The University of Michigan
Radiation Laboratory
3228 EECS Building
Ann Arbor, MI 48109-2122
Tel: (734) 764-0500

Measured Radio Frequency Emissions
From

Sirius XM
SDARS Signal Repeater

Report No. 415031-492
March 16, 2009

For:
Sirius XM
1500 Eckington PL NE
Concourse Level
Washington, DC 20002

Contact:
Beejay Jolayemi
Tel: (202)-680-4288
Fax: (202)-380-1647
beejay.jolayemi@xmradio.com

Measurements made by: Joseph D. Brunett

Test report written by: Joseph D. Brunett

Tests supervised by:
Report approved by: Valdis V. Liepa
Research Scientist

Summary

Tests for compliance with FCC Regulations Part 15, Subpart C, and Industry Canada RSS-210/GEN, were performed on Sirius XM SDARS Signal Repeater.

In testing completed on March 10, 2009, the device tested met fundamental emission limits by 1.7 dB, band edge limits by more than 4.5 dB, and harmonic limits by more than 10.5 dB. Radiated spurious emissions meet the FCC/IC Class B limit by more than 1.6 dB. AC power line conducted emissions meet the FCC/IC Class B limit by more than 4.6 dB.

1 Introduction

Sirius XM SDARS Signal Repeater was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as subsequently amended, and with Industry Canada RSS-210/Gen, Issue 7, June 2007. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" and the document, "FCC Regulatory Requirements for Design and Sale of SDARS In-Home Repeater v.2.3" The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057A-1).

2 Test Equipment Used

The pertinent test equipment commonly used in our facility for measurements is listed in Table 2.1 below. The middle column identifies the specific equipment used in these tests. The quality system employed at the University of Michigan Radiation Laboratory Willow Run Test Range has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to national standards.

Table 2.1 Test Equipment.

Test Instrument	Used	Manufacturer/Model	Q Number
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131	HP8593E1
Spectrum Analyzer (9kHz-6.5GHz)	X	Hewlett-Packard 8595E, SN: 3543A01546	JDB8595E
Power Meter		Hewlett-Packard, 432A	HP432A1
Harmonic Mixer (26-40 GHz)		Hewlett-Packard 11970A, SN: 3003A08327	HP11970A1
S-Band Std. Gain Horn		S/A, Model SGH-2.6	SBAND1
C-Band Std. Gain Horn	X	University of Michigan, NRL design	CBAND1
XN-Band Std. Gain Horn	X	University of Michigan, NRL design	XNBAND1
X-Band Std. Gain Horn	X	S/A, Model 12-8.2	XBAND1
X-band horn (8.2- 12.4 GHz)		Narda 640	XBAND2
X-band horn (8.2- 12.4 GHz)		Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)		FXR, Inc., K638KF	KBAND1
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1	LBBIC1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2	HBBIC1
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3	UMDIP1
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C, SN: 992 (Ref. Antennas)	EMDIP1
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223	EMROD1
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855	EMLOOP1
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan	UMRH1
Amplifier (5-1000 MHz)	X	Avantek, A11-1, A25-1S	AVAMP1
Amplifier (5-4500 MHz)	X	Avantek	AVAMP2
Amplifier (4.5-13 GHz)	X	Avantek, AFT-12665	AVAMP3
Amplifier (6-16 GHz)		Trek	TRAMP1
Amplifier (16-26 GHz)		Avantek	AVAMP4
LISN Box	X	University of Michigan	UMLISN1
Signal Generator		Hewlett-Packard 8657B	HPSG1
Vector Signal Generator (XM Gen.)	X	Rhode & Schwarz SMU200	RSSMU200
Vector Signal Generator	X	Rhode & Schwarz SMIQ03B	RSSMIQ
IQ Modulator (Sirius IQ for SMIQ03B)	X	Rhode & Schwarz AMIQ	RSAMIQ

3 Configuration and Identification of Device Under Test

The Device Under Test (DUT) is a 902-928 MHz Downconverter-Transceiver. The device demodulates the incoming band (centered at 2338.75 MHz) to IQ and employs that IQ in modulating its 915 MHz carrier in the 902-928 MHz ISM band. The size of the DUT is 2.5(W) x 4(H) x 4(D) inches. During testing, an XM satellite signal generator was employed to generate the XM signals that were directly injected into the external antenna input jack. A vector signal generator with IQ modulator was employed to generate the SIRIUS satellite radio stimulus per the specified test procedure (see Section 5 of this report). Nominal operating voltage is 115 VAC.

The DUT is designed and manufactured by Sirius XM, 1500 Eckington PL NE, Concourse Level, Washington, DC 20002.

3.1 Variants & Modes of Operation

There is only a single version of this device. The device provided is capable of both short-term battery operation (30 minutes) via a 9 VDC battery and continuous operation using an AC-DC 5V wall adapter. The battery mode is implemented to allow a user to determine a location with good satellite/terrestrial signal before AC power must be applied. In testing, worst case emissions were observed with the device operating from the wall adapter and are fully reported herein.

3.2 Changes Made to the DUT

No changes were made to the DUT by this test laboratory.

3.3 External Device Photos

Refer to separate Photo Exhibit file for this unit.

3.4 Internal Device Photos

Refer to separate Photo Exhibit file for this unit.

4 Emission Limits

4.1 Radiated Emission Limits (FCC 15.249, 15.209; IC RSS-210e:A2.9)

The DUT tested is a 902-928 MHz ISM band transmitter, subject to FCC 15.249 and IC RSS-210e A2.9 and all other sections referred to therein. The applicable critical testing frequencies with corresponding emission limits are given in Tables 4.1 and 4.2.

Table 4.1. Radiated Emission Limits (Ref: FCC: 15.249; IC: RSS-210e A2.9)

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (μV/m)
902 - 928	50	500

1) Field strength limits are specified at a distance of 3 meters.
2) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209 (Class B), whichever is the lesser attenuation.
3) Peak field strength of any emission above 1GHz shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

Table 4.2. Radiated Emission Limits
(FCC: 15.33, 15.35, 15.109/15.209; IC: RSS-210e, 2.7 Table 2)

Freq. (MHz)	Class A, E_{lim} dB(μV/m)	Class B, E_{lim} dB(μV/m)
30-88	49.5	40.0
88-216	54.0	43.5
216-960	56.9	46.0
Above 960	60.0	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW)
Quasi-Peak readings apply up to 1000 MHz (120 kHz BW) for PRF > 20 Hz

4.2 Conducted Emission Limits (FCC 15.107)

Table 4.3. Conducted emission limits (FCC 15.107; IC RSS-Gen 7.2.2 Table 2 (CISPR)).

