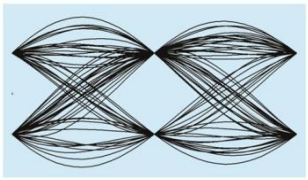


MaxEye Digital Audio and Video Signal Generation

AM/FM/RDS/TMC Signal Generation Toolkit

Version 1.0.0

Getting Started Guide

MAXEYE TECHNOLOGIES

Contents

List of Abbreviations

AM:	Amplitude Modulation
FM:	Frequency Modulation
RDS:	Radio Data System
USRP:	Universal Software Radio Peripheral
API:	Application Programming Interface
BER:	Bit Error Ratio
PAPR:	Peak to Average Power Ratio
SFP:	Soft Front Panel
UTC:	Universal Time Coordinated
RFSG:	Radio Frequency Signal Generator
VST:	Vector Signal Transceiver

1 Introduction

This toolkit offers standard based test solution for designing, evaluating and manufacturing AM/FM/RDS/TMC receivers. Radio Data System (RDS) is a communications protocol standard for transmitting digital information in traditional FM radio broadcast. RDS standardizes several types of information transmitted, including time, station identification and program information. RDS is also used for transmitting traffic information using Traffic Message Channel.

Radio Broadcast Data System (RBDS) is the official name used for the U.S. version of RDS. The two standards are only slightly different. MaxEye AM/FM/RDS/TMC toolkit supports both the European and US versions. The toolkit supports real-time signal generation.

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 AM/FM/RDS/TMC signal generation toolkit with the programming examples and Soft front panel (MaxEye Universal Radio Signal Generator) by using NI Vector Signal Generator (NI VSG), Vector Signal Transceiver (NI VST) and Universal Software Radio Peripheral (NI USRP).

2 Installed File Location

2.1 Soft Front Panel

The AM FM RDS signal generation soft front panel is located in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Application.

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

The Soft Front Panel can be automated from the remote computer by using both LabVIEW Remote APIs and C Remote APIs.

You can also find a shortcut to the above location from the windows start menu. **Start->All Programs->MaxEye->Digital Radio Toolkits->AM FM RDS TMC 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\AM FM RDS TMC Generation\Remote

The remote C programming examples are installed in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C

(***Note**: - For 32-bit Operating System*, C examples are installed in, C:\Program Files\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C)

You can also find a shortcut to the above location from the windows start menu. **Start->All Programs->MaxEye->Digital Radio Toolkits->AM FM RDS TMC Generation** ***Note**: - For Windows 10,* **Start ->MaxEye**

2.3 Toolkit Remote API VIs

The toolkit Remote APIs are installed in <LabVIEW>\vi.lib\addons\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Generation\API.

You can also find a shortcut to the above location from the windows start menu.
Start->All Programs->MaxEye->Digital Radio Toolkits->AM FM RDS TMC Generation ***Note**: - For Windows 10,* **Start ->MaxEye**

2.4 Documentation

The toolkit help file is installed in, <LabVIEW>\help\MaxEye\Digital Video Toolkits\MaxEye AM FM RDS Signal Generation Help.chm

The toolkit documentation files are installed in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Documentation.

(***Note**: - For 32-bit Operating System*, toolkit documentation is located in C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Documentation)

The remote C API documentation file is installed in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Documentation.

(***Note**: - For 32-bit Operating System*,C API documentation file is installed in C:\Program Files \MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Documentation)

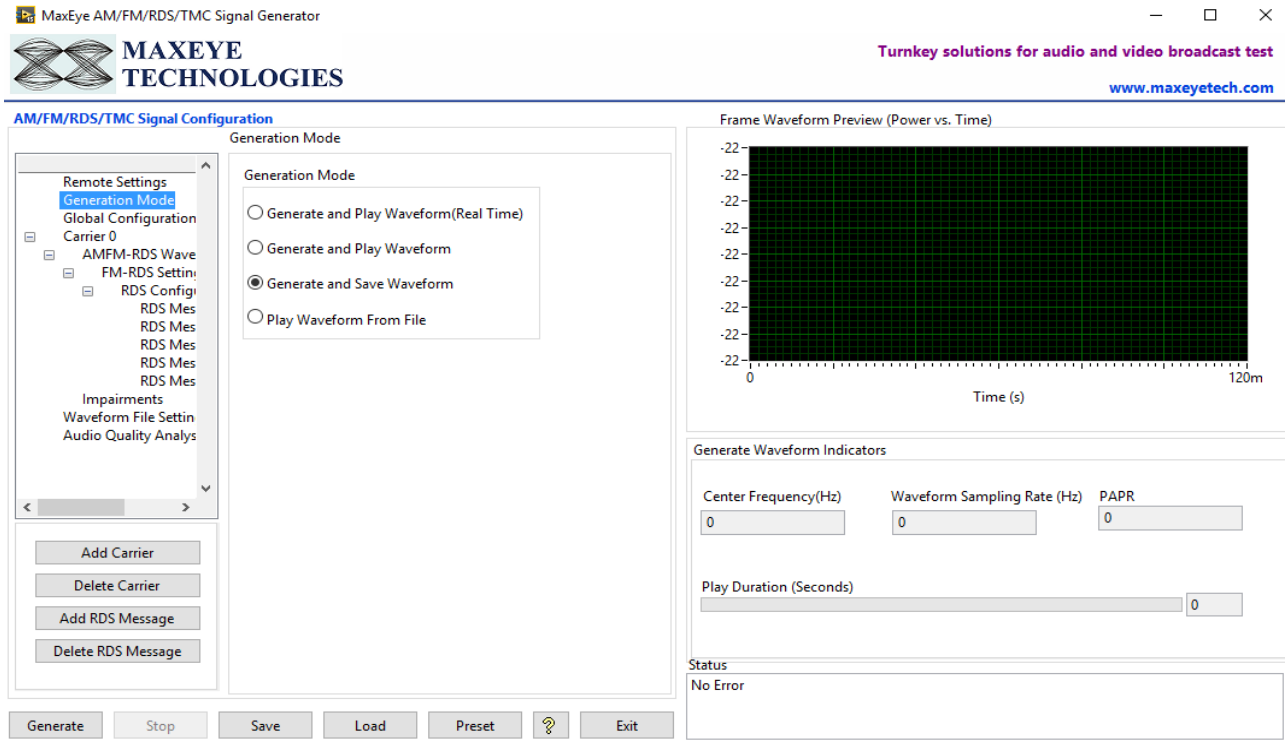
You can also find a shortcut to the above location from the windows start menu. **Start->All Programs->MaxEye->Digital Radio Toolkits->AM FM RDS TMC Generation** ***Note**: - For Windows 10,* **Start ->MaxEye**

3 Soft Front Panel

The soft front panel (SFP) for AM FM RDS TMC Signal Generation allows engineers 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.

3.1 MaxEye AM FM RDS TMC Signal Generation SFP

The figure below shows the AM FM RDS TMC Signal Generation SFP.



3.1.1 Generate and Save Waveform/ Generate and Play Waveform

Generate and Play waveform is used to generate AM FM RDS TMC signal using hardware. Generate and Save Waveform is used to generate the baseband IQ waveform and store in a file. For this configuration hardware is not required. The Play Waveform from File mode reads the AM FM RDS TMC waveform from the file created using the Generate and Save Waveform and then downloads the waveform to NI RFSG Memory and then plays the waveform.

Use the Generate and Save Waveform mode

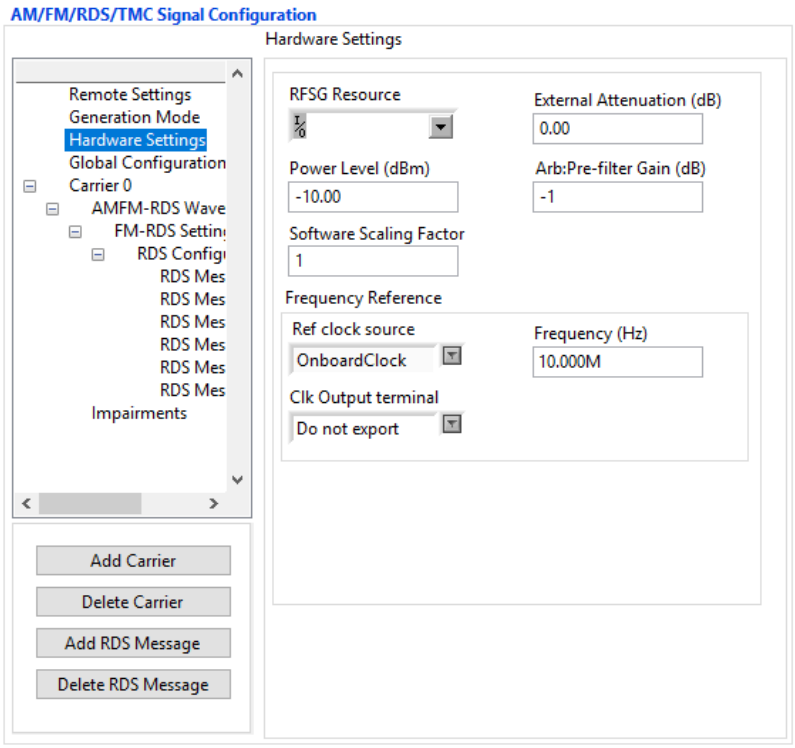
- To generate and store the custom waveforms based on your test requirement.

- 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 (BER) for longer duration.

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

1. Select **Waveform Format** -> **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.*

➢ VSG/ VST

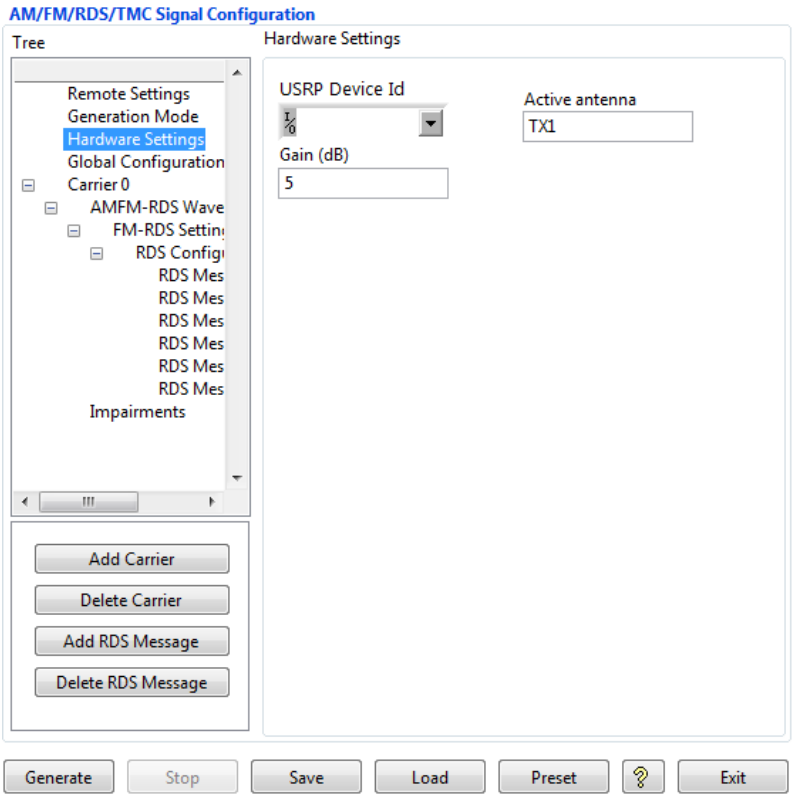
- **RFSG Resource –** Select the Resource Name used in NI Measurement and Automation Explorer (NI MAX) for the NI PXIe-5672/5673/5673E or NI PXIe 5644R/45R/46R or NI 5840 device.

- **Power Level (dBm) –** Specifies the Average Power level of the signal in dBm.
- **External Attenuation (dB) –** Specifies the external amplification or attenuation, 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 AWG Pre-filter Gain. 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.
- **Ref Clock 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.
- **Software Scaling Factor -** Specifies how much to scale the data before writing it with the niRFSG Write Arb Waveform VI. The resulting waveform must be smaller than 1.0 in complex magnitude.

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.

➢ USRP

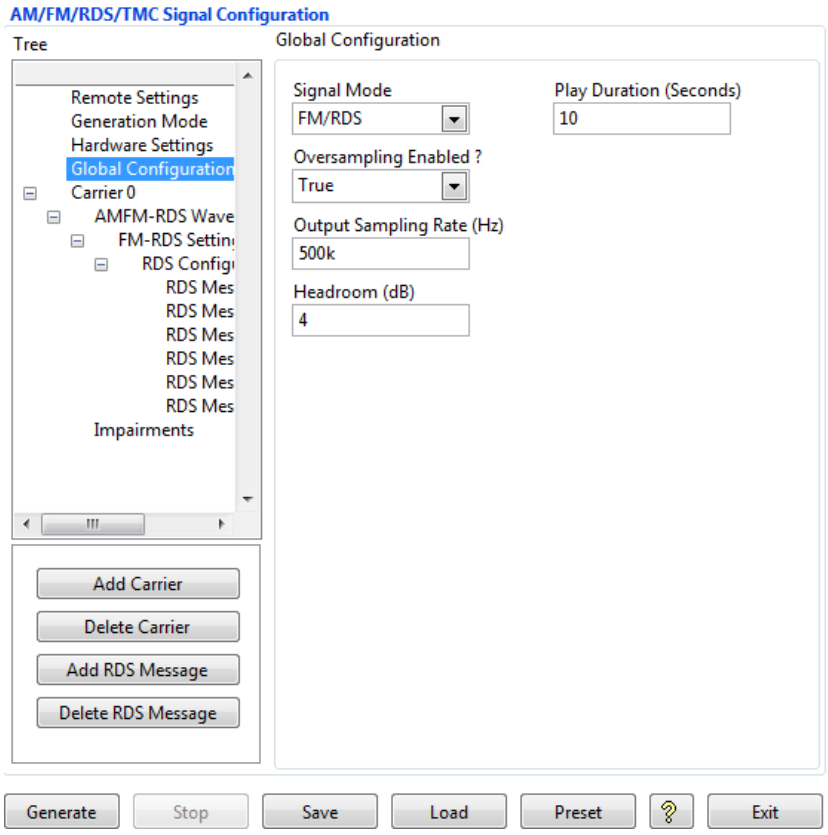
The figure below shows the hardware settings for USRP.



- **USRP IP Address** – Configure the IP address of the NI USRP
- **Gain (dB)** – Configure the aggregate gain, in dB, to be applied to the RF signal.
- **Active Antenna** – Configure the antenna port to be used for this channel.

For more information on Active Antenna, Gain (dB), Coerced IQ rate, Coerced Carrier Frequency and Coerced Gain, please refer NI USRP help file.

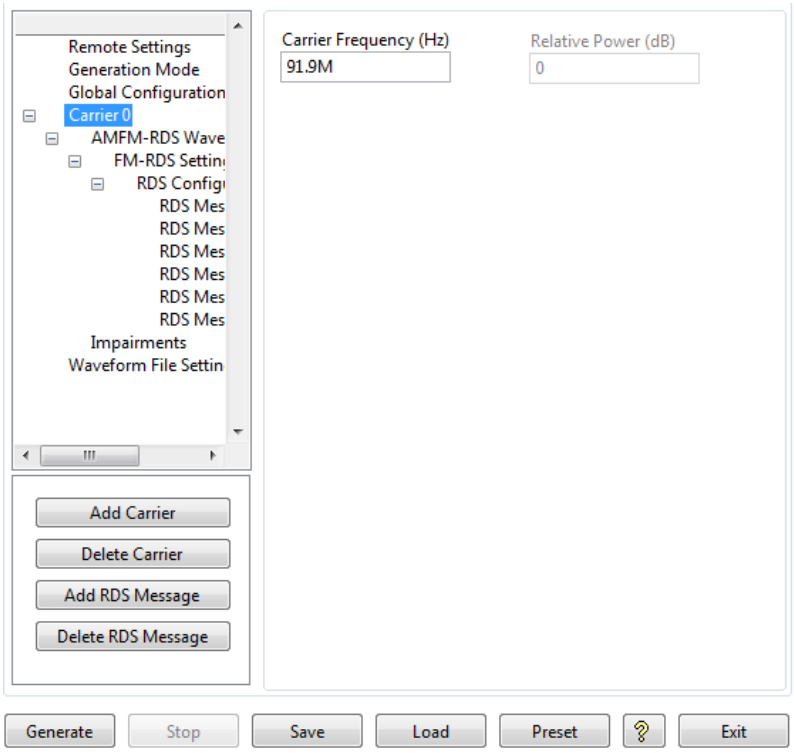
3. Select **Global Configuration** to configure the following parameters.



- **Signal Mode** – Select Mode as FM/RDS or AM.
- **Play Duration** – The Play Duration, Seconds property decides the duration of waveform to be generated. To generate longer duration of the waveform increase the Play Duration, Seconds value.
- **Headroom (dB)** – The toolkit uses this value for scaling the waveform. If the PAPR of the signal is higher than the Headroom then the toolkit clips the signal. To avoid clipping Headroom value should be higher than the PAPR of the signal.
- **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**.

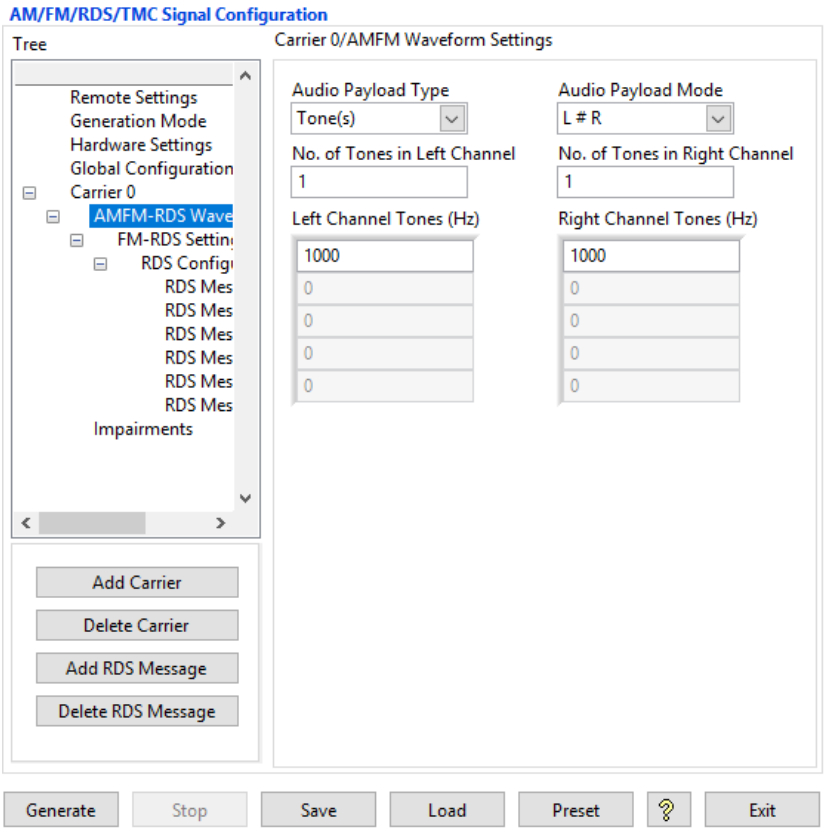
4. Select **Carrier** to configure the following parameters.



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.*

- **Carrier Frequency (Hz)** – Configure the Carrier Frequency for the selected carrier in Hz.
- **Relative Power (dB) -** Configure the Relative Power for the selected Carrier in dB.

