

MaxEye Digital Audio and Video Signal Generation

AM/FM/RDS/TMC Signal Generation Toolkit

Version 1.0.0

Getting Started Guide



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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** <u>Note</u>: - 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 <u>Note</u>: - 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 <u>Note</u>: - 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 <u>Note</u>: - 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.

😽 MaxEye AM/FM/RDS/TMC Si	gnal Generator				- 🗆 ×
MAXEY TECHNO	E DLOGIES			Turnkey solutions for audio	and video broadcast test www.maxeyetech.com
AM/FM/RDS/TMC Signal Config	uration		Frame Waveform Preview	w (Power vs. Time)	
	Generation Mode		-22-		
Remote Settings	Generation Mode		-22-		
Generation Mode Global Configuration AMFM-RDS Wave AMFM-RDS Settin RDS Configu RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes Impairments Waveform File Settin Audio Quality Analys	 Generate and Play Waveform(Real Time) Generate and Play Waveform Generate and Save Waveform Play Waveform From File 		-22- -22- -22- -22- -22- -22- -22- -22	Time (s)	120m
< Add Carrier Delete Carrier Add RDS Message Delete RDS Message			Center Frequency(Hz) 0 Play Duration (Seconds) Status No Error	Waveform Sampling Rate (Hz)	PAPR 0
Generate Stop	Save Load Preset	8 Exit			

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.

	Hardware Settings	
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Setting RDS Configu RDS Mes RDS Mes	RFSG Resource	External Attenuation (dB) 0.00 Arb:Pre-filter Gain (dB) -1
RDS Mes RDS Mes RDS Mes RDS Mes Impairments	Ref clock source OnboardClock Clk Output terminal Do not export	Frequency (Hz)
Add Carrier Delete Carrier Add RDS Message Delete RDS Message		

<u>Note</u>: - 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.

AM/FM/RDS/TMC Signal Confi	guration		
Tree	Hardware Settings		
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Settin RDS Configi RDS Mes RDS Mes	USRP Device Id Gain (dB) 5	Active antenna TX1	
Add Carrier Add Carrier Delete Carrier Add RDS Message Delete RDS Message			
Generate Stop	Save Load	Preset 💡	Exit



- 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.

Tree	Global Configuration	
Remote Settings Generation Mode Hardware Settings Global Configuration AMFM-RDS Wave AMFM-RDS Settin RDS Configur RDS Mes RDS Mes	Signal Mode FM/RDS Oversampling Enabled ? True Output Sampling Rate (Hz) 500k Headroom (dB) 4	Play Duration (Seconds)
< Add Carrier Add Carrier Delete Carrier Add RDS Message Delete RDS Message		
Generate Stop	Save	Preset 💡 Exit

- 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.

 Remote Settings Generation Mode Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Setting RDS Mes RDS Mes 	Carrier Frequency (Hz) 91.9M	Relative Power (dB) 0
▼ 		
Add Carrier Delete Carrier Add RDS Message Delete RDS Message		
Generate Stop	Save	Preset Exit

<u>Note</u>: - 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

AM/FM/RDS/TMC Signal Confi	iguration	
Tree	Carrier 0/AMFM Waveform Settin	igs
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave	Audio Payload Type Tone(s) No. of Tones in Left Channel 1 Left Channel Tones (Hz)	Audio Payload Mode L # R No. of Tones in Right Channel 1 Right Channel Tones (Hz)
FM-RDS Setting BDS Configu	1000	1000
RDS Mes	0	0
RDS Mes	0	0
RDS Mes RDS Mes	0	0
RDS Mes	0	0
RDS Mes		·
< >		
Add Carrier		
Delete Carrier		
Add RDS Message		
Delete RDS Message		
Generate Stop	Save Load	Preset 💡 Exit

• 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,
 - \succ L = R,
 - \succ 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

AM/FM/RDS/TMC Signal Configuration							
Carrier 0/AMFM Waveform Settings							
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 MMFM-RDS Wave B FM-RDS Setting RDS Configu RDS Mes RDS Mes	~	Audio Paylo Wav File File Path (*	oad Type				
Add Carrier Delete Carrier Add RDS Message Delete RDS Message							
Generate Stop		Save	Load	Preset	8 E	xit	

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

> AM

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



AM/FM/RDS/T	MC Signal Co	nfiguration				
		Carrier 0/AM	FM-RDS Wavefor	m Settings/AM S	ettings	
 Remote Generat Hardwa Global (Carrier (AMP Audio C AMD Audio C Add Delete RD 	Settings ion Mode re Settings Configuration) M-RDS Wave M Settings juniments Quality Analys Quality Analys Carrier Carrier Carrier S Message	AM Modul 0.3 AM Suppre False	ation Index	AM Modula Double Sid	e Band	De V
Generate	Stop	Save	Load	Preset	?	Exit

- **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



AM/FM/RDS/TMC Signal Configuration						
Carrier 0/FM Waveform Settings/FM Settings						
 Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Settin RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes Add Carrier Delete Carrier Add RDS Message Delete RDS Message 	FM Mode Stereo Pilot Deviat 10 Data Service True Data Deviat 6	v ion (%) Enabled ? v ion (%)	FM Deviatio 75k Pre-empha: 50us Data Service RDS	sis E Mode		
Generate Stop	Save	Load	Preset	8	Exit	

- 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

AM/FM/RDS/TMC Signal Config	guration Carrier 0/EM Waveform Settings/E	FM-RDS Settings/RDS Configuration
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Settin RDS Mes RDS Mes	Carrier 0/FM Waveform Settings/F RDS Global Settings Country Code 13 Program Reference Number 1 Traffic Program Identification Off	M-RDS Settings/RDS Configuration Coverage Area Local Program Type (RDS) News Program Type (RBDS) News
< > < > < > < > < > < > < > < > < > < >		
Generate Stop	Save Load	Preset 💡 Exit

- **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.