Frequency MHz	Class A (dBμV)		Class B (dBμV)	
	μV	dBμV	μV	dBμV
0.150 - 0.50	79	66	66 - 56*	56 - 46*
0.50 - 5	73	60	56	46
5 - 30	73	60	60	50

Notes: 1. The lower limit shall apply at the transition frequency
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15-0.50MHz:
*Class B Quasi-peak: $dB\mu V = 50.25 - 19.12*\log(f)$
*Class B Average: $dB\mu V = 40.25 - 19.12*\log(f)$
3. 9 kHz RBW

4.3 DUT Stimulus

Since the DUT acts as a downconverter/transceiver, the appropriate input stimulus under which the DUT must meet the above emission limits must be well defined. These stimuli have been specified in the document *"[1]FCC Regulatory Requirements For Design and Sale of SDARS In-Home Repeater v.2.3"* for both the XM and SIRIUS bands, and are outlined in this section.

4.3.1 Required Test Stimuli

This section outlines a test stimulus equivalent to that agreed to by the FCC in [1]. The full set of modulation schemes below were tested as prescribed in [1], with minor modification allowing for the use of a true XM satellite signal generator. As in previous filings, it was determined that a reduced test set, using only high, middle, and low input power settings for each mode was sufficient to demonstrate compliance.

Base Stimulus- XM Satellite (XM East):
Base Satellite signal: Input power @ transmitter input: -66 dBm.
Modulation: QPSK
Bandwidth: 2 x 1.89 MHz
Frequency: 2333.465 MHz & 2344.045 MHz

XM Satellite Stimulus (XM East and XM West):
Satellite signal: Input power @ transmitter input: -55 to –75 dBm in 5 dB increments.
Modulation: QPSK
Total Bandwidth: 2 x 1.89 MHz
Frequencies: Test @ 2333.465 MHz + 2344.045 MHz, 2335.305 MHz + 2342.205 MHz

XM Terrestrial Stimulus (XM Ter 1 & 2):
Terrestrial signal: Input @ transmitter input: -20 to –70 dBm in 20 dB increments.
Modulation: OFDM (DQPSK carriers)
Total Bandwidth: 2 x 2.98 MHz
Frequency: Test @ 2337.490 MHz & 2340.020 MHz

Sirius Satellite Stimulus (Sirius Sat 1 only):
Satellite signal: Input power @ transmitter input: -60 to –80 dBm in 5 dB increments.
Modulation: QPSK
Total Bandwidth: 4.2 MHz
Frequency: Test @ 2322.293 MHz
(NOTE: Base stimulus also present)

Sirius Terrestrial Stimulus (Sirius Ter):
Terrestrial signal: Input @ transmitter input: -20 dBm.
Modulation: OFDM (DQPSK carriers)
Bandwidth: 4.096 MHz
Frequency: Test @ 2326.25 MHz
(NOTE: Base stimulus also present)

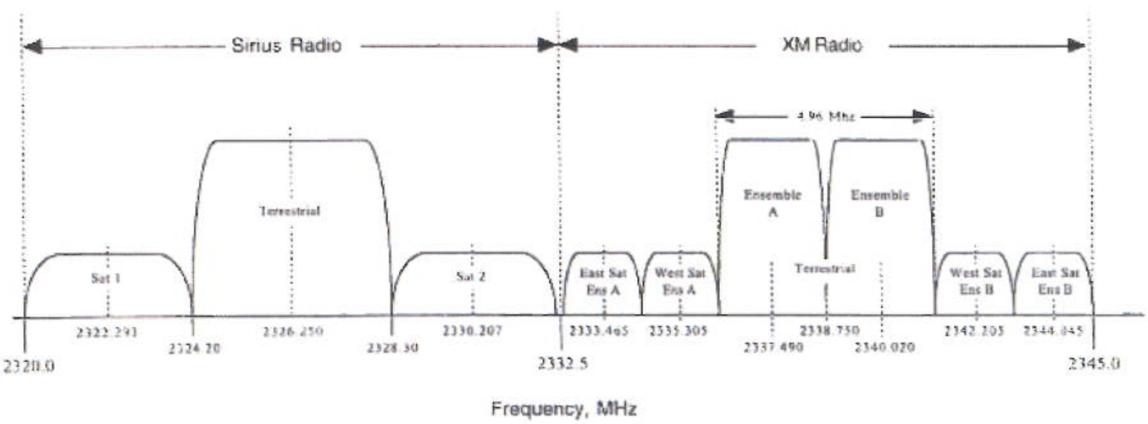
Single-Tone Spur Stimulus:
Single-Tone Sweep: -81.6 dBm, swept from 2312 to 2352 MHz in 1 MHz increments.
(Note: Base stimulus also present).

The following table summarizes the test scenarios and their respective input test stimuli reported. The figure depicting the SDARS spectrum (at the bottom of the page) is used as reference.

Table 5.1 Table of Radiated Test Stimuli [1]

Test Scenario	Stimuli
(5.1)	XM East Base Stimulus: -66 dBm @ 2333.465 MHz & 2344.045 MHz (QPSK)
(5.2A)	XM East Sat. Stimulus: -55 to -75 dBm @ 2333.465 MHz & 2344.045 MHz (QPSK)
(5.2B)	XM West Sat. Stimulus: -55 to -75 dBm @ 2335.305 MHz & 2342.205 MHz (QPSK)
(5.3)	Sirius Sat. 1 Stimulus: -60 to -80 dBm @ 2322.293 MHz, SIR QPSK (including (5.1))
(5.4)	XM Ter. (Ens. A + B): -20 to -70 dBm @ 2337.490 MHz & 2340.020 MHz, (OFDM)
(5.5)	Sir. Terrestrial: -20 dBm @ 2326.250 MHz, (OFDM) (including (5.1))
(5.6)	Single Tone Spur: -81.6 dBm @ (2312.0 to 2352.0) MHz (including (5.1))

NOTE: The agreed upon test procedure, as outlined in 2004, detailed that an equivalent to the XM satellite signal was to be generated using QPSK modulation and would depict the two lower (East Sat + West Sat; Ensemble A) and two upper (East Sat + West Sat; Ensemble B) satellite channels as distinct pairings (e.g. one QPSK signal with 3.77 MHz bandwidth for each). This was proposed at the time because true XM satellite signal generators were not yet available and no one vector signal generator could represent the actual XM East and XM West satellite pairings. SDARS generators are now available and generate the XM East and XM West satellite signal pairings as they exist in practice, employing the same power spectral density (PSD) but transmitting only East or West satellite pairings. Such a generator is employed in this testing. The East and West signals are tested in 5.2A and 5.2B, respectively, and represent a worse inter-modulation condition (for out-of-band emissions) that that originally proposed while exhibiting subjecting the DUT to the same PSD as the original test procedure.



