Agilent CMMB Conformance Testing Using the PXB with N7623B Signal Studio for Digital Video

Application Note

Agilent Technologies

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Introduction

CMMB, which stands for China Mobile Multimedia Broadcasting, is the Chinese mobile video industry standard, developed and specified by the State Administration of Radio, Film, and Television(SARFT). The core part of the CMMB system is the transmission technology called STiMi (Satellite-Terrestrial Interactive Multimedia Infrastructure), defined in GY/T 220.1[1]. GY/T 220.2[2] specifies the video, audio, data and control information multiplex frame structure. GY/T 220.7[3] specifies the performance requirements for the CMMB terminal.

Agilent provides CMMB signal sources based on the GY/T 220.1 and GY/T 220.2 standards, which can be used for receiver R&D and manufacturing across different platforms. Agilent PXB with N7623B Signal Studio for Digital Video can fully support the performance tests defined in GY/T 220.7.

This application note gives a brief introduction to the CMMB technologies and performance test requirements and explains the test setup and configuration using the PXB and N7623B for each test.

CMMB Technologies and Conformance Test Specs Overview

The CMMB system is an 8 MHz or 2 MHz system, designed for broadcasting in mobile environments using a combination of satellite and terrestrial transmission. It is based on an OFDM modulation scheme and LPDC+ RS channel coding with interleaving and the frame is carefully designed for power saving. Figure 1 contains a block diagram of the CMMB system.

While CMMB doesn't use a standard MPEG2 transport stream (TS), it does use a multiplexing structure specifically designed for this system. The stream following this structure is known as an MFS (multiple Frame Stream). Agilent provides a transport stream library that includes several MFS files for different system configurations.

The key features of CMMB include:

- Timeslot-based frame structure for power saving
- OFDM for mobile reception and SFN
- LDPC + deep interleaving for high receiver performance
- Beacon for fast synchronization
- Logical channel for flexible service configuration

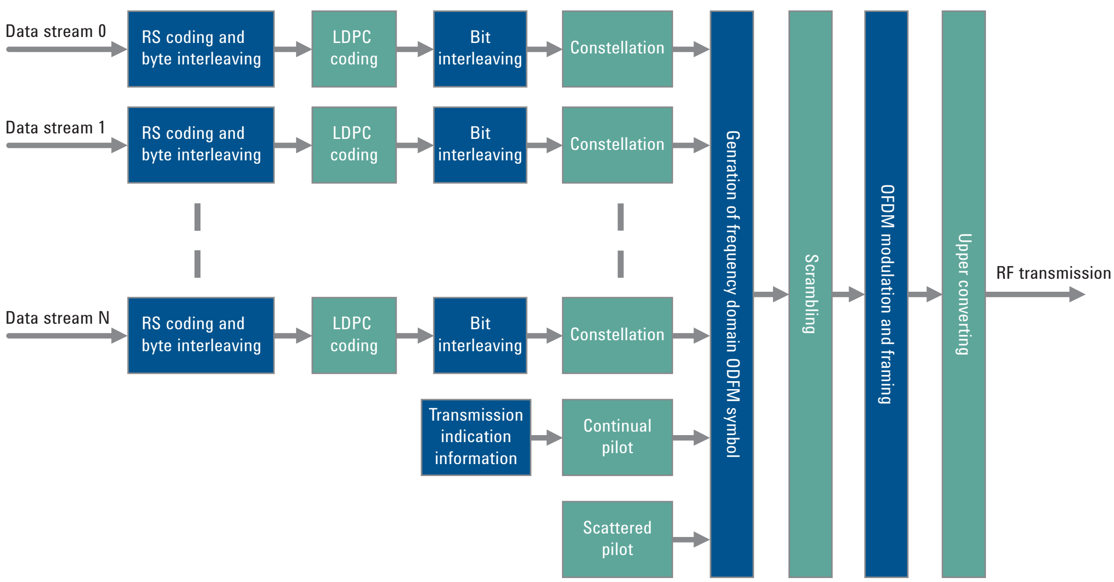


Figure 1. CMMB block diagram.

