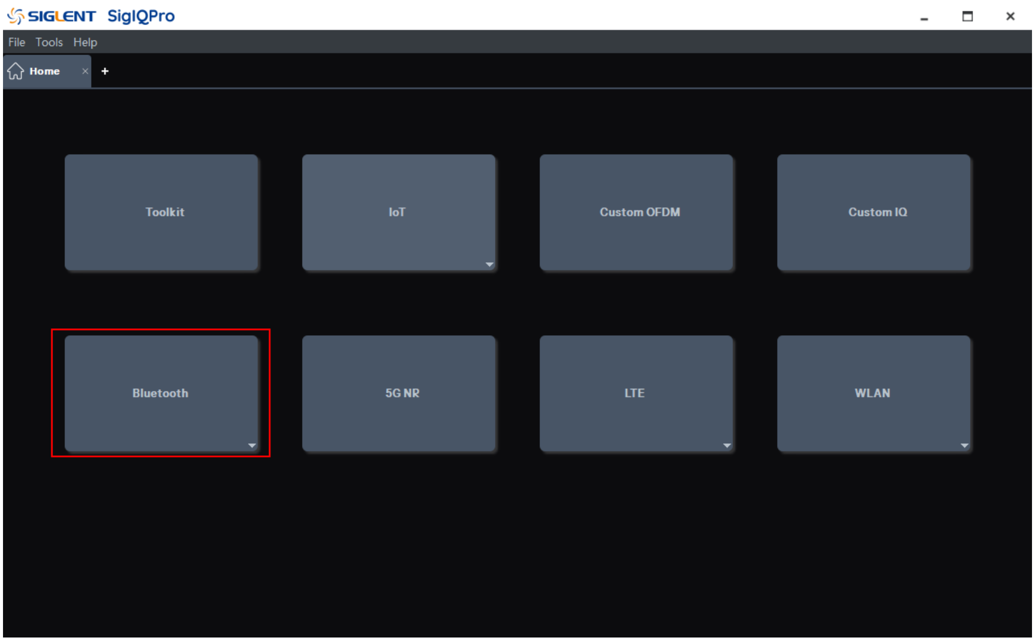
4.9 Bluetooth BR+EDR

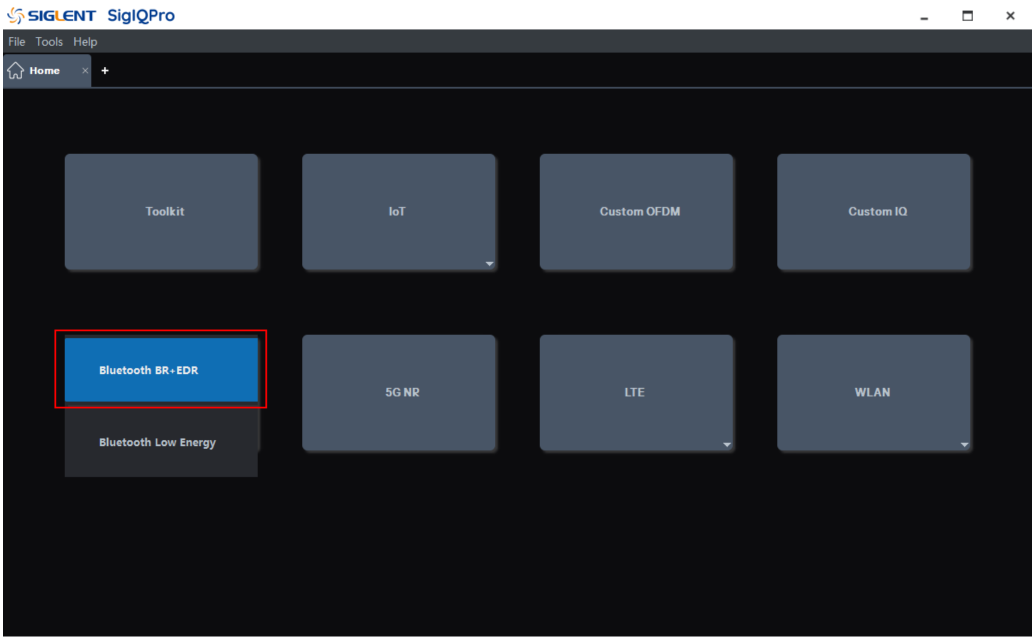
Bluetooth devices operate in the unlicensed 2.4 GHz ISM (Industrial Scientific Medical) band. A frequency hop transceiver is applied to combat interference and fading.

Two modulation modes are defined. A mandatory mode, called Basic Rate, uses a shaped, binary FM modulation to minimize transceiver complexity. An optional mode, called Enhanced Data Rate, uses PSK modulation and has two variants: π/4-DQPSK and 8DPSK. The symbol rate for all modulation modes is 1 Msym/s. The gross air data rate is 1 Mb/s for Basic Rate, 2 Mb/s for Enhanced Data Rate using π/4-DQPSK and 3 Mb/s for Enhanced Data Rate using 8DPSK.

Protocol version: 5.0

You can click **Bluetooth** -> **Bluetooth BR+EDR** on the homepage to enter the BR/EDR Bluetooth setting interface.





4.9.1 Parameters Setup

Press **Parameters Setup** in the left window to enter parameter settings.

4.9.1.1 Basic

1. Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

2. Total Sample Points

Display the generated waveform length (number of points).

Note: This parameter is displayed only and cannot be edited.

3. Waveform Length

Display the generated waveform length (in second).

Note: This parameter is displayed only and cannot be edited.

4. I/Q Map

Choice: Normal | Inverted ; Default: Normal.

Use the drop-down menu to select a normal or inverted I/Q signal. If invert is selected, the I signal is unchanged and the Q is reversed.

5. Oversampling Ratio

Range: 2 to 100 ; Default: 10.

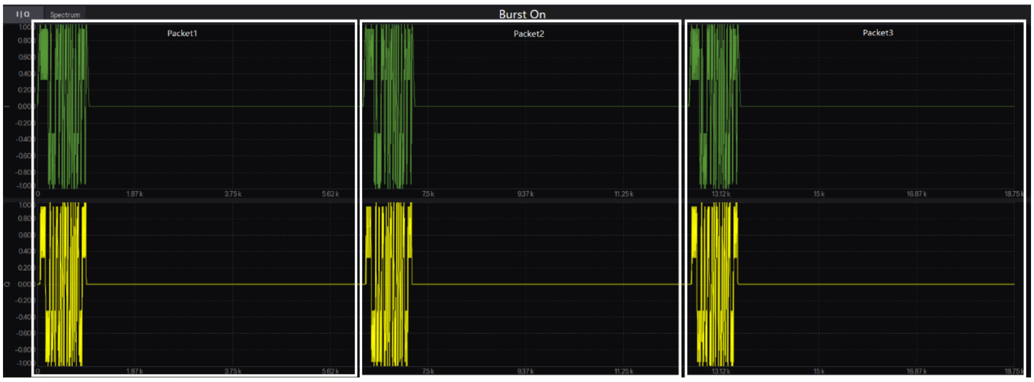
Set the number of samples calculated per I/Q symbol.

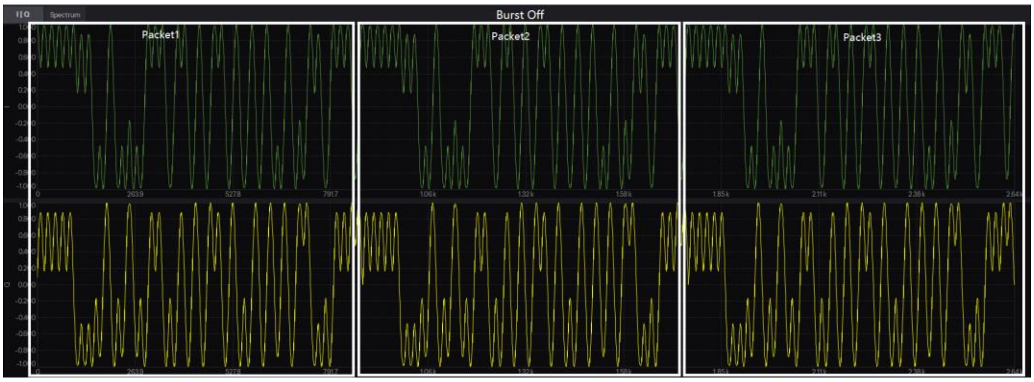
4.9.1.2 Bursting and Power Ramp

1. Bursting Active

Choice: On | Off ; Default: On.

Use the drop-down menu to enable or disable the bursting in the waveform. When enabled, the packet transmission timing of the test signal adheres to the Bluetooth TDD slot structure for the selected packet type.





2. Power Ramp

Range: 1 to 10 us ; Default: 6 us.

Set the power ramp up and power ramp down length of the burst.

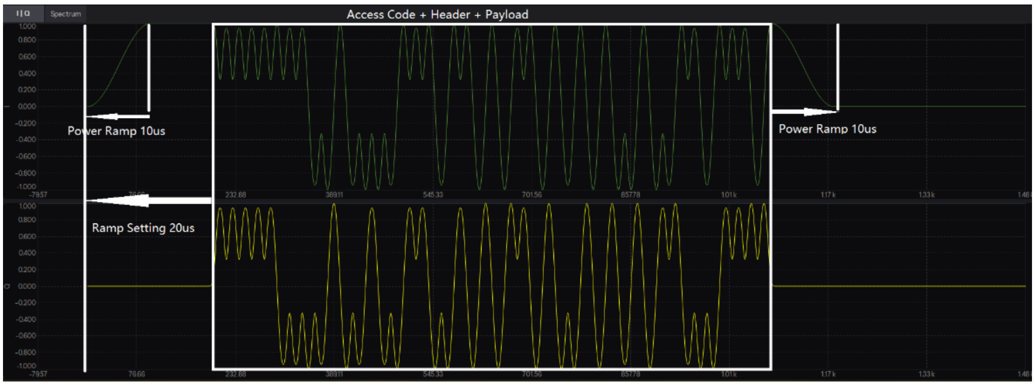
The power ramp up refers to the time when the carrier frequency ramped from idle power to transmitted power. The power ramp is shaped with a cosine function.

3. Ramp Settling

Range: 1 to 20 us ; Default: 6 us.

Set the Ramp Settling length of the burst.

The Ramp Settling refers to the time when the carrier frequency ramped from idle power to transmitted power and remains stable until it begins to transmit the first symbol.



4.9.1.3 Impairments

1. Modulation Index

Range: 0.05 to 0.95 ; Default: 0.315.

Set the modulation index of GFSK.

Specifies the modulation index used by GFSK, which is the ratio of peak-to-peak frequency deviation to the bit rate.

2. Frequency Drift

1) State

Choice: On | Off ; Default: Off.

Use the drop-down menu to enable or disable the frequency drift impairment applied to the packet. This impairment adds a dynamic error to the transmission frequency. It is used to simulate the frequency drift impairment repeats at the beginning of each timeslot and occurs over a time period equal to the packet duration.

2) Type

Choice: Linear | Sine ; Default: Linear.

Use the drop-down menu to select the type of frequency drift applied to the Bluetooth packet.

3) Deviation

Range: -100 to 100 kHz ; Default: 0 kHz.

Set the maximum deviation of frequency drift impairment.

4) Rate

Choice: 300 Hz | 500 Hz | 1.6 kHz | 10 kHz;

Default: 1.6 kHz.

Use the drop-down menu to select the frequency drift rate.

3. Frequency Offset

Range: -200 to 200 kHz ; Default: 0 kHz.

Sets the static offset of the carrier frequency. This static offset is used to simulate a Bluetooth device transmitting at a frequency slightly offset from the specified carrier.

4. Symbol Timing Error

Range: -50 to 50 ppm ; Default: 0 ppm.

Set the shift of standard symbol rate for transmission. This shift varies the symbol rate of the Bluetooth signal.

It is used to simulate a Bluetooth device transmitting at a slight deviation in the sampling clock.

5. Relative Power

Range: -10 to 10 dB ; Default: 0.00 dB.

Set the average power level of the synchronization sequence and payload relative to the access code and header portion during transmission.

4.9.1.4 Dirty Transmitter

1. State

Choice: On | Off ; Default: Off.

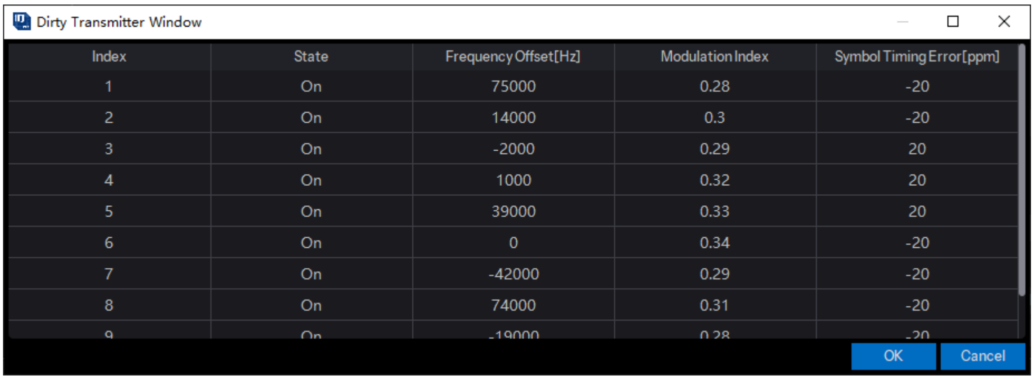
Use the drop-down menu to enable or disable the dirty transmitter test. When this setting is set to On, the Dirty Transmitter Impairments Setup window appears.

2. Number of Packet per Set

Range: 1 to 50 ; Default: 1.

Set the number of packets for each set of parameters displayed in the Dirty Transmitter Window.

3. Dirty Transmitter Window



1) Index

This cell displays the impairment set index number.

2) State

Use this cell to enable or disable a specified impairment set in dirty transmitter test.

3) Frequency Offset [Hz]

Range: -200 to 200 kHz.

Set the static offset of the carrier frequency. This static offset is used to simulate a Bluetooth device transmitting at a frequency slightly offset from the specified carrier.

4) Modulation Index

Range: 0.05 to 0.95.

Specify the modulation index used by GFSK, which is the ratio of peak-to-peak frequency deviation to the bit rate.

5) Symbol Timing Error [ppm]

Range: -50 to 50.

Set the shift of standard symbol rate for transmission. This shift varies the symbol rate of the Bluetooth signal. It is used to simulate a Bluetooth device transmitting at a slight deviation in the sampling clock.

4.9.1.5 Frequency Hopping

1. State

Choice: On | Off ; Default: Off.

Use the drop-down menu to enable or disable frequency hopping.

2. Hop Selection

Choice: Selection Kernel | User Defined;

Default: Selection Kernel.

Use the drop-down menu to set the hop selection type.

Note: This setting can be edited only when the Hopping State is turned On. “Selection Kernel” means that the hopping sequence will be calculated using basic hop selection kernel, which uses ’CLK Start’ and ’UAP/LAP’ as input parameters.

“User Defined” means that the user input sequence will be used as hopping sequence.

3. CLK Start

Range: 0x0000000 to 0xFFFFFFF; Default: 0x0000000.

Set the starting value of CLK as an input of kernel hop selection.

Note: This setting can be edited only when the Hopping State is turned On and Hop Selection is Selection Kernel.

4. User Sequence

Set the user defined hopping sequence using comma as separator.

Note: This setting can be edited only when the Hopping State is turned On and Hop Selection is User Defined.

5. **Hop Channel**

Range: 0 to 78 ; Default: 0.

Set the fixed frequency channel index used for packet transmission.

Note: This setting can be edited only when the Hopping State is turned Off.

4.9.2 Packet

Press **Packet** in the left window to enter parameter settings.

4.9.2.1 General Setting

1. **Bluetooth Mode**

Choice: Basic Rate | Enhanced Data Rate;

Default: Basic Rate.

Use the drop-down menu to select the Bluetooth mode of the packet.

2. **Transport Mode**

Choice: ACL | eSCO | SCO (Basic Rate Only);

Default: ACL.

Use the drop-down menu to select the Transport Mode of the packet.

3. **Packet Type**

Use the drop-down menu to select the packet type.

Type code	Slot occupied	SCO (1Mbps)	eSCO (1Mbps)	eSCO (2-3Mbps)	ACL (1Mbps)	ACL (2-3Mbps)
0000	1	NULL	NULL	NULL	NULL	NULL
0001	1	POLL	POLL	POLL	POLL	POLL
0010	1	FHS	—	—	FHS	FHS
0011	1	DM1	—	—	DM1	DM1
0100	1	—	—	—	DH1	2-DH1
0101	1	HV1	—	—	—	—
0110	1	HV2	—	2-EV3	—	—
0111	1	HV3	EV3	3-EV3	—	—
1000	1	DV	—	—	—	3-DH1
1001	1	—	—	—	AUX1	AUX1
1010	3	—	—	—	DM3	2-DH3

1011	3	—	—	—	DH3	3-DH3
1100	3	—	EV4	2-EV5	—	—
1101	3	—	EV5	3-EV5	—	—
1110	5	—	—	—	DM5	2-DH5
1111	5	—	—	—	DH5	3-DH5
n/a	1	ID	ID	ID	ID	ID

4. Occupied Slots

Display the number of time slots occupied by the specified packet.

5. Modulation Type

Display the modulation type applied to the specified packet.

- GFSK: Basic Rate
- GFSK+ DQPSK: Enhanced Data Rate (2Mbps)
- GFSK+ D8PSK: Enhanced Data Rate (3Mbps)

4.9.2.2 Packet Setting

1. Packet Data Type

Choice: Standard | All Data ;

Default: Standard.

Use the drop-down menu to select the packet data type.

- Standard: Uses packet type information to generate packet data.
- All Data: The package structure is filled with raw data without regard to package type information.

2. Data Whitening

Choice: On | Off;

Default: Off.

Use the drop-down menu to set the data whitening state of the packet payload.

Before transmission of all packets both the header and the payload shall be scrambled with a data whitening word in order to randomize the data from highly redundant patterns and to minimize DC bias in the packet. The scrambling shall be performed prior to the FEC encoding.

3. BD_ADDR

Range: 0x000000000000 to 0xFFFFFFFFFFFF;

Default: 0x000000000008.

Display the Bluetooth Device Address in hexadecimal form. Each Bluetooth device shall be allocated a unique 48-bit Bluetooth device address (BD_ADDR). This address shall be obtained from the IEEE Registration Authority. The address is divided into three fields: LAP, UAP and NAP. The structure of BD_ADDR is as follows:

LSB → MSB

LAP						UAP		NAP			
0000	0001	0000	0000	0000	0000	0001	0100	0111	1011	0011	0101

4. LAP

Range: 1x000000 to 0xFFFFFF;

Default: 0x000008.

This 24-bit field shall contain the lower address part of the device.

5. UAP

Range: 0x00 to 0xFF;

Default: 0x00.

This 8-bit field should contain the upper address part of the device.

6. NAP

Range: 0x0000 to 0xFFFF;

Default: 0x0000.

This 16-bit filed should contain the non-significant address part of the device.

7. LT_ADDR

Range: 0 to 7; Default: 1.

Set the logical transport address in the packet header.

The 3-bit LT_ADDR field contains the logical transport address for the packet. This field indicates the destination slave (or slaves in the case of a broadcast) for a packet in a master-to-slave transmission slot and indicates the source slave for a slave-to-master transmission slot.

8. FLOW

Range: 0 to1 ;

Default: 1.

Set the flow control bit in the packet header.

The FLOW bit is used for flow control of packets over the ACL logical transport. When the RX buffer for the ACL logical transport in the recipient is full, a STOP indication (FLOW=0) shall be returned to stop the other device from transmitting data temporarily. The STOP signal only affects ACL packets. Packets including only link control information (ID, POLL, and NULL packets), SCO packets or eSCO packets can still be received. When the RX buffer can accept data, a GO indication (FLOW=1) shall be returned. When no packet is received, or the received header is in error, a GO shall be assumed implicitly. In this case, the slave can receive a new packet with CRC although its RX buffer is still not emptied. The slave shall then return a NAK in response to this packet even if the packet passed the CRC check.

The FLOW bit is not used on the eSCO logical transport and shall be set to one on transmission and ignored upon receipt. The FLOW bit is reserved for future use on the CSB logical transport.

9. ARQN

Range: 0 to 1 ;

Default: 0.

Set the ARQ control bit in the packet header.

The 1-bit acknowledgment indication ARQN is used to inform the source of a successful transfer of payload data with CRC, and can be positive acknowledge ACK or negative acknowledge NAK.

10. SEQN

Range: 0 to 1 ;

Default: 0.

Set the sequential number index in the packet header.

In Multiple Packet distribution case, the SEQN bit will be set automatically. In the first CRC data packet at the start of the connection, SEQN shall be set to 1. If a new packet is sent, the value of SEQN will be toggled. If the number of total packets is not even, a padding packet will be added to keep the SEQN toggling rule.

4.9.2.3 Payload Setting

1. Payload Length

Set the number of bytes for the payload of the Bluetooth packet. If the packet has a payload header, it indicates the length field of the header.

2. Payload Data

Choice: PN9 | PN15 | USER ; Default: PN9.

Use the drop-down menu to set the type of packet payload.

When Data Continuous is set to ON and PN9 or PN15 is selected, the software automatically configures the Length and Repetitions fields. The number of packets required to accommodate the selected continuous PN pattern is also automatically determined and updated the number of bits.

If USER is selected as the data pattern, the number of bits displayed in the Data Length field is equal to the length of the user data multiplied by Data Repetition. The maximum number of bits allowed by the packet type. Any remaining bits in the user data file beyond the maximum amount will be truncated.

Note: This parameter is displayed only when the current packet contains the payload data field.

3. LLID

Range: 0 to 3 ; Default: 2.

Set the logical link indication in the packet payload header.

Note: This parameter is displayed only when the current packet contains the payload header field.

4. FLOW

Range: 0 to 1 ; Default: 1.

The flow indicator in the payload is used to control the flow at the L2CAP level.

It is used to control the flow per logical link. FLOW=1 means flow-on (GO) and FLOW=0 means flow-off (STOP). After a new connection has been established the flow indicator shall be set to GO. When a device receives a payload header with the flow bit set to STOP, it shall stop the transmission of ACL packets before an additional amount of payload data is sent.

Note: This parameter is displayed only when the current packet contains the payload header field.

5. EIR

Range: 0 to 1 ; Default: 0.

Set the extended inquiry response packet following indication bit in the FHS packet.

This bit shall indicate that an extended inquiry response packet may follow.

Note: This parameter is displayed only when the current packet is the FHS packet.

6. SR

Choice: R0, R1, R2, Reserved;

Default: R0.

Set the scan repetition mode in the FHS packet.

This 2-bit field is the scan repetition filed and indicates the interval between two consecutive page scan windows.

Note: This parameter is displayed only when the current packet is the FHS packet.

7. Class Of Device

Range: 0x000000 to 0xFFFFFF;

Default: 0x000000.

Set the class of Bluetooth device.

This 24-bit field shall contain the class of device of the device that sends the FHS packet. This field is defined in Bluetooth Assigned Number.

Note: This parameter is displayed only when the current packet is the FHS packet.

8. CLK

Range: 0x0000000 to 0x3FFFFFF;

Default: 0x0000000.

Set the native clock of the Bluetooth device.

This 26-bit field shall contain the value of the native clock of the device that sends the FHS packet, sampled at the beginning of the transmission of the access code of this FHS packet. This clock value has a resolution of 1.25ms (two-slot interval). For each new transmission, this field is updated so that it accurately reflects the real-time clock value.

Note: This parameter is displayed only when the current packet is the FHS packet.

9. Page Scan Mode

Choice: Mandatory, Reserved;

Default: Mandatory.

Set the page scan mode in the FHS packet.

This 3-bit field shall indicate which scan mode is used by default by the sender of the FHS packet.

Note: This parameter is displayed only when the current packet is the FHS packet.

10. Payload Data (Voice)

Choice: PN9 | PN15 | USER;

Default: PN9.

Set the voice field data type of the DV packet. The DV packet payload is divided into a voice field of 80 bits and a data field containing up to 150 bits.

Note: This parameter is displayed only when the current packet is the DV packet.

11. Payload Distribution

Choice: Single Packet | Multiple Packet;

Default: Single Packet.

Use the drop-down menu to set the distribution type of packet payload.

When Single Packet is selected, the software creates a waveform that consists of one Bluetooth packet. When downloaded to the signal source, the waveform is repeatedly played back resulting in a packet sequence comprised of identical packets. When Multiple Packet is selected, the software creates a waveform that consists of a multiple packet sequence. A data pattern is distributed into the payload portion of each packet in the sequence. Once downloaded to the instrument, the signal generator plays back the entire package sequence repeatedly.

12. Data Continuous

Choice: On | Off ; Default: On.

Use the drop-down menu to set the continuous state of the packet payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet.

13. Data Repetition

Set the repetition number of the packet payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet and Data Continuous is set to Off.

14. Data Length

Set the number of total bits contained in the payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet and Data Continuous is set to Off.

15. Number Of Full Packets

Display the number of full packets occupied by the packet payload.

16. Number Of Partial Packets

Display the number of partial packets occupied by the packet payload.

Because the payload portion of each packet is filled to capacity, if possible, the number of partial packets appended to the end of a packet sequence will always be 0 or 1.

17. Number Of Padding Packets

Choice: 0 | 1 ; Default: 0.

Sets the number of padding packets occupied by the packet payload.

When the software creates a multiple packet sequence, the sequence bit in the header field is toggled after each packet transmission in the sequence. This indicates to the Bluetooth device that the incoming packet is not a re-transmitted packet. To maintain an alternating sequence bit when the waveform is repeatedly played back, an even number of packets must be generated. If the data pattern length is set such that an odd number of packets are required to send the data, then a pad packet is appended to the end of the packet sequence. The pad packet has no payload and is only generated in this circumstance to accommodate the alternating sequence bit.

4.10 Bluetooth Low Energy

Bluetooth Low Energy (LE) devices operate in the unlicensed 2.4 GHz ISM (Industrial Scientific Medical) band. A frequency hopping transceiver is used to combat interference and fading.
Two modulation schemes are defined. The mandatory modulation scheme (“1 Msym/s modulation”) uses a shaped, binary FM to minimize transceiver complexity. The symbol rate is 1 Msym/s. An optional modulation scheme (“2Msym/s modulation”) is similar but uses a symbol rate of 2 Msym/s. Protocol version: 5.2.

The 1 Msym/s modulation supports two PHYs:

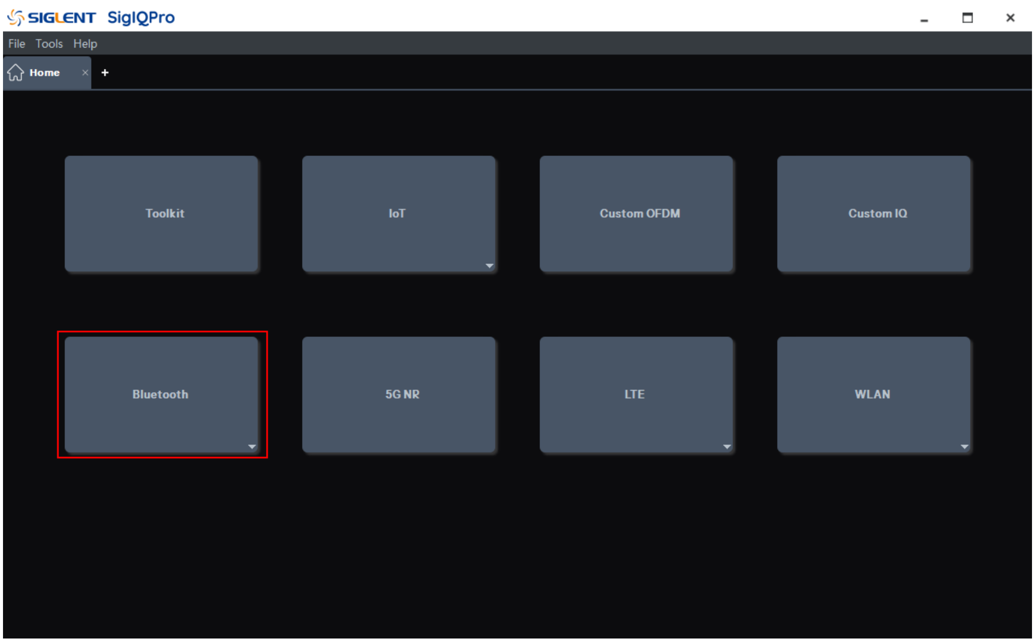
- LE 1M, with uncoded data at 1 Mb/s;
- LE Coded, with the Access Address, Coding Indicator, and TERM1 coded at 125 kb/s and the payload coded at either 125 kb/s or 500 kb/s.

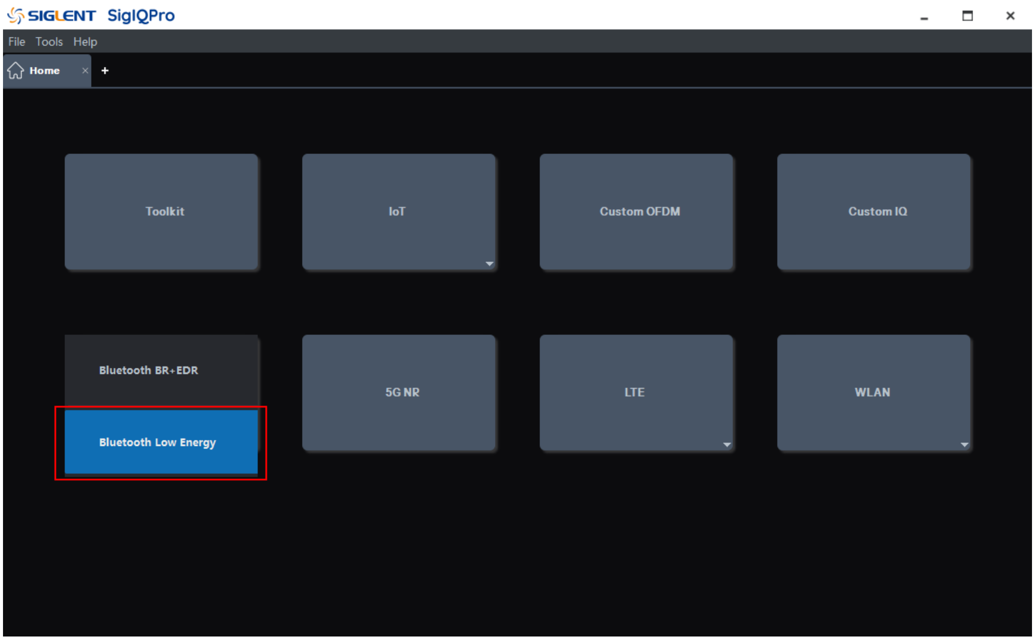
A device shall support the LE 1M PHY. Support for the LE Coded PHY is optional.

The 2 Msym/s modulation supports a single PHY:

- LE 2M, with uncoded data at 2 Mb/s

You can click **Bluetooth** -> **Bluetooth Low Energy** on the homepage to enter the Bluetooth LE setting interface.





4.10.1 Parameters Setup

Press Parameters Setup in the left window to enter parameter settings.

4.10.1.1 Basic

1. Waveform Name

When you download the waveform, the name you defined here will be displayed on the signal generator, if you do not define it, the signal generator will automatically generate a name for the waveform.

2. Total Sample Points

Display the generated waveform length (number of points).

Note: This parameter is displayed only and cannot be edited.

3. Waveform Length

Display the generated waveform length (in second).

Note: This parameter is displayed only and cannot be edited.

4. I/Q Map

Choice: Normal | Inverted ; Default: Normal.

Use the drop-down menu to select a normal or inverted I/Q signal. If invert is selected, the I signal is unchanged and the Q is reversed.

5. Oversampling Ratio

Range: 2 to 100 ; Default: 10.

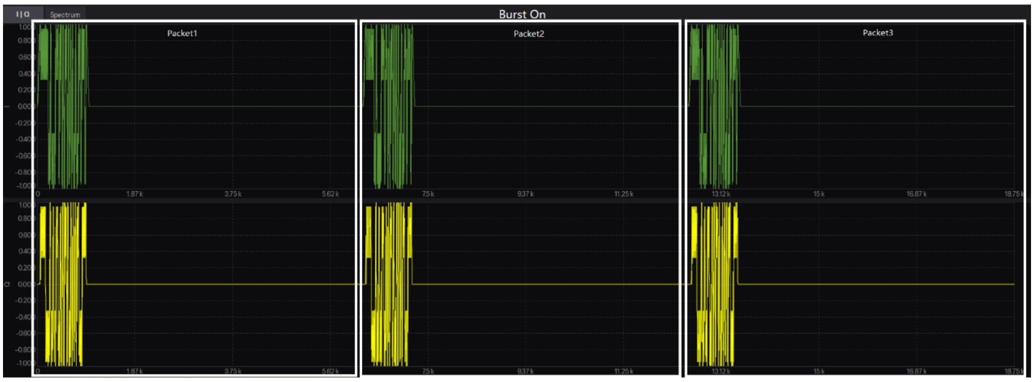
Set the number of samples calculated per I/Q symbol.

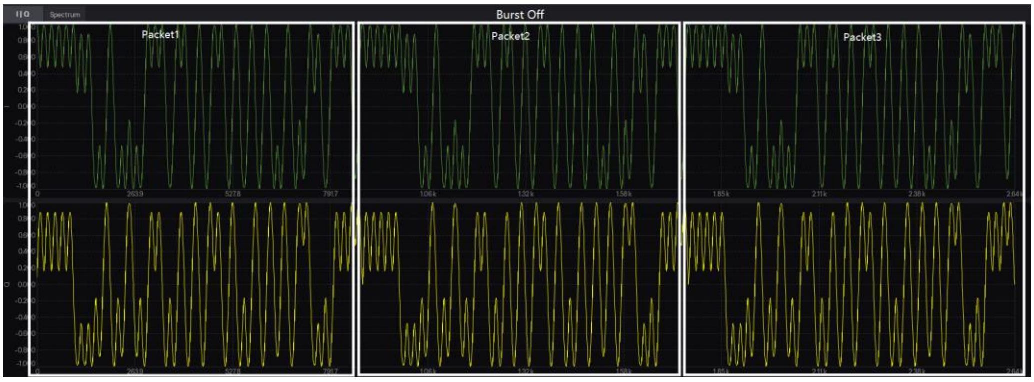
4.10.1.2 Bursting and Power Ramp

1. Bursting Active

Choice: On | Off ; Default: On.

Use the drop-down menu to enable or disable the bursting in the waveform. When enabled, the packet transmission timing of the test signal adheres to the Bluetooth TDD slot structure for the selected packet type.





2. Power Ramp

Range: 1 to 10 us ; Default: 6 us.

Set the power ramp up and power ramp down length of the burst.

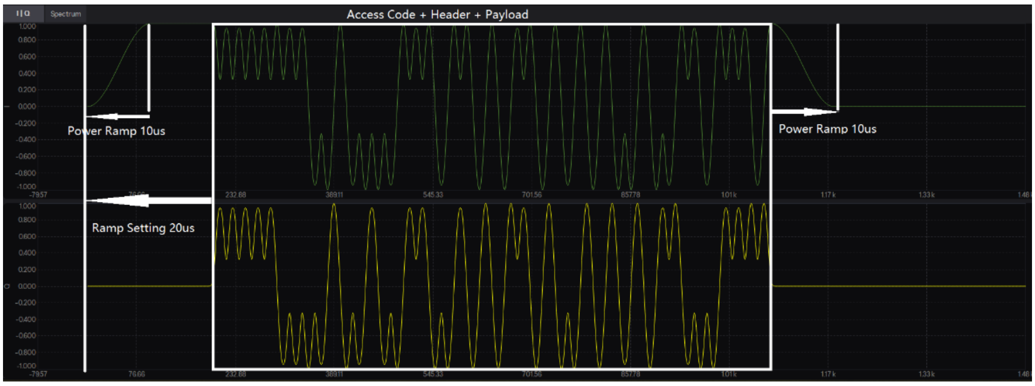
The power ramp up refers to the time when the carrier frequency ramped from idle power to transmitted power. The power ramp is shaped with a cosine function.

3. Ramp Setting

Range: 1 to 20 us ; Default: 6 us.

Set the Ramp Settling length of the burst.

The Ramp Settling refers to the time when the carrier frequency ramped from idle power to transmitted power and remains stable until it begins to transmit the first symbol.



4.10.1.3 Impairment

1. Modulation Index

Range: 0.45 to 0.55 ; Default: 0.5.

Set the modulation index of GFSK.

Specifies the modulation index used by GFSK, which is the ratio of peak-to-peak frequency deviation to the bit rate.

2. Frequency Drift

1) State

Choice: On | Off ; Default: Off.

Use the drop-down menu to enable or disable the frequency drift impairment applied to the packet.

This impairment adds a dynamic error to the transmission frequency. It is used to simulate the frequency drift impairment repeats at the beginning of each timeslot and occurs over a time period equal to the packet duration.

2) Type

Choice: Linear | Sine ; Default: Linear.

Use the drop-down menu to select the type of frequency drift applied to the Bluetooth packet.

3) Deviation

Range: -100 to 100kHz ; Default: 0 kHz.

Set the maximum deviation of frequency drift impairment.

4) Rate

Choice: 625Hz | 750Hz | 1250Hz ; Default: 1250Hz.

Use the drop-down menu to select the frequency drift rate.

3. Frequency Offset

Range: -200 to 200kHz ; Default: 0kHz.

Sets the static offset of the carrier frequency. This static offset is used to simulate a Bluetooth device transmitting at a frequency slightly offset from the specified carrier.

4. Symbol Timing Error

Range: -50 to 50ppm ; Default: 0ppm.

Set the shift of standard symbol rate for transmission. This shift varies the symbol rate of the Bluetooth signal.

It is used to simulate a Bluetooth device transmitting at a slight deviation in the sampling clock.

4.10.1.4 Dirty Transmitter

1. State

Choice: On | Off ; Default: Off.

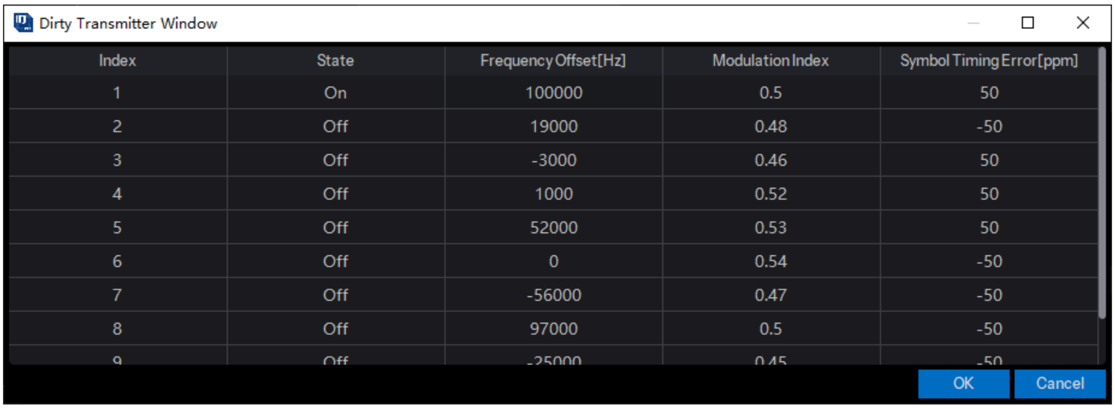
Use the drop-down menu to enable or disable the dirty transmitter test. When this setting is set to On, the Dirty Transmitter Impairments Setup window appears.

2. Number of Packet per Set

Choice: 1 | 2 | 50 ; Default: 1.

Use the drop-down menu to select the number of packets for each set of parameters displayed in the Dirty Transmitter Window.

3. Dirty Transmitter Window



1) Index

This cell displays the impairment set index number.

2) State

Use this cell to enable or disable a specified impairment set in dirty transmitter test.

3) Frequency Offset [Hz]

Range: -200 to 200kHz.

Sets the static offset of the carrier frequency. This static offset is used to simulate a Bluetooth device transmitting at a frequency slightly offset from the specified carrier.

4) Modulation Index

Range: 0.45 to 0.55.

Set the modulation index of GFSK.

Specifies the modulation index used by GFSK, which is the ratio of peak-to-peak frequency deviation to the bit rate.

5) Symbol Timing Error [ppm]

Range: -50 to 50.

Set the shift of standard symbol rate for transmission. This shift varies the symbol rate of the

Bluetooth signal. It is used to simulate a Bluetooth device transmitting at a slight deviation in the sampling clock.

4.10.2 Packet

Press **Packet** in the left window to enter parameter settings.

4.10.2.1 General Setting

1. Channel Type

Choice: Advertising | Data | Test ;

Default: Test.

