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Measured Radio Frequency Emissions
From

Delphi SDARS Downconverter/Transmitter
Model(s): SA10116

Report No. 415031-246
May 9, 2005

For:
Delphi Automotive Systems
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Summary

Tests for compliance with FCC Regulations, according to Part 15.249, were performed on Delphi Automotive Systems SDARS Downconverter/Transmitter.

In testing completed on April 18, 2005, the device tested met the emission limits at the fundamental by more than 2.5 dB, at the band edges by more than 1.1 dB, and by 4.1 dB at the harmonics. Radiated digital emissions from circuitry used to enable the operation of the device meet the FCC/IC Class B limit by more than 2.9 dB. AC power line conducted emissions meet the FCC/IC Class B limit by more than 2.2 dB.

1. Introduction

Delphi Automotive Systems SDARS Downconverter/Transmitter was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989, and with Industry Canada RSS-210, Issue 5, dated November 10, 2001. 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 2057).

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.

Table 2.1. Test Equipment.

Test Instrument	Eqpt. Used	Manufacturer/Model
Spectrum Analyzer (0.1-1500 MHz)		Hewlett-Packard, 182T/8558B
Spectrum Analyzer (9kHz-22GHz)		Hewlett-Packard 8592L, SN: 3710A00856
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131
Spectrum Analyzer (9kHz-26GHz)		Hewlett-Packard 8563E, SN: 3310A01174
Spectrum Analyzer (9kHz-40GHz)		Hewlett-Packard 8564E, SN: 3745A01031
Power Meter		Hewlett-Packard, 432A
Power Meter		Anritsu, ML4803A/MP
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500
Harmonic Mixer (60-90 GHz)		Pacific Millimeter Prod., VN, SN: 47
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26
C-band horn (4 - 6.2 GHz)	X	University of Michigan, NRL design
Xn-band horn (6.0 – 8.4 GHz)	X	University of Michigan, NRL design
X-band horn (8.2- 12.4 GHz)		Narda 640
X-band horn (8.2- 12.4 GHz)	X	Scientific Atlanta , 12-8.2, SN: 730
K-band horn (18-26.5 GHz)		FXR, Inc., K638KF
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A
U-band horn (40-60 GHz)		Custom Microwave, HO19
V-band horn (60-90 GHz)		Custom Microwave, HO12
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3
Dipole Antenna Set (30-1000 MHz)		EMCO 2131C, SN: 992
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan
Amplifier (5-1000 MHz)		Avantek, A11-1, A25-1S
Amplifier (5-4500 MHz)	X	Avantek
Amplifier (4.5-13 GHz)	X	Avantek, AFT-12665
Amplifier (6-18 GHz)		Trek
Amplifier (18-26.5 GHz)		Avantek, AMT-26158-13
Vector Signal Generator	X	Agilent E4438C
Signal Generator	X	Rohde & Schwarz SMIQ 03S
LISN (50 µH)	X	University of Michigan
Signal Generator (0.1-2060 MHz)		Hewlett-Packard, 8657B

3. Configuration and Identification of Device Under Test

The Device Under Test (DUT) is a 902-928 MHz Downconverter/Transmitter. The device directly translates XM Satellite signals in the SDARS band centered at 2338.75 MHz to the 902-928 MHz ISM band. The size of the DUT is 6(W) x 4(H) x 1(D) inches. During testing, a pair of signal generators capable of XM satellite radio simulation were used to excite the DUT per the agreed upon specifications (see Section 5 of this report). Nominal operating voltage is 120 VAC.

The DUT was manufactured by Jabil Circuit Inc., 3800 Giddings Road, Auburn Hills, MI 48326. It is identified as:

Delphi SDARS Downconverter/Transmitter
Model(s): SA10116
S/N: 0047
FCC ID(s): L2C0029TR
IC(s): 3432A-0029TR

3.1 Changes made to the DUT

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

4. Emission Limits

4.1 Radiated Emission Limits (FCC 15.249, 15.209)

The DUT tested is a 902-928 MHz ISM band transmitter, subject to FCC 15.249, 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)

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (mV/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-210, 7.3)

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)

4.2 Conducted Emission Limits (FCC 15.107)

Table 4.3. Conducted emission limits (FCC:15.107 (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: dBμV = 50.25 - 19.12*log(f)

*Class B Average: dBμV = 40.25 - 19.12*log(f)

3. 9 kHz RBW

4.3 DUT Stimulus

Since the DUT acts as a downconverter / transmitter, 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"* and are outlined in this section.

