Application Note

CMX7031/CMX7041 FI-2.0
for U.S. 6.25kHz Digital Radio

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1 Introduction

The CMX7031 and CMX7041 devices (CMX7031/CMX7041) use CML's *FirmASIC*® technology to deliver multiple feature suites from a single flexible IC. A specific feature suite is determined by loading a particular Function Image™ into the IC, which allows the user to change device function and operation. This capability allows a single CMX7031 or CMX7041 device to provide functions supporting all of analog only, digital (voice) only, and multi-mode analog/digital voice radio designs.

CMX7031/CMX7041 Function Image™ 2.0.1 (FI-2.0) provides a 4.8kbps and 9.6kbps root-raised cosine (RRC with alpha=0.2) filtered 4FSK data modem function set focused on digital applications for 6.25kHz and 12.5kHz RF channel spacings, respectively.

The data modem provides high performance features including:

- Baseband root-raised cosine modulator and demodulator
- Soft decision demodulator mode for enhanced error correction performance when used with a low rate vocoder supporting soft decision FEC
- High performance, automatic, Rx frame sync detection that minimizes host processing
- 72-bit data buffers to minimize host interaction
- User selectable I/Q or VCO modulator Tx interface modes

All device features, including auxiliary ADCs/DACs, RF synthesizer, soft gain controls, etc., are fully described in the CMX7031/CMX7041 datasheet.

4.8kbps modulation is a good fit for digital voice radios that use a low rate (2.4kbps + 1.2kbps FEC = 3.6kbps) vocoder.

This application note presents the RF spectrum developed using CMX7031/CMX7041 FI-2.0 4.8kbps digital modulation and shows that it fits the FCC Rule Part 90 Emission mask E applicable to 6.25kHz modulations.

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3 Requirements

FCC Rule Part 90 (47CFR Part 90) pertains to Private Land Mobile Radio Services and its section 90.210 defines the specific emission masks related equipment must satisfy. The popular 150-174 MHz and 421-512 MHz frequency bands support 6.25kHz, 12.5kHz and 25kHz RF channels. The use of 6.25kHz FDMA channels is particularly attractive for digital voice radio applications because they yield a high number of independent voice channels from a given block of spectrum.

Emission masks can vary with RF band, channel spacing (modulation bandwidth), and RF power. Emission mask E, defined in 90.210, applies to 6.25kHz modulations. Its shape varies with transmit power as summarized in Figure 1.

