ALTERNATIVE APPROACH FOR ETSI FM SOUND BROADCASTING TRANSMITTER TESTING

Kitti Wongthavarawat

National Electronics and Computer Technology Center, Thailand
kitti.wongthavarawat@nectec.or.th

ABSTRACT

Bringing all FM transmitters of the community FM radio station to comply with the standard is a crucial step to solve the radio interference issue in Thailand. The proposed solution of FM transmitter testing is practical, cost effective and complying with ETSI FM Testing Method. It can be used as the alternative approach for FM transmitter testing.

Keywords: *FM transmitter testing, standardized coloured noise, frequency deviation, out-of-band emission*

1. INTRODUCTION

FM Sound Broadcasting is very popular in Thailand. There were around 300 commercial FM radio stations in 1997. Since then the community FM radio stations have been establishing due to The 1997 Constitution of the Kingdom of Thailand. Thailand was lacking of broadcasting regulator for 14 years. The number of community FM radio station is continuously increasing without regulation. There are more than 7000 community FM radio stations in 2012. Several community FM stations broadcast the below standard FM signal which causes the severe interference to other services. National Broadcasting and Telecommunications Commission (NBTC) or broadcasting and telecommunication regulator is newly appointed in 2011. One of the very first priorities of NBTC is to solve the problem of community FM radio stations. The strategy is to bring all community FM radio stations to the trial operator license system in order to have the proper regulation. The community FM radio stations are required to correct their own FM transmitter to comply with the standard imposed by NBTC within one year. FM transmitter must be checked at designated testing laboratories. It is quite challenging for testing laboratories to handle all 7000 FM radio stations within one year. The FM transmitter standard is based on ETSI EN302018-1. According to ETSI standard, some of the tests require the audio source generation such as Audio Frequency (AF) Signal Generator, coloured noise filter, noise power meter and etc. Most of the testing laboratories are lacking of these equipments. Some equipments are expensive and hard to find. Therefore, this paper proposes the alternative solution of FM transmission testing without using the mentioned audio source generation equipments. The propose solution is practical, cost effective and complying with the ETSI standard. The paper is organized as the follows. The next section describes ETSI FM sound broadcasting transmitter testing. Section 3 describes the propose solution. Audio test file verification is explained in Section 4. Section 5 described about the equipment preparation and the conclusion is in the Section 6.

2. ETSI FM SOUND BROADCASTING TRANSMITTER TESTING

NBTC imposes the standard of FM sound broadcasting transmitter based on ETSI EN 302018-1 [1]. It consists of five technical characteristics and test methods, 1) Rated output power 2) Frequency error 3) Spurious emission 4) Frequency deviation and 5) Out-of-band emission. First three of test methods do not require the audio source to feed to FM transmitter for the testing while the last two of test methods require the audio source. Therefore, this paper focuses on the alternative audio source for Frequency deviation and out-of-band emission testing.

2.1 Frequency deviation testing

Frequency deviation testing is designed to check the capability of the limiter function of FM transmitter to keep the frequency deviation in the specific limit. The maximum frequency deviation limit is ±75 kHz. The brief test procedure is the following:

1. Connect AF signal generator to FM transmitter (as shown in Figure 1).
2. Use AF signal generator to generate the single frequency tone of 1 kHz and Channel R is louder than Channel L 6 dB (L=R-6dB).
3. Increase the volume of the tone until the frequency deviation reaches ±40 kHz.
4. Increase the volume of the tone by +12 dB and measure frequency deviation. If the limiter function of FM transmitter works properly, the frequency deviation will stay within ± 75 kHz, otherwise, it fails.

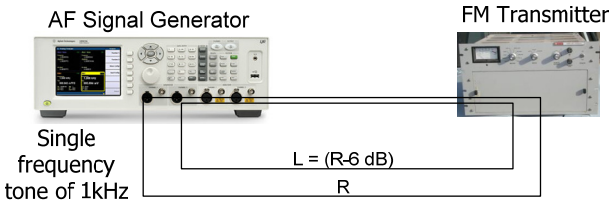

Figure 1: Frequency deviation test setup

2.2 Out-of-band emission testing

The definition of Out-of-band emission [1] is the emission on a frequency or frequencies immediately outside the necessary bandwidth, which results from modulation process, but excludes spurious emission. The testing is designed to check if the modulation process of FM transmitter is working properly to control its emission spectrum within the limit. The limit is shown in Figure 2.

