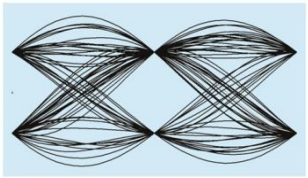


MaxEye Digital Video Signal Generation

DVB-T Signal Generation Toolkit

Version 1.0.0

Getting Started Guide

MAXEYE TECHNOLOGIES

Contents

List of Abbreviations

DVB-T: Digital Video Broadcasting - Terrestrial

SFP: Soft Front Panel

RFSG: Radio Frequency Signal Generator

OFDM: Orthogonal Frequency Division Multiplexing

AWG: Arbitrary Waveform Generator

BER: Bit Error Ratio

VST: Vector Signal Transceiver

AWGN: Additive White Gaussian Noise

FFT: Fast Fourier Transform

PAPR: Peak to average power ratio

API: Application Program Interface

1 Introduction

MaxEye Technologies provides generation functions in LabVIEW and C for generating the standard complaint signals for various digital audio and video broadcasting standards. This guide explains how to use the DVB-T signal generation toolkit using the Soft Front Panel (SFP) and programming examples by using NI Vector Signal Transceiver (NI VST).

DVB-T is an abbreviation for "Digital Video Broadcasting - Terrestrial", it is the DVB European-based consortium standard for the broadcast transmission of digital terrestrial television that was first published in 1997 and first broadcast in the UK in 1998. This system transmits compressed digital audio, digital video and other data in an MPEG transport stream, using Orthogonal Frequency Division Multiplexing (OFDM) modulation.

2 Installed File Location

2.1 Soft Front Panel

The DVB-T signal generation soft front panel is located in, C:\Program Files(x86)\MaxEye\Digital Video Toolkits\DVB-T Generation\Application

(***Note***: - *For 32-bit Operating System*, SFP is located in C:\Program Files\MaxEye\Digital Video Toolkits\DVB-T Generation\Application)

You can also find a shortcut to the above location from the windows start menu.
Start->All Programs->MaxEye->Digital Video Toolkits->DVB-T Generation
Note: - *For Windows 10,* **Start-> MaxEye**.

2.2 Programming Examples

The Remote LabVIEW programming examples are installed in, <LabVIEW>\examples\MaxEye \Digital Video Toolkits\DVB-T Generation\Remote.

The remote C Examples are located in, C:\Program Files(x86)\MaxEye\Digital Video Toolkits \DVB-T Generation\Examples\C

(***Note***: - *For 32-bit Operating System*, C Examples are located in C:\Program Files\MaxEye\Digital Video Toolkits\DVB-T Generation\Examples\C)

You can also find a shortcut to the above location from the windows start menu.

Start->All Programs->MaxEye->Digital Video Toolkits->DVB-T Generation->Examples
Note: - *For Windows 10,* **Start-> MaxEye**.

2.3 Remote API VIs

The Remote LabVIEW APIs are installed in, <LabVIEW>\vi.lib\addons\MaxEye\Digital Video Toolkits\DVB-T Generation\Generation\API.

2.4 Documentation

The toolkit help file is installed in, <LabVIEW>\help\MaxEye\Digital Video Toolkits\MaxEye DVB-T Signal Generation Help.chm

The toolkit documentation files are installed in C:\Program Files(x86)\MaxEye\Digital Video Toolkits\DVB-T Generation\Documentation.

(***Note**: - For 32-bit Operating System*, toolkit documentation are located in C:\Program Files\MaxEye\Digital Video Toolkits\DVB-T Generation\Documentation)

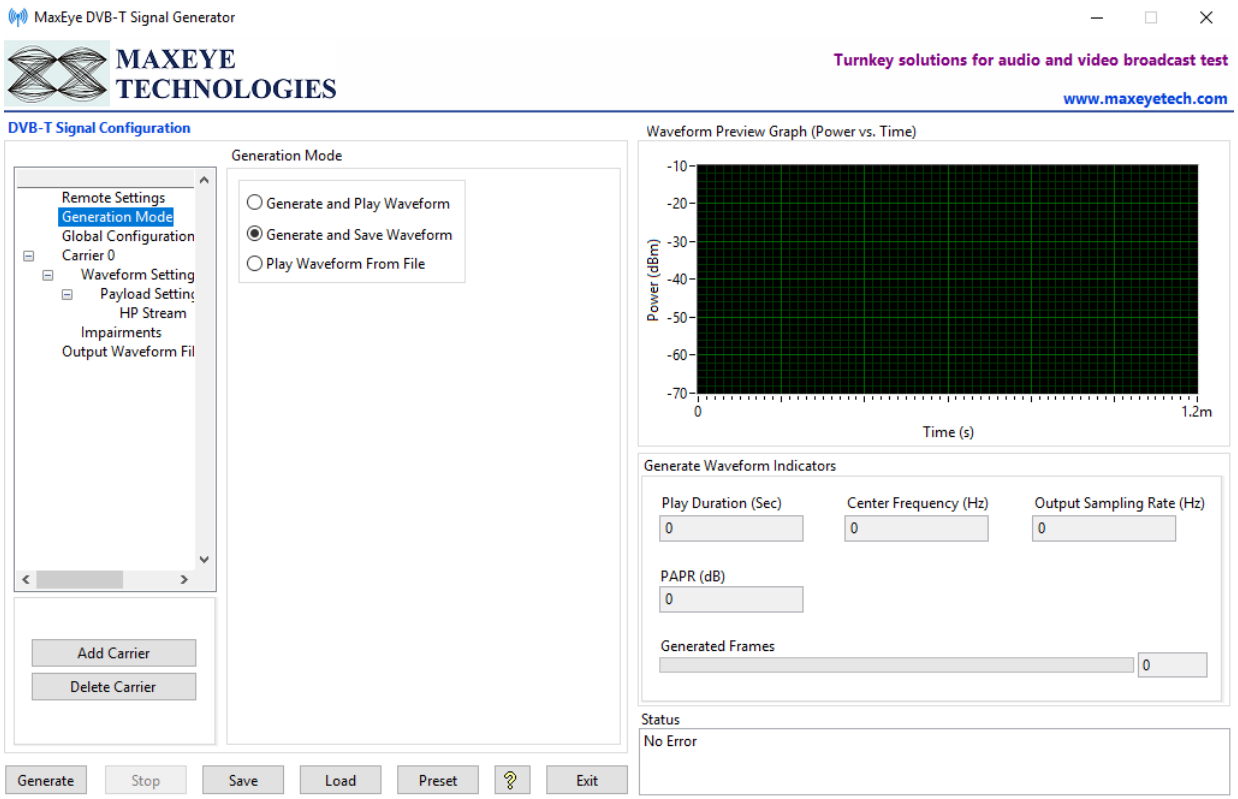
You can also find a shortcut to the above location from the windows start menu.
Start->All Programs->MaxEye->Digital Video Toolkits->DVB-T Generation-> Documentation
***Note**: - For Windows 10,* **Start-> MaxEye**.

3 Soft Front Panel

The soft front panel (SFP) for DVB-T Signal Generator allows engineer to quickly generate the signals by selecting appropriate generation mode and other configurations. The default signal generation mode of the SFP is Generate and Save Waveform in file and in this mode the generated waveform is stored in a file. Multiple carriers (stations) can also be generated using SFP.

3.1 MaxEye DVB-T Signal Generation SFP

The figure below shows the DVB-T Signal Generation SFP.



3.1.1 Generate and Save Waveform/Generate and Play Waveform

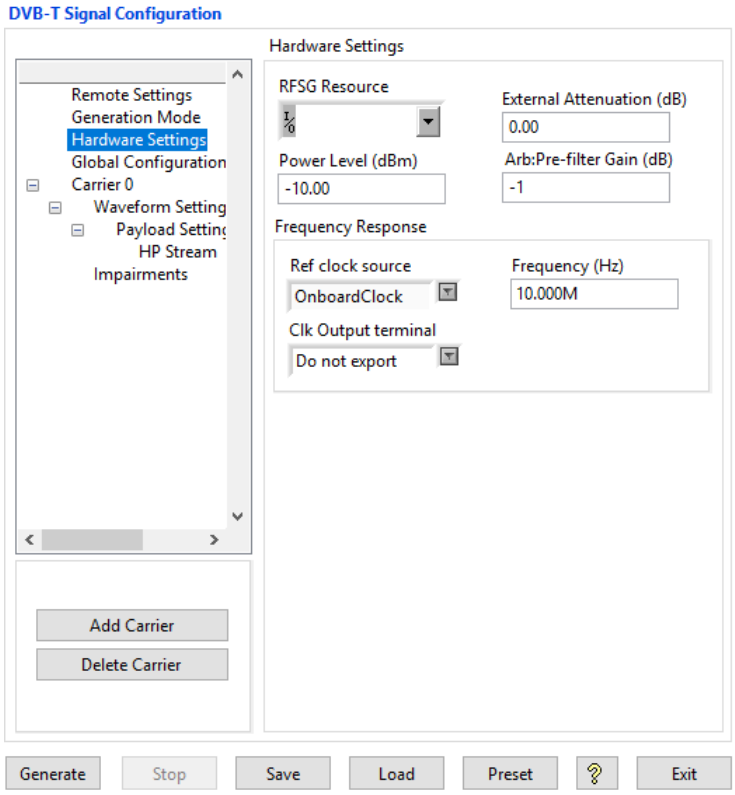
Generate and Play waveform is used to generate DVB-T signal using hardware. Generate and Save waveform is used to generate the baseband IQ waveform and store in a file. For this mode hardware is not required. The Play Waveform from File mode reads the DVB-T waveform from the file created using the Generate and Save Waveform and then downloads the waveform to NI Radio Frequency Signal Generator (RFSG) Memory and then plays the waveform.

Use the Generate and Save Waveform mode

- To generate and store the custom waveforms based on your test requirement.
- To avoid generating the waveform at the beginning of your test every time. This reduces your test starting time as some of the signal configuration will take longer to generate the waveform.
- For generating the longer duration waveform as the RFSG memory size is limited.
- For testing your receiver for continuous signal reception.
- For receiver sensitivity measurement Bit Error Ratio (BER) for longer duration.

Follow the procedure below to generate signals using these generation modes.

1. Select **Generation Mode** -> **Generate and Save Waveform** or **Generate and Play Waveform**
2. Select **Hardware Settings** to configure the following parameters.