<u>Note</u>: - 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. <u>Note</u>: 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. <u>Note</u>: - 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.

Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Waveform S FM-RDS Settings RDS Configuration RDS Message0 Impairments Audio Quality Analysis Add Carrier Delete Carrier Add RDS Message Delete RDS Message Delete RDS Message		Carrier 0/FM Wavefor	n Settings/FM Sett	ings/RDS Message0
Generation Mode Hardware Settings Global Configuration Carrier RDS Configuration RDS Configuration RDS Configuration RDS Configuration RDS Message0 Impairments Audio Quality Analysis Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Remote Settings	Message Type		
Group Type Group Version Group Type O Version A Version A AMFM-RDS Waveform S FM-RDS Settings RDS Configuration Impairments Audio Quality Analysis Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Generation Mode	Basic Tuning and S	witching	~
Global Configuration Carrier 0 AMFM-RDS Waveform S FM-RDS Settings RDS Configuration Impairments Audio Quality Analysis Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Hardware Settings	Group Type	Grou	p Version
Carrier 0 AMFM-RDS Waveform S FM-RDS Settings RDS Configuration RDS Message0 Impairments Audio Quality Analysis Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Global Configuration	Group Type 0	Versi	ion A
AMFM-RDS Waveform S FM-RDS Settings RDS Configuration RDS Message Impairments Audio Quality Analysis Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Carrier 0	Message Basic Tuni	ing and Switching	
 FM-RDS Settings RDS Configuration RDS Message Impairments Add Carrier Delete Carrier Add RDS Message Delete RDS Message 	AMFM-RDS Waveform S	message basic run	ing and Switching	
RDS Configuration RDS Message Impairments Audio Quality Analysis Off Music/Speech Switch Code Music Music Music/Speech Switch Code Music Music Music Music/Speech Switch Code Delete Carrier Add RDS Message Delete RDS Message	FM-RDS Settings	Traffic Announcem	ient Prog	Iram Service Name
RDS Message Impairments Audio Quality Analysis Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Music/Speech Switch Code Alternate Frequency Method A Number of Alternate Frequencies 0 Number of Alternate Frequencies 0 Add Carrier Add RDS Message Delete RDS Message Delete RDS Message	RDS Configuration	Off	~ RDS	Test
Impairments Audio Quality Analysis Music/Speech Switch Code Alternative Frequency Method Alternate Frequencies 0 Number of Alternate Frequencies 0 Add Carrier Add RDS Message Delete RDS Message Delete RDS Message	RDS Message0			
Audio Quality Analysis Music Alternative Frequency Method Alternate Frequencies Number of Alternate Frequencies 0 Number of Alternate Frequencies 0 Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Impairments	Music/Speech Swit	ch Code Deco	oder Identification Code
Alternative Frequency Method Alternate Frequencie Method A Number of Alternate Frequencies 0 Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Audio Quality Analysis	Music	∨ Ь1	
Method A Number of Alternate Frequencies 0 Add Carrier Delete Carrier Add RDS Message Delete RDS Message		Alternative Frequen	cy Method	Alternate Frequencies
Add Carrier Add RDS Message Delete RDS Message		Method A	ý 40	0
< <p>Add Carrier Add Carrier Delete Carrier Add RDS Message Delete RDS Message</p>			v~	
< Add Carrier Delete Carrier Add RDS Message Delete RDS Message		Number of Alternat	e Frequencies	
< Add Carrier Delete Carrier Add RDS Message Delete RDS Message		0		
< Add Carrier Delete Carrier Add RDS Message Delete RDS Message				
Add Carrier Delete Carrier Add RDS Message Delete RDS Message	< >			
Add Carrier Delete Carrier Add RDS Message Delete RDS Message				
Add Carrier Delete Carrier Add RDS Message Delete RDS Message				
Delete Carrier Add RDS Message Delete RDS Message	Add Carrier			
Add RDS Message Delete RDS Message	Delete Carrier			
Add RDS Message Delete RDS Message	belete camer			
Delete RDS Message	Add RDS Message			
Delete RDS Message				
	Delete RDS Message			

<u>Note</u>: - 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

<u>Note</u>: - 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

AM/FM/RDS/TMC Signal Configu	Carrier 0/FM Waveform Settings/F	M Settings/RDS Message0
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Waveform S FM-RDS Settings RDS Configuration RDS Message0 Impairments Audio Quality Analysis	Message Type Basic Tuning and Switching Group Type Group Type 0 Basic Tuning and Switching Traffic Announcement Off Music/Speech Switch Code Music Alternative Frequency Method Method B Number of AFs in list	Group Version Version A Program Service Name RDS Test Decoder Identification Code b1 Number of AF Lists 0 AF List 0 0
< Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Tuning Frequency	AF Type 0 Same Block 0
Generate Stop	Save Load	Preset 💡 Exit

- 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.