Display the channel type of Bluetooth low energy wireless technology packet. Use the drop-down menu to select the channel type of Bluetooth low energy packet.

2. Packet Type

Choice: Test_Packet | ADV_IND | ADV_DIRECT_IND | ADV_NONCONN_IND | ADV_SCAN_IND | ADV_EXT_IND | AUX_ADV_IND | AUX_SYNC_IND | AUX_CHAIN_IND | SCAN_REQ | SCAN_RSP | AUX_SCAN_REQ | AUX_SCAN_RSP | CONNECT_IND | AUX_CONNECT_REQ | AUX_CONNECT_RSP | LL_Data | LL_CONNECTION_UPDATE_IND | LL_CHANNEL_MAP_IND | LL_TERMINATE_IND LL_ENC_REQ | LL_ENC_RSP | LL_START_ENC_REQ | LL_START_ENC_RSP | LL_UNKNOWN_RSP | LL_FEATURE_REQ | LL_FEATURE_RSP | LL_PAUSE_ENC_REQ | LL_PAUSE_ENC_RSP | LL_VERSION_IND | LL_REJECT_IND | LL_SLAVE_FEATURE_REQ | LL_CONNECTION_PARAM_REQ | LL_CONNECTION_PARAM_RSP | LL_REJECT_EXT_IND | LL_PING_REQ | LL_PING_RSP | LL_LENGTH_REQ | LL_LENGTH_RSP | LL_PHY_REQ | LL_PHY_RSP | LL_PHY_UPDATE_IND | LL_MIN_USED_CHANNELS_IND | LL_CTE_REQ | LL_CTE_RSP | LL_PERIODIC_SYNC_IND | LL_CLOCK_ACCURACY_REQ | LL_CLOCK_ACCURACY_RSP;

Default: Test_Packet.

Set the packet type of Bluetooth low energy wireless technology.

- Advertising Channel Type: ADV_IND | ADV_DIRECT_IND | ADV_NONCONN_IND | ADV_SCAN_IND | ADV_EXT_IND | AUX_ADV_IND | AUX_SYNC_IND | AUX_CHAIN_IND | SCAN_REQ | SCAN_RSP | AUX_SCAN_REQ | AUX_SCAN_RSP | CONNECT_IND | AUX_CONNECT_REQ | AUX_CONNECT_RSP;

- Data Channel Type: LL_Data | LL_CONNECTION_UPDATE_IND | LL_CHANNEL_MAP_IND | LL_TERMINATE_IND LL_ENC_REQ | LL_ENC_RSP | LL_START_ENC_REQ | LL_START_ENC_RSP | LL_UNKNOWN_RSP | LL_FEATURE_REQ | LL_FEATURE_RSP | LL_PAUSE_ENC_REQ | LL_PAUSE_ENC_RSP | LL_VERSION_IND | LL_REJECT_IND | LL_SLAVE_FEATURE_REQ | LL_CONNECTION_PARAM_REQ | LL_CONNECTION_PARAM_RSP | LL_REJECT_EXT_IND | LL_PING_REQ | LL_PING_RSP | LL_LENGTH_REQ | LL_LENGTH_RSP | LL_PHY_REQ | LL_PHY_RSP | LL_PHY_UPDATE_IND | LL_MIN_USED_CHANNELS_IND | LL_CTE_REQ | LL_CTE_RSP | LL_PERIODIC_SYNC_IND | LL_CLOCK_ACCURACY_REQ | LL_CLOCK_ACCURACY_RSP;

Use the drop-down menu to select the packet type of Bluetooth low energy.

3. Packet Format

Set the PHY type. LE supports LE 1M PHY, LE 2M PHY, and LE Coded PHY.

4. Coding Indicator

Coding Indicator (CI) is a field of encoded Packet that determines the encoding mode of FEC Block 2. If 0 is set, S=8 is selected; if 1 is set, S=2 is selected. The default value is 0.

5. Channel Index

Range: 0 to 39 ; Default: 0.

Set the current RF channel index of Bluetooth low energy packet.

The LE system operates in the 2.4 GHz ISM band at 2400-2483.5 MHz. The LE system uses 40 RF channels. These RF channels are divided into 3 RF channels known as the "primary advertising channels", used for initial advertising and all legacy advertising activities, and 37 RF channels known as the "general-purpose channels", used for the majority of communications. Please refer to Table 1.3 of Vol 6 Part B of Core v5.2 for more information.

6. Access Address

Range: 0x00000000 to 0xffffffff ;

Default: 0x8e89bed6.

Set the logical link specify address of Bluetooth low energy packet. Please refer to section 2.1.2 of Vol 6 Part B of Core v5.2 for more information.

Note: The Access Address for all other advertising physical channel packets shall be 0b10001110-10001001-10111110-11010110 (0x8E89BED6).

7. CRC Preload

Range: 0x000000 to 0xffffff ;

Default: 0x555555.

Set the CRC preload state of Bluetooth low energy packet.

The PDU is followed by a 24-bit CRC. It shall be calculated over the PDU. Please refer to section 3.1.1 of Vol 6 Part B of Core v5.2 for more information.

Note: The CRC Preload for all other advertising physical channel packets shall be 0x555555.

8. Data Whitening

Choice: On | Off ;

Default: Off.

Use the drop-down menu to enable or disable data whitening for the PDU and CRC data of Bluetooth low energy packet.

Data whitening is used to avoid long sequences of zeros or ones, e.g.,0b0000000 or 0b1111111, in the data bit stream. Whitening shall be applied on the PDU and CRC of all Link Layer packets and is performed after the CRC generation in the transmitter. The whitener and de-whitener are defined the same way, using a 7-bit linear feedback shift register with the polynomial x7 + x4 + 1. Please refer to section 3.2 of Vol 6 Part B of Core v5.2 for more information.

9. Idle Interval

Range: 150 – 150000 us ;

Default: 249 us.

Set the idle interval time in-between frames in microseconds.

Note: This parameter is visible and configurable only when the Bursting Active is on.

10. Packet Length

Display the packet length in microseconds.

Note: This value is read-only and automatically updated with Channel Type, Packet Type, Packet Format and Length.

4.10.2.2 Test PDU Header Setting

Set **General Setting** -> **Channel Type** as Test.

1. Payload Type

Display the payload type field of Test PDU header. Please refer to Table 4.1 of Vol 6 Part B of Core v5.2 for more information.

Note: This value is read-only and automatically updated when Payload Data is changed.

2. CP

Range: 0 – 1 ; Default: 0.

Set the CTEInfo Present (CP) field of the Test PDU header. This value indicates whether the CTEInfo field is present and therefore whether the test packet has a Constant Tone Extension.

If the CP field is 0, then no CTEInfo field is present and there is no Constant Tone Extension in the test packet. If the CP field is 1, then the CTEInfo field is present and the test packet includes a Constant Tone Extension.

Please refer to section 4.1.4 of Vol 6 Part B of Core v5.2 for more information.

3. Length

Range: 0 – 255 ; Default: 37.

Set the Test PDU payload length in bytes. It will be included in PDU Length field of the Test PDU header.

4. CTE Time

Range: 2 – 20 ; Default: 20.

Set the CTE Time field of CTE Info Header to indicate the length of the Constant Tone Extension in 8 µs units. Please refer to section 2.5.2 of Vol 6 Part B of Core v5.2 for more information.

Note: This parameter is visible and configurable only when the CP is 1.

5. CTE Type

Choice: AOA | AOD(1us) | AOD(2us) ;

Default: AOA.

Set the CTE Type field of CTE Info Header to indicate the type of the Constant Tone Extension and the duration of the switching slots. Please refer to section 2.5.2 of Vol 6 Part B of Core v5.2 for more information.

Note: This parameter is visible and configurable only when the CP is 1.

4.10.2.3 Test PDU Payload Setting

Set **General Setting** -> **Channel Type** as Test.

1. Payload Distribution

Choice: Single Packet | Multiple Packet ;

Default: Single Packet.

Use the drop-down menu to set the distribution type of packet payload.

When Single Packet is selected, the software creates a waveform that consists of one Bluetooth low energy packet. When downloaded to the signal source, the waveform is repeatedly played back resulting in a packet sequence comprised of identical packets. When Multiple Packet is selected, the software creates a waveform that consists of a multiple packet sequence. A data pattern is distributed into the payload portion of each packet in the sequence. Once downloaded to the instrument, the signal generator plays back the entire package sequence repeatedly.

2. Payload Data

Choice: PRBS9 | 11110000 | 10101010 | PRBS 15 | 11111111 | 00000000 | 00001111| 01010101 | ;

Default: PRBS9.

Use the drop-down menu to select the type of Test PDU payload. Please refer to section 4.1.4 and 4.1.5 of Vol 6 Part B of Core v5.2 for more information.

When Data Continuous is set to ON and PN9 or PN15 is selected, the software automatically configures the Length and Repetitions fields. The number of packets required to accommodate the selected continuous PN pattern is also automatically determined and updated the number of bits.

3. Data Continuous

Choice: On | Off ; Default: On.

Use the drop-down menu to set the continuous state of the packet payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet.

4. Data Repetition

Set the repetition number of the packet payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet and Data Continuous is set to Off.

5. **Data Length**

Set the number of total bits contained in the payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet and Data Continuous is set to Off.

6. **Number Of Full Packets**

Display the number of full packets occupied by the packet payload.

7. **Number Of Partial Packets**

Display the number of partial packets occupied by the packet payload.

Because the payload portion of each packet is filled to capacity, if possible, the number of partial packets appended to the end of a packet sequence will always be 0 or 1.

4.10.2.4 Advertising PDU Header Setting

Set **General Setting** -> **Channel Type** as Advertising.

1. **PDU Type**

Display the value of PDU Type field in in the advertising PDU header. Please refer to section 2.3 of Vol 6 Part B of Core v5.2 for more information.

Note: This value is read-only and automatically updated when Packet Type is changed.

2. **ChSel**

Choice: 0 | 1 ; Default: 0.

Set the ChSel (Channel Selection) field of the advertising PDU header.

1: The device supports the LE Channel Selection Algorithm #2 feature.

0: The device does not support the LE Channel Selection Algorithm #2 feature.

Note: If the ChSel, TxAdd or RxAdd fields are not defined as used in a given PDU then they shall be considered reserved for future use.

3. **TxAdd**

Choice: 0 | 1 ; Default: 0.

Set the TxAdd field of the advertising PDU header. The TxAdd in the advertising physical channel PDU header indicates whether the transmit address is public (TxAdd = 0) or random (TxAdd =1).

Note: If the ChSel, TxAdd or RxAdd fields are not defined as used in a given PDU then they shall be considered reserved for future use.

4. **RxAdd**

Choice: 0 | 1 ; Default: 0.

Set the RxAdd field of the advertising PDU header. The RxAdd in the advertising physical channel PDU header indicates whether the receiver address is public (RxAdd = 0) or random (RxAdd = 1).

Note: If the ChSel, TxAdd or RxAdd fields are not defined as used in a given PDU then they shall be considered reserved for future use.

5. **Length**

Display the value of Length field in in the Advertising PDU header. The Length field indicates the length of the Advertising PDU payload in octets.

Note: This value is read-only and automatically updated when with advertising PDU payload setting.

4.10.2.5 Advertising PDU Payload Setting (ADV_IND, ADV_NONCONN_IND, SCAN_RSP, ADV_SCAN_IND)

Set **General Setting** -> **Channel Type** as Advertising, and set Packet Type as ADV_IND, ADV_NONCONN_IND, SCAN_RSP or ADV_SCAN_IND.

1. **AdvA**

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008.

Set the advertiser address of Bluetooth low energy device. It will be included in AdvA field of the advertising PDU Payload.

2. **Payload Data**

Choice: PN9 | PN15 | USER ; Default: PN9.

Use the drop-down menu to set the type of packet payload.

When Data Continuous is set to ON and PN9 or PN15 is selected, the software automatically configures the Length and Repetitions fields. The number of packets required to accommodate the selected continuous PN pattern is also automatically determined and updated the number of bits. If USER is selected as the data pattern, the number of bits displayed in the Data Length field is equal to the length of the user data multiplied by Data Repetition. The maximum number of bits allowed by the packet type. Any remaining bits in the user data file beyond the maximum amount will be truncated.

3. Payload Length

Range: 0 to 31 ; Default: 31.

Set the number of bytes for the payload of the Bluetooth low energy packet.

4.10.2.6 Advertising PDU Payload Setting (ADV_DIRECT_IND)

Set **General Setting** -> **Channel Type** as Advertising, and set Packet Type as ADV_DIRECT_IND.

1. AdvA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008

Set the advertiser's public or random device address as indicated by TxAdd. It will be included in AdvA field of the advertising PDU Payload.

2. TargetA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008

Set the target’s public or random device address as indicated by RxAdd. It will be included in TargetA field of the advertising PDU Payload. The TargetA field is the address of the device to which this PDU is addressed.

4.10.2.7 Advertising PDU Payload Setting (SCAN_REQ, AUX_SCAN_REQ)

Set **General Setting** -> **Channel Type** as Advertising, and set Packet Type as SCAN_REQ or AUX_SCAN_REQ.

1. ScanA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008

Set the scanner's public or random device address as indicated by TxAdd. It will be included in ScanA field of the advertising PDU Payload.

2. AdvA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008.

Set the target's public or random device address as indicated by RxAdd. It will be included in AdvA field of the advertising PDU Payload. The AdvA field is the address of the device to which this PDU is addressed.

4.10.2.8 Advertising PDU Payload Setting (CONNECT_IND, AUX_CONNECT_REQ)

Set **General Setting** -> **Channel Type** as Advertising, and set Packet Type as ADV_EXT_IND, AUX_ADV_IND.

1. InitA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008.

Set the initiator's public or random device address as indicated by TxAdd. It will be included in InitA field of the advertising PDU Payload.

2. AdvA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008.

Set the advertiser's public or random device address as indicated by RxAdd. It will be included in AdvA field of the advertising PDU Payload. The AdvA field is the address of the device to which this PDU is addressed.

3. Access Address

Range: Range: 0x00000000 to 0xffffffff ;

Default: 0x00000000.

Set the ACL connection's Access Address determined by the Link Layer. It will be included in AA field of the advertising PDU Payload. Please refer to section 2.1.2 of Vol 6 Part B of Core v5.2 for more information.

4. **CRCInit**

Range: 0x000000 to 0xffffff ;

Default: 555555.

Set the initialization value for the CRC calculation for the ACL connection. It will be included in CRCInit field of the advertising PDU Payload.

5. **WinSize**

Range: 1 to Lesser of 8 and (Interval - 1) ;

Default: 1.

Set the WinSize field of the advertising PDU Payload. The WinSize field is set to indicate the *transmitWindowSize* value, in the following manner: *transmitWindowSize* = WinSize * 1.25ms.

6. **WinOffset**

Range: 0 to Interval ; Default: 0.

Set the WinOffset field of the advertising PDU Payload. The WinOffset field is set to indicate the *transmitWindowOffset* value, in the following manner: *transmitWindowOffset* = WinOffset * 1.25ms.

7. **Interval**

Range: 6 to 3200 ; Default: 6.

Set the Interval field of the advertising PDU Payload. The Interval field is set to indicate the *connInterval*, in the following manner: *connInterval* = Interval * 1.25 ms.

8. **Latency**

Range: 0 to 500 ; Default: 6.

Set the Latency field of the advertising PDU Payload. The Latency field is set to indicate the *connSlaveLatency* value, in the following manner: *connSlaveLatency* = Latency.

9. **Timeout**

Range: 10 to 3200 ;

Default: 10.

Set the Timeout field of the advertising PDU Payload. The Timeout field is set to indicate the *connSupervisionTimeout* value, in the following manner: *connSupervisionTimeout* = Timeout *10 ms.

10. ChM

Range: 0x0000000000 to 0x1fffffffff ;

Default: 0x0000000001.

Set the ChM (channel map) field of the advertising PDU Payload.

The ChM field contains channel map indicating used and unused data channels. Every channel is represented with bit positioned as per the data channel index. The LSB represents data channel index 0 and the bit in position 36 represents data channel index 36. A bit value of 0 indicates that the channel is Unused. A bit value of 1 indicates that the channel is Used. The bits in positions 37, 38 and 39 are reserved for future use.

11. Hop

Range: 5 to 16 ;

Default: 5.

Set the Hop field of the advertising PDU Payload. The Hop field is set to indicate the *hopIncrement* used in the data channel selection algorithm.

12. SCA

Choice: 251-500 ppm | 151-250 ppm | 101-150 ppm | 76-100 ppm | 51-75 ppm | 31-50 ppm | 21-30 ppm | 0-20 ppm ;

Default: 251-500 ppm.

Use the drop-down menu to select the SCA (Sleep Clock Accuracy) type. It will be included in SCA field of the PDU Payload. The SCA field is set to indicate the *masterSCA* used to determine the worst-case Master's sleep clock accuracy.

4.10.2.9 Advertising PDU Payload Setting (ADV_EXT_IND, AUX_ADV_IND, AUX_ADV_IND, AUX_CHAIN_IND, AUX_SCAN_RSP, AUX_CONNECT_RSP)

Set **General Setting** -> **Channel Type** as Advertising, and set Packet Type as ADV_EXT_IND, AUX_ADV_IND, AUX_ADV_IND, AUX_CHAIN_IND, AUX_SCAN_RSP or AUX_CONNECT_RSP.

1. Extended Header Length

Display the Extended Header Length field of the Common Extended Advertising Payload.

The Extended Header Length is a value between 0 and 63 and indicates the size of the variable length Extended Header field.

2. AdvMode

Choice: Non-conn&Non-scan | Conn&Non-scan | Non-conn&Scan ;

Default: Non-conn&Non-scan.

Use the drop-down menu to select the mode of the advertisement. It will be included in AdvMode field of the Common Extended Advertising Payload.

3. Payload Data

Use the drop-down menu to select the data type of the AdvData field.

4. Data Length

Range: 0 – 254.

Set the AdvData field length in bytes.

5. Extended Header

1) AdvA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008.

Set the advertiser's public or random device address as indicated by TxAdd.

2) TargetA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008.

Set public or random device address for the scanner or initiator, as indicated by RxAdd. The TargetA field is the address of the device to which this PDU is addressed.

3) CTEInfo

- **CTE Time**

Range:2 – 20 ;

Default:20.

Set the CTE Time field of CTE Info Header to indicate the length of the Constant Tone Extension in 8μs units. Please refer to section 2.5.2 of Vol 6 Part B of Core v5.2 for more information.

- **CTE Type**

Choice: AOA | AOD(1us) | AOD(2us) ;

Default: AOA.

Set the CTE Type field of CTE Info Header to indicate the type of the Constant Tone Extension and the duration of the switching slots. Please refer to section 2.5.2 of Vol 6 Part B of Core v5.2 for more information.

4) AdvDataInfo

- **Advertising Data ID**

Range: 0x0 – 0xfff ;

Default: 0x0.

Set the Advertising Data ID field of AdvDataInfo to distinguish between different advertising sets transmitted by this device.

- **Advertising Set ID**

Range: 0x0 – 0xf ;

Default: 0x0.

Set the Advertising Set ID field of AdvDataInfo to indicate to the scanner whether it can assume that the data contents in the AdvData are a duplicate of the previous AdvData sent in an earlier packet.

5) AuxPtr

The presence of the AuxPtr field indicates that some or all of the advertisement data is in a subsequent auxiliary packet. The contents of the AuxPtr field describe this packet.

- **Channel Index**

Range: 0 – 39 ; Default: 0.

Set the Channel Index field of AuxPtr. The Channel Index field contains the general-purpose channel index used to transmit the auxiliary packet.

- **CA**

Choice: 51 - 500 ppm | 0 - 50 ppm;

Default: 51 - 500 ppm.

Use the drop-down menu to select clock accuracy of the advertiser that will be used between the packet containing this data and the auxiliary packet.

- **Offset Units**

Choice: 30 us | 300 us;

Default: 30 us.

Use the drop-down menu to select the units used by the AUX Offset Field.

- **AUX Offset**

Range: 0 – 8191 ;

Default: 8191.

Set the value of Aux Offset field. The Aux Offset field contains the time from the start of the packet containing the AuxPtr field to the approximate start of the auxiliary packet. The value of the AUX Offset field is in the unit of time indicated by the Offset Units field; the offset is determined by multiplying the value by the unit.

- **AUX PHY**

Choice: LE 1M | LE 2M | LE Code ;

Default: LE 1M.

Use the drop-down menu to select the PHY used to transmit the auxiliary packet.

6) SyncInfo

- **Sync Packet Offset**

Range: 0 – 8191 ;

Default: 8191.

Set the value of Sync Packet Offset field. The Sync Packet Offset field contains the time from a reference point to the start of the AUX_SYNC_IND packet that this SyncInfo field describes. The value of the Sync Packet Offset field is in the unit of time indicated by the Offset Units field; the offset is determined by multiplying the value by the unit.

- **Offset Units**

Choice: 30 us | 300 us;

Default: 30 us.

Use the drop-down menu to select the units used by the Sync Packet Offset Field.

- **Offset Adjust**

Choice: 0 | 1 ; Default: 0.

Set the value of Offset Adjust field. If the Offset Adjust field is set to 1, the actual sync packet offset adding 2.4576 seconds.

- **Interval**

Range: 6 – 65535 ; Default: 6.

Set the value of Interval field. The Interval field contains the time in 1.25 ms units from the start of one packet of the periodic advertising train to the start of the next packet.

- **ChM**

Range: 0x0000000000 to 0x1fffffffff ;

Default: 0x0000000001.

Set the value of ChM (channel map) field.

The ChM field contains channel map indicating used and unused data channels. Every channel is represented with bit positioned as per the data channel index. The LSB represents data channel index 0 and the bit in position 36 represents data channel index 36. A bit value of 0 indicates that the channel is Unused. A bit value of 1 indicates that the channel is Used. The bits in positions 37, 38 and 39 are reserved for future use.

- **SCA**

Choice: 251-500 ppm | 151-250 ppm | 101-150 ppm | 76-100 ppm | 51-75 ppm | 31-50 ppm | 21-30 ppm | 0-20 ppm ;

Default: 251-500 ppm.

Use the drop-down menu to select the SCA (Sleep Clock Accuracy) type. The SCA field is set to indicate the masterSCAused to determine the worst-case Master's sleep clock accuracy.

- **Access Address**

Range: Range: 0x00000000 to 0xffffffff ;

Default: 0x00000000.

Set the ACL connection's Access Address determined by the Link Layer. Please refer to section 2.1.2 of Vol 6 Part B of Core v5.2 for more information.

- **CRCInit**

Range: 0x000000 to 0xffffff ; Default: 0x555555.

Set the initialization value for the CRC calculation for the ACL connection.

- **Event Counter**

Range: 0– 65535 ; Default: 0.

Set the value of Event Counter field.

The Event Counter field contains the value of paEventCounter that applies to the AUX_SYNC_IND packet that this SyncInfo field describes. Please refer to section 2.3.4.6 of Vol 6 Part B of Core v5.2 for more information.

7) TxPower

Range: -127 – 126 ; Default: 0.

Set the value of TxPower field. The TxPower field indicates the transmitted power level of the packet containing the data type. It may be used to calculate path loss on a received packet.

8) ACAD

Use the drop-down menu to select the data type of the ACDC (Additional Controller Advertising Data) field. Please refer to section 2.3.4.8 of Vol 6 Part B of Core v5.2 for more information.

9) Length

Range: 0 – 62 ; Default: 0.

Set the ACAD field length in bytes.

The ACAD field length is the Extended Header length minus the sum of the size of the extended header flags (1 octet) and those fields indicated by the flags as present.

4.10.2.10 Data PDU Header Setting

Set **General Setting** -> **Channel Type** as Data.

1. **LLID**

Display the LLID field of the Data PDU Header. The LLID field determines the format of the payload.

- 1 = LL Data PDU: Continuation fragment of an L2CAP message, or an empty PDU
- 2 = LL Data PDU: Start of an L2CAP message, or a complete L2CAP message with no fragmentation
- 3 = LL Control PDU

Note: This parameter can be edited only when Packet Type is LL_Data.

2. **NESN**

Range: 0 to 1 ; Default: 0.

Set the NESN (next expected sequence number) field of the Data PDU Header.

3. **SN**

Range: 0 to 1 ; Default: 0.

Set the SN (sequence number) field of the Data PDU Header.

4. **MD**

Range: 0 to 1 ; Default: 0.

Set the MD (more data) field of the Data PDU Header.

5. **CP**

Range: 0 – 1 ; Default: 0.

Set the CTEInfo Present (CP) field of the Data PDU header. This value indicates whether the CTEInfo field is present and therefore whether the packet has a Constant Tone Extension.

If the CP field is 0, then no CTEInfo field is present and there is no Constant Tone Extension in the test packet. If the CP field is 1, then the CTEInfo field is present and the test packet includes a Constant Tone Extension.

Please refer to section 4.1.4 of Part B of volume 6 in Bluetooth Core Specification Version 5.2 for more information

6. **Length**

Range: 0 – 255 ; Default: 31.

Set the Data PDU payload length in bytes. It will be included in Length field of the Data PDU header.

4.10.2.11 Data PDU Payload Setting (LL_Data)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_Data.

1. Payload Distribution

Choice: Single Packet | Multiple Packet; Default: Single Packet.

Use the drop-down menu to set the distribution type of packet payload.

When Single Packet is selected, the software creates a waveform that consists of one Bluetooth low energy packet. When downloaded to the signal source, the waveform is repeatedly played back resulting in a packet sequence comprised of identical packets. When Multiple Packet is selected, the software creates a waveform that consists of a multiple packet sequence. A data pattern is distributed into the payload portion of each packet in the sequence. Once downloaded to the instrument, the signal generator plays back the entire package sequence repeatedly.

2. Payload Data

Choice: PN9 | PN15 | USER ;

Default: PN9.

Use the drop-down menu to select the type of PDU payload.

When Data Continuous is set to ON and PN9 or PN15 is selected, the software automatically configures the Length and Repetitions fields. The number of packets required to accommodate the selected continuous PN pattern is also automatically determined and updated the number of bits.

3. Data Continuous

Choice: On | Off ; Default: On.

Use the drop-down menu to set the continuous state of the packet payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet.

4. Data Repetition

Set the repetition number of the packet payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet and Data Continuous is set to Off.

5. Data Length

Set the number of total bits contained in the payload data.

Note: This parameter is only available when Payload Distribution is set to Multiple Packet and Data Continuous is set to Off.

6. Number Of Full Packets

Display the number of full packets occupied by the packet payload.

7. Number Of Partial Packets

Display the number of partial packets occupied by the packet payload.

Because the payload portion of each packet is filled to capacity, if possible, the number of partial packets appended to the end of a packet sequence will always be 0 or 1.

8. Number Of Padding Packets

Choice: 0 | 1 ; Default: 0.

Sets the number of padding packets occupied by the packet payload.

Note: This parameter is can be edited only when Payload Distribution is Multiple Packet.

When the software creates a multiple packet sequence, the sequence bit in the header field is toggled after each packet transmission in the sequence. This indicates to the Bluetooth device that the incoming packet is not a re-transmitted packet. To maintain an alternating sequence bit when the waveform is repeatedly played back, an even number of packets must be generated. If the data pattern length is set such that an odd number of packets are required to send the data, then a pad packet is appended to the end of the packet sequence. The pad packet has no payload and is only generated in this circumstance to accommodate the alternating sequence bit.

4.10.2.12 Data PDU Payload Setting (LL_CONNECTION_UPDATE_REQ)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_CONNECTION_UPDATE_REQ.

1. Opcode

Display the Opcode field of the PDU Payload. The Opcode field identifies different types of LL Control PDU, as defined in following table.

Opcode	LL Control PDU Name
0x00	LL_CONNECTION_UPDATE_IND

0x01	LL_CHANNEL_MAP_IND
0x02	LL_TERMINATE_IND
0x03	LL_ENC_REQ
0x04	LL_ENC_RSP
0x05	LL_START_ENC_REQ
0x06	LL_START_ENC_RSP
0x07	LL_UNKNOWN_RSP
0x08	LL_FEATURE_REQ
0x09	LL_FEATURE_RSP
0x0A	LL_PAUSE_ENC_REQ
0x0B	LL_PAUSE_ENC_RSP
0x0C	LL_VERSION_IND
0x0D	LL_REJECT_IND
0x0E	LL_SLAVE_FEATURE_REQ
0x0F	LL_CONNECTION_PARAM_REQ
0x10	LL_CONNECTION_PARAM_RSP
0x11	LL_REJECT_EXT_IND
0x12	LL_PING_REQ
0x13	LL_PING_RSP
0x14	LL_LENGTH_REQ
0x15	LL_LENGTH_RSP
0x16	LL_PHY_REQ
0x17	LL_PHY_RSP
0x18	LL_PHY_UPDATE_IND
0x19	LL_MIN_USED_CHANNELS_IND
0x1A	LL_CTE_REQ
0x1B	LL_CTE_RSP
0x1C	LL_PERIODIC_SYNC_IND
0x1D	LL_CLOCK_ACCURACY_REQ
0x1E	LL_CLOCK_ACCURACY_RSP
0x1F	LL_CIS_REQ
0x20	LL_CIS_RSP
0x21	LL_CIS_IND
0x22	LL_CIS_TERMINATE_IND

0x23	LL_POWER_CONTROL_REQ
0x24	LL_POWER_CONTROL_RSP
0x25	LL_POWER_CHANGE_IND
All other values	Reserved for future use

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. WinSize

Range: 1 to Lesser of 8 and (Interval - 1) ; Default: 1.

Set the WinSize field of the data PDU Payload. The WinSize field is set to indicate the *transmitWindowSize* value, in the following manner: *transmitWindowSize* = WinSize * 1.25ms.

3. WinOffset

Range: 0 to Interval ; Default: 0.

Set the WinOffset field of the advertising PDU Payload. The WinOffset field is set to indicate the *transmitWindowOffset* value, in the following manner: *transmitWindowOffset* = WinOffset * 1.25ms.

4. Interval

Range: 6 to 3200 ; Default: 6.

Set the Interval field of the advertising PDU Payload. The Interval field is set to indicate the *connInterval*, in the following manner: *connInterval* = Interval * 1.25 ms.

5. Latency

Range: 0 to 500 ; Default: 6.

Set the Latency field of the advertising PDU Payload. The Latency field is set to indicate the *connSlaveLatency* value, in the following manner: *connSlaveLatency* = Latency.

6. Timeout

Range: 10 to 3200 ; Default: 10.

Set the Timeout field of the advertising PDU Payload. The Timeout field is set to indicate the *connSupervisionTimeout* value, in the following manner: *connSupervisionTimeout* = Timeout *10 ms.

7. Instant

Range: 1 to 32767 ; Default: 1.

Set the count of LL connection event before the new LL connection event of the Bluetooth low energy packet.

4.10.2.13 Data PDU Payload Setting (LL_CHANNEL_MAP_REQ)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_CHANNEL_MAP_REQ.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. ChM

Range: 0x0000000000 to 0x1fffffffff ;

Default: 0x0000000001.

Set the ChM (channel map) field of the PDU Payload.

The ChM field contains channel map indicating used and unused data channels. Every channel is represented with bit positioned as per the data channel index. The LSB represents data channel index 0 and the bit in position 36 represents data channel index 36. A bit value of 0 indicates that the channel is Unused. A bit value of 1 indicates that the channel is Used. The bits in positions 37, 38 and 39 are reserved for future use.

3. Instant

Range: 1 to 32767 ; Default: 1.

Set the count of LL connection event before the new LL connection event of the Bluetooth low energy packet.

4.10.2.14 Data PDU Payload Setting (LL_TERMINATE_IND, LL_REJECT_IND)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_TERMINATE_IND or LL_REJECT_IND.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. **Error Code**

Range: 0x00 to 0xff ;

Default: 0x00.

Set the ErrorCode field of the PDU Payload. The ErrorCode field shall be set to inform the remote device why the connection is about to be terminated.

4.10.2.15 Data PDU Payload Setting (LL_ENC_REQ)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_ENC_REQ.

1. **Opcode**

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. **Rand**

Range: 0x0000000000000000 to 0xffffffffffffffff;

Default: 0x0000000000000000.

Set the random number that is provided by the Host and used with EDIV.

3. **EDIV**

Range: 0x0000 to 0xffff ;

Default: 0000.

Set the encrypted diversifier.

4. **SKDm**

Range: 0x0000000000000000 to 0xffffffffffffffff ;

Default: 0x0000000000000000.

Set the master's portion of the session key identifier.

5. **IVm**

Range: 0x00000000 to 0xffffffff ;

Default: 00000000.

Set the master's portion of the initialization vector.

4.10.2.16 Data PDU Payload Setting (LL_ENC_RSP)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_ENC_RSP.

1. **Opcode**

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. **SKDm**

Range: 0x0000000000000000 to 0xffffffffffffffff ;

Default: 0x0000000000000000.

Set the master's portion of the session key identifier.

3. **IVm**

Range: 0x00000000 to 0xffffffff ;

Default: 00000000.

Set the master's portion of the initialization vector.

4.10.2.17 Data PDU Payload Setting (LL_START_ENC_REQ, LL_START_ENC_RSP, LL_PAUSE_ENC_REQ, LL_PAUSE_ENC_RSP, LL_PING_REQ, LL_PING_RSP, LL_CTE_RSP)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_START_ENC_REQ, LL_START_ENC_RSP, LL_PAUSE_ENC_REQ, LL_PAUSE_ENC_RSP, LL_PING_REQ, LL_PING_RSP or LL_CTE_RSP.

Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

4.10.2.18 Data PDU Payload Setting (LL_UNKNOWN_RSP)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_UNKNOWN_RSP.

1. **Opcode**

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. **Unknown Type**

Range: 0x00 to 0xff ; Default: 0x00.

Set the Opcode field value of received LL Control PDU of the Bluetooth low energy packet.

4.10.2.19 Data PDU Payload Setting (LL_FEATURE_REQ, LL_FEATURE_RSP, LL_SLAVE_FEATURE_REQ)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_FEATURE_REQ, LL_FEATURE_RSP or LL_SLAVE_FEATURE_REQ.

1. **Opcode**

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. **Feature Set**

Range: 0x0000000000000000 to 0xffffffffffffffff;

Default: 0x0000000000000000.

Set the set of features supported by the master's Link Layer of the Bluetooth low energy packet.

4.10.2.20 Data PDU Payload Setting (LL_VERSION_IND)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_VERSION_IND.

1. **Opcode**

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. VersNr (Version Number)

Range: 0x00 to 0xff ; Default: 00.

Set the version of the Bluetooth Controller specification.

3. CompId (Company Identifier)

Range: 0x0000 to 0xffff ; Default: 0000.

Set the company identifier of the manufacturer of the Bluetooth Controller.

4. SubVersNr (Sub-version Number)

Range: 0x0000 to 0xffff ; Default: 0000.

Set the unique value for each implementation or revision of an implementation of the Bluetooth Controller.

4.10.2.21 Data PDU Payload Setting (LL_CONNECTION_PARAM_REQ, LL_CONNECTION_PARAM_RSP)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_CONNECTION_PARAM_REQ or LL_CONNECTION_PARAM_RSP.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. Interval_Min

Range: 6 to 3200 ; Default: 6.

Set the Interval_Min field of the PDU Payload. The Interval_Min field is set to indicate the minimum value of *connInterval*, in the following manner: *connInterval* = Interval_Min * 1.25 ms.

3. Interval_Max

Range: 6 to 3200 ; Default: 3200.

Set the Interval_Max field of the PDU Payload. The Interval_Max field is set to indicate the maximum value of *connInterval*, in the following manner: *connInterval* = Interval_ Max * 1.25 ms.

4. Latency

Range: 0 to 500 ; Default: 0.

Set the Latency field of the PDU Payload. The Latency field is set to indicate the *connSlaveLatency* value, in the following manner: *connSlaveLatency* = Latency. Latency is in units of number of connection events.

5. Timeout

Range: 10 to 3200 ; Default: 10.

Set the Timeout field of the PDU Payload. The Timeout field is set to indicate the *connSupervisionTimeout* value, in the following manner: *connSupervisionTimeout* = Timeout *10 ms.

6. Preferred Periodicity

Range: 0 to 255 ; Default: 0.

Set the PreferredPeriodicity field of the PDU Payload. The PreferredPeriodicityfield is set to indicate a value the connInterval is preferred to be a multiple of. PreferredPeriodicity is in units of 1.25 ms. A value of zero means no preference.

7. Reference Connection Event Counter

Range: 0 to 65535 ; Default: 1.

Set the ReferenceConnEventCount field of the PDU Payload. The ReferenceConnEventCount is set to indicate the value of the connEventCounter relative to which all the valid Offset0 to Offset5 fields have been calculated.

8. Offset 0-5

Range: 0 to 3200, 65535;

Set the Offset 0-5 field of the PDU Payload.

The Offset 0-5 field is set to indicate the possible values of the position of the anchor points of the LE connection with the updated connection parameters relative to the ReferenceConnEventCount. Offset0 to Offset5 fields are in units of 1.25 ms and are in decreasing order of preference, that is, Offset0 is the most preferred value followed by Offset1 and so on. Offset0 to Offset5 shall be less than Interval_Max. A value of 0xFFFF (65535) means not valid. Valid Offset0 to Offset5 fields shall contain unique values. Valid fields shall always be before invalid fields.

4.10.2.22 Data PDU Payload Setting (LL_REJECT_EXT_IND)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_REJECT_EXT_IND.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. Reject Opcode

Range: 0x00 to 0xfff ; Default: 00.

Set the Opcode field value of the LL Control PDU being rejected.

3. Error Code

Range: 0x00 to 0xfff ; Default: 00.

Set the reason the LL Control PDU was being rejected.

4.10.2.23 Data PDU Payload Setting (LL_LENGTH_REQ, LL_LENGTH_RSP)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_LENGTH_REQ or LL_LENGTH_RSP.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. MaxRxOctets

Range: 27 to 251 ; Default: 27.

Set the sender's connMaxRxOctets value. Please refer to section 4.5.10 of Vol 6 Part B of Core v5.2 for more information.

3. MaxRxTime

Range: 328 to 17040 ; Default: 328.

Set the sender's connMaxRxTime value. Please refer to section 4.5.10 of Vol 6 Part B of Core v5.2 for more information.

4. **MaxTxOctets**

Range: 27 to 251 ; Default: 27.

Set the sender's connMaxTxOctets value. Please refer to section 4.5.10 of Vol 6 Part B of Core v5.2 for more information.

5. **MaxTxTime**

Range: 328 to 17040 ; Default: 328.

Set the sender's connMaxTxTime value. Please refer to section 4.5.10 of Vol 6 Part B of Core v5.2 for more information.

4.10.2.24 Data PDU Payload Setting (LL_PHY_REQ, LL_PHY_RSP)

Set General Setting -> Channel Type as Data, and set Packet Type as LL_PHY_REQ or LL_PHY_RSP.

1. **Opcode**

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. **RX PHYS**

Range: 0 to 7 ; Default: 1.

Set to indicate the receiver PHYs that the sender prefers to use.

3. **TX PHYS**

Range: 0 to 7 , Default: 1.

Set to indicate the transmitter PHYs that the sender prefers to use.

4.10.2.25 Data PDU Payload Setting (LL_PHY_UPDATE_REQ)

Set General Setting -> Channel Type as Data, and set Packet Type as LL_PHY_UPDATE_REQ.

1. **Opcode**

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. M_TO_S_PHY

Range: 0 to 7 ; Default: 1.

Set to indicate the PHY that shall be used for packets sent from the master to the slave.

3. S_TO_M_PHY

Range: 0 to 7 ; Default: 1.

Set to indicate the PHY that shall be used for packets sent from the slave to the master.

4. Instant

Range: 1 to 32767 ; Default: 1.

Set the count of LL connection event before the new LL connection event of the Bluetooth low energy packet.

4.10.2.26 Data PDU Payload Setting (LL_MIN_USED_CHANNELS_IND)

Set General Setting -> Channel Type as Data, and set Packet Type as LL_MIN_USED_CHANNELS_IND.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. PHYS

Range: 0 to 7 ; Default: 1.

Set to indicate the PHY(s) for which the slave has a minimum number of used channels requirement.

3. MinUsedChannels

Range: 2 to 37 ; Default: 2.

Set the minimum number of channels to be used on the specified PHY.

4.10.2.27 Data PDU Payload Setting (LL_CTE_REQ)

Set General Setting -> Channel Type as Data, and set Packet Type as LL_CTE_REQ.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. MinCTELenReq

Range: 2-20 ; Default: 20.

Set the minimum length of the Constant Tone Extension requested from the remote device, in 8 μs units. Please refer to section 2.5.1 of Vol 6 Part B of Core v5.2 for more information.

3. CTETypeReq

Choice: AOA | AOD(1us) | AOD(2us) ; Default: AOA.