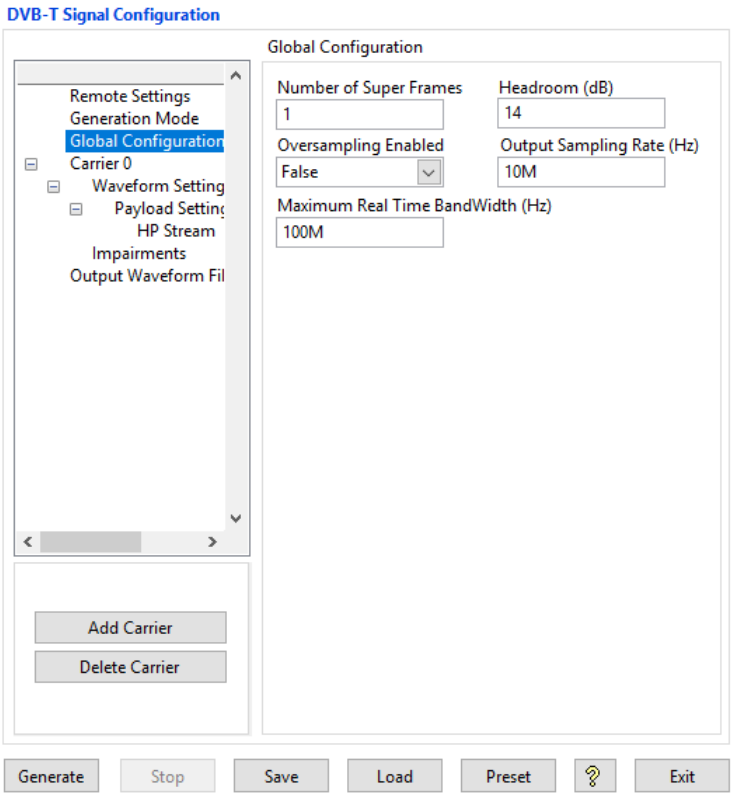
Note: *- These settings need not to be configured if the chosen Generation Mode is Generate and Save Waveform.*

- **RFSG Resource –** Configure the Resource Name used in NI Measurement and Automation Explorer (NI MAX) for the AST-100 and NI PXIe-5840 device.
- **Power Level (dBm) –** Specifies the Average Power level of the signal in dBm.
- **External Attenuation (dB) –** Specifies the external amplification or attenuation, in dB, if any, between the NI RF signal generator and the device under test. Positive values for this property represent amplification, and negative values for this property represent attenuation.
- **Arb: Pre-filter Gain (dB) –** Specifies the Arbitrary Waveform Generator (AWG) Pre-filter Gain, in dB. The pre-filter gain is applied to the waveform data before any other signal processing. Reduce this value to prevent overflow in the AWG interpolation filters. Other gains on the NI-RFSG device are automatically adjusted to compensate for non-unity AWG pre-filter gain.

- **Reference Source –** Specifies the source of the Reference Clock signal.
- **Frequency (Hz) –** Specifies the Reference Clock rate, in Hertz (Hz).
- **Clk Output Terminal –** Specifies the terminal where the signal will be exported.

For more information on External Attenuation (dB), Arb: Pre-filter Gain (dB), Reference Source, Frequency (Hz), Clk Output Terminal, please refer NI RFSG Signal Generators help file.

3. Select **Global Configuration** to configure the following parameters.



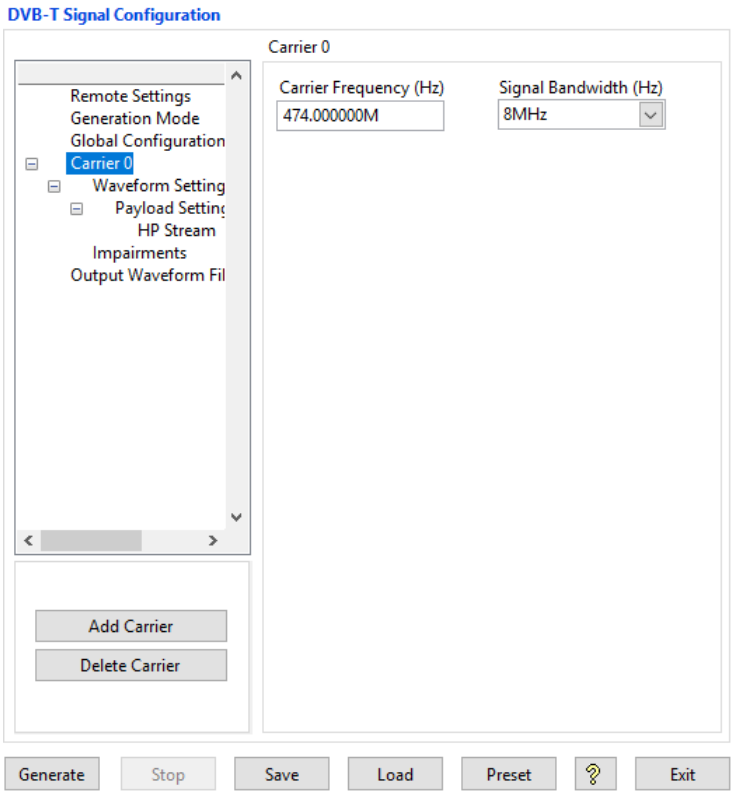
- **Number of Super Frames** – Configure the required number of Transmission Super Frames. The Number of Super Frames property decides the length of waveform to be generated.
- **Headroom (dB) –** Specifies the Headroom value higher than PAPR of the signal to be generated. For more information, please refer MaxEye DVB-T Signal Generation Help.chm.
- **Oversampling Enabled & Output Sampling Rate (Hz) –** Use this configuration only when you want to resample the signal to different sampling rate. The toolkit resamples the generated signal to a sampling rate equal to the **Output Sampling Rate** only if the **Over Sampling Enabled property** is set to True .
- **Maximum Real-Time Bandwidth (Hz) –** The available bandwidth to combine the multi carrier waveform based on the selected hardware.

4. Select **Carrier** to configure the following parameters.

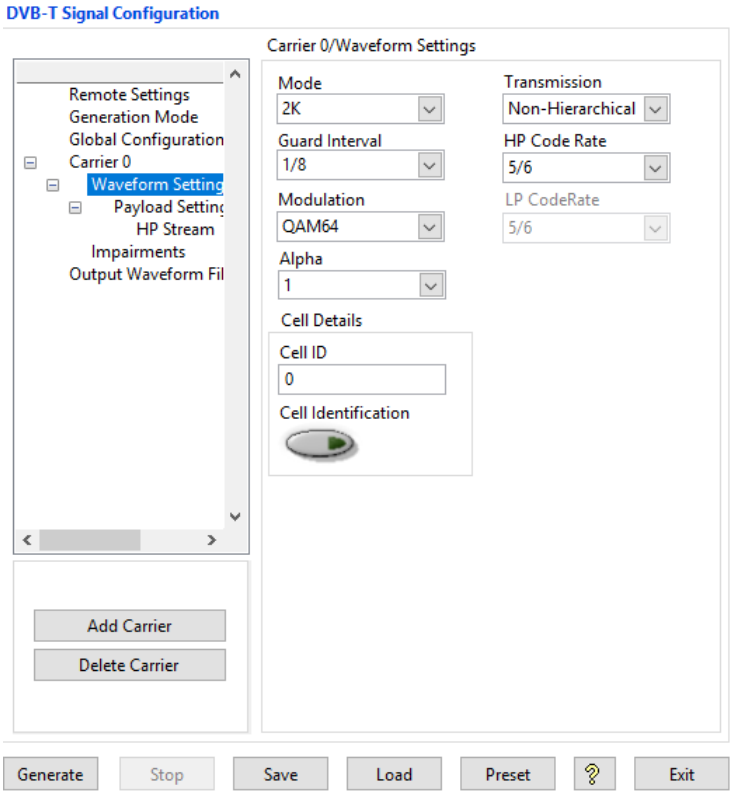
- **Carrier Frequency (Hz)** – Configure the Carrier Frequency for the selected carrier in Hz.
- **Signal Bandwidth (Hz) –** Configure the Bandwidth of the signal for the selected carrier. The toolkit internally uses the Carrier Frequency and Bandwidth property values internally to compute the overall bandwidth and sampling rate of the signal when more than one carrier is used.

  Note: *- By default, the tree control shows Carrier 0. To configure more carriers, click the Add Carrier button and* configure *the following parameters for each carrier.*

  The figure below shows the carrier configuration for each carrier.



4.1 Select **Waveform Settings** to configure the following parameters for the selected carrier.

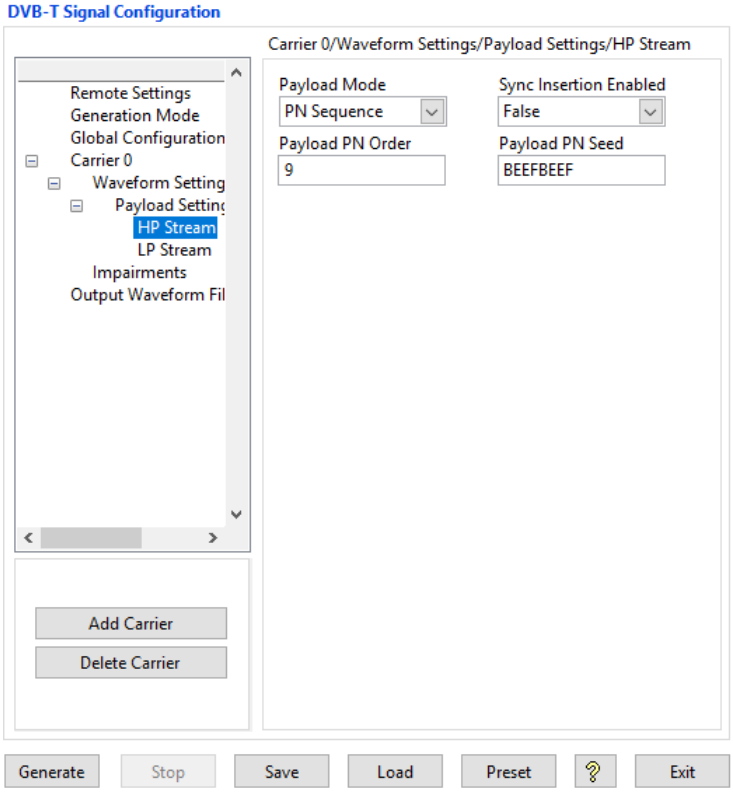


- **Mode –** Configure the Mode Selection for the selected carrier. The valid enum values are 2K, 8K and 4K. The mode selection determines the number of subcarriers used for data, pilot and other control information.
- **Guard Interval –** Configure the Guard Interval for the selected carrier. The Guard Interval is used to specify the length of cyclic prefix as a fraction of the total FFT size. The FFT size in 2K, 8K and 4K are 2048, 8192 and 4096 respectively.
- **Alpha –** Configure the Alpha value for the selected carrier. Alpha is a modulation parameter which will define the modulation is uniform or non-uniform. Alpha value 1 represents to uniform modulation and values 2 and 4 represents non uniform modulation.
- **Transmission** – Configure the Transmission format for the selected carrier. The valid enum values are Non- hierarchical and hierarchical .In Non- hierarchical modulation only one stream, called the "High Priority" (HP) stream is used. In hierarchical modulation, two separate data streams are modulated onto a single DVB-T stream. One stream, called the "High Priority" (HP) stream is embedded within a "Low Priority" (LP) stream. Receivers with "good" reception conditions can receive both streams, while those with poorer reception conditions may only receive the "High Priority" stream.

