MaxEye Digital Audio Signal Generation

DAB/DAB+/DMB Signal Generation Toolkit

Version 1.0.0

Getting Started Guide

Contents

For more information please contact info@maxeyetech.com

List of Abbreviations

DAB: Digital Audio Broadcasting

SFP: Soft Front Panel

RFSG: Radio Frequency Signal Generator

T-DMB: Terrestrial-Digital Multimedia Broadcast

MSC: Main Service Channel

AWG: Arbitrary Waveform Generator

BER: Bit Error Ratio

VST: Vector Signal Transceiver

AWGN: Additive White Gaussian Noise

PAPR: Peak to Average Power Ratio

API: Application Programming Interface

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1 Introduction

MaxEye Technologies provides generation functions in LabVIEW and C for generating the standard complaint signals for various digital audio and video broadcasting standards. This guide explains how to use the DAB/DAB+/DMB signal generation toolkit using the toolkits Soft Front Panel (SFP) and programming examples by using the Second Generation NI Vector Signal Transceiver (AST-1000, PXIe-5840 and PXIe-5820).

Digital Audio Broadcasting (DAB) is a digital radio technology for broadcasting radio stations, used in several countries, particularly in Europe. The DAB family of standards includes DAB and DAB+ for digital radio and DMB for mobile TV. They are flexible, global and open standards and are a means for transmission of terrestrial digital radio signals.

The original DAB specification is based on ETSI EN 300401 and DAB+ enhancement specification is based on ETSI TS 102563 standard. DMB is based on the ETSI standards TS 102427 and TS 102428. T-DMB uses data stream mode on DAB to transmit the video using MPEG Transport Stream (TS) format.

2 Installed File Location

2.1 Soft Front Panel

The DAB/DAB+/DMB signal generation Soft Front Panel (SFP) is located in, C:\ Program Files (x86)\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Application

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

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

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

2.2 Programming Examples

The remote programming examples are installed in <LabVIEW>\examples\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Remote

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

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(*<u>Note</u>: - For 32-bit Operating System*, C Examples are located in C:\Program Files\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Examples\C)

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

2.3   Remote LabVIEW API VIs

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

2.4   Documentation

The Remote LabVIEW API help file is installed in, <LabVIEW>\help\MaxEye\Digital Video Toolkits\MaxEye DABTDMB Signal Generation Help.chm

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

(*<u>Note</u>: - For 32-bit Operating System*, toolkit documentation is located in C:\Program Files\ MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Documentation)

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

3   Soft Front Panel

The soft front panel (SFP) for DAB/DAB+/DMB 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 DAB/DAB+/DMB Signal Generation

The figure below shows the DAB/DAB+/DMB Signal Generation Soft Front Panel.

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3.1.1 Generate and Save Waveform/Generate and Play Waveform

Generate and Play waveform is used to generate DAB/DAB+/DMB signal using hardware. Generate and save waveform is used to generate the baseband IQ waveform and store in a file. For this mode hardware is not required. The Play Waveform from File mode reads the DAB/DAB+/DMB waveform from the file, downloads the waveform to NI RFSG Memory and then plays the waveform in real-time.

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

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DAB/DAB+/DMB Signal Configuration

Note: - *These Hardware Settings tab will not appear if the chosen Generation Mode is Generate and Save Waveform.*

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

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

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

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

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

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

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

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

  The figure below shows the carrier configuration for each carrier.
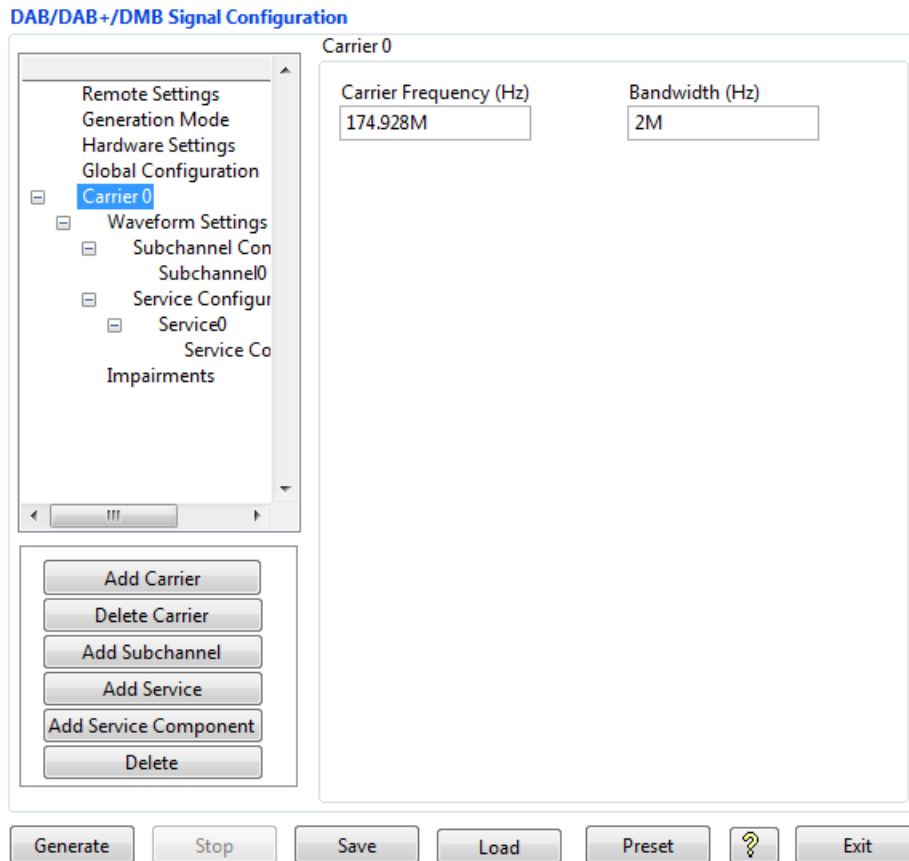
4.1 Select **Waveform Settings** to configure the following parameters for the selected carrier.

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- **Transmission Mode** – Select one of the Transmission Mode as per the requirement. Supported modes are I, II, III, and IV

| Transmission mode	Duration of transmission frame	Number of FIBs per transmission frame	Number of CIFs per transmission frame
I	96 ms	12	4
II	24 ms	3	1
III	24 ms	4	1
IV	48 ms	6	2

- **Input Mode -** Select Input mode as **User or ETI mode**. In the User mode all configuration including subchannel and service needs to be completely configured by the user. In the ETI mode, user need to select only the ETI File Path and the toolkit extracts all other configuration from the ETI file.
- **Ensemble Label -** The Ensemble Label is used to identify the ensemble in a textual format. DAB ensembles are groups of broadcasters transmitting multiple digital radio channels on a single radio transmission. The maximum number of characters that can be given as input to this property is 16 including spaces.