Logical channel

Logical channel is an important concept. There are two kinds of logical channels. One is the control logical channel (CLCH) and the other is the service logical channel (SLCH). The CLCH is transmitted over time slot 0 carrying the control information such as the parameters for SLCH. Each SLCH can be configured to occupy one or more time slots to transmit one service. The receiver only needs to power on during the time slots which contain the selected service, so power can be saved.

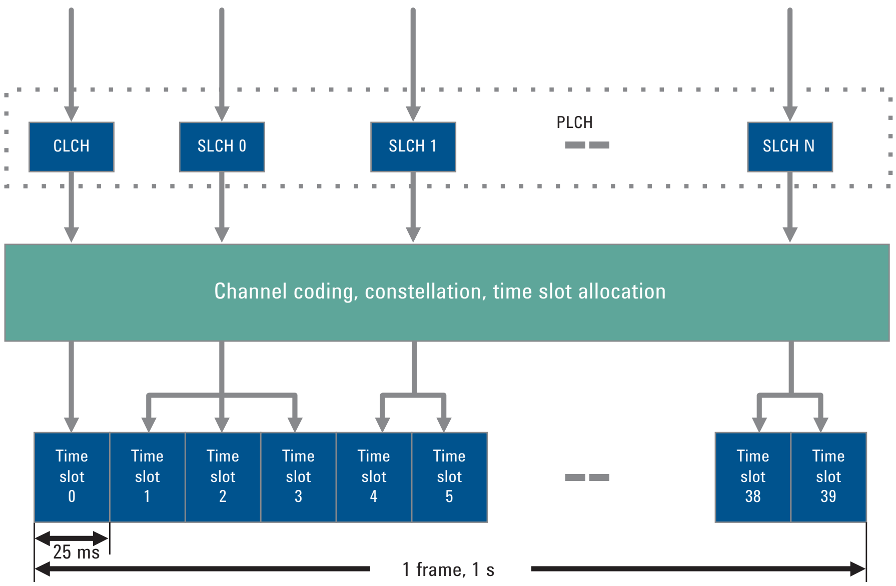


Figure 2. Logical channel structure.

Frame and timeslot

The frame is 1 second long and includes 40 timeslots. One timeslot includes a beacon and 53 OFDM symbols. Transmitter ID and sync sequence are included in the beacon for fast synchronization.

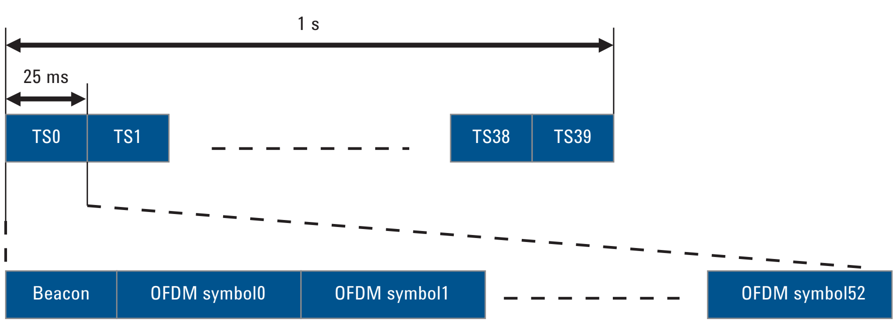


Figure 3. Frame structure.

Conformance test spec

The conformance tests defined in GY/T 220.7[3] mainly include

- Sensitivity test: receiver performance for BPSK, QPSK and 16QAM
- Carrier to noise ratio threshold test: receiver performance under AWGN, static multipath channel, and dynamic multipath channel
- Interference test: performance with interference signals such as co-channel digital TV interference, adjacent channel digital TV interference, co-channel analog TV interference, and adjacent channel analog TV interference

Test block diagram

Figure 4 shows the block diagram for a carrier to noise ratio threshold test conducted under a fading environment. If the DUT (device under test) is the CMMB receiver that has the capability to estimate and report the BER before RS decoding, an additional BER tester is not needed.