Set the type of the Constant Tone Extension requested from the remote device.

4.10.2.28 Data PDU Payload Setting (LL_PERIODIC_SYNC_IND)

Set General Setting -> Channel Type as Data, and set Packet Type as LL_PERIODIC_SYNC_IND.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. ID

Range: 0 to 65535 ; Default: 65535.

Set the identifier provided by the Host.

3. SyncInfo

1) Sync Packet Offset

Range: 0 – 8191 ; Default: 8191.

Set the value of Sync Packet Offset field. The Sync Packet Offset field contains the time from a reference point to the start of the AUX_SYNC_IND packet that this SyncInfo field describes. The value of the Sync Packet Offset field is in the unit of time indicated by the Offset Units field; the offset is determined by multiplying the value by the unit.

2) Offset Units

Choice: 30 us | 300 us ; Default: 30 us.

Use the drop-down menu to select the units used by the Sync Packet Offset Field.

3) Offset Adjust

Choice: 0 | 1 ; Default: 0.

Set the value of Offset Adjust field. If the Offset Adjust field is set to 1, the actual sync packet offset adding 2.4576 seconds.

4) Interval

Range: 6 – 65535 ; Default: 6.

Set the value of Interval field. The Interval field contains the time in 1.25 ms units from the start of one packet of the periodic advertising train to the start of the next packet.

5) ChM

Range: 0x0000000000 to 0x1fffffffff ;

Default: 0x0000000001.

Set the value of ChM (channel map) field.

The ChM field contains channel map indicating used and unused data channels. Every channel is represented with bit positioned as per the data channel index. The LSB represents data channel index 0 and the bit in position 36 represents data channel index 36. A bit value of 0 indicates that the channel is Unused. A bit value of 1 indicates that the channel is Used. The bits in positions 37, 38 and 39 are reserved for future use.

6) SCA

Choice: 251-500 ppm | 151-250 ppm | 101-150 ppm | 76-100 ppm | 51-75 ppm | 31-50 ppm | 21-30 ppm | 0-20 ppm ;

Default: 251-500 ppm.

Use the drop-down menu to select the SCA (Sleep Clock Accuracy) type. The SCA field is set to indicate the *masterSCA* used to determine the worst-case Master's sleep clock accuracy

7) Access Address

Range: Range: 0x00000000 to 0xffffffff ;

Default: 0x00000000.

Set the ACL connection's Access Address determined by the Link Layer. Please refer to section 2.1.2 of Vol 6 Part B of Core v5.2 for more information.

8) CRCInit

Range: 0x000000 to 0xffffff ;

Default: 0x555555.

Set the initialization value for the CRC calculation for the ACL connection.

9) Event Counter

Range: 0 – 65535 ; Default: 0.

Set the value of Event Counter field.

The Event Counter field contains the value of paEventCounter that applies to the AUX_SYNC_IND packet that this SyncInfo field describes. Please refer to section 2.3.4.6 of Vol 6 Part B of Core v5.2 for more information.

4. connEventCount

Range: 0 – 65535 ; Default: 0.

Set the connection event counter value that meets the requirement currEvent – 2^{14} < connEventCount < currEvent + 2^{14}(modulo 65536), where currEvent is the counter value for the connection event when the LL_PERIODIC_SYNC_IND PDU is being transmitted (or retransmitted).

5. lastPaEventCounter

Range: 0 – 65535 ; Default: 0.

Set the paEventCounter applying to the AUX_SYNC_IND PDU used to determine the contents of the SyncInfo.

6. SID

Range: 0 – 15 ; Default: 0.

Set the Advertising SID subfield of the advertising set pointing to the periodic advertising.

7. AType

Range: 0 – 1 ; Default: 0.

Set the AType field to indicate whether the AdvA field is public (AType = 0) or random (AType = 1).

8. SCA

Choice: 251-500 ppm | 151-250 ppm | 101-150 ppm | 76-100 ppm | 51-75 ppm | 31-50 ppm | 21-30 ppm | 0-20 ppm ;

Default: 251 - 500 ppm.

Use the drop-down menu to select the SCA (Sleep Clock Accuracy) type. It will be included in SCA field of the PDU Payload. The SCA field is set to indicate the sleep clock accuracy of the device sending this PDU.

9. PHY

Range: 0 to 7 ; Default: 1.

Set to indicate the PHY used by the periodic advertising.

10. AdvA

Range: 0x000000000000 to 0xffffffffffff ;

Default: 0x000000000008.

set the advertiser's address in the advertising set pointing to the periodic advertising.

11. syncConnEventCount

Range: 0 – 65535 ; Default: 0.

Set the connection event counter for the connection event that the sending device used in determining the contents of this PDU.

4.10.2.29 Data PDU Payload Setting (LL_CLOCK_ACCURACY_REQ, LL_CLOCK_ACCURACY_RSP)

Set **General Setting** -> **Channel Type** as Data, and set Packet Type as LL_CLOCK_ACCURACY_REQ or LL_CLOCK_ACCURACY_RSP.

1. Opcode

Display the Opcode field of the PDU Payload.

Note: This parameter is read-only and automatically updated when Packet Type is changed.

2. SCA

Choice: 251-500 ppm | 151-250 ppm | 101-150 ppm | 76-100 ppm | 51-75 ppm | 31-50 ppm | 21-30 ppm | 0-20 ppm ;

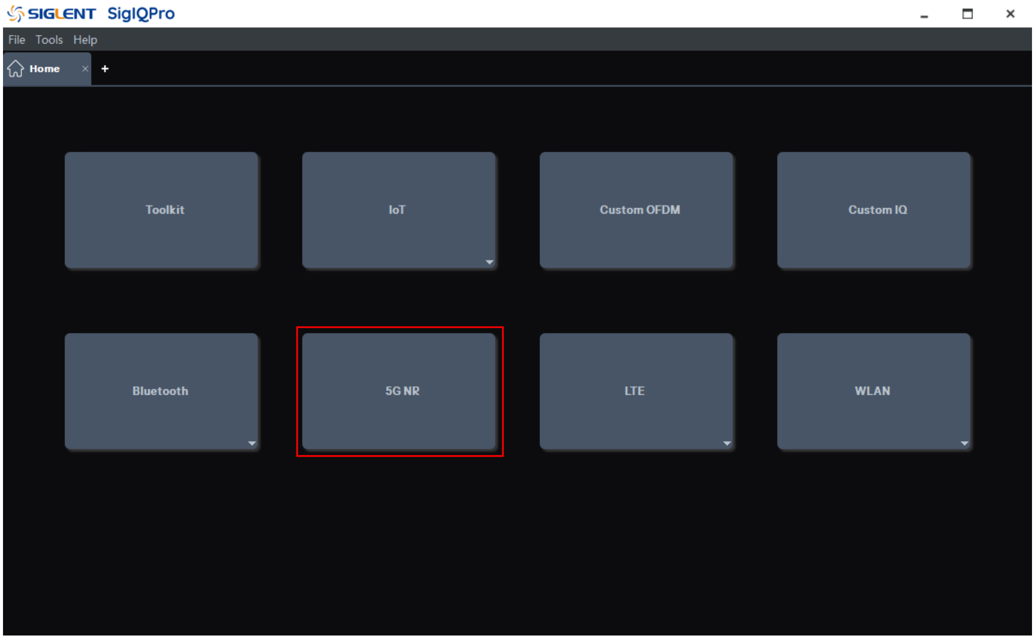
Default: 251 - 500 ppm.

Use the drop-down menu to select the SCA (Sleep Clock Accuracy) type. It will be included in SCA field of the PDU Payload. The SCA field is set to indicate the current masterSCA (if the PDU is sent by the master) or slaveSCA (if the PDU is sent by the slave) used to determine the worst-case sleep clock accuracy of the sending device.

4.11 5G NR

The protocol version realized by this software: 3GPP TS38 V17.3.0 (2022-09).

You can click 5G NR on the home page to enter the corresponding setting interface.



4.11.1 Waveform Setup

Click the Waveform Setup node in the tree view on the left side of the window to enter the waveform setup.

4.11.1.1 Carrier List

1. Add Carrier

The number of carriers can be added: 1 ~ 16, default value: NR Download.

Add a new carrier at the end of the list, options: NR Download | NR Uplink | PRACH.

2. Remove Carrier

Remove the currently selected carrier;

3. Copy Carrier

Adds a copy of the selected channel to the end of the list.

The list shows all the channels, click one of them to select the channel and remove or copy it, and view and modify the parameters of different channels in the tree view on the left side of the window.

4.11.1.2 Basic

1. Waveform Name

This parameter defines the waveform name, when you download the waveform, the name you defined here will be displayed on the generator. Default is empty.

2. Sample Rate

Show the maximum sample rate of all carriers.

3. Frames Number

Settable range: 1 ~ 4 , default: 1.

Set the number of frames contained in the signal exported to file or sent down to the generator.

4. Sample Points

Display the total sample points of the waveform under current configuration.

5. Waveform Length

Displays the length of the waveform in the current configuration.

6. Subframes Number

Display the number of subframes in a frame.

7. Mirror Spectrum

Options: On | Off, Default: Off.

Toggles the state of mirror spectrum, on means inverting the Q channel in the signal IQ data.

8. Phase Compensation

Optional: On | Off, default value: On.

Set the phase compensation switch and the frequency of phase compensation.

Turn on Phase Compensation

To turn on the phase compensation, you need to set the transmitter frequency, which must match the transmitter frequency. When demodulating, it depends on what the frequency of the receiver is, and you need to set the frequency of the receiver as the phase compensation frequency when demodulating.

Turn off phase compensation

At this time, you can transmit at any frequency, but the receiver frequency must be consistent with the transmitter frequency.

9. Radio Frequency

Setting range: 0~200GHz,

default value: 1GHz.

When phase compensation is On, set the current phase compensation frequency.

10. Antennas Number

Set the number of antennas to generate corresponding waveform data, currently only support single antenna.

4.11.1.3 Crest Factor Reduction

1. Crest Factor Reduction

Options: On | Off, default value: Off.

Toggles the enable state of Crest Factor Reduction.

If this parameter is configured as Off, the other parameters in this section will be hidden.

2. Target PAPR

Configurable range: 3dB ~ 100dB , default value: 8dB.

Configure the target PAPR value for baseband signal clipping.

The clipping operation will try to iterate until the target PAPR value is reached or the maximum number of iterations is reached; therefore, when Max Iteration or Cancelling Percent is too small, the signal after clipping may not reach the target PAPR value.

3. Max Iteration

Range: 1 ~ 20, default value: 10.

Configure the maximum number of iterations for peak clipping.

The peak clipping process will try to perform the peak clipping operation iteratively until the target

PAPR value is reached or the maximum number of iterations is reached.

4. **Cancelling Percent**

Range: 0% ~ 100%, Default: 100%.

Configure the percentage of single peak canceling for the peak canceling process.

When performing a single clipping operation, the peak clipping amount is equal to the product of the excess of the peak sample point amplitude compared to the target PAPR limit and the single clipping ratio. If this parameter is too small, the clipping effect will be weakened and it may not be possible to reduce the baseband signal PAPR to the target value.

5. **Block Size**

Range: 20 ~ Total Sample Points, Default: 1000.

Configure the block length of baseband signal during clipping.

When performing peak clipping, the baseband signal is divided into several signal segments, and the peak cancellation process is performed separately. For each segment, only a single peak will be canceled in a single iteration. If the segment length is too large, it will be difficult to perform offset operations on all peaks that exceed the target PAPR limit, resulting in the baseband signal PAPR value not reaching the target value.

6. **Filter Mask**

Configures the filter amplitude-frequency response data used to suppress spectral leakage during clipping processing.

The peak offset sequence generated in the clipping process is filtered before being superimposed on the baseband signal. The software automatically generates a FIR low-pass or band-pass filter based on the given filter amplitude-frequency response.

If the passband of the given filter is too wide, the spectral leakage will be difficult to be effectively suppressed; and if the passband is too narrow, the peak offset sequence will be difficult to effectively offset the peak overrun.

4.11.2 Carrier

Click on the **Carrier** node in the tree view on the left side of the window to enter the parameter settings.

4.11.2.1 General Settings

1. State

Options: On | Off , Default: On.

Carrier Enable Switch.

2. Frequency Offset

Settable range: −400 MHz~ 400 MHz , default value: 0 MHz.

Sets the frequency offset of the current carrier.

3. Timing Offset

Setting range: 0~ 10 ms, default value: 0 s.

Set the time offset of current carrier.

4. Power Boosting

Settable range: −40 ~ 40dB, default value: 0 dB.

Set the relative power of current carrier.

5. Initial Phase

Settable range: 0 ~ 360° , default value: 0° .

Sets the initial phase of the current carrier.

4.11.2.2 Spectrum Control

1. Window Beta

Setting range: 0~0.5, default value: 0.

Set Window Half Length, the value is the ratio of FFT length.

2. Windowing Method

Optional: Center at Symbol Boundary| Start at Symbol Boundary.

Default Center at Symbol Boundary.

Windowing is a technique to reduce the spectral leakage of OFDM modulated signals by smoothing the switching between OFDM symbols. This software module implements two different windowing methods: Window centered at symbol boundary and Window starting at symbol boundary.

For the Window centered at symbol boundary method, the original OFDM symbol samples are cyclically extended at the beginning and end, and the cyclically extended data are copied from the original OFDM symbol samples at the end and the header of the samples. For OFDM symbols with cyclic prefix and/or cyclic suffix enabled, the cyclic delay data is copied before the cyclic prefix source data and/or after the cyclic suffix source data. The length of the cyclic delay at both ends is equal to one-fourth of the length of a single edge (rising or falling) of the window function.

After the cyclic delay, the center of the rising cosine window edge is aligned with the original boundary of the OFDM symbol, and the window function is multiplied point-by-point with the data at the beginning and end of the OFDM symbol. This is shown in the following figure

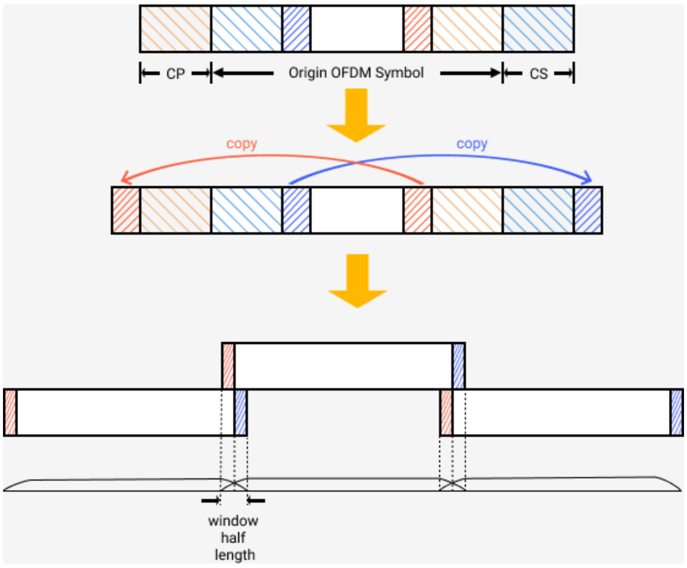


Figure 4-1 Window centered at symbol boundary approach

For the window starting at symbol boundary method, the original OFDM symbol sampled data is only cyclically extended at the tail, the cyclic extension method is similar to the previous method, but the extension length is one half of the single edge of the window function.

Then, the starting position of the ascending cosine window edge is aligned with the original boundary of the OFDM symbol, and the window function is multiplied point by point with the delayed data at the end of the OFDM symbol. This is shown in the following figure

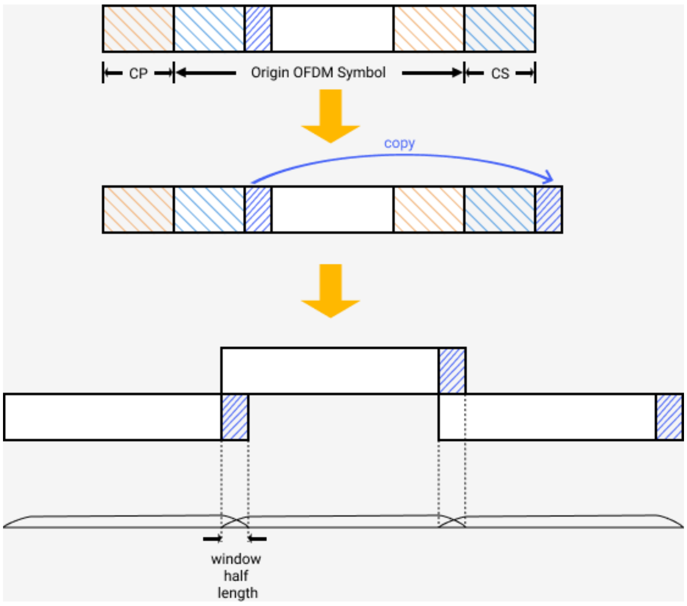


Figure 4-2 Window starting at symbol boundary approach

3. Baseband Filter

Options: On | Off , Default: On.

Baseband Filter switch, turn it on to filter each numerologies of the carrier.

4.11.2.3 Cell-Specific Settings

1. Carrier Type

Options: NR Download | NR Uplink | PRACH.

This option is used to switch between different carriers.

2. Cell ID

Settable range: 0~1007, default 0.

Sets the cell ID number.

3. Channel Bandwidth

Optional range: 0~1007, default 0:

FR1 5MHz | FR1 10MHz | FR1 15MHz | FR1 20MHz | FR1 25MHz | FR1 30MHz

FR1 35MHz | FR1 40MHz | FR1 45MHz | FR1 50MHz | FR1 60MHz | FR1 70MHz

FR1 80MHz | FR1 90MHz | FR1 100MHz

FR2-1 50MHz | FR2-1 100MHz | FR2-1 200MHz | FR2-1 400MHz

FR2-2 100MHz | FR2-2 400MHz | FR2-2 800MHz | FR2-2 1600MHz | FR2-2 2000MHz .

Default value: FR1 100MHz .

To set the channel bandwidth, different bandwidths correspond to the three frequency **ranges** of FR1, FR2-1 and FR2-2 in the 3GPP protocol, and the constraints of subcarrier spacing SCS and number of RBs are shown in Table 4-1 ,Table 4-2 and Table 4-3 .

Table 4-1 （Table 5.3.2-1） *Transmission bandwidth configuration* N_{RB} for FR1

SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	35 MHz	40 MHz	45 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}
15	25	52	79	106	133	160	188	216	242	270	N/A	N/A	N/A	N/A	N/A
30	11	24	38	51	65	78	92	106	119	133	162	189	217	245	273
60	N/A	11	18	24	31	38	44	51	58	65	79	93	107	121	135

Table 4-2 (Table 5.3.2-2) *Transmission bandwidth configuration* $N_{RB}$for FR2-1

SCS (kHz)	50 MHz	100 MHz	200 MHz	400 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}
60	66	132	264	N/A
120	32	66	132	264

Table 4-3 (Table 5.3.2-3) Transmission bandwidth configuration $N_{RB}$for FR2-2

SCS (kHz)	100 MHz	400 MHz	800 MHz	1600 MHz	2000 MHz
	NRB	NRB	NRB	NRB	NRB
120	66	264	N/A	N/A	N/A
480	N/A	66	124	248	N/A
960	N/A	33	62	124	148

4. Frequency Range

Displays the frequency band of the current carrier, there are three frequency bands FR1, FR2-1 and FR2-2 in the 3GPP protocol, when FR2 is mentioned, the frequency ranges of both FR2-1 and FR2-2 shall apply unless otherwise stated. This parameter is determined based on the Channel Bandwidth, see Table 4-4.

Table 4-4 Operating frequency range

Frequency range designation		Corresponding frequency range
FR1		410 MHz – 7125 MHz
FR2	FR2-1	24250 MHz – 52600 MHz
	FR2-2	52600 MHz – 71000 MHz

5. Numerology

Options:

FR1: μ= 1:30KHz| μ = 2:60KHz ;

FR2-1: μ= 2:60KHz| μ = 3:120KHz| μ = 4:240KHz ;

FR2-2: μ= 3:120KHz| μ = 5:480KHz| μ = 6:960KHz .

This parameter is the subcarrier parameter set μ, which is used to characterize the waveform, and supports seven different subcarrier intervals, as shown in **错误!未找到引用源。** to **错误!未找到引用源。** and **错误!未找到引用源。** . The Numerologies related parameters are: SubcarrierSpacing and μ, CyclicPrefix type (CyclicPrefix: normal and Extended), RB Start and RB Size.

Table 4-5 Parameter Set Settings for Supported Transmissions

μ	$\Delta f = 2^{\mu} \cdot 15\,[\mathrm{kHz}]$	Cyclic prefix
0	15	Normal
1	30	Normal
2	60	Normal, Extended
3	120	Normal
4	240	Normal
5	480	Normal
6	960	Normal

6. Sample Rate

Displays the sample rate calculated from the maximum configured bandwidth of the current carrier activation.

7. Intra-Cell Guard Band (u =1) (uplink)

This parameter sets up to four protection bands within the cell in the NR spectrum sharing scenario. Three parameters can be set for each guard band as follows:

1) Guard Band Start

Settable range: 1~ 158 ;

Sets the guard band start position.

2) Guard Band Size

Setting range: 1~ 158 ;

Sets the number of CRBs.

3) Guard Band End

Settable range: 1~ 158 ;

Sets the end position of the guard band.

Note: This parameter is used for uplink only and will be hidden when **Carrier Type** is switched to Downlink or PRACH.

8. Point A

Displays a reference point for frequency domain resource allocation within a certain bandwidth, i.e. Common Resource Block 0 (CRB0).

9. Configured Bandwidth

Displays the maximum value corresponding to the numerologies of the current carrier's configured bandwidth.

10. RB Start

Configurable range: 0~ Maximum number of RBs under current Numerologies – 6 .

Sets the starting RB position under current Numerologies, the parameter is the offset relative to pointA.

11. RB Size

Settable range: 6~ Maximum number of RBs under current Numerologies – **RB start** .

Set the number of RBs under current Numerologies.

12. k0

Can be set for Single Numerology.

Settable range: -6, 0 ,6 , default value: 0.

Set the offset of the center of the resource cell of the current Numerologies relative to the center of the Carrier.

4.11.2.4 BWP

BWP (Bandwidth part) is a set of sub-resources from the common resource. A Carrier can define multiple BWPs, and all channels except SSB must be transmitted on the specified BWP.

1. **Add BWP**

Multiple BWPs can be added.1.

Adds a new BWP to the end of the list.

2. **Remove BWP**

Removes the currently selected BWP.

3. **Copy BWP**

Adds a copy of the selected BWP to the end of the list.

4. **ID**

Show the ID of the currently selected BWP, when you add a new BWP, the ID will be increased from 1 by default.

5. **Name**

Displays the name of the currently selected BWP, and when you add a new BWP, it will be named in order from BWP1 to BWPn.

6. **Numerology**

Sets the subcarrier interval for the current BWP, constrained by the parameters **Numerology** (see5) and **Channel Bandwidth**.

7. **Cyclic Perfix**

Displays the CP type of the current BWP.

8. **RB start**

Settable range: **RB start** of corresponding Numerologies ~ Maximum number of RBs under current Numerologies – 6.

Set the RB start position of current BWP, this parameter is the offset relative to pointA, this parameter must be greater than or equal to the **RB start of** corresponding Numerologies (see10).

9. **RB Number**

Settable range: 6~ Maximum number of RBs under current Numerologies – **RB start** .

Sets the number of RBs in the current BWP.

10. **Number of Coreset**

Range: 1~ 3.

Sets the number of coresets in the current BWP.

11. **First Coreset index**

Displays the index of the first CORESET.

4.11.2.5 Uplink

4.11.2.5.1 UL FRC Config

Click **UL FRC Config** when the waveform type is Uplink to enter the setting of uplink Fixed Reference Channels test mode.

1. **Fixed Reference Channels**

Optional:

FR1-FRC-A-1| FR1-FRC-A-2| FR1-FRC-A-3| FR1-FRC-A-3A| FR1-FRC-A-3B

FR1-FRC-A-4| FR1-FRC-A-5| FR1-FRC-A-8-A-7| FR1-FRC-A-9-A-8| FR1-FRC-A-1

FR1-FRC-A-2| FR1-FRC-A-3| FR1-FRC-A-3A| FR1-FRC-A-3B| FR1-FRC-A-4

FR1-FRC-A-5| FR1-FRC-A-8-A-7| FR1-FRC-A-9-A-8

Default value: FR1-FRC-A-1 .

Select different fixed reference channel test modes, corresponding to 3GPP protocol 38.141 Appendix A.

2. **Reference Channel**

Optional:

G-FR1-A1-1 | G-FR1-A1-2 | G-FR1-A1-3 | G-FR1-A1-4 | G-FR1-A1-5 | G-ER1-A1-6

G-FR1-A1-7 | FR1-A1-8 | G-FR1-A1-9 | G-FR1-A1-10 | G-FR1-A1-11 | G-FR1-A1-12
G-FR1-A1-13 | G-FR1-A1-14 | G-FR1-A1-15 | G-FR1-A1-16 | G-FR1-A1-17
G-FR1-A1-18 | G-FR1-A1-19

G-FR1-A2-1 | G-FR1-A2-2 | G-FR1-A2-3 | G-FR1-A2-4 | G-FR1-A2-5 | G-FR1-A2-6
G-FR1-A2-7 | G-FR1-A2-8 | G-FR1-A2-9 | G-FR1-A2-10 | G-FR1-A2-11 | G-FR1-A2-12
G-FR1-A2-13 | G-FR1-A2-14

G-FR1-A3-8 | G-FR1-A3-9 | G-FR1-A3-10 | G-FR1-A3-11 | G-FR1-A3-12 | G-FR1-A3-13
G-FR1-A3-14 | G-FR1-A3-22 | G-FR1-A3-23 | G-FR1-A3-24 | G-FR1-A3-25
G-FR1-A3-26 | G-FR1-A3-27 | G-FR1-A3-28 | G-FR1-A3-31 | G-FR1-A3-32
G-FR1-A3-33 | G-FR1-A3-33A | G-FR1-A3-34 | G-FR1-A3-34A | G-FR1-A3-35
G-FR1-A3-36 | G-FR1-A3-37 | G-FR1-A3-38

G-FR1-A3A-1 | G-FR1-A3A-2 | G-FR1-A3A-3 | G-FR1-A3A-4

G-FR1-A3B-1 | G-FR1-A3B-2 | G-FR1-A3B-3 | G-FR1-A3B-4 | G-FR1-A3B-5
G-FR1-A3B-6 | G-FR1-A3B-7 | G-FR1-A3B-8

G-FR1-A4-8 | G-FR1-A4-9 | G-FR1-A4-10 | G-FR1-A4-11 | G-FR1-A4-12 | G-FR1-A4-13
G-FR1-A4-14 | G-FR1-A4-22 | G-FR1-A4-23 | G-FR1-A4-24 | G-FR1-A4-25
G-FR1-A4-26 | G-FR1-A4-27 | G-FR1-A4-28 | G-FR1-A4-29 | G-FR1-A4-29A
G-FR1-A4-30 | G-FR1-A4-30A-FR1-A4-31A | G-FR1-A4-31 | G-FR1-A4-32A
G-FR1-A4-32

G-FR1-A5-8 | G-FR1-A5-9 | G-FR1-A5-10 | G-FR1-A5-11 | G-FR1-A5-12 | G-FR1-A5-13
G-FR1-A5-14-FR1-A5-15 | G-FR1-A5-16

G-FR1-A8-1 | G-FR1-A8-2 | G-FR1-A8-3 | G-FR1-A8-4

G-FR1-A9-1 | G-FR1-A9-2 | G-FR1-A9-3 | G-FR1-A9-4 | G-FR1-A9-5

Default value: G-FR1-A1-1 .

Select the test mode of different subcarriers according to different Fixed Reference Channels, corresponding to 3GPP protocol 38.141 Appendix A.

3. **Bandwidth**

Optional: there are different selection intervals according to the selection of the parameter **Reference Channel** .

default value: FR1 50 MHz.

Please refer to Appendix A of 3GPP protocol 38.141 for the test mode of selecting different fixed reference channels.

4. **Duplex Type**

Optional: TDD | FDD, default: TDD.

Select different duplex types.

5. **Periodicity**

Optional: 0.50 ms| 1.00 ms| 2.00 ms| 2.50 ms| 5.00 ms| 10.00 ms .

Default: 2.00 ms .

Sets the period of generating resources for determining different time slot allocations, constrained by the parameter **Reference Channel** .

6. **Number of Uplink Slots**

Configurable range: 0~ 10 , default value: 1.

Set the number of uplink slots, constrained by the parameter **Periodicity** .

Note: Only available when TDD is selected for Duplex Type, and will be hidden when FDD is selected for Duplex Type.

7. **TDD Slot Allocation**

Displays the uplink and downlink slot allocation of the current carrier, constrained by the parameter **Number of Uplink Slots** .

8. **RB Offset**

Settable range: 0~ Maximum number of RBs under current Numerologies – **RB start** , Default value: 0.

Set the number of RBs for offset.

9. **Mapping Type**

Optional: Type A| Type B , Default: Type A .

Used to set the PUSCH mapping type.

10. **DMRS Type A Position**

Optional: 2| 3 , Default: 2.

Sets the high-level parameter dmrs-TypeA-Position.

11. **Phase Compensation**

Optional: On | Off , default: On.

Sets the phase compensation switch and the frequency of phase compensation.

12. **Radio Frequency**

Settable range: 0~200GHz, default value: 1GHz.

Set the current frequency of phase compensation when phase compensation is On.

4.11.2.5.2 PUCCH Test Config

Click **PUCCH Test Config** to enter the PUCCH test mode setting when the waveform type is Uplink.

1. **Test Model Type**

Optional:

38.141-8.3.1 ACK missed detection for PUCCH format 0

38.141-8.3.2.1 NACK to ACK detection for PUCCH format 1

38.141-8.3.2.2 ACK missed detection for PUCCH format 1

38.141-8.3.3.1 ACK missed detection for PUCCH format 2

38.141-8.3.3.2 UCI BLER performance for PUCCH format 2

38.141-8.3.4 UCI BLER performance for PUCCH format 3

38.141-8.3.5 UCI BLER performance for PUCCH format 4

38.141-8.3.6.1.1 NACKto ACK detection for multi-slot PUCCH format 1

38.141-8.3.6.1.2 ACK missed detection for multi-slot PUCCH format 1

38.141-8.3.7 ACK missed detection for interlaced PUCCH format 0

38.141-8.3.8.1 NACK to ACK detection for interlaced PUCCH format 1

38.141-83.8.2 ACK missed detection for interlaced PUCCH format 1

38.141-8.39 UCI BLER performance for interlaced PUCCH format 2

38.141-8.3.10 ACK missed detection for interlaced PUCCH format 3

Default entry: 38.141-8.3.1 ACK missed detection for PUCCH format 0 .

Select the type of PUCCH test you want.

2. SubCarrier Spacing

Optional: 15KHz| 30KHz| 60KHz| 120KHz .

Default value: 30KHz .

Select the subcarrier spacing for the current test pattern.

3. Bandwidth

Optional: FR1 10MHz| FR1 20MHz| FR1 40MHz| FR1 100MHz| FR2 50MHz| FR2 100MHz .

Default: FR1 100MHz .

Select the bandwidth of the current test mode, constrained by SubCarrier Spacing .

4. Duplex Type

Optional: TDD | FDD , default: TDD.

Select different duplex types.

5. Number of Symbols

Selectable range: 1~ 2 , default value: 1.

Set the number of symbols for the current test mode.

Note: Displayed in some test modes only, fixed to 1 for the rest of the test modes.

6. Additional DMRS State

Optional: Off| On .

Default value: Off .

Sets whether PUCCH Format 3 and PUCCH Format 4 use additional DMRS.

7. Tranemission Periodicity

Options: 500 µs | 625 µs | 1000 µs | 1250 µs | 2000 µs | 2500 µs | 5000 µs | 10000 µs .

Default value: 5000 μs .

Set the transmission period of current test mode.

8. Number of Downlink Slots

Sets the number of consecutive Full DL slots, starting from the start position.

The range is determined by numerology and slot configuration.

9. Number of Uplink Slots

Sets the consecutive Full UL slots. starting from the end position.

The range is determined by numerology and slot configuration.

10. TDD Slot Allocation

Set the current test mode uplink and downlink slot allocation, enter "U" to indicate that the current time slot is uplink, "S" to indicate that the current time slot is special symbol, and "D" to indicate that the current time slot is downlink. Enter "U" to indicate that the current time slot is uplink, enter "S" to indicate that the current time slot is special symbol, enter "D" to indicate that the current time slot is downlink.

11. Format3 Test Type

Option: Test 1| Test 2, Default: Test 1.

The test type can be selected when PUCCH is Format 3.

4.11.2.5.3 PUCCH

Click the PUCCH node in the tree view on the left side of the window to enter the parameter settings. You can define more than one PUCCH per BWP.

1. Add PUCCH

Multiple PUCCH channels can be added, default value: 1.

Add a new PUCCH channel at the end of the list.

2. Remove PUCCH

Removes the currently selected PUCCH channel.

3. General Settings

1) **Name**

Displays the name of the currently selected PUCCH channel. When you add a new PUCCH channel, it will be named in order from UCI0 to UCIn.

2) **State**

Optional: On | Off, default: On.

PUCCH channel enable switch.

3) **Power Boosting**

Settable range: -40 dB~ 40 dB. Default value: 0 dB.

Sets the power of PUCCH data relative to other channels.

4) **PUCCH Format**

Settable range: Format 0 | Format 1 | Format 2 | Format 3 | Format 4.

Default: Format 0.

Select the PUCCH format.

4. **Transmission Settings**

1) **Allocated Slots**

Settable range: 0~ 10*2^μ, default value: 0.

Sets the Slot number for transmitting PUCCH in one frame. It can be set in the following three ways:

a) If you need to configure by individual slots, you can use "," as the separator, e.g.: 0,1,2,3.
b) If you need to configure by range of slots, you can use 2:7 for start index and last index, for example 2:7 for 2,3,4,5,6,7.
c) If you need to configure by different steps, you can use two ":" to indicate the start slot, step and last slot respectively, for example, 0:2:8 means 0,2,4,6,8.

   The above three configuration methods can be used in combination.

2) **First Symbol**

Settable range: 0~ 13, the default value is determined according to different PUCCH formats.

Set the first symbol of current PUCCH.

3) **Symbol Number**

Set the number of available symbols for current PUCCH, the setting range depends on different PUCCH format, please refer to Table 4-6 PUCCH format and symbol constraints. .

Table 4-6 PUCCH format and symbol constraints.

PUCCH format	Number of symbols
0	1 - 2
1	4 - 14
2	1 - 2
3	4 - 14
4	4 - 14

4) BandWidth Part

Selects the BWP of the current PUCCH transmission.

5) Interlaced Transmission

Optional: On | Off, Default: On.

Interleave Transmission Enable Switch, Interleave Transmission only supports subcarrier intervals of 15kHz and 30kHz, and conflicts with frequency hopping.

Note: When Interleave transmission is On, the parameters **RB Offset** and **RB Number** will be hidden and the parameters **RB-Set Index** , **Interlace0** and **Interlace1** will be displayed.

6) RB set Index

The settable range is determined according to the carrier setting, default value: 0.

Sets the RB set index used for the current PUCCH transmission.

7) Interlace0

Settable range: -1~ 9 (u = 0) | 0~ 4 (u = 1); default value: 0.

Sets the parameter Interlace0 for the current PUCCH, see 3GPP Physical Layer Protocol (TS38.211) for details.

Note: Displayed only if the parameter **Interlaced Transmission** is On.

8) Interlace1

Settable range: -1~ 9 (u = 0) | -1~ 4 (u = 1); Default: -1 (i.e. no configuration).

Sets the parameter Interlace1 for the current PUCCH, see 3GPP Physical Layer Protocol (TS38.211) for details.

Note, only displayed if the parameter **Interlaced Transmission** is On and **the PUCCH Format** is format 2| 3.

9) PUCCH Interlace0

Optional: 10 | 11 | not configured, default: 10.

Set the number of RBs after current PUCCH interleaving, not configured means the number of RBs is unlimited and distributed in the whole bandwidth.

Note: Displayed only when the parameter **Interlaced Transmission** is On.

10) PUCCH Interlace1

Options: 10 | 11 | not configured, Default: 10

Sets the current number of RBs after PUCCH interleaving, not configured means the number of RBs is unlimited and distributed in the whole bandwidth.

Displayed only when **Interlaced Transmission** is On and **PUCCH Format** is format 2| 3.

11) RB Offset

Settable range: 0~ Current BWP RB number - 1 , Default value: 0.

Set the offset RB number of current PUCCH relative to the start of BWP.

12) RB Number

Settable range: See Table 4-7 PUCCH format and RB number constraints .

Sets the number of RBs for the current PUCCH.

Table 4-7 PUCCH format and RB number constraints

PUCCH format	RB Number
0	1
1	1
2	1 - 16
3	1 - 16 (except 7, 11, 13, 14)
4	1

5. PUCCH Parameters

1) Hopping ID

Settable range: -1~ 1023 , Default value: -1 (Setting to -1 means CellID is used).

Set the hopping ID when the current PUCCH is in the format 0| 1| 3| 4.

Note: Displayed only when **PUCCH Format** is format 0| 1| 3| 4.

2) PUCCH-Group Hopping

Optional: Neither | Enable | Disable , Default: Neither .

Sets the high-level parameter pucch-GroupHopping when PUCCH is format 0| 1| 3| 4, as described in the 3GPP protocol.

Note: Displayed only when **PUCCH Format** is format 0| 1| 3| 4.

3) Scrambling ID

Settable range: -1~ 1023 , Default: -1 (setting to -1 means CellID is used).

Set the scrambling ID for scrambling sequence generation.

Note: Displayed only when **PUCCH Format** is format 2| 3| 4.

4) n RNTI

Settable range: 0~ 65535 , Default value: 0.

Sets the n_RNTI parameter generated by the scrambling code sequence.

Note: Displayed only when **PUCCH Format** is format 2| 3| 4.

5) N_ID_0

Settable range: -1~ 65535 , Default value: -1 (set to -1 to use CellID) .

N_ID_0 of DMRS sequence is set when the current PUCCH is format 2| 3| 4 .

Note: Displayed only when **PUCCH Format** is format 2| 3| 4.

6) Initial Cyclic Shift

Settable range: 0~ 11 , Default value: 0.

Set the initial cyclic shift (m_0) of its sequence when the current PUCCH is format 0| 1.

Note: Displayed only when **PUCCH Format** is format 0| 1.

7) intra-slot Frequency Hopping

Options: On | Off , Default: Off.

Enable/disable intra-slot frequency hopping. Only supported by PUCCH format 1.

Note: Displayed only when **PUCCH Format** is format 1.

8) Number of Slots for PUCCH Repetition

Configurable range: 1~ Min (number of slots configured, 8), Default: 1 .

Sets the number of slots for PUCCH repetition during PUCCH transmission.

Note: Displayed only when **PUCCH Format** is format 1| 3| 4.

9) Pi/2 BPSK Enabled

Options: On | Off , Default: Off.

Enables or disables Pi/2 BPSK modulation.

Note: Displayed only when **PUCCH Format** is format 3| 4.

10) Additional DMRS

Optional: On | Off , Default: Off.

Enables or disables additional DMRS.

Note: Displayed only when **PUCCH Format** is format 3| 4.

11) DMRS Power Boosting

Settable range: -40 dB~ 40 dB , Default value: 0 dB.

Sets the power of DMRS relative to PUSCH.

12) dmrs-Uplink Transform Precoding PUCCH

Optional: On | Off , default: Off .

Enable or disable the high-level parameter *dmrs-UplinkTransformPrecodingPUCCH* specified by 3GPP protocol.

13) Second Hop RB offset

Settable range: 0~ **Current** BWP RB number - 1 , Default value: 0 .

Set the first PRB position of the second hopping frequency when the hopping frequency is turned on.

14) inter-slot Frequency Hopping

When the number of slots is greater than 1, i.e., the number of slots configured by the parameter

Allocated Slots is greater than 1, turn on and off the inter-slot hopping frequency. Only PUCCH format 1 is supported.

Note: Displayed only when **PUCCH Format** is format 1.

15) **OCC Index**

Sets the index value of the spread spectrum sequence, which corresponds to the parameter TimeDomainOCC of PUCCH Format 1 and the parameter occ-Index of PUCCH Format 2| 3| 4 in 3GPP protocol.

Note: Displayed only when **PUCCH Format** is format 1| 2| 3| 4.

6. **PUCCH Contents**

1) **UCI Format**

Optional: SR and HARQ-ACK | HARQ-ACK| SR

Selects UCI contents when PUCCH is format 0| 1.

Note: Displayed only when **PUCCH Format** is format 0| 1, and when **PUCCH Format** is format 1, the current parameter only supports HARQ-ACK| SR.