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- **Create ETI Frame Enabled** –If this control is set to 1 (True) then the toolkit creates ETI frames as per the standard and writes the data in the file specified by the ETI File Path property. This control is enabled only if the input mode is User.
- **Ensemble Reference** –This is a 12 bit field used to identify the number of the ensemble. The valid value for Ensemble Reference is from 0 to 4095. Each carrier must have unique ensemble reference for generating multicarrier DAB signal.
- **Country Identifier**– This is a 4 bit Country Identifier as defined by the standard TS 101 756, tables 3 to 7.
- **Extended Country Code**– This is an 8 bit Extended Country Code as defined by the standard TS 101 756, tables 3 to 7.
- **ETI File Path**– Specifies the ETI File Path. When the Input Mode is User and the Create ETI Frame Enabled is set to True the toolkit creates the ETI frame and writes in to this file. When the Input Mode is ETI File then then toolkit reads the ETI frames from this file to create the DAB signal.
- **Ensemble Linking Enabled-**The Ensemble linking is done when same Ensemble is transmitted in two different DAB frequencies. When the Ensemble Linking Enabled is set to true the user need to configure additional parameters required for the Ensemble Linking Feature. Press the Configure button to configure these additional parameters. The Configure button opens the below dialog box.
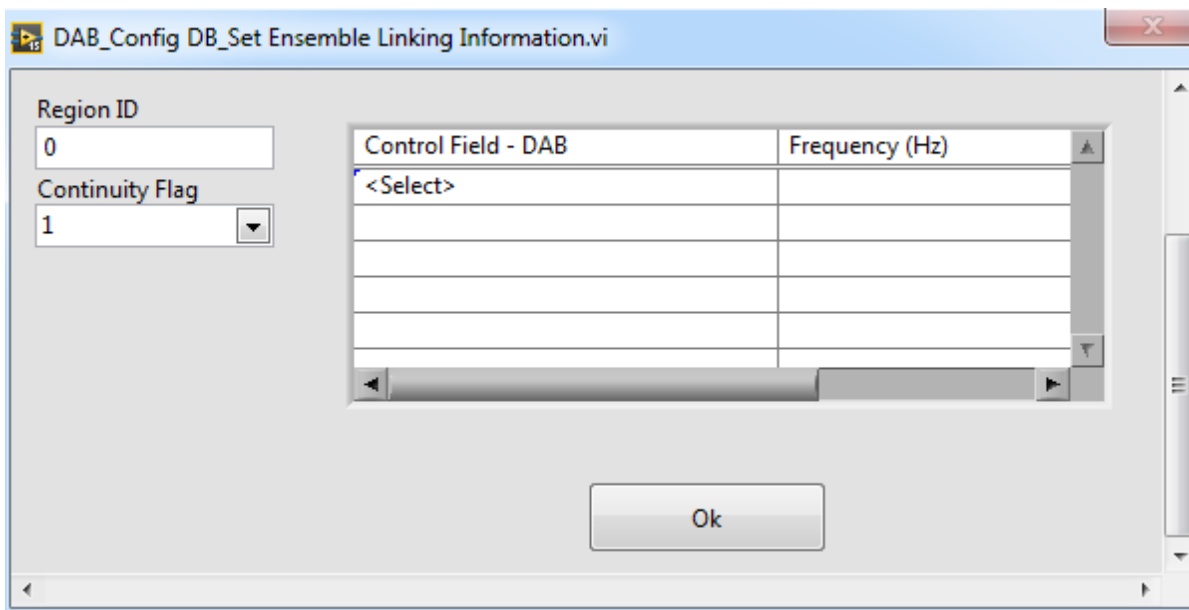
- **Region ID**- Specify the Region ID of the Ensemble to be linked. This an 11 bit identifier used to identify the target region.
- **Continuity Flag -** The continuity flag indicates whether continuous (i.e. uninterrupted) audio output is possible or not when switching frequencies. The Flag value 0 meansContinuous audio

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output not expected, the ensemble is not co-timed and synchronized. Flag value 1 means Ensembles are synchronized and co-timed.

- **Control Field** – Control Field value specifies the linked ensemble is in geographically adjacent area or not adjacent area.
- **Frequency**- Specifies the Frequency of the linked Ensemble, in Hz.

4.2 Select **Subchannel Configuration** to configure the following parameters for the selected carrier. User can configure Maximum 10 subchannels for each Carrier. The subchannels carry the data specified in the service components and each service component should be uniquely attached to the subchannel.

Click on **Subchannel0** to configure for first Subchannel.

- **Subchannel Protection Mode** – Select Subchannel Protection mode as Long form or Short form. Two forms of signalling the sub-channel size and error protection are used. The first is a Short Form which is used for service components employing the Unequal Error Protection (UEP) profiles and Long Form is used for Equal Error Protection Profiles (EEP).
- ➢ **Short Form -** The following parameters needs to be configured for Short Form.

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- **UEP Table Index –** Configure the UEP Table Index if Subchannel Protection Mode is selected as Short Form. The toolkit uses UEP Table Index to extract the Subchannel size, protection level and bit rate from the below table. The data rate of the service component linked with the subchannel should be equal to this bitrate.

Index	Sub-channel size (CU)	Protection level	Bit rate (kbit/s)	Index	Sub-channel size (CU)	Protection level	Bit rate (kbit/s)
0	16	5	32	33	64	5	128
1	21	4	32	34	84	4	128
2	24	3	32	35	96	3	128
3	29	2	32	36	116	2	128
4	35	1	32	37	140	1	128
5	24	5	48	38	80	5	160
6	29	4	48	39	104	4	160
7	35	3	48	40	116	3	160
8	42	2	48	41	140	2	160
9	52	1	48	42	168	1	160
10	29	5	56	43	96	5	192
11	35	4	56	44	116	4	192
12	42	3	56	45	140	3	192
13	52	2	56	46	168	2	192
	x			47	208	1	192
14	32	5	64	48	116	5	224
15	42	4	64	49	140	4	224
16	48	3	64	50	168	3	224
17	58	2	64	51	208	2	224
18	70	1	64	52	232	1	224
19	40	5	80	53	128	5	256
20	52	4	80	54	168	4	256
21	58	3	80	55	192	3	256
22	70	2	80	56	232	2	256
23	84	1	80	57	280	1	256
24	48	5	96	58	160	5	320
25	58	4	96	59	208	4	320
26	70	3	96		x		
27	84	2	96	60	280	2	320
28	104	1	96		x		
29	58	5	112	61	192	5	384
30	70	4	112		x		
31	84	3	112	62	280	3	384
32	104	2	112		x		
	x			63	416	1	384

- **Subchannel Identifier –** Each Subchannel must have unique identifier and the valid value is form 0 to 63.
- ➤ **Long Form –** The following parameters needs to be configured for the Long Form.
- **Subchannel Protection Level** – Eight options are available for the Subchannel Protection level. They are further classified into two groups. Please refer the tables below for the corresponding coding rate and Subchannel Size for each option.