AM/FM/RDS/TMC Signal Conf	iguration				
	Carrier 0/FM V	Vaveform Setting	gs/FM Settings/R	DS Mes	sage0
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0	Message Ty Programme Group Type Group Type Program Ite	pe e Item Number a e 1 v	Group Versi Version A	ion	~
AMFM-RDS Waveform S FM-RDS Settings RDS Configuration	Linkage Act	uator	-		
RDS Message0 Impairments Audio Quality Analysis	Extended Co × 0 Day 0 Hour 0 Minute 0	buntry Code			
Add Carrier Delete Carrier Add RDS Message	Language C	ode			
Delete RDS Message					
Generate Stop	Save	Load	Preset	?	Exit

- 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.

<u>Note</u>:-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).

	Carrier 0/FM Waveform Settin	gs/FM Settings/RDS Message0
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Waveform S FM-RDS Settings RDS Configuration <u>RDS Message0</u> Impairments Audio Quality Analysis	Message Type Radio Text Group Type Group Type 2 Radio Text Type A/B Flag A Radio Text	Group Version Version A
< Add Carrier Delete Carrier Add RDS Message Delete RDS Message		
Generate Stop	Save Load	Preset 💡 Exit

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.
 <u>Note</u>: 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.

AM/FM/RDS/T	MC Signal C	onfig	uration				
			Carrier 0/FM V	Vaveform Setting	s/FM Settings/R	DS Mes	sage0
Remote Setting Generation Mo Global Configu	gs ode uration	^	Message Ty Clock-time Group Type	pe and date	Group Versi	ion	
Carrier 0			Group Type	4 🗸	Version A		\sim
AMFM-RDS	Waveform S	S	Clock Time	and Date			
FM-RDS RDS C RD Impairment Waveform File Audio Quality	Settings Configuration IS Message0 IS Settings Analysis	~	Year 0 Month 0 Date 0 UTC Hour 0 UTC Minute 0 Lease Lines				
Add	Carrier		0	Offset			
Delete Add RDS Delete RD	Carrier Message S Message						
Generate	Stop		Save	Load	Preset	?	Exit

- **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.



AM/FM/RDS/TMC Signal Configu	Iration	
	Carrier 0/FM Waveform Settings/FN	A Settings/RDS Message0
<u> </u>	Message Type	
Remote Settings	Traffic Message Channel	
Generation Mode	Group Tures	Group Version
Global Configuration	Group Type	Version A
Carrier U	Group Type 8	Version A
EM-RDS Settings	Traffic Message Channel	
BDS Configuration	Location Table Number	Mode
RDS Message0	0	Basic 🗸
Impairments	Service Identifier	Direction
Waveform File Settings	0	Positive 🗸
Audio Quality Analysis	Location Code	Extent Code
	0	0 🗸
	Event Code	Duration Code
	0	0 🗸
	Alternative Frequency Indicator	Diversion Advice
v	Off 🗸	Off 🗸
< >	International	Inter 8A Gap
	Off 🗸	3 Groups 🗸
Add Carrier	National	Delay Time (Td)
	Off 🗸	0 sec 🗸
Delete Carrier	Regional	Activity Time (Ta)
Add RDS Message	Off 🗸	1 sec 🗸
	Urban	Window Time (Tw)
Delete KDS Message	Off 🗸	0 sec 🗸
Generate Stop	Save Load	Preset 💡 Exit

- **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.

<u>Note</u>: - 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.



M/FM/RDS/TMC Signal Config	juration				
	Carrier 0/FM W	aveform Settin	gs/FM Settings/F	RDS Mess	age5
Remote Settings Generation Mode Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Setting	Message Typ Enhanced O Group Type Group Type Enhanced Ot	ther 14 the	Group Vers Version A	sion	•
 RDS Configu RDS Mes 	Information PTY (ON) a	Type nd TA 💌	Country Co × D	ode	
RDS Mes RDS Mes RDS Mes	Frequency N Alternate	1ethod 💌	Coverage A Local	Area	•
RDS Mes RDS Mes	Alternate Fre	quencies	Reference	Number	
Impairments Waveform File Settin	91.5M		PI Code		
-	91.5M 91.5M		x D005 TP Identifi	cation	
	91.5M		On		•
Add Carrier	Program Ty No Program	pe n Type 💌	Off	ouncem	ent ▼
Delete Carrier Add RDS Message Delete RDS Message					
Generate Stop	Save	Load	Preset	2	Exit

- **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

 Cannel o AMFM-RDS Wave FM-RDS Setting RDS Configi RDS Mes <li< th=""><th>Quadrature Skew (degree) 0 I DC Offset (%) 0 AWGN Enabled True Signal Loss Enabled? True</th><th>IQ Gain Imbalance (dB) 0 Q DC Offset (%) 0 Carrier to Noise Ratio (dB) 0</th></li<>	Quadrature Skew (degree) 0 I DC Offset (%) 0 AWGN Enabled True Signal Loss Enabled? True	IQ Gain Imbalance (dB) 0 Q DC Offset (%) 0 Carrier to Noise Ratio (dB) 0
Add Carrier Delete Carrier Add RDS Message Delete RDS Message	Signal Loss Time Offset (s)	Signal Loss Duration (s)

- **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.
 <u>Note</u>: Needs to be configured only when the generation mode is Generate and Save waveform.