2) **SR Configuration**

Optional: Negative | Positive, default: Negative.

Select SR configuration.

Note:

① When the parameter **UCI Format** is SR, the current parameter is Positive by default and is not assignable;

② When the parameter **UCI Format** is HARQ-ACK, the current parameter is hidden.

3) **Scrambling State**

Optional: On | Off , default: On.

Enables or disables PUCCH channel data scrambling.

Note: Displayed only when **PUCCH Format** is format 2| 3| 4.

4) **Channel Coding**

Options: On | Off , Default: On.

Enables or disables channel coding.

Note: Displayed only when **PUCCH Format** is format 2| 3| 4.

5) **UCI Content**

Optional: On | Off , Default: Off.

Enables or disables the control information content (UCI) when PUCCH is Format 2| 3| 4 .

Note: Displayed only when **PUCCH Format** is format 2| 3| 4.

6) **Payload data**

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files , Default: PN9 ITU .

Set the Payload data type, you can choose PN code or custom data.

7) **Payload size**

The settable range calculates the constraints according to the specific RE number and coding related content, see 3GPP protocol for details.

Set the Payload data size.

4.11.2.5.4 PUSCH

Click the PUSCH node in the tree view on the left side of the window to enter the parameter setting.

1. **Add PUSCH**

Multiple PUSCH channels can be added, the default number is 1.

Add a new PUSCH channel at the end of the list.

2. **Remove PUSCH**

Removes the currently selected PUSCH channel.

3. **General Settings**

1) **State**

Options: On | Off , Default: On.

PUSCH Channel Enable Switch.

2) **Power**

Settable range: -40 dB~ 40 dB , Default value: 0 dB.

Sets the power of PUCCH data relative to other channels.

3) **RNTI**

Settable range: 0~ 65535 , default value: 0.

Set the n_RNTI of the PUSCH data scrambling sequence to distinguish different UEs.

4) **nID**

Configurable range: -1~ 1023 , Default: -1 (setting to -1 means CellID is used).

Sets the nID of the PUSCH data scrambling sequence.

5) **Transform Precoding**

Optional: On | Off , Default: Off.

Enables or disables Transform Precoding.

6) **Rapid**

Settable range: -1~ 63 , Default: -1 (i.e. no configuration).

Sets n_{RAPID} for the PUSCH data scrambling sequence.

4. **Transmission Settings**

1) **DMRS Port(s)**

Settable range: 0~ 4 , Default value: 0.

Set the DMRS port number, can set one or more values, when set more than one value, it means PUSCH has multiple layers, the maximum support is 4 layers. For specific constraints, see Table 4-8 .

Table 4-8 Antenna Port and DM-RS Duration Constraint Relationships

DM-RS Duration	l'	Supported Antenna Ports $\tilde{p}$	
		Configuration type 1	Configuration type 2
single-symbol DM-RS	0	0 - 3	0 - 5
double-symbol DM-RS	0, 1	0 - 7	0 - 11

2) **Layers Number**

The setting range is constrained by **DMRS Port(s)** , see 3GPP protocol for details.

Set the number of PUSCH layers, the maximum support is 4 layers.

3) Antenna Port Number

Optional: 1| 2| 4 , Default: 1.

Set the total antenna number, maximum support 4 antennas.

4) Number of DMRS CDM groups without data

Configurable range: 1~ 2 (configuration Type1)| 1~ 3 (configuration Type2) , Default: 1.

Sets the number of CDM groups of DMRS that are not allowed to map PUSCH data.

5) Antenna Port(s)

Options: Port_0 | Port_1 | Port_2 | Port_3 , Default: Port_0 .

Selects the data for each antenna, specifying which layer's data stream or which antenna port (with precoding) the corresponding antenna outputs.

6) TPMI

Settable range:

- Single layer single antenna: 0;
- Single layer 2 antenna: 0~ 5;
- Single layer 4 antenna: 0~ 27;
- 2-layer 2 antenna: 0~ 2;
- 2 layer 4 antenna: 0~ 21;
- Layer 3 4 antenna: 0~ 6;
- layer 4 antenna: 0~ 4.

Default value: 0 .

When the parameter **Codebook** is On, you can set the corresponding code matrix index according to the number of layers and antenna ports.

7) Codebook

Optional: On | Off , Default: Off .

Enables or disables codebook transmission.

5. Resource Allocation

1) Allocated Slots

Settable range: 0~ 10*2^µ , Default value: 0.

Sets the Slot number of the transmitted PUSCH in one frame. It can be set in the following three ways:

- If you need to configure by single slot, you can use "," as the separator, e.g.: 0,1,2,3 .
- If you need to configure by a range of slots, you can use 2:7 to indicate the start index and the last index, e.g. 2:7 means 2,3,4,5,6,7.
- If you need to configure by different steps, you can use two ":" to indicate the starting slot, step and last slot respectively, for example, 0:2:8 means 0,2,4,6,8.

  The above three configuration methods can be used in combination.

2) Symbol Start

Range: 0~ 13 , Default: 0.

Set the first symbol position of current PUSCH.

3) Symbol Number

Setting range: 0~ 14 (Normal)| 0~ 11 (Extended),

default value: 14| 11.

Set the number of available symbols for current PUSCH, the maximum value is related to CP type.

4) BWP

Select the BWP for current PUSCH transmission.

5) Resource Allocation Type

Optional: Type0| Type1 | Type2 ,

Default: Type1 .

Select the frequency domain resource allocation type, see 3GPP Protocol Physical Layer for details.

6) RB Offset

Settable range: 0~ Current BWP RB number – 1 ,

Default value: 0 .

Sets the offset RB number relative to the start of BWP when the current PUSCH is Type1.

Note: Displayed only when **Resource Allocation Type** is Type1.

7) RB Number

Range: 0~ Current BWP RB Number – **RB Offset** ,

Default: Maximum RB Number.

Sets the number of RBs when the current PUSCH is Type1.

Note: Displayed only when **Resource Allocation Type** is Type1.

8) RBGsize

Settable range: select the RBG range according to the resource size of BWP, the specific constraints are shown in the Table 4-9 , default value: 16.

Set the size of RBG.

Table 4-9 BWP and RBG constraints

Bandwidth Part Size	RBG Configuration 1	RBG Configuration 2
1 - 36	2	4
37 - 72	4	8
73 - 144	8	16
145 - 275	16	16

9) RBGBitmap

Setting content: one bit represents one RBG, setting 1 means active, the number of bits is calculated according to the RBG size meter and BWP.

Sets the number and location of RBGs.

Note: Displayed only when the parameter **Resource Allocation Type** is Type0.

10) Hopping Mode

Optional: Disable| Intra-slot Frequency hopping| Inter-slot Frequency hopping, default: Disable .

Select to turn off or on the different hopping modes.

Note: Displayed only when the parameter **Resource Allocation Type** is Type0.

11) Hopping RB Offset

Settable range: 0~ Current BWP RB Number – **RB Number** – **RB Offset** , default value: 0.

When the parameter **Hopping Mode** is turned on, set the RB offset parameter for calculating the RB start of every second hop.

Note: Displayed only when the **Hopping Mode** parameter is not Disable.

6. Modulation and Coding

1) **Coding**

Options: On | Off , Default: On.

Enables or disables LDPC coding of PUSCH data.

2) **MCS Table**

When transmission precoding is not enabled:

Options: QAM64| QAM256| QAM64Low SE| QAM1024 .

When transmission precoding is enabled:

Optional: QAM64| QAM256| QAM64Low SE| QAM1024 , Default: QAM64 .

Select the table for calculating the TB size accordingly, see 3GPP Protocol Physical Layer Agreement for the table.

3) **MCS Index**

Default value: 0.

Sets the corresponding MCS index, with the specific range related to the table corresponding to the 3GPP protocol.

4) **xOverhead**

Optional: 0 | 6 | 12 | 18, Default: 0.

Sets the high-level parameter *xOverhead* of the 3GPP protocol*, which* is used to set the parameter N_{oh}^{PRB} for calculating the TBS.

5) **Coding Rate**

Displays the coding rate, obtained from the parameter **MCS Table** .

6) **Modulation**

Displays the modulation mode, obtained from the **MCS Table** .

7) **Payload Data**

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files, default: PN9.

Set the Payload Data type, you can choose PN code or customized data.

8) **RV index**

Settable range: 0~ 3 , default value: 0.

Set the RV index of redundant version for rate matching.

7. **DMRS Settings**

1) **DMRS-Downlink-r16**

Options: On | Off , Default: Off.

Sets whether to provide the high-level parameter *dmrsUplink-r16*.

2) **n_SCID**

Settable range: 0~ 1 , Default value: 0 .

Sets the parameter n_{SCID} for sequence generation.

3) **Scrambling ID0**

Settable range: -1~ 65535 , Default value: -1 (set to -1 to use CellID).

Sets N_{ID}^{0} for DMRS sequence generation.

4) **Scrambling ID1**

Settable range: -1~ 65535 , Default value: -1 (set to -1 to use CellID).

Sets N_{ID}^{1} for DMRS sequence generation.

5) **DMRS Power**

Settable range: -40 dB~ 40 dB . Default value: 0 dB.

Sets the power of PUSCH DMRS relative to the PUSCH channel.

6) **DMRS Configuration Type**

Optional: Type1| Type2 , Default: Type1.

Sets the DMRS configuration type.

7) **DMRS Length**

Optional: Single Symbol|Double Symbol , default: Single Symbol.

Sets the DMRS symbol length.

8) **DMRS Additional Position**

Optional:

- Single symbol DMRS:

  DMRS: pos0 | pos1 | pos2 | pos3;

- DMRS Length is Double Symbol or Single symbol when FH is turned on in the time slot:

  pos0 | pos1.

Set the 3GPP protocol high-level parameter *dmrs-AdditionalPosition*.

9) DMRS TypeA Position

Optional: 2| 3 , Default: 2.

Sets the 3GPP protocol high-level parameter *dmrs-TypeA-Position*.

10) DMRS Mapping type

Optional: TypeA| TypeB , default: TypeA.

Sets the PUSCH mapping type.

11) DMRS Hopping

Optional: Disable| group hopping| Sequence Hopping, Default: Disable.

Disable or select different types of DMRS hopping.

12) n_RS

Settable range: -1~ 65535 , Default value: -1 (set to -1 to use CellID).

Set $n_{\mathrm{ID}}^{\mathrm{RS}}$ for DMRS generation.

8. PTRS Settings

1) PTRS Enabled

Options: On | Off , Default: On.

PTRS Enabled switch.

2) PTRS Power

Settable range: -40 dB~ 40 dB , Default value: 0 dB.

Sets the power of PTRS data relative to PUSCH data.

3) Frequency Density (K_PTRS)

Selectable range: 2| 4 , default value: 2.

Sets the frequency density.

4) Time Density (L_PTRS)

Option: 2| 4 , Default: 2.

Sets the number of points for each PT-RS group.

5) PTRS RE Offset

Option: 00| 01 | 10 | 11 , Default: 00.

Sets the RE offset of PTRS.

6) Enable LBRM

7) PTRS Port

Settable range: 0~ 5 , default value: same as **DMRS Port**.

Sets the port number of the PTRS, either one or more values can be set. The value set must be contained within the DMRS Port, if the

If the **DMRS Port** does not have a port number that supports a PTRS port, PTRS will not open.

8) n PTRS Group Sample

Sets the number of points for each PT-RS group.

9) n PTRS Group

Optional: 2| 4| 8 , Default: 2.

Sets the number of PT-RS groups.

10) n PTRS ID

Settable range: 0~ 65535 , default value: 0.

Set the initialization parameter for PTRS sequence generation when transmission precoding is enabled N_{ID} .

4.11.2.5.5 SRS

Click on the SRS node in the tree view on the left side of the window to enter the parameter settings.

1. **Add SRS**

Multiple channels can be added, the default number is 1 .

Add a new SRS channel at the end of the list.

2. **Remove SRS**

Removes the currently selected SRS channel.

3. **General Settings**

1) **Name**

Displays the name of the currently selected SRS channel, in order from SRS0 to SRSn when you add a new SRS channel.

2) **State**

Options: On | Off, Default: Off.

Sets the current SRS channel enable switch.

3) **Power Boosting**

Settable range: -40 dB~ 40 dB. Default value: 0 dB.

Sets the power of the current SRS data relative to the carrier.

4) **Number of Antenna Ports**

Optional: 1| 2| 4 , Default: 1 .

Set the number of antenna ports, corresponding to the parameter $N_{\text{ap}}^{\text{SRS}}$ in 3GPP protocol.

5) **Antenna Port(s) Generated**

Range: 0~ Port Number-1 , default value: Port_0.

Specify the data of each antenna, the data is derived from SRS of each port number, when there are multiple antennas, a port number of SRS must be specified for each antenna, multiple antennas can be of the same port number, and no SRS data can be selected.

6) **SRS-for-positioning**

Optional: On | Off , Default: Off.

Sets whether the current SRS is configured via IE SRS-PosResource.

4. Time Domain Resource

1) Periodicity(T_SRS)

Set the Periodicity parameter T_{SRS} when the current SRS is set to Periodic or Semi-Persisten.

2) Slot Offset(T_offset)

Setting range: 0 ~ T_{SRS} -1 , default value: 0.

When SRS is set to Periodic or Semi-Persisten, set the Period parameter T_{offset} .

3) Allocation slots

Range: 0~ 20 , Default: 0 .

This parameter can be configured when the current SRS is set to non-periodic, and is used to set the Slot number of the transmitted SRS within a frame.

It can be set in the following three ways:

- If you need to configure by single slot, you can use "," as the separator, e.g.: 0,1,2,3 .
- If you need to configure by range of slots, you can use 2:7 for start index and last index, e.g. 2:7 for 2,3,4,5,6,7 .
- If you need to configure by different steps, you can use two ":" to indicate the starting slot, step and last slot respectively, for example, 0:2:8 means 0,2,4,6,8.

All the above three configuration methods can be used in combination.

Note: Only the slot number is displayed when the current SRS setting is Periodic.

4) Start Position(l_offset)

Setting range: $N_{symb}^{SRS} - 1$~ 13 , default value: 0.

Set the l_{offset} parameter in 3GPP protocol.

5) Number of symbols(N_symb_SRS)

Optional range: 1| 2| 4| 8| 10| 12| 14 , default value: 1.

Selects the number of symbols of the current SRS, corresponding to the parameter N_{symb}^{SRS} in the 3GPP protocol.

6) Repetition Factor(R)

Optional: 1| 2| 4, default value: 1.

Set the P_F parameter of current SRS.

5. Frequency Domain Resource

1) Bandwidth Part

Selects the BWP of the current SRS transmission.

2) Transmission Comb Number(K_TC)

Optional: 2| 4| 8 , Default: 2.

Set the parameter K_{TC} in 3GPP protocol, which will limit the maximum value of $\bar{k}_{\text{TC}}$ (**Transmission Comb Offset**).

3) Transmission Comb Offset(k_TC)

Settable range: 0~ K_TC − 1 , default value: 0 .

Sets the parameter Transmission Comb offset for the current SRS, corresponding to the 3GPP protocol$\bar{k}_{\text{TC}}$ parameter.

4) SRS Bandwidth index(B_SRS)

Settable range: 0~ 3 , default value: 0.

Sets the parameter B_{SRS} in 3GPP protocol.

5) SRS Bandwidth index(C_SRS)

Settable range: 0~ 63 , default value: 0.

Set the parameter C_{SRS} in 3GPP protocol.

6) Frequency Hopping(b_hop)

Settable range: 0~ 3 , default value: 0.

Set the frequency hopping parameter in 3GPP protocol b_{hop} .

7) Frequency Domain Shift(n_shift)

Settable range 0 ~ 268 , default value: 0.

Set the current SRS frequency domain shift parameter n_{shift} .

8) Frequency Domain Position(nRRC)

Sets the frequency domain position of the current SRS.

9) kf

Settable range: 0~ pf - 1 , default value: 0.

Set the parameter k_{F} in the 3GPP protocol.

10) pf

Optional range: 1| 2| 4 , default value: 1 .

Set the parameter P_{F} in the 3GPP protocol.

6. Sequence Generation

1) GroupSequenceHopping

Optional: 0 (Neither)| 1 (Group Hopping)| 2 (Sequence Hopping).

Default value: 0 (Neither).

Set the current SRS sequence hopping mode.

2) Cyclic Shift Config(n_SRS_cs)

Configurable range: 0 ~ $n_{\mathrm{SRS}}^{\mathrm{cs,max}}-1$, Default value: 0 . (Parameter $n_{\mathrm{SRS}}^{\mathrm{cs,max}}$ is affected by the K_TC parameter, see Table 4-10 for the constraints)

Set the parameter $n_{\mathrm{SRS}}^{\mathrm{cs}}$ in the 3GPP protocol.

Table 4-10 Constraints of K_TC with $n_{\mathrm{SRS}}^{\mathrm{cs,max}}$

K_{TC}	$n_{\mathrm{SRS}}^{\mathrm{cs,max}}$
2	8
4	12
8	6

3) Sequence identity(n_ID_SRS)

Settable range: 0~ 65535 , default value: 0.

Set the current SRS $n_{\mathrm{ID}}^{\mathrm{SRS}}$

4.11.2.6 Downlink

4.11.2.6.1 DL Test Model

Click DL Test Model when the waveform type is Downlink to enter the setting of Downlink Test Model.

1. **Test Model**

Optional:

NR-FR1-TM1.1 | NR-FR1-TM1.2 | NR-FR1-TM2 | NR-FR1-TM2a | NR-FR1-TM2b

NR-FR1-TM3.1 | NR-FR1-TM3.1a | NR-FR1-TM3.1b | NR-FR1-TM3.2 | NR-FR1-TM3.3

NR-FR1-TM11 | NR-FR1-TM1.2 | NR-FR1-TM2 | NR-FR1-TM2a | NR-FR1-TM2b

NR-FR1-TM3.1 NR-FR1-TM3.1a | NR-FR1-TM3.1b | NR-FR1-TM3.2 | NR-FR1-TM3.3

NR-FR2-TM1.1 | NR-FR2-TM2 | NR-FR2-TM2a | NR-FR2-TM3.1 | NR-FR1-TM3.1a

Default value: NR-FR1-TM1.1 .

Select the test model you want, this parameter is constrained by **Test Model** .

2. **Bandwidth**

Optional:

FR1 5MHz| FR1 10MHz| FR1 15MHz| FR1 20MHz| FR1 25MHz| FR1 30MHz

FR1 35MHz| FR1 40MHz| FR1 45MHz| FR1 50MHz| FR1 60MHz| FR1 70MHz

FR1 80MHz| FR1 90MHz| FR1 100MHz| FR2-1 50MHz| FR2-1 100MHz

FR2-1 200MHz| FR2-1 400MHz| FR2-2 100MHz| FR2-2 400MHz| FR2-2 800MHz

FR2-2 1600MHz| FR2-2 2000MHz

Default value: FR1 100MHz.

3. **Numerology**

Optional:

FR1: μ= 1:30KHz| μ = 2:60KHz ;

FR2-1: μ= 2:60KHz| μ = 3:120KHz| μ = 4:240KHz ;

FR2-2: μ= 3:120KHz| μ = 5:480KHz| μ = 6:960KHz .

Default value: μ= 1:30KHz .

Sets the subcarrier spacing for the current test pattern, consistent with the parameter **Numerology** in **Carrier** (see5).

4. **Duplex Type**

Optional: TDD | FDD, default: TDD.

Select different duplex types.

5. **n ID**

Settable range: 0~ 1023 , default: 1.

Sets the cell ID of the current test pattern.

6. Layers

Configurable range: 1~ 2 , default value: 1.

Sets the number of layers for the current test pattern.

7. Modulation

Displays the modulation mode of the current test pattern.

8. Phase Compensation State

Selectable range: On | Off , default value: On.

Sets the phase compensation switch and the frequency of phase compensation.

9. Radio Frequency

Settable range: 0~200GHz , default value: 1GHz.

Set the current frequency of phase compensation when the phase compensation is On.

4.11.2.6.2 DL FRC Config

Click **DL FRC Config** to enter the setting of downlink FRC test mode when the waveform type is Downlink.

1. FRC Type

Optional:

FR1 QPSK| FR1 64QAM| FR1 256QAM| FR1 1024QAM

FR2 QPSK| FR2 64QAM| FR2 256QAM .

2. Numerology

Options:

FR1: μ= 1:30KHz| μ = 2:60KHz ;

FR2-1: μ= 2:60KHz| μ = 3:120KHz| μ = 4:240KHz ;

Default: μ= 1:30KHz .

Sets the subcarrier interval for the current test pattern.

3. **BandWidth**

Optional:

FR1 5MHz| FR1 10MHz| FR1 15MHz| FR1 20MHz| FR1 25MHz| FR1 30MHz

FR1 35MHz| FR1 40MHz| FR1 45MHz| FR1 50MHz| FR1 60MHz| FR1 70MHz

FR1 80MHz| FR1 90MHz| FR1 100MHz

FR2-1 50MHz| FR2-1 100MHz | FR2-1 200MHz| FR2-1 400MHz

Default value: FR1 100MHz .

Sets the channel bandwidth for this test mode.

4. **Duplex Type**

Optional: TDD | FDD, default: TDD.

Select different duplex types.

5. **Phase Compensation State**

Options: On | Off , Default: On.

Set the phase compensation switch and the frequency of phase compensation.

6. **Radio Frequency**

Set the current frequency of phase compensation when the phase compensation is On, the setting range is according to the frequency range supported by the device.

4.11.2.6.3 SS/PBCH Block

Click on the SS/PBCH Block node in the tree view on the left side of the window to enter the parameter settings.

1. **General Settings**

1) **State**

Options: On | Off , Default: Off.

SS/PBCH Block Channel Enable Switch.

2) **SS/PBCH Block Pattern**

SS/PBCH Block Pattern Optional:

15kHz: Case A ;

30kHz: Case B | Case C ;

120kHz: Case D;

240kHz: Case E.

Default value: Case B .

Sets the sync broadcast block style.

3) Numerology

Displays the subcarrier parameter set μ of the SSB, consistent with the parameter **Numerology** in **Carrier** (see5).

4) Periodicity

Options: 5ms | 10ms | 20ms | 40ms | 80ms | 160m, Default: 10ms.

Sets the sync broadcast period.

5) Half Frame Index

Settable range: 0~ 1 (0: first half frame, 1: second half frame), default value: 0.

When the parameter **Periodicity** (SSB period) is not 5ms, this parameter is used to specify which half frame the SSB is in.

6) Lmax

Optional:

CaseA / CaseB, CaseC: 4| 8 ;

CaseD / CaseE: 64 .

Set the number of SS/PBCH blocks, the specific selection is constrained by **SS/PBCH Block Pattern**.

7) Active Indices

Set the number of active SS/PBCH blocks in one half frame, the maximum value is constrained by **Lmax** . Example: When the maximum number of SS/PBCH blocks is 4, you can set the active indices to be any one or more of 0~3.

You can set it in the following three ways:

- If you need to configure by single SS/PBCH block, you can use "," as the separator, example:

0,1,2,3 .

- If you need to configure by range of SS/PBCH blocks, you can use 2:7 for start index and last index, for example, 2:7 for 2,3,4,5,6,7.
- If you need to configure by different steps, you can use two ":" to indicate the starting SS/PBCH block position, step size and last SS/PBCH block position respectively, for example, 0:2:8 means 0,2,4,6,8.

The above three configuration methods can be used in combination.

8) SS/PBCH Block Power

Configurable range: -40 dB~ 40 dB , default value: 0 dB.

Sets the power of the Sync Broadcast Block relative to other channels.

9) PSS Power

Setting range: -40 dB~ 40 dB, default value: 0 dB.

Set the power of PSS with respect to SSS or PBCH, the power of SSS and PBCH is the same.

10) RB Offset

Settable range: -1~ Maximum number of RBs for numerology - 1 , Default value: -1 .

Sets the offset of the center of the Synchronous Broadcast Block (SSB) relative to CRB0 (PointA).

11) kSSB

Settable range: 0~ 23 (u=0 and u=1) | 0~ 11 (u=3 and u=4) , Default value: 0 .

Set the parameter kSSB size for SS/PBCH.

2. NR-PBCH Settings

1) Channel Coding

Options: On | Off , Default: On.

Enables or disables channel coding.

2) Auto MIB

Optional: On | Off , Default: On.

Enables or disables automatic MIB generation.

3) Payload Data

Options: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files.

Default: PN9 .

Set the Payload data type, you can choose PN code or custom data.

Note: Configurable only when Auto MIB is Off, not configurable when Auto MIB is On, displayed as Auto.

3. MIB Setting

1) subCarrierSpacingCommon

Optional:

FR1: 15kHz | 30kHz.

FR2: 60kHz | 120kHz.

Default: 30kHz.

The current parameter is read-only (30kHz) when only a single **Numerology** exists.

2) ssb-SubCarrierOffset

Settable range: 0~ 31 , default value: 0.

Sets the frequency domain offset in terms of the number of subcarriers between the SSB and the entire resource block grid.

3) Dmrs Config SIB

Optional: 2| 3, Default: 2 .

Select the location of the PDSCH or PUSCH DMRS.

4) PDCCH Config SIB1

Settable range: 0~ 255 , Default value: 0 .

Sets the bandwidth for PDCCH/SIB, common CORESET, common search space and necessary PDCCH parameters.

5) Cell Barred

Optional: 0:barred| 1:notbarred , Default: 0:barred .

Select the barred value, a barred value of 0 indicates that the cell is barred from access.

6) **Intra Freq Reselection**

Optional: 0:allowed| 1:notallowed , Default: 0: allowed .

This parameter indicates whether the same frequency cell re-selection is allowed or not.

4.11.2.6.4 PDCCH

Click the PDCCH node in the tree view on the left side of the window to enter the parameter setting.

1. **Add PDCCH**

Multiple channels can be added, the default number is 1.

Add a new PDCCH channel at the end of the list.

2. **Remove PDCCH**

Remove the currently selected PDCCH channel.

3. **Copy PDCCH**

Removes the currently selected PDCCH channel.

4. **General Settings**

1) **State**

Options: On | Off , Default: On.

PDCCH Channel Enable Switch.

2) **Power Boosting**

Settable range: -40 dB~ 40 dB , default value: 0 dB.

Sets the power of PDCCH data relative to other channels.

3) **DMRS Power**

Settable range: -40 dB~ 40 dB , Default: 0 dB.

Set the power of PDCCH DMRS relative to PDCCH channel.

4) **DMRS-Scrambling-ID**

Settable range: -1~ 65535 , Default value: -1 (Setting to -1 means CellID is used).

Sets the nID for DMRS sequence generation.

5) RNTI

Settable range: 0~ 65535 , Default value: 0.

Setting the scrambling RNTI for CRC

6) C-RNTI

Settable range: 0~ 65535 , default value: 0.

Set the C-RNTI value, this parameter is used in the following two cases:

- If pdcch-DMRS-ScramblingID is not configured, to be used as data scrambling in UE-specific search space.
- If not 0, used for CCE offset calculation for UE-specific search spaces.

5. Search Spaces

1) CORESET Selection

Use the drop-down list to select the CORESET for the current PDCCH, subject to the number of CORESETs .

2) Allocated Slots

Settable range: 0~ 10*2^µ , default value: 0.

Allocated Slots Sets the number of slots of the transmitted PDCCH within a frame. It can be set in the following three ways:

- If you need to configure by single slot, you can use "," as separator, e.g. 0,1,2,3.
- If you need to configure by a range of slots, you can use 2:7 for the start index and the last index, e.g. 2:7 for 2,3,4,5,6,7.
- If you need to configure by different steps, you can use two ":" to indicate the start slot, step and last slot respectively, for example, 0:2:8 means 0,2,4,6,8.

The above three configuration methods can be used in combination.

3) Search Space

Optional: UE-Specific | Common , Default: UE-Specific.

Use the drop-down list to select the search space.

4) Aggregation Level

Options: 1 | 2 | 4 | 8 | 16 , Default: 4.

Set the aggregation level of PDCCH, the optional maximum aggregation level is constrained by CORESET .

5) **Number of PDCCH Candidates**

Options: 1 | 2 | 3 | 4 | 5 | 6 | 8 , Default: 1 .

Sets the number of search space candidates used to calculate CCE Offset.

6) **Candidate Index**

Range: 0~ PDCCH Candidate Number – 1 , Default Value: 0 .

Sets the candidate index of the search space for the current PDCCH aggregation level.

7) **Start Symbol Within Slot**

Settable range: 0~ 13 , default value: 0.

Set the start symbol position of current PDCCH within a slot.

6. **DCI Payload Data**

1) **Coding**

Optional range: 0 13 , default value: 0 .

Enables or disables channel coding.

2) **Payload Data**

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files , Default: PN9 ITU .

Set the Payload data type, you can choose PN code or customized data.

3) **Payload Size**

Settable range: 1~ 408 , default value: 20.

Set the size of Payload data.

4.11.2.6.5 CORESET

Click the PDCCH node in the tree view on the left side of the window, and enter the parameter setting from CORESET on the top of the PDCCH list.

1. **Add CORESET**

You can add multiple CORESETs, the default number is 1.

Add a new CORESET at the end of the list.

2. Remove CORESET

Remove the currently selected CORESET.

3. Control Resource Sets

1) BWP ID

Use the drop-down list to select the BWP number of the current CORESET, subject to the number of BWPs .

2) CORESET ID

Use the drop-down list to select the BWP number of the current CORESET, the options are constrained by the number of CORESETs .

3) RB Offset

Range: 0~ Current BWP RB number - 1, Default: 0.

Set the offset RB number of the current CORESET relative to the start of BWP.

4) Duration

Settable range: 1~ 3 , Default value: 1.

Sets the number of symbols in the current CORESET.

5) Freq Domain Resources

Setting content: one bit means one RBG, setting 1 means active, the number of bits is calculated according to the RBG size meter and BWP.

Set the number and position of RBGs.

6) CCE-REG Mapping Type

Optional: Interleaved | Non-Interleaved ,

Default: Non-Interleaved .

Sets the mapping type of CCE to REG.

7) REG-BundleSize

Optional: 2| 3| 6 , Default: 6.

When the parameter CCE-REG Mapping Type is set to interleaved mapping, this parameter is used to set the parameter L for interleaved mapping, the specific constraints are described in the 3PGG protocol; for non-interleaved mapping, L defaults to 6.

Note: This parameter is only displayed when CCE-REG Mapping Type is set to Interleaved.

8) Interleaver Size

Optional: 2| 3| 6 , Default: 2.

Sets the interleaver size of the interleaver mapping.

Note: Displayed only when CCE-REG Mapping Type is set to Interleaved.

9) Shift Index

Settable range: -1~ 274 ,

Default value: 0 (Set to -1 to use CellID).

Set the n_{shift} parameter for Interleaved Mapping.

Note: Displayed only when CCE-REG Mapping Type is set to Interleaved.

10) Precoder Granularity

Optional: Reg Bundle Size| CORESET Size .

Default: Reg Bundle Size .

Sets the precoding granularity; when this parameter is set to Reg Bundle Size, DMRS maps only to REGs with PDCCHs; when it is set to CORESET Size, DMRS maps to all RBs of CORESET.

Note: Displayed only when CCE-REG Mapping Type is set to Interleaved.

4.11.2.6.6 PDSCH

Click the PDSCH node in the tree view on the left side of the window to enter the parameter settings.

1. Add PDSCH

Multiple channels can be added , the default number is 1.

Add a new PDSCH channel at the end of the list.

2. Remove PDSCH

Removes the currently selected PDSCH channel.

3. Copy PDSCH

Removes the currently selected PDSCH channel.

4. General Settings

1) State

Options: On | Off , Default: On.

PUSCH Channel Enable Switch.

2) Power

Settable range: -40 dB~ 40 dB , Default value: 0 dB.

Sets the power of PUSCH data relative to other channels.

3) RNTI

Settable range: 0~ 65535 , default value: 0.

Set the PDSCH data scrambling sequence of n_{RNTI} for distinguishing different UEs.

4) nID

Settable range: -1~ 65535 , Default value: -1 (Setting to -1 means CellID is used).

Set the nID of the PDSCH data scrambling sequence.

5. Transmission Settings

1) DMRS Port(s)

Configurable range: 0~ 3 , Default value: 0 .

Set the port number of DMRS.

2) Layers Number

Range: 1~ 4 , Default: 1.

The number of layers of PDSCH, calculated according to the number of DMRS port numbers.

3) Antenna Port(s)

Available options: Port_0 | Port_1 | Port_2 | Port_3 ,

Default: Port_0 .

Specifies the data for each antenna that is used to assign the PDSCH layers to the antenna. The number of antenna ports is determined by the antenna data in Waveform Setup.

4) Number of DMRS CDM groups without data

Configurable range: 1~ 3 , Default value: 1.

Set the number of DMRS CDM groups without data mapping for PDSCH. Configuration Type1 has 2 CDM groups with setting range 1~2, and Configuration Type2 has 3 CDM groups with setting range 1~3.

6. Resource Allocation

1) Allocated Slots

Configurable range: 0~ 10*2^µ , default value: 0.

Set the Slot number of PDSCH transmitted in one frame. It can be set in the following three ways:

- If you need to configure by individual slots, you can use "," as the separator, for example: 0,1,2,3.
- If you need to configure by range of slots, you can use 2:7 for start index and last index, e.g. 2:7 for 2,3,4,5,6,7.
- If you need to configure by different steps, you can use two ":" to indicate the starting slot, step and last slot respectively, for example, 0:2:8 means 0,2,4,6,8.

The above three configuration methods can be used in combination.

2) Symbol Start

Range: 0~ 13 , Default: 0.

Set the first symbol position of current PDSCH.

3) Symbol Number

Range: 0~ 14 (Normal)| 0~ 11 (Extended),

Default value: 14| 11 .

Set the number of available symbols for current PDSCH, the maximum value is related to CP type.

4) BWP

Select the BWP for current PDSCH transmission.

5) Resource Allocation Type

Optional: Type0| Type1 , Default: Type1 .

Select the type of frequency domain resource allocation for the current PDSCH, see 3GPP Protocol Physical Layer for details.

6) **RB Offset**

Settable range: 0~Current BWP RB number - 1 ,

Default value: 0 .

Sets the offset RB number relative to the start of BWP when the current PUSCH is Type1.

Note: Displayed only when the parameter **Resource Allocation Type** in this section is Type1.

7) **RB Number**

Settable range: 0~Current BWP RB count - **RB Offset** ,

Default value: max RB count.

Sets the number of RBs when the current PUSCH is Type1.

Note: Displayed only when the parameter **Resource Allocation Type** is Type1 in this section.

8) **VRB to PRB Interleaver**

Optional: Interleaved | Non-Interleaved ,

Default: Non-Interleaved .

Sets the mapping method of VRB to PRB.

9) **VRB Bundle**

Optional: 2| 4 , Default: 2.

Set the size of the bundle for interleaved mapping.

7. **Modulation and Coding**

1) **Coding**

Options: On | Off , Default: On.

Enables or disables LDPC coding of PDSCH data.

2) **MCS Table**

Options: QAM64| QAM256| QAM64Low SE| QAM1024 ,

Default: QAM64.

Select the table for calculating the TB size accordingly, see 3GPP Protocol Physical Layer Agreement.

3) MCS Index

Default value: 0.

Set the corresponding MCS index, the specific range is related to the corresponding table of the 3GPP protocol.

4) xOverhead

Optional: 0 | 6 | 12 | 18 , Default Value: 0 .

Sets the high-level parameter *xOverhead* of the 3GPP protocol*, which* is used to set the parameter for calculating the TBS N_{oh}^{PRB} .

5) TB Scaling Factor S

Optional value: 1 | 0.5| 0.25 , Default value: 1 .

Set the Scaling Factor S used to calculate the TBS, please refer to 3GPP protocol TS38.214 Table 5.1.3.2-2 for the exact value.

6) Coding Rate

Display the coding rate, which is obtained according to the parameter MCS Table .

7) Modulation

Displays the modulation mode, which is obtained according to the parameter MCS Table .

8) Payload Data

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files ,

Default: PN9.

Set the Payload Data type, you can choose PN code or customized data.

9) RV index

Settable range: 0~ 3 , default value: 0.

Set the RV index of the redundant version with matching rate.

8. DMRS Settings

1) DMRS-Downlink-r16

Options: On | Off , Default: Off.

Sets whether to provide the high-level parameter *dmrsUplink-r16*.

2) n_SCID

Settable range: 0~ 1 , Default value: 0 .

Sets the parameter n_{SCID} for sequence generation.

3) Scrambling ID0

Settable range: -1~ 65535 , Default value: -1 (set to -1 to use CellID).

Sets N_{ID}^{0} for DMRS sequence generation.

4) Scrambling ID1

Settable range: -1~ 65535 , Default value: -1 (set to -1 to use CellID).

SetsN_{ID}^{1} for DMRS sequence generation.

5) DMRS Power

Settable range: -40 dB~ 40 dB , default: 0 dB.

Set the power of PDSCH DMRS relative to PUSCH channel.

6) DMRS Configuration Type

Optional: Type1| Type2 , Default: Type1.

Sets the DMRS configuration type.

7) DMRS Length

Options: Single Symbol|Double Symbol , Default: Single Symbol.

Default value: Single Symbol.

Sets the DMRS symbol length.

8) DMRS Additional Position

Optional:

- Single symbol DMRS:

  pos0 | pos1 | pos2 | pos3 ;

- DMRS Length is Double Symbol or Single symbol when FH is turned on in the time slot:

  Single symbol: pos0 | pos1 .

Default value: pos0.

Set the 3GPP protocol high-level parameter *dmrs-AdditionalPosition* .

9) **DMRS TypeA Position**

Optional: 2| 3 . Default value: 2 .

Sets the 3GPP protocol high-level parameter *dmrs-TypeA-Position* .

10) **DMRS Mapping type**

Optional: TypeA| TypeB , default: TypeA.

Sets the PDSCH mapping type.

11) **DMRS Mapping Reference**

Optional CRB| RRB , Default: CRB.

Select the reference point for DMRS mapping, please refer to 3GPP protocol for details.

9. **PTRS Settings**

1) **PTRS Enabled**

Optional: On | Off , default: On.

PTRS Enabled switch.

2) **PTRS Power**

Settable range: -40 dB~ 40 dB , Default value: 0 dB.

Sets the power of PTRS data relative to PUSCH data.

3) **Frequency Density (K_PTRS)**

Selectable range: 2| 4 , default value: 2.

Sets the frequency density.

4) **Time Density (L_PTRS)**

Option: 2| 4 , Default: 2.

Sets the number of points for each PT-RS group.

5) **PTRS RE Offset**

Option: 00| 01 | 10 | 11 , Default: 00.

Sets the RE offset of PTRS.

4.11.2.6.7 CSI-RS

Click on the CSI-RS node in the tree view on the left side of the window to enter the parameter settings.

1. Add CSI-RS

Multiple channels can be added , the default number is 1.

Add a new CSI-RS channel at the end of the list.

2. Remove CSI-RS

Removes the currently selected CSI-RS channel.

3. Copy CSI-RS

Removes the currently selected CSI-RS channel.

4. General Settings

1) State

Options: On | Off , Default: On.

CSI-RS Channel Enable Switch.

2) Power Boosting

Settable range: -40 dB~ 40 dB ,

Default: 0 dB.

Sets the power of CSI-RS data relative to other channels.

3) Antenna Port(s)

Optional range: Port_0 | Port_1 | Port_2 | Port_3 ,

Default value: Port_0 .

Sets the mapping of CSI-RS ports to antenna ports.

4) nID

Settable range: 0~ 65535 , default value: 1000 .

Set the parameter n_{ID} to generate CSI-RS sequence.

5) Zero Power

Options: On | Off , Default: Off.

Sets the CSI-RS type, either zero-power (On) or non-zero-power (Off).

5. Resource Allocation

1) CSI-RS Locations Table Index

Configurable range: 1~ 18 , Default value: 1.

Set the row index of the CSI-RS Locations Table, see 3GPP protocol 38211 Table 7.4.1.5.3-1 for details.

2) Slot Allocation

Configurable range: 0~ 10*2^µ , default value: 0.

Sets the Slot number of the CSI-RS to be transmitted within a frame. It can be set in the following three ways:

- If you need to configure by single slot, you can use "," as the separator, e.g.: 0,1,2,3 .
- If you need to configure by range of slots, you can use 2:7 to indicate the start index and the last index, e.g. 2:7 for 2,3,4,5,6,7 .
- If you need to configure by different steps, you can use two ":" to indicate the starting slot, step and last slot respectively, for example, 0:2:8 means 0,2,4,6,8.

The above three configuration methods can be used in combination.

3) BWP

Select the BWP of the current CSI-RS transmission.

4) RB Offset

Configurable range: 0~ Current BWP RB number + BWP RB start number - 4 ,

Default value: 0 .