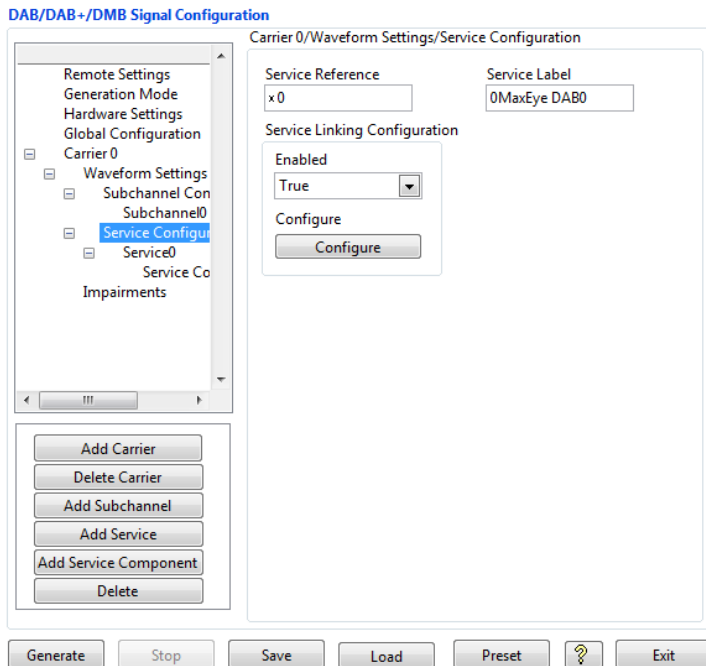For more information please contact info@maxeyetech.com

Sub-channel size for data at different coding rates, as a function of the data rate 8 n kbit/s (where n is an integer ≥ 1)

Protection level	1-A	2-A	3-A	4-A
Convolutional coding rate	1/4	3/8	1/2	3/4
Sub-channel size (CUs)	12 n	8 n	6 n	4 n

Sub-channel size for data at different coding rates, as a function of the data rate 32 n kbit/s (where n is an integer ≥ 1)

Protection level	1-B	2-B	3-B	4-B
Convolutional coding rate	4/9	4/7	4/6	4/5
Sub-channel size (CUs)	27 n	21 n	18 n	15 n

- **EEP n value -** Configure this value as per the above table. The n value determines the Subchannel size and its data rate.

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

Service Configuration defines the services and service components carried in the ensemble. Each Service is uniquely identified by the Service Reference and Service Label. One Service can carry multiple service components. Maximum number of allowed service components per service is 8. User can configure maximum 10 services for each Carrier. Click on **Service0** to configure for first Service.

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- **Service Reference –**This is a unique identifier for a specified Service.
- **Service Label** - The Service Label is used to identify the service in textual format.
- **Service linking Configuration –**This feature is used to indicate the receivers that the same service or similar service is transmitted in other ensembles or FM Stations or DRM stations. Set this control to True to enable the toolkit to include service linking parameters in the transmitted signal. If Service linking is Enabled then press the Configure button, the following dialog box will appear and user has to configure the parameters related to the service linking.

Service linking information allows the service provider to establish one or more sets of identifiers that carry identical, in the case of a hard link, or related, in the case of a soft link, content. The set of identifiers is called a linkage set. There may be several linkage sets that are valid at different times of day. Each linkage set is identified by the Linkage Set Number together with a set of flags, and by use of the Linkage Actuator, linkage sets can be activated and deactivated.

- **Service Linking type**- Specifies the type of the service linking.
- ➢ Same Service on Different Ensembles (DAB-DAB) – Select this option if the same service is carried on the different ensembles.
- ➢ Regional Variations of a Service on Different Ensembles (DAB-DAB) – Select this option if the regional variations of the same service is carried on other ensembles
- ➢ Technology Variations of a Service on Different Ensembles (DAB-DAB+) – Select this option if the same service is carried on the different ensembles using different formats. For example same service encoded using DAB and DAB+ format carried in different ensembles.
- ➢ Soft Linking – Select this option to specify the suitable alternative content or related services, this form of service linking is called soft linking.
- ➢ DAB to Multiple Networks–Select this option to specify that the service is linked to the FM or DRM stations.

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- **Identifier list flag-**Identifier list flag indicates whether the Identifiers of the linked services are included in the service linking. Identifier list flag set to 0 (Id list absent) indicates Id list not included and 1 (Id list present) indicates Id list included.
- **Linkage actuator**–This 1-bit flag indicates whether the service link is active or deactivated/potential future link.

➢ Deactive/future link – This indicates the link is deactivated or potential future link
➢ Active link- This indicates the link is currently active

- **Link type –** This 1-bit flag indicates whether the link is soft link or hard link. The soft link indicates the related services and hard link indicates the same service component carried in another service
- **International Linkage Set Indicator (ILS)-** This 1-bit flag indicates whether the link affects only one country (national) or several countries (international)
- **Country Identifier (CI)**–Specifies the country code of the one of the participating countries. For example, if Switzerland and Italy share a programme, they shall choose either HEX 4 or 5 for CI, and then agree on for a unique Linkage Identifier (LI) or Linkage Set Number (LSN).
- **Linkage Set Number (LSN or LI)**- This 12-bit field represents a number which shall be common to all Services linked together as a set. The use of LSN = "0000 0000 0000" is reserved. The LSNs shall be co-ordinate between all broadcasters in a particular country such that they are unique in combination with the flags.
- **Region ID –**This 11-bit field identifies the region for which the frequency information applies. If the Region ID is "0000 0000 000", no area is specified.
- **Range and Modulation(R&M)**–The Range and Modulation value specifies the type of the identifier.

➢ DAB Ensemble – If R&M value is set to 0 (DAB Ensemble), then the Id Field contains the DAB Ensemble ID.
➢ DRM – If R&M value is set to 6 (DRM), then the Id Field contains the DRM Service Identifier.
➢ FM with RDS – If R&M value is set to 8 (FM with RDS), then the Id Field contains the RDS PI code (Program Identifier).
➢ FM without RDS – If R&M value is set to 9 (FM without RDS), then the Id Field contains the Dummy code.
➢ AM (MW in 9 KHz) – If R&M value is set to 10 (AM (MW in 9 KHz)), then the Id Field contains the Dummy code.
➢ AM (MW in 5 KHz) – If R&M value is set to 12 (AM (MW in 5 KHz)), then the Id Field contains the Dummy code.
➢ AMSS – If R&M value is set to 14 (AMSS), then the Id Field contains the AMSS Service Identifier.

- **Short hand indicator (shd) –**The Shd field indicates whether the Ids in the Id list represents single or multiple services. **0** represent a single service and **1** represents multiple services.
- **Number of Identifiers (Ids or SIds)–**This specifies the Number of identifiers used in the Id list.
- **Id Field**– ID Field specifies the Identifier Field and the type of identifier depends on the Range and Modulation (R&M) value.
- **Service Identifier(SIDs)–**Specifies the service identifier of the program and the type of service identifier depends on the Range and Modulation (R&D) value.
- **Conditional Access Identifier (CAId)–**This 3 bit field specifies the conditional access system used for the service. This value is set to 0 when conditional access is not used.
- **Continuity Flag–**This field specifies whether continuous audio output expected or not. The value 0 corresponds to Continuous audio output not expected, the ensemble is not co- timed and synchronized. The value 1 corresponds to Ensembles are synchronized and continuous output expected
- **Control Field** – Control Field specifies whether the linked service is transmitted in geographically adjacent or not adjacent area.
- **Frequency**- Specifies the frequency of the linked service. The interpretation of this value depends on the Range and Modulation value.

If R&M is,

0 (DAB Ensemble): This is encoded as 19 bit field and the value corresponds to the DAB ensemble frequency. The toolkit internally multiples the value specified by 16 KHz to get the DAB ensemble frequency.

6 (DRM): This is encoded as 15 bit field and the value corresponds to the DRM signal frequency. The toolkit internally multiples the value specified by 1 KHz to get the DRM signal frequency.

8 (FM with RDS) & 9(FM without RDS): This is encoded as 8 bit field and the value corresponds to the FM station frequency. The toolkit computes the frequency based on the formula given below.

Frequency (Hz) = 87.5 MHz + (Frequency Value - 100 kHz)

10 (AM (MW in 9 KHz)): This is encoded as 8 bit field and the value corresponds to the AM station frequency. The toolkit computes the frequency based on the formula given below.