- **Modulation** – Select one of the Modulation Scheme as per the requirement. Supporting schemes are QPSK, 16QAM and 64QAM.
- **HP Code Rate** – Select one of the coding rates for the HP stream as per the requirement. Supporting coding rates are 1/2, 2/3, 3/4, 5/6 and 7/8.
- **LP Code Rate –** Select one of the coding rates for the LP stream if the transmission is Hierarchical. Supporting coding rates are 1/2, 2/3, 3/4, 5/6 and 7/8

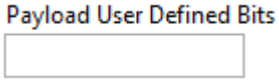
4.2 Select **Payload Settings** and Configure the HP stream and LP Stream Payload configurations

➢ **HP Stream / LP Stream -** Configure the HP Stream / LP Stream Payload for the DVB-T signal Generation**.**

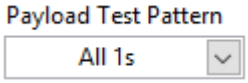


- **Payload Mode –** Configure various payload settings. The possible payload options are
  - **PN Sequence** – Configure the **Sync Insertion Enabled, Payload PN Order, PN Seed** properties. The toolkit generates pseudo random sequence based on the **PN Order** and **Seed value**. The generated bit sequence is used as a payload for generating the signal. Use this mode for testing the receiver performance for random payload values. When the number of super frames is more than 1 then the toolkit maintains payload continuity across the super frames. The below parameters need to be configured in layer configuration.

- **User defined bits** – Configure **Sync Insertion Enabled and Payload User Defined Bits** properties. Specifies a bit pattern as an array of ones and zeros. If the array length is greater than the required payload length, the toolkit uses a subset of the required length from the beginning of the array for waveform generation. If the array length is less than the required payload length, the toolkit repeats the bit pattern until the required length is achieved.



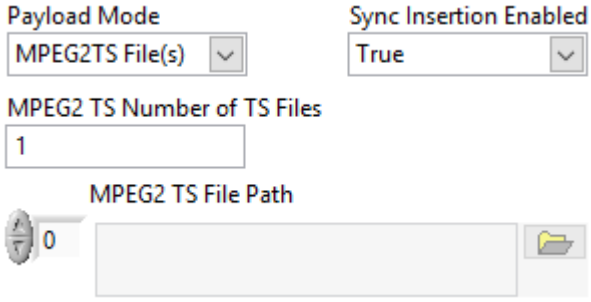
- **Test Pattern** – Configure **Sync Insertion Enabled and Payload Test Pattern** properties. The possible values for the **Test Pattern are All 1s, All 0s, 10101010 and 01010101**. This mode is used for generating signal with known test patterns. The below parameters need to be configured in layer configuration.



- **Test File –** Configure the Sync Insertion Enabled and Payload File Path properties. This mode is used for generating signal with the binary data from the file. The below parameters need to be configured in layer configuration.

- **MPEG2TS File(s) –** In this mode configure the MPEG2 TS Number of TS Files and MPEG2 TS File Path property.

  If the Sync Insertion Enabled property is set to True, the toolkit inserts MPEG2 TS packet sync byte (0x47) after every 187 bytes. The length of the TS packet is 188 bytes and the first byte is a sync byte (0x47).

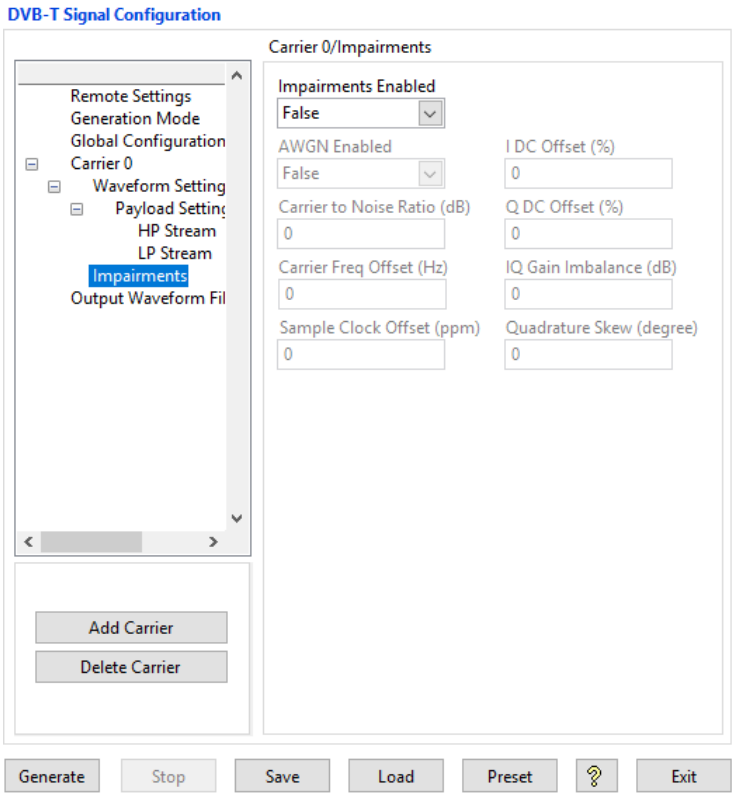


- **MPEG2 TS Number of TS Files –** Configure the Number of MPEG2 TS Number of Files for the selected carrier.
- **MPEG2 TS File Path –** Select the MPEG2 TS File based on the number of TS files configured for the selected carrier.

4.3 Select **Impairments** to configure the following parameters for the selected carrier.

- **Impairments Enabled -** If this property is set to True then the toolkit adds the impairments to the generated signal as per the user configuration for the supported impairments.

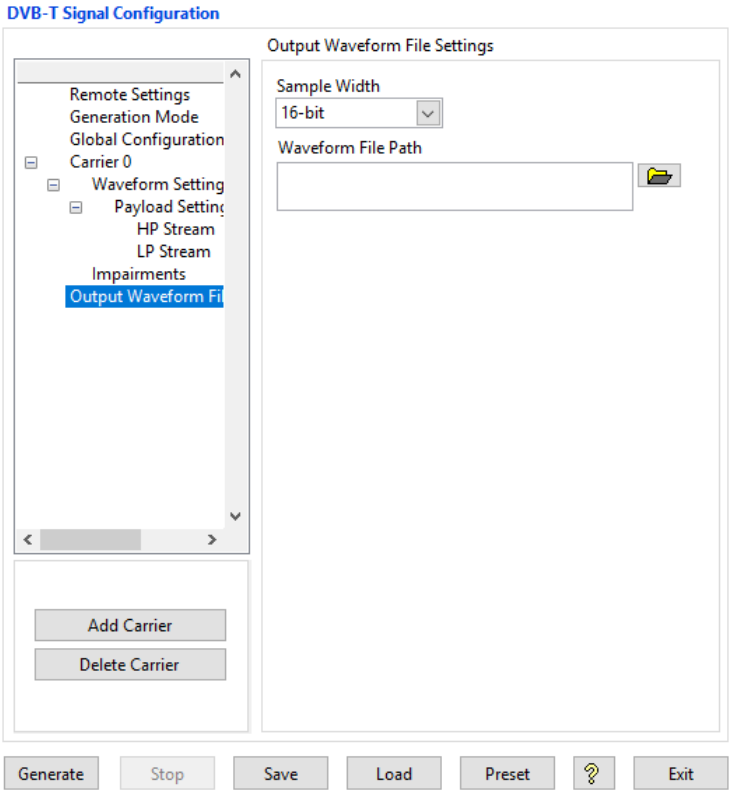
Note: *- If Impairments Enabled is True, then the following parameters are enabled in the SFP otherwise the controls are disabled and grayed out.*



- **Clock Offset (PPM) -** The toolkit applies the clock offset to the generated waveform based on this value. The applied clock offset is relative to the clock frequency of the signal generator. The default value is 0.
- **Frequency Offset, Hz-** The toolkit applies frequency offset to the created waveform based on the value configured in this property. The applied frequency offset is relative to the signal generator's carrier frequency. The default value is 0.
- **Quadrature skew-** Quadrature Skew specifies the deviation in angle from 90 degrees between the in-phase (I) and quadrature-phase (Q) signals. The default value for the Quadrature Skew is 0.
- **IQ gain imbalance, dB-** This value specifies the ratio, in dB, of the mean amplitude of the in-phase (I) signal to the mean amplitude of the quadrature-phase (Q) signal. The default value is 0.

- **I DC offset, %-** The toolkit adds the DC offset to the in-phase signal component (I) of the complex waveform as a percentage of the root mean square magnitude of the unaltered I signal. The default value is 0.
- **Q DC Offset, %-** The toolkit adds the DC offset to the quadrature-phase signal component (Q) of the complex waveform as a percentage of the root mean square magnitude of the unaltered Q signal. The default value is 0.
- **AWGN Enabled-** If this property is set to True then the toolkit adds Additive White Gaussian Noise (AWGN) to the created waveform based on the value configured in the Carrier to Noise Ratio property.
- **Carrier to Noise Ratio, dB-** This value specifies the Carrier to Noise ratio of the generated signal. The default value is 40dB.
- Select **Output Waveform File Settings** to configure the following parameters to save output waveform in a file.
- **Sample Width –** The default sample width of the output waveform is 16-bits. The available options are 8-bits and 16-bits. We recommend using 16-bits sample width for better signal quality of the generated waveform.
- **Waveform File Path-** Select a path to save the waveform.