4.4 Input Signal Discrimination Requirement

The FCC and IC have agreed [1,3] that the DUT is not required to determine if a signal is valid prior to downconversion and transmission because the input spectrum being repeated resides in the restricted (SDARS) band. However, the design must meet the emissions limits when energy other than the desired signal exists at the input, as dictated in the test procedure.

4.5 Supply Voltage Variation

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

5 Test Procedure and Computations

5.1 Test Procedure: General

Prior to any measurements, all active components of the test setup were allowed a warm-up for a period of approximately one hour, or as recommended by their manufacturers.

5.2 Test Procedure: Radiated Emissions

5.2.1 Semi-anechoic Chamber Measurements

To familiarize with the radiated emission behavior of the DUT, the DUT was first studied and measured in a shielded semi-anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with a turntable, an antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

In testing for radiated emissions, the DUT was stimulated as mentioned in the previous section. It was placed on the test table flat, on its side, or on its end. In the chamber we studied and recorded all the emissions using a Bicone antenna up to 300 MHz and ridged horn and standard gain horn antennas above 300 MHz. The measurements made in the chamber below 1 GHz are used for pre-test evaluation only. The measurements made above 1 GHz are used in pre-test evaluation and in the final compliance assessment. The DUT is testing over three axes. Photographs included in this filing show the indoor testing of the DUT.

Note 1: For the horn antenna, the antenna pattern is more directive and hence the measurement is essentially that of free space (no ground reflection). Consequently it is not essential to measure the DUT for both antenna polarizations, as long as the DUT is measured on all three of its major axis. In the chamber we also recorded the spectrum and modulation characteristics of the carrier. These data are presented in subsequent sections. As a general procedure, emissions are first tested using a peak detector. If the DUT does not meet the quasi-peak (or average) limits via these measurements, quasi-peak (or average) measurements are then made to demonstrate compliance.

Note 2: In order to meet the output power limits for all input signals (from the XM home antenna), the repeater transmitter uses active gain controls (AGCs) to limit the output power. Rather than adjusting the bias condition for amplifiers, the AGC feedback loop uses attenuators. Therefore, the bias condition of each amplifier does not depend upon the input signal conditions. The maximum power (and harmonic levels) from the final amplifier occur when the input signal is maximized by a XM terrestrial station. This was verified in pretesting, and thus worst case harmonic emissions are reported for testing under the highest level (5.4) XM terrestrial stimuli.

5.2.2 Open Area Test Site (OATS) Measurements

After the chamber measurements, emissions were re-measured on the outdoor 3-meter site at fundamental and harmonics up to 1 GHz using tuned dipoles and/or the high frequency Bicone. The DUT is testing on 3 axes to determine the worst case emissions. Photographs included in this filing show the DUT on the Open Area Test Site (OATS).

5.2.3 Field Computations

To convert the dBm measured to E(dBμV/m) at the test receiver antenna, E(dBμV/m) is computed from

$$E(dB\mu V/m) = 107\ dB + Pr(R_{meas})(dBm) + K_a - Kg$$

or

$$E(dB\mu V/m) = Pr(R_{meas})(dB\mu V) + K_a - Kg$$

Where P_r = power recorded on spectrum analyzer at the distance R_{meas}, dBm or dBμV
K_a = antenna factor, dB/m
K_g = pre-amp gain and/or cable loss, dB

When presenting the data, the highest measured emission at each frequency under all of the possible orientations is given.

5.3 Test Procedure: Conducted Emissions

The DUT is powered from a standard 120 VAC line via a transformer. No change in conducted emissions was observed for different operating modes. The results demonstrate emissions from the DUT operating under test stimuli (5.4).

6 Measurement Results

6.1 Digital Radiated Emissions

Table 6.1. Spurious Radiated Emissions 30 MHz to 1000 MHz. RBW = 120 kHz, VBW>RBW. DUT meets FCC/IC Class B spurious emissions limits by more than 1.6 dB. Note that in indoor pre-testing (up to 2.9 GHz), there were no other significant spurious emissions observed. See Figure 6.1

6.2 Radiated Emissions – Peak to Average Ratio

Table 6.2. Measurement distance is 3 m. The DUT demonstrates a quasi-peak to average ratio (f < 1000 MHz) of no less than 3.6 dB and a peak to average emissions ratio (f > 1000 MHz) of no more than 13.1 dB for all modes tested.

Table 6.2 Worst Case QPk and Avg. Values Relative to Pk.

Test Scenario	Quasi-Peak (dB)	Average (dB)
5.1	-4.6	-11.0
5.2 A	-4.6	-11.0
5.2 B	-4.7	-10.8
5.3	-3.6	-10.3
5.4	-4.7	-13.1
5.5	-4.8	-11.1
5.6	0.0 (CW Spur)	0.0 (CW Spur)

6.3 Radiated Emissions – Fundamental and Band Edges

Figures 6.2-6.5. Fundamental and Band Edge Radiated Emissions: 902 – 928 MHz (only the worst case plot for each type of stimuli is provided). 120 kHz RBW, VBW > RBW for f < 1 GHz, 1 MHz RBW, VBW>RBW for f > 1 GHz; measurement distance is 3 m. (Pk > QPk where applicable. Limits are Quasi-Peak Limits.) Outdoor measured data is reported in Table 6.3(a-c). Figures 6.2-6.5 are noise-floor limited, but show no emissions in restricted bands for all modes of operation. The DUT meets the fundamental emissions limits by 1.7 dB, and the restricted band emissions limits by 4.5 dB in the worst case.

6.4 Radiated Emissions – Harmonics

Harmonic Radiated Emissions: 1 MHz RBW,10 kHz VBW; measurement distance is 3 m. All emissions reported in Table 6.3(c). The DUT meets the harmonic emissions limits by more than 10.5 dB.

6.5 Conducted Emissions

Figures 6.5-6.6. Worst case conducted emissions. 9 kHz RBW, VBW > RBW. The DUT meets conducted emissions limits by more than 4.6 dB. All emissions reported in Table 6.4.

6.6 Effect of Supply Voltage Variation

The DUT is designed to operate on 120 VAC. The relative radiated emissions and frequency were recorded at the fundamental as the supply voltage was varied from 85 to 135 VAC. Figure 6.7 shows the emission power variation. Current at 115.0 VAC was 19.2 mA.