Frequency (Hz) = 144 kHz + (Frequency Value - 9 kHz) if Frequency Value < 16;

Frequency (Hz) = 387 kHz + (Frequency Value - 9 kHz) if Frequency Value >= 16

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12 (AM (MW in 5 KHz)): This is encoded as 16 bit field and the value corresponds to the AM station frequency. The toolkit internally multiples the value specified by 5 KHz to get the AM station frequency.

14 (AMSS): This is encoded as 15 bit field and the value corresponds to the AMSS signal frequency. The toolkit internally multiples the value specified by 1 KHz to get the AMSS signal frequency.

For more technical details please refer the DAB standard document for service information features **ETSI TS 103 176 V1.1.1 (2012-08).**4.3 Select **Impairments** to configure the following parameters for the selected carrier.

4.3.1 Select **Service Component Configuration** to configure the following parameters for the selected carrier.

- **Transport Mechanism Id**–Specifies the transport mechanism to be used, the supported modes are MSC – Stream Mode (audio) and MSC – Stream Mode (data). Use MSC – Stream Mode (audio) for DAB/DAB+ Signal generation and MSC – Stream Mode (data) for DMB signal generation.

- **Data Service Component Type** –Specifies the data service component type. The current version of the toolkit only supports T- DMB. For DMB signal generation the data service component type should be set to T-DMB. The toolkit ignores this property if the Transport Mechanism Id is set to MSC – Stream Mode (audio).
- **Audio Service Component Type –** Specifies the audio service component type when the Transport Mechanism Id is set to MSC – Stream Mode (audio). The Supported Types are Foreground sound, Background sound, Multi-channel audio and DAB Plus.
- **Service Component Identifier -** Unique identifier for a specified Service Component. Each Service Component must have unique identifier.
- **Subchannel Identifier**–Specifies the subchannel identifier assigned for this service component. Each service component should be uniquely assigned with the Subchannel to carry the service component information.
- **Service Component Label**–Specifies the label for a service component. The Service Component Label is used to identify the service component in textual format.
- **Primary Secondary Flag –** Specifies the service component is the primary service component of the service or secondary service component.
- **Payload Settings**

➢ **PN Sequence** – Configure **Payload PN Order** and **Payload PN Seed** properties. The toolkit generates pseudo random sequence based on the **PN Order** and **Seed value.** The generated bit sequence is used as a payload for generating the signal. Use this mode for testing the receiver performance for random payload values. When the number of super frames is more than 1 then the toolkit maintains payload continuity across the super frames.

Payload Mode	Sync Insertion Enabled
PN Sequence	True
Payload PN Order	Payload PN Seed
9	× BEEFBEEF

➢ **User defined bits** – Enter the desired bit pattern in the **Payload User Defined Bits** property. The generator repeats the entered bit pattern till the number of bits required for the frame, for the given configuration, is met.

Payload Mode	Sync Insertion Enabled
User Defined Bits	True
Payload User Defined Bits	
000	

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➢ **Test Pattern** – The possible values for the **Test Pattern are All 1s, All 0s, 10101010 and 01010101**.This mode is used for generating signal with known test patterns.

➢ **Test File** –This mode is used for generating signal with the binary data from the file.

➢ **MPEG2TS File(s)** – Select this mode for **DMB (Select Transport Mechanism Id as MSC - Stream Mode (data) and Data Service Component Type as T- DMB)** Configure the **MPEG2 TS File Path** properties and the toolkit ignores other properties available in the Payload settings/Digital Video Payload Control.

Payload Mode

MPEG Layer II ▼

Payload File Path

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➢ **MPEG 4 HE AAC v2 Audio** – Select this mode for **DAB plus (Select Audio Service Component Type as DAB Plus)** available in the same service component item in the tree structure). Configure **Payload File Path** property for selecting appropriate MPEG 4 HE AAC v2 Audio file**.**The bitrate of the subchannel carrying this service component should match with the AAC audio file bitrate.

Payload Mode

MPEG 4 HE AAC ▼

Payload File Path

[   ] 📁

4.4 Select **Impairments** to configure the following parameters for the selected carrier. Below figure shows the controls related to Impairments.

• **Impairments Enabled -**Set this property to True to add impairments to the generated signal. Otherwise toolkits ignore these impairments properties.
• **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.

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- **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 add Additive White Gaussian Noise (AWGN) to the created waveform based on the value configured in the Carrier to Noise Ratio property. The default value is False.
- Carrier to Noise Ratio, dB - This value specifies the Carrier to Noise ratio of the generated signal. The default value is 40dB
- **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

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5. Select **Waveform File Settings** to configure the following parameters. Below figure shows the controls in Waveform file settings.
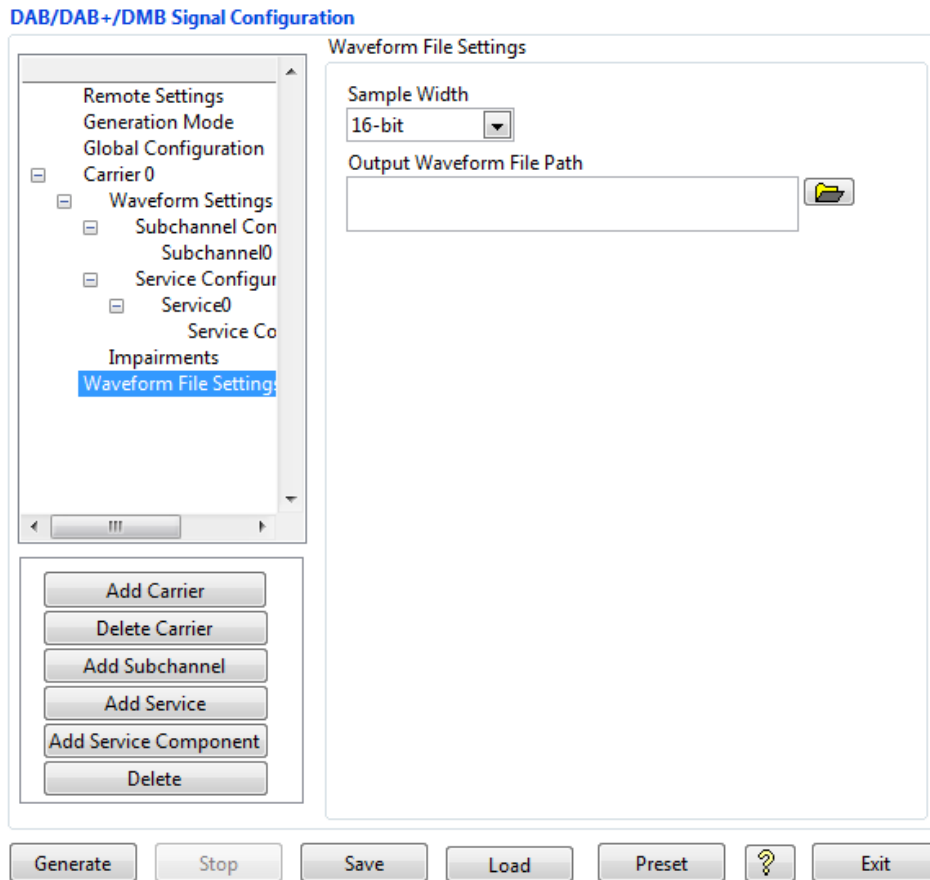
- **Sample Width** – The default sample width of the output waveform is 16-bits. The available options are 8-bits and 16-bits. We recommend using 16-bits sample width for better signal quality of the generated waveform.
- **Output Waveform file path-** Select a path to save the waveform. Needs to be configured only when the generation mode is Generate and Save waveform.