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



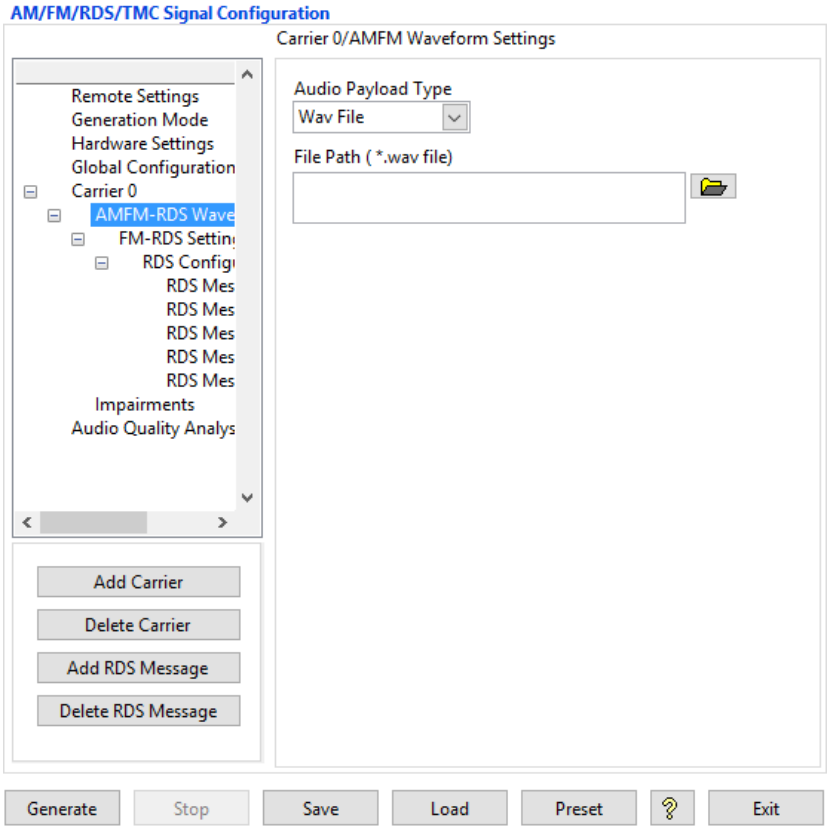
- **Audio Payload Type** – Select Type as Tone(s) (Default) or Wav File

➢ Tone(s)

- AudioPayloadMode – Specifies the sync between left and right channel. The default value is L # R. Given below are the possible values
  - ➢ L # R,
  - ➢ L = R,
  - ➢ L = -R,
  - ➢ L Only,
  - ➢ R Only.
- **No. of Tones in Left Channel** – Configure the number of tones in left channel. No. of Tones in Left Channel and the number of elements in the Left Channel Tones (Hz) control must be same.

- **No. of Tones in Right Channel** – Configure the number of tones in right channel. No. of Tones in Right Channel and the number of elements in the Right Channel Tones (Hz) control must be same.
- **Left Channel Tones (Hz) –** Configure the left channel tone values in Hz. The toolkit generates sine tones based on the frequency and combines all the tones before FM or AM modulation. The number of elements should be equal to the No. of Tones in Left Channel.
- **Right Channel Tones (Hz) –** Configure the right channel tone values in Hz. The toolkit generates sine tones based on the frequency and combines all the tones before FM or AM modulation. The number of elements should be equal to the No. of Tones in Right Channel.

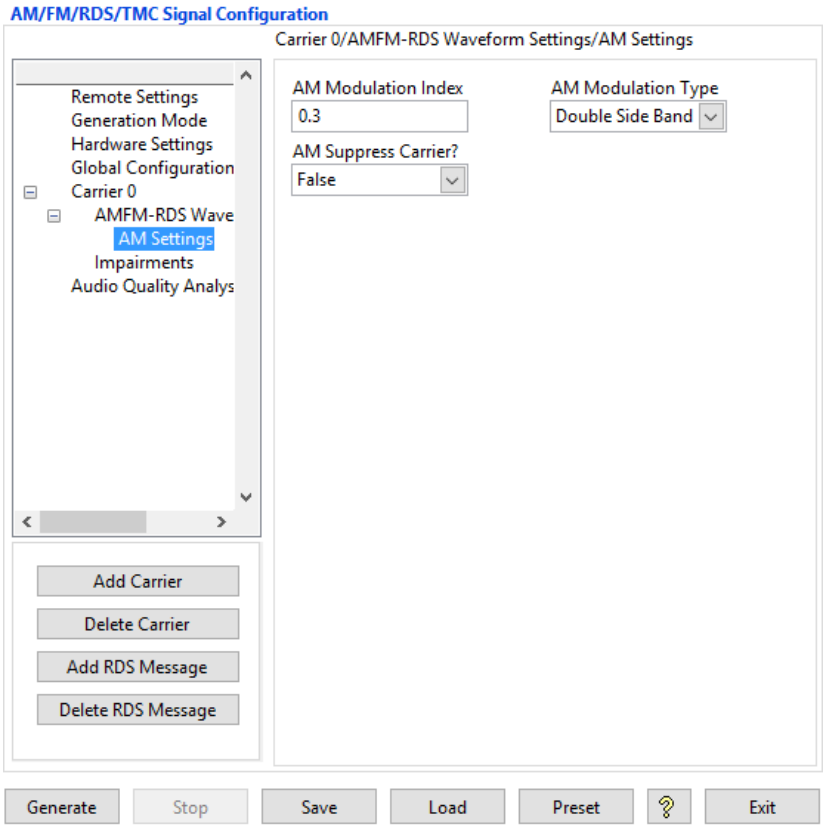
➢ Wav File



- **File Path (*.wav file) –** Configure the file path of the wav file.

➢ AM

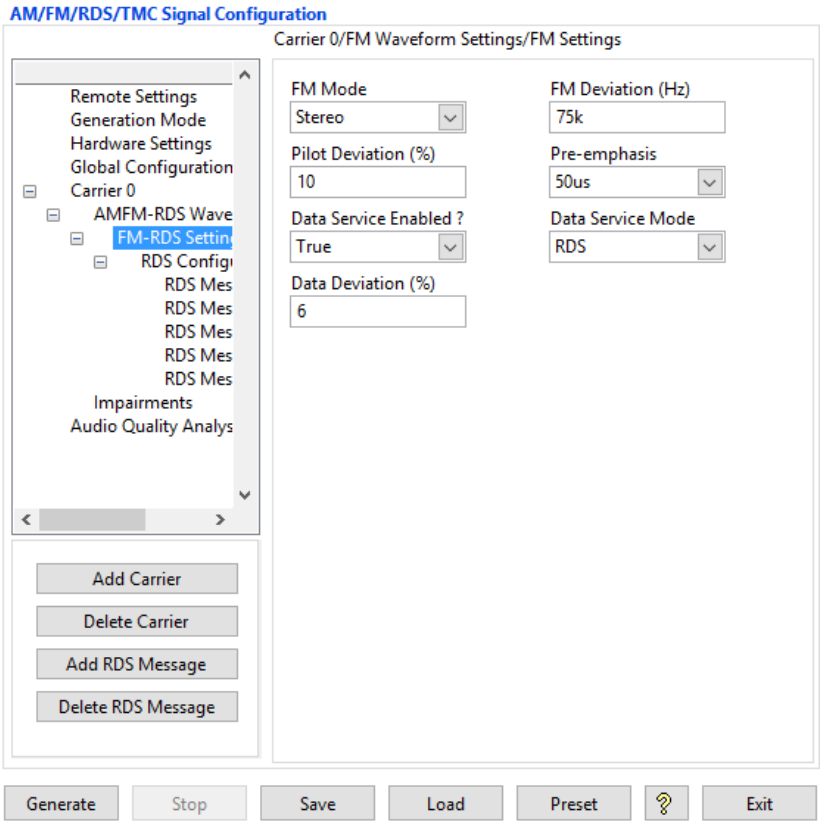
4.2. Select **AM Settings** to configure the following parameters



- **AM Modulation Index –** Configure the AM modulation index property. The default value is 0.3
- **AM Modulation Type –** Select type as Double Side Band or Single Side Band or Vestigial Side Band. The default is Double Side Band.
- **AM Suppress Carrier? –** Select suppress carrier as False or True. The default value is False.

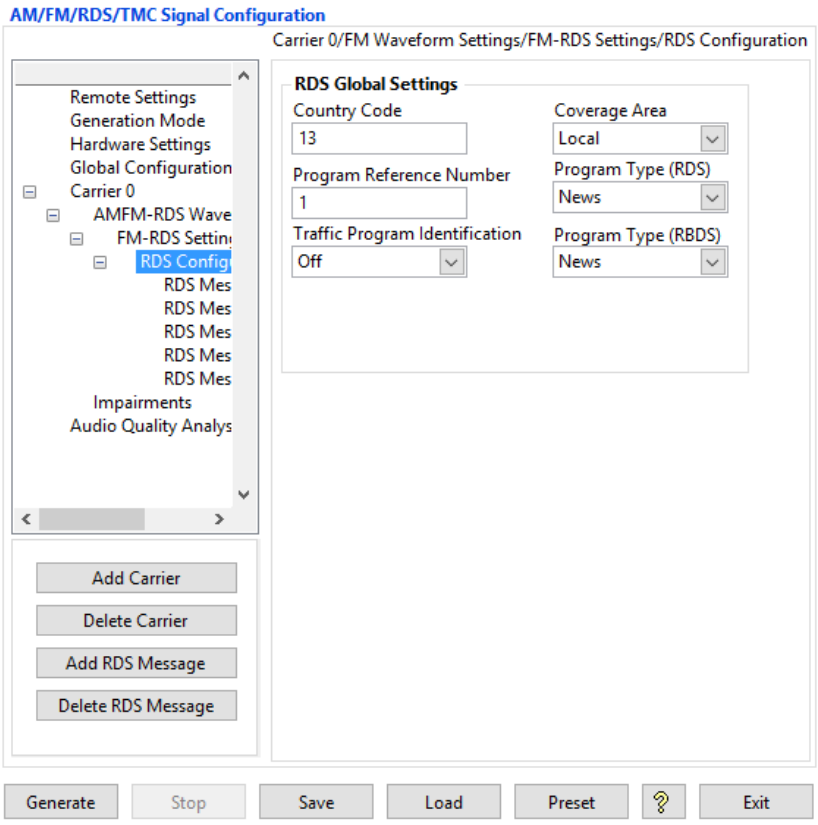
➢ FM/RDS

4.3. Select **FM-RDS Settings** to configure the following parameters for the selected carrier



- **FM Mode –** Select mode as Mono or Stereo.
- **FM Deviation (Hz) –** Configure the FM deviation value in Hz. Default value is 75 kHz**.**
- **Pilot Deviation (%) –** Configure Pilot deviation value in %. Default value is 10%**.**
- **Pre-emphasis –** Pre-emphasis provides increased amplitude to the higher modulating frequencies prior to modulation under a well-defined pre-emphasis (high-pass filter) curve, in order to compensate the effect of noise with increasing modulation frequency.
- **Data Service Enabled? –** Set this value to True to transmit RDS or RBDS messages in the FM signal.
- **Data Deviation (%) –** Configure Data deviation value in %. Default value is 6%**.**
- **Data Service Mode –** Select mode as RDS or RBDS. **Radio Data System (RDS)** is a communication protocol standard for embedding small amounts of digital information in conventional FM radio broadcasts. RDS standardizes several types of information transmitted, including time, station identification and programme information. **Radio Broadcast Data System (RBDS)** is the official name used for the U.S. version of RDS.

4.4. Select **RDS Configuration** to configure the following parameters for the selected carrier



- **Country Code –** Specifies the unique identifier for the country. Refer the Annex D and Annex N of the RDS standard specification "The new RDS IEC 62106:1999 standard" for the details.

- **Coverage Area –** Specifies the coverage area for the transmission. The valid values are.
  0 : Local, 1 : International, 2 : National, 3 : Supra-regional, 4 : Regional 1, 5 : Regional 2, 6 : Regional 3, 7 : Regional 4, 8 : Regional 5, 9 : Regional 6, 10 : Regional 7, 11 : Regional 8, 12 : Regional 9, 13 : Regional 10, 14 : Regional 11, 15 : Regional 12.
  The default value is Local.

- **Program Reference Number –** Configure the control with valid Program Reference Number. The default Program Reference Number is 1.

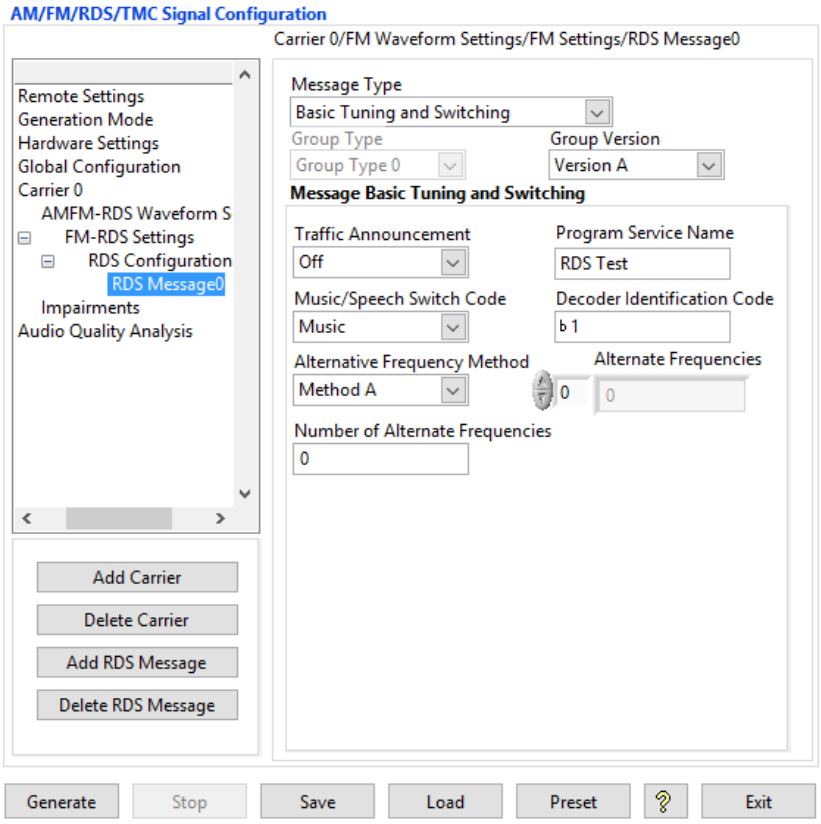
***Note**: - These Country Code, Coverage Area and Programme Reference Number collectively makes a Program Identification (PI) code. The PI code is used for the identification of the transmitting radio station and the transmitted content. It enables the RDS tuner to distinguish between different countries and areas with the same program. As the PI code is not capable of covering the large number of participating countries, the Extended Country Code can be used additionally.*

- **Traffic Program Identification –** Set Traffic Program Identification as ON or OFF**.** Traffic Program identifies if the station is capable of sending traffic announcements or not. This control works with **Traffic Announcement** control given in Basic Tuning and Switching section. ***Note****: - Set both the controls Traffic Program Identification and Traffic Announcement control to ON state for sending traffic announcement.*

- **Program Type (RDS) –** Program Type describes the type of programme transmitted. ***Note****: - Configure this control only if selected Data Service Mode is RDS.*

- **Program Type (RBDS) –** Same as Program Type (RDS).

4.5. Select **RDS Message** to configure the following service parameters for the selected carrier.



Note: *- By default, the tree control shows RDS Message 0. To configure more RDS Messages, click the Add RDS Message button and configure the following parameters for each service.*

- **Message Type –** Select the desired type of RDS Message.
- **Group Version –** Select the desired Group Version. In Version A, the PI code is inserted in block 1 only. In Version B, the PI code is inserted in block 1 and block 3.

- **Group Type –** Indicate the Group type of the selected Message Type.

➢ Basic Tuning and Switching

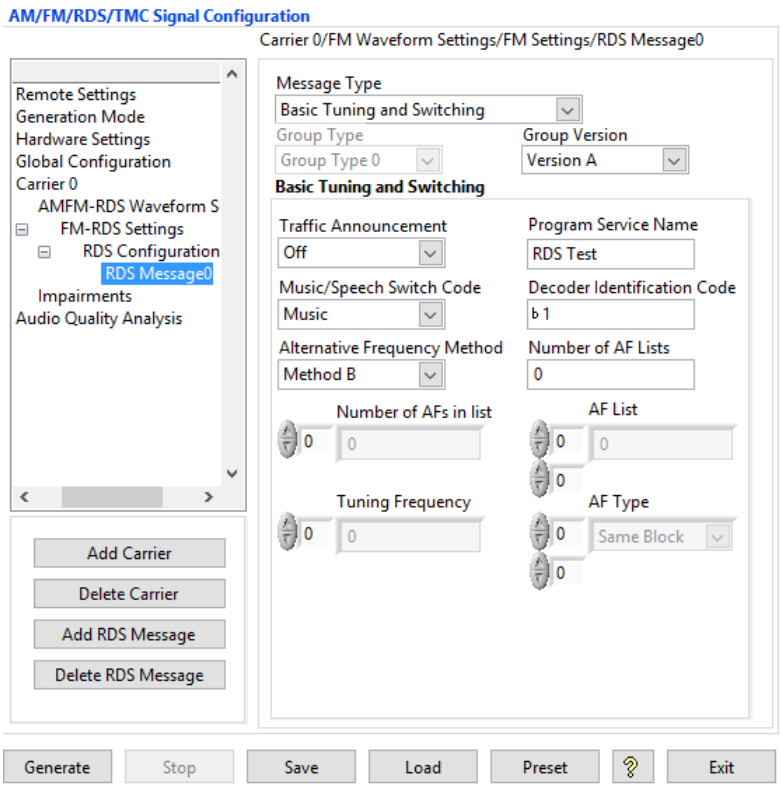
This message type allows a radio station to transmit Traffic Announcement, Music/Speech Switch Code, Tuning Frequency and Program Service Name of the Broadcasting Station.

- **Traffic Announcement –** Set Traffic Announcement property ON to send traffic announcement
  Note*: - Traffic Program Identification too must be ON.*
- **Program Service Name –** The Program Service Name contains max. 8 alphanumeric characters. It can be used to inform the user about the station ID. The PS is usually displayed by every RDS enabled tuner.
- **Music/ Speech Switch Code –** The Music/Speech switch is used to identify if music or speech program is transmitted. The signal supports tuner with two individual volume modes one for music, the other for speech. This enables the user to configure the settings according to individual requirements.
- **Decoder Identification –** These indicate which possible operating modes are appropriate for use with the broadcast audio and to indicate if PTY codes are switched dynamically.
- **Alternate Frequency Method –** Select between Method A or Method B. Method A is used for lists up to 25 in number. Method B is used for larger lists.

➢ Method A

- **Number of Alternate Frequencies –** Specifies the total number of alternative frequencies.
- **Alternate Frequencies –** Configure this control to specify the alternative frequencies.

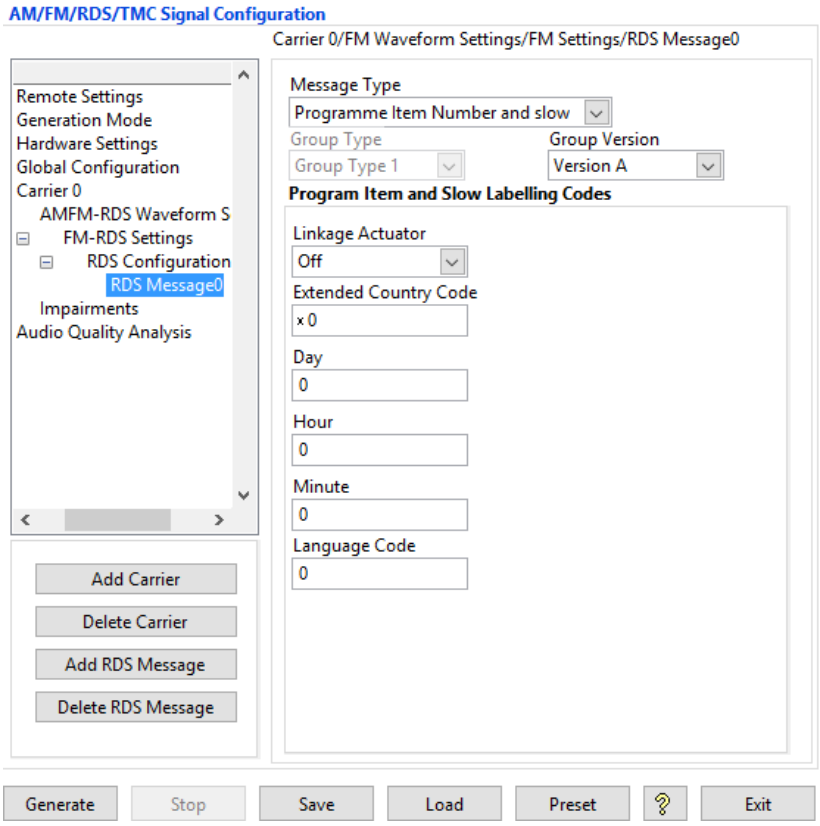
➢ Method B



- **Number of AF Lists –** Configure this control to specify the total number of AF Lists.
- **Number of AFs in list –** Specify the number of alternate frequencies in each list. Each row corresponds to each list. Use the index display to navigate through different lists.
- **AF List –** Specify the alternate frequencies for each AF list. Each row corresponds to each AF list. Enter the alternate frequencies column wise for each list. Use the index display to navigate through different AF list and alternate frequency.
- **AF Type –** Specify the type of each alternate frequency entered in the AF List. Each row corresponds to each AF list. Configure the type of alternate frequencies column wise for each list. Use the index display to navigate through different AF list and type of alternate frequency.
- **Tuning Frequency –** Specify the tuning frequency. The alternate frequency list is specified for this tuning frequency.

