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Exhibit 5

Incumbent Part 90 SMR System Impact To Sensus NBPCS Operation

Date: May 13, 2015
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SECTION 1: INTRODUCTION

1.1 SCOPE

The purpose of this document is to provide a summary of how incumbent SMR systems have affected Sensus NBPCS receiver operations in the past.

1.2 BACKGROUND

The FCC has historically grouped like systems together in the SMR and NBPCS bands. These systems have shared similar attributes:

- Narrow band modulations.
    - Part 90 Subpart S uses spectral mask I to insure transmitters with an audio low pass filter adhere to a maximum authorized bandwidth of 12.5 KHz.
    - Part 90 Subpart S uses spectral mask J to insure transmitters without an audio low pass filter adhere to a maximum authorized bandwidth of 13.6 KHz.
- Small channel spacing of 12.5 KHz in the SMR 896-901 band.
- Narrow bandwidth receivers which are highly sensitive.
- Low noise floors at the base station receiver inputs due to narrow band modulations used for transmission.
- The desire for long range, highly sensitive system performance from:
    - Paging transmitters which are located in buildings, worn close to the body, and encounter significant path loss from the transmitter to the base station receiver.
    - Specialized Mobile Radio terminals (which may include voice transmissions) that range from portable, hand-held units to vehicle mounted units. These SMR units are used in buildings and in dense urban areas which encounter significant path loss and fading loss.

The FCC allowed cellular telephone systems to operate in the SMR (NEXTEL) and NBPCS (Space Data and others) bands. A large number of these systems utilized the iDEN network designed by Motorola. iDEN handsets which operated in the 896-901 and 901-902 MHz band were also inherently narrow band in operation due to the mask limitations for operating in these bands. iDEN systems could operate at higher transmit bandwidths if the individual 12.5 KHz channels were aggregated (many operated in 125 KHz channel widths subdivided into 10, 12.5 kHz channels) but the individual handset units were usually kept to narrow band modulations to support as many users as possible in the limited amount of spectrum available for their use.
iDEN mobile units protected the subscribers in the adjacent channel by incorporating high fidelity transmitters which produced very little noise in the adjacent channels. SMR

systems also utilized high fidelity transmitters in most cases to keep from interfering with adjacent channel users.
The technology utilized in the 1990's and 2000's for generating narrow band transmissions was inherently quiet. Modulations were usually generated in narrow loop bandwidth PLLs which utilized high fidelity RF oscillators which further helped the noise levels in the adjacent channels to be low. The narrow loop bandwidths were needed both for modulation containment and to allow the PLL to step in fine frequency increments.
Modulating techniques incorporating I/Q mixers placed between the frequency generation hardware and the transmitter power amplifier or in the reference path to the PLL were commonplace. The modulating signals (phase/frequency/amplitude) applied to the I/Q modulators had narrow band filtering applied to them, which also limited the noise due to modulation in the adjacent channels to be low. Care needed to be used with these I/Q techniques as the hardware could add significant noise to the transmitted signal itself.

SECTION 2: SPECTRAL OCCUPANCY

2.1. SPECTRAL OCCUPANCY AND SPECTRAL MASKS

Three spectral masks will be used for the discussions to follow. Mask J is presently used for all 13.56 KHz authorized bandwidth transmitters in the 896-901 MHz SMR band. Mask J is applied when the transmitting circuitry does not have a low pass filter before the modulator. Usually the types of transmissions generated by equipment which uses Mask J are digital in nature.

Part 24 systems in the 901-902 MHz channel adjacent to the SMR spectrum can use one of two spectral masks constraining their modulations. The narrower mask is for 10 KHz authorized bandwidths. A wider mask is usually set to be 20 KHz wide for 25 KHz channel widths, but may be extended up to the limit usable in a licensee's spectrum depending on the width of the spectrum the licensee holds.