3.1.2 Generate and Play Waveform (Real-Time)

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

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

2. Select **Hardware Settings** to configure the following parameters.

For more information please contact info@maxeyetech.com

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

3. In **Global Configuration**, Number of Frames parameter needs not to be configured.
4. In **Carrier Configuration** only carrier 0 needs to be configured. More than one carrier is not supported in Real-Time mode.

3.1.3 Play Waveform from File

In this generation mode DAB/DAB+/DMB Signal Generator reads the waveform from the file created using the Generate and Save waveform generation mode, and then downloads the waveform in real-time to NI RFSG Memory and then plays the waveform. This example uses NI RFSG in streaming mode for playing the waveform in real-time. The real-time signal generation capability of this example is based on the specifications of the CPU and available RAM memory.

Follow the procedure below to generate waveform using this generation mode
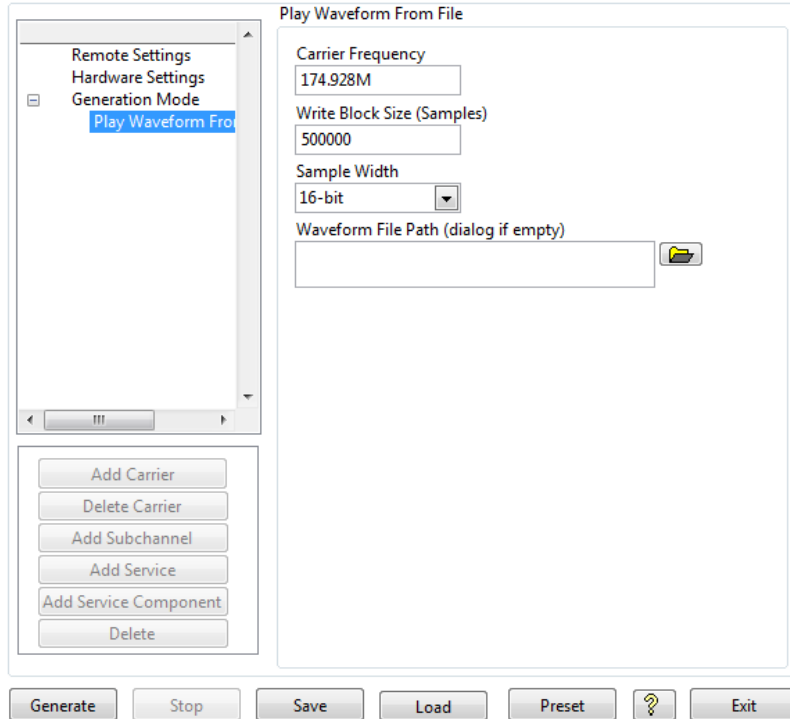
1. Select **Generation Mode** -> **Play Waveform from File**

2. Select **Hardware Settings** to configure the following parameters.

Refer section 3.1.1 of this document to configure the desired hardware.
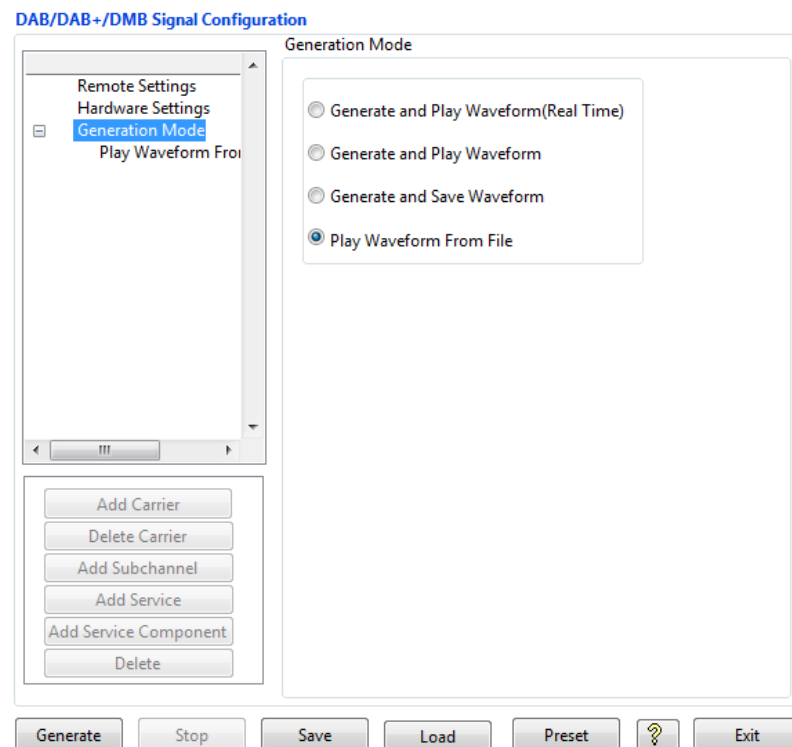
3. Select **Play Waveform from File** to configure the following parameters
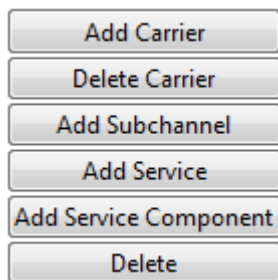
- **Carrier Frequency (Hz) –** Specifies the carrier frequency of the DRM signal to be generated in Hz.
- **Write Blocks Size (Samples) –** The waveform is written in the hardware as blocks. This parameter configures the size of the block in samples.
- **Sample Width –** Use the same sample width value used for saving the waveform in the file.
- **Waveform File Path –** Give the absolute path of the saved waveform intended to play in this generation mode.

Refer section 3.1.2 of this document to configure the other controls.

3.1.4 General SFP Controls and Indicators Details

For more information please contact info@maxeyetech.com

- **Add carrier –** Click to add new carrier with default values.
- **Delete Carrier –** Click to delete 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 Service –** Click to add new service for the selected carrier.
- **Add Subchannel** - Click to add new subchannel in the subchannel configuration.
- **Add Service Component**- Click to add new service component in the selected service.
- **Delete –** Click on the subchannel or Service or service component to delete the settings.

Generate	Stop	Save	Load	Preset	?	Exit

- **Generate-** Click to generate signal. The toolkit internally validates the configuration and generates waveform otherwise returns error for wrong configuration.

- **Save –** Saves the entire configuration in the INI file.
- **Load**– Loads the entire configuration from file to the Soft Front Panel.
- **Preset –** Click to reinitialize all parameters to their defaults values.
- **Exit –** Click to exit the application.
- **Generate Waveform Indicators –** Displays the progress of waveform generation.

Generate Waveform Indicators

Play Duration (Sec)	Center Frequency (Hz)	Output Sampling Rate (Hz)
0	0	0

PAPR

0

Generating Frames

0

Status

No Error

- **Status –** Displays warning or error.
- **Play Duration (sec) –** Indicates the total duration, in seconds, of waveform generated. To generate longer duration of the waveform increase the Number of Transmission Super Frames value.