➢ Programme Item Number and Slow Labelling Codes

This message type allows a radio station to transmit Extended Country Code, Language Code, and Linkage Actuator.

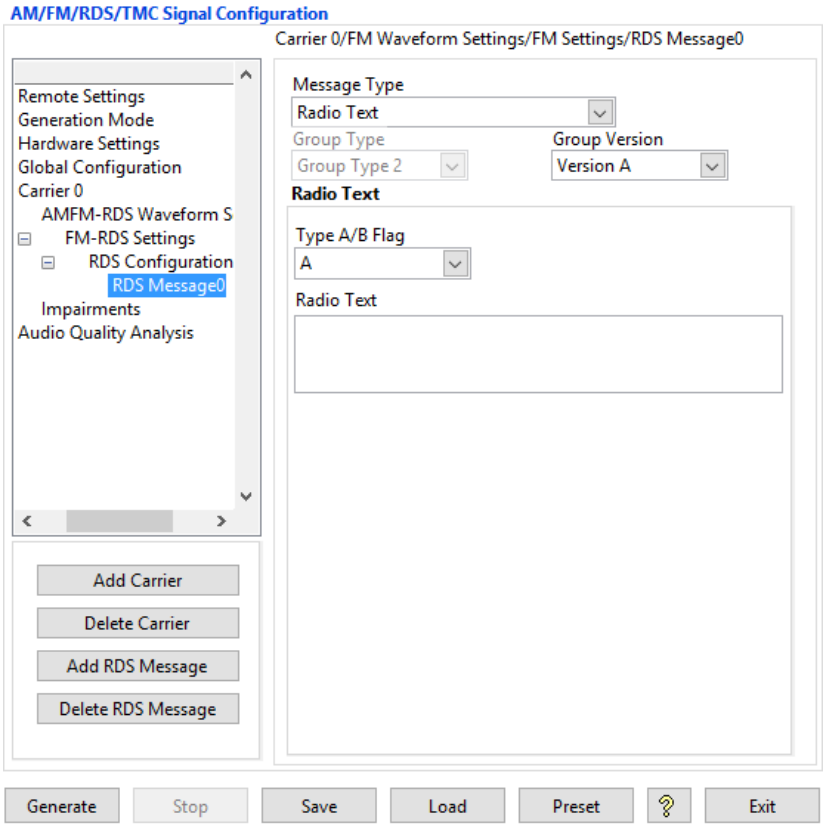


- **Linkage Actuator** – Linkage actuator allows to link this station to another station that offer the same program.
- **Extended Country Code** – Configure the unique and valid extended country code for the selected country. Refer the Annex D and Annex N of the RDS standard specification "The new RDS IEC 62106:1999 standard" for the details. .
- **Language Code** – Specify the language code of the target audience. Refer the Annex J of the RDS standard specification "The new RDS IEC 62106:1999 standard" for the details.
- **Day** – Specify the Day of the broadcast.
- **Hour** – Specify the Hour of the broadcast.
- **Minute** – Specify the Minute of the broadcast.

***Note**:-Day, Hour and Minute collectively forms the Program Item Number (PIN). PIN specifies is the scheduled broadcast start time.*

➢ Radio Text

This message type allows a radio station to transmit a 64-character free-form text that can be either static (such as station slogans) or in sync with the programming (such as the title and artist of the currently playing song).

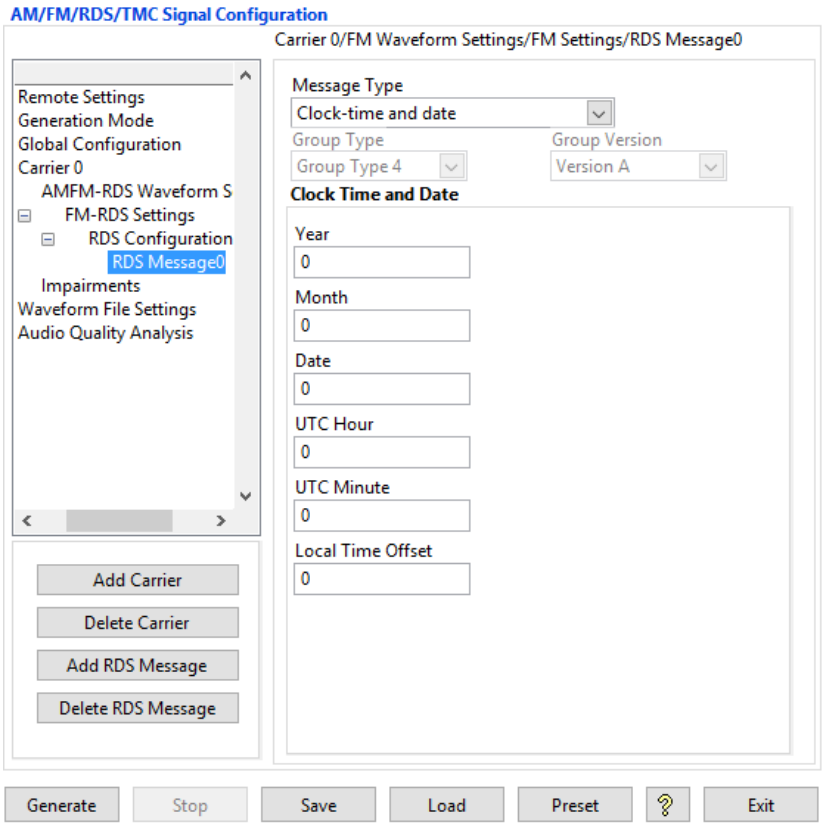


Group Version A supports up to 64 characters and Group Version B supports only up to 32 characters.

- **Type A/ B Flag** – Specifies the Group Version. In Version A, the PI code is inserted in block 1 only. In Version B, the PI code is inserted in block 1 and block 3.
  Note: - If the receiver detects a change in the **Type A/B Flag**, then the whole Radio Text display shall be cleared and the newly received Radio Text message segments shall be written into the display.
- **Radio Text** – Enter the Radio Text to be transmitted.

➢ Clock Time and Date

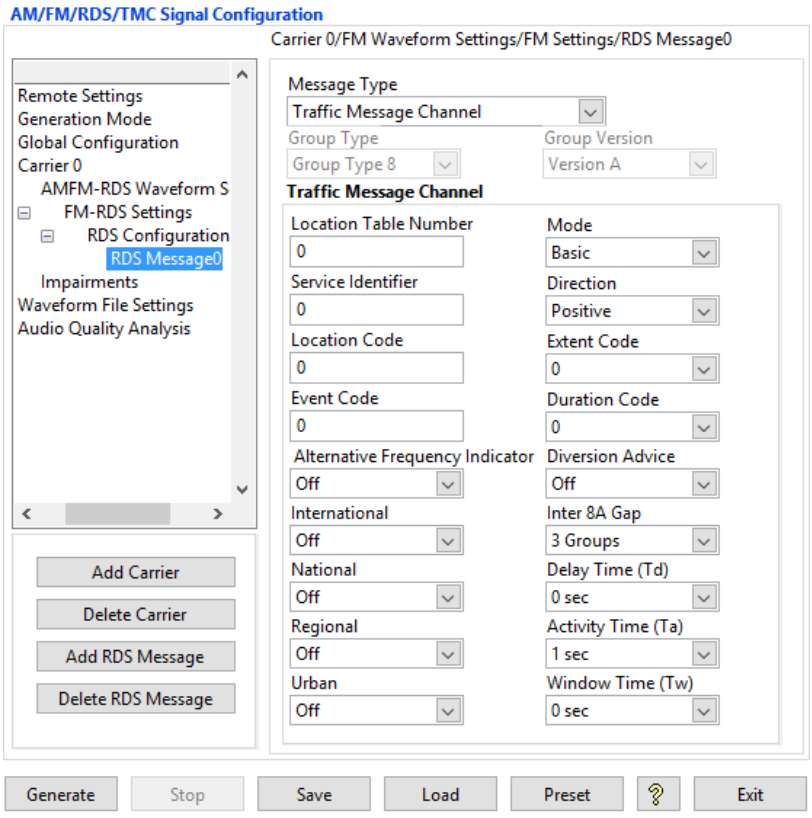
This message type can synchronize a clock in the receiver. The transmitted clock-time and date shall be accurately set to UTC plus local offset time. Otherwise the transmitted CT codes shall all be set to zero.



- **Year** – Specify the year of broadcast.
- **Month** – Specify the month of broadcast.
- **Date** – Specify the date of broadcast.
- **UTC Hour** – Specify the hour of broadcast, in UTC time.
- **UTC Minute** – Specify the Minute of broadcast, in UTC time.
- **Local Time Offset** – Specify the Local Time Offset, if any.

➢ Traffic Message Channel

This message type allows communication of traffic events, such as accidents and queues, to user. If traffic event affect the current route plotted by the user, then the information is used for calculating and suggesting detours and alternate routes.

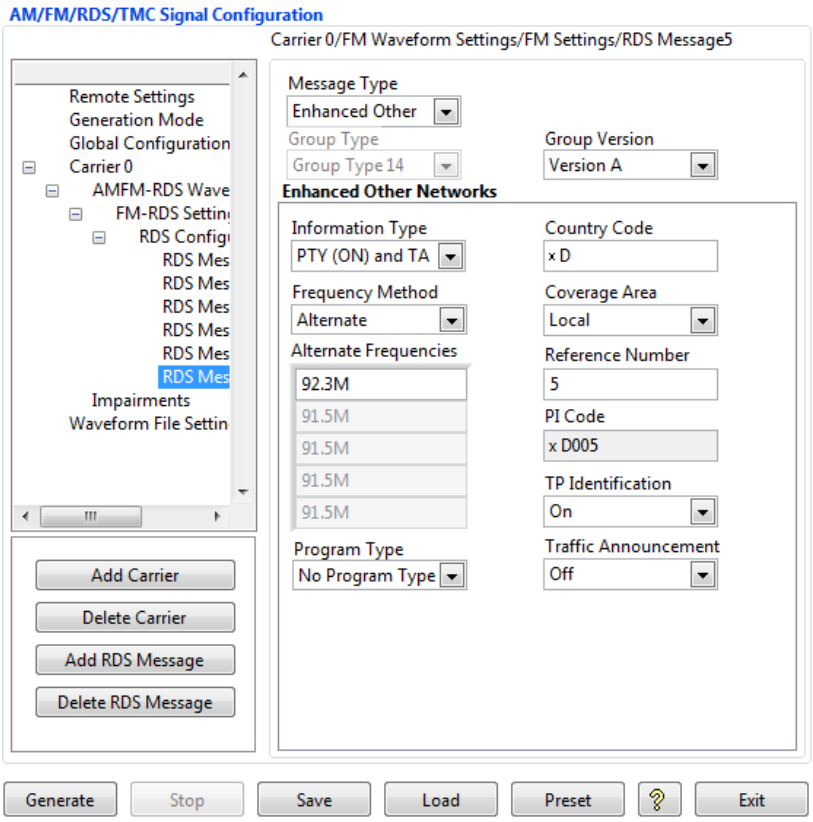


- **Location Table Number** – Configure this control to specific location table number. This number specifies the unique identification of the service.
- **Mode** – Choose the Basic Mode. Enhanced mode is not supported by the current version of the toolkit.
- **Service Identifier** – The Service Identifier identifies the data service provider in its country.
- **Direction** – Select direction as positive or negative from the location where the event has happened. This indicates the direction of the affected traffic flow.
- **Location Code** – Location code defines the location where the event occurred.
- **Extent Code** – This property shows the extension of the current event, it is measured in terms of steps. This is a 3-bit field and it gives the number of steps through adjacent locations that are affected by the events.
- **Event Code** – Configure this control with standard event codes to define the event occurred. The event code is a simple 11 bit code that is used as a pointer to an event description inside the event list.
- **Diversion Advice** – Set Diversion Advice to ON, to receive diversion advices in the navigation system.
- **Duration Code** – Configure this control to simulate the information about the timeframe of the traffic event or any event. See the Duration code below with the corresponding duration.

- **Alternate Frequency Indicator** – Specifies if all frequencies of a programme network fulfil the conditions for using Tuning Information or not. If set to 1, indicates that all alternative frequencies broadcast in the 0A-group for the audio program can be used to switch to the next station. In all other cases the AFI bit is set to 0.
- **International** – Indicates the geographical scope of the location.
- **National** – Indicates the geographical scope of the location.
- **Regional** – Indicates the geographical scope of the location.
- **Urban** – Indicates the geographical scope of the location.
- **Inter 8A Gap** – Specify the minimum number of non-8A groups to be transmitted between two 8A groups.
- **Delay Time (Td)** – Specifies the delay between the start of the minute and the start of the first time slot. The default delay time is 0.
- **Activity Time (Ta)** – Specifies the time during which 8A group is inserted in the RDS data stream. The default activity time is 1 sec.
- **Window Time (Tw)** – Specifies the time during which no 8A groups are inserted in the RDS data stream. The default window time is 1 sec.

➢ Enhanced Other Networks

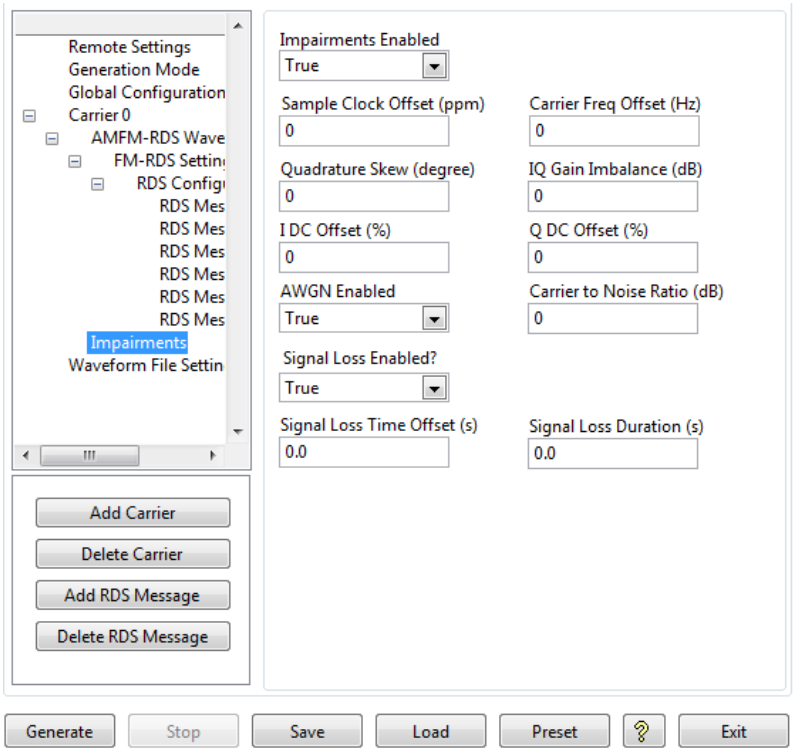
- **Information Type** - Select one of the Information Type.
- **Country Code** – Specifies the unique identifier for the country for other programs. Refer the Annex D and Annex N of the RDS standard specification "The new RDS IEC 62106:1999 standard" for the details.
- **Coverage Area** – Specifies the coverage area for the transmission for other programs. The valid values are.0 : Local, 1 : International, 2 : National, 3 : Supra-regional, 4 : Regional 1, 5 : Regional 2, 6 : Regional 3, 7 : Regional 4, 8 : Regional 5, 9 : Regional 6, 10 : Regional 7, 11 : Regional 8, 12 : Regional 9, 13 : Regional 10, 14 : Regional 11, 15 : Regional 12. The default value is Local.
- **Program Reference Number** – Configure the control with valid Program Reference Number for other programs. The default Program Reference Number is 1.
  Note: *- These Country Code, Coverage Area and Programme Reference Number collectively make a Program Identification (PI) code. The PI code is used for the identification of the transmitting radio station and the transmitted content. It enables the RDS tuner to distinguish between different countries and areas with the same program. As the PI code is not capable of covering the large number of participating countries, the Extended Country Code can be used additionally.*
- **Frequency Method** - Select one of the Frequency methods.
- **Alternate Frequencies** – Configure this control to specify the alternative frequencies for other programs.



- **Mapped Frequencies** - Configure this control to specify the Mapped frequencies. Maximum five mapped frequencies can be transmitted.
- **Traffic Program Identification** – Set Traffic Program Identification as ON or OFF for other programs. Traffic Program identifies if the station is capable of sending traffic announcements or not. This control works with Traffic Announcement control given in EON Message.
  Note: - Set both the controls Traffic Program Identification and Traffic Announcement control to ON state for sending traffic announcement.
- **Traffic Announcement** – Set Traffic Announcement property ON to send traffic announcement for other programs.
- **Program Type** – Program Type describes the type of programme transmitted for other programs.
- **Program Service Name** – The Program Service Name contains max. 8 alphanumeric characters. This PS is for other programs. It can be used to inform the user about the station ID. The PS is usually displayed by every RDS enabled tuner.
- **Linkage Set Number** - Sets the Linkage Set Number LSN for other programs. The LSN is a 12-bit number.
- **International Linkage Set** - Enables/disables the international linkage set indicator ILS for other programs.
- **Linkage Actuator** - Enables/disables the linkage actuator LA for other programs.

- **Extended Generic** - Enables/disables the extended generic indicator EG for other programs.
- **Day** – Specify the Day of the broadcast for other programs.
- **Hour** – Specify the Hour of the broadcast for other programs.
- **Minute** – Specify the Minute of the broadcast for other programs.
  Note:-Day, Hour and Minute collectively forms the Program Item Number (PIN).
  PIN specifies is the scheduled broadcast start time.

4.6. Select **Impairments** to configure the following impairment parameters

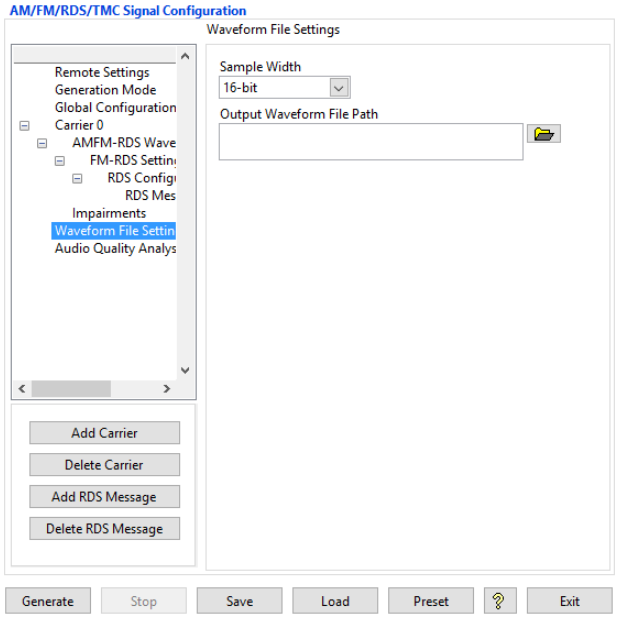


- **Impairments Enabled** – If this property is set to **True** then the toolkit adds the impairments to the generated signal as per the user configuration for the supported impairments.
- **Clock Offset (PPM)** – The toolkit applies the clock offset to the generated waveform based on this value. The 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 0dB.
- **Signal Loss Enabled-** Set this property to True to simulate Signal Loss in the generated signal.
  Signal Loss Time Offset (s) - Specifies the Signal Loss Time Offset in seconds.
  Signal Loss Duration (s) - Specifies the Signal Loss Duration in seconds.