The University of Michigan
Radiation Laboratory
3228 EECS Building
Ann Arbor, MI 48109-2122
Tel: (734) 764-0500

Table 6.1 Highest Digital Radiated Emissions Measured

											Sirius XM; FCC/IC Class B
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	52.7	Bic	V	-66.7	Pk	8.8	25.8	23.3	40.0	16.7	background
2	52.7	Bic	H	-80.0	Pk	8.8	25.8	10.0	40.0	30.0	noise
3	63.9	Bic	H	-73.7	Pk	7.8	25.6	15.5	40.0	24.5	noise
4	63.9	Bic	V	-62.2	Pk	7.8	25.6	27.0	40.0	13.0	background
5	86.0	Bic	V	-67.8	Pk	7.7	25.3	21.6	40.0	18.4	background
6	122.8	Bic	H	-74.1	Pk	10.2	24.7	18.4	43.5	25.1	background
7	122.8	Bic	H	-77.7	Pk	10.2	24.7	14.8	43.5	28.7	noise
8	161.6	Bic	V	-73.9	Pk	13.2	24.1	22.3	43.5	21.2	background
9	161.6	Bic	H	-79.2	Pk	13.2	24.1	17.0	43.5	26.5	noise
10	234.2	Bic	H	-81.3	Pk	14.7	23.2	17.2	46.0	28.8	noise
11	234.2	Bic	V	-82.6	Pk	14.7	23.2	15.9	46.0	30.1	noise
12	898.7	SBic	H	-74.3	QPk	29.2	17.6	44.4	46.0	**1.6**	Intermod. Product*
13	931.0	SBic	V	-77.1	QPk	29.9	17.4	42.3	46.0	3.7	Intermod. Product*
14	931.0	SBic	H	-80.5	QPk	29.9	17.4	38.9	46.0	7.1	Intermod. Product*
15	931.0	SBic	V	-81.2	QPk	29.9	17.4	38.2	46.0	7.8	Intermod. Product*
16											
17											
18	* Intermodulation product observed for stimulus 5.2A (-55 dBm input)										
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34	Note:	Worst case emissions measured. No observed change to digital emissions									
35		for different modes of operation.									
36											
37											
38											
39											
40											
41											
42											
43											

Meas. 03/09/2009-03/10/2009; U of Mich.

Table 6.3(a) 15.249 (902-928 MHz ISM Band)

				Radiated Emissions							Sirius XM Repeater; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. dBm	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass* dB	Comments
1	**(5.1) XM Sat. Base Stimulus; -66 dBm @ 2333.465 MHz & 2344.045 MHz (QPSK)**										
2	909.4	SBic	H	-27.1	Pk	29.4	17.4	91.9	94.0	**2.1**	
3	909.4	SBic	V	-29.0	Pk	29.4	17.4	90.0	94.0	4.0	
4	900.6	SBic	H/V	-79.4	QPk	29.2	17.5	39.4	46.0	6.6	lower band edge, noise
5	928.5	SBic	H/V	-79.5	QPk	29.8	17.3	40.0	46.0	6.0	upper band edge, noise
6											
7	**(5.2A) XM Sat. East Stimulus; -55 dBm @ 2333.465 MHz & 2344.045 MHz (QPSK)**										
8	909.4	SBic	H	-27.7	Pk	29.4	17.4	91.3	94.0	**2.7**	
9	909.4	SBic	V	-28.7	Pk	29.4	17.4	90.3	94.0	3.7	
10	901.1	SBic	H/V	-80.0	QPk	29.2	17.5	38.8	46.0	7.2	lower band edge, noise
11	928.8	SBic	H/V	-81.5	QPk	29.8	17.3	38.0	46.0	8.0	upper band edge, noise
12											
13	**(5.2A) XM Sat. East Stimulus; -65 dBm @ 2333.465 MHz & 2344.045 MHz (QPSK)**										
14	909.4	SBic	H	-27.2	QPk	29.4	17.4	91.8	94.0	**2.2**	
15	909.4	SBic	V	-28.7	QPk	29.4	17.4	90.3	94.0	3.7	
16	902.0	SBic	H/V	-79.0	QPk	29.3	17.4	39.8	46.0	6.2	lower band edge, noise
17	928.2	SBic	H/V	-81.9	QPk	29.8	17.3	37.6	46.0	8.4	upper band edge, noise
18											
19	**(5.2A) XM Sat. East Stimulus; -75 dBm @ 2333.465 MHz & 2344.045 MHz (QPSK)**										
20	909.4	SBic	H	-27.2	QPk	29.4	17.4	91.8	94.0	**2.2**	
21	909.4	SBic	V	-28.8	QPk	29.4	17.4	90.2	94.0	3.8	
22	902.0	SBic	H/V	-78.8	QPk	29.3	17.4	40.0	46.0	6.0	lower band edge, noise
23	928.0	SBic	H/V	-81.2	QPk	29.8	17.3	38.3	46.0	7.7	upper band edge, noise
24											
25	**(5.2B) XM Sat. West Stimulus; -55 dBm @ 2335.305 MHz & 2342.205 MHz (QPSK)**										
26	912.3	SBic	H	-26.8	QPk	29.5	17.4	92.3	94.0	**1.7**	
27	912.3	SBic	V	-30.2	QPk	29.5	17.4	88.9	94.0	5.1	
28	900.8	SBic	H/V	-79.3	QPk	29.2	17.5	39.5	46.0	6.5	lower band edge, noise
29	928.4	SBic	H/V	-80.2	QPk	29.8	17.3	39.3	46.0	6.7	upper band edge, noise
30											
31	**(5.2B) XM Sat. West Stimulus; -65 dBm @ 2335.305 MHz & 2342.205 MHz (QPSK)**										
32	912.3	SBic	H	-27.3	QPk	29.5	17.4	91.8	94.0	**2.2**	
33	912.3	SBic	V	-29.5	QPk	29.5	17.4	89.6	94.0	4.4	
34	900.8	SBic	H/V	-79.6	QPk	29.2	17.5	39.2	46.0	6.8	lower band edge, noise
35	928.4	SBic	H/V	-81.2	QPk	29.8	17.3	38.3	46.0	7.7	upper band edge, noise
36											
37	**(5.2B) XM Sat. West Stimulus; -75 dBm @ 2335.305 MHz & 2342.205 MHz (QPSK)**										
38	912.3	SBic	H	-27.9	QPk	29.5	17.4	91.2	94.0	**2.8**	
39	912.3	SBic	V	-29.3	QPk	29.5	17.4	89.8	94.0	4.2	
40	900.8	SBic	H/V	-78.2	QPk	29.2	17.5	40.6	46.0	5.4	lower band edge, noise
41	928.4	SBic	H/V	-80.5	QPk	29.8	17.3	39.0	46.0	7.0	upper band edge, noise
42											
43											
44											

Univ. of Mich. Meas. 03/09/2009

Table 6.3(b) 15.249 (915 MHz ISM Band)