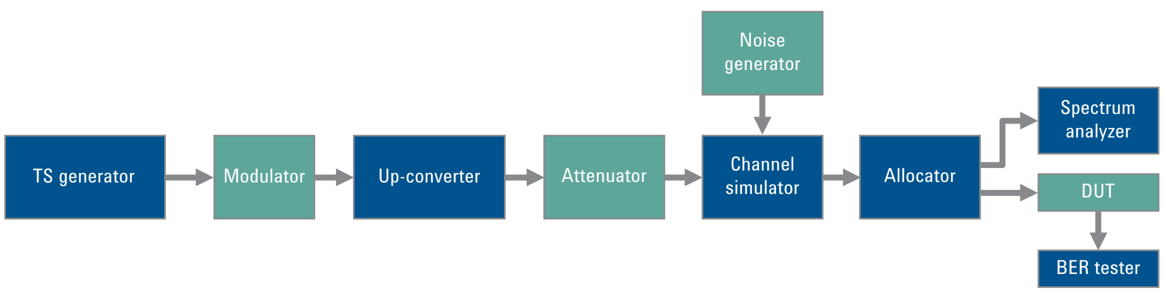


Figure 4. Block diagram for carrier-to-noise ratio threshold under fading environment.

PXB and N7623B in Brief

PXB

N5106A PXB is a multi-channel baseband signal generator. At the heart of the PXB are its configurable DSP blocks which can be configured to act as baseband generators or faders to suit testing needs. The PXB has reconfigurable architecture with internal signal routing so it can be easily configured for different tests through the GUI or SCPI.

For the CMMB test, the PXB can be configured with one baseband card with 2 DSP blocks. One DSP block is used for the CMMB signal, the other one can be used for fading or interference signal generation. The memory size of the PXB is 512 MSa, so the playback time for the CMMB waveform can be 50 secs, which is long enough for all the tests.

N7623B

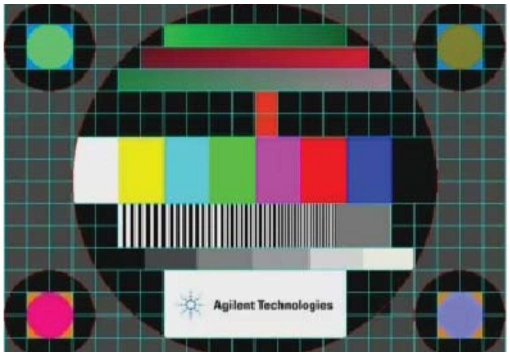
N7623B Signal Studio for Digital Video provides digital video signals for almost all of the main digital video standards, including the DVB series, CMMB, ISDB-T, and ATSC. The waveforms generated by N7623B can be played back on the E4438C ESG, N5182A MXG and N5106B PXB.

N7623B Signal Studio for Digital Video can read the MFS files to generate CMMB waveforms to support subjective video test. There are two types of MFS files.

Type 1: Only one program is included.

Type 2: Includes several programs multiplexed and one control frame. The control frame contains several tables for physical layer configuration.

Agilent provides a CMMB transport stream library Z2093-CMMB, including ten stream files of type 1 and two stream files of type 2 for different system configurations (LDPC rates and modulation schemes). The videos in type 1 files are standard TV test pattern color bars and the videos in type 2 files are several real TV programs. Both types of files can work with N7623B, while type 1 is more flexible and type 2 is easier to set up.



Test Setup and Configuration

Conformance testing requires desired signals as well as impairments such as interference signal, fading, and AWGN. The system setup is shown in Figure 5, which contains three steps:

Step 1:

Generate the waveforms of the desired signal and download them into the N5106A PXB using N7623B. N7623B can be installed in a controller PC or in the PXB directly.

Step 2:

Connect the PXB to the MXG via an LVDS digital bus cable and configure the MXG to generate the RF signal. Make sure the LAN or GPIB connection to the MXG works well. Note that you need to set the output power of the MXG according to the specs and take the attenuation caused by the cable into consideration.

Step 3:

Configure the PXB to play back the waveforms and to add the impairments as specified in the specs.

Figure 5. Conformance testing system setup.

The configurations for each model are shown in Table 1.