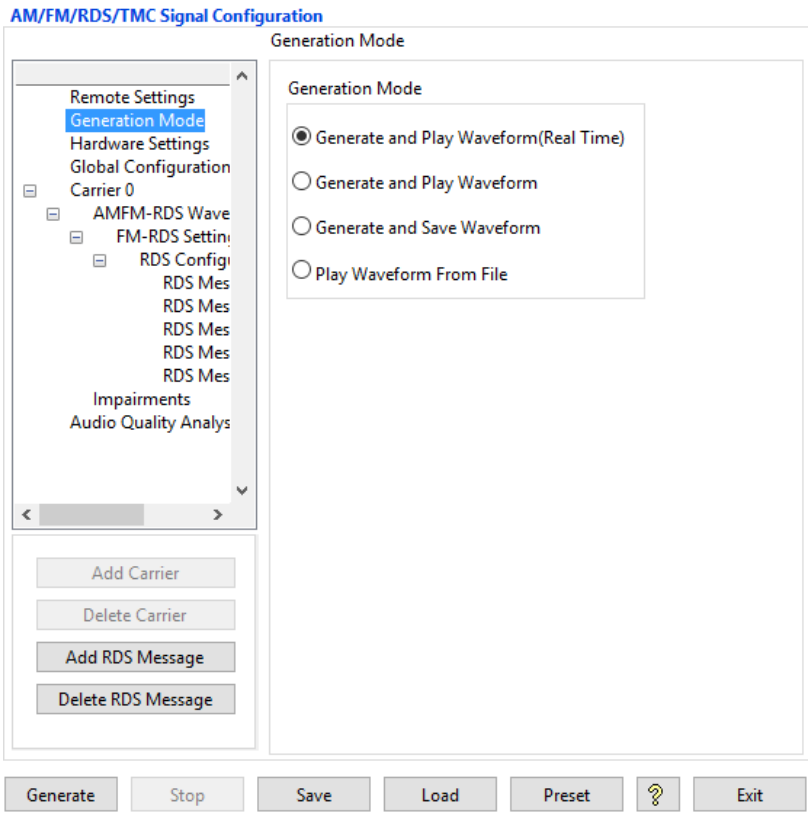
5. Select **Waveform File Settings** to configure the following parameters

These settings need to be configured only if the generation mode is Generate and Save Waveform.



- **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.
- **Output 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.

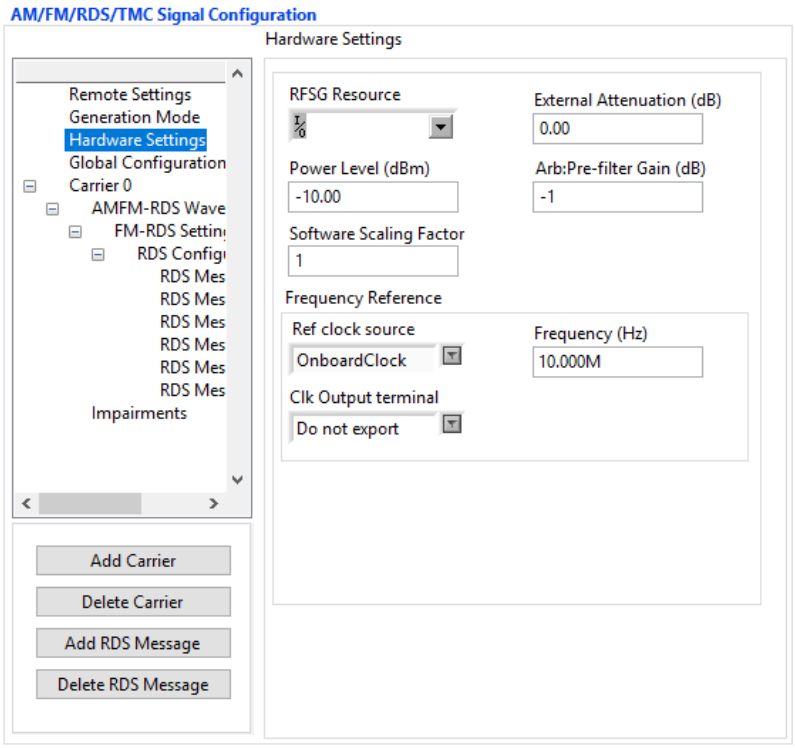
3.1.2 Generate and Play Waveform (Real-Time)



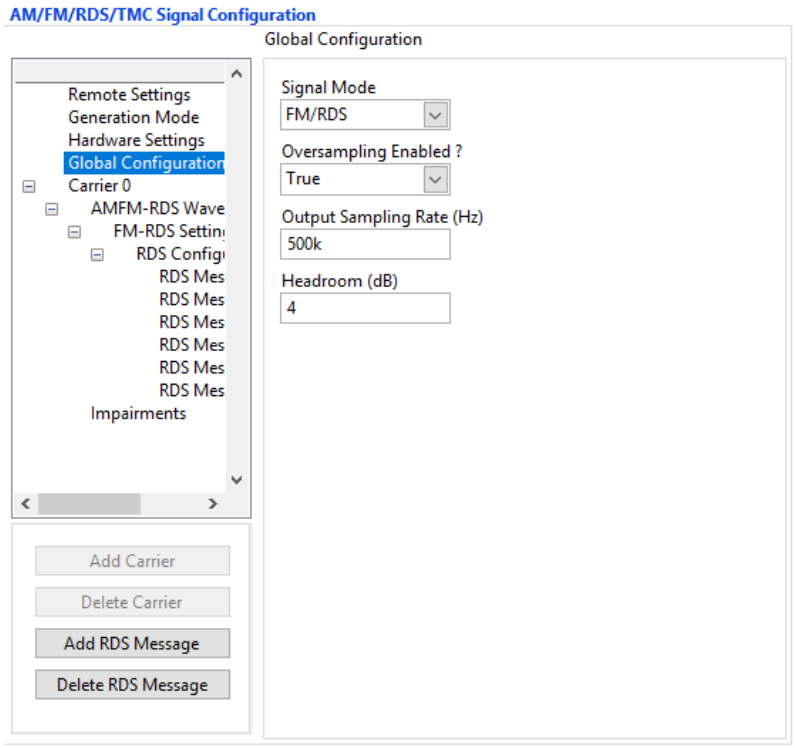
1. Select **Waveform Format** -> **Generation Mode** -> **Generate and Play Waveform (Real Time)**

In this mode the waveform is generated in real-time and the number of carriers supported is one. Follow the same procedure given in section 3.1.1 of this document for signal configuration and hardware settings, except for the changes mentioned below.

2. In step 2, if the hardware used is VSG, additionally one more control need to be configured



3. In step 3, **Global Configuration**, **Play Duration in Seconds** parameter need not to be configured.



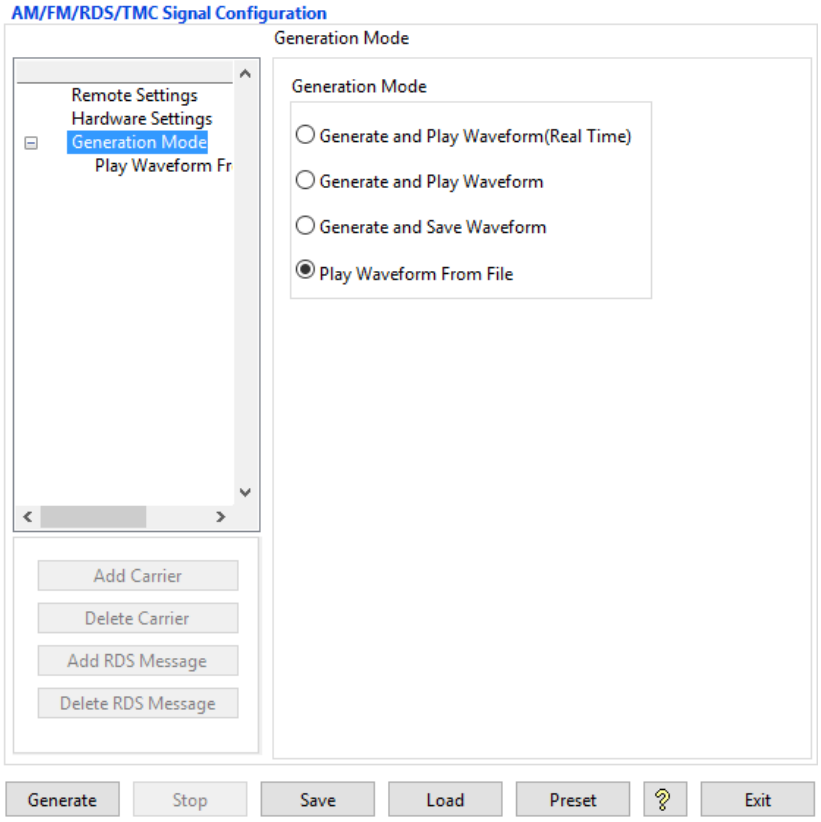
4. In step 4, **Carrier Configuration**, only Carrier 0 needs to be configured. More than 1 carrier is not supported in Real-Time generation mode.

5. Skip the Step 6, **Waveform Settings**, since this generation mode doesn't save the waveform in any file.

3.1.3 Play Waveform from File

In this generation mode AM FM RDS TMC 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 document, 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.

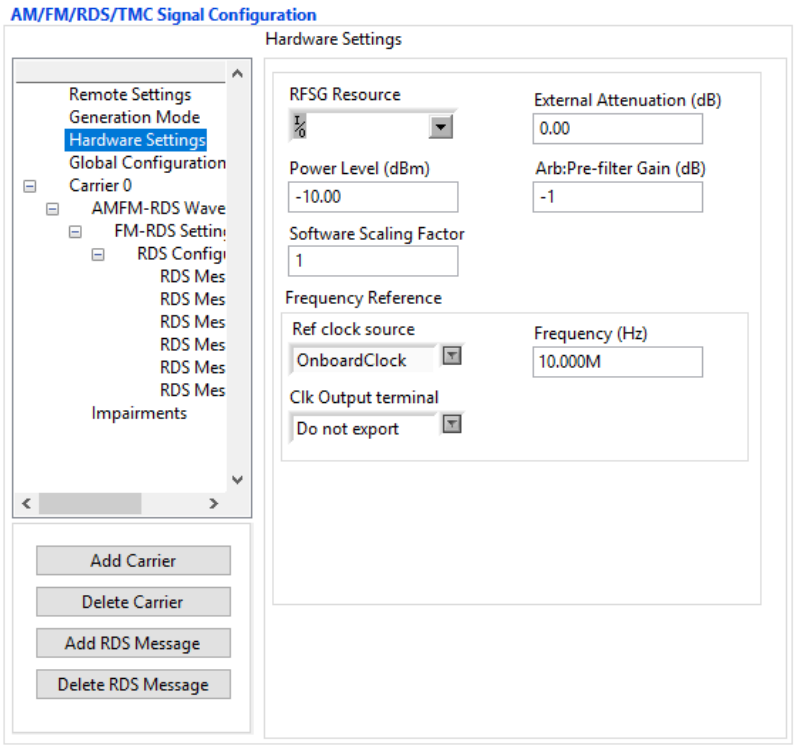


Follow the procedure below to generate waveform using this generation mode

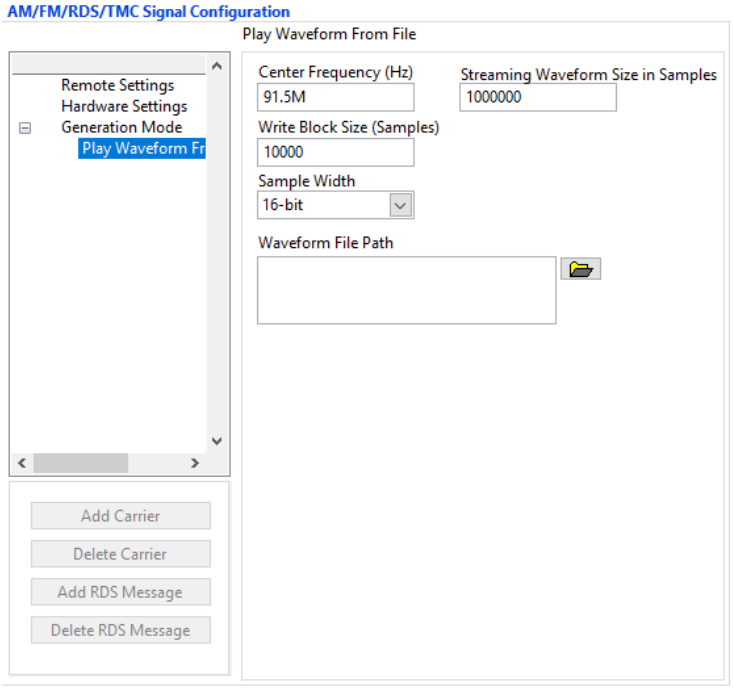
1. Select **Waveform Format** -> **Generation Mode** -> **Play Waveform from File**
2. Select **Hardware Settings** to configure the following parameters.

Refer section 3.1.1 of this document to configure the desired hardware.

If the hardware used is **VSG**, additionally one more control need to be configured.



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

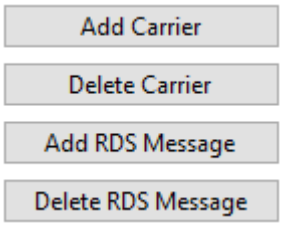


- **Center Frequency (Hz) –** Specify the center frequency of the AM FM signal in Hz.
- **Write Blocks Size (Samples) –** The waveform is written in the hardware as blocks. This parameter configures the size of the block in samples.
- **Sample Width –** Use the same sample width value used for saving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

3.2 General SFP Controls and Indicators Details

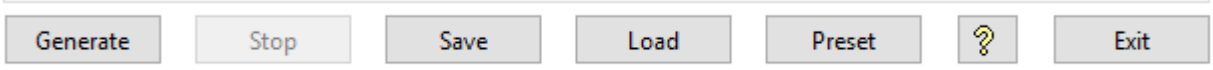
- **Add carrier –** Click to add new carrier configuration with default values.
- **Delete Carrier –** Click to delete the selected carrier. Click on the appropriate **carrier tag** in a tree control or on any **child tag** like waveform settings, impairments, service configuration under specific **parent 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.*

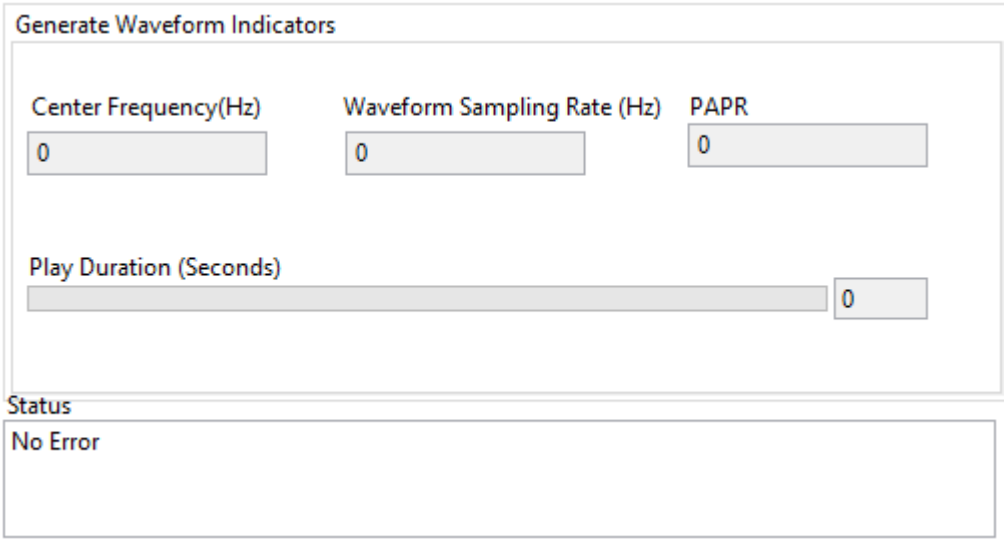


All the items under the **parent carrier tag** specify configuration that need to be configured for each and every unique carrier.

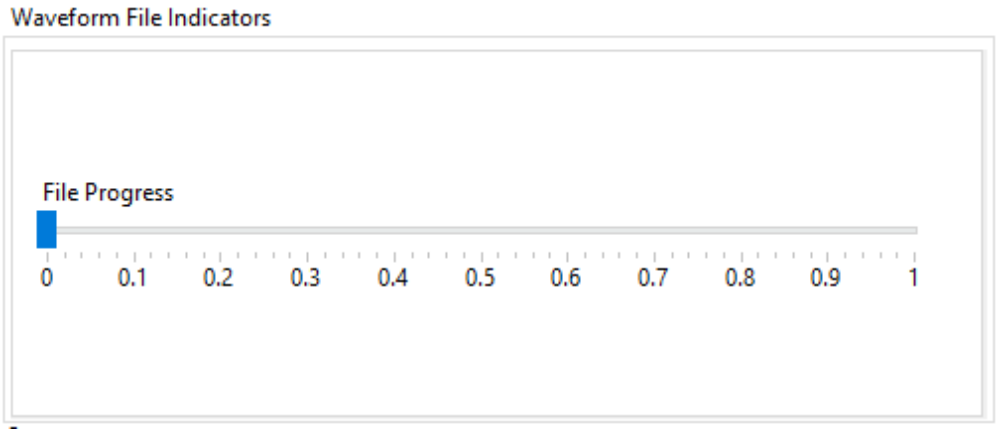
- **Add RDS Message –** Click to add **RDS message** under specific carrier configuration**.** Click on the appropriate **carrier tag** in a tree control or on any **child tag** like waveform settings, impairments, under specific **parent carrier tag** (carrier 0, carrier 1 etc.) to select under which **carrier** the new **RDS message** is going to be added.
- **Delete RDS Message** – Click on the specific **RDS Message tag** under from which carrier **RDS Message** are going to be deleted.
- **Generate** - Click to generate signal as per the parameters configured. ***Note:*** - Parameters can be changed at run time ones **Generate** button has been pressed.
- **Stop** – Click to stop the signal generation.
- **Save** – Saves the entire configuration in the INI 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 –** Display of progress of generating frames.



- **Status** – Displays warning or error.
- **Play Duration (Seconds) –** Indicates the total duration, in seconds, of waveform generated.
- **Waveform 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.
- **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.
- **PAPR –** Indicates Peak to Average Power Ratio, which is calculated by dividing the peak power by the Root Mean Square (RMS) value of the waveform. This value is used to set the Headroom (dB) value.



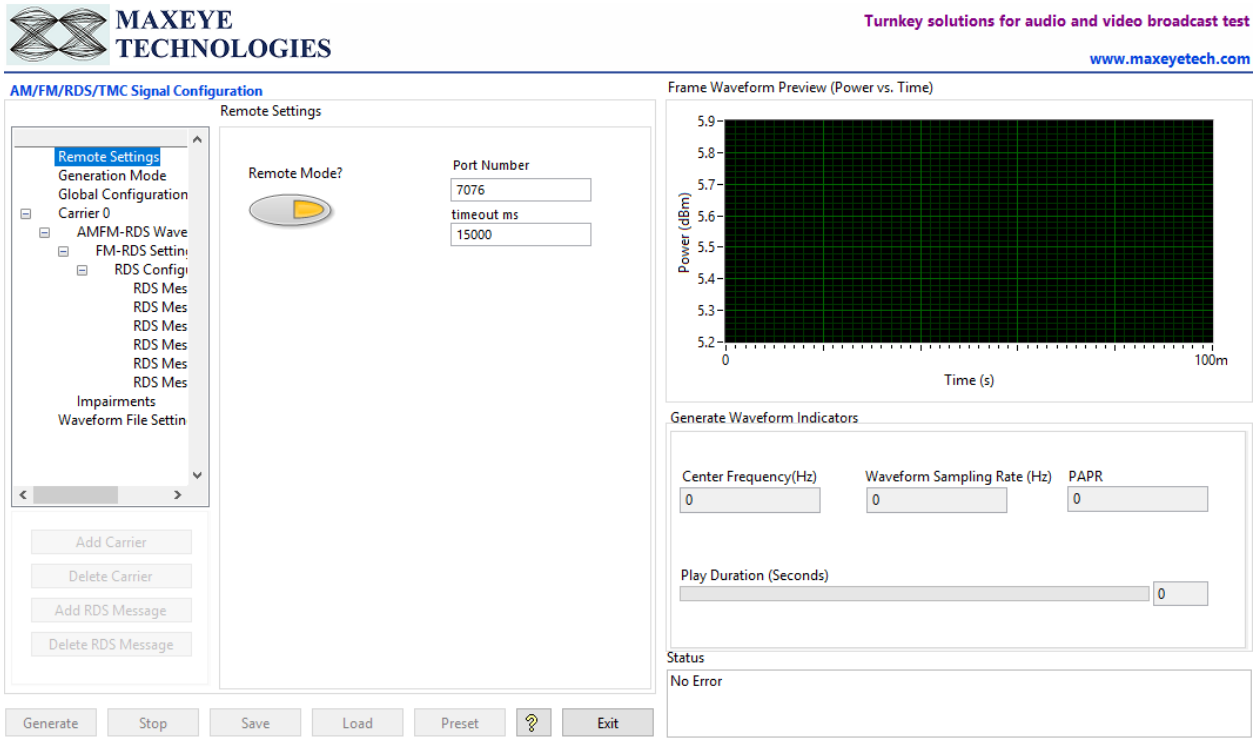
- **Stop** – Click to this button to abort the generation at any time.



- **File Progress** – Indicates the progress of waveform generation.

3.3 Remote Mode

Remote mode allows user to control the MaxEye AM FM RDS TMC Signal Generation software remotely using server application (LabVIEW or C) to generate signals. This Server application/examples/APIs is provided with the AM FM RDS TMC signal generation toolkit.