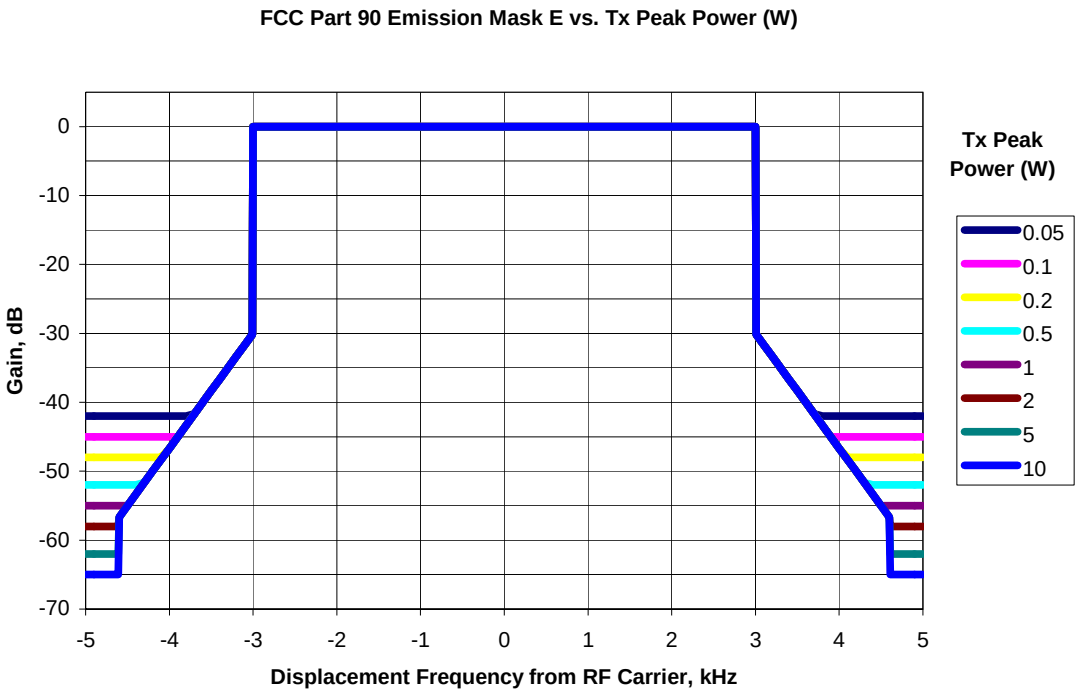

Figure 1 FCC 90.210 Emission Mask E for Some Tx Powers from 50mW to 10W

FCC 90.210 also specifies that emission mask tests be evaluated with the following spectrum analyzer settings:

- RBW = 100Hz (RBW = resolution bandwidth)
- VBW >=100Hz (VBW = video bandwidth)
- Max Hold
- Sufficient sweeps to build up the spectrum
- Reference set at the maximum power in the modulation.
- The 0dB mask reference (top of the mask) set to the highest emission contained within the authorized bandwidth (6kHz).

4 Test Procedure

The CMX7031/CMX7041 4FSK transmit functions are identical, and both devices support user selection of one of two Tx interface modes: direct VCO or I/Q modulator. (The choice of which external RF modulator type is up to the user; the I/Q modulator avoids a need to trim modulator deviation, which some find attractive.) Both VCO and I/Q interface mode cases were tested using the following two test equipment RF modulators operating at 200MHz:

1. A VCO modulator (HP /Agilent 8657B signal generator representing direct two-point VCO modulation).
2. An I/Q modulator (Rohde & Schwarz SMIQ02 signal generator).

A PE0201 CMX7031/CMX7041 evaluation kit was used in combination with a PE0001 evaluation interface card. The Tx modulation output signal(s) from the PE0201 were buffered using LMH6609 operational amplifier(s) to ensure sufficient drive capability for the test equipment inputs. The system was DC coupled.

Using a built-in function the CMX7031/CMX7041 Tx data pattern was set to a pseudo-random bit sequence (PRBS). (See register $C1 description in the device datasheet for more details.)

The two resulting spectra (one for each of VCO and I/Q modulator cases) were evaluated against the most demanding FCC Emission mask E, which is for ≥10W RF transmit power. For convenience the actual test equipment transmit power was less than 10W; the results are wholly applicable because the 4FSK modulation is constant envelope and so would not undergo spectral spreading by the use of higher power RF PA.

The VCO and I/Q test modulator's respective output powers were 0dBm and -10dBm thus the mask's 'top' (0dB attenuation reference position) was positioned to a different power for each. These are only differences in vertical (power) scaling and do not compromise results; the appropriately scaled mask is shown in each result plot.

5 Results

The RF spectra for the VCO and I/Q modulator cases are shown below.