3.1.2 Generate and Play Waveform (Real-Time)

AM/FM/RDS/TMC Si	ignal Config	juration				
		Generation M	ode			
Remote Settin Generation M Hardware Sett Global Config Carrier 0 AMFM-RD FM-RDS RDS RI RI RI RI RI RI Audio Quality	ngs lode tings juration IS Wave S Settin Configu DS Mes DS Mes DS Mes DS Mes DS Mes DS Mes ts / Analys	Generation Generation Generation Generation Play Wa	Mode e and Play Wave e and Save Wave veform From Fil	form(Real Time) form e		
Add Carrie	r					
Delete Carrie	er					
Add RDS Mess	age					
Delete RDS Mes	ssage					
Generate	Stop	Save	Load	Preset	8	Exit

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 <u>section 3.1.1</u> 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



AM/FM/RDS/TMC Signal Configu	uration	
	Hardware Settings	
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Wave FM-RDS Settin RDS Config RDS Mes RDS Mes	RFSG Resource	External Attenuation (dB) 0.00 Arb:Pre-filter Gain (dB) -1
RDS Mes RDS Mes RDS Mes RDS Mes Impairments	Ref clock source OnboardClock T Clk Output terminal Do not export T	Frequency (Hz)
< > Add Carrier Delete Carrier Add RDS Message Delete RDS Message		

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

AM/FM/RDS/TMC Signal Configura	ation
GI	lobal Configuration
 Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Setting RDS Configi RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes Add Carrier Delete Carrier Add RDS Message Delete RDS Message 	Signal Mode FM/RDS Oversampling Enabled ? True Output Sampling Rate (Hz) 500k Headroom (dB) 4



- 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.

AM/FM/RDS/TMC Signal Config	guration				
	Generation M	ode			
Remote Settings Hardware Settings Generation Mode Play Waveform Fr	Generation Mi Generation Generation Generation Play Wa	ode Mode e and Play Wavef e and Save Wavef veform From File	orm(Real Time) orm form		
Delete RDS Message					
Generate Stop	Save	Load	Preset	8	Exit

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.

	Hardware Settings	
Remote Settings Generation Mode Hardware Settings Global Configuration Carrier 0 AMFM-RDS Wave FM-RDS Settini RDS Configu RDS Mes RDS Mes	RFSG Resource Power Level (dBm) -10.00 Software Scaling Factor 1 Frequency Reference	External Attenuation (dB) 0.00 Arb:Pre-filter Gain (dB) -1
RDS Mes RDS Mes RDS Mes RDS Mes Impairments	Ref clock source OnboardClock Clk Output terminal Do not export	Frequency (Hz)
Add Carrier Delete Carrier Add RDS Message Delete RDS Message		



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

AM/FM/RDS/TMC Signa	al Configu	iration	
	I	Play Waveform From File	
Remote Settings Hardware Setting Generation Mode Play Waveforr	∧ e m Fr	Center Frequency (Hz) 91.5M Write Block Size (Samples) 10000 Sample Width 16-bit Waveform File Path	Streaming Waveform Size in Samples
Add Carrier			
Delete Carrier			
Add RDS Message	e		
Delete RDS Messag	ge		

- 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.



Add Carrier
Delete Carrier
Add RDS Message
Delete RDS Message

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.

Generate	Stop	Save	Load	Preset	2	Exit
----------	------	------	------	--------	---	------

- **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. Same 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.



Generate Waveform Indicat	ors	
Center Frequency(Hz)	Waveform Sampling Rate (Hz)	PAPR
0	0	0
Play Duration (Seconds)		
		U
Status		
No Error		

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

File Progress 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9	
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9	
	1

• 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.





Turnkey solutions for audio and video broadcast test

							www.maxeyetech.com
AM/FM/RDS/T	MC Signal Config	uration					Frame Waveform Preview (Power vs. Time)
Remote Generat Global (Carrier (AMF F F B	Settings ion Mode onfiguration M-RDS Wave A-RDS Settini RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes RDS Mes	Remote Setting	gs Node?	Port Numb 7076 timeout m: 15000	er ;		5.9- 5.8- 5.7- 6 5.6- 5.5- 5.4- 5.3- 5.2- 0 Time (s)
Add Delete Add RDS Delete RD	m File Settin Carrier Carrier Message S Message						Generate Waveform Indicators Center Frequency(Hz) Waveform Sampling Rate (Hz) PAPR 0 0 0 Play Duration (Seconds) 0 Status No Error
Generate	Stop	Save	Load	Preset	?	Exit	

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

3#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 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 Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 92300000, 92700000, 93000000};
double RelativePowerDB[MAX_NUM_CARRIERS] = {91500000, 91900000, 92300000, 92700000, 93000000};
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 92300000, 92700000, 93000000};
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 923000000, 927000000, 93000000};
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 923000000, 927000000, 930000000};
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 923000000, 927000000, 930000000};
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 923000000, 927000000, 930000000};
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 923000000, 92700000, 930000000};
double RelativePowerD8[MAX_NUM_CARRIERS] = {91500000, 91900000, 923000000, 92700000, 930000000};
double Carrier_Frequency[MAX_NUM_CARRIERS] = {91500000, 91900000, 92300000, 92700000, 93000000};
double MelativePowerD8[MAX_NUM_CARRIERS] = {10, 0, 0, 0, 0};
/*** Global Configuration settings ***/
double Output_Sampling_Rate=500000;
UINT16 Command_Type=0;
UINT16 Command_Type=0;
UINT16 SaveConfiguration = 0;
//
char SaveConfiguration_FilePath[]="C:\WAXEYE\\TS Files\\AMFM\\AMFM_1Carr_91.5M.bin";
//
char Waveform File Path[]="C:\MAXEYe\\Test.wfm";