3.3.1 AM FM RDS TMC Signal Generation Remote Mode in SFP Procedure

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 **7076**.
- **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, application returns an error. The default Timeout is **15 seconds**.

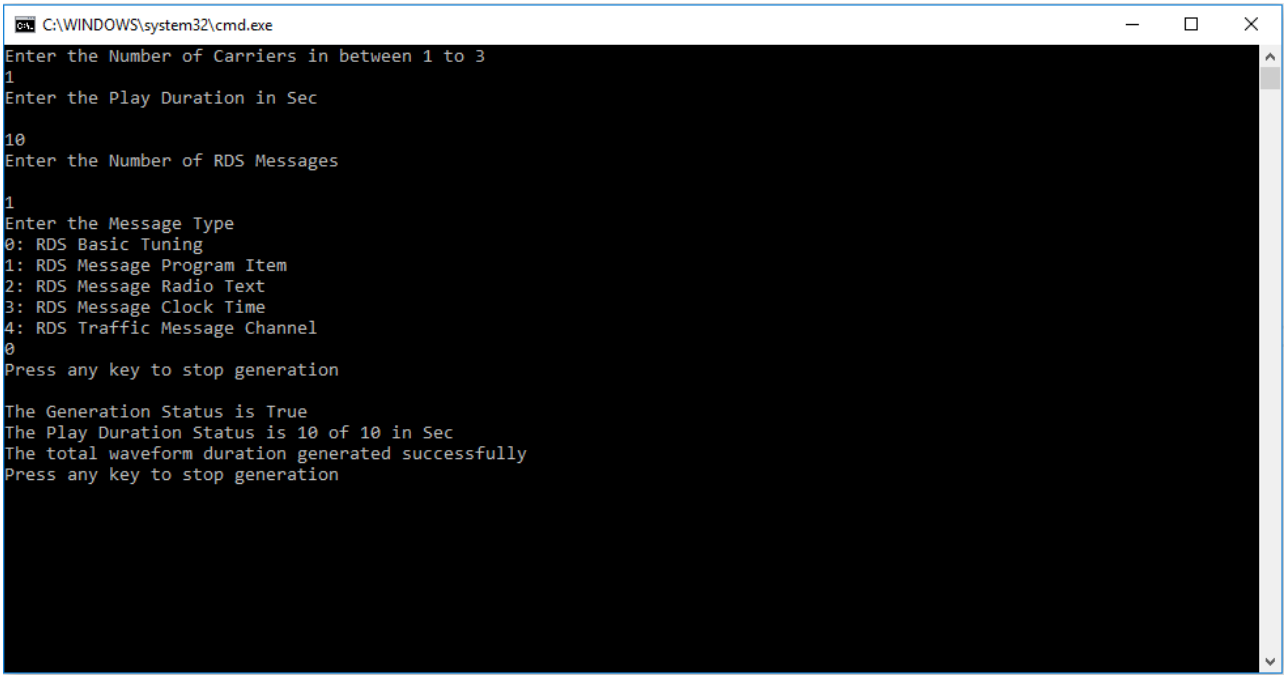
3.3.2 Remote C Examples

3.3.2.1 AM FM Generate and Save Waveform

```
#include <stdio.h>
#include "..\Includes\MaxEye Utilities Typedefs.h"
#include "..\Includes\MaxEye AMFM Generate and Save Defines.h"
#include "..\Includes\MaxEye AMFM Generate and Save Externs.h"


/**Carrier Configuration***/
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 92300000, 92700000, 93000000};
double RelativePowerDB[MAX_NUM_CARRIERS]={-10,0,0,0,0};

/*** Global Configuration settings ***/
double Output_Sampling_Rate=500000;
UINT16 Over_Sampling_Enabled=0;
char IP_Address[]= "localhost";
double Headroom=4;

UINT16 Command_Type=0;                                                    //0- StartGeneration, 1- StopGeneration

UINT16 SaveConfiguration = 0;                                           //0- Disabled, 1- Enabled to Save configurations in file.
char SaveConfiguration_FilePath[]="C:\MAXEYE\\TS Files\\AMFM\\AMFM_1Carr_91.5M.bin";          //Configure file path to save the configuration


char Waveform_File_Path[]="C:\MaxEye\\Test.wfm";

/*** FMRDS_SETTINGS ****/
uint16_t FMMode[MAX_NUM_CARRIERS]={1,1,1,1,1};
double FMDeviationHz[MAX_NUM_CARRIERS]={15000,75000,75000,7500075000};
double PilotDeviation[MAX_NUM_CARRIERS]={110,10,10,10,10};
uint16_t PreEmphasis[MAX_NUM_CARRIERS]={1,1,1,1,1};
uint16_t DataServiceEnabled[MAX_NUM_CARRIERS]={1,1,1,1,1};
uint16_t DataServiceMode[MAX_NUM_CARRIERS]={0,0,0,0,0};
double DataDeviation[MAX_NUM_CARRIERS]={6,6,6,6,6};
```

Follow the procedure below to configure the example

1. Find the C example in C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Generate and Save Waveform.
   (***Note**: - For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Generate and Save Waveform)
2. Open the desired example directory and open the solution file **AMFM Generate and Save Waveform.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye AMFM Generate and Save Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye AMFM 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.

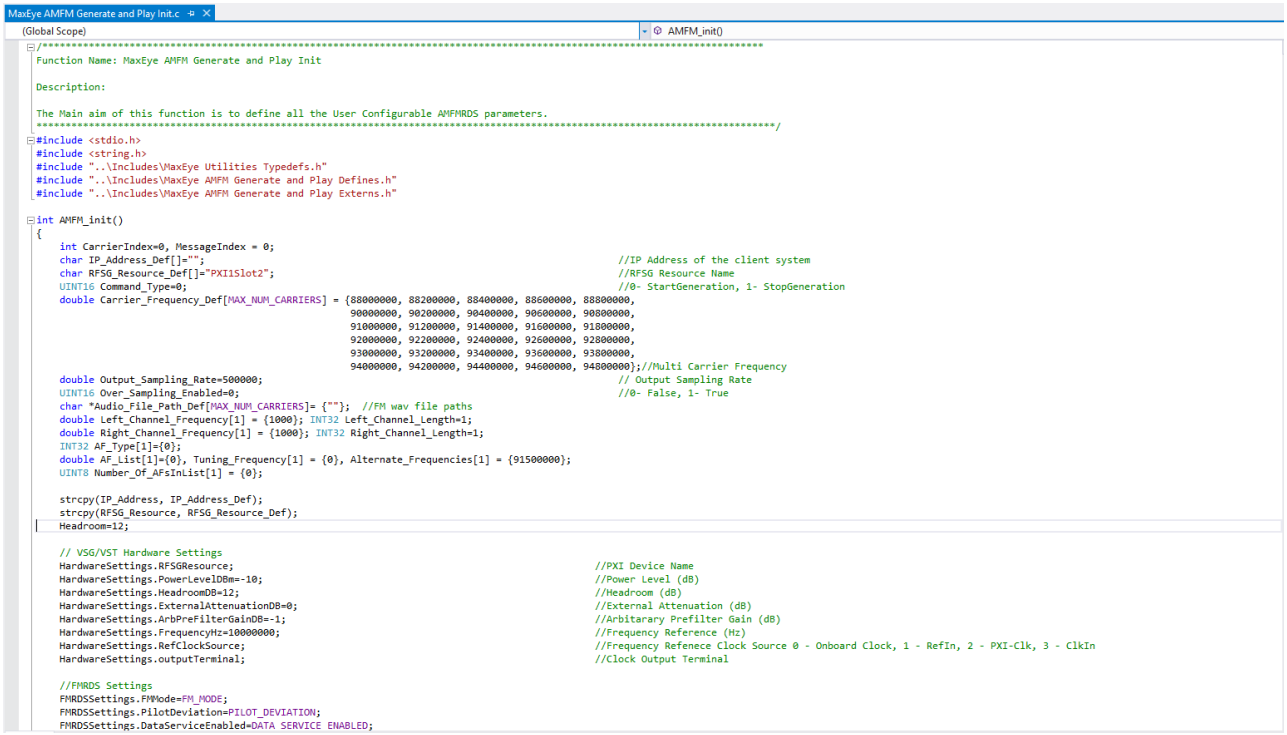


6. Enter the required **Number of Carriers**.
7. Enter the desired **Play Duration in seconds**.
8. Enter the **Number of RDS Messages.**
9. Enter the **Message Type.**

Now the application 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.

10. Press any key, to stop the generation.

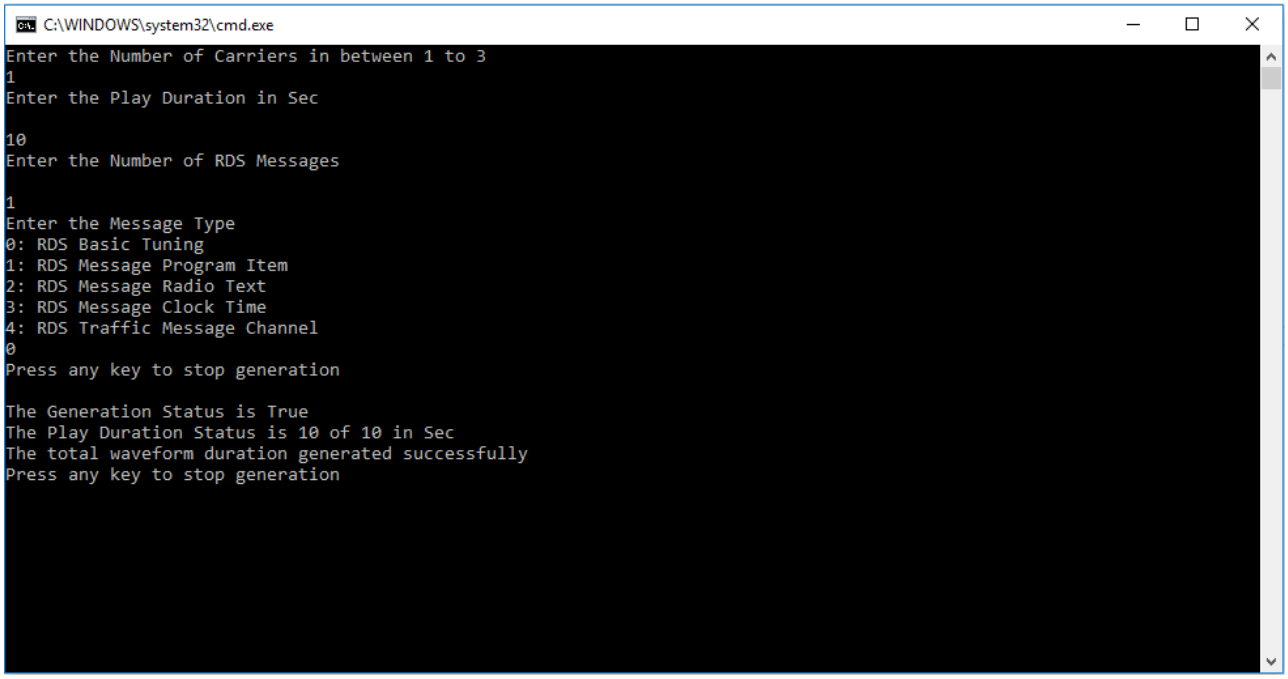
3.3.2.2 AM FM Generate and Play Waveform



```
MaxEye AMFM Generate and Play Init.c
(Global Scope)                                                                    AMFM_init()
/*****************************************************************************************************************
Function Name: MaxEye AMFM Generate and Play Init

Description:

The Main aim of this function is to define all the User Configurable AMFMRDS parameters.
*****************************************************************************************************************/
#include <stdio.h>
#include <string.h>
#include "..\Includes\MaxEye Utilities Typedefs.h"
#include "..\Includes\MaxEye AMFM Generate and Play Defines.h"
#include "..\Includes\MaxEye AMFM Generate and Play Externs.h"

int AMFM_init()
{
    int CarrierIndex=0, MessageIndex = 0;
    char IP_Address_Def[]="";                                                   //IP Address of the client system
    char RFSG_Resource_Def[]="PXI1Slot2";                                       //RFSG Resource Name
    UINT16 Command_Type=0;                                                      //0- StartGeneration, 1- StopGeneration
    double Carrier_Frequency_Def[MAX_NUM_CARRIERS] = {88000000, 88200000, 88400000, 88600000, 88800000,
                                                      90000000, 90200000, 90400000, 90600000, 90800000,
                                                      91000000, 91200000, 91400000, 91600000, 91800000,
                                                      92000000, 92200000, 92400000, 92600000, 92800000,
                                                      93000000, 93200000, 93400000, 93600000, 93800000,
                                                      94000000, 94200000, 94400000, 94600000, 94800000};//Multi Carrier Frequency
    double Output_Sampling_Rate=500000;                                         // Output Sampling Rate
    UINT16 Over_Sampling_Enabled=0;                                             //0- False, 1- True
    char *Audio_File_Path_Def[MAX_NUM_CARRIERS]= {""};  //FM wav file paths
    double Left_Channel_Frequency[1] = {1000}; INT32 Left_Channel_Length=1;
    double Right_Channel_Frequency[1] = {1000}; INT32 Right_Channel_Length=1;
    INT32 AF_Type[1]={0};
    double AF_List[1]={0}, Tuning_Frequency[1] = {0}, Alternate_Frequencies[1] = {91500000};
    UINT8 Number_Of_AFsInList[1] = {0};

    strcpy(IP_Address, IP_Address_Def);
    strcpy(RFSG_Resource, RFSG_Resource_Def);
    Headroom=12;

    // VSG/VST Hardware Settings
    HardwareSettings.RFSGResource;                                  //PXI Device Name
    HardwareSettings.PowerLevelDBm=-10;                             //Power Level (dB)
    HardwareSettings.HeadroomDB=12;                                 //Headroom (dB)
    HardwareSettings.ExternalAttenuationDB=0;                       //External Attenuation (dB)
    HardwareSettings.ArbPreFilterGainDB=-1;                         //Arbitarary Prefilter Gain (dB)
    HardwareSettings.FrequencyHz=10000000;                          //Frequency Reference (Hz)
    HardwareSettings.RefClockSource;                                //Frequency Refenece Clock Source 0 - Onboard Clock, 1 - RefIn, 2 - PXI-Clk, 3 - ClkIn
    HardwareSettings.outputTerminal;                                //Clock Output Terminal

    //FMRDS Settings
    FMRDSSettings.FMMode=FM_MODE;
    FMRDSSettings.PilotDeviation=PILOT_DEVIATION;
    FMRDSSettings.DataServiceEnabled=DATA_SERVICE_ENABLED;
```

Follow the procedure below to configure the example

1. Find the C example in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Generate and Play Waveform
   (***Note***: - *For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Generate and Play Waveform)
2. Open the desired example directory and open the solution file **AMFM Generate and Play Waveform.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye AMFM Generate and Play Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye AMFM 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.

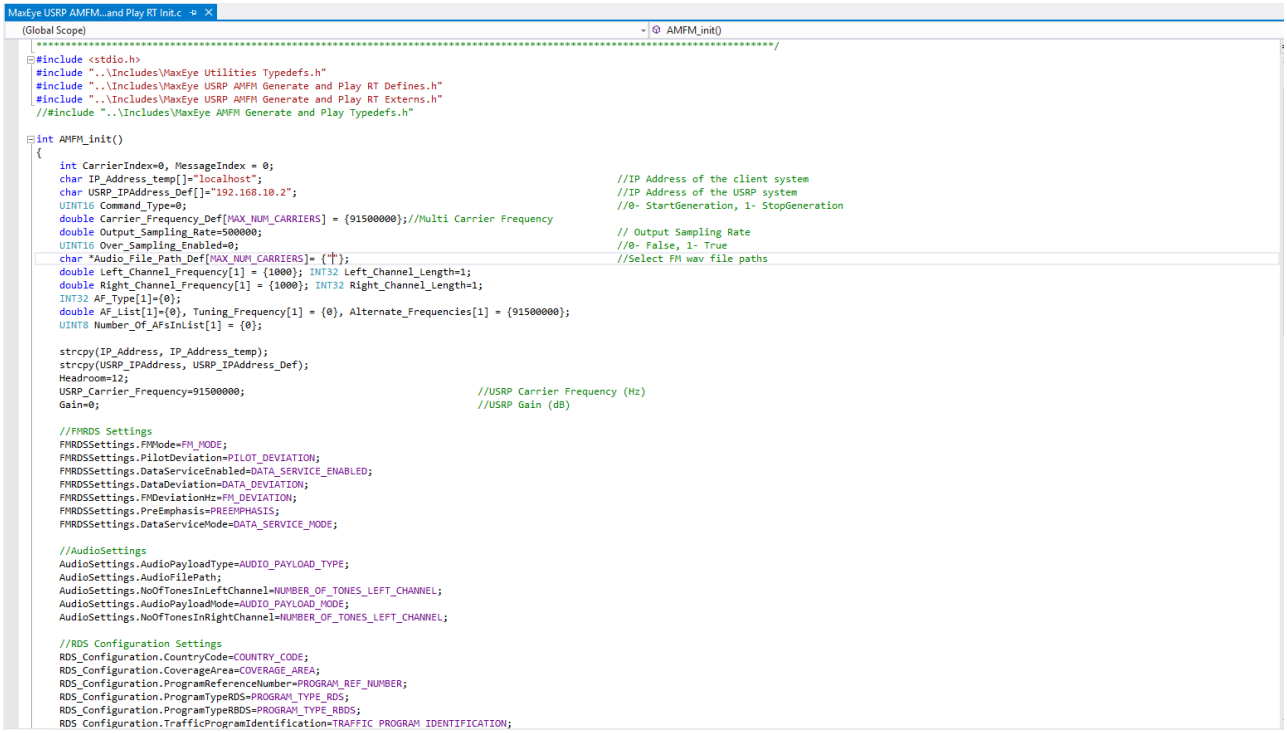


6. Enter the required **Number of Carriers**.
7. Enter the desired **Play Duration in seconds.**
8. Enter the **Number of RDS Messages.**
9. Enter the **Message Type.**

Now the application 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.