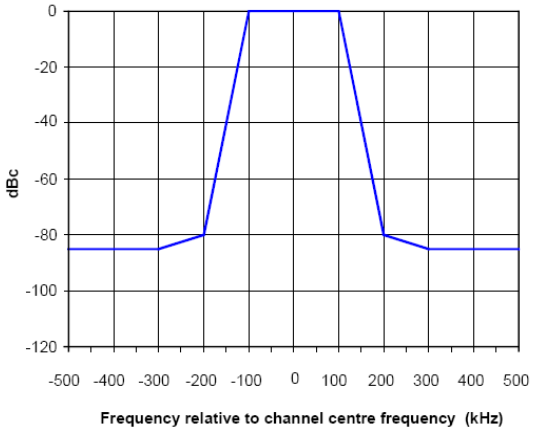

Figure 2: Out-of-band emission limit [1]

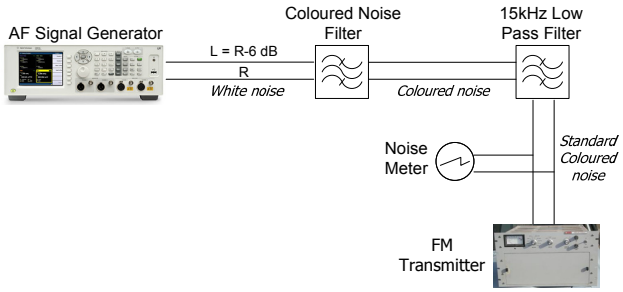

Figure 3: Out-of-band emission test setup

The brief test procedure is following.

1. Connect AF signal generator to FM transmitter (as shown in Figure 1)
2. Use AF signal generator to generate the single frequency tone of 1 kHz and Channel R is louder than Channel L 6 dB (L=R-6dB). It is similar to Frequency deviation testing.
3. Increase the volume of the tone until the frequency deviation reaches ±40 kHz. Use the noise meter to measure the power level (RMS power) and record it.
4. Connect AF signal generator, coloured noise filter, 15kHz low pass filter and noise meter to FM transmitter as shown in Figure 3. AF signal generator generates "White Noise". The white noise passes through coloured noise filter which has the circuit and frequency response shown in Figure 4 and Figure 5. Then it also passes through 15kHz Low Pass filer with a slope of 60 dB/octave. The final output tone is called the standardized coloured noise. According to the standard, the standardized coloured noise simulates the modern dance music program which is used to represent the typical sound broadcasting program.
5. Increase the volume of the standardized coloured noise until the RMS power read by the noise meter reaches the same level as in the step 3.
6. Use spectrum analyzer to analyze the output RF spectrum of FM transmitter and compare it against the out-of-band emission limit.

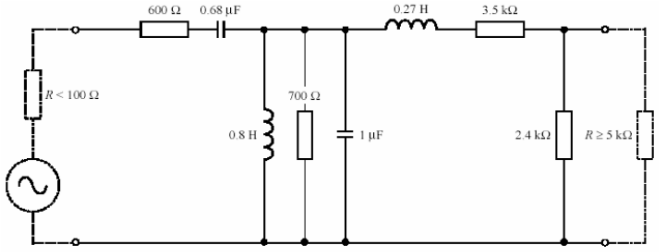

Figure 4: Coloured noise filter circuit [1]

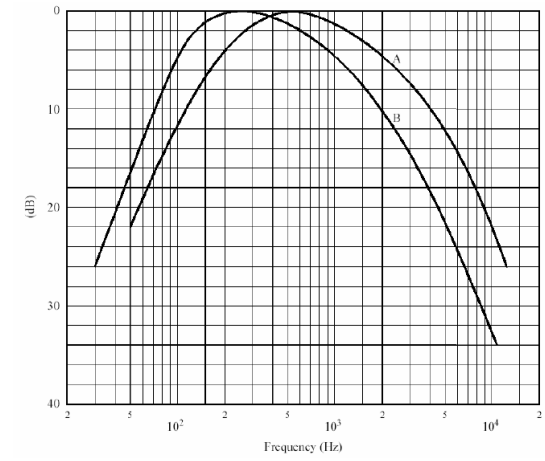

Figure 5: Frequency response of coloured noise circuit [1]

In summary, there are four audio tones needed for Frequency deviation testing and Out-of-band emission testing. For Frequency deviation testing, it requires two audio tones:

- Tone 1: Tone1kHz_baseline_(L=R-6dB)
  - 1kHz single frequency tone
  - Channel R is louder than Channel L 6 dB or L=R-6 dB
- Tone 2: Tone1kHz_+12dB_(L=R-6dB)
  - 1kHz single frequency tone

- Tone 2 is louder than Tone 1 +12dB
- L=R-6dB

For Out-of-band emission testing, it requires two audio tones:

- Tone 3: Tone1kHz_baseline_(L=R-6dB)
  - 1kHz single frequency tone
  - L=R-6dB
- Tone 4: ColouredNoise_baseline_(L=R-6dB)
  - Standardized coloured noise tone
  - RMS power is equal to Tone 3
  - L=R-6dB

3. PROPOSED SOLUTION

Our target is to provide the audio test tone for the testing without using AF signal generator, coloured noise filter, and noise meter. AF signal generator is expensive. Most of testing laboratories are still lacking of AF signal generator. Furthermore, commercial coloured noise filter is hard to find. The laboratories have to build their own coloured noise filter based on the circuit in Figure 4 and they also need to calibrate the built coloured noise filter.

Therefore, this paper proposes the alternative audio sources using the audio test files which have the same technical characteristics as the audio source according to ETSI. The audio files can be played on the computer or typical CD player. As mentioned in the end of previous section, there are four audio test tones for the FM transmitter testing. Tone 1 and Tone 3 are the same. Therefore, the paper proposes to create three audio test files:

1) Tone1kHz_baseline_(L=R-6dB).wav
2) Tone1kHz_+12dB_(L=R-6dB).wav
3) ColouredNoise_baseline_(L=R-6dB).wav

All three audio test file are created by Audacity program [2] which is the OpenSource audio editing software. Frequency response and audio level of the audio files are carefully adjusted to comply with ETSI EN302018-1. The audio test files are saved into the format of WAV file (16-bit PCM, 44100 Hz sampling rate) which can be opened on the computer and can be copied to the AudioCD in order to play with CD player. The usage of audio test files for FM transmitter testing is shown in Figure 6.

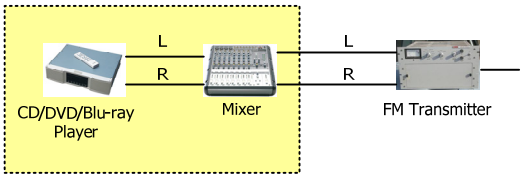

Figure 6: FM transmitter testing using audio test files

The FM transmitter testing procedure using audio test files are slightly different from ETSI.

The test procedure using audio test files for Frequency deviation

1) Setup equipments as in the Figure 6
2) Open Tone1kHz_baseline_(L=R-6dB).wav and adjust the volume at the mixer until the frequency deviation reaches ±40 kHz
3) Open Tone1kHz_+12dB_(L=R-6dB).wav and measure the frequency deviation

The test procedure using audio test files for Out-of band emission.

1) Setup equipments as in the Figure 6
2) Open Tone1kHz_baseline_(L=R-6dB).wav and adjust the volume at the mixer until the frequency deviation reaches ±40 kHz
3) Open ColouredNoise_baseline_(L=R-6dB).wav and then use the spectrum analyzer to check out-of-band emission

Comparing to ETSI test procedure, the test procedure using audio test file is much simpler.

4. AUDIO TEST FILES VERIFCATION

This section is to verify the technical characteristic of audio test files if they comply with ETSI EN302018-1. There are two verification tests (as shown in Figure 7)

1) Verification test at audio test files. This test is to analyze the technical characteristic of audio test files by using the software audio analyzer tool.
2) Verification test to audio test tone. This test is to analyze the technical characteristics of audio test tone at the output of mixer by using Audio Analyzer (Agilent U8903A).