//0- StartGeneration, 1- StopGeneration

//O- Disabled, 1- Enabled to Save configurations in file. //Configure file path to save the configuration

char Waveform_File_Path[]="C: WaxEye\\Test.wfm";
/*** FMRDS_SETTINGS ****/
uintl6_t FMMode[MAX_NUM_CARRIERS]={1,1,1,1,1};
double FMDeviationt[MAX_NUM_CARRIERS]={110,10,10,10,10};
uintl6_t PreEmphasis[MAX_NUM_CARRIERS]={11,1,1,1,1};
uintl6_t DataServiceEnabled[MAX_NUM_CARRIERS]={0,0,0,0,0};
double DataDeviation[MAX_NUM_CARRIERS]={0,0,0,0,0};
double DataDeviation[MAX_NUM_CARRIERS]={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.



C:\WINDOWS\system32\cmd.exe	-	×
Enter the Number of Carriers in between 1 to 3 1		^
Enter the Play Duration in Sec		
10 Enter the Number of RDS Messages		
1 Enter the Message Type 0: RDS Basic Tuning 1: RDS Message Program Item 2: RDS Message Radio Text 3: RDS Message Clock Time 4: RDS Traffic Message Channel 0 Press any key to stop generation		
The Generation Status is True The Play Duration Status is 10 of 10 in Sec The total waveform duration generated successfully Press any key to stop generation		

- 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	
lest strong	
The Main aim of this function is to define all the User Configurable AMFMRDS parameters.	

====lude <stdio.h></stdio.h>	
#include \String.n/ #include \\ \Trcludes\WayEve Utilities Typedefs h"	
#include \Includes\MaxEve AMFM Generate and Play Defines.h"	
<pre>#include "\Includes\MaxEye AMFM Generate and Play Externs.h"</pre>	
int AMFM_init()	
i international de la constante de	
char TP Address Defla".	//TP Address of the client system
char RESG Resource Defl="PXIISlot2":	//RFSG Resource Name
UINT16 Command Type=0;	//0- StartGeneration, 1- StopGeneration
double Carrier_Frequency_Def[MAX_NUM_CARRIERS] = {88000000, 88200000, 88400000, 88600000, 8	880000,
90000000, 90200000, 90400000, 90600000, 9	080000,
91000000, 91200000, 91400000, 91600000, 9	180000,
92000000, 92200000, 92400000, 92600000, 9	2800000,
95000000, 95200000, 95000000, 95	Societos,
double Output Sampling Rate=500000:	// Output Sampling Rate
UINT16 Over Sampling Enabled=0;	//0- False, 1- True
<pre>char *Audio_File_Path_Def[MAX_NUM_CARRIERS]= {""}; //FM wav file paths</pre>	
<pre>double Left_Channel_Frequency[1] = {1000}; INT32 Left_Channel_Length=1;</pre>	
<pre>double Right_Channel_Frequency[1] = {1000}; INT32 Right_Channel_Length=1;</pre>	
INT32 AF_Type[1]={0;	
<pre>double Ar_List[1]={0}, lunimg_requency[1] = {0}, Alternate_requencies[1] = {91500000};</pre>	
office number_of_washrist[1] = {e};	
<pre>strcpy(IP_Address, IP_Address_Def);</pre>	
<pre>strcpy(RFSG_Resource, RFSG_Resource_Def);</pre>	
Headroom=12;	
// VSG/VST Handware Settings	
// vsg/vsi naroware settings	//PVT 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.KetLlockSource;	//Frequency Reference Clock Source 0 - Unboard Clock, 1 - Refin, 2 - PXI-Clk, 3 - Clkin
haruwaresettings.outputierminiai,	
//FMRDS Settings	
FMRDSSettings.FMMode=FM_MODE;	
FMRDSSettings.PilotDeviation=PILOT_DEVIATION;	
FMRDSSettings.DataServiceEnabled=DATA SERVICE ENABLED;	

Follow the procedure below to configure the example

- 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
 (<u>Note: - For 32-bit Operating System</u>, 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.



C:\WINDOWS\system32\cmd.exe	-	×
Enter the Number of Carriers in between 1 to 3		^
Enter the Play Duration in Sec		
10		
Enter the Number of RDS Messages		
1		
Enter the Message Type		
0: RDS Basic Tuning		
1: RDS Message Program Item		
2: RDS Message Radio Text		
3: RDS Message Clock Time		
4: RDS Trattic Message Channel		
e Press any key to stop generation		
The Generation Status is True		
The Play Duration Status is 10 of 10 in Sec		
The total waveform duration generated successfully		
Press any key to stop generation		