10. Press any key, to stop the generation.

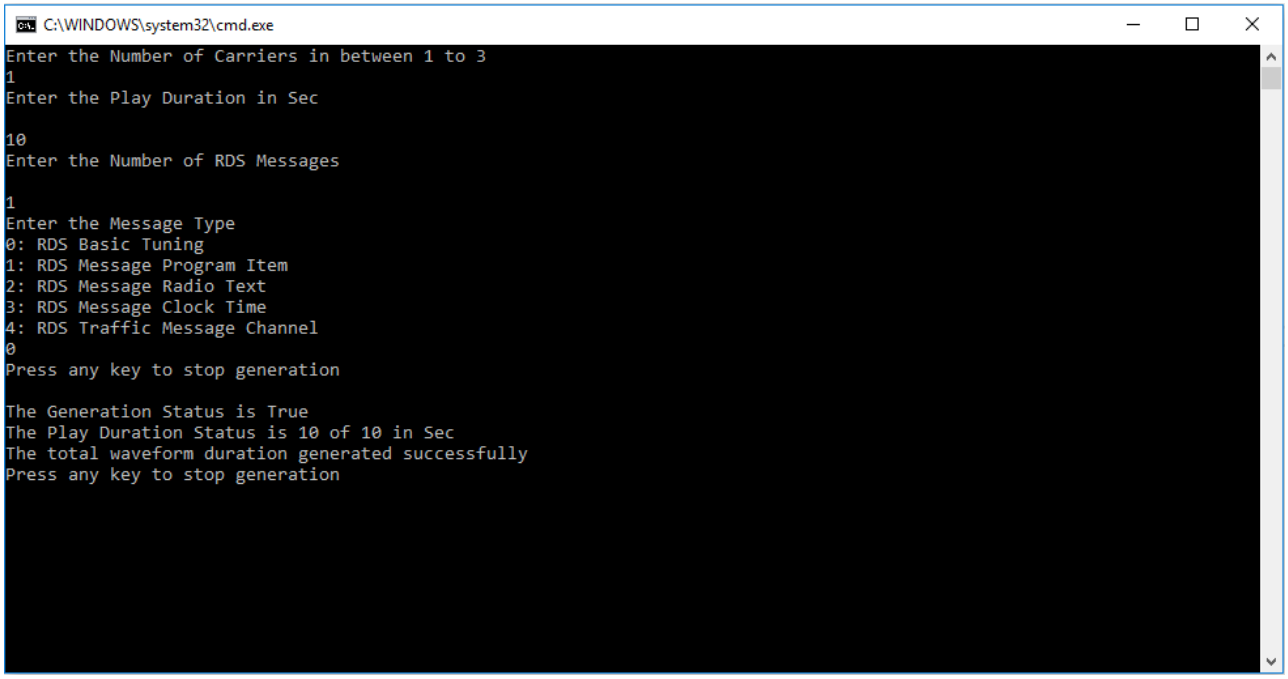
3.3.2.3 AM FM USRP Generate and Play Waveform




```
/*****************************************************************************************************************/
#include <stdio.h>
#include "..\Includes\MaxEye Utilities Typedefs.h"
#include "..\Includes\MaxEye USRP AMFM Generate and Play RT Defines.h"
#include "..\Includes\MaxEye USRP AMFM Generate and Play RT Externs.h"
//#include "..\Includes\MaxEye AMFM Generate and Play Typedefs.h"

int AMFM_init()
{
    int CarrierIndex=0, MessageIndex = 0;
    char IP_Address_temp[]="localhost";                                  //IP Address of the client system
    char USRP_IPAddress_Def[]="192.168.10.2";                            //IP Address of the USRP system
    UINT16 Command_Type=0;                                               //0- StartGeneration, 1- StopGeneration
    double Carrier_Frequency_Def[MAX_NUM_CARRIERS] = {91500000};//Multi Carrier Frequency
    double Output_Sampling_Rate=500000;                                  // Output Sampling Rate
    UINT16 Over_Sampling_Enabled=0;                                      //0- False, 1- True
    char *Audio_File_Path_Def[MAX_NUM_CARRIERS]= {""};                   //Select FM wav file paths
    double Left_Channel_Frequency[1] = {1000}; INT32 Left_Channel_Length=1;
    double Right_Channel_Frequency[1] = {1000}; INT32 Right_Channel_Length=1;
    INT32 AF_Type[1]={0};
    double AF_List[1]={0}, Tuning_Frequency[1] = {0}, Alternate_Frequencies[1] = {91500000};
    UINT8 Number_Of_AFsInList[1] = {0};

    strcpy(IP_Address, IP_Address_temp);
    strcpy(USRP_IPAddress, USRP_IPAddress_Def);
    Headroom=12;
    USRP_Carrier_Frequency=91500000;                                     //USRP Carrier Frequency (Hz)
    Gain=0;                                                              //USRP Gain (dB)

    //FMRDS Settings
    FMRDSSettings.FMMode=FM_MODE;
    FMRDSSettings.PilotDeviation=PILOT_DEVIATION;
    FMRDSSettings.DataServiceEnabled=DATA_SERVICE_ENABLED;
    FMRDSSettings.DataDeviation=DATA_DEVIATION;
    FMRDSSettings.FMDeviationHz=FM_DEVIATION;
    FMRDSSettings.PreEmphasis=PREEMPHASIS;
    FMRDSSettings.DataServiceMode=DATA_SERVICE_MODE;

    //AudioSettings
    AudioSettings.AudioPayloadType=AUDIO_PAYLOAD_TYPE;
    AudioSettings.AudioFilePath;
    AudioSettings.NoOfTonesInLeftChannel=NUMBER_OF_TONES_LEFT_CHANNEL;
    AudioSettings.AudioPayloadMode=AUDIO_PAYLOAD_MODE;
    AudioSettings.NoOfTonesInRightChannel=NUMBER_OF_TONES_LEFT_CHANNEL;

    //RDS Configuration Settings
    RDS_Configuration.CountryCode=COUNTRY_CODE;
    RDS_Configuration.CoverageArea=COVERAGE_AREA;
    RDS_Configuration.ProgramReferenceNumber=PROGRAM_REF_NUMBER;
    RDS_Configuration.ProgramTypeRDS=PROGRAM_TYPE_RDS;
    RDS_Configuration.ProgramTypeRBDS=PROGRAM_TYPE_RBDS;
    RDS_Configuration.TrafficProgramIdentification=TRAFFIC_PROGRAM_IDENTIFICATION;
```

Follow the procedure below to configure the example

1. Find the C example in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM USRP Generate and Play Waveform
   (***Note***: - *For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM USRP Generate and Play Waveform)
2. Open the desired example directory and open the solution file **AMFM USRP Generate and Play Waveform.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye AMFM USRP Generate and Play Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye AMFM USRP 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.

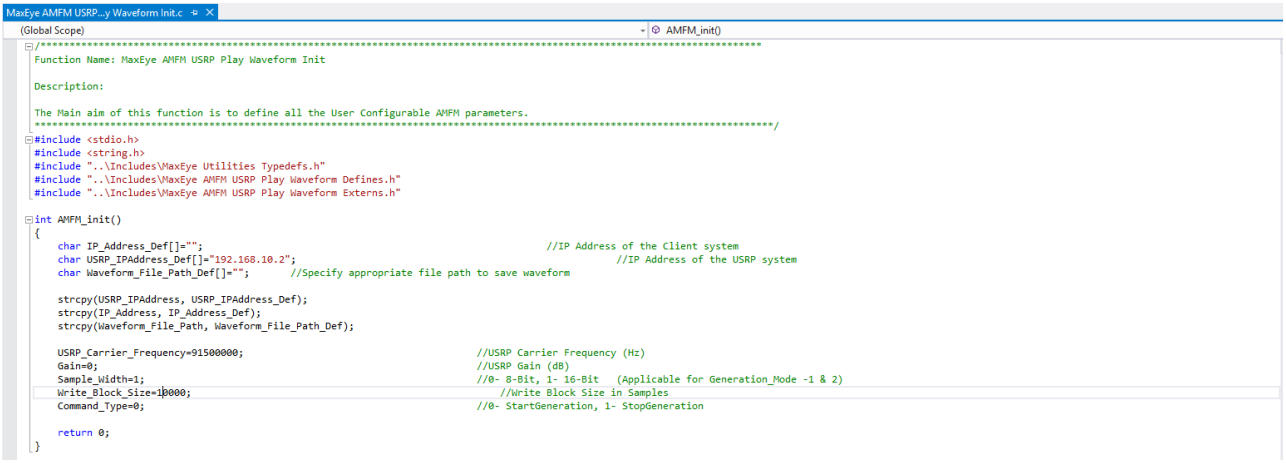


6. Enter the required **Number of Carriers**.
7. Enter the desired **Play Duration in seconds.**
8. Enter the **Number of RDS Messages.**
9. Enter the **Message Type.**

Now the application 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.

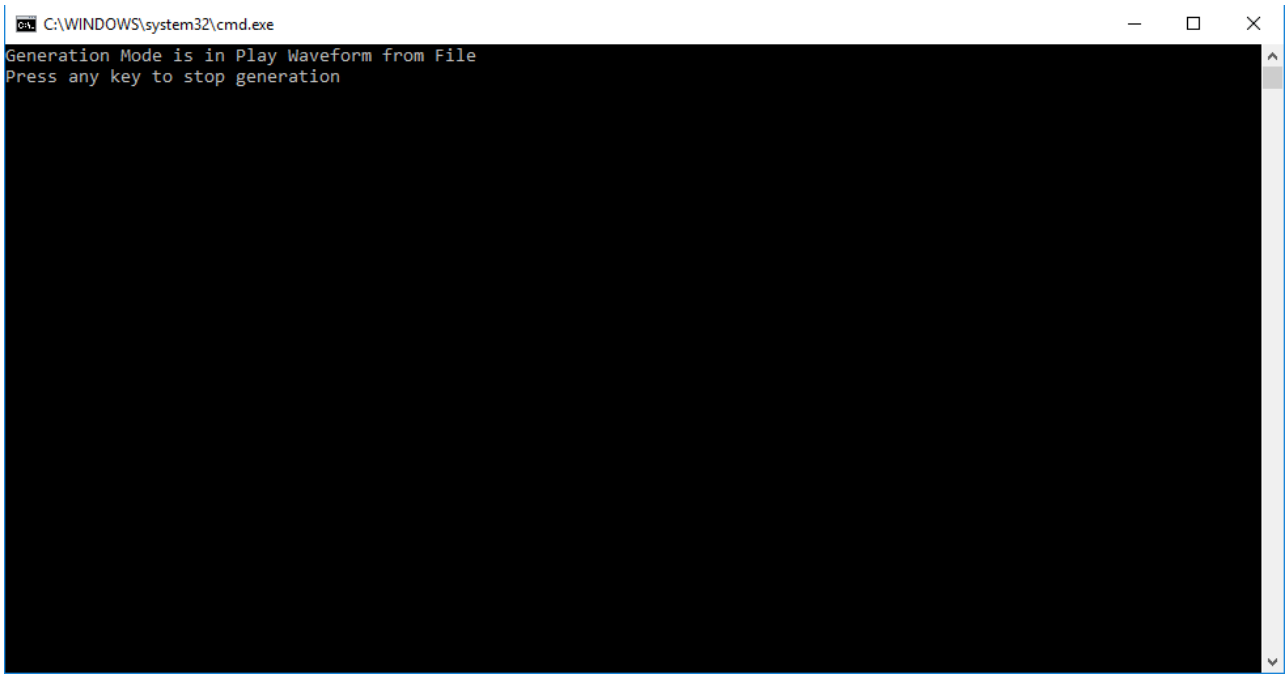
10. Press any key, to stop the generation.

3.3.2.4 AM FM USRP Play Waveform from File



Follow the procedure below to configure the example

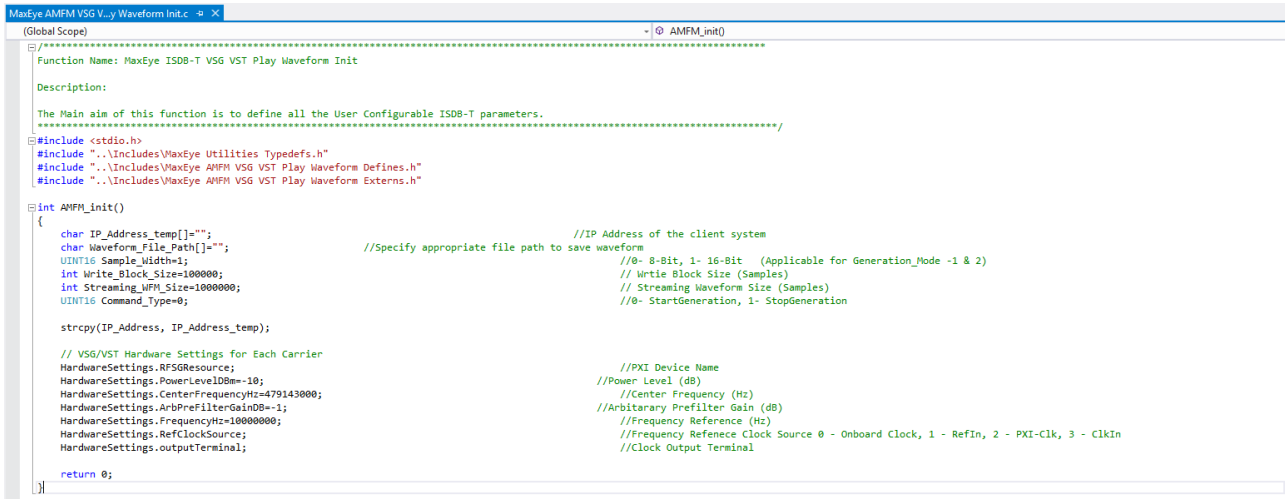
1. Find the C example in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM USRP Play Waveform from File
   (***Note**: - For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM USRP Play Waveform from File)
2. Open the desired example directory and open the solution file **USRP Play Waveform from File.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye AMFM USRP Play Waveform Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye AMFM USRP Play Waveform Main.c** and press Run button or (Ctrl + F5) for running the example. Generator status is displayed in the console application window that appears after running the example.



Now the application 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.

6. Press any key, to stop the generation.

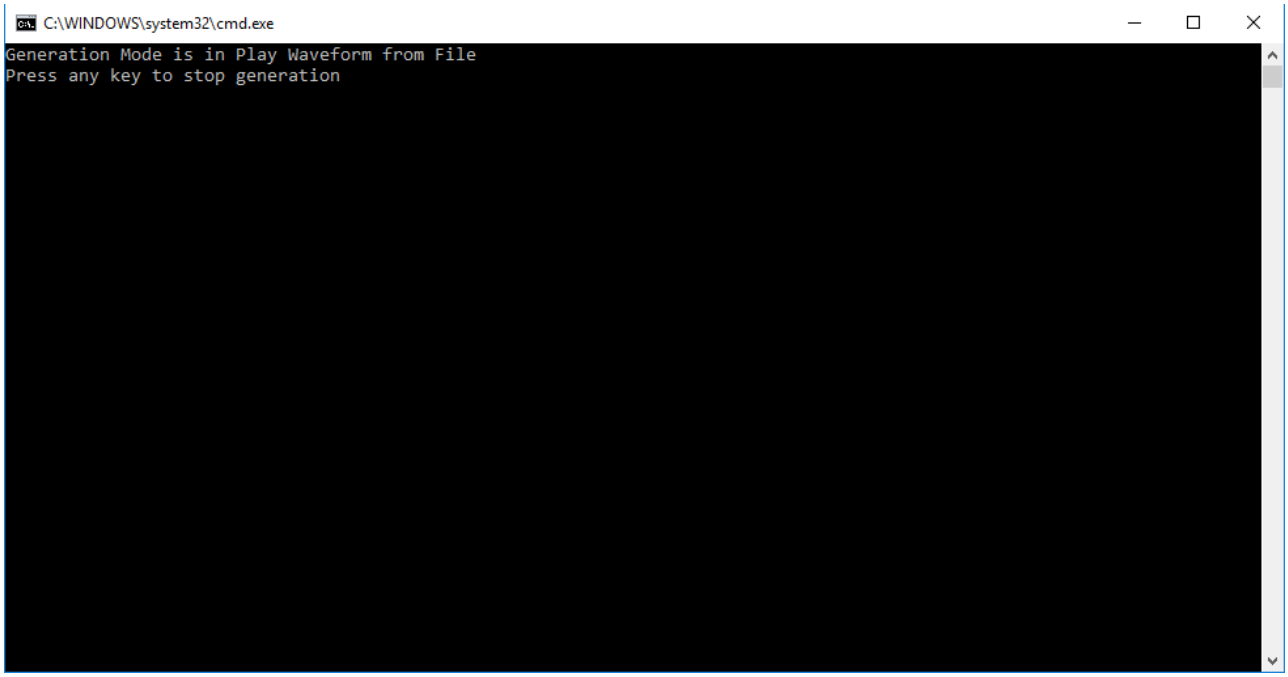
3.3.2.5 AM FM VST/VSG Play Waveform from File



```
MaxEye AMFM VSG V...y Waveform Init.c
(Global Scope)                                                    AMFM_init()
/*****************************************************************************************************************
Function Name: MaxEye ISDB-T VSG VST Play Waveform Init

Description:

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

int AMFM_init()
{
    char IP_Address_temp[]="";                                          //IP Address of the client system
    char Waveform_File_Path[]="";                   //Specify appropriate file path to save waveform
    UINT16 Sample_Width=1;                                                  //0- 8-Bit, 1- 16-Bit   (Applicable for Generation_Mode -1 & 2)
    int Write_Block_Size=100000;                                            // Wrtie Block Size (Samples)
    int Streaming_WFM_Size=1000000;                                         // Streaming Waveform Size (Samples)
    UINT16 Command_Type=0;                                                  //0- StartGeneration, 1- StopGeneration

    strcpy(IP_Address, IP_Address_temp);

    // VSG/VST Hardware Settings for Each Carrier
    HardwareSettings.RFSGResource;                                          //PXI Device Name
    HardwareSettings.PowerLevelDBm=-10;                                   //Power Level (dB)
    HardwareSettings.CenterFrequencyHz=479143000;                           //Center Frequency (Hz)
    HardwareSettings.ArbPreFilterGainDB=-1;                               //Arbitarary Prefilter Gain (dB)
    HardwareSettings.FrequencyHz=10000000;                                  //Frequency Reference (Hz)
    HardwareSettings.RefClockSource;                                        //Frequency Refenece Clock Source 0 - Onboard Clock, 1 - RefIn, 2 - PXI-Clk, 3 - ClkIn
    HardwareSettings.outputTerminal;                                        //Clock Output Terminal

    return 0;
}
```

Follow the procedure below to configure the example

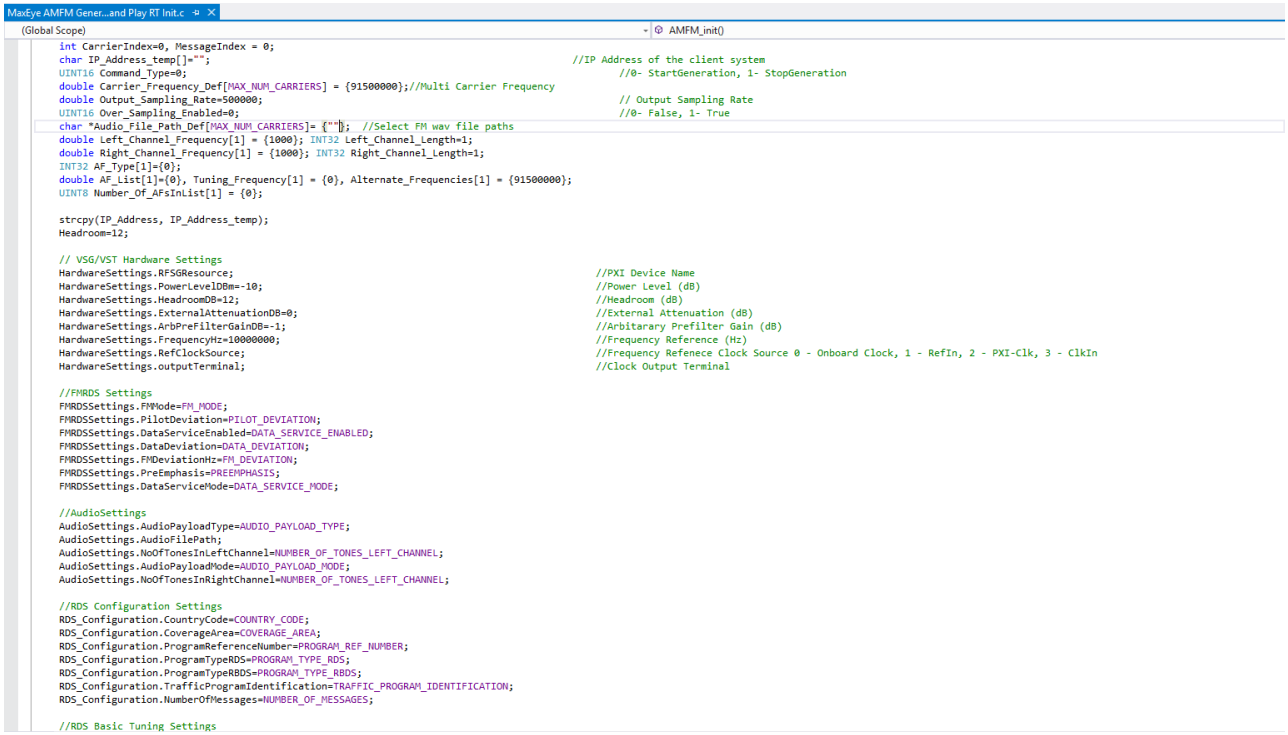
1. Find the C example in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM VSG VST Play Waveform from File.
   (***Note**: - For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM VSG VST Play Waveform from File)
2. Open the desired example directory and open the solution file **AMFM VSG VST Play Waveform from File.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye AMFM VSG VST Play Waveform Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye AMFM VSG VST Play Waveform Main.c** and press Run button or (Ctrl + F5) for running the example. Generator status is displayed in the console application window that appears after running the example.



Now the application 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.