Note: - Needs to be configured only when the generation mode is Generate and Save waveform.



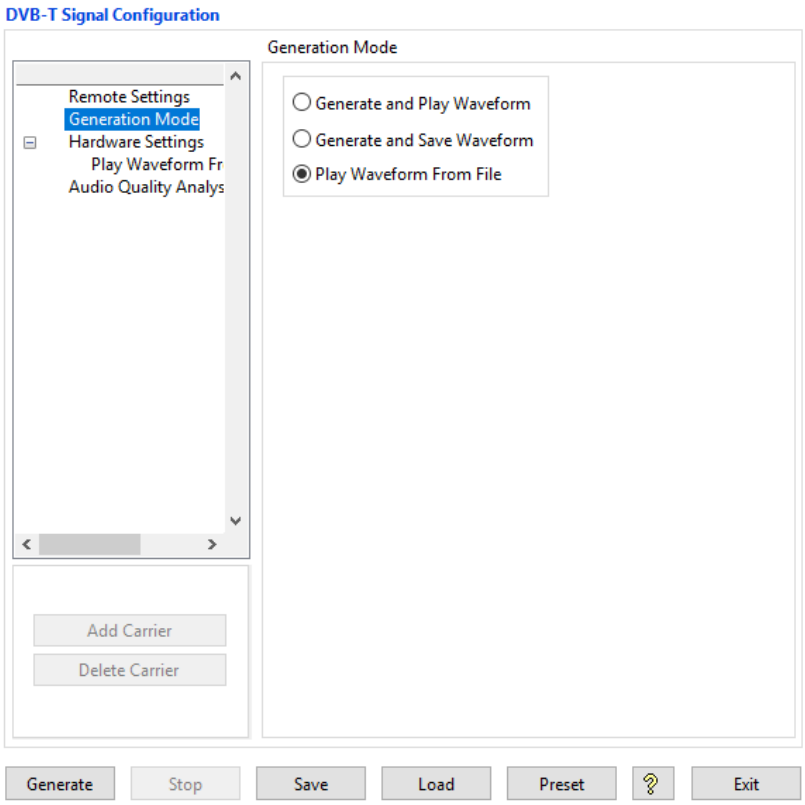
3.1.2 Play Waveform from File

In this generation mode DVB-T Signal Generator reads the waveform from the file created using the Generate and Save waveform generation mode, explained in the section 3.1.1 of this section, and then downloads the waveform in real-time to NI RFSG Memory and then plays the waveform. This example is created using the NI RFSG streaming example available in the NI website.

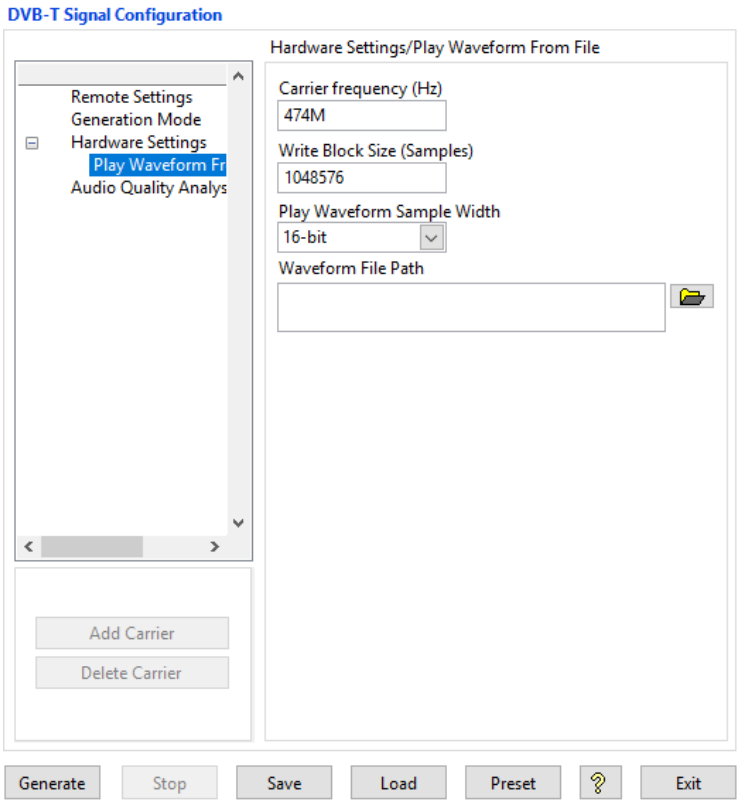
This example uses NI RFSG in streaming mode for playing the waveform in real-time. The performance of this example is related to the performance of the CPU and available RAM memory.

Follow the procedure below to generate waveform using this generation mode

1. Select **Generation Mode** -> **Play Waveform from File**



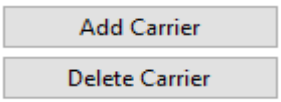
2. Select **Play Waveform from File** to configure the following parameters



- **Center Frequency (Hz) –** Specifies the center frequency of the signal to be generated in Hz
- **Write Blocks Size (Samples) –** The waveform is written in the hardware as blocks. This parameter configures the size of the block in samples.
- **Sample Width –** Use the same sample width value used for saving the waveform in the file.
- **Waveform File Path –** Give the absolute path of the saved waveform intended to play in this generation mode.

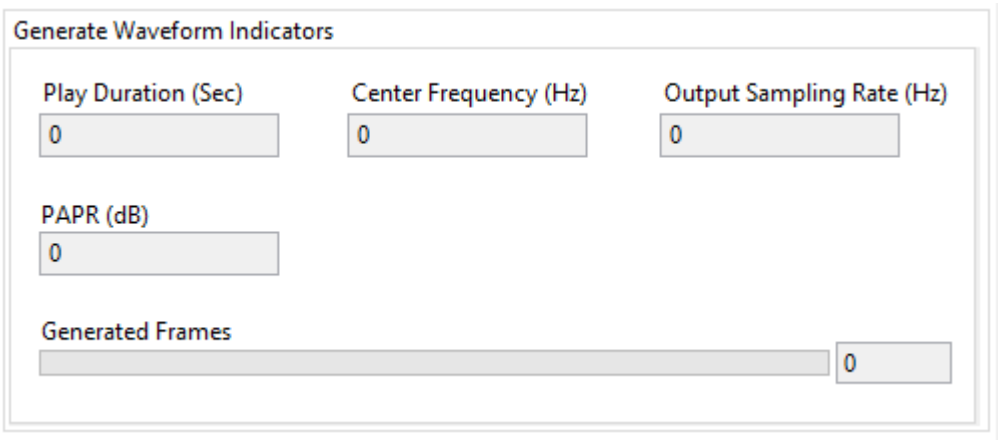
3.2 General SFP Controls and Indicators

- **Add carrier –** Click to add new carrier configuration with default values.
- **Delete Carrier –** Click to delete the selected carrier. Click on the appropriate **carrier tag** in a tree control or on any **child tag** like waveform settings, impairments, service configuration under specific **parent carrier tag** (carrier 0, carrier 1 etc.) to select which **carrier** is going be deleted.
  ***Note**: - One carrier configuration is default which can't be deleted.*
  All the items under the **parent carrier tag** specify configuration that need to be configured for each and every unique carrier.



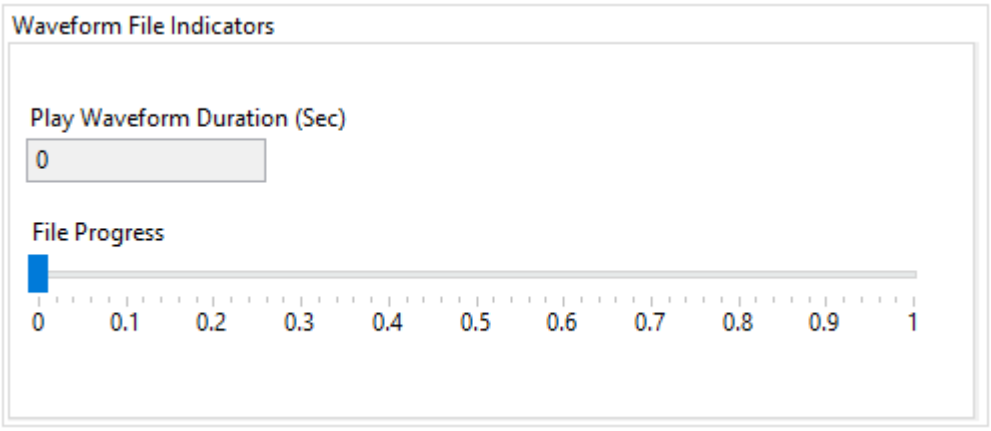
- **Generate -** Click to generate signal as per the parameters configured.
- **Stop** – Click to stop the signal generation.
- **Save** – Saves the entire configuration in the binary file.
- **Load** – Load the entire configuration back to the application which has been saved previously by Clicking **Save button.**
- **Preset** – Click to reinitialize all parameters to their defaults values.
- **Exit** – Click to exit the application.

Generate Waveform Indicators



- **Play Duration (sec) –** Indicates the total duration, in seconds, of waveform generated. To generate longer duration of the waveform increase the Number of Frames value.
- **Center Frequency (Hz) –** Indicates the center frequency of the multiple carrier waveform. The same frequency must be used when using **Play Waveform from File** examples.
- **Output Sampling Rate (Hz) –** Indicates the sampling frequency of the generated IQ baseband waveform. **S**ame sampling rate/IQ rate must be used when using **Play Waveform from File** examples.
- **PAPR –** Peak to average power ratio, the peak divided by the Root Mean Square (RMS) of the waveform. Based on this value, the Headroom (dB) can be set.
- **Generating Frames –** To visualize the progress of generating signal.

Waveform File Indicators



- **Play Waveform Duration (sec) –** Indicates the total duration, in seconds, of waveform generated. To generate longer duration of the waveform increase the Number of Frames value.
- **File Progress –** Indicates the file progress of a generating waveform.
- **Status** – Displays warning or error.