2.2. MASK J

2.2.1. Mask J is defined in CFR 47 Part 90.210(j):

(j) Emission Mask J. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) as follows:
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 2.5 kHz, but no more than 6.25 kHz: At least 53 log (fd/2.5) dB;
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 6.25 kHz, but no more than 9.5 kHz: At least 103 log (fd/3.9) dB;
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 9.5 kHz: At least 157 log (fd/5.3) dB, or 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

2.2.2 A plot of emissions Mask J versus displacement from the signal center frequency is shown in FIGURE 1:

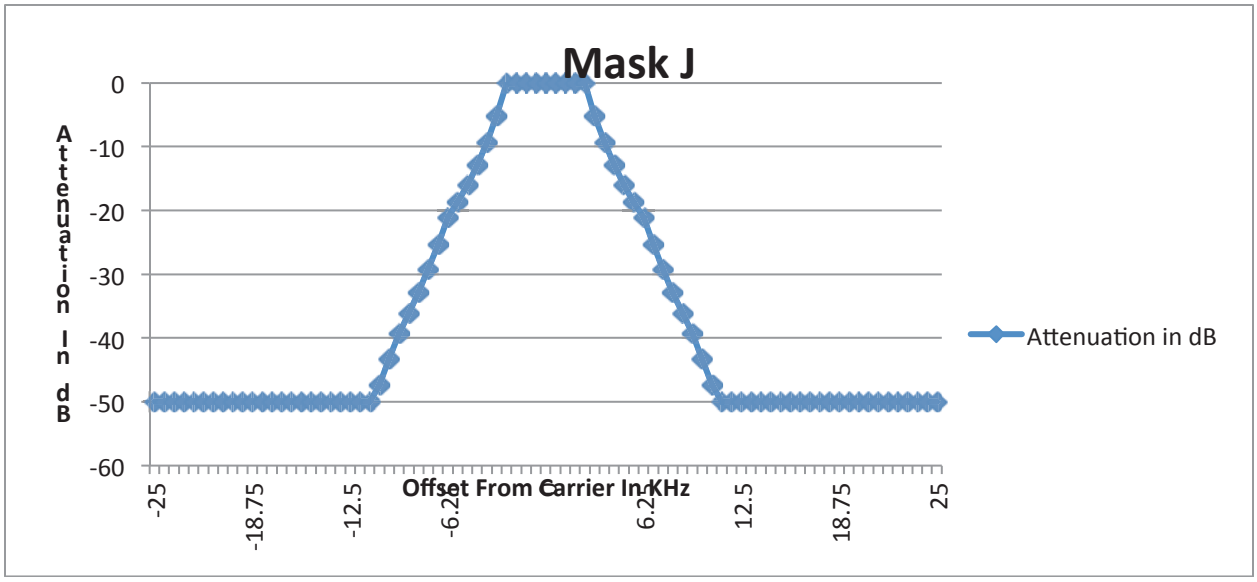


FIGURE 1: Mask J

2.3. PART 24 10 kHz AUTORIZED BANDWIDTH MASK

2.3.1. Part 24 10 kHz authorized bandwidth mask is defined in CFR 47 Part 24.133(2.)

(2) For transmitters authorized a bandwidth of 10 kHz:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of up to and including 20 kHz: at least $116\times Log_{10}((f_d+5)/3.05)$ decibels or $50+10\times Log_{10}(P)$ decibels or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 20 kHz: at least $43+10\ Log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation.

(b) The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the transmitter power.

(c) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

(d) The following minimum spectrum analyzer resolution bandwidth settings will be used: 300 Hz when showing compliance with paragraphs (a)(1)(i) and (a)(2)(i) of this section; and 30 kHz when showing compliance with paragraphs (a)(1)(ii) and (a)(2)(ii) of this section.