4.3.1 Required Test Stimuli

This section outlines the test stimulus agreed upon between the FCC and Delphi [1]. The full set of modulation schemes below were tested as proscribed in [1]. However, in analyzing the data it was determined that a reduced test set, using only high, middle, and lower input power settings for each mode was sufficient to demonstrate compliance. If desired, the data for intermediate power levels can be provided.

Base Stimulus:
Base Satellite signal: Input power @ transmitter input: -66 dBm.
Modulation: QPSK
Bandwidth: 3.77 MHz
Frequency: 2334.385 MHz

XM Satellite Stimulus:
Satellite signal: Input power @ transmitter input: -55 to –75 dBm in 5 dB increments.
Modulation: QPSK
Bandwidth: 3.77 MHz
Frequencies: Test @ 2334.385 MHz and 2343.125 MHz

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

XM Terrestrial Stimulus:
Terrestrial signal: Input @ transmitter input: -20 to –70 dBm in 20 dB increments.
Modulation: OFDM (DQPSK carriers)
Bandwidth: 4.96 MHz
Frequency: Test @ 2338.75 MHz

Sirius Terrestrial Stimulus:
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).

4.4 Input Signal Discrimination Requirement
The FCC has agreed[1] 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.

4.5 Supply Voltage Variation (FCC 15.31(e))
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

The following table summarizes the test scenarios and their respective input test stimuli reported.

Table 5.1 Table of Radiated Test Stimuli[1]

Test Scenario	Stimuli
(5.1)	Base Stimulus: -66 dBm @ 2334.385 MHz Terrestrial QPSK
(5.2A)	XM Sat. Stimulus: (-55 to -75) dBm @ 2334.385 MHz XM QPSK
(5.2B)	XM Sat. Stimulus: (-55 to -75) dBm @ 2343.125 MHz XM QPSK
(5.3)	Sirius Sat. Stimulus: (-60 to -80) dBm @ 2322.293 MHz, SIR QPSK (including (5.1))
(5.4)	XM Terrestrial: (-20 to -70) dBm @ 2338.75 MHz, XM OFDM
(5.5)	Sir. Terrestrial: -20 dBm @ 2326.25 MHz, SIR OFDM (including (5.1))
(5.6)	Single Tone Spur: -81.6 dBm @ (2312 to 2352) MHz (including (5.1))

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 Anechoic Chamber Measurements

To familiarize with the radiated emission behavior of the DUT, the DUT was first studied and measured in a shielded 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. 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 FCC output power limits for all input signals (from the XM home antenna), the repeater transmitter uses active gain control (AGC) to limit the output power to the antenna. Rather than adjusting the bias condition for amplifiers, the AGC feedback loop uses PIN diode attenuators. Therefore, the bias condition of each amplifier does not depend upon the input signal conditions. It follows that the maximum power (and harmonic levels) from the final amplifier will occur when the input signal is maximized nearby the XM terrestrial repeaters. Thus, harmonic emissions are reported for testing under (5.4) XM terrestrial.

5.2.2 Open Area Test Site (OATS) Measurements

After the chamber measurements, the 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. 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, 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 (FCC 15.109)

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

6.2 Radiated Emissions – Peak to Average Ratio (FCC 15.249(e), 15.35)

Figure 6.2-6.3. Peak to Average Ratio (only worst case plots provided). Measurement distance is 3 m. The DUT demonstrates a quasi-peak to average ratio (f < 1000 MHz) of no less than 4.1 dB and a peak to average emissions ratio (f > 1000 MHz) of no more than 15.4 dB for all modes of testing.

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

Test Scenario	Quasi-Peak (dB)	Average (dB)
5.1	-11.0	-15.4
5.2 A	-4.6	-10.8
5.2 B	-5.0	-6.6
5.3	-11.0	-15.4
5.4	-4.1	-10.8
5.5	-11.0	-15.4
5.6	0.0 (CW Spur)	0.0 (CW Spur)

6.3 Radiated Emissions – Fundamental and Band Edges (FCC 15.249, 15.209)

Figures 6.4-6.10. Fundamental and Band Edge Radiated Emissions: 902 – 928 MHz (only the worst case plot for each type of stimuli is provided). RBW = 120 kHz, VBW > RBW for f < 1 GHz, RBW=1 MHz, VBW>RBW for f > 1 GHz; measurement distance is 3 m. (Pk > QPk where applicable. Limits are Quasi-Peak Limits) Data is reported in Table 6.3. For PEAK field strength measurements, the DUT meets the FCC 15.249 fundamental emissions limits by more than 2.5 dB, and the band edge emissions limits by more than 1.1 dB in the worst case.