					Radiated Emissions						Sirius XM Repeater; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. dBuV	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass* dB	Comments
1	**(5.3) Sirius Sat. 1 Stimulus + (5.1); -60 dBm @ 2322.293 MHz, SIR QPSK**										
2	909.7	SBic	H	-27.0	Pk	29.4	17.4	92.0	94.0	**2.0**	
3	909.7	SBic	V	-28.8	Pk	29.4	17.4	90.2	94.0	3.8	
4	901.1	SBic	H/V	-77.3	QPk	29.2	17.5	41.5	46.0	4.5	lower band edge, noise
5	929.7	SBic	H/V	-79.6	QPk	29.8	17.3	39.9	46.0	6.1	upper band edge, noise
6											
7	**(5.3) Sirius Sat. 1 Stimulus + (5.1); -70 dBm @ 2322.293 MHz, SIR QPSK**										
8	909.7	SBic	H	-27.7	Pk	29.4	17.4	91.3	94.0	**2.7**	
9	909.7	SBic	V	-28.9	Pk	29.4	17.4	90.1	94.0	3.9	
10	901.1	SBic	H/V	-78.0	QPk	29.2	17.5	40.8	46.0	5.2	lower band edge, noise
11	929.7	SBic	H/V	-81.2	QPk	29.8	17.3	38.3	46.0	7.7	upper band edge, noise
12											
13	**(5.3) Sirius Sat. 1 Stimulus + (5.1); -80 dBm @ 2322.293 MHz, SIR QPSK**										
14	909.7	SBic	H	-27.9	Pk	29.4	17.4	91.1	94.0	**2.9**	
15	909.7	SBic	V	-28.7	Pk	29.4	17.4	90.3	94.0	3.7	
16	901.1	SBic	H/V	-78.2	QPk	29.2	17.5	40.6	46.0	5.4	lower band edge, noise
17	929.7	SBic	H/V	-81.2	QPk	29.8	17.3	38.3	46.0	7.7	upper band edge, noise
18											
19	**(5.4) XM Ter. (Ens. A + B): -20 dBm @ 2337.490 MHz & 2340.020 MHz, (OFDM)**										
20	913.7	SBic	H	-26.8	QPk	29.5	17.4	92.3	94.0	**1.7**	
21	913.7	SBic	V	-28.0	QPk	29.5	17.4	91.1	94.0	2.9	
22	901.6	SBic	H/V	-79.9	QPk	29.2	17.4	38.9	46.0	7.1	lower band edge, noise
23	928.5	SBic	H/V	-80.3	QPk	29.8	17.3	39.2	46.0	6.8	upper band edge, noise
24											
25	913.7	SBic	H	-27.9	QPk	29.5	17.4	91.2	94.0	**2.8**	
26											
27	**(5.4) XM Ter. (Ens. A + B): -40 dBm @ 2337.490 MHz & 2340.020 MHz, (OFDM)**										
28	913.7	SBic	H	-27.8	QPk	29.5	17.4	91.3	94.0	**2.7**	
29	913.7	SBic	V	-29.3	QPk	29.5	17.4	89.8	94.0	4.2	
30	901.6	SBic	H/V	-80.9	Pk	29.2	17.4	37.9	46.0	8.1	lower band edge, noise
31	928.5	SBic	H/V	-81.4	Pk	29.8	17.3	38.1	46.0	7.9	upper band edge, noise
32											
33	**(5.4) XM Ter. (Ens. A + B): -60 dBm @ 2337.490 MHz & 2340.020 MHz, (OFDM)**										
34	913.7	SBic	H	-28.9	QPk	29.5	17.4	90.2	94.0	**3.8**	
35	913.7	SBic	V	-27.5	Pk	29.5	17.4	91.6	94.0	2.4	
36	901.6	SBic	H/V	-81.0	Pk	29.2	17.4	37.8	46.0	8.2	lower band edge, noise
37	928.5	SBic	H/V	-80.9	Pk	29.8	17.3	38.6	46.0	7.4	upper band edge, noise
38											
39	**(5.4) XM Ter. (Ens. A + B): -70 dBm @ 2337.490 MHz & 2340.020 MHz, (OFDM)**										
40	913.7	SBic	H	-29.7	QPk	29.5	17.4	89.4	94.0	**4.6**	
41	913.7	SBic	V	-28.9	QPk	29.5	17.4	90.2	94.0	3.8	
42	901.6	SBic	H/V	-81.1	Pk	29.2	17.4	37.7	46.0	8.3	lower band edge, noise
43	928.5	SBic	H/V	-81.0	Pk	29.8	17.3	38.5	46.0	7.5	upper band edge, noise
44											

Univ. of Mich. Meas. 03/09/2009

Table 6.3(c) 15.249 (915 MHz ISM Band)

					Radiated Emissions						Sirius XM Repeater; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. dBuV	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass* dB	Comments
1	**(5.5) Sir. Terrestrial + (5.1): -20 dBm @ 2326.25 MHz, (OFDM)**										
2	909.3	SBic	H	-27.6	QPk	29.4	17.4	91.4	94.0	**2.6**	
3	909.3	SBic	V	-30.2	Pk	29.4	17.4	88.8	94.0	5.2	
4	901.1	SBic	H/V	-80.2	QPk	29.2	17.5	38.6	46.0	7.4	upper band edge, noise
5	928.2	SBic	H/V	-81.3	QPk	29.8	17.3	38.2	46.0	7.8	lower band edge, noise
6											
7	**(5.6) Single Tone Spur: -75.6 dBm @ 2312 - 2352 MHz x 1MHz (including (5.1))**										
8	906.3	SBic	H/V	-63.1	Pk	29.3	17.4	55.8	94.0	38.2	
9	907.3	SBic	H/V	-44.2	Pk	29.4	17.4	74.7	94.0	19.2	
10	908.3	SBic	H/V	-33.9	Pk	29.4	17.4	85.1	94.0	8.9	
11	909.3	SBic	H/V	-27.2	Pk	29.4	17.4	91.8	94.0	**2.2**	
12	911.3	SBic	H/V	-32.9	Pk	29.4	17.4	86.1	94.0	7.8	
13	912.3	SBic	H/V	-33.0	Pk	29.5	17.4	86.1	94.0	7.9	
14	913.3	SBic	H/V	-32.9	Pk	29.5	17.4	86.2	94.0	7.8	
15	917.3	SBic	H/V	-35.3	Pk	29.6	17.4	83.9	94.0	10.1	
16	918.3	SBic	H/V	-36.4	Pk	29.6	17.4	82.8	94.0	11.2	
17	920.3	SBic	H/V	-29.6	Pk	29.6	17.4	89.7	94.0	4.3	
18	922.3	SBic	H/V	-42.2	Pk	29.7	17.3	77.1	94.0	16.9	
19	923.3	SBic	H/V	-60.3	Pk	29.7	17.3	59.0	94.0	34.9	
20	901.1	SBic	H/V	-80.4	QPk	29.2	17.6	42.0	46.0	4.0	lower band edge, noise
21	928.9	SBic	H/V	-80.9	QPk	29.8	17.4	41.0	46.0	5.0	upper band edge, noise
22											
23	**Worst Case spurious + Harmonics: (5.4) XM Ter. (Ens. A + B) at -20 dBm**										
24	1830.0	Horn RG	H/V	-85.6	Avg	22.1	0.0	43.5	54.0	**10.5**	max all
25	2745.0	Horn RG	H/V	-68.7	Avg	24.8	25.8	37.3	54.0	16.7	max all
26	3660.0	Horn RG	H/V	-78.7	Avg	27.5	23.8	32.0	54.0	22.0	max all
27	4575.0	Horn C	H/V	-68.8	Avg	24.5	34.1	28.7	54.0	25.3	max all
28	5490.0	Horn C	H/V	-68.9	Avg	24.8	38.0	24.9	54.0	29.1	max all
29	6405.0	Horn Xn	H/V	-70.0	Avg	24.5	38.0	23.5	54.0	30.5	noise
30	7320.0	Horn Xn	H/V	-65.3	Avg	25.2	36.8	30.1	54.0	23.9	max all
31	8235.0	Horn X	H/V	-70.1	Avg	27.0	36.8	27.1	54.0	26.9	noise
32	9150.0	Horn X	H/V	-68.9	Avg	27.5	36.8	28.8	54.0	25.2	max all
33											
34											
35											
36											
37											
38											
39	Note:	It was determined (as explained in the the test report) that the worst case harmonic emissions									
40		come during the XM Terrestrial Stimulus (5.4) due to its higher input power level.									
41											
42	*AVG measured with RBW = 1 MHz, VBW = 10 kHz.										

