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FM Analog and FM Digital Technologies Spectral Occupancy

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The information presented below is a summary from existing documents describing each technology.

This document is intended to clarify the spectral occupancy of some of the different broadcast digital signal technologies and how they relate to the FM band.

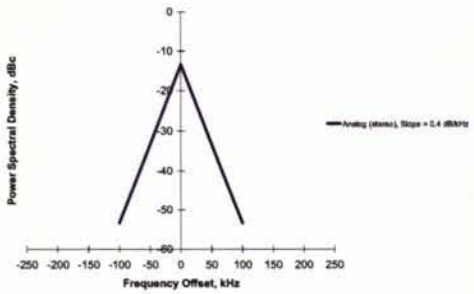

Figure 1

1 FM Analog

Notwithstanding that Canadian Broadcasters are very familiar with the FM analog spectral occupancy, a theoretical representation of the FM analog stereo signal is shown in **Figure 1**. Since most of the Canadian FM radio stations are stereophonic, the representation shows a stereo signal with a modulation slope of 0.4 dB/kHz. This slope reflects the average value measured for the FM stereo stations in the Ottawa region. An FM mono signal would have a steeper slope than the FM stereo signal of approximately 1.4 dB/kHz (again according to CRC measurements in the Ottawa region).

The FM analog nominal bandwidth is 200 kHz.

2 FM-IBOC

The FM-IBOC is a digital technology which has 3 basic configurations: hybrid, extended hybrid, and all-digital. Both the hybrid and extended hybrid systems are approved for immediate deployment in the US. The extended hybrid system increases the capacity of the digital component by adding more sub carriers inwards towards the analog host that may overlap with the outer part of the analog signal. The all-digital system would be the end result of IBOC evolution, eventually replacing the hybrid and extended hybrid systems.

There are 4 service modes defined for FM hybrid and extended hybrid IBOC transmissions as specified in the NRSC standard. MP1 (hybrid IBOC) is the main service mode and it has a digital sideband bandwidth of approximately 69 kHz on each side of the FM analog signal. The other 3 service modes (extended hybrid

IBOC), MP2, MP3 and MP11 have digital sideband bandwidths of approximately 76, 83, and 97 kHz respectively, on each side of the FM analog signal.

On the spectral representations depicted below, the power level of the digital sidebands in the hybrid system is set at –20 dB with respect to the FM carrier power (i.e. -23 dBc per sideband) even though this signal level can be increased as high as -10 dB in the US. The power spectral density of each digital sideband is constant and equal to -35.4 dBc/kHz.

The FM-IBOC hybrid and extended hybrid nominal bandwidth is 400 kHz.

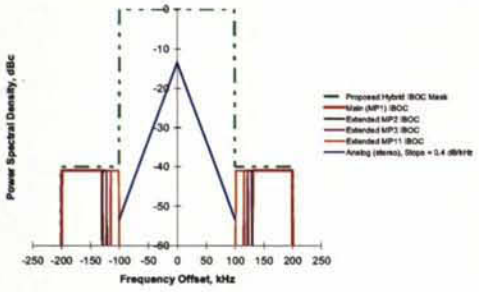

Figure 2

Both banks of digital sidebands carry the same information/signal. The transmitted signal is therefore more robust because of this frequency duplication.

Recently, the NRSC allowed the use of asymmetric sidebands in order to minimize the risk of interference to adjacent channel FM radio stations (this requires an experimental authorization from the FCC).

Figure 3 represents the eventual full digital IBOC mode. The FM analog signal is now turned off and the power of the digital IBOC signal is spread over the entire 400 kHz bandwidth with higher signal strength from -200 kHz to -150 kHz and from +150 kHz to +200 kHz.

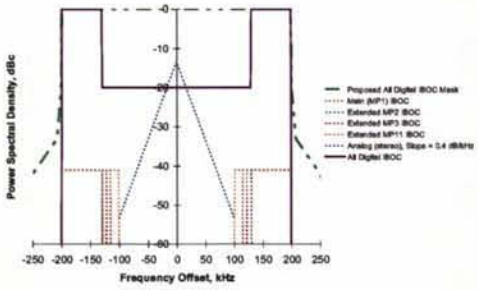

Figure 3

3 DRM+

DRM+ is a digital signal that can also be used in the FM band with a bandwidth of 96 kHz as shown on **Figure 4**.

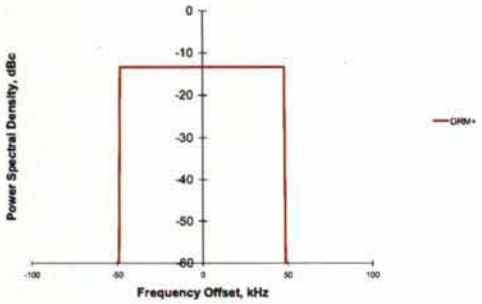

Figure 4

It is recommended to locate the DRM+ signal at a minimum spacing of 150 kHz from the FM carrier frequency and with at least 20 dB of signal power level difference in order to maintain the existing FM analog protection ratios and subsequent audio quality. The spectral separation of the DRM+ signal can also be increased in 50 kHz increments and the signal power level difference revised accordingly.

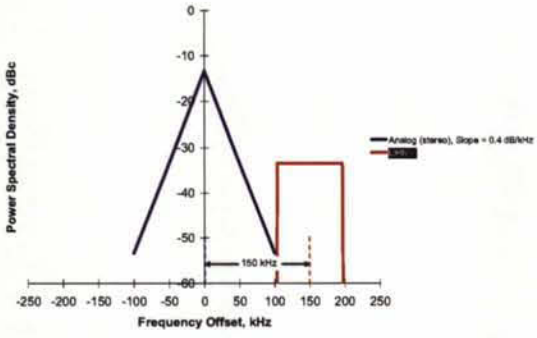

Figure 5

The DRM+ signal can be linked to an FM analog station (transmit the same program) or it can also have a different content (a new radio station). A DRM+ signal linked to an FM analog station can also be dropped-in anywhere in the FM band (not required to be adjacent to its FM analog signal).

In summary:

The broadcasting technologies have different requirements and some of them have more flexibility than others. The FM analog signal has a nominal bandwidth of 200 kHz, the FM-IBOC uses the existing FM channel allocation plan and requires a bandwidth of 400 kHz while the DRM+ signal with its 96 kHz bandwidth can be dropped-in at any 50 kHz increment in the FM band.

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