- 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

MaxEye USRP AMFMand Play RT Init.c 😕 🔀		
(Global Scope)		
<pre>#include <stdio.h></stdio.h></pre>		
<pre>#include "\Includes\MaxEye Utilities Typedefs.h"</pre>		
<pre>#include "\Includes\MaxEye USRP AMFM Generate and Play RT Defines.h"</pre>		
<pre>#include "\Includes\MaxEye USRP AMFM Generate and Play RT Externs.h"</pre>		
<pre>//#include "\Includes\MaxEye AMFM Generate and Play Typedefs.h"</pre>		
□int AMFM_init()		
{		
<pre>int CarrierIndex=0, MessageIndex = 0;</pre>		
<pre>char IP_Address_temp[]="localhost";</pre>	/	/IP Address of the client system
<pre>char USRP_IPAddress_Def[]="192.168.10.2";</pre>		/IP Address of the USRP system
UINT16 Command_Type=0;	/	/0- StartGeneration, 1- StopGeneration
double Carrier_Frequency_Det[MAX_NUM_CARRIERS] = {91500000};//Multi Car	rrier Frequency	
double Output_Sampling_Rate=500000;		/ Output Sampling Rate
UINI16 Over_Sampling_Enabled=0;	/	/0- False, 1- True
char "Audio_File_Path_Det[MAX_NUM_CARRIERS]= { };	/	/select FM way file paths
double Left_channel_Frequency[1] = {1000}; INIS2 Left_channel_Length=1	; _1.	
TNT32 AE Type[1]=(4);	-1,	
double AE List[1]={0}. Tuning Erequency[1] = {0}. Alternate Erequencies	<pre>s[1] = {91500000};</pre>	
UINT8 Number Of AFsInList[1] = {0}:		
<pre>strcpy(IP Address, IP Address temp);</pre>		
<pre>strcpy(USRP_IPAddress, USRP_IPAddress_Def);</pre>		
Headroom=12;		
USRP_Carrier_Frequency=91500000;	//USRP Carrier Frequency	(Hz)
Gain=0;	//USRP Gain (dB)	
//FMRUS Settings		
FMRDSSettings.FMMode=FM_MODE;		
FMRDSSettings.PilotDeviation=Pilot_DEviation;		
EMDDCCattings DataDeviation_DATA_DEVIATION.		
EMPDCS attings EMDeviationHT=EM_DEVIATION;		
EMDDSSettings DreEmphacis-DDEEMDHASTS		
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;		
PDS Configuration CountryCode=COUNTRY CODE:		
PDS_Configuration_CoverageArea=COVERAGE_APEA:		
RDS_configuration_ProgramReferenceNumber=PROSPAN_REF_NUMBER+		
RDS_configuration.ProgramTyneRDS=PROGRAM_TYPE_RDS:		
RDS Configuration.ProgramTypeRBDS=PROGRAM_TYPE_RBDS:		
RDS Configuration.TrafficProgramIdentification=TRAFFIC PROGRAM IDENTIF	ICATION:	

Follow the procedure below to configure the example

- 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 (<u>Note:</u> - 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.
- 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.



GE C:\WINDOWS\system32\cmd.exe	-	х
Enter the Number of Carriers in between 1 to 3 1		^
Enter the Play Duration in Sec		
10		
Enter the Number of RDS Messages		
1		
Enter the Message Type		
0: RDS Basic Tuning		
1: RDS Message Program Item		
2: RDS Message Radio Text		
3: RDS message Clock Time		
A NOS TRATTIC MESSage Channel		
Press any key to stop generation		
The Generation Status is True		
The Play Duration Status is 10 of 10 in Sec		
The total waveform duration generated successfully		
Press any key to stop generation		
		\sim

- 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

MaxE	eye AMFM USRPy Waveform Init.c 😐 🗙	
(0	Blobal Scope)	- © AMFM_init()
	=/*************************************	
	Function Name: MaxEye AMFM USRP	lay Waveform Init
	Description:	
	The Main aim of this function is	to define all the User Configurable AVEM parameters.
6	<pre>#include <stdio.h> #include <stdio.h> #include "\Includes\MaxEye Uti #include "\Includes\MaxEye AMF include "\Includes\MaxEye AMF</stdio.h></stdio.h></pre>	Itles Typedefs.h" USBP Play Waveform Defines.h" USBP Play Waveform Externs.h"
6	<pre>int AMFM_init() { char IP_Address_Def[]=""; char USRP_IPAddress_Def[]="1 char Waveform_File_Path_Def[</pre>	2.168.10.2"; //IP Address of the Client system =""; //Specify appropriate file path to save waveform
	<pre>strcpy(USRP_IPAddress, USRP_ strcpy(IP_Address, IP_Address strcpy(Waveform_File_Path, Waveform_File_Path, Waveform_File_P</pre>	PAddress Def);
	USRP_Carrier_Frequency=91500	00; //USAP_Carrier Frequency (Hz) //USAP_Cain (H)
	Sample Width=1:	//0- 8-Bit (1-16-Bit (Applicable for Generation Mode -1 & 2)
	Write Block Size=10000;	//Write Block Size in Samples
	Command_Type=0;	//0- StartGeneration, 1- StopGeneration
	return 0; }	

Follow the procedure below to configure the example

- 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 (<u>Note</u>: - 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.



C:\WINDOWS\system32\cmd.exe	_	×
Generation Mode is in Play Waveform from File Press any key to stop generation		^
		~

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



Follow the procedure below to configure the example



- 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.
 (<u>Note</u>: - 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