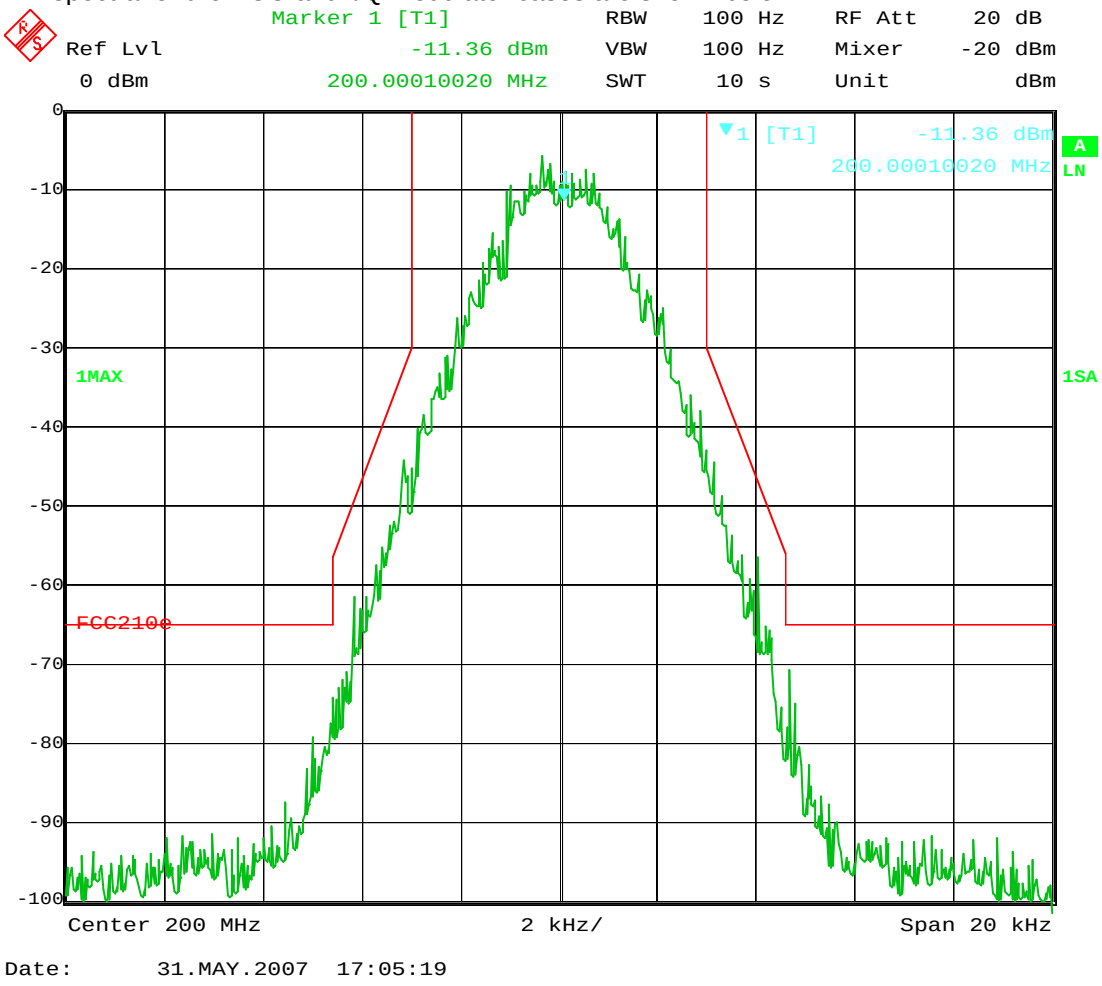

Figure 2 CMX7031/CMX7041 4.8kbps 4FSK VCO Modulator RF Spectrum vs. Mask E

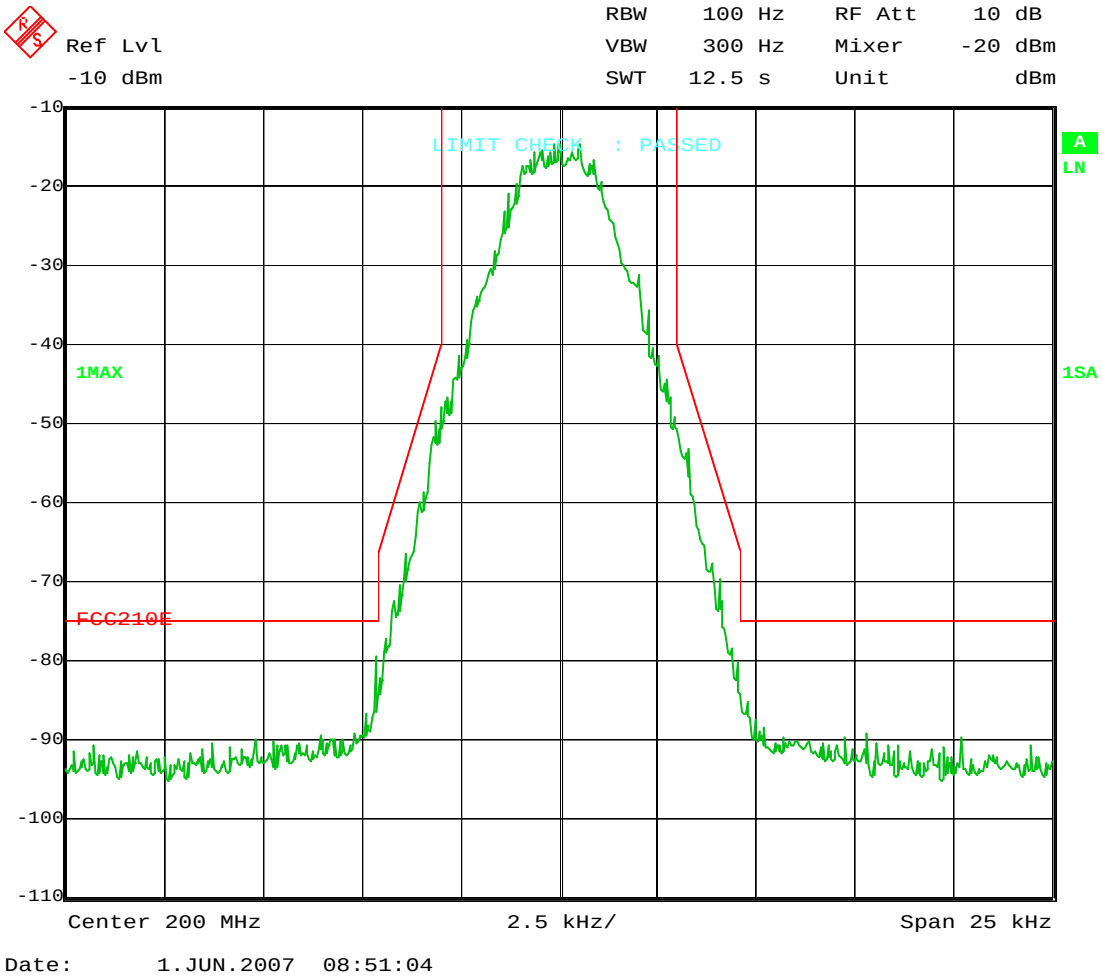

Figure 3 CMX7031/CMX7041 4.8kbps 4FSK I/Q Modulator RF Spectrum vs. Mask E

Notes:

1. The VCO and I/Q test modulator's respective output powers were 0dBm and -10dBm thus the mask's 'top' (0dB attenuation reference position) was positioned to a different power for each. These are only differences in vertical (power) scaling and do not compromise results; the appropriately scaled mask is shown in each result plot.
2. The spectrum in Figure 3 is 'more smooth' and slightly closer to the mask than the one in Figure 2. This difference comes from a minor difference in test procedure; when developing Figure 3 the spectrum analyzer was left running in Max Hold for about 30 minutes, which is quite a long time. This difference in appearance does not alter any conclusions.

6 Conclusion

The 4.8kbps 4FSK RF modulations developed using CMX7031/CMX7041 devices, when loaded with Function Image™ 2.0.1 and connected to an external RF modulator, yields an RF emission spectrum that comfortably fits the FCC 47CFR Part 90, 6.25kHz Emission mask E. Both the VCO and I/Q Tx output interface modes of the CMX7031/CMX7041 devices yield this same positive result to show the devices are an attractive choice for 6.25kHz digital radio applications in the United States.

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