2.3.2. A plot of Part 24, 10 kHz authorized bandwidth mask is shown in FIGURE 2:

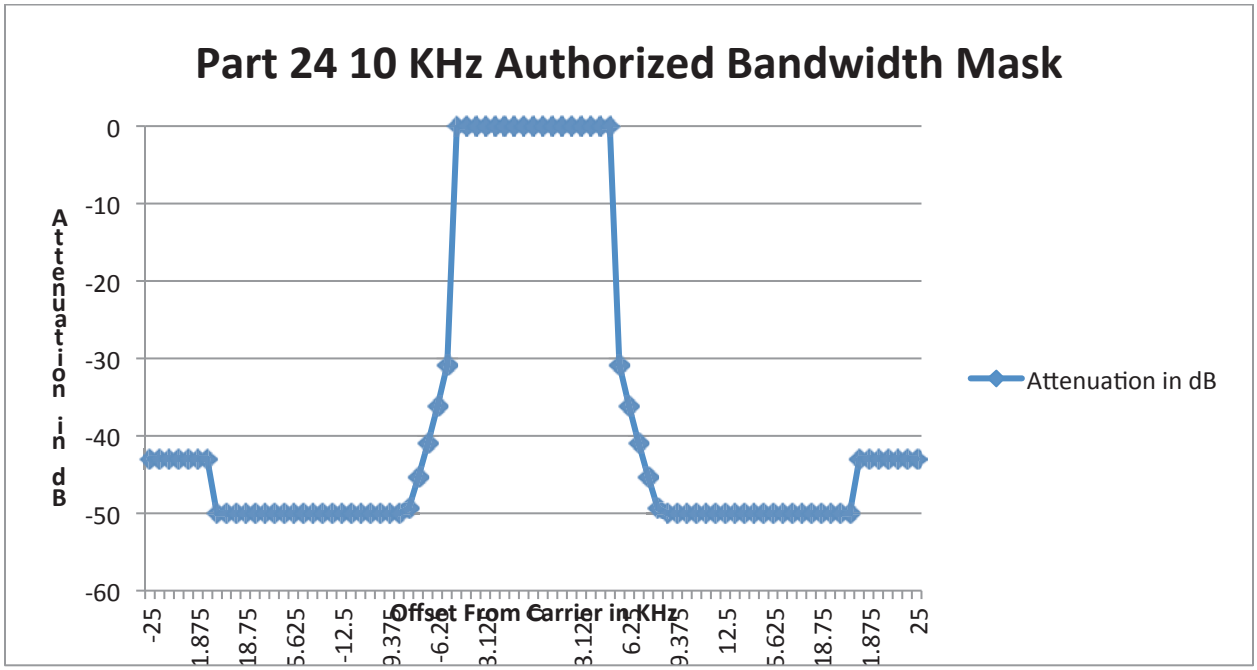


FIGURE 2: Part 24, 10 kHz Authorized Bandwidth Mask

2.4. PART 24 20 kHz AUTORIZED BANDWIDTH MASK

2.4.1. Part 24 10 kHz authorized bandwidth mask is defined in CFR 47 Part 24.133(1.)

(1) For transmitters authorized a bandwidth greater than 10 kHz:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of up to and including 40 kHz: at least 116 Log_{10} ((f_d+10)/6.1) decibels or 50 plus 10 Log_{10} (P) decibels or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 40 kHz: at least 43+10 Log_{10} (P) decibels or 80 decibels, whichever is the lesser attenuation.