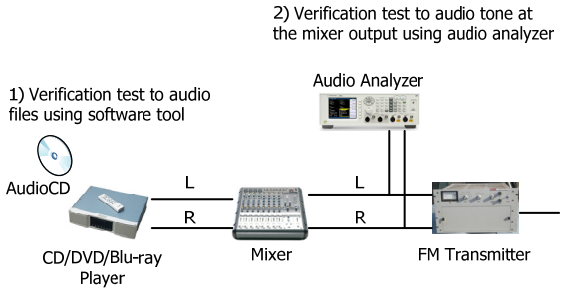

Figure 7: Verification test

Table 1: Verification Result

Audio files	Technical characteristics	ETSI EN302018-1	1) Audio files verification	2) Audio tone verification
Track 01 Tone1kHz_ Baseline_(L=R-6 dB Sterero)	Frequency	1kHz	**1kHz**	**0.99990kHz**
	R – L difference	6 dB	**6.01 dB**	**6.02 dB**
Track 02 Tone1kHz_+12 dB_(L=R-6 dB Stereo)	Frequency	1kHz	**1kHz**	**0.99998kHz**
	R – L difference	6 dB	**6.01 dB**	**6.03 dB**
	Volume difference to Track 01	12 dB	**12 dB**	**12 dB**
Track 03 ColouredNoise_ Baseline_(L=R-6 dB Stereo)	R – L difference	6 dB	**6.01**	**6.02 dB**
	RMS power difference to Track 01	0 dB	**0 dB**	**0.14 dB**
	Frequency spectrum		**Figure 8**	**Figure 9**

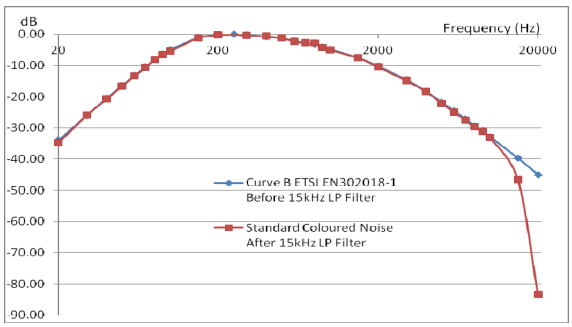

Figure 8: Frequency response of standardized coloured noise between audio test file and Curve B in ETSI EN302018-1

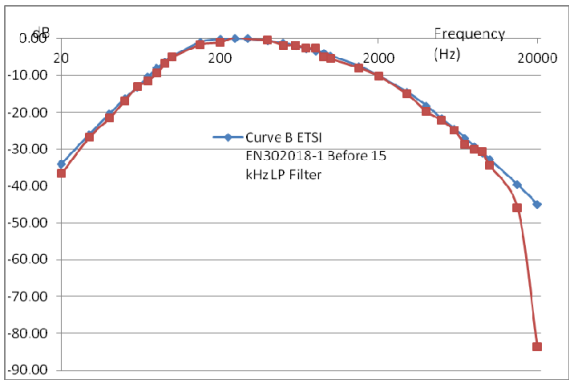

Figure 9: Frequency response of standardized coloured noise between audio test tone (at mixer output) and Curve B in ETSI EN302018-1

The verification result is shown in the Table 1 and Figure 8 and 9. All audio files comply with ETSI EN302018-1. Even though there is insignificant difference of between the audio test file and ETSI EN302018-1, it does not affect the result of FM transmitter test. Audio test files are also tested on the real FM transmitter comparing to audio test tone from AF signal generator (Figure 10). Both results are the same (Figure 10).

Figure 10: FM Transmitter Testing

5. EQUIPMENT PREPARATION FOR FM SOUND BROACASTING TRANSMITTER TESTING USING AUDIO TEST FILES

The equipments required for FM transmitter testing using audio test files are the following:

1) **CD/DVD/Blu-ray player:** the player that can play the AudioCD of the audio test files. The typical player with RCA line out or audio out is recommended. It is recommended to avoid the portable CD player or the player that has the audio adjustment such as volume, equalizer, and balance. If audio adjustment is not deactivating, the testing result will not be reliable.
2) **Mixer or Pre-amplifier:** the typical mixer or pre-amplifier with gain +/- 15 dB is recommended.
3) **Audio cable:** use the high quality with low signal loss of audio cable is recommended.

The audio test files can be downloaded at NBTC website (http://www.nbtc.go.th). It should be cautious that during the test, do not adjust the volume of mixer beyond the audio clipping limit of the mixer, otherwise, the testing result is not reliable.

6. CONCLUSION

Bringing all FM local transmitters to the standard is a crucial step to solve the radio interference issue in Thailand. The proposed audio test files for FM transmitter testing is practical and cost effective. The technical characteristics of audio test files are complied with ETSI FM Testing Method. It can be used as the alternative approach for FM transmitter testing.

7. ACKNOWLEDGMENTS

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8. REFERENCES

[1] ETSI EN302018-1, *Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Frequency Modulation (FM) sound broadcasting service; Part 1: Technical characteristics and test method,*
[2] Audacity, http://audacity.sourceforge.net/