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- **PAPR** – Indicates Peak to Average Power Ratio, in dB, which is calculated by dividing the peak power by the Root Mean Square (RMS) value of the waveform. This value can be used to set the Headroom (dB) value.
- **Output Sampling Rate (Hz)** – Indicates the sampling frequency of the generated IQ baseband waveform.
- **Generating Super Frames** – To visualize the progress of generating signal.
- **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.
- **Stop** – Click to this button to abort the generation at any time.
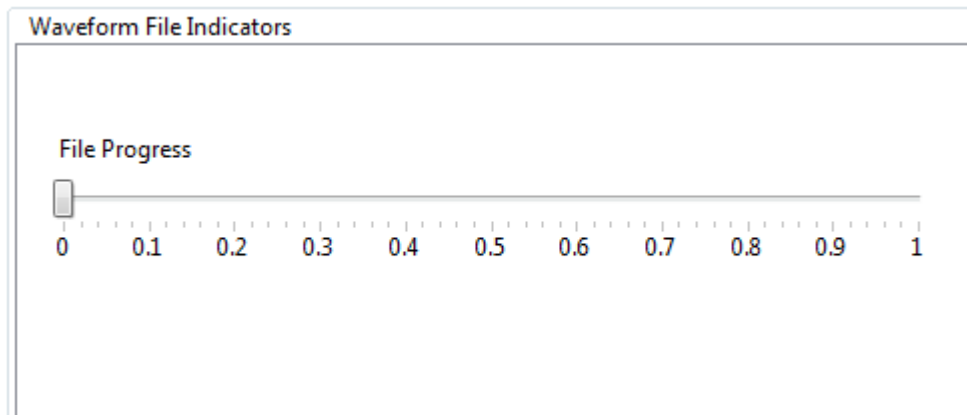
- **File Progress** – Indicates the progress of waveform generation.

3.2 Remote Mode

Remote mode allows user to control the MaxEye DAB/DAB+/DMB Signal Generator software remotely using server application (LabVIEW or C) to generate signals. The Server application examples and APIs are provided with the DAB/DAB+/DMB signal generation toolkit.

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

For more information please contact info@maxeyetech.com

- **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 (MaxEye DAB-TDMB Signal Generation) and server application must have same port number. The default Port Number is **7074**.
- **Timeout (ms)** – Configure this control if **Remote Mode is ON.** Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DAB/DAB+/DMB Signal generator software returns an error. The default Timeout is **20 seconds**.

3.2.1 Remote LabVIEW Examples

3.2.1.1 Generate and Save waveform

Follow the below procedure to configure the example

1. Find the LabVIEW example in the following location <LabVIEW>examples\MaxEye\Digital Video Toolkits\DAB-TDMB Generation\Remote
2. Open **MaxEye DAB SG Remote Generate and Save Waveform in File.vi**
3. The user configurations are organized into the following categories displayed in multiple Tabs
   - Network Settings

For more information please contact info@maxeyetech.com

- Global Configuration
- Carrier Configuration
- DAB Configuration
- Service 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 DAB-TDMB Signal Generation is intended to run.
- **Port Number–**Both client (MaxEye DAB-TDMB Signal Generation) and server application must have same port number. The default Port Number is **7074**.
- **Timeout (ms)** – Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DAB-TDMB Signal Generation returns an error. The default Timeout is **20 seconds**.
- **Number of Carriers (Actual)** – Displays the Total Number of Actual Carriers is configured.
- **Center Frequency (Hz)** – Displays the center frequency of the multiple carrier waveforms.
- **Play Duration (Sec)** – Displays the total duration, in seconds, of waveform generated.
- **Output Sampling Rate (Hz)** – Displays the sampling frequency of the generated IQ baseband waveform.
- **PAPR** – Displays Peak to Average Power Ratio, in dB.

For more information please contact info@maxeyetech.com

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

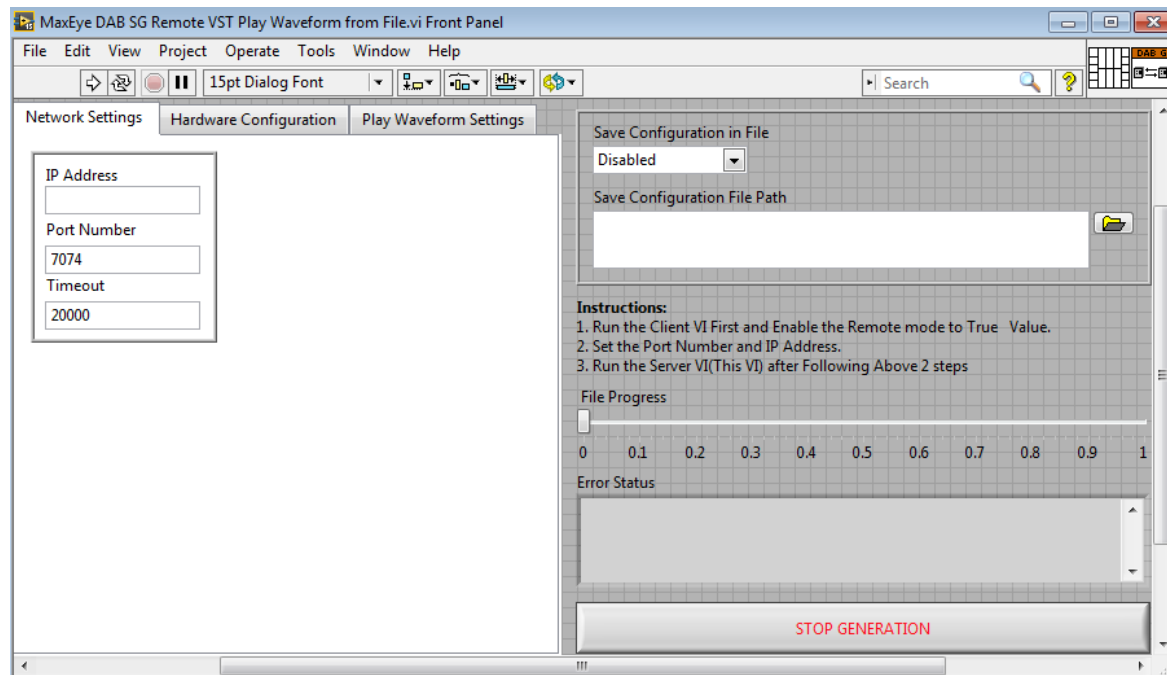For configuring other configuration parameters, please refer section 3.1.1 of this document

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

3.2.1.2 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\DAB-TDMB Generation\Remote
2. Open **MaxEye DAB RFSG Remote Generate Multiple Frames.vi**
3. The user configurations are organized into the following categories displayed in multiple Tabs
    - Network Settings
    - Hardware Configuration
    - Global Configuration
    - Carrier Configuration
    - DAB Configuration
    - Service Configuration
    - Impairments