Univ. of Mich. Meas. 03/09/2009

Table 6.5 Highest Conducted Emissions Measured

Sirius XM; FCC/IC Class B												
	Freq.	Line	Peak Det., dBμV		Pass	QP Det., dBμV		Pass	Ave. Det., dBμV		Pass	
#	MHz	Side	Vtest	Vlim*	dB*	Vtest	Vlim	dB	Vtest	Vlim	dB	Comments
1	0.14	Lo	40.4	56.3	16.0		66.4			56.3		
2	0.20	Lo	33.4	53.6	20.2		63.7			53.6		
3	0.28	Lo	35.2	50.8	15.7		60.9			50.8		
4	0.41	Lo	40.2	47.6	7.4		57.6			47.6		
5	0.46	Lo	39.5	46.6	7.1		56.7			46.6		
6	0.47	Lo	36.7	46.4	9.8		56.5			46.4		
7	0.69	Lo	33.8	46.0	12.2		56.0			46.0		
8	1.38	Lo	34.6	46.0	11.4		56.0			46.0		
9	1.49	Lo	35.6	46.0	10.4		56.0			46.0		
10	1.59	Lo	34.2	46.0	11.9		56.0			46.0		
11	1.84	Lo	35.9	46.0	10.1		56.0			46.0		
12	2.48	Lo	36.5	46.0	9.5		56.0			46.0		
13	16.43	Lo	33.3	50.0	16.7		60.0			50.0		
14												
15												
16												
17	0.14	Hi	43.0	56.3	13.4		66.4			56.3		
18	0.20	Hi	39.5	53.4	14.0		63.5			53.4		
19	0.28	Hi	37.1	50.8	13.8		60.9			50.8		
20	0.41	Hi	42.7	47.7	5.0		57.7			47.7		
21	0.46	Hi	42.1	46.6	**4.6**		56.7			46.6		
22	0.55	Hi	38.9	46.0	7.1		56.0			46.0		
23	0.61	Hi	38.5	46.0	7.5		56.0			46.0		
24	0.84	Hi	38.9	46.0	7.1		56.0			46.0		
25	0.96	Hi	37.0	46.0	9.0		56.0			46.0		
26	1.23	Hi	36.5	46.0	9.5		56.0			46.0		
27	2.41	Hi	40.3	46.0	5.7		56.0			46.0		
28	8.41	Hi	36.0	50.0	14.0		60.0			50.0		
29	16.43	Hi	33.2	50.0	37.2		60.0			50.0		
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40	Note:	Worst case emissions measured. No observed change to digital emissions										
41		for different modes of operation.										
42												
40												

**Average limit* Meas. 03/09/2009; U of Mich.

Since Vpeak >= Vqp >= Vave and if Vtestpeak < Vavelim, then Vqplim and Vavelim are met.

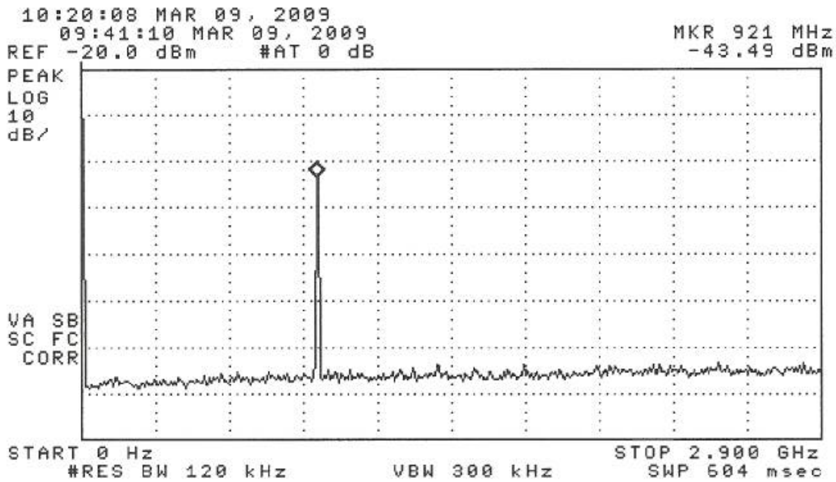


Figure 6.1. Emission spectrum of the DUT. The amplitudes are only indicative (not calibrated).