Sets the current CSI-RS offset RB number relative to the BWP start.

Note: Setting the RB number must be a multiple of 4.

5) **RB Number**

Settable range: 4~Current BWP RB Number - **RB Offset** ,

Default value: Maximum RB Number.

Sets the number of RBs for the current CSI-RS.

Note: Setting the RB number must be a multiple of 4.

6) **First Symbol (l0)**

Settable range: 0~ 13 , default value: 10.

Set l0 of the CSI-RS location table, see 3GPP protocol 38.211 Table 7.4.1.5.3-1 for details.

7) **First Symbol2 (l1)**

Settable range: 2~ 12 , default value: 2.

Set l1 of the CSI-RS location table as described in 3GPP protocol 38.211 Table 7.4.1.5.3-1 .

Note: Displayed only if the **CSI-RS Locations Table Index** is 13 | 14 | 16 | 17.

8) **Freq Domain Bitmap**

Setting content: one bit means one RBG, checking means active.

Set the frequency domain location of CSI-RS by bitmap, the number of bits is constrained by **CSI-RS Locations Table Index** .

Note: If **CSI-RS Locations Table Index** is 1, 4 bits can be set;

When **CSI-RS Locations Table Index** is 2, 12 bits can be set;

If the **CSI-RS Locations Table Index** is 4, 3 bits can be set;

For CSI-RS Locations Table Index of 2 , 12 bits can be set; for **CSI-RS Locations Table Index** of 4, 3 bits can be set; for other values, 6 bits can be set.

9) **Density**

Optional: 1 | 0.5, default: 1.

Set the density of CSI-RS, this parameter is constrained by the Locations Table, see 3GPP protocol 38.211 Table 7.4.1.5.3-1 for details.

Note: ① When **CSI-RS Locations Table Index** is set to 1, Density = 3;

② Density = 1 when **CSI-RS Locations Table Index** is set to 4~ 10 ;

The parameter is hidden in the above two cases.

When **CSI-RS Locations Table Index** is set to other values, Density=1 | 0.5, this parameter is only displayed at this time.

10) PRB Allocation for Density= 0.5

Option: Even | Odd , Default: Even.

When **Density** is 0.5, set the position of PRBs, either odd PRBs or even PRBs .

Note: Displayed only when **Density** is 0.5.

11) RE used for PDSCH

Options: On | Off , Default: Off.

Sets whether the resources configured for CSI-RS can be used for PDSCH or not, On means PDSCH will be mapped to CSI-RS resources and CSI-RS will override PDSCH, Off means PDSCH mapping will skip CSI-RS resources.

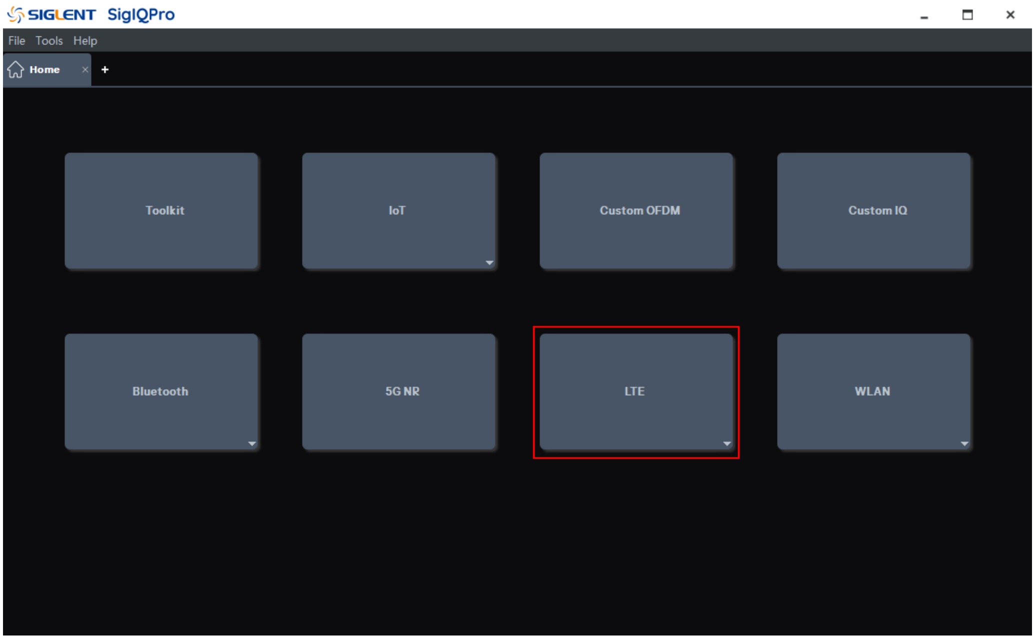
12) CSI-RS Type

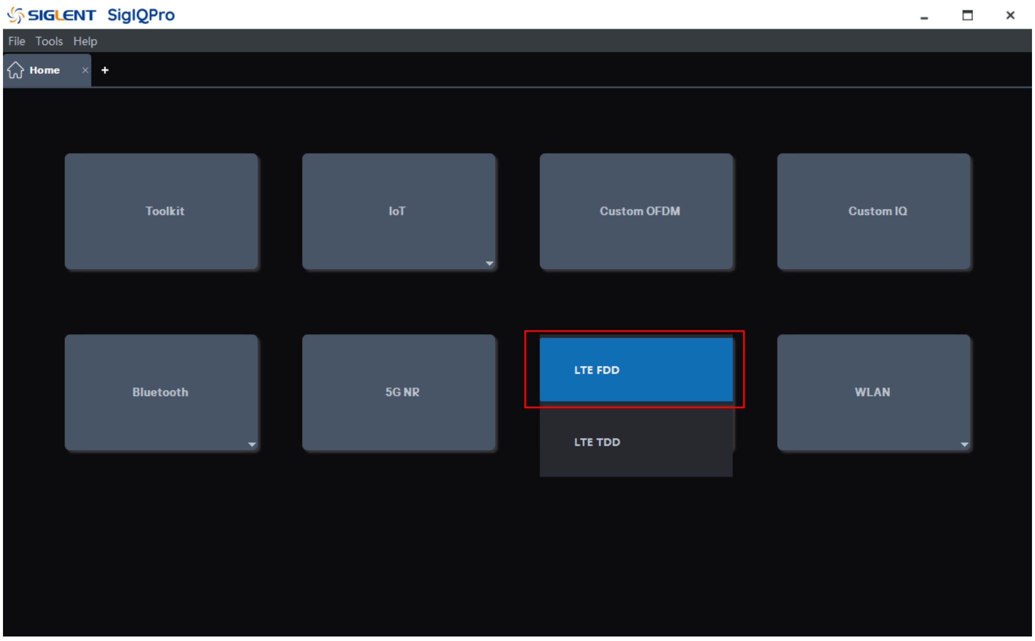
Displays the CDM type of the CSI-RS.

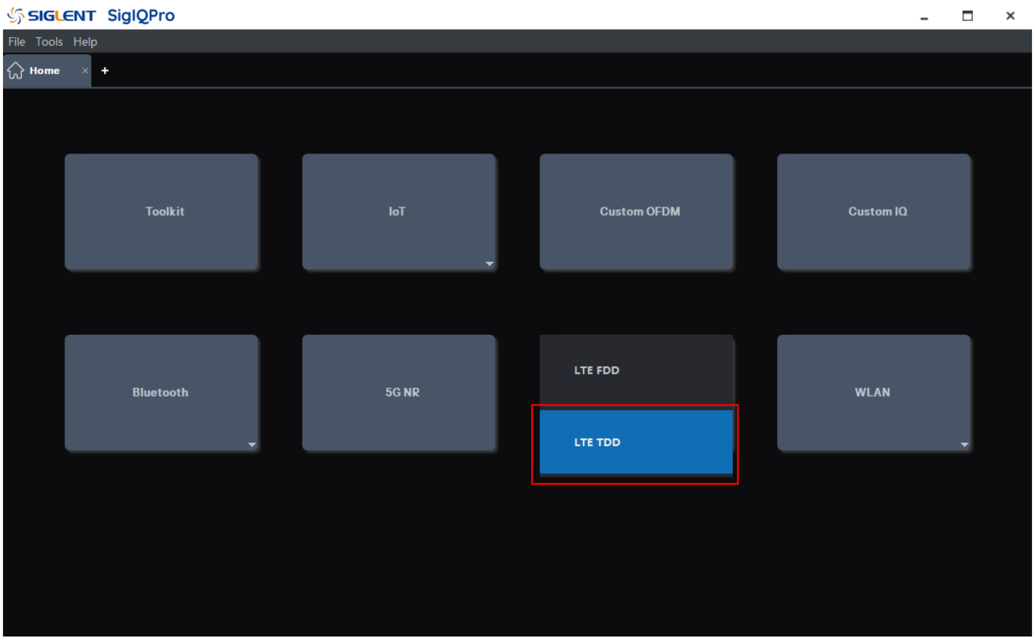
4.12 LTE

The protocol version realized by this software: 3GPP TS36 V17.3.0 .

You can click LTE on the home page to select different duplex types and enter the corresponding setting interface.







4.12.1 Waveform Setup

Click the **Waveform Setup** node in the tree view on the left side of the window to enter the waveform setup.

1. **Frame Number**

Settable range: 1~4, default value: 1.

Set the number of frames in the generated waveform.

2. **Sample Rate**

Display the sample rate of the generated waveform.

Note: This parameter can only be displayed but not edited.

3. **Sample Points**

Displays the length of the generated waveform in points.

Note: This parameter is not editable.

4. **IQ Map**

Optional: normal| invert , Default: normal.

This parameter toggles the inversion state of the baseband IQ data.

5. **Subframe Number**

Displays the number of subframes of the generated waveform.

Note: This parameter is only displayed without editing.

6. **Crest Factor Reduction**

Options: on | off , Default: off.

Toggles the state of Crest Factor Reduction for baseband signal spectrum.

4.12.2 Carrier

Click the Carrier node in the tree view on the left side of the window to enter the parameter setting.

1. **State**

Options: on | off, default: on.

Toggles the carrier enable state.

2. **Carrier Type**

Options: DownLink | UpLink , default: DownLink.

Toggles the carrier type.

3. **CP Type**

Optional: Normal | Extended, default: Normal.

Toggles the cyclic prefix type, selects Normal Cyclic Prefix or Extended Cyclic Prefix.

4. **Channel Bandwidth**

Options: 1400K | 3M | 5M | 10M | 15M | 20M , default: 20M.

Switch the bandwidth of the carrier.

5. **Antenna Number**

Options: 1| 2| 4| 8 , Default: 1.

Sets the total number of antennas used for transmission.

6. **Antenna Port**

Optional:

When Antenna Number is 1, the option is Port 0;

When Antenna Number is 2, the options are Port 0,1;

When Antenna Number is 4, the options are Port 0,1,2,3;

When Antenna Number is 8, the options are Port 0,1,2,3,4,5,6,7;

Default value: Port 0 .

Sets the antenna port number used for transmission.

7. Cell ID

Settable range: 0~503 , Default value: 0.

Set the value of Cell ID.

8. Baseband Filter

Options: on | off , Default: on.

Toggles the enable state of the baseband filter.

9. Frequency Offset

Settable range: 0 hz~ 75Mhz , default: 0 hz.

Sets the frequency offset of the carrier with respect to the generator.

10. Time Offset

Settable range: 0ms~10ms, default value: 0ms.

Set the timing offset.

11. Oversampling Rate

Settable range: 1~4, default value: 1.

Set the oversampling rate of the generated waveform.

12. Init Phase

Settable range: 0°~ 359° , default value: 0° .

Sets the initial phase of the carrier waveform.

13. Sequence Hopping Type

OFF | Group Hopping | Sequence Hopping , default value: Off.

Set whether to turn off or turn on Group Hopping/Sequence Hopping, PUCCH and PUSCH are unified by this parameter.

14. TDD Configure (TDD)

Optional: Config 0~6 , Default: Config 0.

Set TDD uplink-downlink configuration index, for more information, please refer to 3GPP TS 36211.

Note: Displayed only when LTE TDD.

15. Special subframe config (TDD)

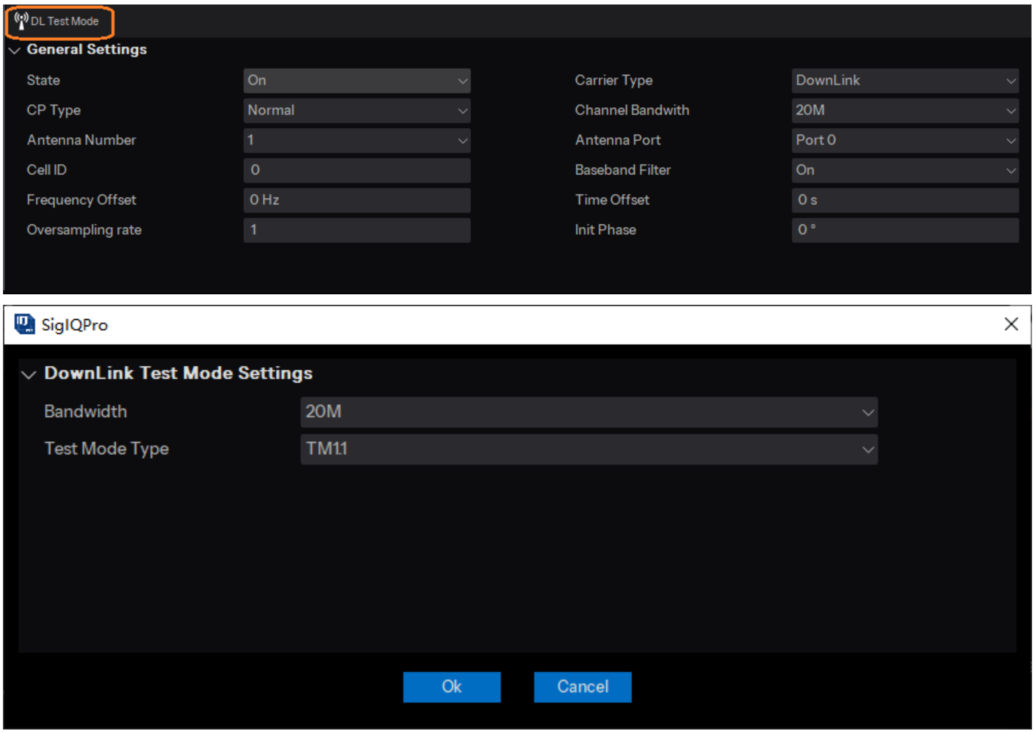
Optional: Config 0~10 , Default: Config 0.

Set the configuration index of TDD special subframe, please refer to 3GPP TS 36211 for more information.

Note: Displayed only when LTE TDD.

16. DL Test Mode

Click DL Test Mode when the waveform type is DownLink to enter the setting of downlink test mode. For more information about Downlink Test Mode, please refer to 3GPP TS 36141 Section 6.1.1.



1) Bandwidth

Options: 1400K | 3M | 5M | 10M | 15M | 20M , Default: 20M.

Sets the bandwidth of the test mode.

2) Test Mode Type

Optional:

E-TM1.1 | E-TM1.2 | E-TM2.0| E-TM2.0a | E-TM2.0b

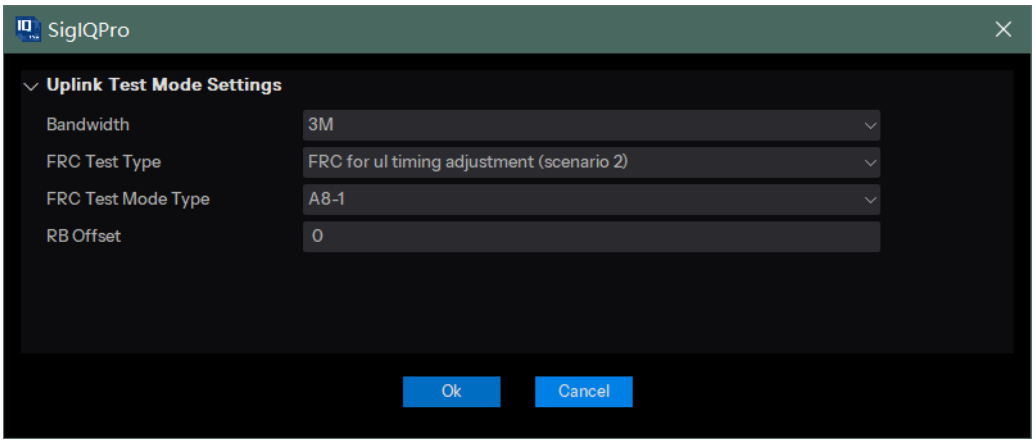
E-TM3.1 | E-TM3.1a| E-TM3.1b| E-TM3.2| E-TM3.3

Default value: E-TM1.1.

Sets the type of test mode.

17. UL FRC Test Mode

Click **UL FRC Test Mode** when the waveform type is Upllink to enter the setting of the uplink FRC test mode. For more information about the uplink test mode, please refer to 3GPP TS 36141.



Uplink Test Mode Settings

1) Bandwidth

Options: 1400K | 3M | 5M | 10M | 15M | 20M , Default: 20M.

Sets the test mode bandwidth.

2) FRC Test Type

Optional:

FRC for reference sensitivity and in-channel selectivity (QPSK R= 1/3)

FRC for dynamic range (16QAM R= 2/3)

FRC for performance requirements (QPSK R= 1/3)

FRC for performance requirements (16QAM R = 3/4)

FRC for performance requirements (64QAM R= 5/6)

FRC for ul timing adjustment (scenario 1)

FRC for ul timing adjustment (scenario 2)

Default: FRC for reference sensitivity and in-channel selectivity (QPSK R= 1/3)

Set the test mode you want.

3) FRC Test Mode Type

Optional:

A1-1| A1-2| A1-3| A1-4| A1-5

A2-1| A2-2| A2-3

A3-1| A3-2| A3-3| A3-4| A3-5| A3-6| A3-7

A4-1| A4-2| A4-3| A4-4| A4-5| A4-6| A4-7| A4-8

A5-1| A5-2| A5-3| A5-4| A5-5| A5-6| A5-7

A7-1| A7-2| A7-3| A7-4| A7-5| A7-6

a8-1| a8-2| a8-3| a8-4| a8-5| a8-6

Default: A1-1 .

Set the type of test pattern you want, the options of this parameter are constrained by **FRC Test Type** .

4) RB Offset

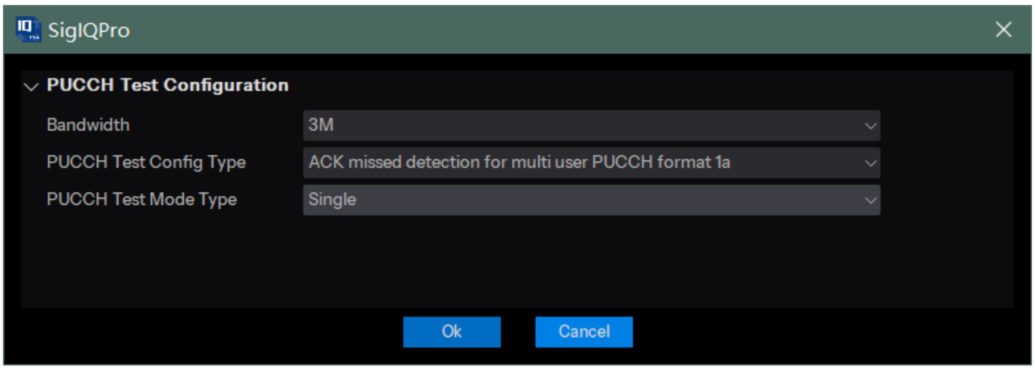
Settable range: 0~ Maximum number of RBs that can be set for the current bandwidth – the number of RBs required for the current test pattern.

Default value: 0.

Sets the RB offset for the current test mode.

18. PUCCH Test Mode

Click **PUCCH Test Mode** when the waveform type is Upllink to enter the PUCCH test mode setting.



PUCCH Test Configuration

1) **Bandwidth**

Options: 1400K | 3M | 5M | 10M | 15M | 20M,

Default: 20M.

Set the bandwidth of PUCCH test mode.

2) **PUCCH Test Config Type**

Optional:

ACK missed detection for multi user PUCCH format 1a;

ACK missed detection for PUCCH format 1b with channel selection;

ACK missed detection for PUCCH format 2;

CQI performance requirements for PUCCH format 2 with dtx detection .

Default: ACK missed detection for multi user PUCCH format 1a .

Select the PUCCH test mode.

3) **PUCCH Test Mode Type**

Optional: Single| interferer 1| interferer 2| interferer 3 ,

Default: Single .

Sets the test mode type.

4.12.3 Channel (DL)

When the waveform type is DownLink, the channels related to the downlink are displayed under the Channel node in the tree view on the left side of the window, and you can enter the configuration interface of the related channels by clicking each channel.

4.12.3.1 BCH

Click the BCH node in the tree view on the left side of the window to enter the parameter setting.

1. **State**

Optional: On | Off, default: On.

Toggles the enable state of BCH channel.

2. **Power Boosting**

Configuration range: 0 dB~20 dB,

Default value: 0 dB.

Set the power level of the channel in dB.

3. Data Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | Auto| User Files .

Default: Auto .

Set the data source of BCH channel, when Auto is selected, the Master Information Block (MIB) will be generated automatically according to the data content.

4. Coding State

Options: On | Off , Default: On.

Toggles the coding enable state of BCH channel.

5. Scrambling State

Options: On |Off , Default: On.

Toggles the scrambling enable state of the BCH channel.

4.12.3.2 SS

Click the SS node in the tree view on the left side of the window to enter the parameter setting.

1. PSS State

Optional: On | Off, default: On.

Toggles the enable state of PSS channel.

2. PSS Power

Settable range: 0 dB~ 20 dB , default value: 0 dB.

Sets the power level of the channel in dB.

3. SSS State

Selectable range: On | Off , default value: On.

Toggles the enable state of SSS channel.

4. SSS Power

Settable range: 0 dB~ 20 dB , default value: 0 dB.

Sets the power level of the channel in dB.

4.12.3.3 CRS

Click the CRS node in the tree view on the left side of the window to enter the parameter setting.

1. State

Displays the enable state of the CRS channel.

Note: This parameter is only displayed and cannot be edited.

2. Power Boosting

Setting range: 0 dB~20 dB, default value: 0 dB.

Set the power level of the channel in dB.

3. Port Number

Optional:

When Antenna Number = 1, the option is 1 Port;

When Antenna Number = 2, the options are 1 Port | 2 Port;

When Antenna Number = 4 / 8, the options are 1 Port | 2 Port | 4 Port.

Default value: 1 Port .

Sets the number of antenna ports for CRS.

4. Transmit Number

Optional:

When Port Number is 1 Port, the available options are Port 0;

When Port Number is 2 Ports, the option is Port 0 | Port 1;

When Port Number is 4 Ports, the options are Port 0 | Port 1 | Port 2 | Port 3.

Default: Port 0 .

Sets the CRS transmission port.

4.12.3.4 PRS

Click the PRS node in the tree view on the left side of the window to enter the parameter settings.

1. State

Options: On | Off , Default: Off.

Toggles the enable state of the PRS channel.

2. **Power Boosting**

Settable range: 0 dB~20 dB, Default value: 0 dB.

Set the power level of the channel in dB.

3. **Bandwidth**

Optional:

When Channel Bandwidth= 1400K, the option is 1400K;

When Channel Bandwidth = 3M, the options are 1400K | 3M;

When Channel Bandwidth = 5M, the options are 1400K | 3M | 5M;

When Channel Bandwidth = 10M, the options are 1400K | 3M | 5M | 10M;

When Channel Bandwidth = 15M, the options are 1400K | 3M | 5M | 10M | 15M;

When Channel Bandwidth = 20M, the options are 1400K | 3M | 5M | 10M | 15M | 20M .

Default: the value of Channel Bandwidth.

Sets the bandwidth occupied by the PRS signal.

4. **N_PRS**

Options: 1 subframe | 2 subframes | 4 subframes | 6 subframes ,

Default: 1 subframe .

Sets the number of consecutive subframes transmitted by the PRS signal in the downlink.

5. **I_PRS**

Settable range: 0~2554 , default value: 0.

Sets the PRS configuration index, for more information please refer to 3GPP TS 36211 Section 6.10.4.3.

6. **T_PRS**

Displays the subframe configuration period for PRS.

Note: This parameter is only displayed not editable.

7. **Delta PRS**

Displays the subframe offset of the PRS.

Note: This parameter only displays non-editable.

4.12.3.5 CSI-RS

Click on the CSI-RS node in the tree view on the left side of the window to enter the parameter settings.

1. State

Options: On | Off , Default: Off.

Toggles the enable state of the CSI-RS channel.

2. Power Boosting

Settable range: 0 dB~20 dB , default value: 0 dB.

Set the power level of the channel in dB.

3. Port Number

Optional:

When Antenna Number = 1, the option is 1;

When Antenna Number = 2, the options are 1 | 2;

When Antenna Number = 4, the options are 1 | 2 | 4;

When Antenna Number = 8, the options are 1 | 2 | 4| 8 .

Default Value: 1 .

Sets the number of antenna ports for CSI-RS.

4. Total Ports

Displays the virtual ports used to transmit CSI-RS signals.

Note: This parameter is displayed only and cannot be edited.

5. Config

Configurable range:

When CP Type is Normal, the settable range is 0~ 31;

When CP Type is Extend, the setting range is 0~27.

Default value: 0.

Set the CSI-RS Mapping Configuration Index, please refer to 3GPP TS 36211 Section 6.10.5.2 for more information.

6. i CSIRS

Settable range: 0~154 , Default value: 0 .

Set the CSI-RS subframe configuration index, for more information please refer to 3GPP TS 36211 Section 6.10.5.3.

7. tCSIRS

Displays the CSI-RS subframe period.

Note: This parameter is only displayed non-editable.

8. Delta CSIRS

Displays the subframe offset of the CSI-RS.

Note: This parameter only displays non-editable.

4.12.3.6 CFI

Click on the CFI node in the tree view on the left side of the window to enter the parameter settings.

1. State

Displays the enable state of the CFI channel.

Note: This parameter is only shown as non-editable.

2. Power Boosting

Configuration range: 0 dB~20 dB , Default value: 0 dB.

Set the power level of the channel in dB.

3. Scrambling State

Options: On |Off , Default: On.

Toggles the scrambling enable state of CFI channel.

4. Coding State

Optional: On |Off , Default: On.

Toggles the coding enable state of CFI channel.

5. CFI Allocation

Displays the Control Format Indicator value for each subframe as determined by the DCI setting.

Note: This parameter is displayed only and is not editable.

4.12.3.7 HI

Click the HI node in the tree view on the left side of the window to enter the parameter setting.

1. State

Optional: On | Off , Default: On.

Toggles the enable state of the HI channel.

2. Power Boosting

Configuration range: 0 dB~20 dB, Default value: 0 dB.

Set the power level of the channel in dB.

3. Scrambling State

Options: On |Off , Default: On.

Toggles the scrambling enable state of CFI channel.

4. Coding State

Optional: On |Off , Default: On.

Toggles the coding enable state of CFI channel.

5. Duration

Optional: Normal | Extend , Default: Normal.

Toggles the HI duration type, selects Normal duration or Extend duration.

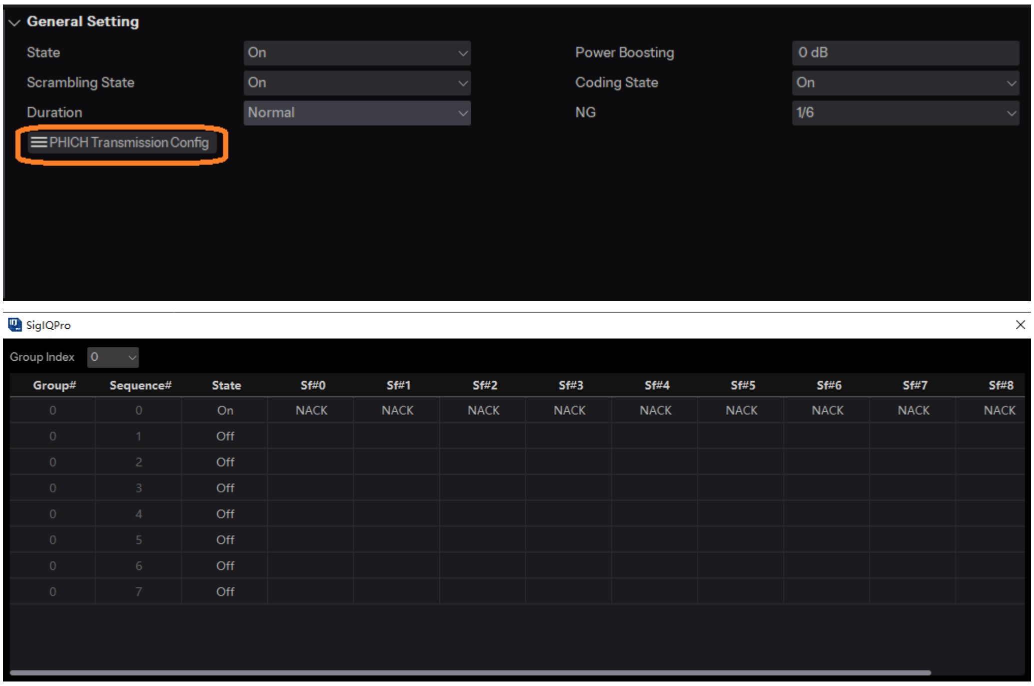
6. NG

Optional: 1/6| 1/2| 1| 2 , Default value: 1/6.

Sets the assigned value of the HI channel.

7. PHICH Transmission Config

Click PHICH Transmission Config to set the PHICH transmission configuration.



1) Group Index

Toggles the serial number of the configuration group.

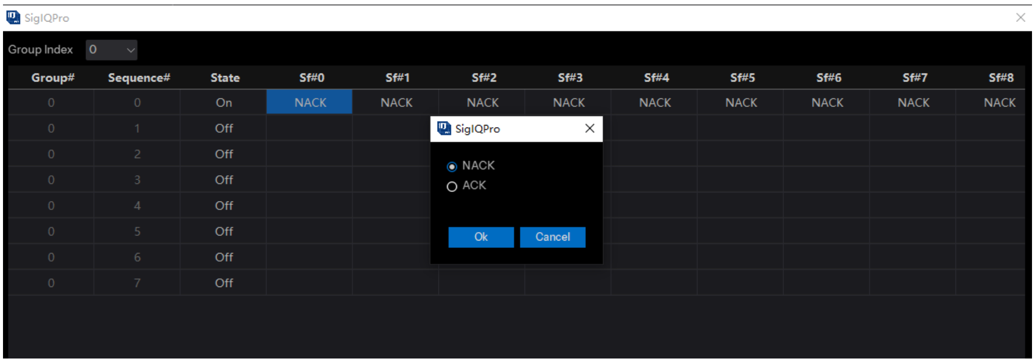
2) State

Toggles the enable state of HI in the group.

3) Sf#

Configure the answer state of HI for the corresponding subframe.

Click the HI Answer State form to configure the HI answer state, the default answer state is NACK.



4.12.3.8 DCI

Click the DCI node in the tree view on the left side of the window to enter the parameter setting.

1. State

Displays the enable state of the DCI channel.

Note: This parameter is only displayed and cannot be edited.

2. Power Boosting

Configuration range: 0 dB~20 dB, default value: 0 dB.

Set the power level of the channel in dB.

3. Scrambling State

Options: On |Off , Default: On.

Toggles the scrambling enable state of DCI channel.

4. Coding State

Optional: On |Off , default: On.

Toggles the coding enable state of the DCI channel.

5. Resource Allocation

Resource Allocation

If the Channel Bandwidth is greater than 1400K, the range is 1 ~ 3, and the length is the number of subframes;

Channel Bandwidth equal to 1400K can be set in the range of 2~ 4 and the length is the number of subframes.

Default value:

When Channel Bandwidth is greater than 1400K, the default value is 1 and the length is the number of subframes;

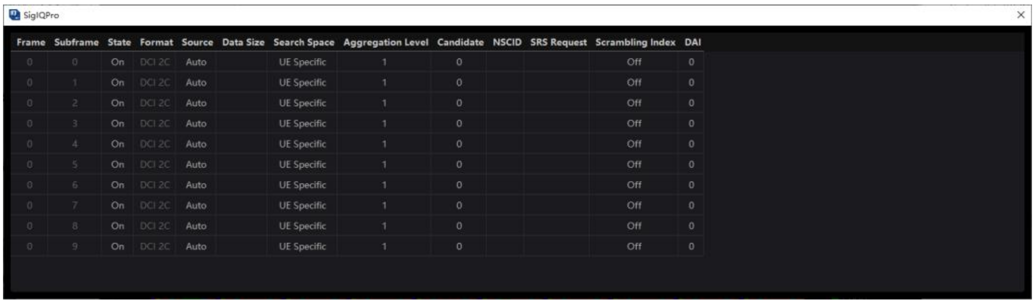
When Channel Bandwidth is equal to 1400K, the settable range is 2 and the length is the number of subframes;

The default value of unenabled subframe is 0 which cannot be changed.

Set the number of symbols used for PDCCH transmission in each subframe.

6. DCI # DLSCH Transmission Config

Click DCI # DLSCH Transmission Config to enter the corresponding DCI transmission configuration interface.



1) State

Optional: On | Off, default: On.

Toggles the enable state of PDCCH and PDSCH channels for the corresponding subframe.

2) Format

Displays the DCI format of the corresponding subframe.

Note: This parameter only displays non-configurable. For more information about DCI format, please refer to 3GPP TS 36212 Section 5.3.3.

3) Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | Auto | User Files .

Default: Auto .

Set the data source of DCI information, when Auto is selected, DCI data will be generated automatically according to the data content.

4) Date Size

Displays the bit length of DCI data when Source is not Auto.

Note: This data is displayed only when it is not configurable.

5) Search Space

Optional: UE Specific | Common, Default: UE Specific.

Sets the type of search space for DCI.

6) Aggregation Level

Optional: UE Specific | Common , default: UE Specific:

When Search Space is UE Specific, the options are 1| 2| 4| 8 ;

When Search Space is Common, the options are 4 | 8 .

Default Value: 1 .

Sets the aggregation level of the DCI.

7) **Candidate**

Candidate Range:

When Search Space is UE Specific and Aggregation Level is 1 or 2, the settable range is 0-5;

When Search Space is UE Specific and Aggregation Level is 4 or 8, the settable range is 0-1;

When the Search Space is Common and the Aggregation Level is 4, the settable range is 0-3;

When Search Space is Common and Aggregation Level is 8, the settable range is 0-1.

For more information, refer to 3GPP TS 36213 Section 9.1.1.

Default value: 0 .

Sets the DCI candidate.

8) **NSCID**

Optional: 0| 1 , Default value: 0 .

Sets the NSCID value when the DCI is in a specific format.

9) **SRS Request**

Optional:

When this field is 2 bits, the options are: 0| 1| 2| 3 ;

When this field is 1 bit, the options are: 0 | 1.

Default: 0 .

Sets the SRS request for PUSCH scheduling information transmitted on the PDCCH. Refer to 3GPP TS 36213 Section 8.2 and 3GPP TS 36212 Section 5.3.3 for more information.

10) **Scrambling Index**

Options: On | Off , Default: Off.

Toggles the state of the scrambling index bit of the DCI.

11) **TPC Bits**

Optional range: 0~3, default value: 0.

Sets the TPC bits.

12) DAI (TDD)

Optional range: 0| 1| 2| 3 , Default value: 0 .

Set the value of Downlink Assignment Indicator.

7. UL Bandwidth

Optional: 1400KHz | 3MHz | 5MHz | 10MHz | 15MHz | 20MHz , default value: 20MHz .

Toggles the bandwidth of the carrier in DCI uplink scheduling.

8. UE Tx Antenna

Options: TX0 | TX1 , Default: TX0.

Set the transmission antenna of UE in DCI uplink scheduling.

9. Assigned Process

Displays the assigned process.

Note: This parameter only shows non-configurable.

10. UE RNTI

Configurable range: 0~ 65535 , Default: 1.

Sets the RNTI of the uplink UE.

11. UE UL Transmit Mode

Optional: TM1 | TM2 , Default: TM1.

Set the uplink UE transmission mode.

12. Number of UE UL Codewords

Settable range: 1~2, default value: 1.

Set the number of UE UL Codewords.

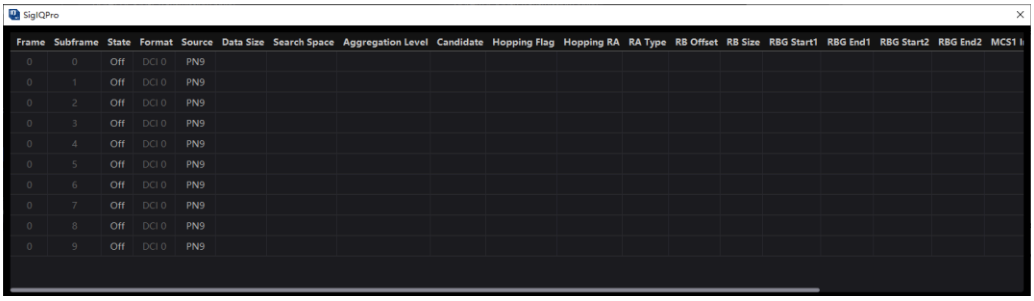
13. UE UL Number of Antenna

Optional: 1| 2| 4 Antenna , default value: 1.

Set the number of user uplink antennas.

14. DCI # UL Transmission Config

Click DCI # UL Transmission Config to enter the corresponding DCI transmission configuration interface, please refer to Channel (UL) for more information.



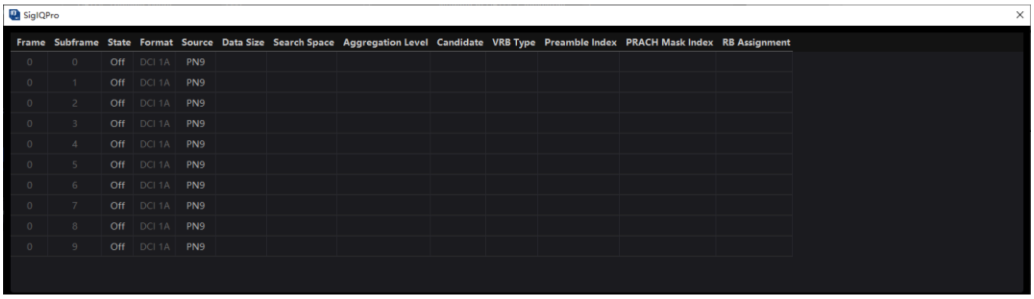
15. RA RNTI

Configuration range: 0~65535 , Default value: 1.

Set the value of RA RNTI.

16. DCI # RA Initial Transmission Config

Click DCI # RA Initial Transmission Config to enter the corresponding DCI transmission configuration interface.



1) State

Optional: On | Off , Default: Off.

Toggles the enable state of the corresponding DCI.

2) Format

Displays the DCI format of the corresponding subframe.

Note: This parameter is only shown as non-configurable. For more information about DCI format, please refer to 3GPP TS 36212 Section 5.3.3.

3) Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files.

Default: PN9 .

Sets the data source for DCI information.

4) Date Size

When displaying the bit length of the DCI data.

Note: This data is displayed only if it is not configurable.

5) Search Space

Optional: UE Specific | Common , Default: UE Specific.

Sets the type of search space for DCI.

6) Aggregation Level

Optional:

When Search Space is UE Specific, the options are 1| 2| 4| 8 ;

When Search Space is Common, the options are 4 | 8 .

Default Value: 1 .

Sets the aggregation level of the DCI.

7) Candidate

Candidate Range:

When Search Space is UE Specific and Aggregation Level is 1 or 2, the settable range is 0-5;

When Search Space is UE Specific and Aggregation Level is 4 or 8, the settable range is 0-1;

When the Search Space is Common and the Aggregation Level is 4, the settable range is 0-3;

When Search Space is Common and Aggregation Level is 8, the settable range is 0-1.

For more information, refer to 3GPP TS 36213 Section 9.1.1.

Default value: 0 .

Sets the DCI candidate.

8) VRB Type

Displays the VRB type.

Note: This parameter only displays non-configurable.

9) Preamble Index

Optional range: 0~63 , default value: 0.

Sets the leading index.

10) PRACH Mask Index

Optional range: 0~15 , default value: 0.

Set the Mask Index of PRACH.

11) RB Assigment

Show RB Assigment.

Note: This parameter only shows non-configurable.

17. TPC PUSCH RNTI

Optional range: 0~ 65535 , Default value: 1.

Sets the PUSCH RNTI.