2.4.2. Part 24, 10 kHz authorized bandwidth mask is shown in FIGURE 3:

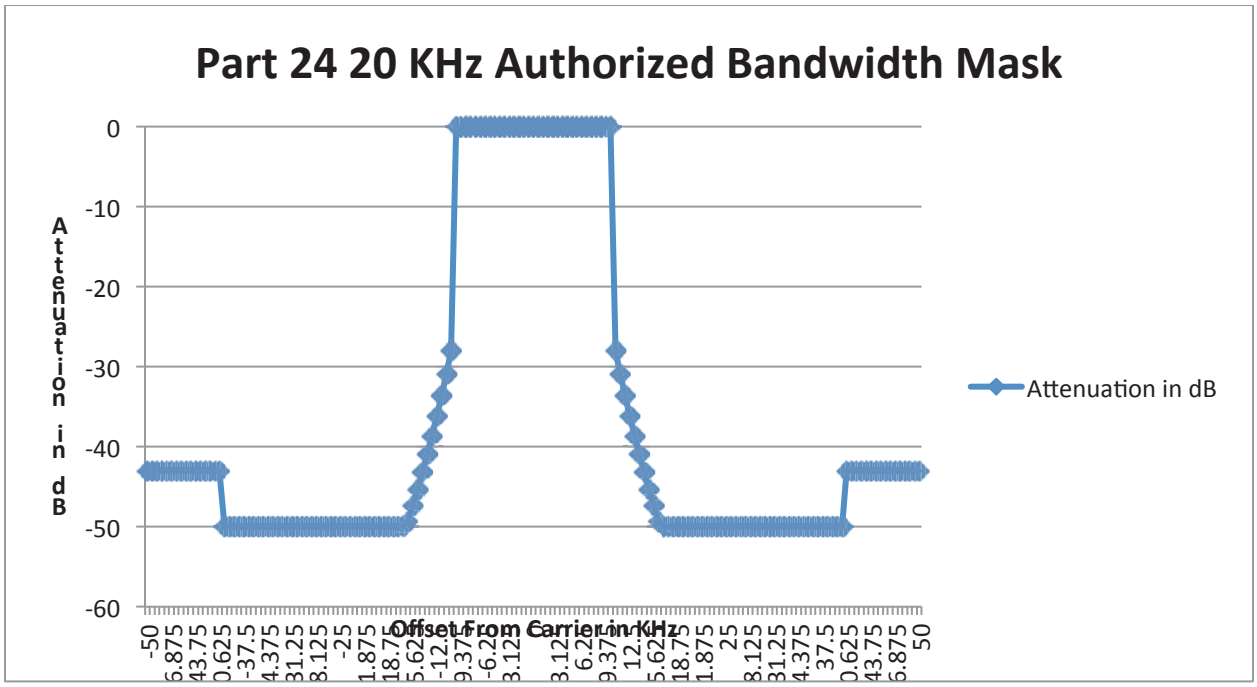


FIGURE 3: Part 24, 20 kHz Authorized Bandwidth Mask

2.5. DISCUSSION OF MEASUREMENTS FOR ALL MASKS

2.5.1. In Band Emissions Measurements

From the center of the authorized bandwidth up to and including the displacement frequency which denotes the out of channel attenuation the measurement bandwidth is usually set between100 Hz and 300 Hz.

2.5.2. Out Of Band Emissions Measurements

The out of band emissions measurements (usually noted as a hard limit plus 10*LOG(P) related to 1 Watt) are measured in a 30 KHz bandwidth. More often than not, compliance to these limits are shown at higher offsets than a few hundreds of kHz for the test reports on the FCC OET site as the intent is usually to show harmonic or spurious emissions from the unit under test not associated with the modulation.

In this author's experience, the out of channel emissions limits are suspect and worth further scrutiny if emissions closer to the carrier frequency are measured in the 100 Hz bandwidth used for the in-channel measurements and are seen to be "above the out of channel limit line measured in a 100 Hz bandwidth" by over 25 dB (i.e. 10LOG(30,000/100)) then a more stringent measurement may be needed using a 30 KHz measurement bandwidth and filters to reject the carrier frequency.

In other cases the measurement for out of channel emissions may be taken in a 100 Hz bandwidth, translated from dBm/100 Hz to dBm/30KHz and compared against the limits.

For the sake of the following discussions all out of channel measurements will be converted to dBm/Hz and dBm/30 kHz so that a direct relationship to the spectral masks may be made.

SECTION 3: MEASUREMENTS DERIVED FROM ON-LINE FCC OET TEST REPORTS OF LEGACY EQUIPMENT IN SMR AND NBPCS BANDS

3.1. OVERVIEW

3.1.1. Source Of Data Used

The data and plots that follow were collected using the FCC OET Equipment Authorization Web Site. The plots are directly copied from the test reports submitted for the FCCID of the equipment stated in each heading.

3.1.2. Data Manipulation

The original data from the test reports taken from the FCC OET Equipment Authorization Web Site was not altered. If annotation is made to the copied data, it is only intended to clarify the measurements as taken. The data and test results are in no way altered or changed.

3.1.3. Measurement Frequencies

The majority of the measurements below are taken in the 896-901 MHz FCC Part 90 SMR spectrum. The iDEN i475 unit has measurements in both the 896-901 MHz SMR and 901-902 NBPCS spectrum.

3.2. MOTOROLA iDEN i475 FCC ID: IHDT56MG1

3.2.1. Spectral Mask Measurement SMR Band 896-901 MHz

The transmitter spectrum shown in the next Figure shows the modulated output of a Motorola iDEN transmitter subscriber unit operating in the 896-901 MHz band. Modulation is as shown in FIGURE 4.