6. Press any key, to stop the generation.

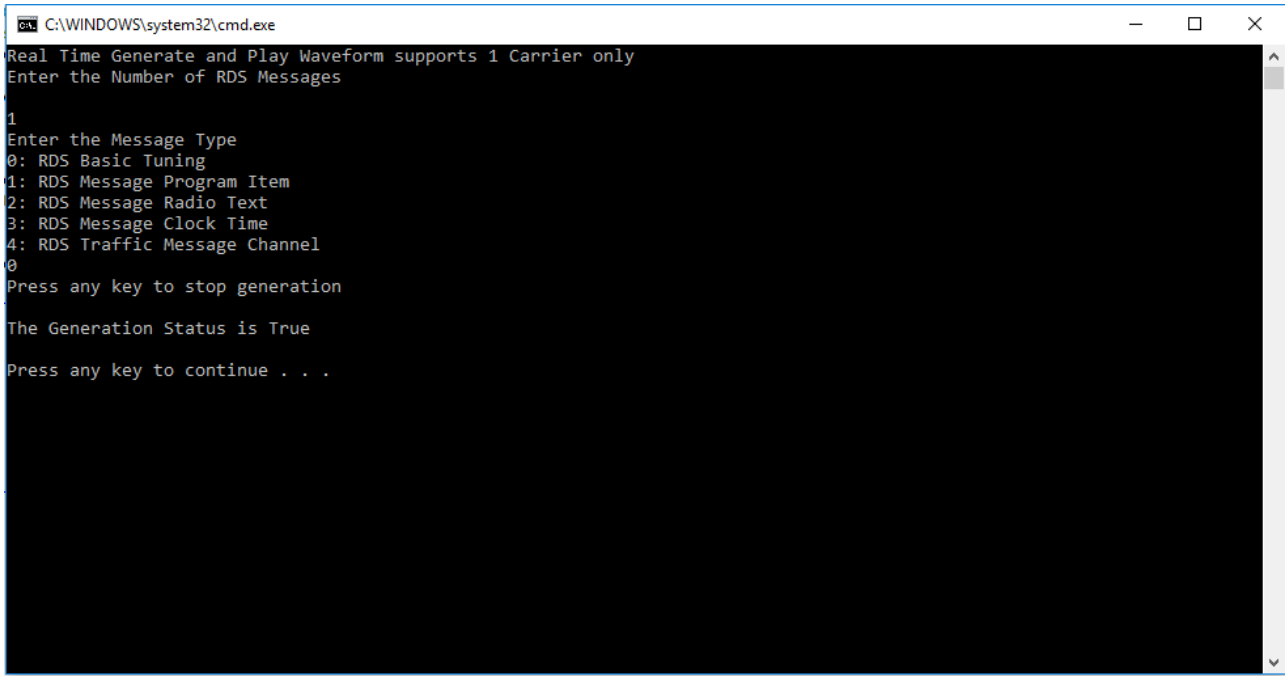
3.3.2.6 AM FM VSG/ VST Generate and Play Real Time




```
int CarrierIndex=0, MessageIndex = 0;
char IP_Address_temp[]="";                                          //IP Address of the client system
UINT16 Command_Type=0;                                                    //0- StartGeneration, 1- StopGeneration
double Carrier_Frequency_Def[MAX_NUM_CARRIERS] = {91500000};//Multi Carrier Frequency
double Output_Sampling_Rate=500000;                                       // Output Sampling Rate
UINT16 Over_Sampling_Enabled=0;                                           //0- False, 1- True
char *Audio_File_Path_Def[MAX_NUM_CARRIERS]= {""};  //Select FM wav file paths
double Left_Channel_Frequency[1] = {1000}; INT32 Left_Channel_Length=1;
double Right_Channel_Frequency[1] = {1000}; INT32 Right_Channel_Length=1;
INT32 AF_Type[1]={0};
double AF_List[1]={0}, Tuning_Frequency[1] = {0}, Alternate_Frequencies[1] = {91500000};
UINT8 Number_Of_AFsInList[1] = {0};

strcpy(IP_Address, IP_Address_temp);
Headroom=12;

// VSG/VST Hardware Settings
HardwareSettings.RFSGResource;                                      //PXI Device Name
HardwareSettings.PowerLevelDBm=-10;                                 //Power Level (dB)
HardwareSettings.HeadroomDB=12;                                     //Headroom (dB)
HardwareSettings.ExternalAttenuationDB=0;                           //External Attenuation (dB)
HardwareSettings.ArbPreFilterGainDB=-1;                             //Arbitarary Prefilter Gain (dB)
HardwareSettings.FrequencyHz=10000000;                              //Frequency Reference (Hz)
HardwareSettings.RefClockSource;                                    //Frequency Refenece Clock Source 0 - Onboard Clock, 1 - RefIn, 2 - PXI-Clk, 3 - ClkIn
HardwareSettings.outputTerminal;                                    //Clock Output Terminal

//FMRDS Settings
FMRDSSettings.FMMode=FM_MODE;
FMRDSSettings.PilotDeviation=PILOT_DEVIATION;
FMRDSSettings.DataServiceEnabled=DATA_SERVICE_ENABLED;
FMRDSSettings.DataDeviation=DATA_DEVIATION;
FMRDSSettings.FMDeviationHz=FM_DEVIATION;
FMRDSSettings.PreEmphasis=PREEMPHASIS;
FMRDSSettings.DataServiceMode=DATA_SERVICE_MODE;

//AudioSettings
AudioSettings.AudioPayloadType=AUDIO_PAYLOAD_TYPE;
AudioSettings.AudioFilePath;
AudioSettings.NoOfTonesInLeftChannel=NUMBER_OF_TONES_LEFT_CHANNEL;
AudioSettings.AudioPayloadMode=AUDIO_PAYLOAD_MODE;
AudioSettings.NoOfTonesInRightChannel=NUMBER_OF_TONES_LEFT_CHANNEL;

//RDS Configuration Settings
RDS_Configuration.CountryCode=COUNTRY_CODE;
RDS_Configuration.CoverageArea=COVERAGE_AREA;
RDS_Configuration.ProgramReferenceNumber=PROGRAM_REF_NUMBER;
RDS_Configuration.ProgramTypeRDS=PROGRAM_TYPE_RDS;
RDS_Configuration.ProgramTypeRBDS=PROGRAM_TYPE_RBDS;
RDS_Configuration.TrafficProgramIdentification=TRAFFIC_PROGRAM_IDENTIFICATION;
RDS_Configuration.NumberOfMessages=NUMBER_OF_MESSAGES;

//RDS Basic Tuning Settings
```

Follow the procedure below to configure the example

1. Find the C example in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Generate and Play Real Time.
   (***Note**: - For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Generate and Play Real Time)
2. Open the desired example directory and open the solution file **AMFM VSG VST Generate and Play RT.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye AMFM Generate and Play RT Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye AMFM Generate and Play RT 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.

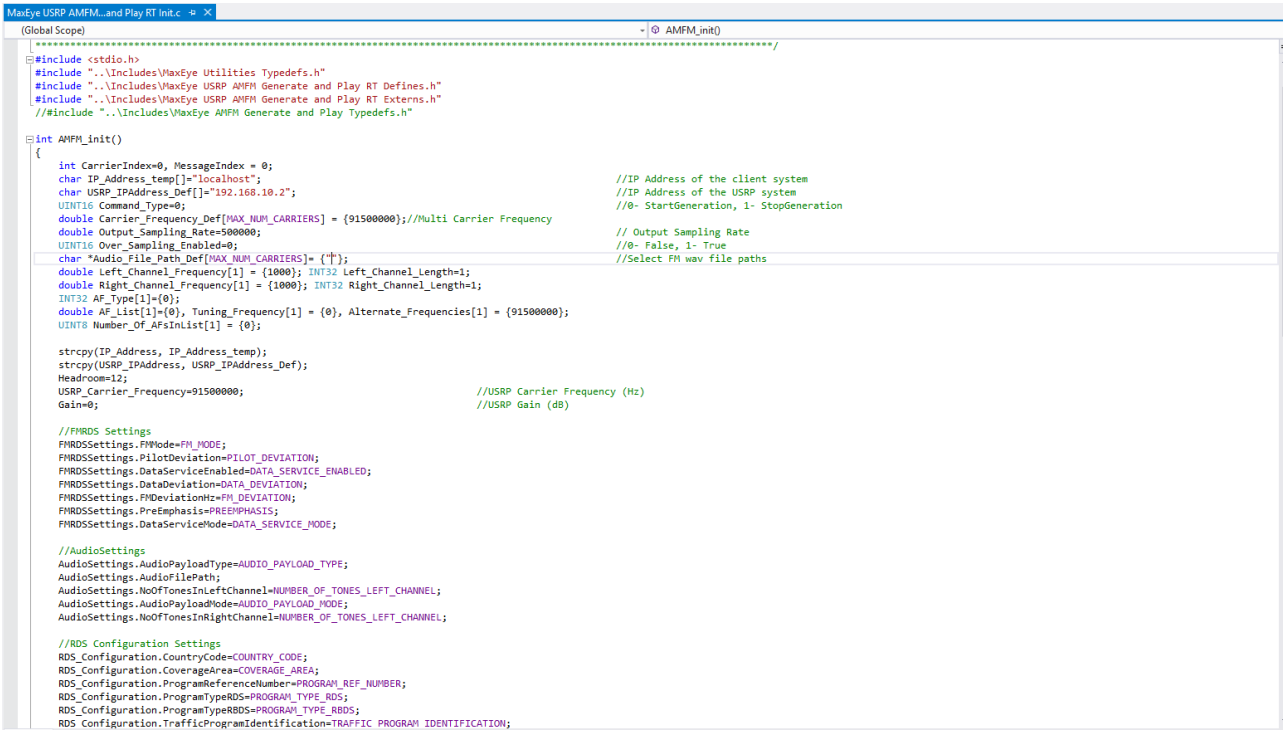


6. Enter the **Number of RDS Messages.**
7. Enter the **Message Type.**

Now the application 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.

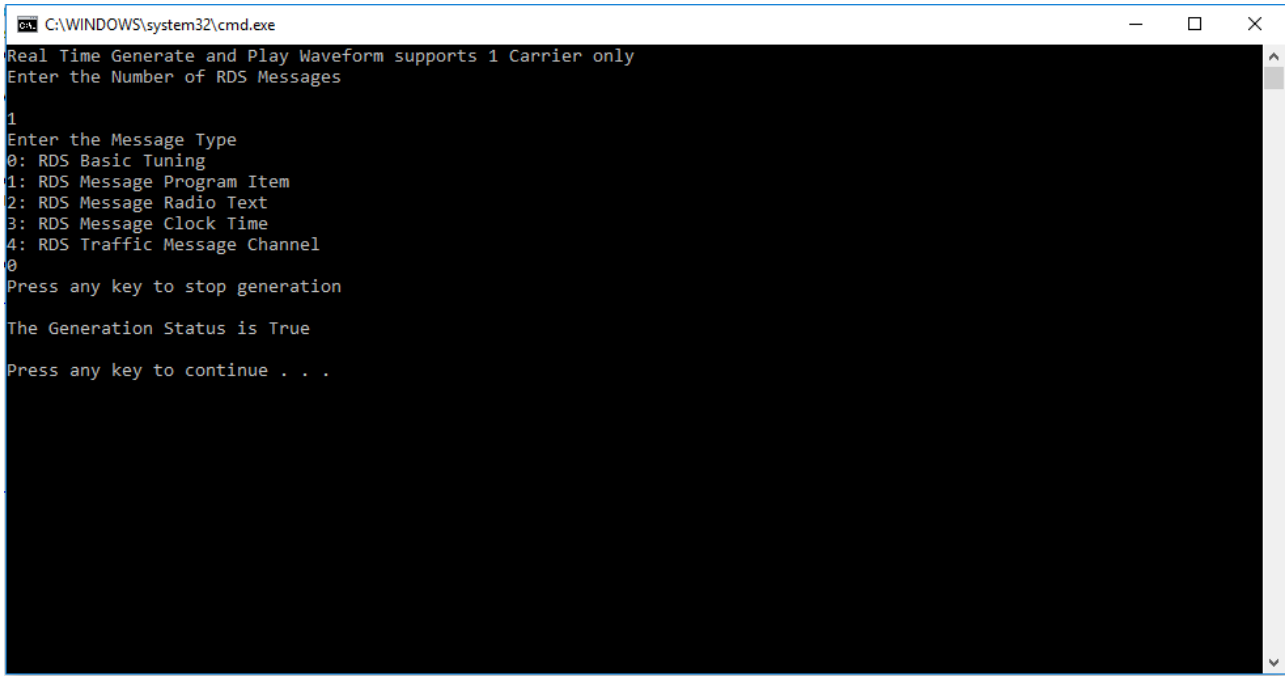
8. Press any key, to stop the generation.

3.3.2.7 AM FM USRP Generate and Play Real Time



Follow the procedure below to configure the example

1. Find the C example in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM USRP Generate and Play Real Time
   (***Note**: - For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM USRP Generate and Play Real Time)
2. Open the desired example directory and open the solution file **AMFM USRP Generate and Play RT.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye USRP AMFM Generate and Play RT Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye USRP AMFM Generate and Play RT 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.

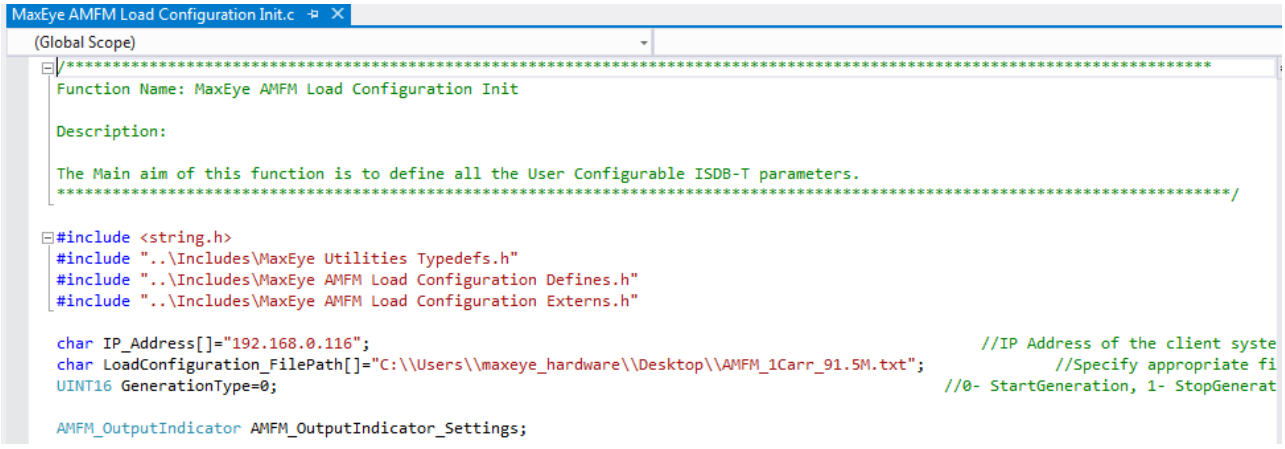


6. Enter the **Number of RDS Messages.**
7. Enter the **Message Type.**

Now the application 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.

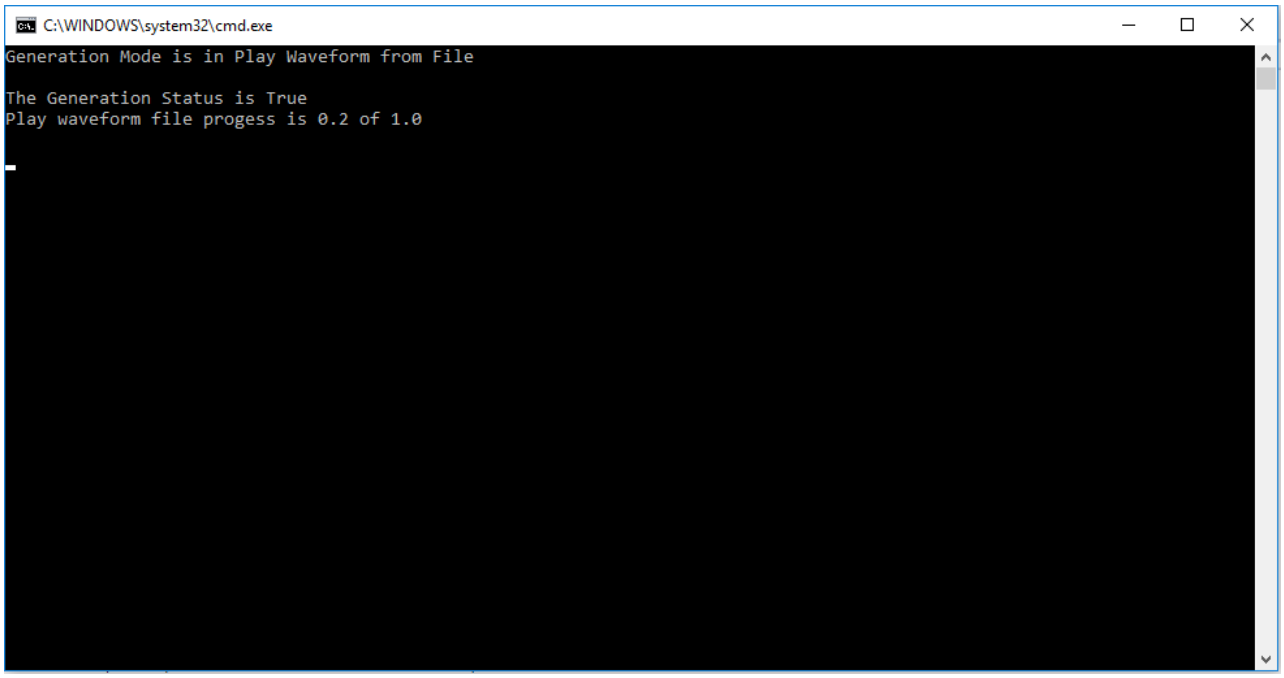
8. Press any key, to stop the generation.

3.3.2.8 AMFM Load Configurations from File



Follow the procedure below to configure the example

1. Find the C example in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Load Configuration from File
   (***Note**: - For 32-bit Operating System*, C examples are installed in, C:\Program Files\ MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Examples\C\AMFM Load Configuration from File)
2. Open the desired example directory and open the solution file **Load Configuration from File.sln** in **Microsoft Visual C++.**
3. Navigate to **MaxEye AMFM Load Configuration Init.c** from the solution explorer.
4. Configure the parameters listed as required. For help, please follow the comments given against each configuration parameter.
5. Navigate to **MaxEye AMFM 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 application 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.

6. Press any key, to stop the generation.

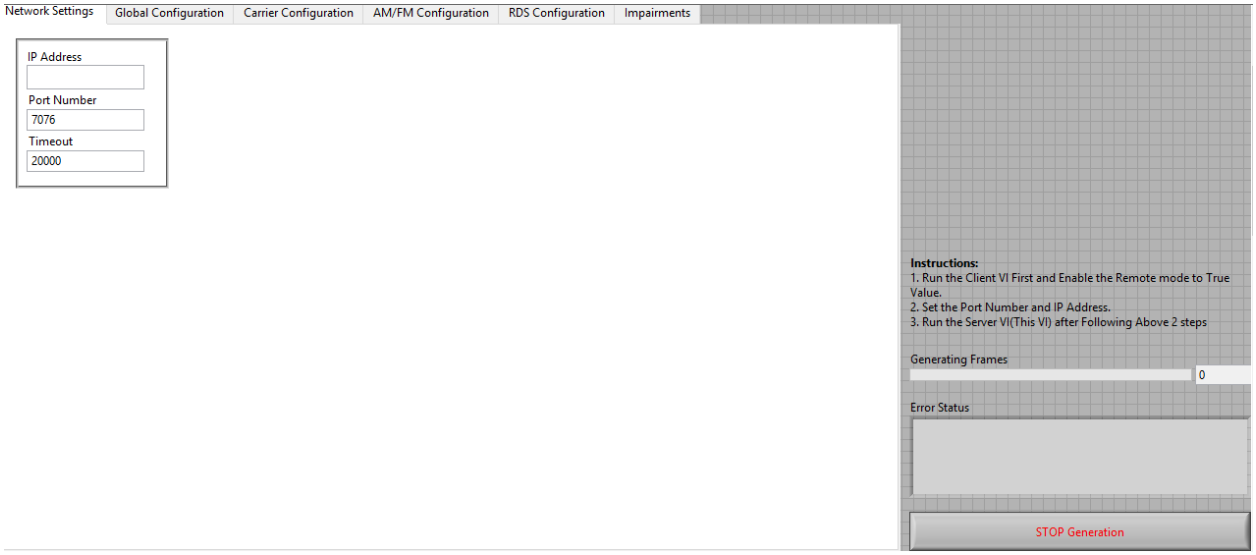
3.3.3 Remote LabVIEW Examples

3.3.3.1 AM FM Remote Generate and Save Waveform

Follow the below procedure to configure the example

1. Find the LabVIEW example in, <LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote
2. Open **MaxEye AMFM RFSG Remote Generate and Save Waveform.vi**
3. The user configurations are organized into the following categories displayed in multiple Tabs
   - Network Settings
   - Global Configuration
   - Carrier Configuration
   - AM/FM Configuration
   - RDS 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 AM FM RDS TMC Signal Generation is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application returns an error. The default Timeout is **20 seconds**.