Table 1. Test system configurations

Model number	Options
N5182A MXG	503 frequency ranges from 250 kHz to 3 GHz
N5106A PXB	186 digital video application bundle including: • 612 2 DSP blocks on 1 baseband card • 632 2 I/O ports - 2 analog I/Q out and 2 digital I/O on 1 I/O card • EFP baseband generation • JFP calibrated AWGN • QFP fading with SISO channel models
N7623B Signal Studio for Digital Video	6FP connect to N5106A YFP CMMB advanced

Configuring the PXB and N7623B for Conformance Testing

CMMB terminal conformance testing needs waveforms with different configurations, such as waveforms for BPSK, QPSK, and 16QAM with ½ or ¾ LDPC code rates, respectively, and it needs impairments such as AWGN, multi-path fading, or interferences. The waveforms are generated using the N7623B and the impairments are generated using the N5106A PXB.

Generating waveforms using the N7623B

N7623B can be used to generate the required waveforms. The setup in N7623B is shown in Figure 6. For the data source, the stream file for dedicated settings should be used (related to code rate and modulation).

Status	On
Reed Solomon Code Rate	**RS(240, 224)**
LDPC Code Rate	1/2
Interleaving	Interleaving Mode 1
Modulation Type	**QPSK**
Scrambler Initial Code	

BPSK
QPSK
16 QAM

Figure 6. N7623B setup.

There are two methods for generating the required waveforms.

Method 1:

Each waveform includes one service program with one configuration. The setting for N7623B is shown in Figure 7 where SLCH 0 carries one program with ½ code rate and QPSK. Multiple waveforms are needed for testing different configurations.

PLCH	Status	Number of Timeslots	RS Rate	LDPC Rate	Modulation
CLCH	On	1	RS(240,240)	1/2	BPSK
SLCH 0	On	4	RS(240,224)	1/2	QPSK
SLCH 1	Off	35	RS(240,240)	1/2	QPSK

Figure 7. The setting for one service program in one waveform.

Method 2:

One waveform includes multiple service programs with different configurations. The setting for N7623B is shown in Figure 8. All required configurations are obtained in this waveform. The receiver can decode each service program, respectively, to get the performance for different configurations. For example, receivers can turn on during SLCH 1 to decode the program carried on the SLCH and report the BER, so the performance for ½ LDPC code rate and 16QAM can be tested. This is a much simpler and faster way to conduct receiver performance testing for different configurations.

PLCH	Status	Number of Timeslots	RS Rate	LDPC Rate	Modulation
CLCH	On	1	RS(240,240)	1/2	BPSK
SLCH 0	On	2	RS(240,224)	1/2	QPSK
SLCH 1	On	2	RS(240,224)	1/2	16 QAM
SLCH 2	On	2	RS(240,224)	3/4	16 QAM
SLCH 3	On	4	RS(240,224)	1/2	QPSK
SLCH 4	On	4	RS(240,224)	3/4	QPSK
SLCH 5	On	4	RS(240,224)	1/2	BPSK
SLCH 6	On	6	RS(240,224)	3/4	BPSK
SLCH 7	On	3	RS(240,224)	1/2	QPSK
SLCH 8	On	4	RS(240,224)	1/2	QPSK
SLCH 9	On	8	RS(240,240)	1/2	QPSK

Figure 8. Settings for multiple service programs in one waveform.

The waveforms will be saved on the hard disk of the PXB and loaded into the PXB's memory through the PXB's baseband generator setting, shown in Figure 9, and then the waveform will be played back. These waveforms will be used for all testing.