FCC Filing Package for Motorola i475-Series Transceivers **FCC ID: IHDT56MG1**

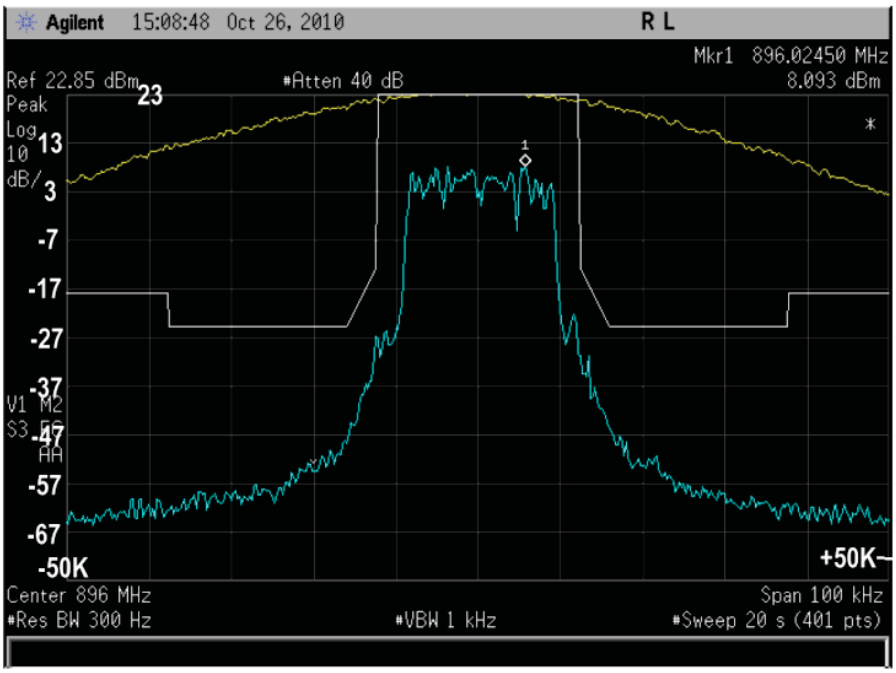


Figure 6a.2.2-11. iDEN 900 MHz Band, Quad-64QAM, Maximum Power, EA Emission Mask

FIGURE 4: Transmitted Spectral Mask From a Motorola i-475 Subscriber Unit.
Note the spectral mask varies from Mask J slightly. Motorola used Mask G for the measurements as it is similar to Mask J with the exception that Mask J does not change to 43 + 10 LOG P at 40 KHz. Motorola calls this variance out in their report.

3.2.2. Measurement Detail SMR Band 896-901 MHz

The main power is measured by the yellow trace and is +23 dBm.

The measurement was invoked for 50+10LOG(P) from 23 dBm for the limit for >9.5 KHz from the carrier needed for Mask J. With 23dBm=0.2W : 50+10LOG(0.2)=43dB which is where the limit line is set.

Relating the limit line above to dBm, annotation was added to the left of the measurement to show the level in dBm for each major horizontal line. Relating the 43 dB limit to dBm displayed above puts the limit line at 23dBm-43dB=-20dBm.

3.2.3. Converting The Out Of SMR Band Emission Level to dBm/Hz and dBm/30KHz.

Noting the power measured in the 300 Hz bandwidth at a 50 KHz offset from the carrier and converting to dBm/Hz in FIGURE 4 would yield (interpreting the plot above as closely as possible) would result in -65dBm/300Hz.

- -65 dBm/300Hz converts to -90 dBm/Hz.
- -65 dBm/300Hz converts to -45 dBm/30KHz

3.2.4. Spectral Mask Measurement NBPCS Band 901-902 MHz

The transmitter spectrum shown in the next Figure shows the modulated output of a Motorola iDEN transmitter subscriber unit operating in the 901-902 MHz band. Modulation is as shown in FIGURE 5.

FCC Filing Package for Motorola i475-Series Transceivers **FCC ID: IHDT56MG1**

6b.2. Modulation Characteristics and Necessary Bandwidth -- Pursuant 47 CFR 2.1033(c)(13), §2.1047(d), §2.1049, §2.202, §24.131, and §24.133(a)(1); RSS-Gen Section 3, RSS-134 Section 6.3.