6.4 Radiated Emissions - Harmonics (FCC 15.249)

Figure 6.3. Harmonic Radiated Emissions: RBW=1 MHz, VBW>RBW; measurement distance is 3 m. (Pk > QPk > Avg, where applicable. Limits are Average Limits) All emissions reported in Table 6.4. The DUT meets the harmonic emissions limits by 4.1 dB in the worst case.

6.5 Conducted Emissions (FCC 15.107)

Figures 6.11-6.14. Worst case conducted emissions. RBW = 9 kHz, VBW > RBW. The DUT meets conducted emissions limits by more than 2.2 dB in the worst case. All emissions reported in Table 6.5.

6.6 Effect of Supply Voltage Variation (FCC 15.31(e))

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 97.5 to 140 VAC. Figure 6.15 shows the emission power variation. Current at 120.0 VAC was 65 mA.

Table 6.1 Highest Digital Radiated Emissions Measured

Delphi SDARS; FCC 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	31.2	Bic	V	-76.2	Pk	13.8	22.7	21.9	40.0	18.1	noise
2	35.9	Bic	H	-76.9	Pk	13.0	22.6	20.5	40.0	19.5	noise
3	52.6	Bic	H	-77.2	Pk	11.4	22.3	18.9	40.0	21.1	noise
4	52.6	Bic	V	-72.6	Pk	11.4	22.3	23.5	40.0	16.5	noise
5	80.0	Bic	V	-71.5	Pk	11.1	21.9	24.7	40.0	15.3	noise
6	85.5	Bic	H	-76.4	Pk	11.3	21.9	20.1	40.0	19.9	noise
7	110.6	Bic	V	-76.2	Pk	12.6	21.6	21.9	43.5	21.6	noise
8	112.0	Bic	H	-63.6	Pk	12.7	21.5	34.6	43.5	8.9	background
9	133.3	Bic	V	-73.6	Pk	13.9	21.3	26.1	43.5	17.4	noise
10	142.0	Bic	H	-76.7	Pk	14.4	21.1	23.5	43.5	20.0	noise
11	142.0	Bic	V	-68.3	Pk	14.4	21.1	31.9	43.5	11.6	noise
12	171.9	Bic	H	-75.7	Pk	15.4	20.7	26.0	43.5	17.5	noise
13	171.9	Bic	V	-76.4	Pk	15.4	20.7	25.3	43.5	18.2	noise
14	213.8	Bic	H	-77.6	Pk	16.1	20.2	25.2	43.5	18.3	noise
15	213.8	Bic	V	-73.4	Pk	16.1	20.2	29.4	43.5	14.1	noise
16	233.6	Bic	H	-76.7	Pk	16.7	20.0	27.0	46.0	19.0	noise
17	249.1	Bic	H	-72.5	Pk	17.8	19.8	32.5	46.0	13.5	noise
18	249.1	Bic	V	-72.5	Pk	17.8	19.8	32.5	46.0	13.5	noise
19	255.4	SBic	H	-74.9	Pk	17.0	19.7	29.4	46.0	16.6	noise
20	300.3	SBic	H	-74.8	Pk	18.5	19.2	31.5	46.0	14.5	noise
21	328.2	SBic	V	-80.1	Pk	19.3	18.9	27.3	46.0	18.7	noise
22	335.9	SBic	H	-76.9	Pk	19.5	18.8	30.8	46.0	15.2	noise
23	400.9	SBic	H	-75.6	Pk	21.1	18.1	34.4	46.0	11.6	noise
24	443.4	SBic	H	-77.5	Pk	22.0	17.6	33.9	46.0	12.1	noise
25	523.4	SBic	H	-78.4	Pk	23.5	18.2	33.9	46.0	12.1	noise
26	610.0	SBic	H	-85.9	Pk	24.9	17.4	28.6	46.0	17.4	noise
27	641.1	SBic	H	-78.5	Pk	25.4	17.2	36.7	46.0	9.3	noise
28	821.9	SBic	H	-75.7	Pk	27.6	15.8	43.1	46.0	**2.9**	background
29	829.3	SBic	V	-82.7	Pk	27.7	15.8	36.2	46.0	9.8	noise
30	986.2	SBic	H	-76.2	Pk	29.3	14.8	45.2	54.0	8.8	noise
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. 4/18/2005; U of Mich.