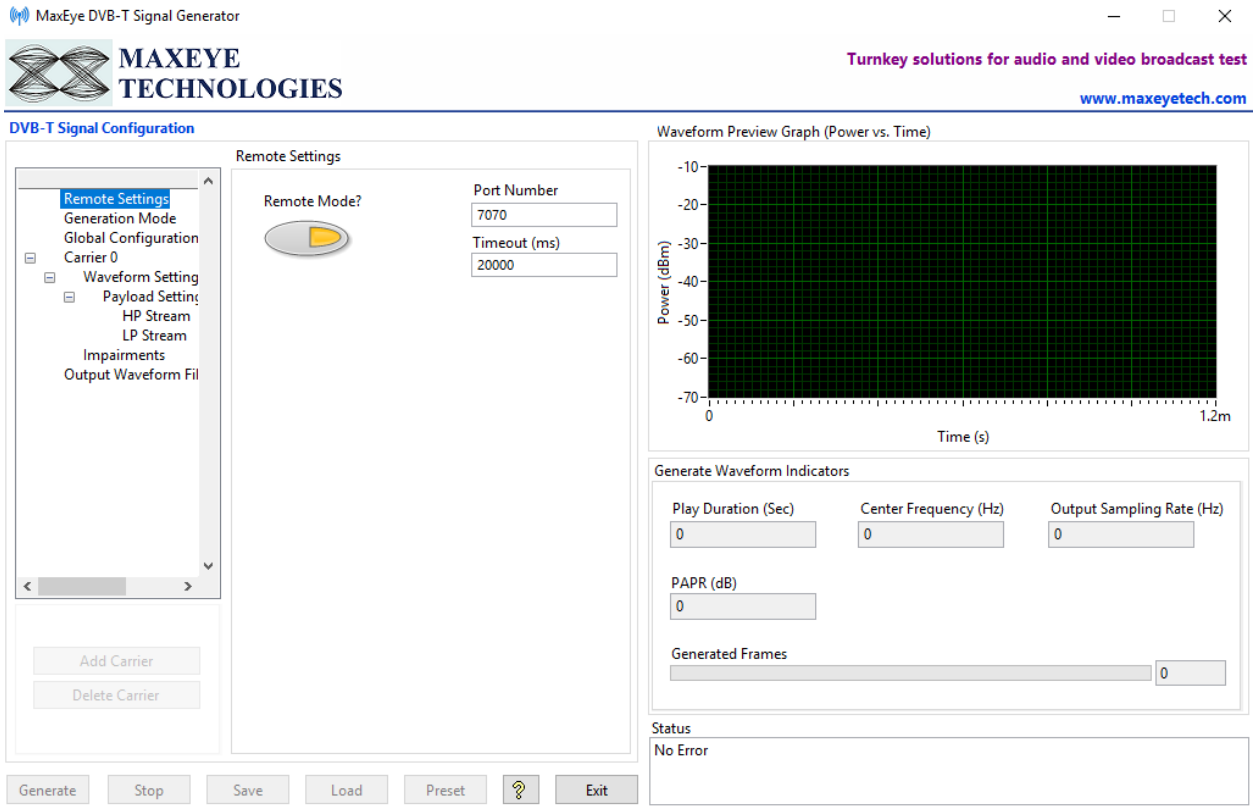
3.3 Remote Mode

Remote mode allows user to control the MaxEye DVB-T Signal Generator remotely using programming examples (LabVIEW or C) to generate signals. The programming examples and APIs are provided with the DVB-T signal generation toolkit.

Follow the below procedure in SFP to run the DVB-T Signal Generator in Remote Mode

1. Select **Remote Settings** to configure the following parameters

- **Remote Mode?** – Turn **Remote Mode?** Switch **ON** (Remote) or **OFF** (Local) as required. The glowing yellow LED indicates ON state of the switch. By default, the Remote Mode? Switch is in **OFF** state.
- **Port Number** – Configure this control if **Remote Mode is ON**. Both client and server application must have same port number. The default Port Number is **7070**.
- **Timeout (ms)** – Configure this control if **Remote Mode is ON.** Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DVB-T Signal Generator returns an error. The default Timeout is **20 seconds**.



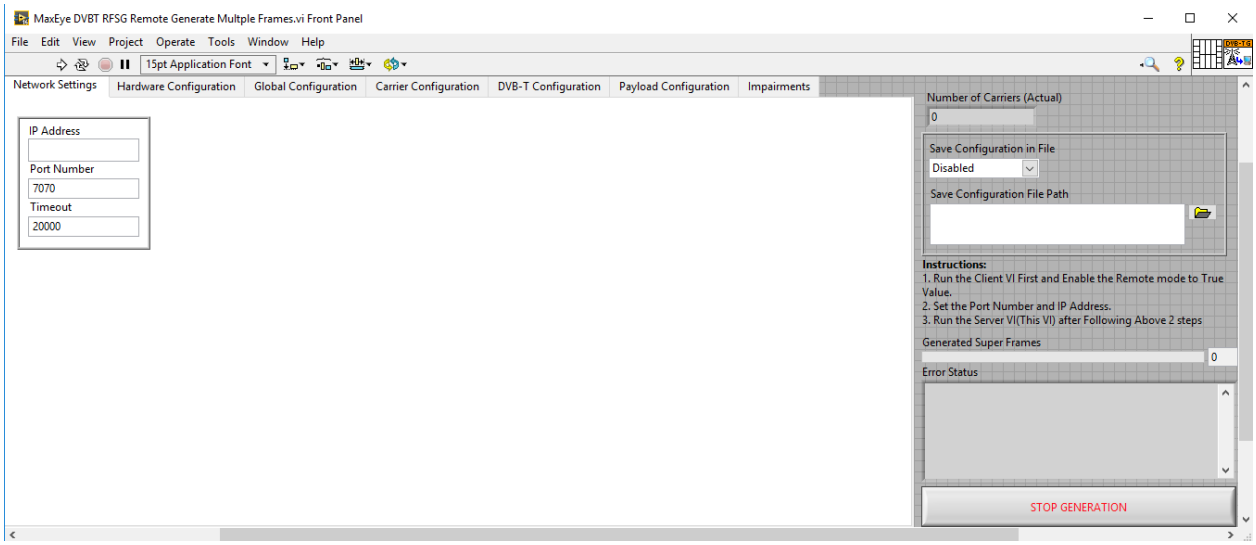
3.3.1 Remote LabVIEW Examples

3.3.1.1 DVB-T Generate Multiple Frames

Follow the below procedure to configure the example

1. Find the DVB-T LabVIEW Remote example in, <LabVIEW>\examples\MaxEye\Digital Video Toolkits\DVB-T Generation\Remote
2. Open **MaxEye DVBT RFSG Remote Generate Multiple Frames.vi**
3. The user configurations are organized into the following categories displayed in multiple Tabs
   - Network Settings
   - Hardware Configuration
   - Global Configuration
   - Carrier Configuration
   - DVB-T Configuration
   - Payload Configuration
   - Impairments

Navigate to the **Network Settings** tab to configure the following parameters



- **IP Address –** Configure the IP address of the client system in which the MaxEye DVB-T Signal Generator is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7070**.
- **Timeout (ms)** – Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DVB-T Signal Generator returns an error. The default Timeout is **20 seconds**.

For configuring other parameters, please refer section 3.1.1 of this document.

- **Save Configuration in File –** Configure this value to Enabled, if configuration to be saved in a file.
- **Save Configuration File Path** – Configure the file path to save the configurations in file.

- **Number of carriers(Actual)** – Specifies the actual number of carriers generating/generated

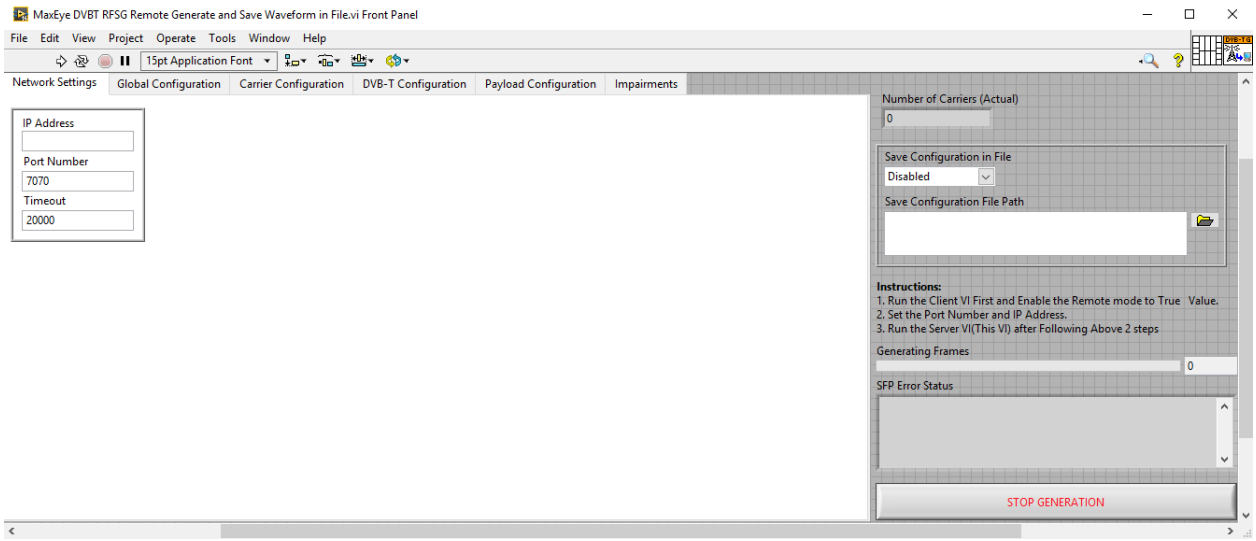
4. Run the example. Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.1.2 DVB-T Generate and Save Waveform in file

Follow the below procedure to configure the example

1. Find the DVB-T LabVIEW Remote example in, <LabVIEW>\examples\MaxEye\Digital Video Toolkits\DVB-T Generation\Remote
2. Open **MaxEye DVBT SG Remote Generate and Save Waveform in File.vi**
3. The user configurations are Organized into the following categories displayed in multiple Tabs
   - Network Settings
   - Global Configuration
   - Carrier Configuration
   - DVB-T Configuration
   - Payload Configuration
   - Impairments

Navigate to the **Network Settings** tab to configure the following parameters



- **IP Address –** Configure the IP address of the client system in which the MaxEye DVB-T Signal Generator is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7070**.
- **Timeout (ms)** – Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DVB-T Signal Generator returns an error. The default Timeout is **20 seconds**.