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

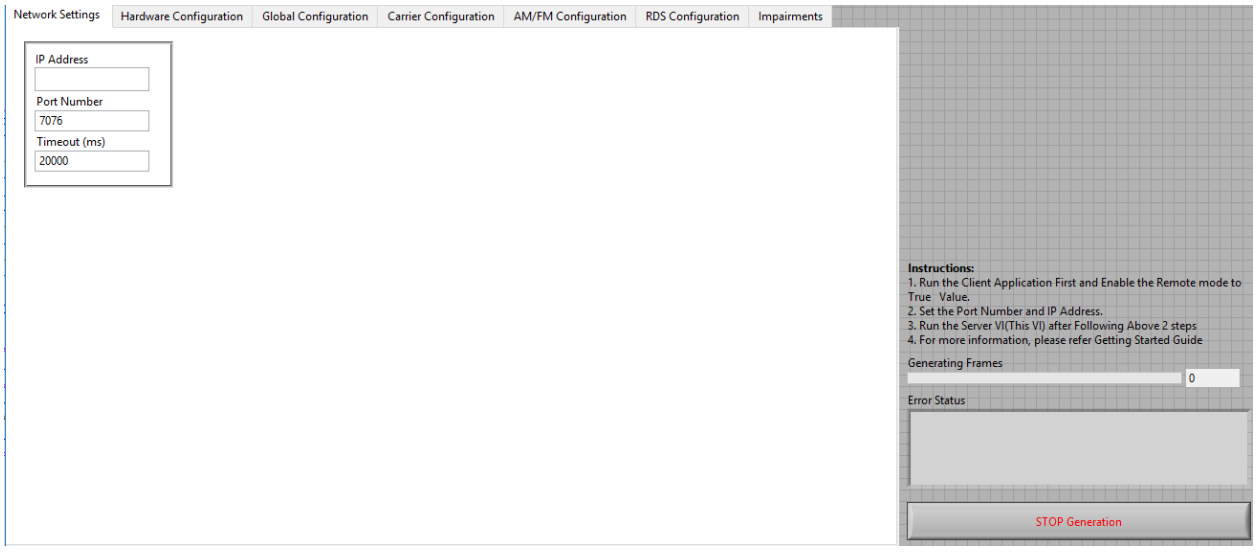
4. Run the example. Now the application validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.3.2 AMFM Remote Generate Multiple Frames

Follow the below procedure to configure the example

1. Find the LabVIEW example in the following location <LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote
2. Open **MaxEye AMFM RFSG Remote Generate Waveform.vi**
3. The user configurations are organized into the following categories displayed in multiple Tabs
   - Network Settings
   - Hardware Configuration
   - Global Configuration
   - Carrier Configuration
   - AM/FM Configuration
   - RDS 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 AM FM RDS TMC Signal Generation is intended to run.

- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application returns an error. The default Timeout is **20 seconds**.

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

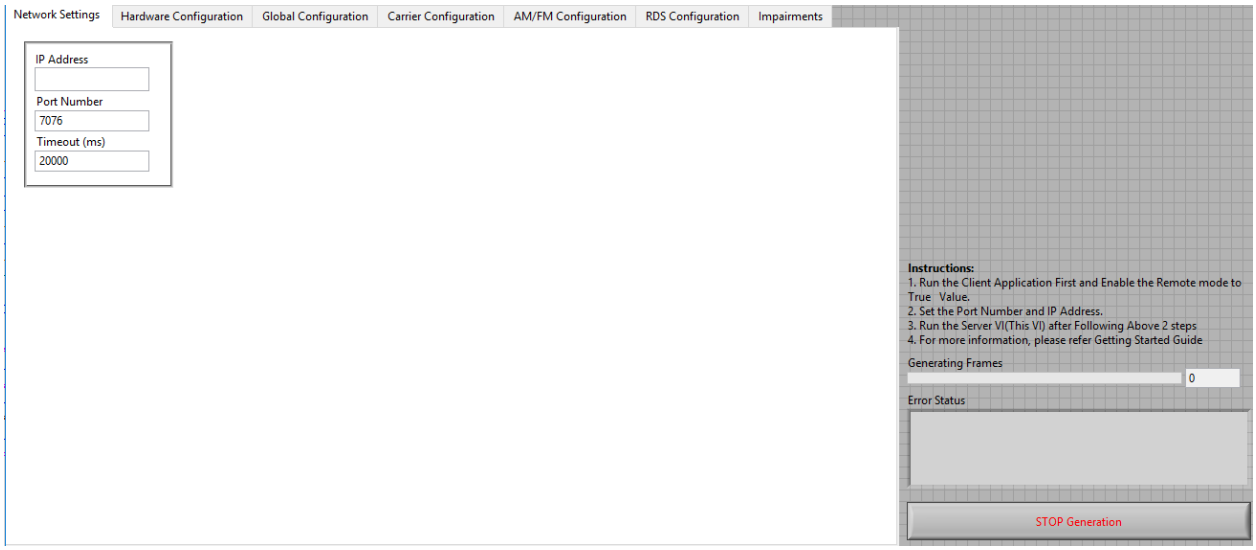
4. Run the example. Now the application validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.3.3 AMFM Remote USRP Generate Multiple Frames

Follow the below procedure to configure the example

5. Find the LabVIEW example in the following location <LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote
6. Open **MaxEye AMFM RFSG Remote USRP Generate Waveform.vi**
7. The user configurations are organized into the following categories displayed in multiple Tabs
   - Network Settings
   - Hardware Configuration
   - Global Configuration
   - Carrier Configuration
   - AM/FM Configuration
   - RDS 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 AM FM RDS TMC Signal Generation is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application returns an error. The default Timeout is **20 seconds**.

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

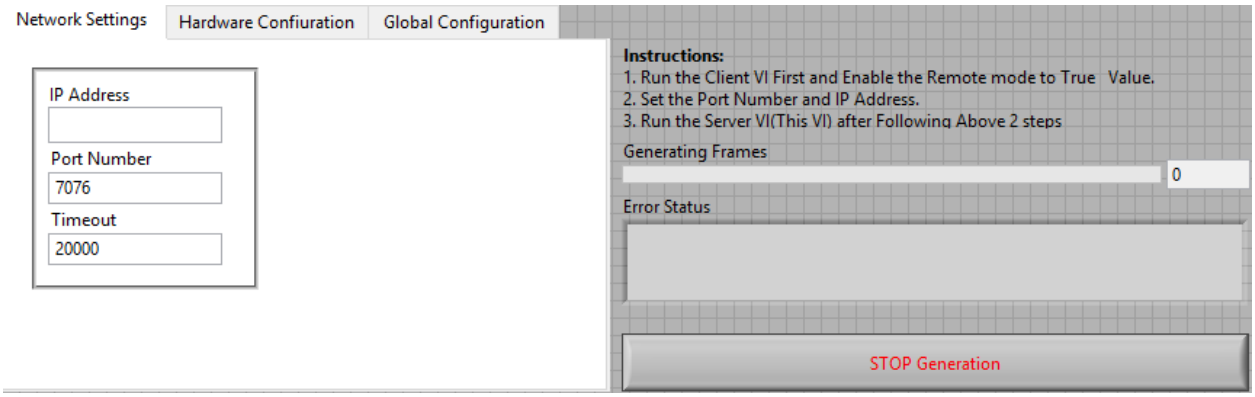
8. Run the example. Now the application validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.3.4 AM FM Remote USRP Play Waveform from File

Follow the below procedure to configure the example

1. Find the LabVIEW example in the following location ,<LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote
2. Open **MaxEye AMFM SG Remote USRP Play Waveform from File.vi**
3. The user configurations are divided into 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 AM FM RDS TMC Signal Generation is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application returns an error. The default Timeout is **20 seconds**.

For configuring other configuration parameters, please refer section 3.1.3 of this document.

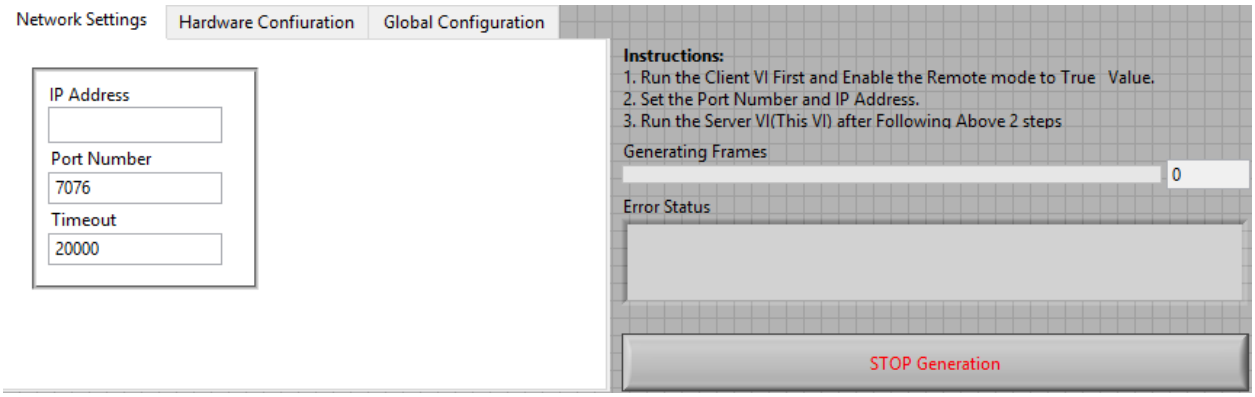
4. Run the example. Now the application validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.3.5 AM FM Remote VSG VST Play Waveform from File

Follow the below procedure to configure the example

1. Find the LabVIEW example in the following location <LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote
2. Open **MaxEye AMFM SG Remote VSG VST Play Waveform from File.vi**
3. The user configurations are divided into 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 AM FM RDS TMC Signal Generation is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application returns an error. The default Timeout is **20 seconds**.

For configuring other configuration parameters, please refer section 3.1.3 of this document.

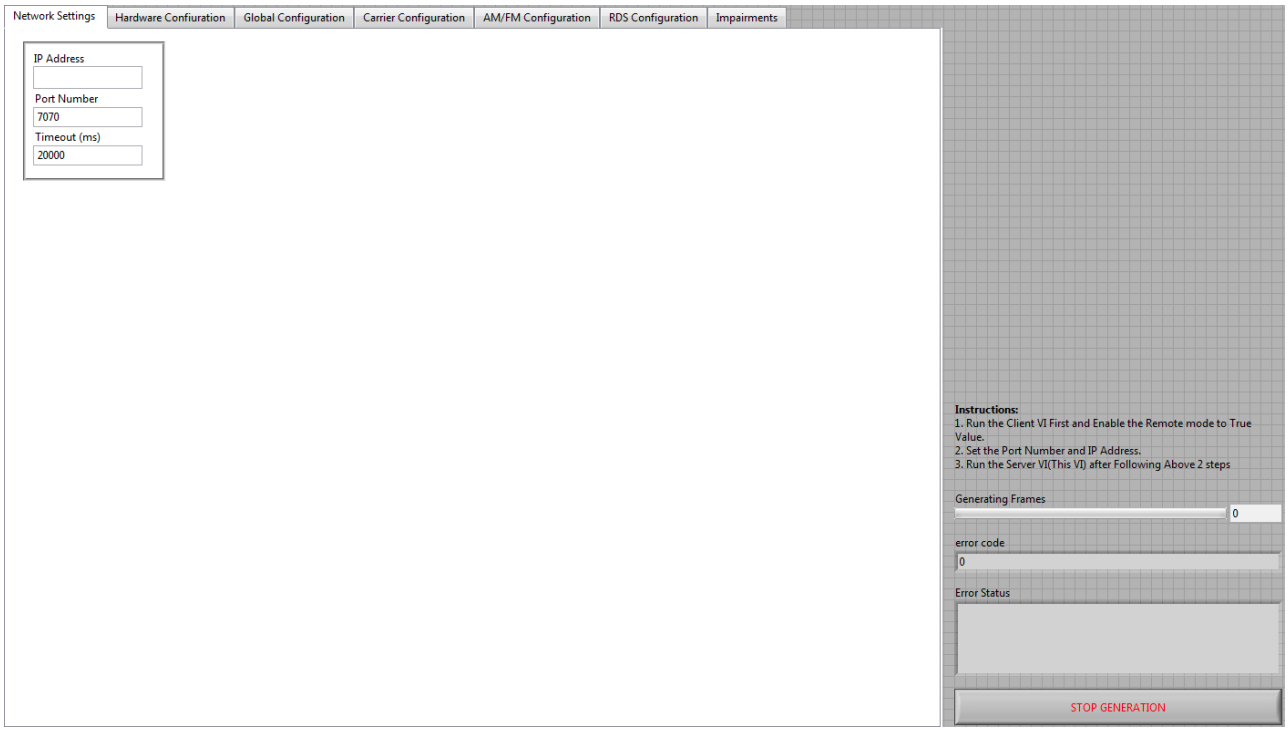
4. Run the example. Now the application validates the user configuration and reports error to the user if the configuration is not as per the standard or not supported by the toolkit. If the configuration is successfully validated the remote system starts generating the waveform.

3.3.3.6 AM FM RDS Remote Generate Multiple Frames (Real-Time)

Follow the below procedure to configure the example

1. Find the LabVIEW example in the following location <LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote
2. Open **MaxEye AMFM RFSG Remote Generate Waveform(Real Time).vi**
3. The user configurations are divided into following categories displayed in multiple Tabs
   - Network Settings
   - Hardware Configuration
   - Global Configuration
   - Carrier Configuration
   - AM/FM Configuration
   - RDS 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 AM FM RDS TMC Signal Generation is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application returns an error. The default Timeout is **20 seconds**.

For configuring other configuration parameters, please refer section 3.1.2 of this document.

4. Run the example. Now the application 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.

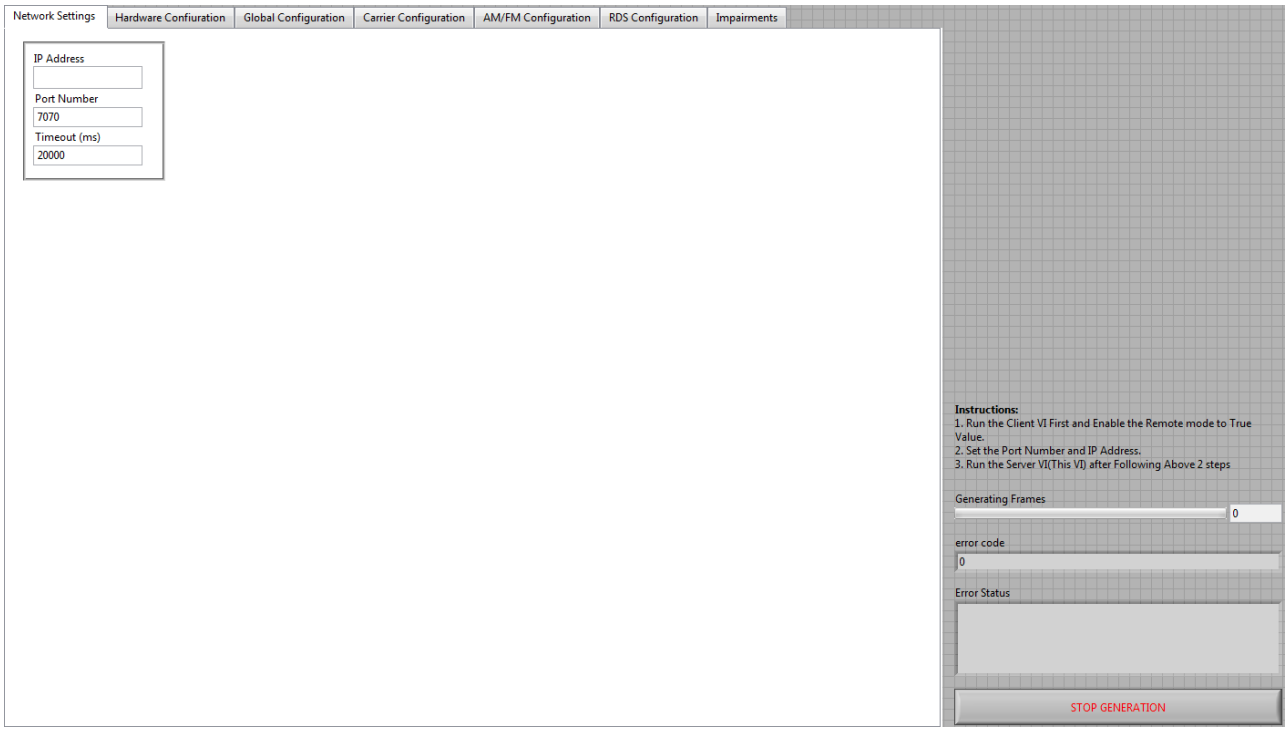
3.3.3.7 AM FM RDS Remote USRP Generate Multiple Frames (Real-Time)

Follow the below procedure to configure the example

1. Find the LabVIEW example in the following location <LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote

2. Open **MaxEye AMFM RFSG Remote USRP Generate Waveform(Real Time).vi**
3. The user configurations are divided into following categories displayed in multiple Tabs
    - Network Settings
    - Hardware Configuration
    - Global Configuration
    - Carrier Configuration
    - AM/FM Configuration
    - RDS 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 AM FM RDS TMC Signal Generation is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application returns an error. The default Timeout is **20 seconds**.

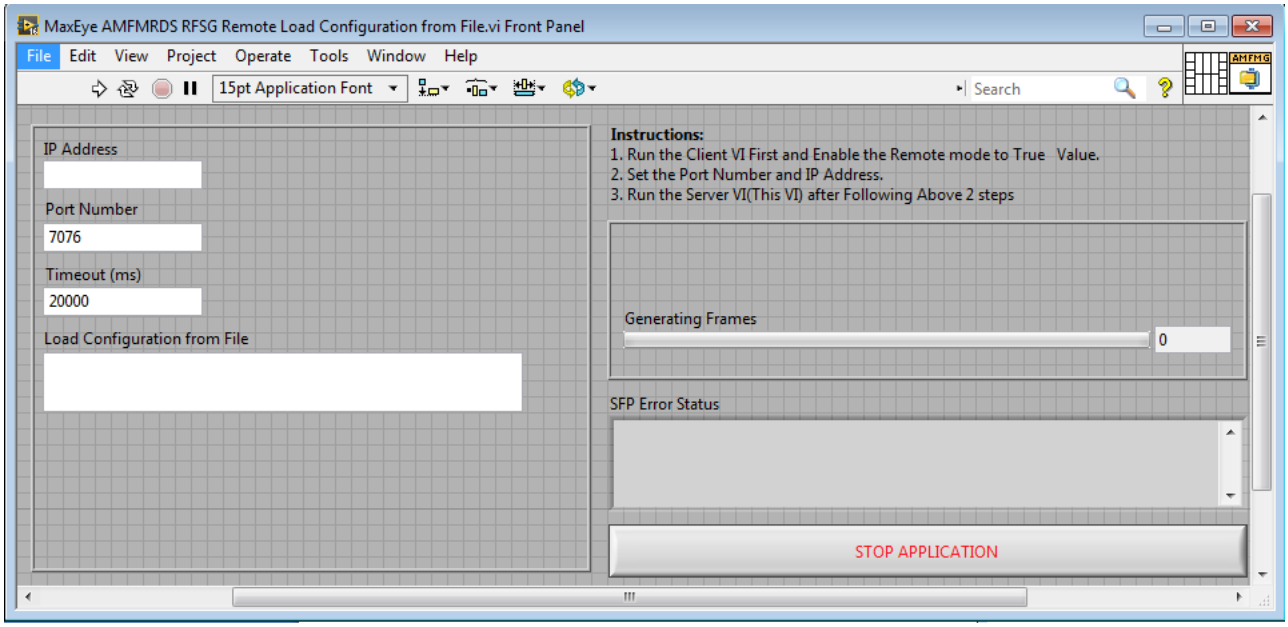
For configuring other configuration parameters, please refer section 3.1.2 of this document.

4. Run the example. Now the application 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.

3.3.3.8 AMFM Load Configurations from File

Follow the below procedure to configure the example

1. Find the LabVIEW example in the following location <LabVIEW>examples\MaxEye\Digital Video Toolkits\AM FM RDS TMC Generation\Remote
2. Open **MaxEye AMFMRDS RFSG Remote Load Configuration from File.vi**



- **IP Address –** Configure the IP address of the client system in which the MaxEye AM FM RDS TMC Signal Generation is intended to run.
- **Port Number –** Both client and server application must have same port number. The default Port Number is **7076**.
- **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 application 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 application 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.

4 How to configure parameters for Single Carrier/ Multiple Carriers

The controls Carrier Configuration, AM/FM Configuration, RDS Configuration and Impairments Configurations 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 AM/FM Configuration Control array with index display (highlighted in yellow).