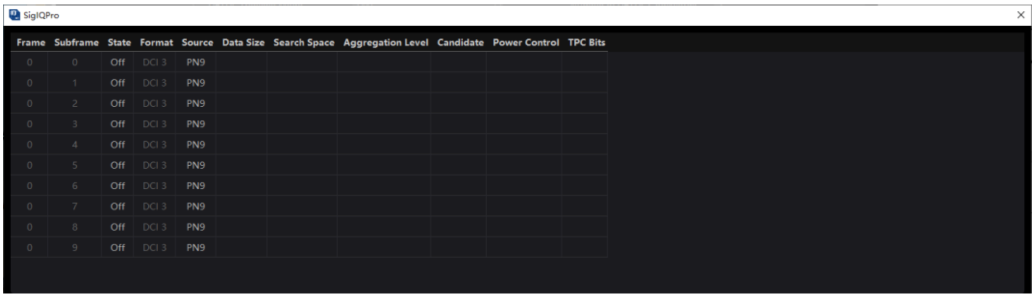
18. TPC PUCCH RNTI

Optional range: 0~65535 , default value: 1 .

Set the RNTI of PUCCH.

19. DCI # UL-Power-Control Transmission Config

Click DCI # UL-Power-Control Transmission Config to enter the corresponding DCI transmission configuration interface. For more information, please refer to DCI # DLSCH Transmission Config.



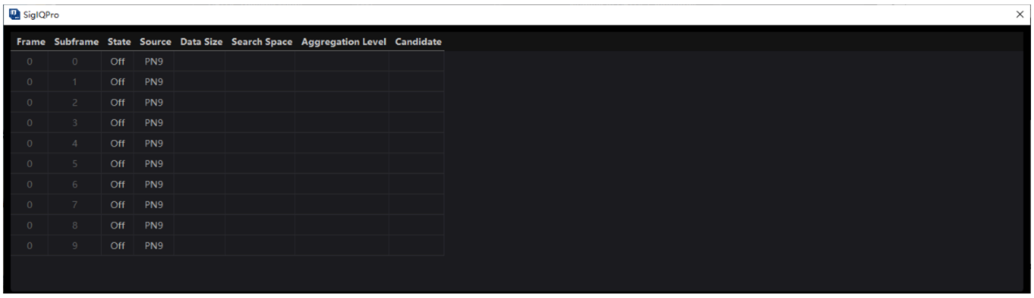
20. User RNTI

Configuration range: 0~65535 , default value: 1.

Set the value of User RNTI.

21. DCI # User Transmission Config

Click DCI # User Transmission Config to enter the corresponding DCI transmission configuration interface. For more information, please refer to DCI # DLSCH Transmission Config.



4.12.3.9 DL-SCH

Click the DL-SCH node in the tree view on the left side of the window to enter the DL-SCH channel parameter settings for the corresponding number.

1. State

Optional: On | Off , Default: On.

Toggles the enable state of DL-SCH channel.

2. Power Boosting

Configuration range: 0 dB~20 dB,

Default value: 0 dB.

Set the power level of the channel in dB.

3. UE Category

Optional:

Category0_1 Layer | Category1_1 Layer | Category2_1 Layer | Category3_1 Layer |

Category4_1 Layer | Category5_1 Layer | Category6_2 Layer | Category6_4 Layer |

Category7_2 Layer | Category7_4 Layer | Category8_8 Layer | Category9_2 Layer |

Category9_4 Layer | Category10_2 Layer | Category10_4 Layer | Category11_2 Layer |

Category11_4 Layer

Category11_4 Layer | Category12_2 Layer | Category12_4 Layer | Category13_2 Layer |

Category13_4 Layer

Category13_4 Layer | Category14_8 Layer | Category12_2 Layer | Category12_4 Layer

Default value: Category0_1 Layer .

Set the UE Category of DL-SCH, please refer to 3GPP TS 36306 for more information.

4. Scrambling State

Optional: On |Off , Default: On.

Toggles the scrambling enable state of the DL-SCH channel.

5. RNTI Type

Options: PRNTI | CRNTI |SIRNTI ,

Default: CRNTI.

Sets the RNTI type of the DL-SCL.

6. RNTI

Settable range:

When RNTI Type is PRNTI, the value is 65534;

When RNTI Type is CRNTI, the settable range is 0 to 65533;

When RNTI Type is SIRNTI, the value is 65535.

Default Value:

When RNTI Type is PRNTI, the value is 65534;

When RNTI Type is CRNTI, the default value is 1;

When RNTI Type is SIRNTI, the value is 65535.

Sets the RNTI value for the DL-SCH.

7. RS State

Optional: On | Off , Default value: Off.

Toggles the enable state of the UE Specific Reference Signal channel.

8. RS Power

Configuration range: 0 dB~20 dB , Default value: 0 dB.

Set the power level of the channel in dB.

9. RS Beam Cfg Mode

Options: Degree | Complex, Default: Degree.

Sets the antenna beam configuration.

10. RS Beam for Port

Settable range: -90~ 90 , Default value: 0.

Sets the value of the main flap direction of the antenna beam for Port.

11. UE Specific CRS Port

Optional:

Port5 | Port7 | Port11 | Port13 | Port7, Port8 | Port11, Port13 | Port7, Port8, Port9, Port10 | Port7, Port8, Port9, Port10 | Port12, Port13, Port14 .

Port7, Port8, Port9, Port10, Port11, Port12, Port13, Port14 .

Default Value:

The default value is Port5 when Transmission Mode is TM7;

The default value for other Transmission Modes is Port7.

Set the transmission port of the UE reference signal, please refer to 3GPP TS 36211 for more information.

12. Transmission Mode

Optional:

When Antenna Number is 1, the options are TM1| TM7~ TM10 ;

If the Antenna Number is 2 or 4, the options are TM2~TM10;

When the Antenna Number is 8, the options are TM9~TM10.

Default Value:

The default value is TM1 when Antenna Number is 1 ;

The default value is TM4 when Antenna Number is 2 or 4;

The default value is TM9 when Antenna Number is 8.

Set the transmission mode of DL-SCH.

13. Coding State

Optional: On | Off, default: On.

Toggles the coding enable state of DL-SCH channel.

14. Data Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | Auto| User Files. Default: PN9 .

Sets the data source for the DL-SCH channel.

15. MCS Index Table

Optional: Table 1~4 , Default: Table 1 .

Set the TBS index table, please refer to 3GPP TS 36213 for more information.

16. RV Index Config

Options: Auto | Manual , Default: Manual.

Sets the RV configuration method.

17. RV Index Sequence

Configurable range: When RV Index Config is Auto, the configurable range is 0~3 and the length is 1~16.

Default value: 0,2,3,1.

18. Number of HARQ Processes

Displays the number of HARQ processes.

Note: This parameter is only displayed if it is not configurable.

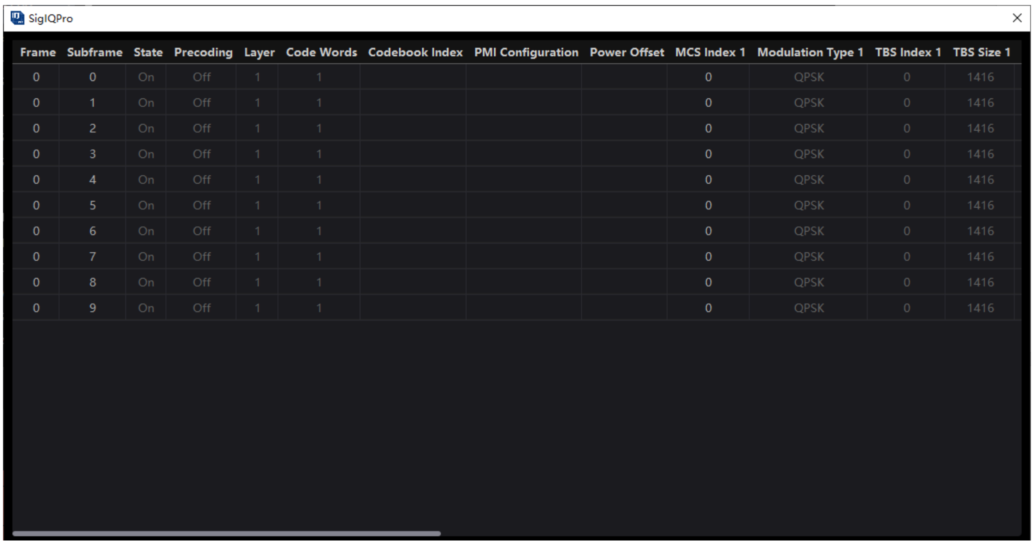
19. Assigned Processes

Displays the number of associated processes.

Note: This parameter is only displayed if it is not configurable.

20. Transmission Configuration

Click Transmission Configuration to enter the corresponding DL-SCH transmission configuration interface.



1) **State**

Displays the PDCCH enable state on the subframe.

Note: This parameter is not configurable.

2) **Precoding**

Optional: Off | TX Diversity | Spatial Mulpex , Default: Off.

Configure the precoding type of DL-SCH, please refer to 3GPP TS 36211 for more information.

3) **Layer**

Options: 1| 2| 4 , Default: 1.

Configure the number of layers of DL-SCH, please refer to 3GPP TS 36211 for more information.

4) **Code Words**

Optional range 1~2

Default value: 1

Set the number of DL-SCH code words, please refer to 3GPP TS 36211 for more information.

5) **Codebook Index**

Optional range: 0~15

Default value: 0

Set the codebook index, please refer to 3GPP TS 36211 for more information.

6) **PMI Configuration**

Optional:

The option is TPMI Indicated| Last PMI when Precoding is Spatial Mulpex, otherwise the parameter is hidden.

Default value: TPMI Indicated.

Set the PMI reported by UE.

7) **Power Offset**

Optional:

When Transmission Mode is TM5 and Precoding is Spatial Mulpex, the option is 0 dB | -10log10(2) dB.

The parameter is hidden in other cases.

Default value: 0 dB.

Sets the power offset.

8) MCS Index

Range can be set:

The settable range is 0~28 when MCS Index Table is Table 1;

If MCS Index Table is Table 2, the setting range is 0~27;

If MCS Index Table is Table 2, the range is 0~27; if MCS Index Table is Table 3, the range is 0~26;

If MCS Index Table is Table 3, the range is 0 to 26; if MCS Index Table is Table 4, the range is 0 to 58;

Default value: 0.

Set the MCS index of the DL-SCH, which affects the modulation type and TBS index, please refer to 3GPP TS 36213 for more information.

9) Modulation Type

Displays the modulation type specified by the corresponding MCS index.

Note: This parameter is only shown as non-configurable.

10) TBS Index

Displays the TBS index as specified by the corresponding MCS index.

Note: This parameter is not configurable.

11) TBS Size

Displays the TBS size as specified by the corresponding TBS index.

Note: This parameter is not configurable.

12) Retransmission

Options: On | Off , Default: Off.

Toggles the subframe retransmission enable state.

13) RV Index Seq

Configurable range:

When RV Index Config is Manual, the configurable range is 0~3;

Not configurable when RV Index Config is Auto.

Default Value:

The default value is 0 when RV Index Config is Manual;

When RV Index Config is Auto, the default value is displayed in RV Index Sequence order.

Sets the RV Index Sequence.

14) RA Type

Optional:

When Transmission Mode is TM3~TM4 or TM7~10, the options are: Type 0| Type 1;

When Transmission Mode is TM5~ 6, the parameter is fixed to Type 2;

For the rest of the cases, the options are: Type 0 | Type 1| Type 2.

Default value:

When Transmission Mode is TM5~6, this parameter is fixed to Type 2;

The default value is Type 0 in other cases.

Set the resource allocation type, for more information refer to 3GPP TS 36213 Section 7.1.6.

15) Subset

Settable range:

When RA Type is Type 1 can be set, the parameter is hidden in the rest of the cases;

Fixed to 0 when Channel Bandwidth is 1400K;

When Channel Bandwidth is 3M or 5M, it can be set to 0~ 1;

When Channel Bandwidth is 10M, the range can be set to 0~2;

When the Channel Bandwidth is 15M or 20M, the range is 0~3.

Default value: 0 .

Set the subset number, for more information, please refer to 3GPP TS 36213 Section 7.1.6.

16) Shift

Options: On | Off .

Can be set when RA Type is Type 1, otherwise the parameter is hidden.

Default value: Off .

Toggles the subset offset enable state, please refer to 3GPP TS 36213 Section 7.1.6 for more information.

17) **RBG Bitmap**

Settable range: 0~1 .

It can be set when RA Type is Type 0~ 1, and the parameter is hidden in the rest of the cases.

Default value: display the default value according to the current bandwidth occupancy status.

To set the RB occupancy status, please refer to 3GPP TS 36213 Section 7.1.6 for more information.

18) **VRB Type**

Optional: localized| Distributed .

Can be set when RA Type is Type2, in the rest of the cases the parameter is hidden.

Default value: Localized .

Set the VRB type, refer to 3GPP TS 36213 section 7.1.6 for more information.

19) **RB Size**

Settable range:

When VRB Type is Localized, the settable range is from 1 to the number of RBs specified by Channel Bandwidth;

When VRB Type is Distributed, the settable range is 1~ Channel Bandwidth;

It can be set when RA Type is Type2, and the parameter is hidden in the rest of the cases.

Default Value: displays the default value according to the current bandwidth occupancy status.

Sets the number of RB occupancy for the subframe.

20) **RB Offset**

Settable range:

When VRB Type is Localized, 0~ Number of RBs specified by Channel Bandwidth – RB Size;

When VRB Type is Distributed, 0~ VRB number specified by Channel Bandwidth – RB Size;

It can be set when RA Type is Type2, and the parameter is hidden in the rest of the cases.

Default value: 0 .

Sets the RB offset.

21) **RB Gap**

Optional:

Optional when the number of RBs specified by Channel Bandwidth>= 50 NGap 1| NGap 2 ;

Fixed to NGap 1 when the number of RBs specified by Channel Bandwidth< 50 ;

Settable when VRB Type is Distributed, the parameter is hidden in the rest of the cases.

Default value: NGap 1 .

Toggles the RB Gap type, refer to 3GPP TS 36213 for more information.

4.12.4 Channel (UL)

When the waveform type is DownLink, the channels related to the downlink are displayed under the Channel node in the tree view on the left side of the window, and you can enter the configuration interface of the related channels by clicking each channel.

4.12.4.1 SRS

Click the SRS node in the tree view on the left side of the window to enter the parameter setting.

General Setting

1. State

Options: On | Off, Default: Off.

Toggles the enabling state of SRS channel.

2. Power Boosting

Selectable range: -60.000 ~ 20.000 dB, Default value: 0 dB.

Set the power of SRS relative to the carrier.

3. Subframe Configuration

Configurable range: 0 ~ 15 , default value: 0.

Select the subframe configuration of SRS, see 3GPP protocol for details.

4. SRS Subframe

Displays the current subframe configuration of SRS, constrained by the parameter **Subframe Configuration** .

5. nSRS_CS

Settable range: 0 ~ 7, default value: 0.

Set the SRS parameter n_{SRS}^{cs} to determine the SRS cyclic shift.

6. C_SRS

Settable range: 0 ~ 7, default value: 7.

Set SRS parameter $C_{SRS} \in \{0,1,2,3,4,5,6,7\}$ to select SRS bandwidth configuration.

7. B_SRS

Settable range: 0 ~ 3 , default value: 0 .

Set SRS parameter $B_{SRS} \in \{0,1,2,3\}$.

8. KTC

Settable range: 0 ~ 1, default value: 0.

Set SRS parameter $k_{TC} \in \{0,1\}$.

9. b_hop

Settable range: 0 ~ 3, default value: 3.

Set SRS parameter b_{hop} .

Note: If the parameter $b_{hop} \geq B_{SRS}$ SRS **Frequency Hopping** is on, the parameter $b_{hop} < B_{SRS}$ SRS Frequency **Hopping** is on.

10. I_SRS

Setting range: TDD: 0~ 644; FDD: 0~ 636;

Default value: 0 .

Set the SRS parameter ISRS, which is used to determine the SRS period T_SRS and the subframe offset T_Offset, for the specific constraints, please refer to 3GPP protocol 36211 Table 8.2-1 and Table 8.2-2.

11. nRRC

Settable range: 0~ 23 , Default value: 0 .

Set the SRS parameter n_{RRC} .

12. T_SRS.

Displays the SRS parameter T_{SRS} , subject to I_SRS and 3GPP protocol 36211 Table 8.2-1 and Table 8.2-2.

13. T_Offset

Display parameter T_{offset} , subject to I_SRS and 3GPP protocol 36211 Table 8.2-1 and Table 8.2-2.

14. Frequency Hopping

Displays the SRS frequency hopping enable state, subject to **b_hop** and **B_SRS** .

4.12.4.2 UL-SCH

Click the UL-SCH node in the tree view on the left side of the window to enter the parameter setting.

4.12.4.2.1 General Setting

1. State

Options: On | Off , Default: On.

Toggles the enable state of PUSCH channel.

2. Coding State

Options: On | Off , Default: On.

Toggles the coding state of the PUSCH channel.

3. Scrambling

Options: On | Off , Default: On.

Toggles the scrambling state of the PUSCH channel.

4. RNTI(1)

Configuration range: 0 ~ 65535 , Default value: 1.

Set the RNTI value at code word 0.

5. RNTI(2)

Configuration range: 0 ~ 65535, Default value: 1.

Set the RNTI value for code word 1.

Note: If the code word is 0, the current parameter is hidden.

4.12.4.2.2 PUSCH Common

1. Hopping Mode

Optional: Off | Inter-subframe hopping| Intra and inter-subframe hopping .

Default value: Off.

Off or select different hopping modes for PUSCH.

Intra and inter-subframe hopping: Hopping within the same subframe and between different subframes at the same time.

Inter-subframe hopping: Hopping between subframes, no hopping between two slots in the same subframe.

2. PUSCH Hopping Type

Type1 +1/4 | Type1 -1/4 | Type1 +1/2 | Type2 , | Type1 +1/2 | Type2 , | Type1 +1/4 | Type1 -1/4 | Type1 +1/2

Default: Type1 +1/2.

Note: This option is not available when **Hopping Mode** is Off.

3. N_HO_RB

Type1 +1/4 | Type1 -1/4 | Type1 +1/2 | Type2 .

Default: Type1 +1/2.

Note: This option is not available when **Hopping Mode** is Off.

4. Nsb

Configuration range: 1 ~ 4 , default value: 1.

Set the number of subbands of PUSCH N_{sb} .

Note: This option is not available when Hopping Mode is Off.

5. Delta ss

Configuration range: 0 ~ 29, default value: 0.

Set the DMRS sequence parameter for calculating the sequence shift.

6. nDMRS(1)

Configuration range: 0 ~ (Maximum REs - 1), default value: 0.

Set the DMRS sequence related parameters (set the parameters of Format 4 and Format 5 in PUCCH, the setting range is shown in Table 4-11), to calculate the cyclic shift of the demodulation reference signal (DMRS) within the frame, range: 0 ~ (Maximum REs - 1), default 0

Table 4-11 (TS36.211 Table 5.5.2.1.1-2) Mapping of cyclicShift to $n_{\mathrm{DMRS}}^{(1)}$ values

cyclicShift	$n_{\mathrm{DMRS}}^{(1)}$
0	0
1	2
2	3
3	4
4	6
5	8
6	9
7	10

7. PUSCH ID

Configuration range: 0 ~ 509 ,

Default value: -1 (no configuration).

Set the PUSCH ID value.

8. DMRS PUSCH CSH ID

Configuration range: 0 ~ 509 ,

Default value: -1 (no configuration).

Sets the initial value of the cyclic shift hop used for PUSCH DMRS pseudo-random sequence generation.

4.12.4.2.3 MIMO Settings

1. Layer Number

Configurable range: 1 (1 Antenna) | 2 (2 Antennas) | 4 (4 Antennas) ,

Default value: 1.

Set the layer number of PUSCH, the range of this parameter depends on the number of antennas.

2. Codeword Index

Settable range:

0 ~ 5 (2 Antennas, 1 Layer) | 0 ~ 23 (4 Antennas, 1 Layer) | 0 ~ 15 (4 Antennas, 2 Layers)

0 ~ 11 (4 antennas, layer 3) | 0 (4 antennas, layer 4)

Set the codebook index of PUSCH.

3. Activate DMRS with OCC

Optional: On | Off , Default: Off .

Determines whether DMRS uses orthogonal cover code.

4.12.4.2.4 Transmission Settings

1. Transmission Mode

Displays the current transmission mode of PUSCH, constrained by the number of antennas, TM1 is used for single antenna transmission, TM2 is used for multi-antenna transmission.

2. MCS Table

Optional: Table 1| Table 2 , Default: Table 1.

This parameter is used to determine the MCS (Modulation Coding Scheme) index table, Table 1 is for Supporting64QAM, Table 2 is for Supporting256QAM, for details, please refer to 3GPP protocol 36213.

3. Data(1) Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files,

Default: PN9.

Sets the data sequence for transmission block 1, you can choose PN code or customized data.

4. Data(2) Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files ,

Default: PN9 .

Sets the data sequence of transfer block 2, you can choose PN code or customized data.

5. Harq Process Number

Displays the number of HARQ processes.

6. Assigned Process

Displays the number of currently enabled HARQ processes.

7. Rv Index Config

Range: 0 ~ 3, Default: 0,2,3,1.

Set Rv Index Sequence.

8. Rv Index Sequence

Range: 0 ~ 3, Default Value: 0,2,3,1.

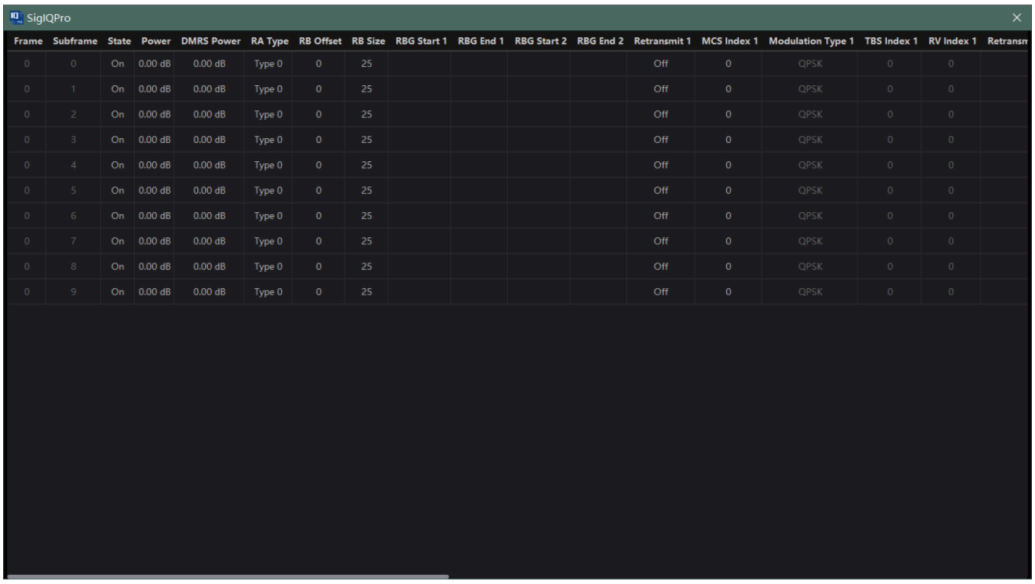
Set the RV Index Sequence. It can be set in the following three ways:

- If you need to configure by single index, you can use "," as the separator, e.g. 0,1,2,3 .
- If you need to configure by index range, you can use 0:3 to indicate the start index and the last index, e.g. 0:3 means 0,1,2,3.
- If you need to configure by different steps, you can use two ":" to indicate the start index, step and last index respectively, for example, 1:2:3 means 1,3.

All the above three configuration methods can be used in combination.

4.12.4.2.5 UL SCH Transmission Table

Click Transmission Configuration to enter the corresponding UL-SCH transmission configuration interface.



1. Frame

Display the frame number of each frame.

2. Subframe

Displays the subframe number corresponding to each subframe.

3. State

Options: On | Off , Default: On.

Toggles the enable switch for each subframe.

4. Power

Settable range: -40 dB~ 40 dB ,

Default value: 0 dB.

Sets the power of each subframe of PUSCH data relative to other channels.

5. DMRS Power

Settable range: -40 dB~ 40 dB,

Default value: 0 dB.

Set the power of PUSCH DMRS relative to PUSCH channel.

6. RA Type

Optional range: Type 0 | Type 1 ,

Default value: Type 0.

Sets the mapping method of PUSCH.

7. RB Offset

Settable range: 0~ Maximum number of RBs that can be set for the current bandwidth - PUSCH **RB Size** .

Default Value: 0 .

Sets the RB offset of the current subframe of PUSCH, the range is constrained by the maximum number of RBs that can be set for the current bandwidth and the **RB Size** .

Note: Only available when RA Type of PUSCH is set to **Type 0** .

8. RB Size

Settable range: 0~ Maximum RBs for current bandwidth.

Default value: 25.

Set the occupied RBs of the current subframe of PUSCH, and the **sum of RB Size** and **RB Offset** cannot exceed the maximum RBs of the current bandwidth.

Note: Only available when RA Type of PUSCH is set to **Type 0** .

9. RBG Start 1

Configurable range: 1~ **RBG End 1** - 1 .

Default value: 1 .

Sets the RBG start position of the current subframe when PUSCH is Type 11 .

Note: Available only when RA Type of PUSCH is set to Type 1.

10. RBG End 1

Configurable range: **RBG Start 1** + 1~ **RBG End 2** - 1 .

Default value: 8 .

Set the RBG end position of the current subframe when PUSCH is Type 1 1 .

Note: It is assignable only when the RA Type of PUSCH is set to Type 1.

11. RBG Start 2

Configurable range: **RBG End 1** + 1~ **RBG Start 2** - 1 .

Default value: 10 .

Sets the RBG start position 1 of the current subframe when PUSCH is set to Type 1.

Note: Assignable only when RA Type of PUSCH is set to Type 1.

12. RBG End 2

Settable range: **RBG End 1** + 1~ Maximum number of RBGs that can be set for the current bandwidth;

Default value: 18 .

Set the current subframe RBG start position when PUSCH is set to Type 1 1 .

Note: Assignable only when RA Type of PUSCH is set to Type 1.

13. Retransmit 1

Optional: On | Off .

Default value: Off .

The subframe retransmit enable state when switching to single code word.

14. **MCS Index 1**

Range: 0~28, Default: 0.

Sets the MCS index 1 of the current subframe (for single codeword), which affects the modulation mode and TBS index, please refer to 3GPP TS 36213 for more information.

15. **Modulation Type 1**

Displays the modulation type of the current subframe, constrained by the parameter **MCS Index 1** .

16. **TBS Index 1**

Displays the TBS index specified by the corresponding MCS index.

17. **RV Index 1**

Settable range: when RV Index Config is Manual, the settable range is 0~3.

Default Value: when RV Index Config is Manual, the default value is 0.

Sets the RV index sequence of the current subframe.

Note: Not configurable when **RV Index Config** is Auto.

18. **Retransmit 2**

Optional: On | Off , Default: Off.

Toggles the subframe retransmit enable state when Codeword Number is 2.

Note: Configurable only when **Codeword Index** is 2.

19. **MCS Index 2**

Range: 0~28, Default: 0.

When the codeword is 2, set the MCS index 1 of the current subframe (for single codeword), which affects the modulation mode and TBS index, please refer to 3GPP TS 36213 for more information.

Note: Only available when **Codeword Index** is 2.

20. **Modulation type 2**

When Codeword Index is 2, displays the modulation type of the current subframe, constrained by parameter MCS Index 2 .

Note: Only available when Codeword Index is 2.

21. TBS Index 2

When the code word is 2, it displays the TBS index corresponding to the MCS index specification.

Note: Only available if Codeword Index is 2.

22. RV Index 2

Range: 0~3 when RV Index Config is Manual.

Default Value: when RV Index Config is Manual, the default value is 0.

When Code Word is 2, set the RV Index Sequence of the current subframe.

Note: ① Not configurable when RV Index Config is Auto.

② Configurable only when Codeword Index is 2.

23. CS Field Index

Configurable range: 0~ 7 , Default value 0.

Sets the cyclic shift index of the current subframe.

24. Harq ACK Enable

Options: On | Off , Default: On.

Toggles the HARQ-ACK enable state of the current subframe.

25. Harq Data Source

Options: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files .

Default: PN9 .

Sets the HARQ-ACK sequence for the current subframe, you can choose PN code or customized data.

26. Harq ACK Info Size

Configurable range: 1~ 128 , Default value: 1.

Set the number of HARQ-ACK bit of the current subframe.

27. Harq ACK Offset Index

Sets the parameter $I_{offset}^{HARQ-ACK}$ for the current subframe, see Table 4-12 for the range and constraints.

Table 4-12 (Table8.6.3 -1): Mapping of HARQ-ACK offset values and the index signalled by higher layers

$I_{offset}^{HARQ-ACK}$	$\beta_{offset}^{HARQ-ACK}$
2.000	2.000
2.000	2.500 1
2	3.125

28. RI Enable

Options: On | Off ,

Default: On.

Toggles the RI enable state of the current subframe.

29. RI Data Source

Options: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files. Default: PN9 .

Set the RI sequence of the current subframe, you can choose PN code or customized data.

30. RI Info Size

Settable range: 1~ 128 ,

Default value: 1.

Set the RI bit number of the current subframe.

31. RI Offset Index

Sets the parameter I_{offset}^{CQI} for the current subframe, the range is shown in Table 4-13.

Table 4-13 (Table8.6.3 -3): Mapping of CQI offset values and the index signalled by higher layers

I_{offset}^{CQI}	β_{offset}^{CQI}
0	reserved
1 reserved	reserved

2 reserved	1.125
1.125	1.250
4	1.375
5	1.625
6	1.750
7	2.000
8	2.250
9	2.500
10	2.875
11	3.125
12	3.500
13	4.000
14	5.000
15	6.250

32. CQI Enable

Options: On | Off , Default: On.

Toggles the CQI enable state of the current subframe.

33. CQI Data Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files , Default: PN9.

Set the CQI sequence of the current subframe, you can choose PN code or customized data.

34. CQI Info Size

Settable range: 1~ 128 , Default: 1.

Set the CQI bit number of the current subframe.

35. CQI Offset Index

Setting range: 2~ 15 , Default value: 2.

Sets the CQI offset of the current subframe.

4.12.4.3 UCI

Click the UCI node in the tree view on the left side of the window to enter the parameter setting.

1. **General Setting**

1) **State**

Options: On | Off , Default: On.

PUCCH channel enable switch.

2) **Scrambling**

Options: On | Off , Default: On.

Toggles the scrambling state of the PUCCH channel.

3) **RNTI**

Settable range: 0~65535 , default value: 1.

Set the RNTI value of PUCCH.

2. **Demodulation Reference Signal Settings**

1) **N_RB(2)**

Range: 0~ Maximum RBs of current bandwidth;

Default value: 0 .

Sets the number of RBs used for PUCCH format 2/2a/2b resources (nPUCCH2).

2) **N_CS(1)**

Settable range: 0~ 7 , default value: 0.

Sets the number of resources used for format 1 in the PUCCH format 1/1a/1b and format 2/2a/2b mixed resources.

3) **Delta Shift PUCCH**

Settable range: 1~ 3 , Default value: 1.

Set the cyclic shift interval for PUCCH format 1/1a/1b $\Delta_{\text{shift}}^{\text{PUCCH}}$.

3. **UL CoMP Settings**

PUCCH ID

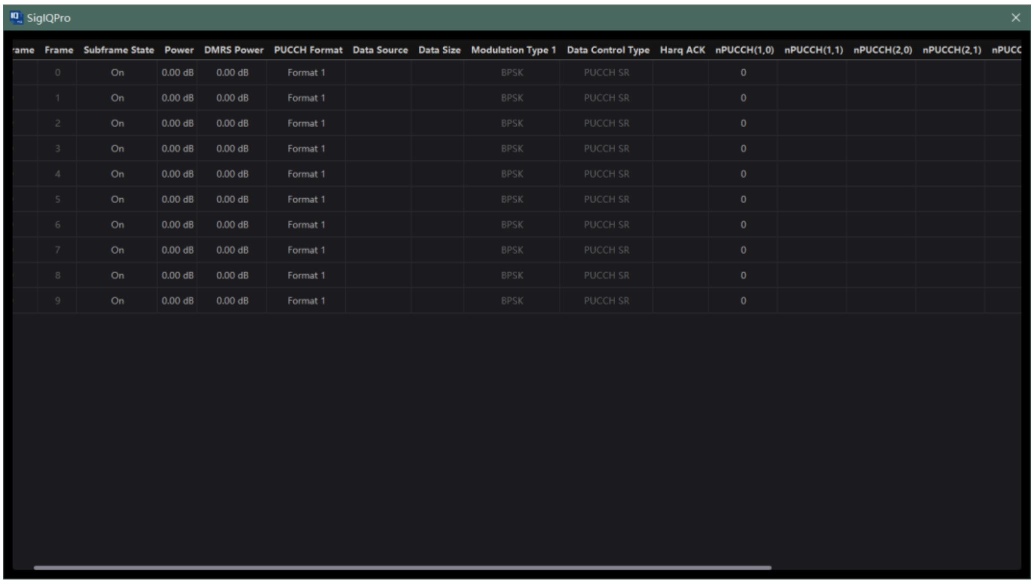
Settable range: -1~ 509 , Default value: -1.

Setting parameter $n_{\mathrm{ID}}^{\mathrm{PUCCH}}$.

4. Transmission Settings

1) Transmission Configuration

Click Transmission Configuration to enter the corresponding UCI transmission configuration interface.



2) Frame

Displays the frame number of each frame.

3) Subframe

Displays the subframe number corresponding to each subframe.

4) State

Options: On | Off . Default: On.

Toggles the enable switch for each subframe.

5) Power

Settable range: −40 dB~ 40 dB . Default value: 0 dB.

Sets the power of each subframe of PUCCH data relative to other channels.

6) DMRS Power

Settable range: −40 dB~ 40 dB. Default value: 0 dB.

Set the power of PUCCH DMRS relative to the PUCCH channel.

7) PUCCH Format

Optional:

Format 1| Format 1a | Format 1b | Format 2 | Format 2a;

Format 2b| Format 3 | Format 4 | Format 5;

Default value: Format 1 .

Sets the PUCCH format of the current subframe.

8) Data Source

Optional: PN9 ITU | PN9 | PN11 | PN15 | PN23 | User Files . Default: PN9 .

Set the data type of the current subframe, you can choose PN code or custom data.

Note: Only available when **PUCCH Format** is set to Format 2a | 2b.

9) Data Size

Settable range: 1~ 13 . Default value: 1.

Sets the number of bits in the current subframe.

Note: Available only when **PUCCH Format** is set to Format 2a | 2b.

10) Modulation Type 1

Displays the modulation type of the current subframe.

11) Data Control Type

Displays the UCI data type of the current subframe.

12) Harq ACK

Optional: ACK | NACK; Default: ACK.

Toggles the HARQ ACK enable state.

Note: Only assignable when **PUCCH Format** is set to Format 1a | 1b| 2a | 2b.

13) nPUCCH(1,0)

Settable range: The maximum value is bound by **CP Type** , current bandwidth maximum RB count and **Delta Shift PUCCH** .

Default value: 0.

Set the resource index of PUCCH Format 1| 1a | 1b, please refer to 3GPP protocol 36211 for details.

Only assignable when PUCCH Format is set to 1| 1a | 1b.

14) nPUCCH(1,1)

Settable range: the maximum value is bound by CP Type , current bandwidth maximum RB count and Delta Shift PUCCH .

Default value: 0.

Set the resource index of PUCCH Format 1| 1a | 1b when the number of antennas is 2. For details, please refer to 3GPP protocol 36211.

Only assignable when PUCCH Format is set to 1| 1a | 1b.

15) nPUCCH(2,0)

Settable range: the maximum value is bound by N_RB(2) and N_CS(1) .

Default value: 0.

Set the resource index of PUCCH Format 2| 2a | 2b, please refer to 3GPP protocol 36211 for details.

Only assignable when PUCCH Format is set to 2| 2a | 2b.

16) nPUCCH(2,1)

Range: The maximum value is bound by N_RB(2) and N_CS(1)

Default value: 0 .

Set the resource index of PUCCH Format 2| 2a | 2b when the number of antennas is 2. For details, please refer to 3GPP protocol 36211.

Only assignable when PUCCH Format is set to 2| 2a | 2b.

17) nPUCCH(3,0)

Settable range: the maximum value is constrained by the maximum number of RBs in the current bandwidth.

Default value: 0 .

Set the resource index of PUCCH Format 3, please refer to 3GPP protocol 36211 for details.

Only assignable when PUCCH Format is set to 3.

18) nPUCCH(3,1)

Settable range: the maximum value is constrained by the maximum number of RBs in the current bandwidth.

Default value: 0 .

Set the resource index of PUCCH Format 3 when the number of antennas is 2. For details, please refer to 3GPP protocol 36211.

Only assignable when **PUCCH Format** is set to 3.

19) nPUCCH(4,0)

Settable range: 0~ Maximum number of RBs/ 2 for current bandwidth.

Default value: 0 .

Sets the resource index of PUCCH Format 4. For details, please refer to 3GPP protocol 36211 .

Matchable only when **PUCCH Format** is set to 4.

20) nPUCCH(5,0)

Settable range: 0~ Maximum number of RBs for current bandwidth.

Default value: 0 .

Sets the resource index for PUCCH Format 5, see 3GPP protocol 36211 for details.

Only assignable when **PUCCH Format** is set to 5.

21) nPUCCH(4,rb)

Displays the number of RBs for the current subframe PUCCH Format 4, corresponding to the parameter $M_{\text{RB}}^{\text{PUCCH4}}$.

Assignable only when **PUCCH Format** is set to 4.

22) noc

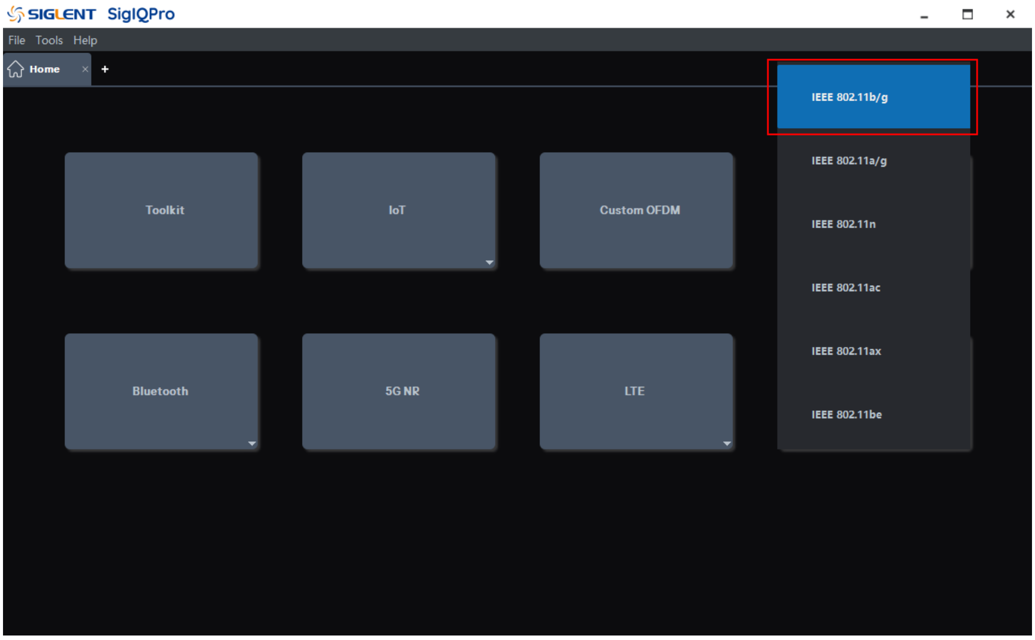
Settable range: 0| 1 , Default value: 0 .

Sets the spreading sequence index of the current subframe PUCCH Format 5 n_{oc} .