For configuring other parameters, please refer section 3.1.1 of this document.

- **Save Configuration in File –** Configure this value to Enabled, if configuration to be saved in a file.
- **Save Configuration File Path** – Configure the file path to save the configurations in file.
- **Number of carriers(Actual)** – Specifies the actual number of carriers generating/generated

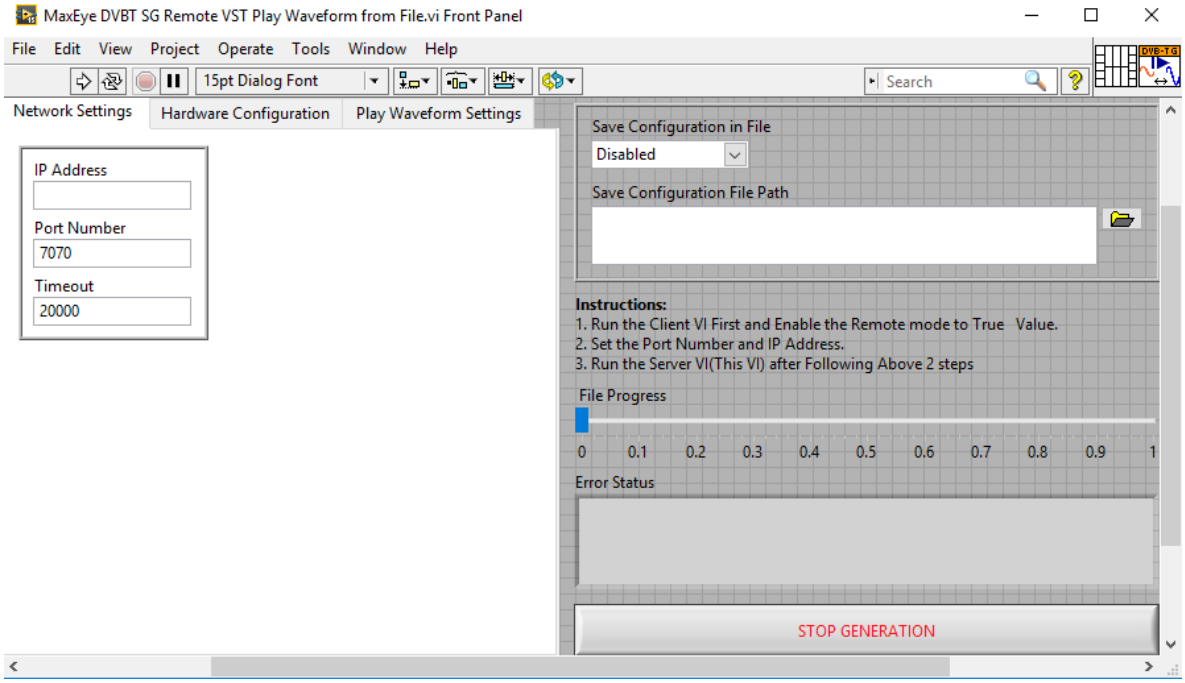
4. Run the example. Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.1.3 DVBT VST Play Waveform from File

Follow the below procedure to configure the example

1. Find the DVB-T LabVIEW Remote example in, <LabVIEW>\examples\MaxEye\Digital Video Toolkits\DVB-T Generation\Remote
2. Open **MaxEye DVBT SG Remote VST Play Waveform from File.vi**
3. The user configurations are Organized into the following categories displayed in multiple Tabs
   - Network Settings
   - Hardware Configuration
   - Play Waveform Settings

Navigate to the **Network Settings** tab to configure the following parameters



- **IP Address –** Configure the IP address of the client system in which the MaxEye DVB-T Signal Generator is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7070**.
- **Timeout (ms)** – Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DVB-T Signal Generator returns an error. The default Timeout is **20 seconds**.

For configuring other parameters, please refer section 3.1.1 of this document.

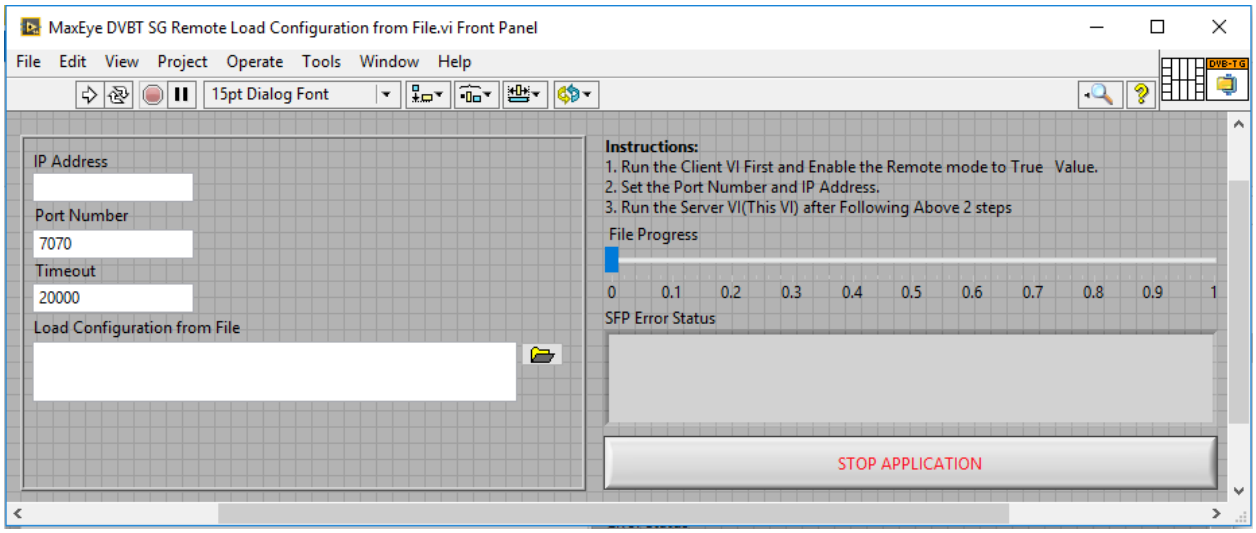
- **Save Configuration in File –** Configure this value to Enabled, if configuration to be saved in a file.
- **Save Configuration File Path** – Configure the file path to save the configurations in file.

4. Run the example. Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.1.4 DVBT Load Configurations from File

Follow the below procedure to configure the example

1. Find the DVB-T LabVIEW Remote example in, <LabVIEW>\examples\MaxEye\Digital Video Toolkits\DVB-T Generation\Remote
2. Open **MaxEye DVBT SG Remote Load Configuration from File.vi**



- **IP Address –** Configure the IP address of the client system in which the MaxEye DVB-T Signal Generator is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7070**.
- **Timeout (ms)** – Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DVB-T Signal Generator returns an error. The default Timeout is **20 seconds**.
- **Load Configuration from File –** Configure the file path to load the saved configurations from file.

3. Run the example. Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.2 Remote C Examples

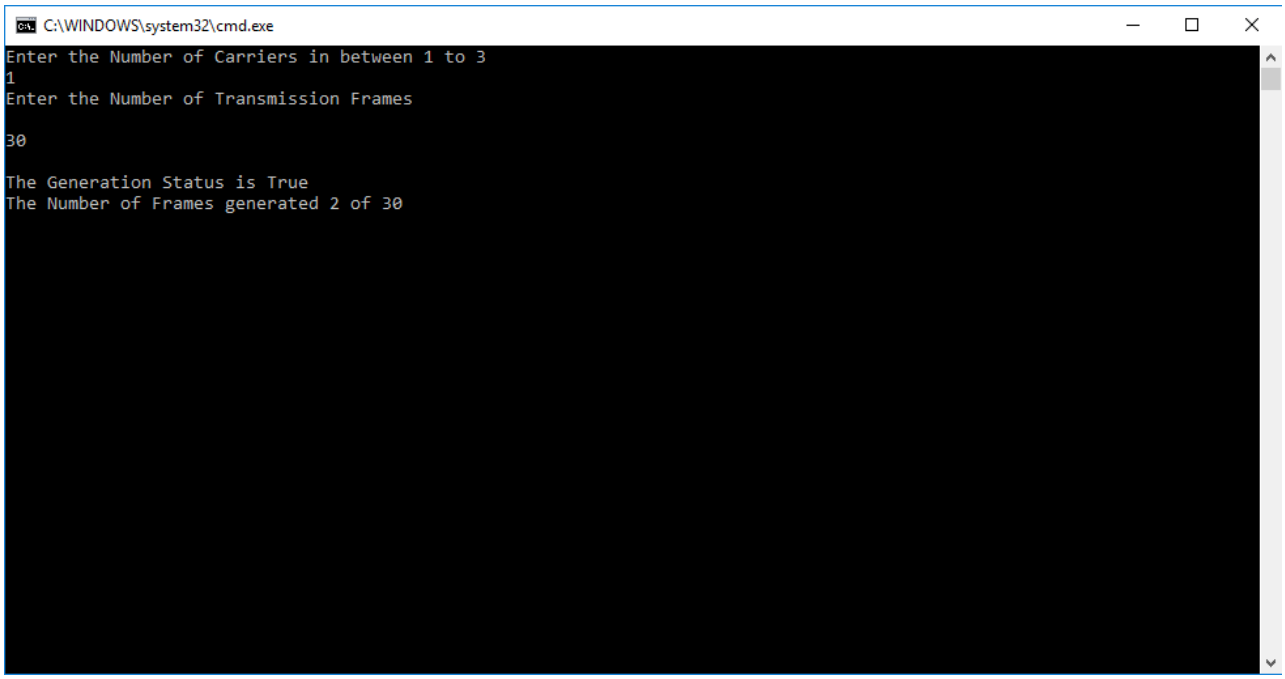
3.3.2.1 DVB-T Generate Multiple Frames

```
Function Name: MaxEye DVB-T Generate and Play Init
Description:
The Main aim of this function is to define all the User Configurable DVB-T parameters.
*****************************************************************************************************************************/

#include <string.h>
#include "..\Includes\MaxEye Utilities Typedefs.h"
#include "..\Includes\MaxEye DVBT Generate and Play Defines.h"
#include "..\Includes\MaxEye DVBT Generate and Play Externs.h"

char IP_Address[]="10.21.0.5";                                          //IP Address of the client system
char RFSG_Resource[50]="PXI1Slot3";
UINT32 Hardware_Type=0;                                                    //Select Hardware Type 0 - VSG/VST, 1-USRP
UINT16 Generation_Type=0;                                                  //0- StartGeneration, 1- StopGeneration, 2- Save Configuration, 3- Load Configuration
UINT16 SaveConfiguration = 0;                                              //0- Disabled, 1- Enabled to Save configurations in file.
char SaveConfiguration_FilePath[]="C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\Recorded file\\save_genandplay_2Carr_20M_C.bin";//Configure file path to save the configuration

double Carrier_Frequency[MAX_NUM_CARRIERS] = {474000000,482000000,490000000};          //Multi Carrier Frequency
UINT16 Carrier_Bandwidth[MAX_NUM_CARRIERS] = {0,0,0};                                   //0- 8MHz, 1- 7MHz, 2- 6MHz
UINT16 Transmission_Mode[MAX_NUM_CARRIERS] ={0,0,0};                                    //Mode 0-2K , 1-8K , 2-4K
UINT16 Transmission_Format[MAX_NUM_CARRIERS] ={0,0,0};                                  //Transmission Type    0- Non Hierarchial , 1- Hierarchial
UINT16 HP_CodeRate[MAX_NUM_CARRIERS]= {3,3,3};                                          //HP Code Rate  0- 1/2, 1- 2/3, 2- 3/4, 3- 5/6, 4- 7/8
UINT16 LP_CodeRate[MAX_NUM_CARRIERS]= {3,3,3};                                          //LP Code Rate  0- 1/2, 1- 2/3, 2- 3/4, 3- 5/6, 4- 7/8
UINT16 Modulation[MAX_NUM_CARRIERS] = {6,6,6};                                          //Modulation 2-QPSK ,4- 16QAM ,6- 64QAM
UINT16 Guard_Intervel[MAX_NUM_CARRIERS]={1,1,1};                                        //Guard Intervel 0- 1/4 ,1- 1/8 ,2- 1/16, 3- 1/32
UINT16 Alpha[MAX_NUM_CARRIERS] = {1,1,1};                                               // Alpha 1- 1,2- 2,4- 4
extern UINT16 HP_PayloadMode[MAX_NUM_CARRIERS]={4,4,4};                                 //0- PNSequence, 1- UserDefinedBits, 2- TestPattern, 3- TestFile, 4-MPEG2TSFile
extern UINT16 LP_PayloadMode[MAX_NUM_CARRIERS]={4,4,4};                                 //0- PNSequence, 1- UserDefinedBits, 2- TestPattern, 3- TestFile, 4-MPEG2TSFile
char *HP_TSFilePath[MAX_NUM_CARRIERS][1] =
{
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00490000.TS"},
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00506000.TS"},          //MPEG2TS_File_Path  Specify appropriate TS File path
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00746000.TS"},
```