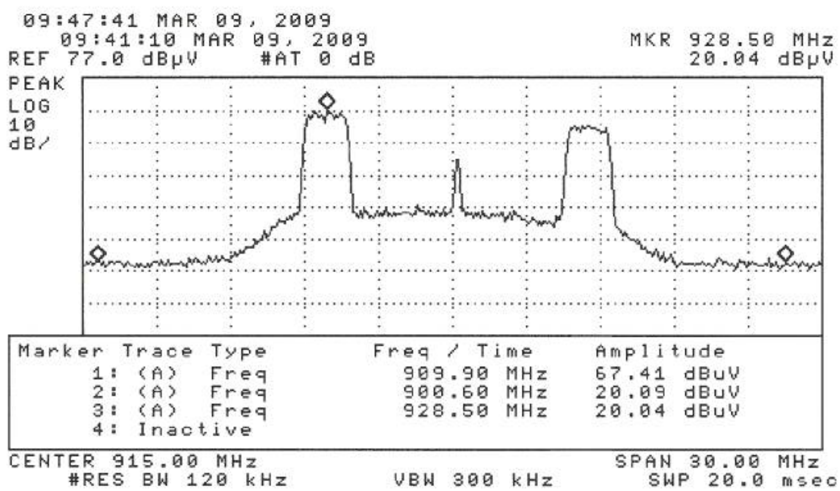
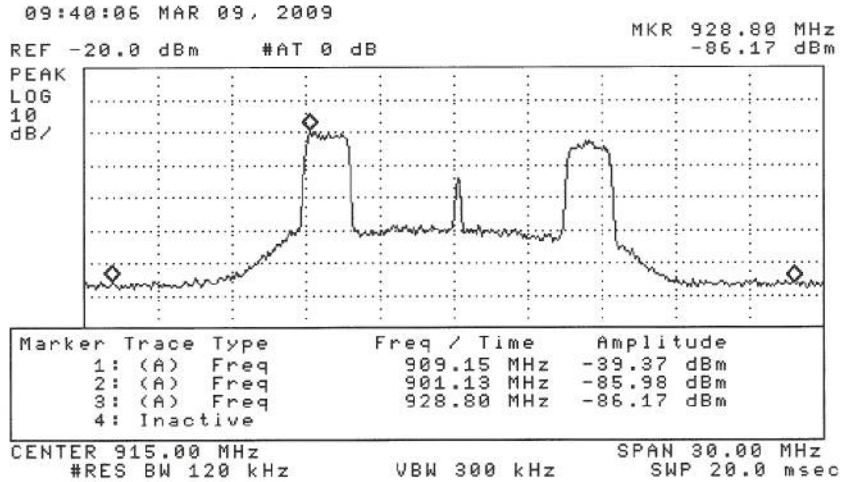
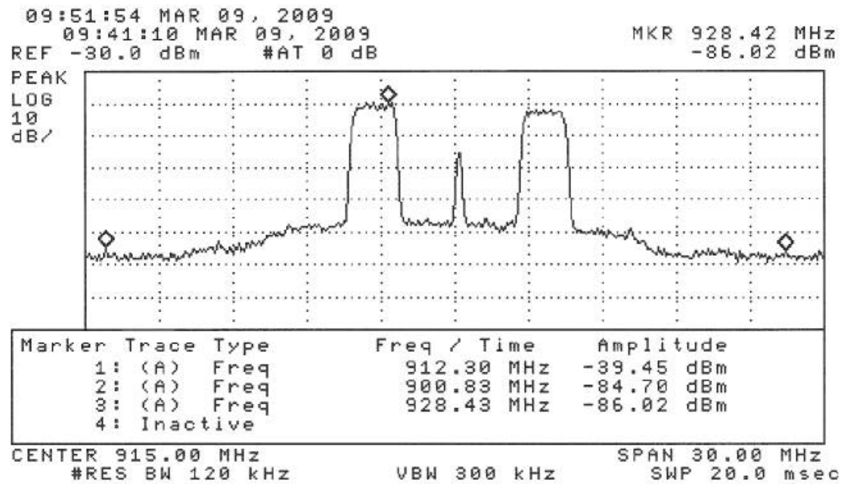


Figure 6.2. Relative band edge emissions from Semi-anechoic Chamber measurements. Scenario (5.1)





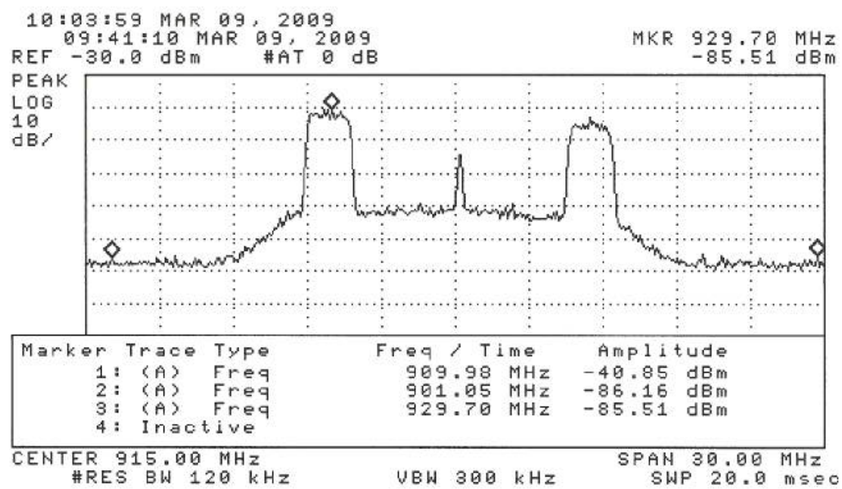
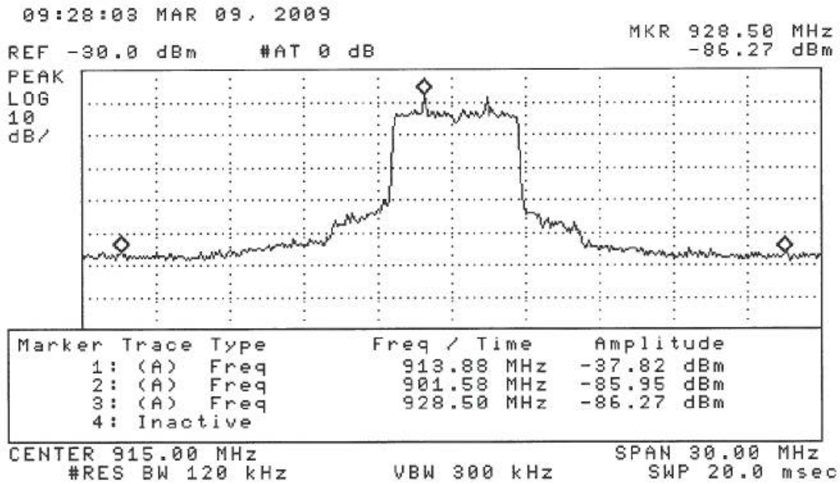


Figure 6.3. Relative band edge emissions from Semi-anechoic Chamber measurements. (top) Scenario (5.2A), (middle) Scenario (5.2B), (bottom) Scenario (5.3)