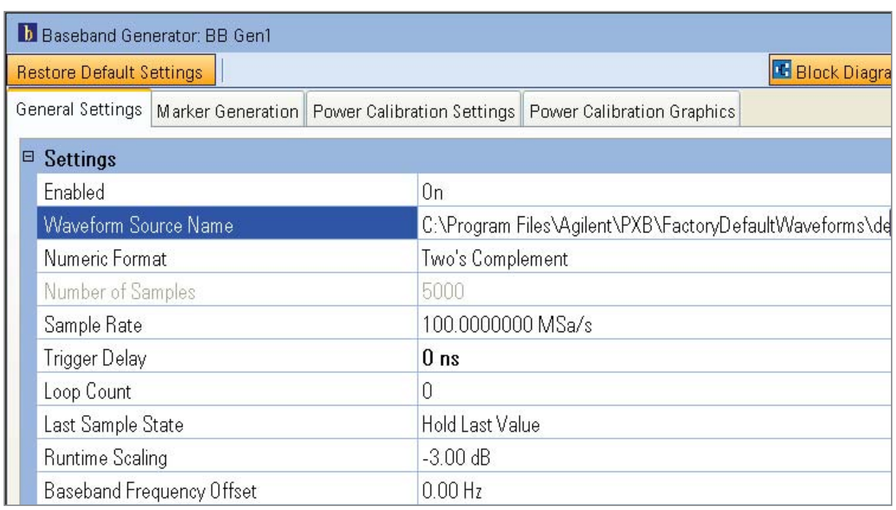


Figure 9. PXB baseband generator setting.

Configure the PXB for Conformance Testing

N5106A PXB can be configured to introduce AWGN, multi-path fading or interference to the signals, which are to be used for C/N and interference tests.

Sensitivity test

The CMMB terminal sensitivity test needs signals of BPSK, QPSK, and 16QAM with LDPC code rate ½ and ¾, as shown in Table 2[3].

Table 2. CMMB receiver sensitivity test performance specs (BER ≤ 3×10^{-6})

Channel configuration		Sensitivity (dBm)
Modulation	LDPC code rate	U band
BPSK	½	-98
	¾	-96
QPSK	½	-95
	¾	-92
16QAM	½	-90
	¾	-86

To perform sensitivity tests on a CMMB terminal, configure the PXB as shown in Figure10. Only one DSP block is used to generate the baseband signal here. The BER requirement is 3×10^{-6}. If the BER reported by the receiver is lower than it, it means this receiver can meet the specs.

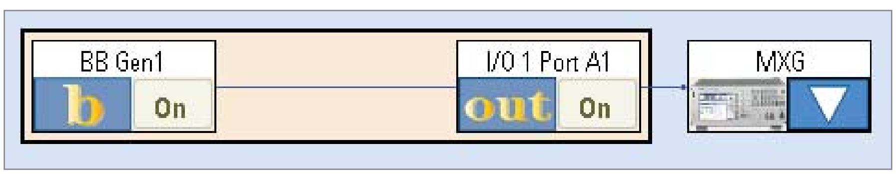


Figure 10. PXB configuration for sensitivity testing.

Carrier to Noise ratio (C/N) threshold test

In the C/N ratio threshold test, performance under AWGN, Rayleigh channel, Dual-path with equal strength channel,and TU-6 channel is defined.

Test 1: C/N performance in the AWGN channel

The specs for the C/N ratio threshold test under AWGN are shown in Table 3[3].

Table 3. C/N in AWGN channel (AWGN, BER ≤ 3×10^{-6})

Channel configuration		C/N (dB)
Modulation	LDPC code rate	
BPSK	½	—
	¾	—
QPSK	½	2.7
	¾	5.1
16QAM	½	8.6
	¾	12

To perform the C/N ratio threshold test, first configure the PXB as shown in Figure 9, turn on AWGN, and set the bandwidth and C/N ratio as shown in Figure 11. The output power level of the MXG should be about 30 dB higher than receiver's sensitivity level.