MaxEye AMFM Generand Play RT Init.c 👒 🗙		
(Global Scope)		 ♦ AMFM_init()
int CarrierIndex=0, MessageIn	dex = 0;	
<pre>char IP_Address_temp[]="";</pre>	//	/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=5	00000;	// Output Sampling Rate
UINT16 Over Sampling Enabled=	0;	//0- False, 1- True
char *Audio File Path Def[MAX	NUM CARRIERS]= {""}: //Select FM way file paths	
double Left Channel Frequency	<pre>[1] = {1000}; INT32 Left Channel Length=1;</pre>	
double Right Channel Frequence	v[1] = {1000}; INT32 Right Channel Length=1;	
INT32 AF Type[1]={0};		
double AF List[1]={0}, Tuning	<pre>Frequency[1] = {0}, Alternate Frequencies[1] = {91500000};</pre>	
UINT8 Number_Of_AFsInList[1]	= {0};	
strcpy(IP_Address, IP_Address	_temp);	
Headroom=12;		
// VSG/VST Hardware Settings		
HardwareSettings.RFSGResource	;	//PXI Device Name
HardwareSettings.PowerLevelDB	m=-10;	//Power Level (dB)
HardwareSettings.HeadroomDB=1	2;	//Headroom (dB)
HardwareSettings.ExternalAtte	nuationDB=0;	//External Attenuation (dB)
HardwareSettings.ArbPreFilter	GainDB=-1;	//Arbitarary Prefilter Gain (dB)
HardwareSettings.FrequencyHz=	10000000;	//Frequency Reference (Hz)
HardwareSettings.RefClockSour	ce;	//Frequency Refenece Clock Source 0 - Onboard Clock, 1 - RefIn, 2 - PXI-Clk, 3 - ClkIn
HardwareSettings.outputTermin	al;	//Clock Output Terminal
//FMRDS Settings		
EMRDSSettings.EMMode=EM_MODE:		
EMRDSSettings.PilotDeviation=	PTLOT DEVIATION:	
FMRDSSettings.DataServiceEnab	led=DATA SERVICE ENABLED:	
FMRDSSettings.DataDeviation=D	ATA DEVIATION:	
EMRDSSettings.EMDeviationHz=E	M DEVIATION:	
EMRDSSettings.PreEmphasis=PRE	EMPHASTS:	
FMRDSSettings.DataServiceMode	=DATA_SERVICE_MODE;	
//AudioSottings		
AudioSettings AudioDauloadTur	e-AUDTO RAVIOAD TYPE.	
AudioSettings AudioEileBath	stovers_rolesone_life;	
AudioSettings NoOfToposTploft	Chapped-MUMBER OF TONES LEFT CHANNEL	
AudioSectings.NoorTonesIntert	and INTO DAVIDAD MODE.	
AudioSettings NoOfTonesTaBigh	+Channel-NUMBER OF TONES LEET CHANNEL.	
Addiose certigs moot toles inkight	commercial of the sector of th	
//RDS Configuration Settings		
RDS_Configuration.CountryCode	-COUNTRY_CODE;	
RDS_Configuration.CoverageAre	a=COVERAGE_AREA;	
RDS_Configuration.ProgramRefe	renceNumber=PROGRAM_REF_NUMBER;	
RDS_Configuration.ProgramType	RDS=PROGRAM_TYPE_RDS;	
RDS_Configuration.ProgramType	RBDS=PROGRAM_TYPE_RBDS;	
RDS_Configuration.TrafficProg	ramIdentification=TRAFFIC_PROGRAM_IDENTIFICATION;	
RDS_Configuration.NumberOfMes	<pre>sages=NUMBER_OF_MESSAGES;</pre>	
//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.



C:\WINDOWS\system32\cmd.exe	_	Х
Real Time Generate and Play Waveform supports 1 Carrier only		^
Enter the Number of RDS Messages		
1		
Enter the Message Type		
0: RDS Basic Tuning		
1: RDS Message Program Item		
2: RDS Message Ralio Text		
3: RDS Message Clock Time		
4: RUS TRATTIC MESSAGE Channel		
o Press any key to ston generation		
The set of set and the set of the		
The Generation Status is True		
Press any key to continue		
		\checkmark

- 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

MaxEye USRP AMFMand Play RT Init.c 👒 🗡	
(Global Scope)	- © AMFM_init()
	/
G≢include <stdio.h> finclude "\Includes\MaxEye Utilities Typedefs.h" #include "\Includes\MaxEye USRP AMFM Generate and Play RT Defines.h"</stdio.h>	
//#include\Includes\MaxEye OSAF AMPH Generate and Flay AT Externs	
□int AMFM_init()	
<pre>int CarrierIndex=0, MessageIndex = 0;</pre>	
<pre>char IP_Address_temp[]="localhost";</pre>	//IP Address of the client system
<pre>char USRP_IPAddress_Def[]="192.168.10.2";</pre>	//IP Address of the USRP system
UINT16 Command_Type=0;	//0- StartGeneration, 1- StopGeneration
<pre>double Carrier_Frequency_Def[MAX_NUM_CARRIERS] = {91500000};//Multi Car</pre>	rier Frequency
<pre>double Output_Sampling_Rate=500000;</pre>	// Output Sampling Rate
UINI16 Over_Sampling_Enabled=0;	//0- False, 1- Frue
char "Audio File Path Det[MAX_NUM_CARRIERS]= { };	//Select FM way file paths
double Left_Channel_Frequency[1] = {1000}; INT52 Left_Channel_Length=1;	
TNT32 AF Type[1]={0}:	**
double AF List[1]={0}. Tuning Frequency[1] = {0}. Alternate Frequencies	[1] = {91500000}:
UINT8 Number_Of_AFsInList[1] = {0};	
<pre>strcpy(IP_Address, IP_Address_temp);</pre>	
<pre>strcpy(USRP_IPAddress, USRP_IPAddress_Def);</pre>	
Headroom=12;	
USRP_Carrier_Frequency=91500000;	//USRP Carrier Frequency (Hz)
Gain=0;	//USRP Gain (dB)
//FRKUS Settings	
EMPDCS attings . PilotDaviation=DILOT DEVIATION:	
EMPDSSettings DataServiceEnabled=DATA SERVICE ENABLED	
EMRDSSettings.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_Contiguration.ProgramTypeRBDS=PROGRAM_TYPE_RBDS;	
RUS Configuration.FrafficProgramIdentification=TRAFFIC PROGRAM IDENTIFI	LATION;

Follow the procedure below to configure the example

- 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 (<u>Note:</u> - 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.