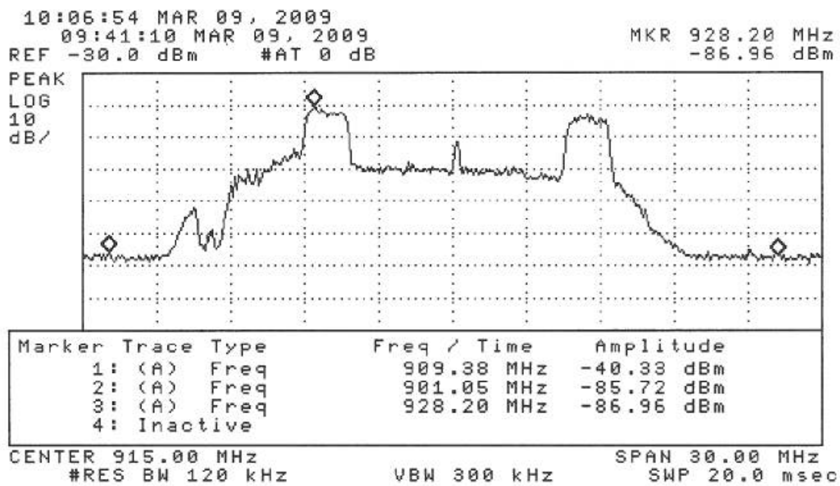


Figure 6.4. Relative band edge emissions from Semi-anechoic Chamber measurements. (top) Scenario (5.4), (bottom) Scenario (5.5).

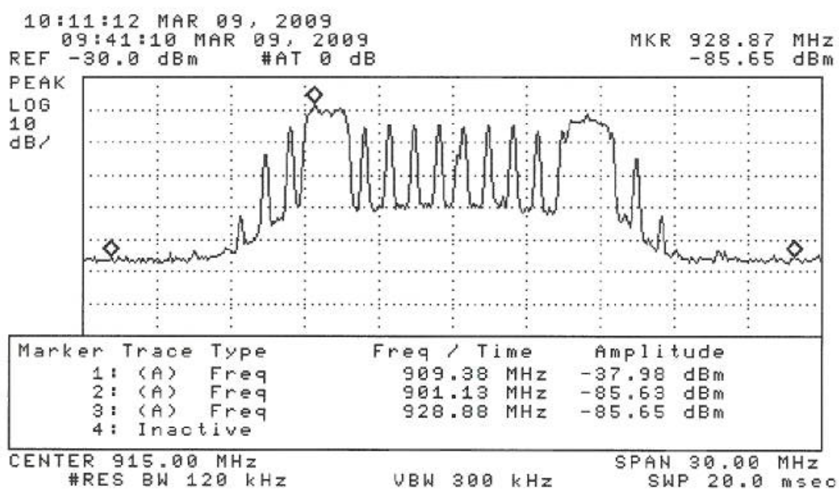


Figure 6.5. Relative band edge emissions from Semi-anechoic Chamber measurements. Scenario (5.6).

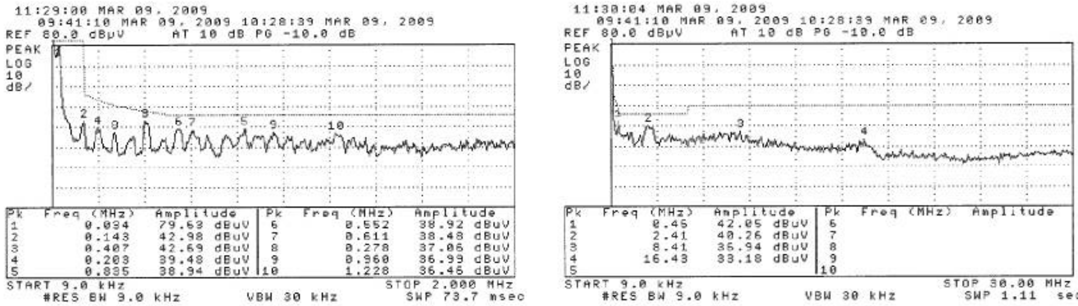


Figure 6.6. AC Conducted Emissions (Stimulus 5.4), HI line; (left) 0-2 MHz, (right) 2-30 MHz

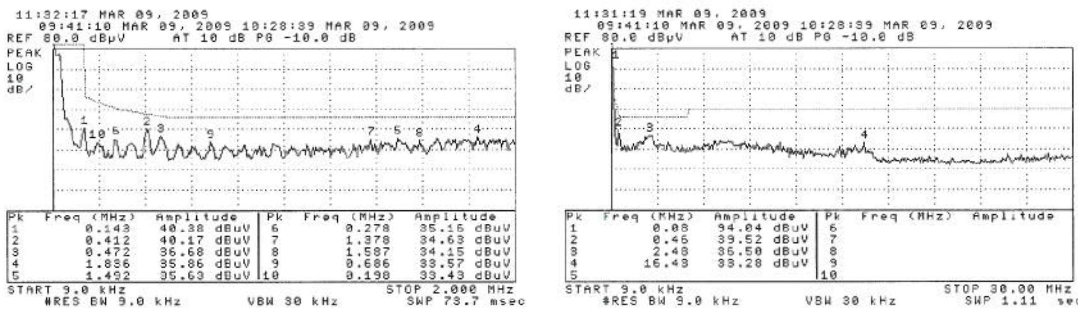


Figure 6.7. AC Conducted Emissions (Stimulus 5.4), LO line; (left) 0-2 MHz, (right) 2-30 MHz

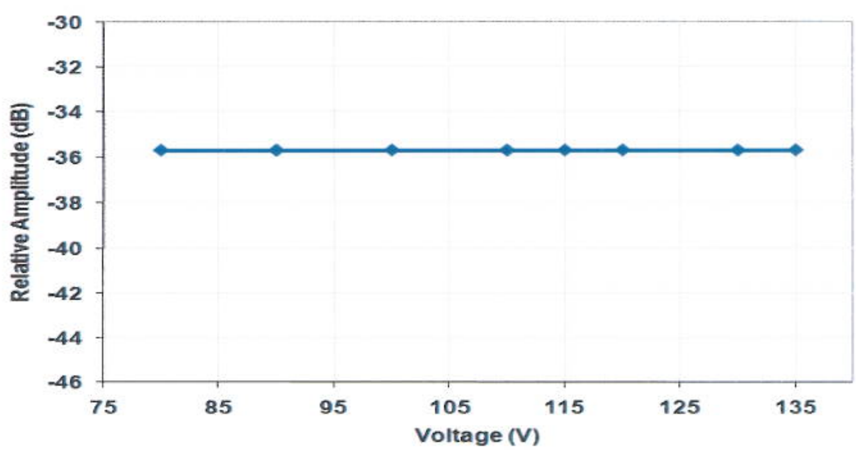


Figure 6.8. Relative emission at fundamental (f_M) vs. supply voltage (Stimulus 5.4).

Refer to separate Photo Exhibit file for this unit.

Refer to separate Photo Exhibit file for this unit.