6b.2.1 Emission Designator 18K3D7W - NBPCS iDEN Measured data

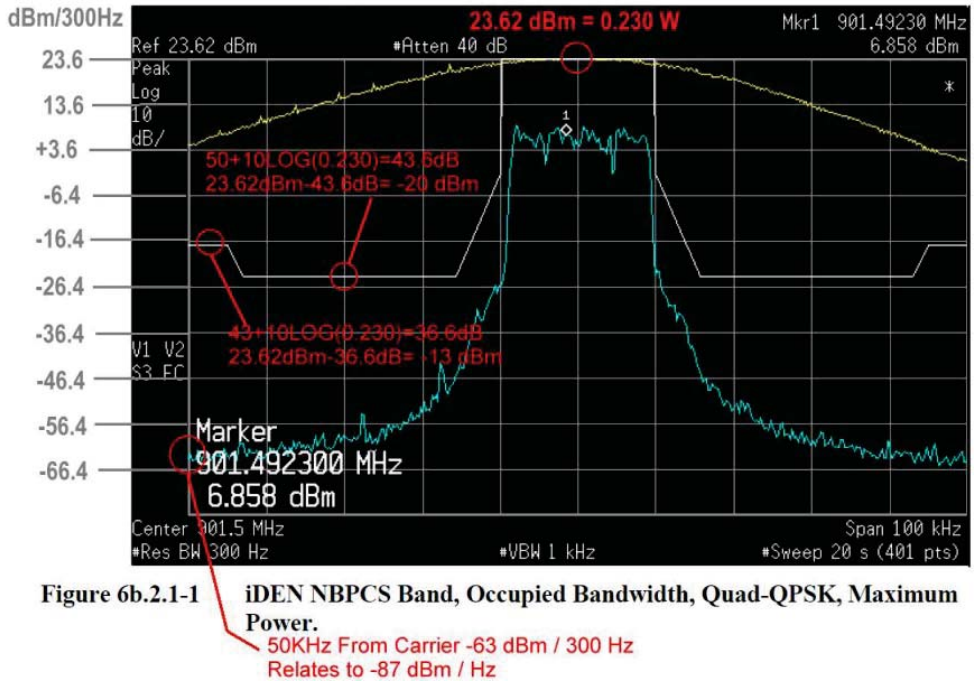


Figure 6b.2.1-1 **iDEN NBPCS Band, Occupied Bandwidth, Quad-QPSK, Maximum Power.**

50KHz From Carrier -63 dBm / 300 Hz
Relates to -87 dBm / Hz

FIGURE 5: Transmitted Spectral Mask From a Motorola i-475 Subscriber Unit. Measurement is compliant to Part 24, 20 kHz Authorized Bandwidth Mask. Figure is annotated for ease of reading.

3.2.5. Measurement Detail NPBCS Band 901-902 MHz

The main power is measured by the yellow trace and is +23.62 dBm.

The measurement was invoked for 43+10LOG(P) from 23.62 dBm for the out of channel limit. With 23.62dBm=0.23W : 43+10LOG(0.23)=36.71dB : 23.62dBm-36.71dB=-13 dBm which is where the limit line is set at a 50 KHz offset to the center frequency.

3.2.6. Converting The Out Of NBPCS Band Emission Level to dBm/Hz and dBm/30KHz

Noting the power measured in the 300 Hz bandwidth at a 50 KHz offset from the carrier and converting to dBm/Hz in FIGURE 4 (interpreting the plot above as closely as possible) would result in -63dBm/300Hz.

- -63 dBm/300Hz converts to -88 dBm/Hz.
- -63 dBm/300Hz converts to -43 dBm/30KHz

3.3. MOTOROLA iDEN i325 FCC ID: AZ489FT5855

3.3.1. Spectral Mask Measurement

The transmitter spectrum shown in the next Figure shows the modulated output of a Motorola iDEN transmitter subscriber unit operating in the 896-901 MHz band. Modulation is as shown in FIGURE 6.

FCC Filing Package for Motorola i325 Transceiver **FCC ID: AZ489FT5855**

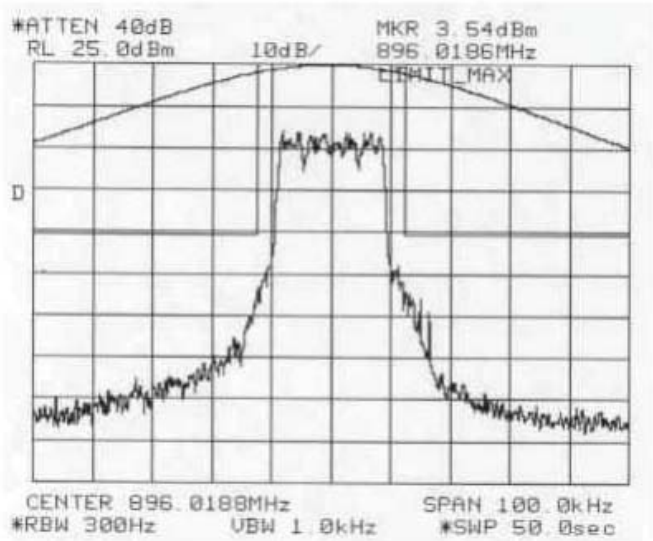


Figure 6-23: Quad-64QAM Modulation performance relative to mask 47 CFR 90.669(a)
(MAXIMUM POWER SETTING)

FIGURE 6: Transmitted Spectral Mask From a Motorola i-325.