C:\WINDOWS\system32\cmd.exe	_	\times
Real Time Generate and Play Waveform supports 1 Carrier only		
Enter the Number of RDS Messages		
1		
Enter the Message Type		
0: RDS Basic Tuning		
1: RDS Message Program Item		
2: RDS Message Radio Text		
3: RDS Message Clock Time		
4: RDS Traffic Message Channel		
o Press any key to ston generation		
These any key to stop generation		
The Generation Status is True		
Press any key to continue		
		\checkmark

- 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

bal Scope) 🚽	
/**************************************	********
Function Name: MaxEye AMFM Load Configuration Init	
Description:	
The Main aim of this function is to define all the User Configurable ISDB-T parameters.	***************************************
<pre>finclude <string.h></string.h></pre>	
<pre>#include "\Includes\MaxEye Utilities Typedefs.h"</pre>	
<pre>#include "\Includes\MaxEye AMFM Load Configuration Defines.h"</pre>	
<pre>#include "\Includes\MaxEye AMFM Load Configuration Externs.h"</pre>	
thar IP Address[]="192.168.0.116";	//IP Address of the client syste
	//Specify appropriate fi
<pre>char LoadConfiguration_FilePath[]="C:\\Users\\maxeye_hardware\\Desktop\\AMFM_1Carr_91.5M.txt";</pre>	



Follow the procedure below to configure the example

- 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 (<u>Note:</u> - 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

Network Settings	Global Configuration	Carrier Configuration	AM/FM Configuration	RDS Configuration	Impairments						
IP Address											
Port Number											
7076											
Timeout											
20000											
							Instructions:				
							1. Run the Client	VI First and Ena	ble the Remot	e mode to	True
							2. Set the Port N 3. Run the Serve	umber and IP Ac VI(This VI) after	ldress. Following Ab	ove 2 steps	s
							Generating Fram	ies		0)
							Error Status				
]				
								STOP G	eneration	_	_

- **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



Network Settings	Hardware Confiuration	Global Configuration	
IP Address Port Number 7076 Timeout 20000			Instructions: 1. Run the Client VI First and Enable the Remote mode to True Value. 2. Set the Port Number and IP Address. 3. Run the Server VI(This VI) after Following Above 2 steps Generating Frames 0 Error Status
			STOP Generation

- **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



Network Settings	Hardware Confiuration	Global Configuration	
IP Address Port Number 7076 Timeout 20000			Instructions: 1. Run the Client VI First and Enable the Remote mode to True Value. 2. Set the Port Number and IP Address. 3. Run the Server VI(This VI) after Following Above 2 steps Generating Frames 0 Error Status
			STOP Generation

- **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 Port Number	
IP Address Port Number	
Port Number	
Port Number	
7070	
Timeout (ms)	
20000	
Instructions	and and the Tour
2. Kun the client Vi rins and Enable the Ke Value.	mote mode to True
2. Set the Port Number and IP Address.	
3. Kun the Server VI (I nis VI) atter Following	Above 2 steps
Generating Frames	
	0
Error Status	
STOP GENERATION	N

- **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

Network Settings	Hardware Confiuration	Global Configuration	Carrier Configuration	AM/FM Configuration	RDS Configuration	Impairments	
		-		-	-		
IP Address							
Port Number							
7070							
Timeout (ms)							
20000							
							Instructions:
							 Run the Client VI First and Enable the Remote mode to True - Value
							2. Set the Port Number and IP Address.
							3. Kun the Server VI(This VI) after Following Above 2 steps
							Generating Frames
							0
							error code
							0
							Fron Status
							STOP GENERATION

- **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

Edit View Project Operate Tools Window Help		ET
💠 🕸 🛑 📕 🛛 15pt Application Font 🔻 🚛 🖬	• 🔅 • Search	<u> </u>
P Address	Instructions: 1. Run the Client VI First and Enable the Remote mode to True 2. Set the Port Number and IP Address. 3. Run the Server VICINE VID after Following Above 2 steps	Value.
Port Number		
7076		
limeout (ms)		
20000	Generating Frames	
.oad Configuration from File		0
	SFP Error Status	
	STOP APPLICATION	

- **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).

a	AM/FM RDS Global Setting	S			
0	AM Modulation Index	Audio Payload Type			
	0.3	Tone(s)			
	AM Modulation Type	AM Suppress Carrier?			
	Double Side Band 💌	False 💌			
	FM Mode	Audio Payload Mode			
	Stereo 👻	L # R 👻			
	FM Deviation (Hz)	No.of Tones in Left Channel			
	75k	1			
	Pilot Deviation (%)	No.of Tones in Right Channel			
	10	1			
	Pre-emphasis	Left Channel Tones (Hz)			
	50us 💌	0 1000			
	Data Service Enabled ?	Right Channel Tones (Hz)			
	True				
	Data Service Mode	Data Deviation (%)			
	RDS 💌	10			
	Audio File Path (*.wav file	e)			