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

- **IP Address – IP Address**–Configure the IP address of the client system in which the MaxEye DAB-TDMB Signal Generation is intended to run.
- **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 **7074**
- **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**.
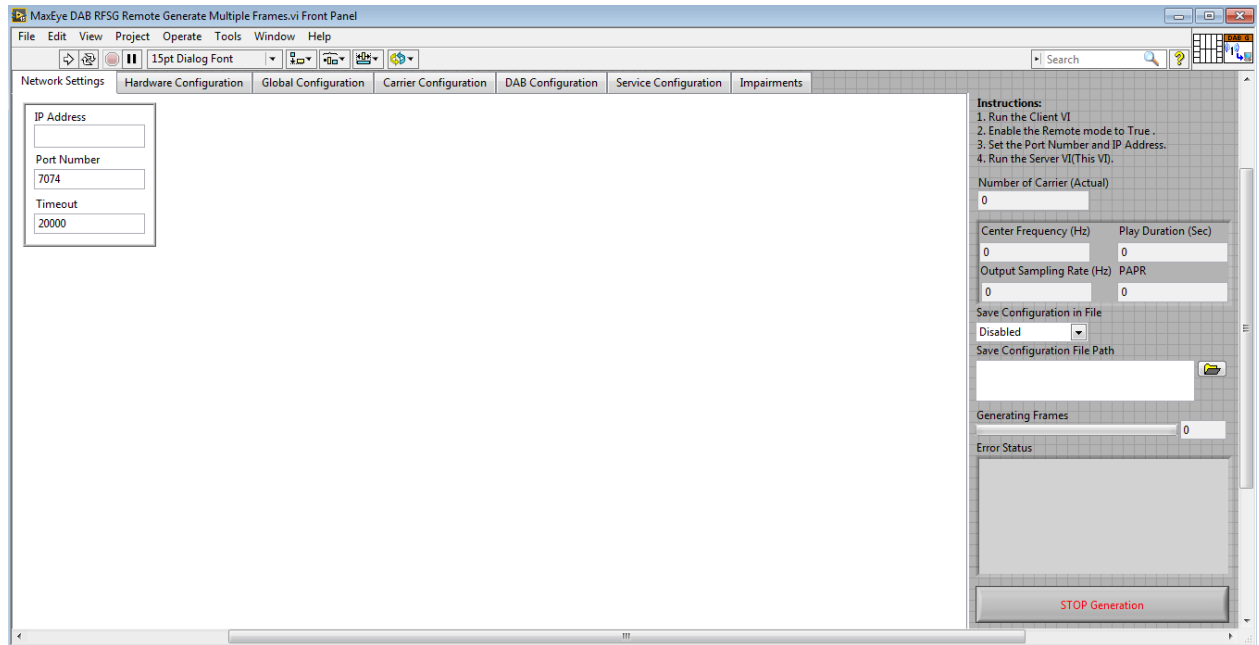
For configuring other parameters, please refer [section 3.1.1](#) of this document.

- **Number of Carriers (Actual)** – Displays the Total Number of Actual Carriers is configured.
- **Center Frequency (Hz)** – Displays the center frequency of the multiple carrier waveforms.
- **Play Duration (Sec)** – Displays the total duration, in seconds, of waveform generated.
- **Output Sampling Rate (Hz)** – Displays the sampling frequency of the generated IQ baseband waveform.
- **PAPR** – Displays Peak to Average Power Ratio, in dB.
- **Save Configuration in File** – Configure this value to Enabled, if configuration to be saved in a file.
- **Save Configuration File Path** – Configure the file path to save the configurations in file.

4. Run the example. Now the 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.

3.2.1.3 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\DAB-TDMB Generation\Remote
2. Open **MaxEye DAB RFSG Remote Generate Multiple Frames (Real Time).vi**

For more information please contact info@maxeyetech.com

3. The user configurations are organized into the following categories displayed in multiple Tabs
    - Network Settings
    - Hardware Configuration
    - Global Configuration
    - Carrier Configuration
    - DAB Configuration
    - Service Configuration
    - Impairments

Navigate to the **Network Settings** tab to configure the following parameters
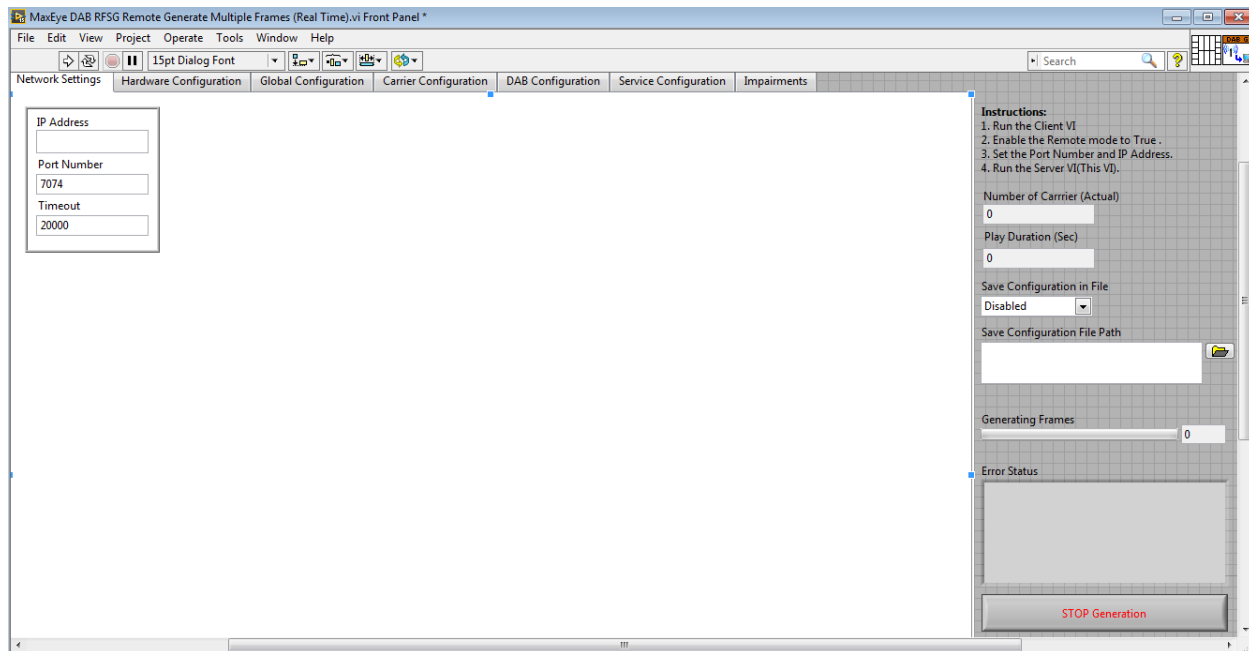
- **IP Address–** Configure the IP address of the client system in which the MaxEye DRM Radio Generator is intended to run.
- **Port Number–** Both client (MaxEye DAB-TDMB Signal Generation) and server application must have same port number. The default Port Number is **7070**.
- **Timeout (ms)** – Timeout specifies the time in milliseconds that the client waits for a connection to be established with the server application. If a connection is not established in the specified time, the MaxEye DAB-TDMB Signal Generation returns an error. The default Timeout is **20 seconds**.
- **Number of Carriers (Actual) –** Displays the Total Number of Actual Carriers is configured.
- **Play Duration (Sec) –** Displays the total duration, in seconds, of waveform generated.

For more information please contact info@maxeyetech.com

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

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

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

3.2.1.4   VST Play Waveform from File

Follow the below procedure to configure the example

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

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

For more information please contact info@maxeyetech.com

- **IP Address** – Configure the IP address of the client system in which the MaxEye DAB_TDMB Signal Generation is intended to run.
- **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 **7074**.
- **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 parameters, please refer section 3.1.1 of this document.