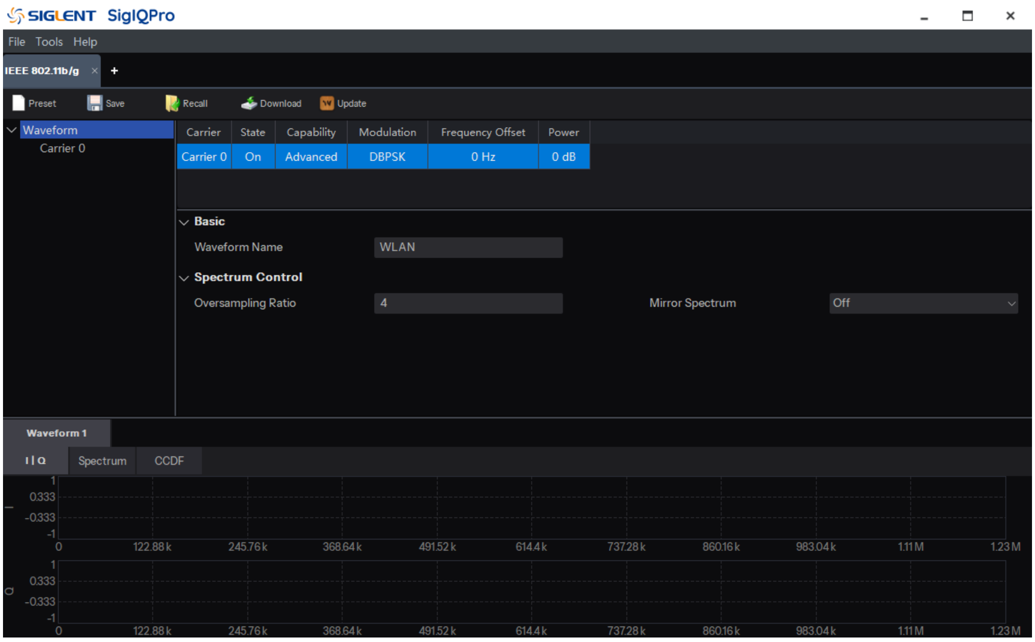
Configurable only when **PUCCH Format** is set to 5.

4.13 WLAN_802_11b/g

On the homepage, click WLAN and select WLAN_802_11b/g (i.e., WiFi1) to enter the corresponding protocol waveform settings page.



The waveform settings panel is used to configure waveform parameters such as data rate.



The parameter configuration for WLAN follows a hierarchical structure, roughly divided into levels such as Waveform and Carrier.

4.13.1 Waveform

The Waveform page is divided into two sections: Basic and Spectrum Control.

4.13.1.1 Basic

This interface configures basic waveform parameters.

Waveform Name

Names the generated waveform. If not configured by the user, the default name is used.

4.13.1.2 Spectrum Control

This interface configures spectrum control-related parameters.

1. Oversampling Ratio

Configurable range: 1-128.

Default value: 4.

Sets the oversampling ratio of the baseband signal.

This parameter increases the actual FFT points during OFDM-modulated baseband signal generation. If set too high, it may reduce signal generation speed or even cause program crashes due to insufficient memory.

2. Mirror Spectrum

Options: On | Off.

Default value: Off.

Toggles the enabled state of baseband signal spectrum mirroring.

Spectrum mirroring is achieved by inverting the Q component of the baseband IQ data.

4.13.2 Carrier

The Carrier page is divided into five sections: Capability, Basic, Coding and Modulation, Spectrum Control, and Payloading Configuration.

4.13.2.1 Capability

This interface configures carrier capability parameters.

Capability

Options: Advanced | Basic

Basic functionality supports RF testing for all wireless LAN signals except channel coding. Advanced functionality supports full channel-coded waveform testing.

4.13.2.2 Basic

1. Number of Frames

Configurable range: 1-2000.

Default value: 1.

Sets the number of frames used in the waveform.

Selecting a value greater than 1 creates multiple consecutive data payload frames.

2. Generation Mode

Options: Framed | Unframed.

Default value: Framed.

Selects framed or unframed mode for signal generation.

3. Head Idle Interval

Configurable range: 0–20 μs.

Default value: 0 μs.

Sets the length of the idle time before the frame header (in microseconds).

4. Idle Interval

Configurable range: 0–20 μs.

Default value: 0 μs.

Sets the length of the idle time between frames (in microseconds).

5. Frequency Offset

Configurable range: 0–30 MHz.

Default value: 0 Hz.

Sets the frequency offset relative to the signal generator's output frequency.

4.13.2.3 Coding and Modulation

Configures coding and modulation-related parameters.

1. **Data Rate**

Options: 1 Mbps (DSSS) | 2 Mbps (DSSS) | 5.5 Mbps (DSSS) | 11 Mbps (DSSS)

The selected data transmission rate automatically sets the modulation and coding rate according to the 802.11 standard.

2. **Modulation**

For 1 Mbps and 2 Mbps data rates, the modulation format is automatically set to DBPSK and DQPSK, respectively, and cannot be changed.

For 5.5 Mbps and 11 Mbps data rates, CCK or PBCC is automatically set as the modulation scheme and cannot be changed.

3. **Preamble Type**

Options: Long | Short, default value: Long.

Selects the preamble type in DSSS/PBCC mode.

4. **Locked Clocks**

Options: On | Off, default value: On.

Only adjustable in advanced functionality. In "Basic" mode, it is automatically set to "On."

5. **Ramp Type**

Options: None | Linear | Cosine

- **None:** Transmits the signal at full power, the simplest power ramping.
- **Linear:** Linear ramping shapes the burst in a linear manner.
- **Cosine:** Cosine ramping minimizes out-of-channel interference.

6. **Ramp Time**

Sets the length of the power rise/fall ramp (in microseconds).

4.13.2.4 Spectrum Control

Configures spectrum control parameters.

1. **Filter**

Options: None | Root Raised Cosine | Gaussian | FIR

- **None:** No filter.
- **Root Raised Cosine:** A root-raised cosine filter with a pulse response that is circular at the symbol rate.
- **Gaussian:** A Gaussian filter with non-zero inter-symbol interference (ISI).
- **FIR:** A finite impulse response filter.

2. **Alpha**

Configurable range: 0.1–1, default value: 0.5.

Only valid for the root-raised cosine filter. Sets the filter's alpha coefficient.

3. **BT**

Configurable range: 0.1–1, default value: 0.5.

Only valid for the Gaussian filter. Determines the degree of signal filtering.

4. **Length**

Configurable range: 0–1000, default value: 10.

The symbol length determines how many symbol periods are used in the calculation.

4.13.2.5 Payloading Configuration

Configures data payload-related parameters.

1. **Data Type**

Options: All 0s, PN9, PN15, Custom. When enabled, the corresponding Seed value setting is displayed.

Sets the data byte pattern in the frame.

2. **Data Length**

Sets the number of data bytes in the frame.

3. **Head Format**

Enables or disables prepending the MAC header to the data payload.

4. FCS

Enables or disables appending the MAC FCS to the data payload. If enabled, the software automatically calculates the FCS.

5. Increment Sequence Number

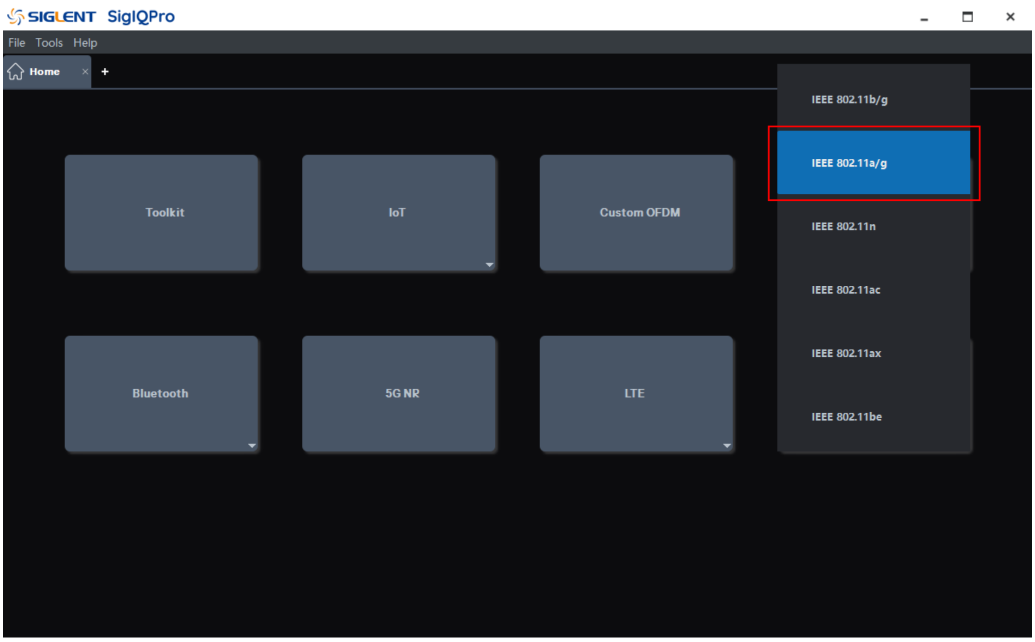
Enables or disables incrementing the sequence number within the Sequence Control field of the MAC header.

6. Sequence Number Increment by: (Frames)

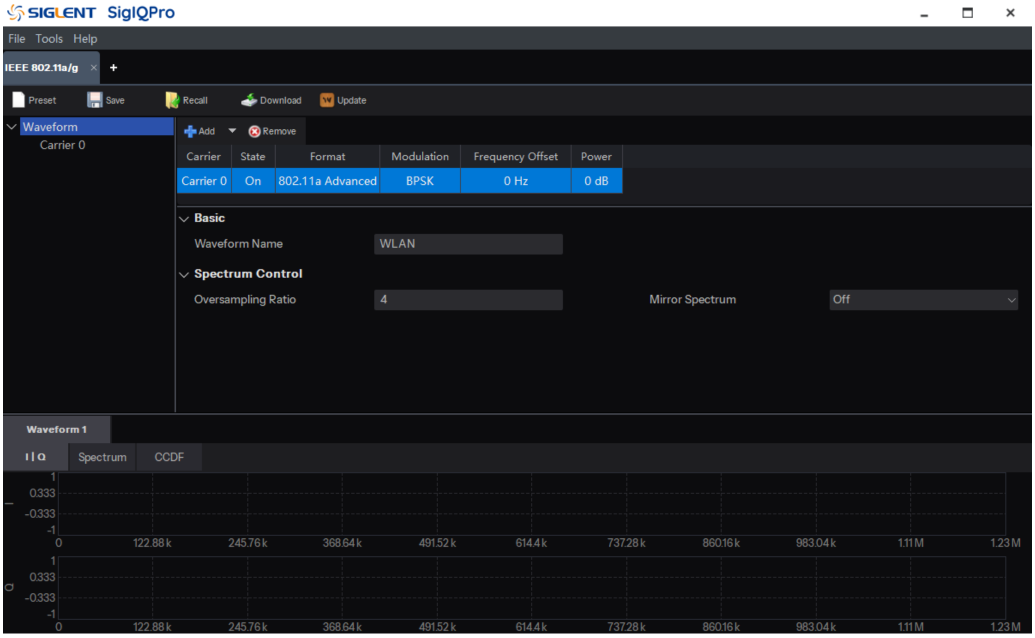
The number of frames set here determines when the sequence number in the Sequence Control field of the MAC header increments.

4.14 WLAN_802_11a/g

On the homepage, click WLAN and select WLAN_802_11a/g (i.e., WiFi2/3) to enter the corresponding protocol waveform settings page.



The waveform settings panel is used to configure waveform parameters such as activation mode, data rate, and data payload.



The WLAN parameter configuration follows a hierarchical structure, roughly divided into levels such as Waveform and Carrier .

4.14.1 Waveform

The Waveform page is divided into two sections: Basic and Spectrum Control .

4.14.1.1 Basic

This interface configures basic waveform parameters.

Waveform Name

Names the generated waveform. If not configured by the user, the default name is used.

4.14.1.2 Spectrum Control

This interface configures spectrum control-related parameters.

1. Oversampling Ratio

Configurable range: 1–128.

Default value: 4.

Sets the oversampling ratio of the baseband signal.

This parameter increases the actual FFT points during OFDM-modulated baseband signal generation. If set too high, it may reduce signal generation speed or even cause program crashes due to insufficient memory.

2. Mirror Spectrum

Options: On | Off.

Default value: Off.

Toggles the enabled state of baseband signal spectrum mirroring.

Spectrum mirroring is achieved by inverting the Q component of the baseband IQ data.

4.14.2 Carrier

The Carrier page is divided into five sections: Capability, Basic, Coding and Modulation, Spectrum Control, and Payloading Configuration.

4.14.2.1 Capability

This interface configures carrier capability parameters.

1. Capability

Options: Advanced | Basic

Basic: Supports RF testing for all wireless LAN signals except channel coding.

Advanced: Supports full channel-coded waveform testing.

2. State

Options: On | Off, default value: On.

Sets the current carrier activation state.

4.14.2.2 Basic

This interface configures basic waveform parameters.

1. Number of Frames

Configurable range: 1–2000. Default value: 1.

Sets the number of frames used in the waveform.

Selecting a value greater than 1 creates multiple consecutive data payload frames.

2. Generation Mode

Options: Framed | Unframed. Default value: Framed.

Selects framed or unframed mode for signal generation.

3. Head Idle Interval

Configurable range: 0–20 μs. Default value: 0 μs.

Sets the length of the idle time before the frame header (in microseconds).

4. Idle Interval

Configurable range: 0–20 μs. Default value: 0 μs.

Sets the length of the idle time between frames (in microseconds).

5. Frequency Offset

Configurable range: 0–30 MHz, Default value: 0 Hz.

Sets the frequency offset relative to the signal generator's output frequency.

6. Relative Power

Relative power value, default: 0 dB.

4.14.2.3 Coding and Modulation

Configures coding and modulation-related parameters.

1. Data Rate

Options:

6 Mbps (OFDM) | 9 Mbps (OFDM) | 12 Mbps (OFDM) | 18 Mbps (OFDM)

24 Mbps (OFDM) | 36 Mbps (OFDM) | 48 Mbps (OFDM) | 54 Mbps (OFDM)

The selected data transmission rate automatically sets the modulation and coding rate according to the 802.11 standard.

2. Modulation

Displays the modulation method corresponding to the selected coding rate.

3. Convolutional Coder

Options: On | Off. Default value: On.

Only adjustable in Advanced mode. In Basic mode, it is automatically set to Off.

4. **Coding Rate**

Displays the coding rate corresponding to the selected data rate.

5. **Interleaver**

Options: On | Off. Default value: On.

Only adjustable in Advanced mode. In Basic mode, it is automatically set to Off.

6. **Scrambler**

Options: On | Off. Default value: On.

Only adjustable in Advanced mode. In Basic mode, it is automatically set to Off.

7. **Scrambler Initialization**

Configurable range: 0–127.

Default value: 93.

Sets the initial value of the scrambler.

8. **Reserved Service Bits**

Sets the 9 reserved service bits in the Service field of OFDM mode.

9. **Subcarrier Mask**

Configures individual OFDM subcarriers through this window.

4.14.2.4 Spectrum Control

Configures spectrum control parameters.

1. **Filter**

Options:

None: No filter.

Gaussian: Gaussian filter with non-zero inter-symbol interference (ISI).

Root Raised Cosine: Root-raised cosine filter with a circular pulse response at the symbol rate.

FIR: Finite impulse response filter.

User Defined: User-defined filter.

2. **Alpha**

Configurable range: 0.1-1.

Default value: 0.5.

Only valid for the root-raised cosine filter. Sets the filter's alpha coefficient.

3. **BT**

Configurable range: 0.1-1.

Default value: 0.5.

Only valid for the Gaussian filter. Determines the degree of signal filtering.

4. **Length**

Configurable range: 0-1000.

Default value: 10.

The symbol length determines how many symbol periods are used in the calculation.

4.14.2.5 Payloading Configuration

Configures data payload-related parameters.

1. **Data Type**

Options: All 0s, PN9, PN15, Custom.

When enabled, the corresponding Seed value setting is displayed.

Sets the data byte pattern in the frame.

2. **Data Length**

Sets the number of data bytes in the frame.

3. **Head Format**

Enables or disables prepending the MAC header to the data payload.

4. **FCS**

Enables or disables appending the MAC FCS to the data payload. If enabled, the software automatically calculates the FCS.

5. **Sequence Number Increment by: (Frames)**

The number of frames set here determines when the sequence number in the Sequence Control field of the MAC header increments.

6. MPDU Length

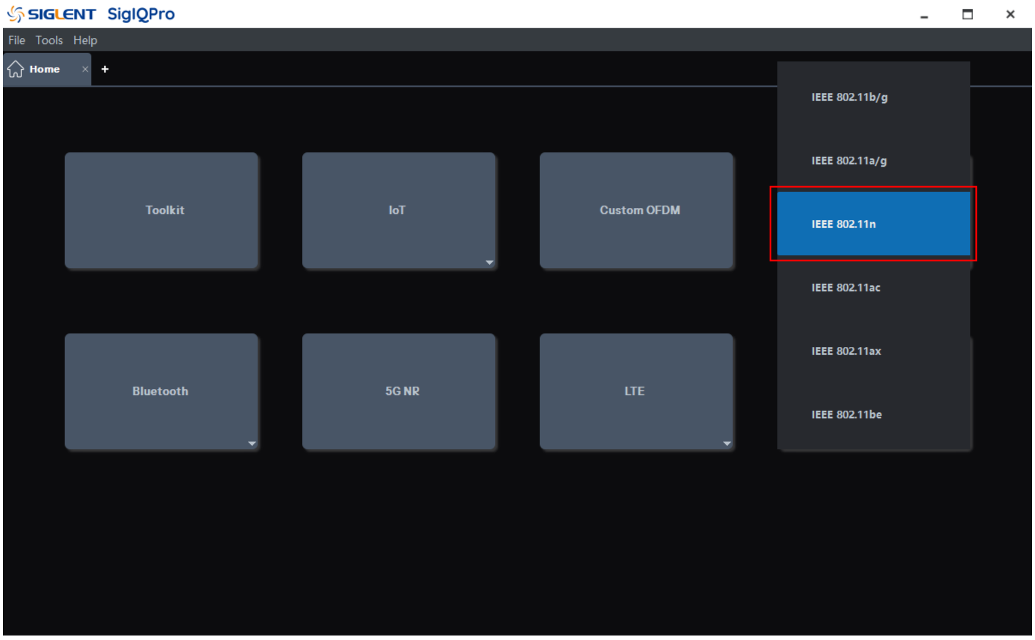
Displays the corresponding MPDU value length.

7. Payload Config Description

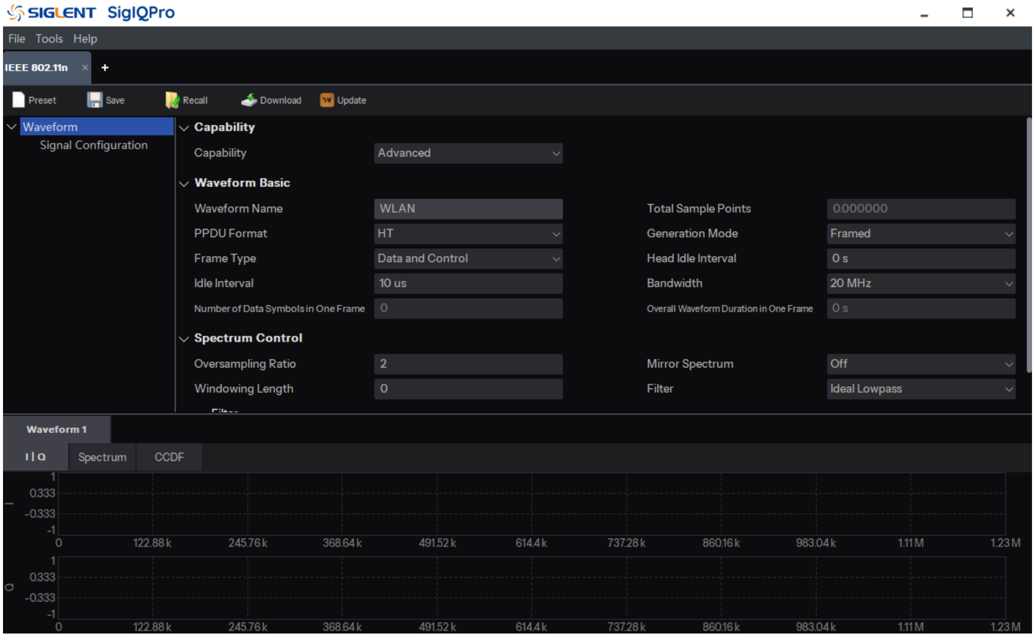
Describes the payload type.

4.15 WLAN_802_11n

On the homepage, click WLAN and select WLAN_802_11n (i.e., WiFi4) to enter the corresponding protocol waveform settings page.



The waveform settings panel is used to configure waveform parameters such as frame type, bandwidth, and modulation scheme.



The WLAN parameter configuration follows a hierarchical structure, roughly divided into levels such as Waveform and Signal Configuration.

4.15.1 Waveform

The Waveform page is divided into three sections: Basic, Waveform Basic, and Spectrum Control.

4.15.1.1 Capability

This interface configures carrier capability parameters.

Capability

Options: Advanced | Basic

Basic: Supports RF testing for all wireless LAN signals except channel coding.

Advanced: Supports full channel-coded waveform testing.

4.15.1.2 Waveform Basic

This interface configures basic waveform parameters.

1. **Waveform Name**

Names the generated waveform. If not configured by the user, the default name is used.

2. **Total Sample Points**

Displays the total number of sampling points.

3. PPDU Format

Options: Legacy Mode | HT.

Default value: HT (unchangeable).

Sets the PPDU mode—either Legacy Mode or HT Mode.

4. Generation Mode

Options: Framed | Unframed.

Selects framed or unframed mode for signal generation.

Framed: Required for receiver testing.

Unframed: Useful for component testing or scenarios requiring continuous, non-burst modulation.

5. Frame Type

Options: Data and Control | Beacon.

Selects the frame type—Data Frame, Control Frame, or Management Frame (e.g., Beacon Frame).

6. Head Idle Interval

Configurable range: 0–20 μs. Default value: 0 μs.

Sets the length of the idle time before the frame header (in microseconds).

7. Idle Interval

Configurable range: 0–20 μs. Default value: 0 μs.

Sets the length of the idle time between frames (in microseconds).

8. Bandwidth

Options: 20 MHz | 40 MHz.

Sets the bandwidth value.

9. Number of Data Symbols in One Frame

The number of OFDM symbols in the data portion of a single frame.

10. Overall Waveform Duration in One Frame

The total duration of the complete waveform in one frame (in seconds).

4.15.1.3 Spectrum Control

This interface configures spectrum control parameters.

1. Oversampling Ratio

Configurable range: 1-128, default value: 2.

Sets the oversampling ratio of the baseband signal.

Increasing this parameter raises the actual FFT points during OFDM-modulated baseband signal generation. If set too high, it may reduce signal generation speed or cause crashes due to insufficient memory.

2. Mirror Spectrum

Options: On | Off, default value: Off.

Toggles the enabled state of baseband signal spectrum mirroring.

Spectrum mirroring is achieved by inverting the Q component of the baseband IQ data.

3. Windowing Length

Sets the number of samples for the windowing function. The window length must not exceed the guard interval of the OFDM symbol.

4. Filter

Options:

None: No filter.

Gaussian: Gaussian filter with non-zero inter-symbol interference (ISI).

Root Raised Cosine: Root-raised cosine filter with a circular pulse response at the symbol rate.

Ideal Lowpass: Low-pass filter.

User Defined: Custom filter.

5. Filter Length

Configurable range: 0-1000, default value: 10.

The symbol length determines how many symbol periods are used in the calculation.

6. BT

Configurable range: 0.1–1, default value: 0.5.

Only valid for the Gaussian filter. Determines the degree of signal filtering.

7. Alpha

Configurable range: 0.1–1, default value: 0.5.

Only valid for the root-raised cosine filter. Sets the filter's alpha coefficient.

8. Filter Coefficient

Filter coefficient settings.

9. Frequency Offset

Configurable range: 0–30 MHz, default value: 0 Hz.

Sets the frequency offset relative to the signal generator's output frequency.

4.15.2 Signal Configuration

The Signal Configuration page is divided into two sections: Coding and Modulation and Payloading Configuration.

4.15.2.1 Coding and Modulation

1. MCS Index

Selects the modulation and coding scheme (MCS) for all spatial streams.

2. Number of Spatial Streams

Specifies the number of spatial streams in HT (High Throughput) mode.

3. Modulation

Displays the modulation method corresponding to the selected coding rate.

4. Coding Rate

Displays the coding rate corresponding to the selected data rate.

5. Data Rate

Displays the corresponding data transmission rate.

6. Number of Transmit Chains

The number of independent RF channels used for signal transmission in wireless communication devices (e.g., Wi-Fi routers), directly related to MIMO technology.

HT Mode: Supports up to 4 transmit chains.

7. Number of Spatial Time Streams

Spatial-time streams are data streams in MIMO systems that extend spatial streams through the time dimension, enhancing transmission reliability or capacity.

In 802.11n (HT Mode) and later standards, achieved via space-time coding (e.g., STBC) or beamforming.

8. Number of Extension Spatial Streams

In MIMO systems, additional virtual data streams extended through techniques like channel bonding, higher-order modulation, or beamforming to improve throughput or coverage.

9. Short Guard Interval

The idle time between OFDM symbols, used to combat inter-symbol interference (ISI) caused by multipath effects.

Standard guard interval: 800 ns.

Short guard interval: 400 ns (improves efficiency by ~10% but is more sensitive to multipath delay).

10. Operating Mode

Options: Green Field | Mixed Mode, default value: Green Field.

Selects the preamble and SIGNAL field format in IEEE 802.11n HT Mode.

Green Field: Optimized for pure 802.11n networks (shorter preamble, no legacy compatibility fields, highest efficiency).

Mixed Mode: Retains legacy preamble for compatibility with 802.11a/b/g devices (slightly lower efficiency).

11. Spatial Mapping

Options: Direct Mapping | Spatial Expansion | User-defined.

Determines how spatial streams are mapped to transmit chains in MIMO systems.

Direct Mapping: High efficiency (ideal for pure HT environments).

Spatial Expansion: Enhanced compatibility/coverage.

User-defined: For experimental or specialized optimization.

12. Spatial Mapping Matrix

In 802.11n (HT Mode) MIMO systems, this matrix maps spatial streams to transmit antenna chains.

13. Scrambler

Options: On | Off. Default value: On.

Enables/disables data scrambling.

14. Scrambler Initialization

Sets the initial seed for the pseudo-random sequence generator, ensuring synchronized scrambling/descrambling between transmitter and receiver.

15. Channel Coding State

Options: On | Off. Default value: On.

Enables/disables channel coding.

16. Channel Coding Mode

Options: BCC | LDPC. Default value: BCC.

Selects the channel coding scheme for error correction:

BCC (Binary Convolutional Code): Traditional coding, low complexity, suitable for low-latency scenarios.

LDPC (Low-Density Parity-Check): Ideal for high-throughput or high-SNR environments.

17. Interleaver

Options: On | Off. Default value: On.

Enables/disables the interleaver.

BCC Mode: Must be enabled (convolutional codes are sensitive to burst errors).

LDPC Mode: Optional (LDPC inherently resists burst errors).

4.15.2.2 Payloading Configuration

1. Aggregation MPDU

Options: On | Off. Default value: Off.

Enables/disables MPDU aggregation, combining multiple MAC Protocol Data Units (MPDUs) into a single Physical Layer Frame (PPDU) to significantly improve throughput.

2. Smoothing

Options: On | Off. Default value: On.

Reduces noise or interference caused by signal abruptness, improving signal stability.

3. MPDU Length

Displays the corresponding MPDU length.

4. Data Type

Options: All 0s, PN9, PN15, Custom.

When enabled, the corresponding Seed value setting is displayed.

Sets the data byte pattern in the frame.

5. Data Length

Sets the number of data bytes in the frame.

6. Head Format

Enables/disables prepending the MAC header to the data payload.

7. FCS

Enables/disables appending the MAC FCS to the data payload. If enabled, the software automatically calculates the FCS.

8. Increment Sequence Number

Enables/disables incrementing the sequence number in the Sequence Control field of the MAC header.

9. Sequence Number Increment by: (Frames)

Configurable range: 0–15. Default value: 1.

Controls the increment rule for the sequence number field in the MAC header (used for frame ordering, deduplication, and reassembly).

10. Increment Fragment Number

Options: On | Off. Default value: On.

Controls the increment behavior of the fragment number in the MAC header (used for reassembling fragmented frames).

Only effective when Sequence Control is enabled.

Applies only to fragmented frames.

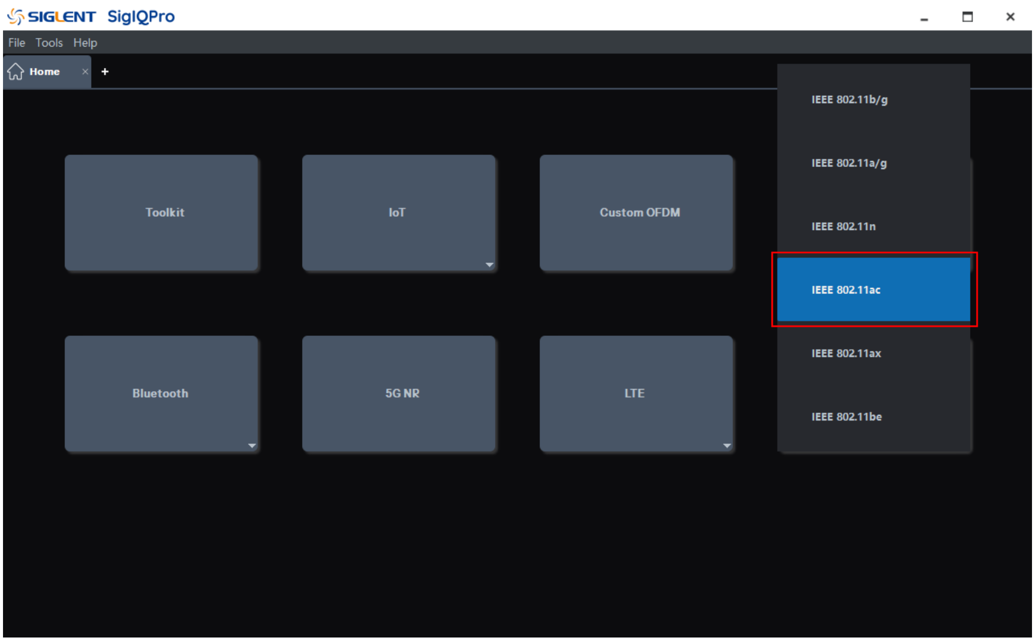
11. Number of Frames

Configurable range: 1–2000. Default value: 1.

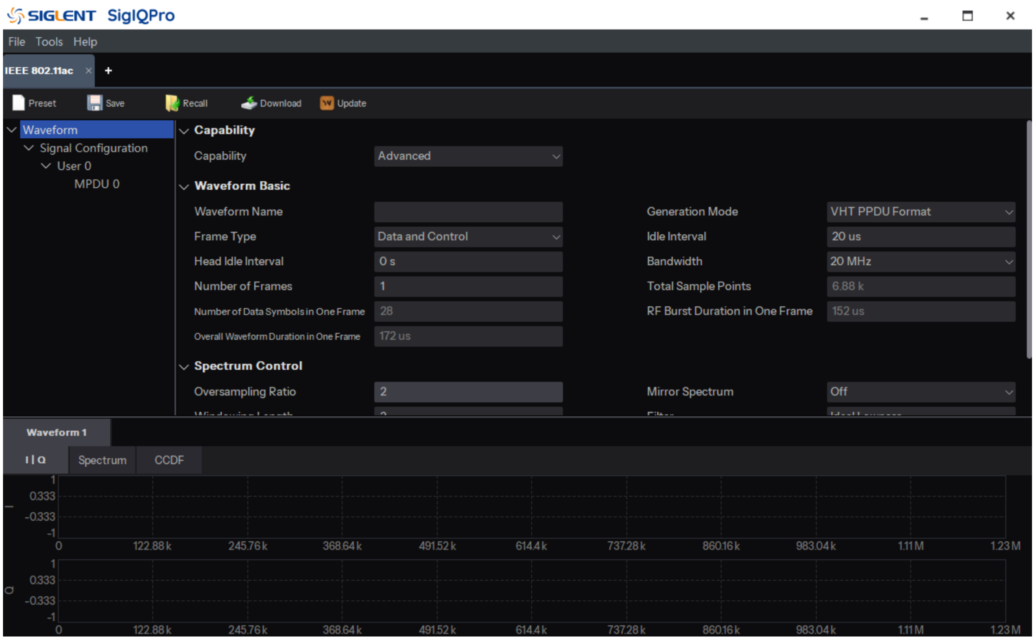
Sets the number of frames used in the waveform.

4.16 WLAN_802_11ac

On the homepage, click WLAN and select WLAN_802_11ac (i.e., WiFi5) to enter the corresponding protocol waveform settings page.



The waveform settings panel is used to configure waveform parameters such as frame type, bandwidth, and modulation scheme.



The WLAN parameter configuration follows a hierarchical structure, roughly divided into levels such as Waveform, Signal Configuration, User, and MPDU.

4.16.1 Waveform

The Waveform page is divided into three sections: Capability, Waveform Basic, and Spectrum Control.

4.16.1.1 Capability

Capability

Options: Advanced | Basic

Basic: Supports RF testing for all wireless LAN signals except channel coding.

Advanced: Supports full channel-coded waveform testing.

4.16.1.2 Waveform Basic

1. Waveform Name

Names the generated waveform. If not configured by the user, the default name is used.

2. Generation Mode

Options: VHT PPDU Format | VHT NDP Format | Non-HT, default value: VHT PPDU Format.

VHT PPDU Format (default): Standard 802.11ac format supporting high-speed data transmission (up to 8 spatial streams, 256-QAM).

VHT NDP Format: Null Data Packet, used for channel sounding (e.g., beamforming training) or ACK feedback, with no payload.

Non-HT: Legacy mode compatible with 802.11a/g devices (lower spectral efficiency but wider coverage).

3. Frame Type

Options: Data and Control | Beacon, currently only Data and Control is available.

Selects the frame type—Data Frame, Control Frame, or Management Frame (e.g., Beacon Frame).

4. Idle Interval

Configurable range: 0–200 ms. default value: 20 μs.

Sets the idle time between frames.

5. Head Idle Interval

Configurable range: 0–200 ms.

Default value: 0 μs.

Sets the idle time before the frame header.

6. Bandwidth

Options: 20 MHz | 40 MHz | 80 MHz | 160 MHz | 80+80 MHz.

Default value: 20 MHz.

Sets the bandwidth.

7. Number of Frames

Configurable range: 1–2000. Default value: 1.

Sets the number of frames in the baseband signal exported to a file or transmitted to the signal generator.

8. Total Sample Points

Displays the total number of baseband signal sampling points under the current configuration.

9. Number of Data Symbols in One Frame

Displays the number of OFDM symbols in the Data field of a single frame.

10. RF Burst Duration in One Frame

Displays the duration of the burst signal in one frame.

11. Overall Waveform Duration in One Frame

Displays the complete duration of the signal in one frame (including idle intervals).

4.16.1.3 Spectrum Control

This interface configures spectrum control-related parameters.

1. Oversampling Ratio

Configurable range: 1–128. Default value: 2.

Sets the oversampling ratio of the baseband signal.

Increasing this parameter raises the actual FFT points during OFDM-modulated baseband signal generation. If set too high, it may reduce signal generation speed or cause crashes due to insufficient memory.

2. Mirror Spectrum

Options: On | Off. Default value: Off.

Toggles the enabled state of baseband signal spectrum mirroring.

Spectrum mirroring is achieved by inverting the Q component of the baseband IQ data.

3. Windowing Length

Configurable range: 0–32. Default value: 2 (sampling points).

Sets the transition length (Ttr) of the windowing function, represented in sampling points.

4. Filter

Options: None | Gaussian | Root Raised Cosine | Ideal Lowpass | User Defined.

Default value: None.

Selects the baseband filter type.

4.16.2 Signal Configuration

The Signal Configuration page is divided into three sections: General, Transmission Setting, and Spatial Mapping.

4.16.2.1 General

1. Short Guard Interval

The idle time between OFDM symbols, used to combat inter-symbol interference (ISI) caused by multipath effects.

Standard guard interval: 800 ns.

Short guard interval: 400 ns (improves efficiency by ~10% but is more sensitive to multipath delay).

2. Space Time Block Coding (STBC)

Options: On | Off, default value: Off.

Enables/disables space-time block coding. When enabled, the number of space-time streams doubles the number of spatial streams.

3. Number of Transmit Chains (Ntx)

The number of independent RF channels used for signal transmission in wireless communication devices (e.g., Wi-Fi routers), directly related to MIMO technology.

HT Mode: Supports up to 4 transmit chains.

4. Number of VHT-LTFs (Nvhtltf)

Used for channel estimation and MIMO equalization in 802.11ac (VHT) and 802.11ax (HE) systems.

5. Number of Space Time Streams (Nsts.total)

Displays the total number of space-time streams, equal to the sum of Nsts for all users.

6. Partial AID

A 9-bit field used to briefly identify the intended recipient of the PSDU (Physical Layer Service Data Unit) in Wi-Fi (e.g., 802.11ac/ax) physical layer frame structures, improving multi-user transmission efficiency.

7. Scrambler Initialization

Configurable range: 0-127, default value: 93.

Sets the initial value of the scrambler.

4.16.2.2 Transmission Setting

Transmission Mode

Options: Single User | Multi User, default value: Single User.

Displays the current transmission mode.

4.16.2.3 Spatial Mapping

1. Spatial Mapping

Options: Direct Mapping | Fourier | User-defined.

Determines how spatial streams are mapped to transmit chains in MIMO systems.

Direct Mapping: High efficiency (ideal for pure VHT environments).

Fourier: Uses Fourier transform to analyze channel characteristics and calculate optimal beam weights.

User-defined: For experimental or specialized optimization.

2. Spatial Mapping Matrix

The spatial mapping matrix, defaulting to the identity matrix (Direct mode).

4.16.3 User

The User page is divided into three sections: User Configuration, Modulation and Coding Scheme, and Transmit Data.

4.16.3.1 User Configuration

1. Scrambler

Sets the scrambler initial value (range: 0-127).

2. Channel Coding Mode

Options: BCC | LDPC.

Default value: LDPC.

Selects the channel coding scheme.

3. Channel Coding State

Options: On | Off, default value: On.

Enables/disables channel coding.

4. BCC Interleaver

Options: On | Off, default value: On.

Enables/disables the BCC interleaver.

5. Number of Spatial Streams

Configurable range: 1–8 (Single User) | 1–4 (Multi User), default value: 1.

Sets the number of spatial streams for the current user.

6. Number of Space Time Streams

Displays the number of space-time streams for the current user.

4.16.3.2 Modulation and Coding Scheme

1. MCS Index

Configurable range: 0–11, default value: 8.

Sets the modulation and coding scheme (MCS) index for the current user.

2. Modulation

Displays the modulation method corresponding to the selected MCS.

3. Coding Rate

Displays the coding rate corresponding to the selected MCS.

4. Data Rate

Displays the data rate corresponding to the selected MCS.

4.16.3.3 Transmit Data

1. Aggregated MPDU

Options: On | Off, default value: Off.

Enables/disables MPDU aggregation, combining multiple MAC Protocol Data Units (MPDUs) into a single Physical Layer Frame (PPDU) to significantly improve throughput.

2. PSDU Length

The length of the Physical Layer Service Data Unit (PSDU).

3. Minimum MPDU Start Spacing

Specifies the minimum time interval between adjacent MPDUs when receiving A-MPDU (Aggregated MPDU), affecting transmission efficiency and compatibility.

4. Minimum MPDU Start Spacing in Octets

The minimum byte interval between adjacent MPDUs in A-MPDU, determined by the time interval and data rate.

5. MPDU Length

The total byte length of the A-MPDU before EOF (End-of-Frame) padding, equal to the sum of all A-MPDU subframe lengths.

4.16.4 MPDU

The MPDU parameter settings page.

4.16.4.1 General Settings

1. Data Type

Options: All 0s | PN9 | PN15 | Custom, default value: PN9.

Selects the bit data generation type.

2. PN Seed

If Data Type is a PN sequence, sets the seed for PN sequence generation (default: all 1s).

3. Data Length

Sets the payload data length (unit: bytes).

4. MPDU Length

Displays the MPDU length in bytes.

5. Head Format

MAC frame structure filling. Click to open a dialog for displaying and filling MAC frame fields.

6. FCS

Options: On | Off, default value: On.

Enables/disables adding FCS (Frame Check Sequence) at the end of the frame.

7. Increment Sequence Number

Enables/disables incrementing the sequence number in the Sequence Control field of the MAC header.

8. Sequence Number Increment by: (Frames)

Configurable range: 0–15, default value: 1.

Controls the increment rule for the sequence number field in the MAC header (used for frame ordering, deduplication, and reassembly).

9. Increment Fragment Number

Options: On | Off, default value: On.