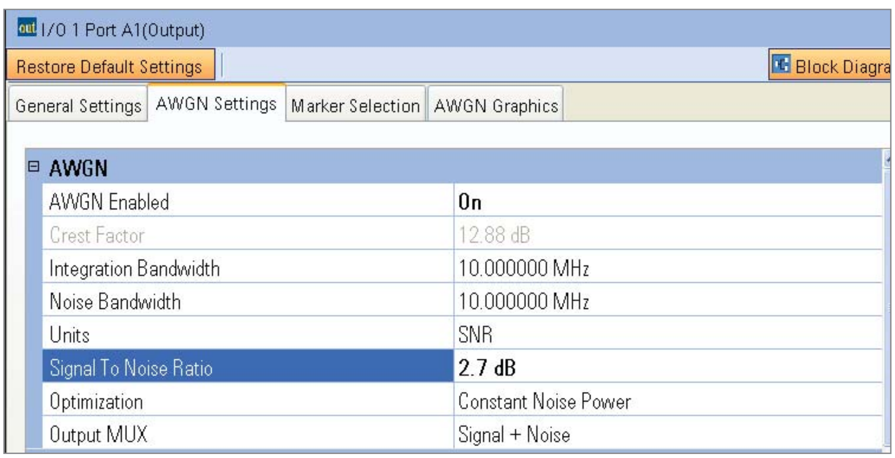


Figure 11. AWGN setting.

Test 2: C/N Performance in Multi-Path Fading Channel

To perform the C/N ratio threshold test in the multi-path fading channel, configure the PXB as shown in Figure 12. Here, one DSP block is used to generate the baseband signal, and one is used for multi-path fading.

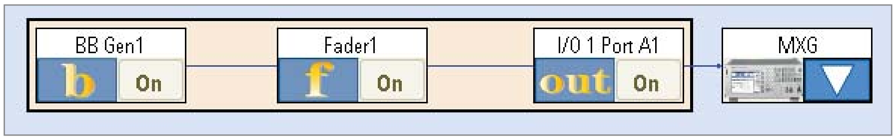


Figure 12. PXB configuration for multipath fading testing.

In GY/T 220.7[3], three multi-path fading environments are defined, as shown in Appendix A. The first one is Rayleigh fading with 20 paths, the second is dual paths with equal strength, and the third is dynamical multipath fading TU-6 with Doppler shift. The specs for C/N tests under three fading channels are shown in Table 4, Table 5, and Table 6[3].

Table 4. C/N in 20-path Rayleigh fading channel (LDPC code rate: ½, BER ≤ 3×10^{-6})

Modulation	C/N (dB)
BPSK	—
QPSK	4.9
16QAM	11.3

Table 5. C/N in dual-path fading channel (LDPC code rate: ½, BER ≤ 3×10^{-6})

Channel configuration		C/N (dB)
Modulation	Delay (μs)	
QPSK	40	7
16QAM	50	11

Table 6. C/N in TU-6 fading channel (LDPC code rate: ½, BER ≤ 3×10^{-6})

Channel configuration		C/N (dB)
Modulation	Doppler (Hz)	
QPSK	20	7.7
	100	7.0
	300	7.8
16QAM	20	14.3
	100	13.7
	250	13.8

To perform tests in the first two fading channels, you can set channel profiles manually via the GUI of the PXB, as shown in Figure13. For each path fading type, delay, loss, phase shift, etc., can be set. This means that the 20-path Rayleigh channel defined in GY/T 200.7 can be supported in the PXB.

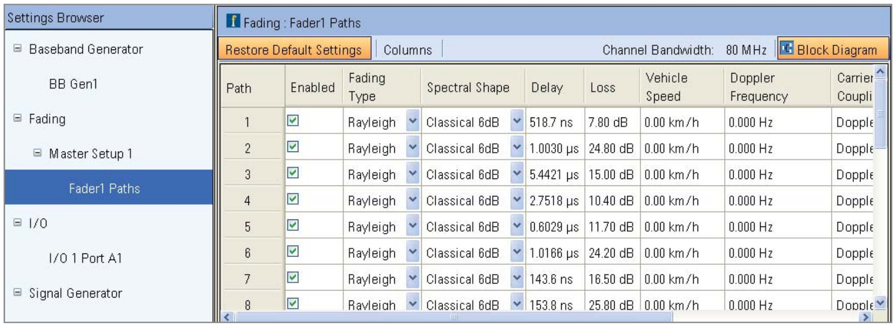


Figure 13. Multipath setting.

For the third case, you can find the TU-6 channel in the pre-defined channel profiles in the PXB, as shown in Figure 14. After the channel profile is selected, set the Doppler shift in the GUI as shown in Figure 13.