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

4. Run the example. Now the 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.

3.2.1.5 Load Configurations from File

Follow the below procedure to configure the example

1. Find the DAB_TDMB LabVIEW Remote example in, <LabVIEW>\examples\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Remote
2. Open **MaxEye DAB SG Remote Load Configuration from File.vi**
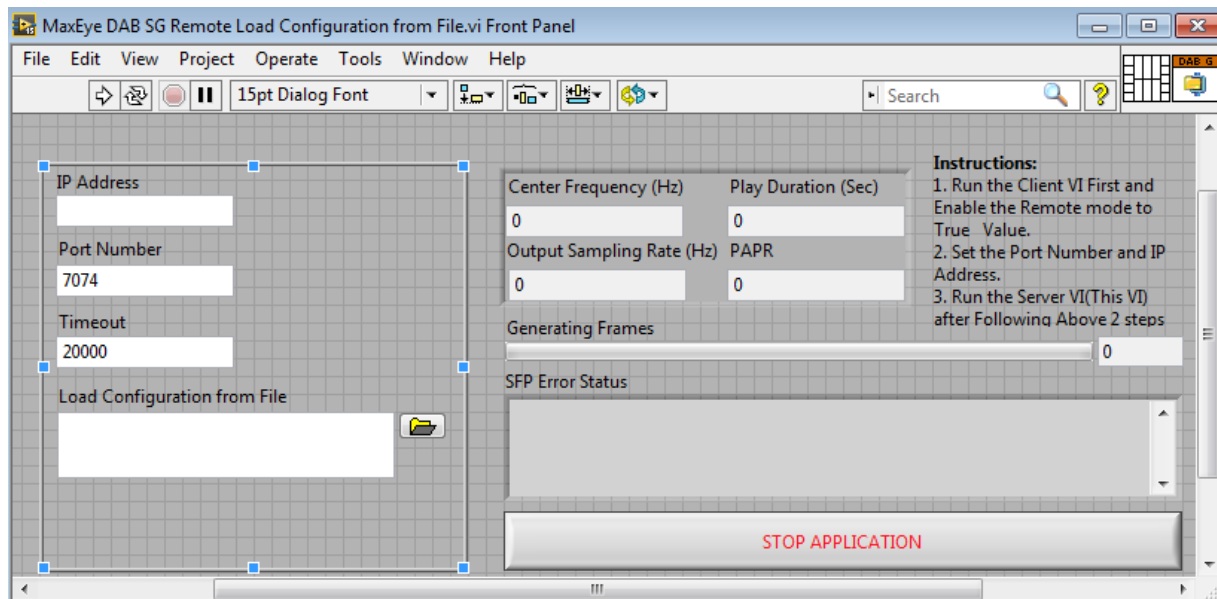
For more information please contact info@maxeyetech.com

- **IP Address** – Configure the IP address of the client system in which the MaxEye DAB_TDMB Signal Generation is intended to run.
- **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 **7074**.
- **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**.
- **Center Frequency (Hz) –** Displays the center frequency of the multiple carrier waveforms.
- **Play Duration (Sec) –** Displays the total duration, in seconds, of waveform generated.
- **Output Sampling Rate (Hz) –** Displays the sampling frequency of the generated IQ baseband waveform.
- **PAPR –** Displays Peak to Average Power Ratio, in dB.
- **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.

3.2.2 Remote C Examples

3.2.2.1 Generate Multiple Frames

Follow the below procedure to configure the example

For more information please contact info@maxeyetech.com

1. Find the Remote C examples in, C:\Program Files (x86)\MaxEye\Digital Video Toolkits\ DAB_TDMB Generation \Examples\C\Generate Multiple Frames
   (*Note: - For 32-bit Operating System*, C Examples are located in C:\Program Files\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Examples\C\Generate Multiple Frames)

2. Open the desired example directory and open the solution file **Generate Multiple Frames.sln** in **Microsoft visual C++.**

3. Navigate to **MaxEye DAB-TDMB 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 DAB-TDMB 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 10
1
Enter the Number of Transmission Frames
100

The Number of Frames generated 100 of 100

Configuration has been saved successfully
Press any key to stop the generation

The Number of Transmission Frames Generated Successfully


Waveform Indicator:
Centre Frequency = 174928000.000000 (Hz)
Output Sampling Rate = 2048000.000000 (Hz)
PAPR = 10.987368
Play Duration = 9.696000 (Sec)
Press any key to continue . . .
```

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

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

8. Press any key, to stop the generation.

For more information please contact info@maxeyetech.com

3.2.2.2 Generate Multiple Frames (Real Time)

Follow the procedure below to configure the example

1. Find the C example in the following location C:\ProgramFiles\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Generation\Examples\C\Generate and play RFSG RT
2. Open the desired example directory and locate the project file **Generate and Play RFSG RT.sln** in Microsoft Visual C++**.**
3. Navigate **MaxEye DAB RFSG 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 DAB RFSG Generate and Play RT Main.c,** press Run or (Ctrl + F5) for running the example. Enter the values in the console application window that appears after running the example.

For more information please contact info@maxeyetech.com

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

6. Press any key, to stop the generation.

3.2.2.3   Generate and Save Waveform

Follow the procedure below to configure the example

1. Find the C example in the following location C:\Program Files\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Generation\Examples\C\Generate and Save Waveform
2. Go to the example directory and open the solution file **Generate and Save Waveform.sln** in Microsoft Visual C++
3. Navigate to **MaxEye DAB 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 **MaxEye DAB Generate and Save Main.c** and press Run or (Ctrl + F5) for running the example. Enter the values in the console application window that appears after running the example.
6. Enter the required **Number of Carriers.**
7. Enter the desired **Number of Frames.**

For more information please contact info@maxeyetech.com

```
C:\Windows\system32\cmd.exe

Enter the Number of Carriers in between 1 to 10
1
Enter the Number of Transmission Frames
100

The Generation Status is True
The Number of Frames generated 100 of 100

Configuration has been saved successfully
Press any key to stop the generation

The Number of Transmission Frames Generated Successfully


Waveform Indicator:
Centre Frequency = 174928000.000000 (Hz)
Output Sampling Rate = 2048000.000000 (Hz)
PAPR = 11.032821
Play Duration = 9.696000 (Sec)
```

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

8. Press any key, to stop the generation

3.2.2.4 VST Play Waveform from File

Follow the below procedure to configure the example

1. Find the C example in, C:\Program Files\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Examples\C\VST Play Waveform from File
   (***Note:*** - For 32-bit Operating System, C Examples are located in C:\Program Files\MaxEye\Digital Video Toolkits\DAB_TDMB Generation\Examples\C\VST Play Waveform from File)
2. Open the desired example directory and locate the project file **VST Play Waveform from File.sln** in **Microsoft visual C++**.
3. Navigate to **MaxEye DAB 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 DAB VST Play Waveform Main.c** and press Run button or (Ctrl + F5) for running the example. Enter the values in the console application window that appears after running the example.

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

6. Press any key, to stop the generation.

For more information please contact info@maxeyetech.com

3.2.2.5 Load Configurations from File

Follow the below procedure to configure the example

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

For more information please contact info@maxeyetech.com

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

7. Press any key, to stop the generation.

4 How to configure parameters for Single Carrier/ Multiple Carriers

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

4.1 Single Carrier

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

4.2 Multiple Carrier

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

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

For more information please contact info@maxeyetech.com

DAB configuration

Transmission Mode
Mode I

Ensemble Label
MaxEye

Extended Country Code
x E1

Country Identifier
x 7

Ensemble Reference
0

Input Mode
User

Create ETI Frame Enabled?
False

ETI File Path

Number of Services
1

Number of Subchannels
1

Subchannel Configuration

Protection Mode
Long Form

Subchannel Identifier
0

Subchannel Protection Level
3-A (Equal)

UEP Table Index
0

EEP n value
16

Linked Ensembles Information

Ensemble Linking Enabled
False

Region ID
0

Continuity Flag
0

Control Field (DAB)
0   Adjacent Area, No

Frequency
0   0

For more information please contact info@maxeyetech.com