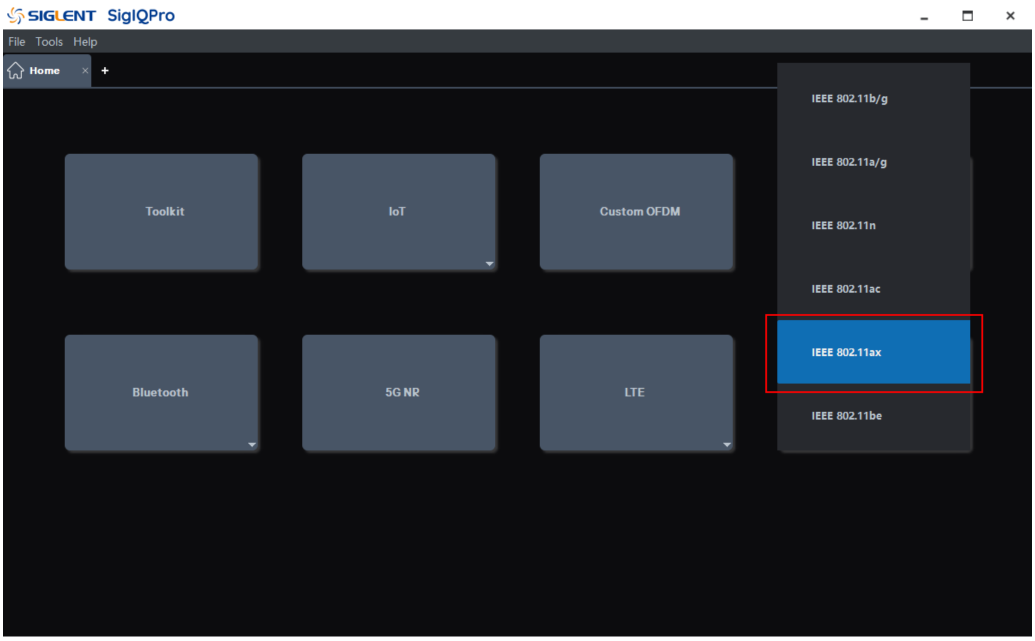
Controls the increment behavior of the fragment number in the MAC header (used for reassembling fragmented frames).

Only effective when Sequence Control is enabled.

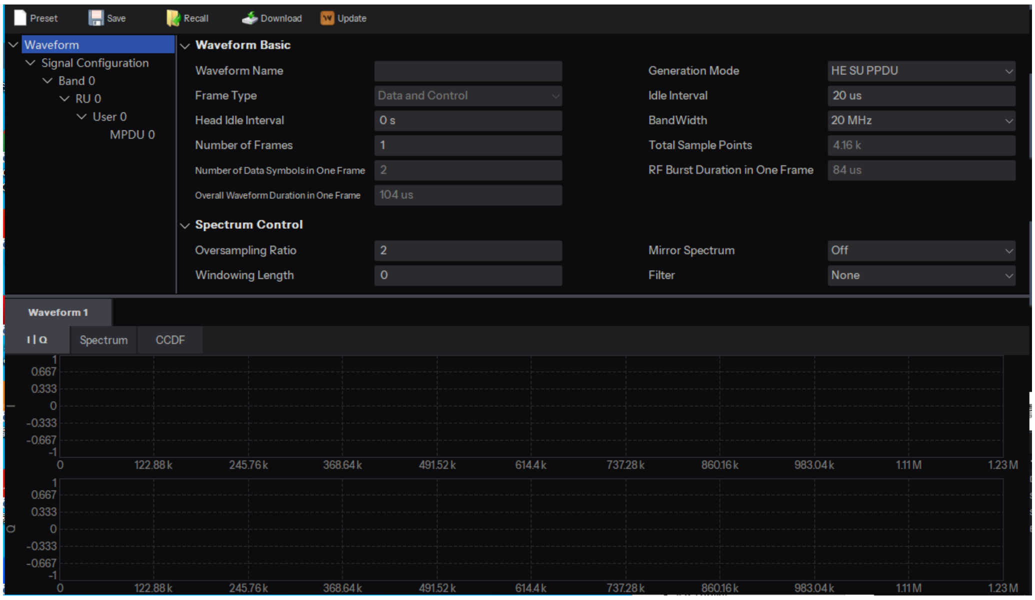
Applies only to fragmented frames.

4.17 WLAN_802_11ax

Home Click WLAN to select WLAN_802_11ax (i.e. WiFi6) to enter the corresponding protocol waveform setting page.



The Waveform Settings panel is used to set the parameters of the waveform, such as frame type, bandwidth, modulation method, etc.



The parameter configuration of WLAN is hierarchical, roughly divided into Waveform, Signal Configuration, Band, RU, User, MPDU and other levels.

4.17.1 Waveform

The Waveform page is divided into two parts: Waveform Basic and Spectrum Control.

4.17.1.1 Waveform Basic

This interface configures the basic parameters of the waveform.

1. Waveform Name

Name the generated waveform. If user does not configure it, the default name will be used.

2. Generation Mode

Options: HE SU PPDU/ HE ER SU PPDU/ HE MU PPDU/ HE Trigger Based PPDU/ HE NDP.

Default value: HE SU PPDU.

Waveform generation method, indicating the frame type of PHY layer PPDU.

3. Frame Type

Indicates the frame type of MAC layer, currently only Data and Control option is available.

4. Idle Interval

Settable range: 0~200ms. Default value: 20us.

Sets the inter-frame idle interval.

5. Head Idle Interval

Settable range: 0~200ms. Default value: 0us.

Set the idle time before frame.

6. BandWidth

Selectable range: 20/40/80/160/80+80 MHz. Default value: 20MHz.

Select the signal bandwidth.

7. Number of Frames

Selectable range: 1~2000. Default value: 1.

Set the number of frames contained in the baseband signal exported to a file or sent to the generator.

8. Total Sample Points

Display the total sample points of baseband signal under current configuration.

9. Number of Data Symbols in One Frame

Displays the number of OFDM symbols in Data field in one frame.

10. RF Burst Duration in One Frame

Displays the duration of the burst signal in one frame.

11. Overall Waveform Duration in One Frame

Displays the overall waveform duration in one frame (including idle interval).

4.17.1.2 Spectrum Control

Parameters related to the spectrum control of this interface.

1. Oversampling Ratio

Settable range: 1 ~ 128. Default value: 2.

Set the oversampling rate of baseband signal.

This parameter will increase the number of actual FFT points when generating the baseband signal for OFDM modulation. If this parameter is too large, it will reduce the signal generation rate and may even lead to a program crash due to lack of memory.

2. Mirror Spectrum

Options: On | Off. Default: Off.

Toggles the state of mirroring the baseband signal spectrum.

Mirror Spectrum is realized by inverting the Q component of the baseband IQ data.

3. Windowing Length

Settable range: 0~32

Default value: 2 samples.

The conversion length (Ttr) of the windowing function, expressed as the number of samples.

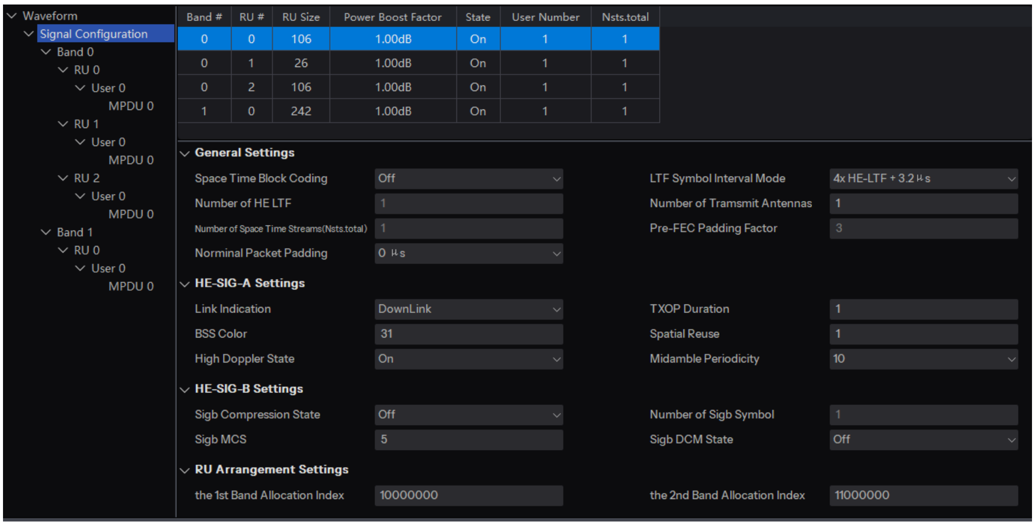
4. Filter

Options: None/Gaussian/Root Raised Cosine/Ideal Lowpass/User Defined.

Default value: None, means no filter.

Select the baseband filter type.

4.17.2 Signal Configuration



Signal Configuration page is divided into General Settings, HE-SIG-A Settings, HE-SIG-B Settings (HE MU), RU Arrangement Settings (HE MU) and Spatial Mapping.

4.17.2.1 General Settings

1. Space Time Block Coding

Options: On | Off .

Default: Off.

If or not the option of Space Time Block Coding is enabled, when it is enabled, the number of space time streams is twice as many as the number of space streams.

2. LTF Symbol Interval Mode

Optional:

1x HE-LTF+0.8us| 2x HE-LTF+0.8us| 2x HE-LTF+16us| 4x HE-LTF+0.8us| 4x HE-LTF+3.2us .

Default value: 4x HE-LTF+3.2us .

Select the HE-LTF type and GI length joint parameter, which is used to adjust the HE-LTF symbol. The HE-LTF type is categorized into 1x, 2x, and 4x methods, and the GI length is categorized into 0.8us, 1.6us, and 3.2us.

3. Number of HE LTF

Displays the number of OFDM symbols of HE-LTF, which is determined by the number of transmitting antennas. It is not editable.

4. Number of Transmit Antennas

Set the number of transmit antennas.

Range: 1~8. Default value: 1.

5. Number of Space Time Streams ($N_{sts,total}$)

Display the total number of space time streams, can not exceed the number of transmit antennas. Cannot be edited.

6. Pre-FEC Padding Factor

Display the pre-FEC padding factor. Range: 1~4, auto-determined, not editable.

7. Norminal Packet Padding

Set the packet extension (i.e. PE) padding length in time.

Optional: 0us, 8us, 16us, default: 0us.

8. Puncture 20MHz subbands

Configured when the bandwidth≥ 80MHz, it indicates the puncturing of 20MHz subchannels. Punctured subchannels are indicated by "0" and unpunctured by "1".

4.17.2.2 HE-SIG-A Settings

1. Link Indication

Indicates whether the packet is transmitted up (UpLink) or down (DownLink). Default: DownLink.

2. TXOP Duration

Fill TXOP length, range: 0~ 127 . Default value: 1.

3. BSS Color

BSS coloring settings, range: 0~ 63 . Default value: 31 .

4. Beam Change

Options: On | Off , Default: On.

(For SU PPDU) Indicates whether the spatial mapping of L-LTF and HE-LTF is the same or not; On means not the same, Off means the same.

5. Spatial Reuse

Setting range: 0~15, default value: 1.

The default value is 1. It is related to the spatial reuse situation and indicates the CCA value.

6. High Doppler State

Selectable range: On | Off, default value: Off.

Indicates the high Doppler state, Off means non-high Doppler, so there is no Midamble in the Data field, On means high Doppler, need to insert Midamble in the Data field.

7. Midamble Periodicity

This item is configured when High Doppler State is On. Optional: 10| 20 , Default: 10.

Indicates how many Data symbols to insert a midamble period.

4.17.2.3 HE-SIG-B Settings

1. Sigb Compression State

Optional: On | Off . Default: Off.

HE-SIG-B Compression State, On means full bandwidth transmission, Off means OFDMA transmission.

2. Number of Sigb Symbol

Displays the number of OFDM symbols for HE-SIG-B, not editable.

3. Sigb MCS

MCS value of HE-SIG-B, settable range: 0~5. Default value: 1.

4. Sigb DCM State

Optional: On | Off . Default: Off.

If or not HE-SIG-B is using DCM modulation, On means DCM modulation is used, and Sigb MCS can only be 0/1/3/4 at this time. Off means no DCM modulation.

5. **Number of Full BW MU-MIMO Users**

This item needs to be configured when Sigb Compression State is On, which indicates the number of users in full bandwidth transmission. The value cannot exceed the Number of Transmit Antennas. Default value: 1.

Note: MU-MIMO transmission will be performed when the number of users exceeds 1.

4.17.2.4 RU Arrangement Settings

1. **Lower Center 26 Tone RU State**

Options: On | Off . Default: Off.

Bandwidth≥ Configured at 80 MHz, indicates the allocation of center-26-tone RUs in the lower 80 MHz band. On means allocated to users with information transmission; Off means not allocated, no information transmission.

2. **Upper Center 26 Tone RU State**

Options: On | Off . Default: Off.

Configured when the bandwidth is 160MHz or 80+80MHz, it indicates the allocation of center-26-tone RUs in the upper 80MHz band. on means allocated to the user, with message transmission; off means not allocated, no message transmission.

3. **the x Band Allocation Index**

The RUs on the 20 MHz subchannels are assigned serial numbers, one serial number value for each 20 MHz subchannel, and the serial number values map a specific RU delineation method.

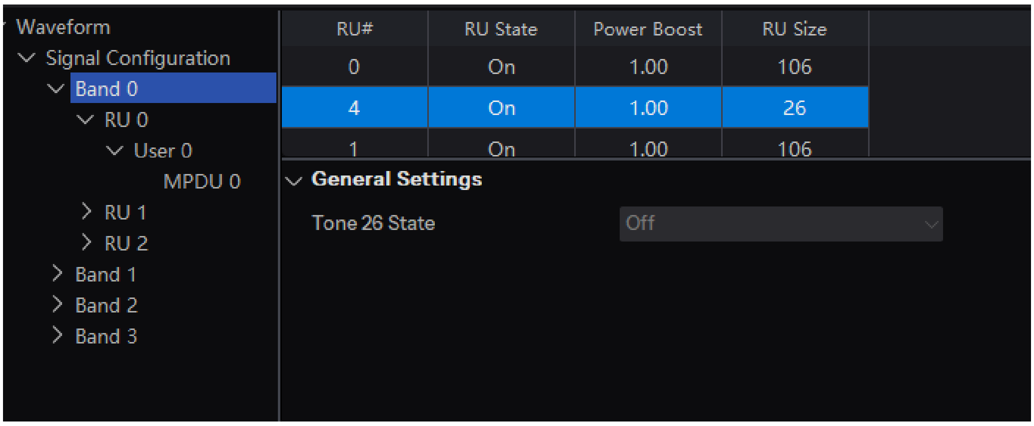
Each RU allocation number is an 8-bit binary number.

4.17.2.5 Spatial Mapping

Spatial Mapping Matrix

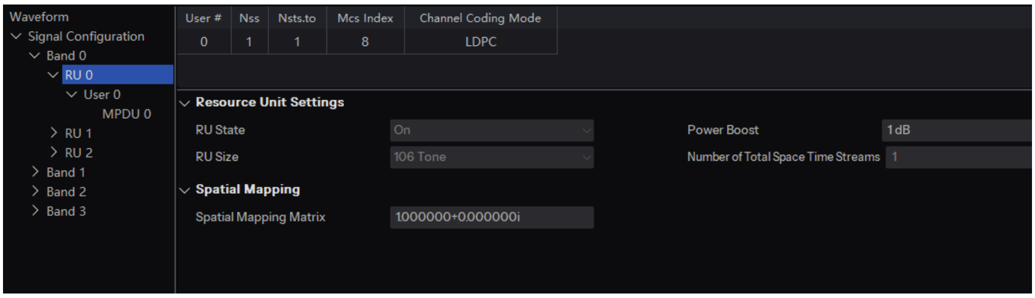
Spatial Mapping Spatial Mapping Matrix, the default is the unit array (Direct mode).

4.17.3 Band



This page displays the setting parameter table of each RU under the corresponding Band.

4.17.4 RU



4.17.4.1 Resource Unit Settings

1. RU State

Options: On | Off , Default: On.

On means the RU will be used to transmit information; Off means the RU is not used and does not carry information.

2. RU Size

Displays the number of subcarriers of the RU and cannot be edited.

3. Power Boost

Configure the power boost factor of this RU, setting range: 0.25 ~ 2 , default value: 1.

4. Number of Total Space Time Streams

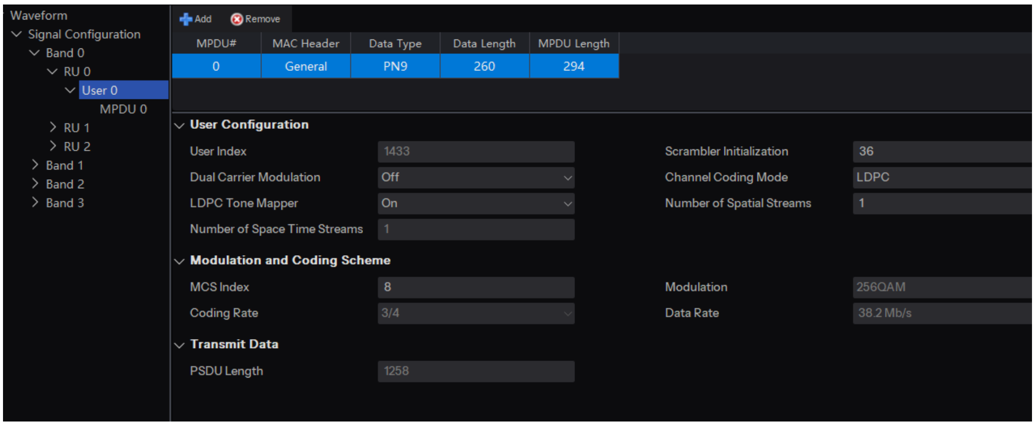
Display the number of Total Space Time Streams of this RU.

4.17.4.2 Spatial Mapping

Spatial Mapping Matrix

Spatial Mapping Spatial Mapping Matrix, the default is unit array (Direct mode).

4.17.5 User



4.17.5.1 User Configuration

1. STA ID

Set user ID number. Range: 0~2047. Default value: 0.

Note: When STA ID is 2046, it means the RU does not transmit data (i.e. empty RU).

2. Scrambler Initialization

Set the initialization value of scrambler, range: 0~127.

3. Dual Carrier Modulation

Optional: On | Off .

Default: Off .

Dual-carrier modulation switch, use DCM modulation when On.

4. Channel Coding Mode

Set the coding mode, select BCC or LDPC, default value: LDPC.

5. LDPC Tone Mapper

On | Off, default value: On.

LDPC Tone Mapper Option: On | Off , default value: On.

6. Number of Spatial Streams

Configure the number of spatial streams for the current user. Setting range: Single User1~ 8 ; Multi-User1~ 4 . Default value: 1.

7. Number of Space Time Streams

Show the number of Space Time Streams of current user.

4.17.5.2 Modulation and Coding Scheme

1. MCS Index

Configure the modulation and coding scheme index of current user data, range: 0~ 11 . Default value: 8.

2. Modulation

After configuring the MCS value, the corresponding modulation mode is displayed.

3. Coding Rate

After configuring the MCS value, the corresponding coding rate is displayed.

4. Data Rate

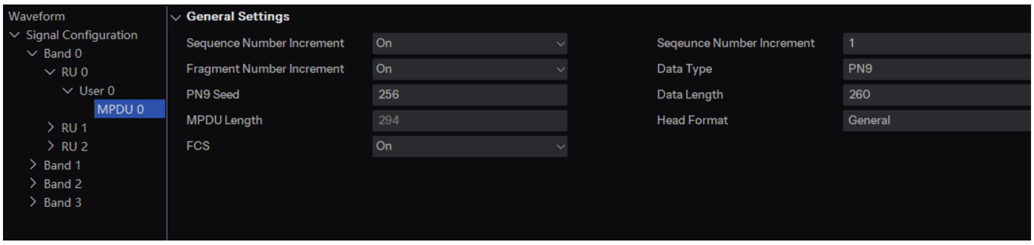
After configuring the MCS value, the corresponding data rate is displayed.

4.17.5.3 Transmit Data

PSDU Length

Displays the number of PSDU bytes.

4.17.6 MPDU



4.17.6.1 General Settings

1. Data Type

Optional: All 0s/PN9/PN15/Custom .

Default is PN9.

Select the type of bit data generation.

2. PN Seed

If Data Type is PN Sequence, set the seed for generating PN sequence. Default: All 1s.

3. Data Length

Set the data length of the load, unit: byte.

4. MPDU Length

Displays the number of bytes of MPDU.

5. Head Format

MAC frame structure filling, click on the pop-up window to display and fill in each field of the MAC frame.

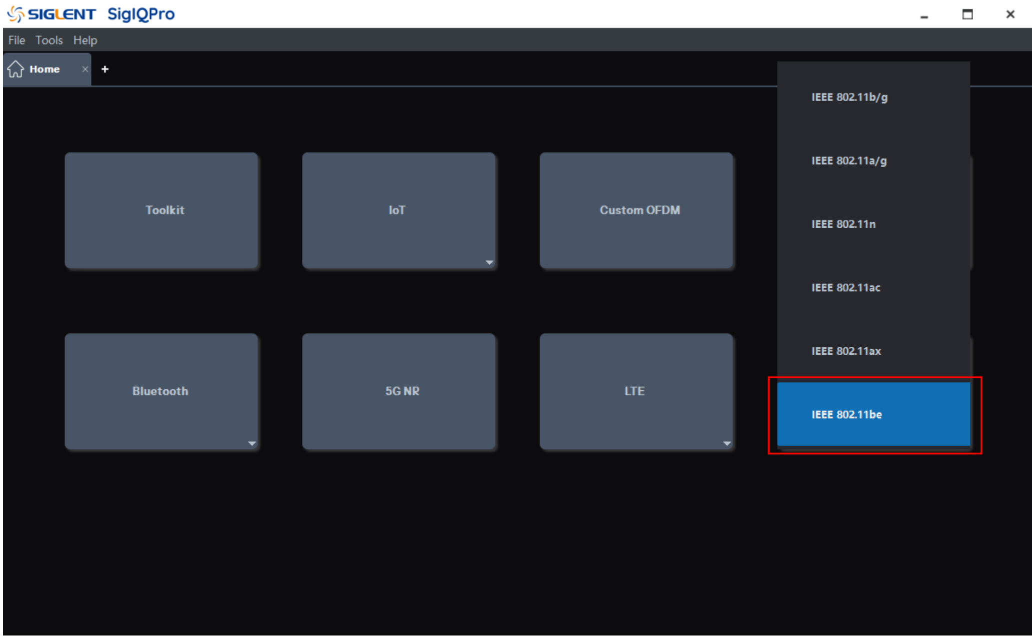
6. FCS

Options: On | Off. Default: On.

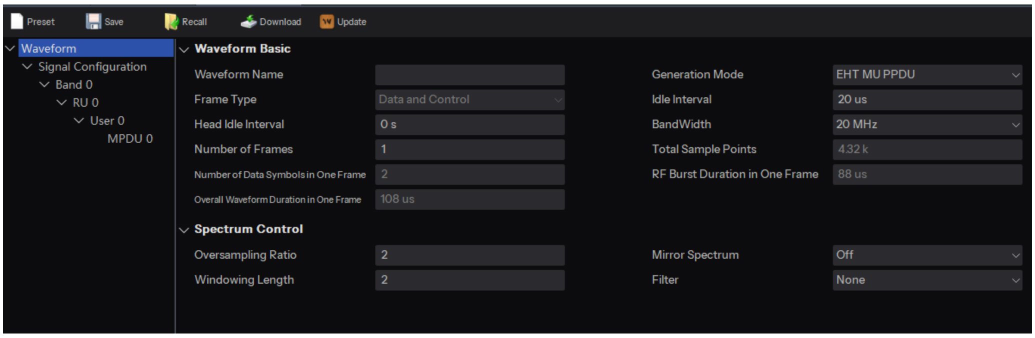
Whether to add FCS check at the end, On means FCS check is needed, Off means no FCS check is added.

4.18 WLAN_802_11be

Click WLAN on the home page and select WLAN_802_11be (i.e. WiFi7) to enter the corresponding protocol waveform setting page.



The Waveform Settings panel is used to set the parameters of the waveform, such as frame type, bandwidth, modulation method, etc.



The parameter configuration of WLAN is hierarchical, roughly divided into Waveform, Signal Configuration, Band, RU, User, MPDU and other levels.

4.18.1 Waveform

The Waveform page is divided into two parts: Waveform Basic and Spectrum Control.

4.18.1.1 Waveform Basic

This interface configures the basic parameters of the waveform.

1. **Waveform Name**

The name of the generated waveform. If user does not configure it, the default name will be used.

2. **Generation Mode**

Optional: EHT MU PPDU/EHT TB PPDU.

Default: EHT MU PPDU.

Generation Mode, indicates the PHY layer PPDU frame type.

3. **Frame Type**

Indicates the frame type of MAC layer, only Data and Control option is available at present.

4. **Idle Interval**

Settable range: 0~200ms.

Default value: 20us.

Sets the inter-frame idle interval.

5. **Head Idle Interval**

Settable range: 0~200ms .

Default value: 0us .

Set the idle time before frame.

6. **BandWidth**

Selectable range: 20/40/80/160/320 MHz .

Default value: 20MHz.

Select the signal bandwidth.

7. **Channelization**

Options: 320 MHz-1/320 MHz-2.

Default: 320 MHz-1.

When the bandwidth is 320 MHz, select the channelization mode.

8. Phase Rotation Coefficients

Options: -1;-1;-1/-1;-1;1/-1;1;-1/-1;1;1/1;-1;-1;-1;-1/1;-1;-1/1;-1;1/1;1;-1/1;1;-1/1;1;1;1; 1,

Default: 1;-1;-1.

When the bandwidth is 320 MHz, select the phase rotation coefficients of the last three 80 MHz blocks.

9. Number of Frames

Range: 1~2000. Default Value: 1 .

Set the number of frames contained in the baseband signal exported to a file or sent to the generator.

10. Total Sample Points

Displays the total sample points of baseband signal under current configuration.

11. Number of Data Symbols in One Frame

Displays the number of OFDM symbols in Data field in one frame.

12. RF Burst Duration in One Frame

Displays the duration of RF Burst in One Frame.

13. Overall Waveform Duration in One Frame

Displays the full waveform duration in One Frame (including idle interval).

4.18.1.2 Spectrum Control

Parameters related to the spectrum control of this interface.

1. Oversampling Ratio

Settable range: 1 ~ 128 . Default value: 2 .

Set the oversampling rate of baseband signal.

This parameter will increase the number of actual FFT points when generating the baseband signal for OFDM modulation. If this parameter is too large, it will reduce the signal generation rate and may even cause the program to crash due to lack of memory.

2. Mirror Spectrum

Options: On | Off. Default: Off.

Toggles the state of mirroring the baseband signal spectrum.

Mirror Spectrum is realized by inverting the Q component of the baseband IQ data.

3. Windowing Length

Settable range: 0~32. Default value: 2 samples.

The conversion length (Ttr) of the windowing function, expressed as the number of samples.

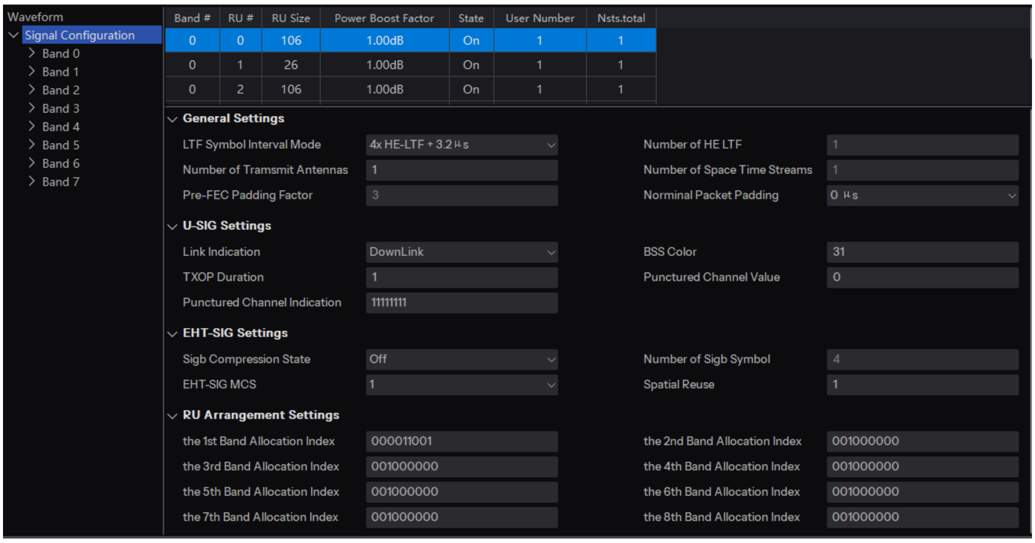
4. Filter

Options: None/Gaussian/Root Raised Cosine/Ideal Lowpass/User Defined.

Default value: None, means no filter.

Select the baseband filter type.

4.18.2 Signal Configuration



Signal Configuration page is divided into General Settings, U-SIG Settings, EHT-SIG Settings(EHT MU), RU Arrangement Settings.

4.18.2.1 General Settings

1. LTF Symbol Interval Mode

Optional: 2x EHT-LTF+0.8us|2x EHT-LTF+1.6us|4x EHT-LTF+0.8us|4x EHT-LTF+3.2us .

Default: 4x EHT-LTF+0.8us|4x EHT-LTF+3.2us.

Default value: 4x EHT-LTF+3.2us .

Select the joint parameter of EHT-LTF type and GI length to adjust the EHT-LTF symbol.

EHT-LTF type is categorized into 2x and 4x, and GI length is categorized into 0.8us, 1.6us and 3.2us.

2. Number of EHT LTF

Displays the number of OFDM symbols of EHT-LTF, which is determined by the number of transmitting antennas. Not editable

3. Number of Transmit Antennas

Set the number of transmitting antennas, range: 1~ 8 , default: 1.

4. Number of Total Spatial Streams ($N_{ss,total}$)

Display the total number of spatial streams, cannot exceed the number of transmit antennas. Cannot be edited.

5. Pre-FEC Padding Factor

Display the pre-FEC Padding Factor, range: 1~4, auto-determined, non-editable.

6. Norminal Packet Padding

Set the packet extension (PE) padding length in time. Can be 0us, 8us, 16us. Default value: 0us.

4.18.2.2 U-SIG Settings

1. Link Indication

Indicates whether the packet is transmitted up (UpLink) or down (DownLink). Default value: DownLink.

2. TXOP Duration

Fill TXOP length, range: 0~127. Default value: 1.

3. BSS Color

BSS Color Setting, range: 0~63. Default value: 31.

4. Punctured Channel Value

Set to "0" or "1", default is "0".

Set the value of the punched sub-channel, for example, "0" for punched and "1" for unpunched.

5. Punctured Channel Indication

Punctured Channel Indication, a set of binary values, each bit represents the punched condition of a 20MHz sub-channel. The default is not punched.

4.18.2.3 EHT-SIG Settings

1. Compression State

Options: On | Off . Default: On.

EHT-SIG Compression status, On for full bandwidth transmission, Off for OFDMA transmission.

2. Number of EHT-SIG Symbol

Displays the number of OFDM symbols of EHT-SIG, not editable.

3. EHT-SIG MCS

EHT-SIG MCS value, range: 0/1/3/15. Default value: 1.

4. Number of Full BW MU-MIMO Users

This item needs to be configured when Compression State is On, and indicates the number of users in full bandwidth transmission. The value cannot exceed the Number of Transmit Antennas.

Default value: 1.

Note: MU-MIMO transmission will be performed when the number of users exceeds 1.

5. Spatial Reuse

Settable range: 0~ 15 . Default value: 1.

Indicates the CCA value in relation to spatial reuse.

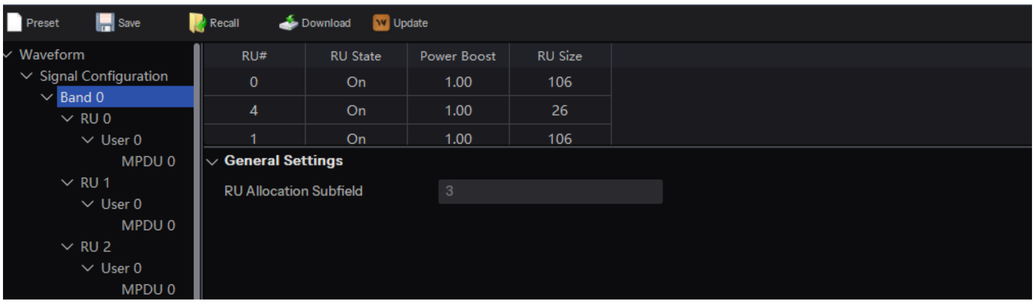
4.18.2.4 RU Arrangement Settings

the x Band Allocation Index

The RU allocation number on the 20 MHz subchannels has a number value for each 20 MHz subchannel, which maps to a specific M/RU division.

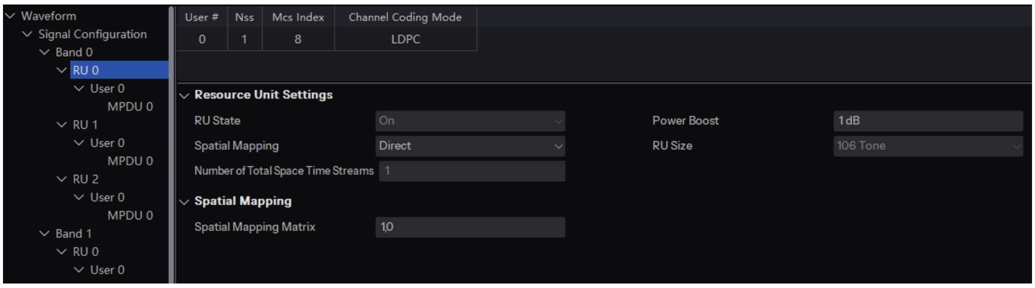
Each M/RU allocation number is a 9-bit binary number.

4.18.3 Band



This page displays a table of setting parameters for each RU under the corresponding Band.

4.18.4 RU



4.18.4.1 Resource Unit Settings

1. RU State

Options: On | Off . Default: On.

On means the RU will be used to transmit information; Off means the RU is not used and does not carry information.

2. RU Size

Displays the number of subcarriers in the RU, not editable.

3. Power Boost

Configure the power boost factor of this RU, setting range: 0.25 ~ 2 . Default value: 1.

4. Number of Total Spatial Streams

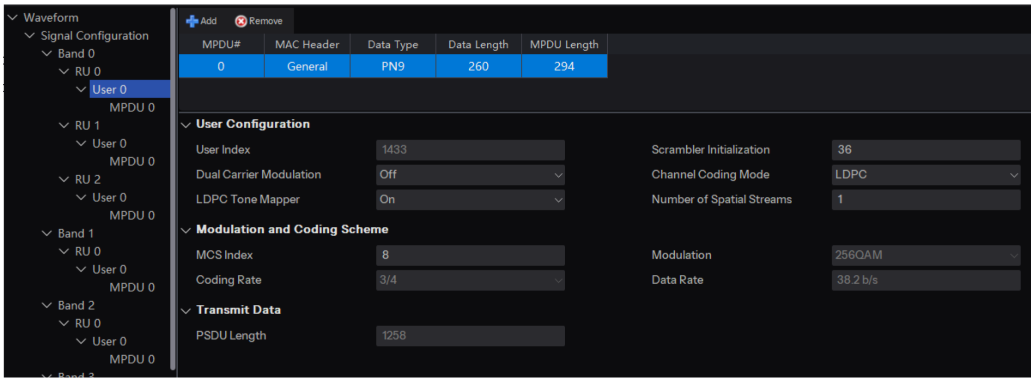
Display the number of total spatial streams of this RU.

4.18.4.2 Spatial Mapping

Spatial Mapping Matrix

Spatial Mapping Spatial Mapping Matrix, the default is unit array (Direct mode).

4.18.5 User



4.18.5.1 User Configuration

1. STA ID

Set the user ID number, range: 0-2047, default: 0.

Note: When STA ID is 2046, it means the RU does not transmit data (i.e. empty RU).

2. Scrambler Initialization

Set the initialization value of scrambler, range: 0~2047.

3. Channel Coding Mode

Option: BCC/LDPC.

Set the coding mode, default is LDPC.

4. LDPC Tone Mapper

Option: On | Off . Default: On.

LDPC Tone Mapper: On | Off . Default: On.

5. Number of Spatial Streams

Configure the number of spatial streams for current user.

Setting range: 1~8 for single user, 1~4 for multi-user.

Default value: 1.

4.18.5.2 Modulation and Coding Scheme

1. MCS Index

Configure the modulation and coding scheme index of current user data,

range: 0~ 13,15. Default: 8.

2. Modulation

After configuring the MCS value, the corresponding modulation mode is displayed.

3. Coding Rate

After configuring the MCS value, the corresponding coding rate is displayed.

4. Data Rate

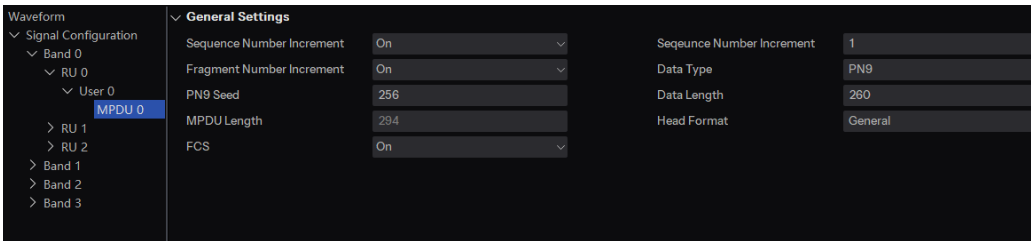
After configuring the MCS value, the corresponding data rate is displayed.

4.18.5.3 Transmit Data

PSDU Length

Displays the number of PSDU bytes.

4.18.6 MPDU



General Settings

1. **Data Type**

Optional: All 0s/PN9/PN15/Custom , default is PN9.

Select the type of bit data generation.

2. **PN Seed**

If Data Type is PN Sequence, set the seed for generating PN sequence. Default: All 1s.

3. **Data Length**

Set the data length of the load, unit: byte.

4. **MPDU Length**

Display the number of bytes of MPDU.

5. **Head Format**

Fill in the MAC frame structure, click it to pop-up window to display and fill in each field of the MAC frame.

6. **FCS**

Options: On | Off, Default: On.

Whether to add FCS checksum at the end, On means FCS checksum is required, Off means FCS checksum is not added.

5 Troubleshooting

If there is an exception when SigIQPro downloads waveforms to SIGLENT signal source or when SIGLENT signal source plays the downloaded waveform, please first check whether there are the following problems.

1. **SigIQPro prompts the download failed**

   If SigIQPro prompts that the download failed, please check whether the connection between SigIQPro and SIGLENT signal source is normal.

2. **SigIQPro prompts the download is successful, but the SIGLENT signal source does not receive the waveform**

   - Check whether the software version is correct

     If you have installed an old software version, please update to the correct version.

   - Check if the correct options are installed

     If the correct option has not been installed and the trial times of the option has been 0, the waveform will not be downloaded to the signal generator. Please install the correct option.

   For more information, please refer to "Hardware Requirements".

3. **The waveform download is successful, but there is an exception when playing the waveform**

   - Check the waveform sample rate

     If waveform sample rate * oversampling ratio exceeds the valid range of instrument sample clock, the downloaded waveform may not be played correctly.

   - Check the waveform points

     If the number of waveform points exceeds the valid range of the number of instrument sampling points, the downloaded waveform may not be played correctly.

     In the above two situations, SigIQPro and SIGLENT signal sources will have prompt messages, please check carefully.

If the problem still remains, please contact **SIGLENT** and provide the details. Thank you!

6 Service and Support

6.1 Service Summary

SIGLENT warrants that the products that it manufactures and sells will be free from defects in materials and workmanship for a period of three years (accessories for a period of one year) from the date of shipment from an authorized Siglent distributor. If the product proves defective within the respective period, **SIGLENT** will provide repair or replacement as described in the complete warranty statement.

To arrange for service or obtain a copy of the complete warranty statement, please contact your nearest Siglent sales and service office. Except as provided in this summary or the applicable warranty statement, **SIGLENT** makes no warranty of any kind, express or implied, including without limitation the implied warranties of merchantability and fitness for a particular purpose. In no event shall **SIGLENT** be liable for indirect, special or consequential damages.

6.2 Contact Us

China:

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About SIGLENT

SIGLENT is an international high-tech company, concentrating on R&D, sales, production and services of electronic test & measurement instruments.

SIGLENT first began developing digital oscilloscopes independently in 2002. After more than a decade of continuous development, SIGLENT has extended its product line to include digital oscilloscopes, isolated handheld oscilloscopes, function/arbitrary waveform generators, RF/MW signal generators, spectrum analyzers, vector network analyzers, digital multimeters, DC power supplies, electronic loads and other general purpose test instrumentation. Since its first oscilloscope was launched in 2005, SIGLENT has become the fastest growing manufacturer of digital oscilloscopes. We firmly believe that today SIGLENT is the best value in electronic test & measurement.

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