3.3.2. Measurement Detail

Note at 50 KHz offsets from the carrier, the noise from the unit is 85 dB below the output power of 25.0 dBm.

3.3.3. Converting The Out Of Band Emission Level to dBm/Hz and dBm/30KHz

The measurement bandwidth in FIGURE 5 is 300 Hz. The measurement at a 50 KHz offset from the center frequency is 25 dBm - 85 dB or -60dBm/300Hz.

- -60 dBm/300Hz converts to -85 dBm/Hz.
- -60 dBm/300Hz converts to -40 dBm/30KHz

3.4. MOTOROLA r750 iDEN Digital Multi-Service Phone FCC ID: AZ489FT5820

3.4.1. Spectral Mask Measurement

The output power of the r750 is lower, presumably for battery life and the fact the unit enjoys some gain from its antenna.

The mask in Figure 7 differs from Mask J slightly, it is based on an MTA mask and the limit line is at 43+10LOG(P), the measurement detail is identical to that used for Mask J as stated earlier.

FCC Filing Package for Motorola r750 Integrated Transceiver **FCC ID:** AZ489FT5820

Figure 6-11: Quad-QPSK Modulation performance relative to mask 47 CFR 90.669(a)
900.99375MHz, MAXIMUM POWER SETTING:

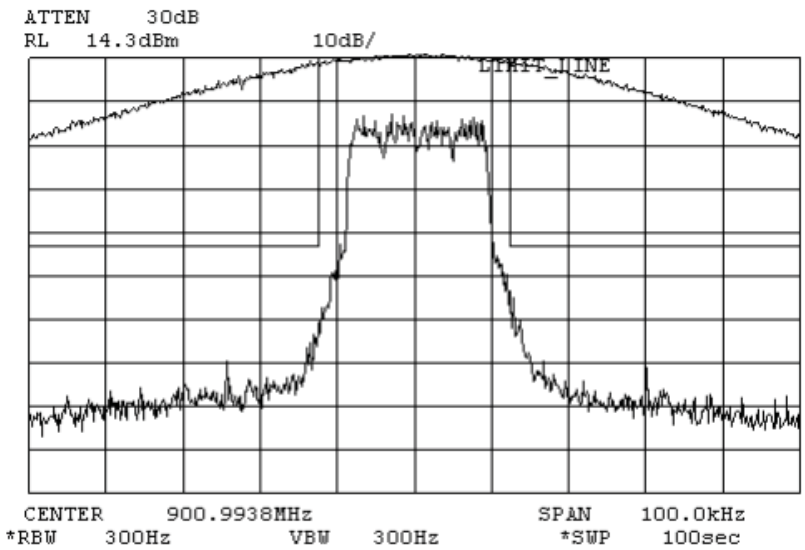


FIGURE 7: Motorola r750 Integrated Transceiver

3.4.2. Measurement Detail

Note at 50 KHz offsets from the carrier, the noise from the unit is 80 dB below the output power of 14.3 dBm.

3.4.3. Converting The Out Of Band Emission Level to dBm/Hz and dBm/30KHz

The measurement bandwidth in FIGURE 6 is 300 Hz. The measurement at a 50 KHz offset from the center frequency is 14.3 dBm - 80 dB or -65.7dBm/300Hz.

- -65.7 dBm/300Hz converts to -90.7 dBm/Hz.
- -65.7 dBm/300Hz converts to -45.7 dBm/30KHz

SECTION 4: DICUSSSION

The data available on the FCC OET Equipment Authorization website for the majority of iDEN SMR subscriber units showed out of channel noise floor conducted levels of better than -85dBm/Hz at 50 KHz separation from the modulated carrier. A number of units were lower than -85dBm/Hz.

Higher power SMR band units used mostly for in-vehicle mobile applications (as their output power levels are quite high and may not pass MPE or SAR FCC limits) show higher noise power in their out of channel spectral measurements. The out of channel noise power remains very low for the units investigated and the low noise power measurements are somewhat masked by the dynamic range of the measuring equipment being used.