Follow the below procedure to configure the example

1. Find the Remote C examples in, C:\Program Files(x86)\MaxEye\Digital Video Toolkits \DVB-T Generation\Examples\C\Generate Multiple Frames
   (***Note**: - For 32-bit Operating System*, C Examples are located in C:\Program Files\MaxEye \Digital Video Toolkits\DVB-T Generation\Examples\C\Generate Multiple Frames)
2. Open the desired example directory and open the solution file **Generate Multiple Frames.sln** in **Microsoft visual C++**.
3. Navigate to **MaxEye DVB-T Generate and Play Init.c** from the solution explorer.
   (Note :-
   - **Save Configuration –** Configure this value to Enabled, if configuration to be saved in a file.
   - **Save Configuration File Path** – Configure the file path to save the configurations in file.

   This file path is used for Load the Saved Configuration data to Load Configuration from File remote Example)
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye DVB-T Generate and Play Main.c** and press Run button or (Ctrl + F5) for running the example. Enter the values in the console application window that appears after running the example.



6. Enter the required **Number of Carriers**.
7. Enter the desired **Number of Frames**.

Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

8. Press any key, to stop the generation.

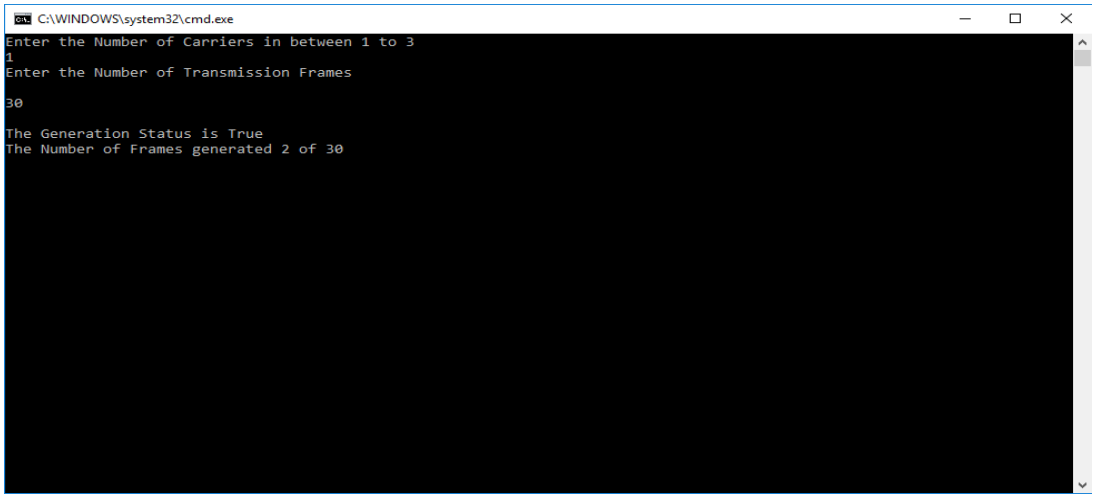
3.3.2.2 DVB-T Generate and Save Waveform

```
Function Name: MaxEye DVB-T Generate and Save Init
Description:
The Main aim of this function is to define all the User Configurable DVB-T parameters.
*****************************************************************************************************************************/

#include <string.h>
#include "..\Includes\MaxEye Utilities Typedefs.h"
#include "..\Includes\MaxEye DVBT Generate and Save Defines.h"
#include "..\Includes\MaxEye DVBT Generate and Save Externs.h"

char IP_Address[]="10.21.0.5";                                          //IP Address of the client system
char Waveform_File_Path[]="C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\Recorded file\\DVB-T_C_2carr_20M_gen_Save.bin";          //Specify appropriate file path to save waveform
UINT16 Generation_Type=0;                                               //0- StartGeneration, 1- StopGeneration, 2- Save Configuration, 3- Load Configuration
UINT16 SaveConfiguration = 0;                                           //0- Disabled, 1- Enabled to Save configurations in file.
char SaveConfiguration_FilePath[]="C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\Recorded file\\save_genandplay_2Carr_20M_C.bin";          //Configure file path to save the configuration

double Carrier_Frequency[MAX_NUM_CARRIERS] = {474000000,482000000,490000000};          //Multi Carrier Frequency
UINT16 Carrier_Bandwidth[MAX_NUM_CARRIERS] = {0,0,0};                   //0- 8MHz, 1- 7MHz, 2- 6MHz
UINT16 Transmission_Mode[MAX_NUM_CARRIERS] ={0,0,0};                    //Mode 0-2K , 1-8K , 2-4K
UINT16 Transmission_Format[MAX_NUM_CARRIERS] ={0,0,0};                  //Transmission Type    0- Non Hierarchial , 1- Hierarchial
UINT16 HP_CodeRate[MAX_NUM_CARRIERS]= {3,3,3};                          //HP Code Rate  0- 1/2, 1- 2/3, 2- 3/4, 3- 5/6, 4- 7/8
UINT16 LP_CodeRate[MAX_NUM_CARRIERS]= {3,3,3};                          //LP Code Rate  0- 1/2, 1- 2/3, 2- 3/4, 3- 5/6, 4- 7/8
UINT16 Modulation[MAX_NUM_CARRIERS] = {6,6,6};                          //Modulation 2-QPSK ,4- 16QAM ,6- 64QAM
UINT16 Guard_Intervel[MAX_NUM_CARRIERS]={1,1,1};                        //Guard Intervel 0- 1/4 ,1- 1/8 ,2- 1/16, 3- 1/32
UINT16 Alpha[MAX_NUM_CARRIERS] = {1,1,1};                               // Alpha 1- 1,2- 2,4- 4
extern UINT16 HP_PayloadMode[MAX_NUM_CARRIERS]={4,4,4};                 //0- PNSequence, 1- UserDefinedBits, 2- TestPattern, 3- TestFile, 4-MPEG2TSFile
extern UINT16 LP_PayloadMode[MAX_NUM_CARRIERS]={4,4,4};                 //0- PNSequence, 1- UserDefinedBits, 2- TestPattern, 3- TestFile, 4-MPEG2TSFile
char *HP_TSFilePath[MAX_NUM_CARRIERS][1] =
{
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00490000.TS"},
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00506000.TS"},          //MPEG2TS_File_Path  Specify appropriate TS File path
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00746000.TS"},
};
char *LP_TSFilePath[MAX_NUM_CARRIERS][1] =
{
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00490000.TS"},
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00506000.TS"},          //MPEG2TS_File_Path  Specify appropriate TS File path
    {"C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\TRPT00746000.TS"},
};
```

Follow the below procedure to configure the example

1. Find the C example in, C:\Program Files(x86)\MaxEye\Digital Video Toolkits\DVB-T Generation\Examples\C\Generate and Save Waveform
   (***Note**: - For 32-bit Operating System*, C Examples are located in C:\Program Files\MaxEye \Digital Video Toolkits\DVB-T Generation\Examples\C\Generate and Save Waveform)
2. Open the desired example directory and open the solution file **Generate and Save.sln** in **Microsoft visual C++.**
3. Navigate to **MaxEye DVB-T Generate and Save Init.c** from the solution explorer.
   *(**Note** :-*
   - **Save Configuration –** Configure this value to Enabled, if configuration to be saved in a file.
   - **Save Configuration File Path** – Configure the file path to save the configurations in file.