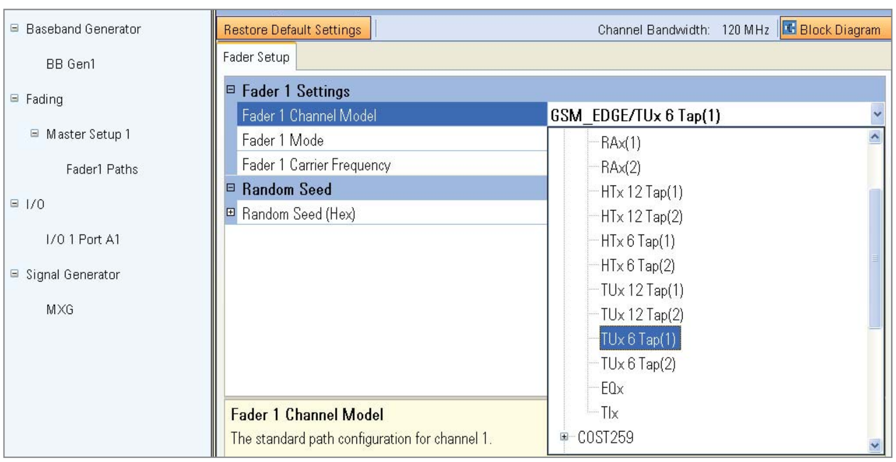


Figure 14. Pre-defined channel profile selection.

After multipath is set up, the C/N can be set up according to Table 4, 5 and 6 for 3 cases, respectively. The required waveform should be played back and the output power level of the MXG should be about 30 dB higher than receiver's sensitivity level.

Interference test

The immunity of the CMMB terminal to interferences includes co-channel digital and analog interference, and adjacent channel digital and analog interference. The specs are shown in Table 7.

Table 7. Immunity to interferences (LDPC code rate: ½)

Interference type	Modulation	C/I (dB)
Co-channel digital	QPSK	—
Upper adjacent digital	QPSK	-37
Lower adjacent digital	QPSK	-37
Co-channel analog	QPSK	-9.2
	16QAM	-4
Upper adjacent analog	QPSK	-42
Lower adjacent analog	QPSK	-43

The configuration of the PXB is shown in Figure 15. Here, one DSP block is used for the desired signals and the other one is used for the interference signal. The waveforms for desired signals and interference signals can be loaded into two baseband generators, respectively. Then, the output of two baseband generators are summed.

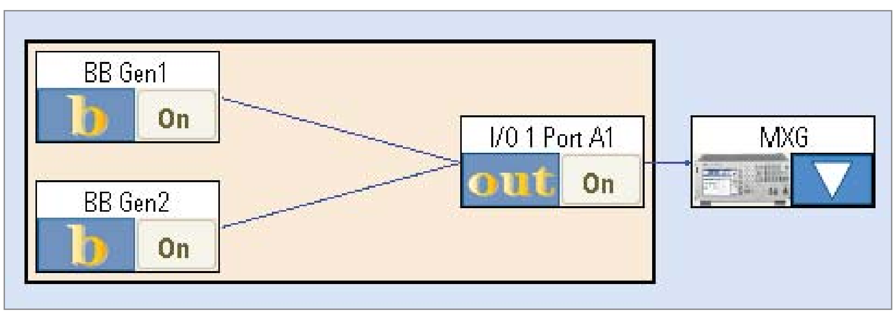


Figure 15. PXB configuration for interference testing.

The interference signals can be co-channel analog TV signals, adjacent digital, or analog TV signals, as defined in Table 7. The frequency offset and power level difference between two signals can be set through the Baseband Frequency Offset and Runtime Scaling for each baseband generator, as shown in Figure 16. For co-channel interference, set the Baseband Frequency Offset to 0. For adjacent channel interference, set the Baseband Frequency Offset to –bandwidth/2 and bandwidth/2, respectively, instead of 0 and bandwidth, in order to make the signal symmetrical to the carrier to avoid an image in the spectrum.