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

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. dBuV	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass* dB	Comments
	Radiated Emissions										Delphi SDARS
	(5.1) Base Stimulus: -66 dBm @ 2334.385 MHz Terrestrial QPSK										
1	909.5	Dip	V	76.6	Pk	28.5	15.3	89.9	94.0	4.1	
2	902.0	Dip	V	30.5	Pk	28.5	15.3	43.6	46.0	2.4	noise floor
3	928.0	Dip	V	31.3	Pk	28.7	15.2	44.9	46.0	**1.1**	noise floor
4											
5											
	(5.2A) XM Sat. Stimulus: -55 dBm @ 2334.385 MHz XM QPSK										
6	909.7	Dip	V	78.3	Pk	28.5	15.3	91.5	94.0	**2.5**	
7	909.7	Dip	V	73.8	QPk	28.5	15.3	87.1	94.0	6.9	
8	902.0	Dip	V	29.6	Pk	28.5	15.3	42.7	46.0	3.3	noise floor
9	928.0	Dip	V	29.9	Pk	28.7	15.2	43.4	46.0	2.6	noise floor
10											
	(5.2A) XM Sat. Stimulus: -65 dBm @ 2334.385 MHz XM QPSK										
11	910.1	Dip	V	76.9	Pk	28.5	15.3	90.2	94.0	3.8	
12	902.0	Dip	V	28.7	Pk	28.5	15.3	41.9	46.0	4.1	noise floor
13	928.0	Dip	V	28.4	Pk	28.7	15.2	42.0	46.0	4.0	noise floor
14											
15											
	(5.2A) XM Sat. Stimulus: -75 dBm @ 2334.385 MHz XM QPSK										
16	910.6	Dip	V	66.1	Pk	28.5	15.3	79.3	94.0	14.7	
17	902.0	Dip	V	30.1	Pk	28.5	15.3	43.3	46.0	2.7	noise floor
18	928.0	Dip	V	28.6	Pk	28.7	15.2	42.2	46.0	3.8	noise floor
19											
20											
	(5.2B) XM Sat. Stimulus: -55 dBm @ 2343.125 MHz XM QPSK										
21	910.6	Dip	V	76.1	Pk	28.5	15.3	89.4	94.0	4.6	
22	902.0	Dip	V	30.0	Pk	28.5	15.3	43.2	46.0	2.8	noise floor
23	928.0	Dip	V	30.1	Pk	28.7	15.2	43.7	46.0	2.3	noise floor
24											
25											
	(5.2B) XM Sat. Stimulus: -65 dBm @ 2343.125 MHz XM QPSK										
26	918.2	Dip	V	74.8	Pk	28.6	15.2	88.2	94.0	5.8	
27	902.0	Dip	V	27.8	Pk	28.5	15.3	41.0	46.0	5.0	noise floor
28	928.0	Dip	V	29.0	Pk	28.7	15.2	42.6	46.0	3.4	noise floor
29											
30											
	(5.2B) XM Sat. Stimulus: -75 dBm @ 2343.125 MHz XM QPSK										
31	919.5	Dip	V	64.5	Pk	28.6	15.2	77.9	94.0	16.1	
32	902.0	Dip	V	28.5	Pk	28.5	15.3	41.7	46.0	4.3	noise floor
33	928.0	Dip	V	29.0	Pk	28.7	15.2	42.6	46.0	3.4	noise floor
34											
35											