   This file path is used for Load the Saved Configuration data to Load Configuration from File remote Example)
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye DVB-T Generate and Save Main.c** and press Run button or (Ctrl + F5) for running the example. Enter the values in the console application window that appears after running the example.



6. Enter the required **Number of Carriers**.
7. Enter the desired **Number of Frames**.

Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

8. Press any key, to stop the generation.

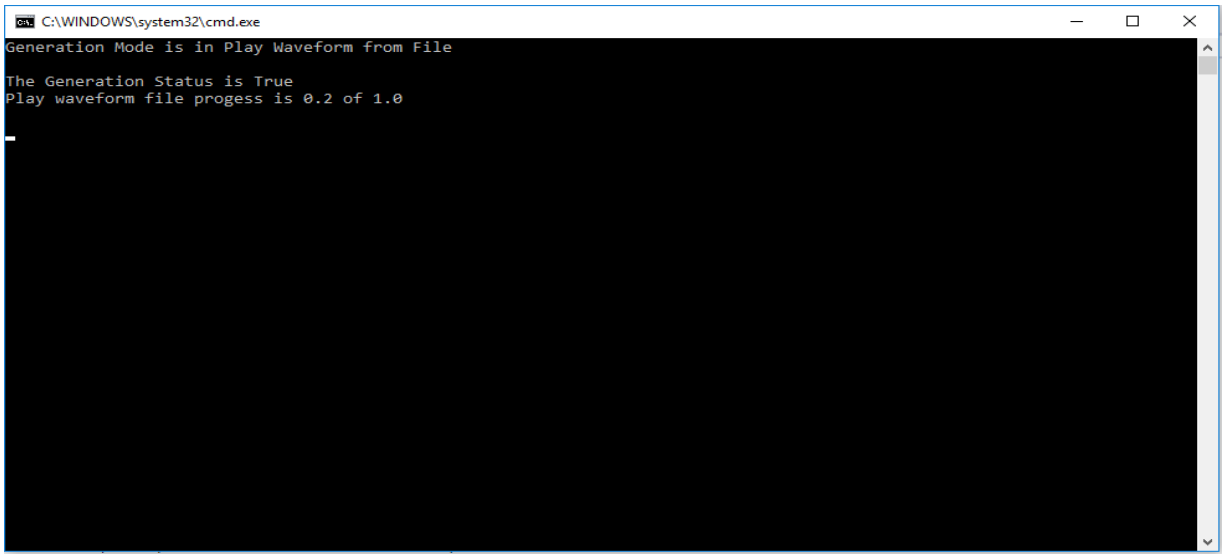
3.3.2.3 DVB-T VST Play Waveform from File

Follow the below procedure to configure the example

```
Function Name: MaxEye DVB-T VSG VST Play Waveform Init

Description:

The Main aim of this function is to define all the User Configurable DVB-T parameters.
*****************************************************************************************************************************/
#include <stdio.h>
#include "..\Includes\MaxEye Utilities Typedefs.h"
#include "..\Includes\MaxEye DVBT VST2.0 Play Waveform Defines.h"
#include "..\Includes\MaxEye DVBT VST2.0 Play Waveform Externs.h"

char IP_Address[]="10.21.0.5";                                          //IP Address of the client system
char RFSG_Resource[]="PXI1Slot3";                                         //RFSG Resource Name
char Waveform_File_Path[]="C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\Recorded file\\DVB-T_C_2carr_20M_gen_Save.bin";
UINT16 Generation_Type=0;                                                 //0- StartGeneration, 1- StopGeneration, 2- Save Configuration, 3- Load Configuration
UINT16 SaveConfiguration=0;                                               //0- Disabled, 1- Enabled to Save configurations in file.
char SaveConfiguration_FilePath[]="C:\\Users\\URTadmin\\Desktop\\MaxEye\\Test Vectors\\DVB-T\\Recorded file\\VST_Play_3Carr2.bin";  //Configure file path to save the configuration
Hardware_Settings HARDWARE_SETTINGS;
Play_Waveform_Settings PLAY_WAVEFORM_SETTINGS;

int DVBT_init()
{
    // VSG/VST Hardware Settings
     HARDWARE_SETTINGS.RFSGResource;                                          //PXI Device Name
     HARDWARE_SETTINGS.PowerLevelDBm=0;                                     //Power Level (dB)

    //Play Waveform Settings
    PLAY_WAVEFORM_SETTINGS.CenterFrequencyHz=478000000;                       //Center Frequency of ISDB-T Signal Generation
    PLAY_WAVEFORM_SETTINGS.WriteBlockSizeSamples=2196052;                     // Wrtie Block Size (Samples)
    PLAY_WAVEFORM_SETTINGS.SampleWidth=1;                                     //0- 8-Bit, 1- 16-Bit

    return 0;
}
```

1. Find the C example in, C:\Program Files(x86)\MaxEye\Digital Video Toolkits\DVB-T Generation\Examples\C\VST Play Waveform from File
   (***Note***: - *For 32-bit Operating System*, C Examples are located in C:\Program Files\ MaxEye\Digital Video Toolkits\DVB-T Generation\Examples\C\VST Play Waveform from File)
2. Open the desired example directory and open the solution file **MaxEye VST Play Waveform.sln** in **Microsoft visual C++.**
3. Navigate to **MaxEye DVB-T VST Play Waveform Init.c** from the solution explorer.
   (Note :-
   - **Save Configuration –** Configure this value to Enabled, if configuration to be saved in a file.
   - **Save Configuration File Path** – Configure the file path to save the configurations in file.

   This file path is used for Load the Saved Configuration data to Load Configuration from File remote Example)
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye DVB-T VST Play Waveform Main.c** and press Run button or (Ctrl + F5) for running the example. Enter the values in the console application window that appears after running the example.



Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

6. Press any key, to stop the generation.

3.3.2.4 DVBT Load Configurations from File

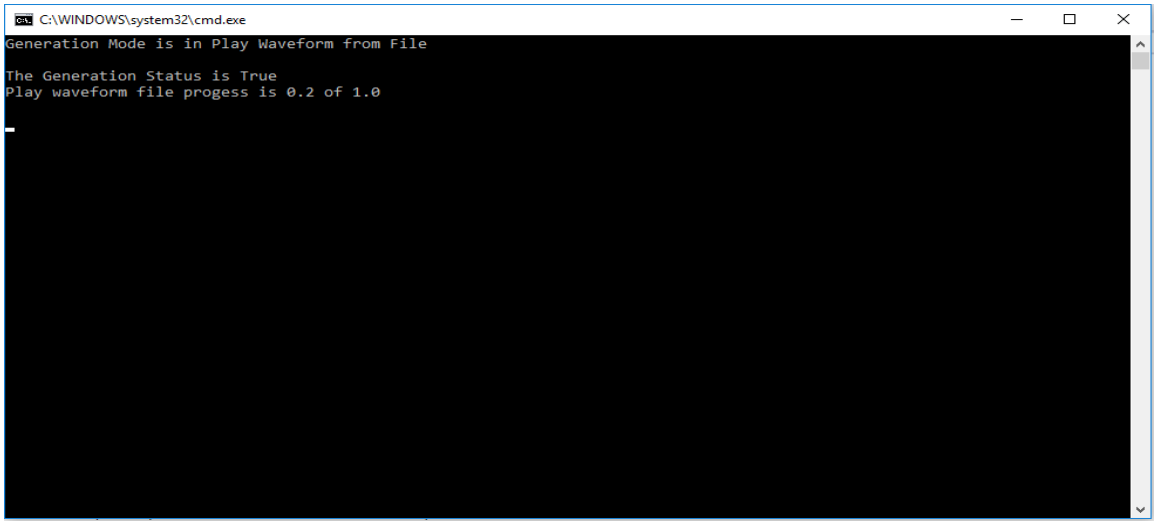
```
Function Name: MaxEye DVB-T Load Configuration Init

Description:

The Main aim of this function is to define all the User Configurable DVB-T parameters.
*****************************************************************************************************************************************/

#include <string.h>
#include "..\Includes\MaxEye Utilities Typedefs.h"
#include "..\Includes\MaxEye DVBT Load Configuration Defines.h"
#include "..\Includes\MaxEye DVBT Load Configuration Externs.h"

char IP_Address[]="192.168.1.135";                          //IP Address of the client system
char LoadConfiguration_FilePath[]="C:\\MAXEYE\\TS Files\\save_genandplay_2Carr_20M_C.bin";//Specify appropriate file path to save waveform
UINT16 Generation_Type=0;                                   //0- StartGeneration, 1- StopGeneration, 2- Save Configuration, 3- Load Configuration
```

Follow the below procedure to configure the example

1. Find the C example in, C:\Program Files(x86)\MaxEye\Digital Video Toolkits\DVB-T Generation\Examples\C\Load Configuration from File
   (***Note**: - For 32-bit Operating System*, C Examples are located in C:\Program Files\ MaxEye\Digital Video Toolkits\DVB-T Generation\Examples\C\Load Configuration from File)
2. Open the desired example directory and locate the project file **Load Configuration from File.sln** in **Microsoft visual C++**.
3. Navigate to **MaxEye DVBT Load Configuration Init.c** from the solution explorer.

(***Note***: - **Load Configuration FilePath –** Configure the file path to load the saved configurations from Save Configuration File)

4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye DVBT Load Configuration Main.c** and press Run button or (Ctrl + F5) for running the example. Enter the values in the console application window that appears after running the example.



Now the MaxEye DVB-T Signal Generator validates the user configuration and reports error to the user if the configuration is not as per standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

6. Press any key, to stop the generation.

4 How to configure parameters for Single Carrier/ Multiple Carriers

The controls in the Carrier Configuration, DVB-T Configuration, Payload Configuration ,Multipath Configuration and Impairments are configured for each carrier. Hence the controls are given in an array where each element corresponds to one carrier. Since the index value starts from 0, the index 0 corresponds to 1st carrier, index 1 corresponds to 2nd carrier and so on.

4.1 Single Carrier

For single carrier configuration, configure only index 0 of the above controls.

4.2 Multiple Carrier

For multiple carriers, use the index display to navigate through different elements and configure for the required number of carriers. For N carriers, configure upto index N-1.

The figure below shows the DVB-T Configuration Control array with index display (highlighted in yellow).