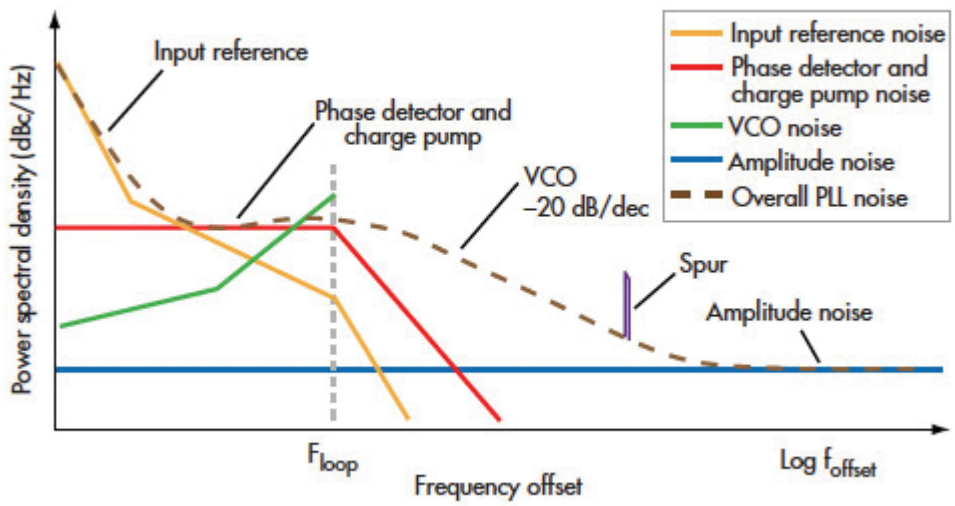
The data available on the FCC OET Equipment Authorization website for the majority of mobile SMR subscriber units at powers less than one Watt showed out of channel noise floor conducted levels of better than -75dBm/Hz at 50 KHz separation from the modulated carrier. A number of units were lower than -75dBm/Hz.

Sensus believes that many units also achieve better noise emissions than their reported -75dBm/Hz reading at 50 KHz offsets, but are limited by the dynamic range of the measuring equipment utilized.

It is our opinion that the RF design of the legacy units in these frequency bands has a tendency to achieve substantial noise emission roll off at offsets closer to the carrier due to:

- High fidelity RF oscillators used in the design of the radios.
- PLL and modulating architectures that are inherently low noise in design.
- Narrow band modulations were required due to narrow authorized bandwidths permitted in the bands.
    - The same point, but referencing data rate limiting on any digital modulations sent in the authorized bandwidths allowed.
    - The narrow authorized bandwidths are regulated by several, narrow band, spectral masks mandated by the FCC for operation in the SMR and NBPCS spectrum (i.e. Mask I, Mask J, Mask H, Mask G, to name a few).
- The need to protect the same user's adjacent channel noise floor 12.5 KHz to 25 KHz from the carrier.
- The fact that if the wider offset noise spectrum of the units tested resides outside the PLL bandwidths of the subscriber units tested, the level of -75 dBm/Hz (and better) will roll off at a slope of 6dB/Octave of frequency separation.

- For example if a level of -75dBm/Hz at a 50 KHz offset from the carrier is measured, the number will increase to -81dBm/Hz at 100 KHz and continue that trend rapidly decreasing to the thermal noise floor.
    - NOTE: Sensus NBPCS channels are only close in proximity to 896-901 MHz upper band edge licensees by less than 100 KHz in a small number of locations.
- A graphic showing the roll off of an RF PLL is supplied for convenience.. The VCO noise rolls off at 20db/decade outside the PLL bandwidth. (From Analog Devices data sheet.)



-
    - 20dB/Decade slope is equal to a slope of 6dB/Octave

Roll-off is given by,

$$\Delta L = 20 \log \left(\frac{\omega_2}{\omega_1} \right) \text{ dB/interval}_{2,1}$$

For a decade this is;

$$\Delta L = 20 \log 10 = 20 \text{ dB/decade}$$

and for an octave,

$$\Delta L = 20 \log 2 \approx 20 \times 0.3 = 6 \text{ dB/8ve}$$

SECTION 5: CONCLUSION

The narrow band nature of the FCC frequency allocations for Specialized Mobile Radio in the 896-901 (935-940) MHz bands and Narrow Band PCS in the 901-902 (930-930.5 and 940-940.5) MHz defined by narrow authorized bandwidths and narrow spectral mask requirements has allowed a multiplicity of users to coexist and operate without significant out of channel emissions.

The low out of channel emissions required by equipment operating in the aforementioned bands has protected the noise floor of all users in these bands allowing for optimal operation of systems in these channels.