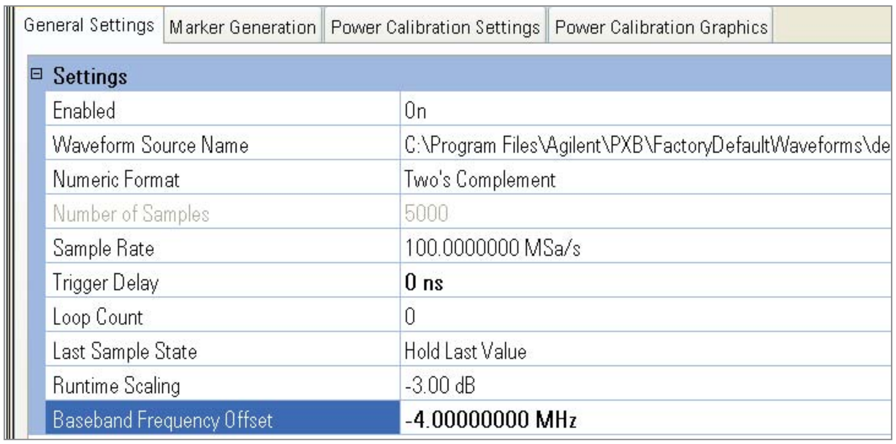


Figure 16. Baseband generator setting for interference testing.

Summary

CMMB receiver conformance testing is defined by SARFT to enable CMMB devices or mobile phones with integrated CMMB receivers to be commercially used. Agilent's efficient receiver performance test system, made up of the PXB and the MXG with Signal Studio for Digital Video (N7623B), allows for testing, as defined in GY/T 200.7, to be conducted easily.

References

1. GY/T 220.1, "Mobile Multimedia Broadcasting Part 1: Frame Structure, Channel coding and Modulation for Broadcasting Channel", 2006.

2. GY/T 220.2, "Mobile Multimedia Broadcasting Part 2: Multiplexing", 2006.

3. GY/T 220.7, "Mobile Multimedia Broadcasting Part 7: Technical Specifications for Receiving and decoding terminal", 2008.

Related Literature

Agilent N5182A MXG Signal Generators, Brochure,
Literature number 5989-5074EN

Agilent N5182A MXG Vector Signal Generator, Data Sheet,
Literature number 5989-5261EN

Agilent N5182A MXG Signal Generators, Configuration Guide,
Literature number 5989-5485EN

Agilent N5106A PXB Baseband Generator and Channel Emulator, Data sheet,
Literature number 5989-8971EN

Agilent N5106A PXB Baseband Generator and Channel Emulator, Quick Start Guide,
Literature number N5105-90004

Agilent N5106A PXB Baseband Generator and Channel Emulator, Configuration Guide,
Literature number 5989-8972EN

For additional information on the Agilent MXG Series signal generator,
go to **http://www.agilent.com/find/mxg**

For additional information on the Agilent PXB Baseband Generator and Channel Emulator,
go to **http://www.agilent.com/find/pxb**

For additional information on Agilent N7623B Signal Studio for Digital Video,
go to **http://www.agilent.com/find/n7623b**

Appendix A

Rayleigh Fading Channel model

Path number	Amplitude (dB)	Delay (us)	Phase shift (°)
1	-7.8	0.518650	336.0
2	-24.8	1.003019	278.2
3	-15.0	5.422091	195.9
4	-10.4	2.751772	127.0
5	-11.7	0.602895	215.3
6	-24.2	1.016585	311.1
7	-16.5	0.143556	226.4
8	-25.8	0.153832	62.7
9	-14.7	3.324886	330.9
10	-7.9	1.935570	8.8
11	-10.6	0.429948	339.7
12	-9.1	3.228872	174.9
13	-11.6	0.848831	36.0
14	-12.9	0.073883	122.0
15	-15.3	0.203952	63.0
16	-16.5	0.194207	198.4
17	-12.4	0.924450	210.0
18	-18.7	1.381320	162.4
19	-13.1	0.640512	191.0
20	-11.7	1.368671	22.6

Tu-6 channel model

Path number	Doppler spectrum	Delay (us)	Amplitude (dB)
1	Rayleigh	0.0	-3
2	Rayleigh	0.2	0
3	Rayleigh	0.5	-2
4	Rayleigh	1.6	-6
5	Rayleigh	2.3	-8
6	Rayleigh	5.0	-10

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