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

Radiated Emissions											Delphi SDARS
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. dBuV	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass* dB	Comments
(5.3) Sirius Sat. Stimulus: -60 dBm @ 2322.293 MHz, SIR QPSK (including (5.1))											
1	909.7	Dip	V	75.2	Pk	28.5	15.3	88.5	94.0	5.5	
2	902.0	Dip	V	28.6	Pk	28.5	15.3	41.8	46.0	4.2	noise floor
3	928.0	Dip	V	31.2	Pk	28.7	15.2	44.8	46.0	1.2	noise floor
4											
5											
(5.3) Sirius Sat. Stimulus: -70 dBm @ 2322.293 MHz, SIR QPSK (including (5.1))											
6	909.1	Dip	V	74.2	Pk	28.5	15.3	87.5	94.0	6.5	
7	902.0	Dip	V	29.1	Pk	28.5	15.3	42.3	46.0	3.7	noise floor
8	928.0	Dip	V	27.2	Pk	28.7	15.2	40.8	46.0	5.2	noise floor
9											
10											
(5.3) Sirius Sat. Stimulus: -80 dBm @ 2322.293 MHz, SIR QPSK (including (5.1))											
11	910.2	Dip	V	75.0	Pk	28.5	15.3	88.3	94.0	5.7	
12	902.0	Dip	V	27.7	Pk	28.5	15.3	40.9	46.0	5.1	noise floor
13	928.0	Dip	V	29.6	Pk	28.7	15.2	43.2	46.0	2.8	noise floor
14											
15											
(5.4) XM Terrestrial: -20 dBm @ 2338.75 MHz, XM OFDM											
16	914.2	Dip	V	74.0	Pk	28.6	15.2	87.3	94.0	6.7	
17	902.0	Dip	V	30.8	Pk	28.5	15.3	44.0	46.0	2.0	noise floor
18	928.0	Dip	V	27.9	Pk	28.7	15.2	41.5	46.0	4.5	noise floor
19											
20											
(5.4) XM Terrestrial: -40 dBm @ 2338.75 MHz, XM OFDM											
21	916.7	Dip	V	72.9	Pk	28.6	15.2	86.3	94.0	7.7	
22	902.0	Dip	V	27.7	Pk	28.5	15.3	40.9	46.0	5.1	noise floor
23	928.0	Dip	V	28.3	Pk	28.7	15.2	41.9	46.0	4.1	noise floor
24											
25											
(5.4) XM Terrestrial: -60 dBm @ 2338.75 MHz, XM OFDM											
26	917.3	Dip	V	73.4	Pk	28.6	15.2	86.8	94.0	7.2	
27	902.0	Dip	V	28.8	Pk	28.5	15.3	42.0	46.0	4.0	noise floor
28	928.0	Dip	V	28.9	Pk	28.7	15.2	42.5	46.0	3.5	noise floor
29											
30											
(5.4) XM Terrestrial: -70 dBm @ 2338.75 MHz, XM OFDM											
31	916.8	Dip	V	65.2	Pk	28.6	15.2	78.6	94.0	15.4	
32	902.0	Dip	V	28.1	Pk	28.5	15.3	41.3	46.0	4.7	noise floor
33	928.0	Dip	V	28.4	Pk	28.7	15.2	42.0	46.0	4.0	noise floor
34											
35											

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

Radiated Emissions										Delphi SDARS
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. dBuV	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass* dB	Comments
(5.5) Sir. Terrestrial: -20 dBm @ 2326.25 MHz, SIR OFDM (including (5.1))											
1	904.6	Dip	V	68.4	Pk	28.5	15.3	81.6	94.0	12.4	
2	902.0	Dip	V	28.4	Pk	28.5	15.3	41.6	46.0	4.4	noise floor
3	928.0	Dip	V	29.3	Pk	28.7	15.2	42.9	46.0	3.1	noise floor
4											
5											
(5.6) Single Tone Spur: -81.6 dBm @ 2312 - 2352 MHz (1 MHz increments) (including (5.1))											
6	907.3	Dip	V	65.0	Pk	28.5	15.3	78.2	94.0	15.8	
7	908.3	Dip	V	67.0	Pk	28.5	15.3	80.3	94.0	13.7	
8	909.4	Dip	V	77.0	Pk	28.5	15.3	90.3	94.0	3.7	
9	916.3	Dip	V	61.2	Pk	28.6	15.2	74.6	94.0	19.4	
10	917.3	Dip	V	62.6	Pk	28.6	15.2	76.0	94.0	18.0	
11	918.3	Dip	V	63.9	Pk	28.6	15.2	77.3	94.0	16.7	
12	919.3	Dip	V	64.5	Pk	28.6	15.2	77.9	94.0	16.1	
13	920.3	Dip	V	64.0	Pk	28.6	15.2	77.4	94.0	16.6	
14	921.3	Dip	V	61.8	Pk	28.7	15.2	75.3	94.0	18.7	
15	902.0	Dip	V	31.0	Pk	28.5	15.3	44.2	46.0	1.8	noise floor
16	928.0	Dip	V	30.0	Pk	28.7	15.2	43.6	46.0	2.4	noise floor
17											
18											
19											
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U. of Mich; Meas. 4/18/2005

Table 6.4 15.249 Radiated Emissions - Harmonics

Radiated Emissions - Harmonics											Delphi SDARS
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. (PK) dBm	Det. Used	Ka dB/m	Kg dB	E3 dBµV/m	E3lim dBµV/m	Pass* dB	Comments
(5.4) XM Terrestrial Signal Stimulus - Worst Case Harmonics											
1	914.2	Dip	V	-33.0	Pk	28.6	15.2	87.3	94.0	6.7	
2	1828.4	Horn	H/V	-42.0	Pk	22.1	28.0	59.1			
3	1828.0	Horn	H/V	-49.0	QPk	22.1	28.0	52.1			
4	1828.0	Horn	H/V	-53.0	Avg	22.1	26.2	49.9	54.0	**4.1**	
5	2746.5	Horn	H/V	-49.1	Pk	24.8	26.2	56.5			
6	2746.5	Horn	H/V	-56.1	QPk	24.8	25.8	49.9			
7	2746.5	Horn	H/V	-60.1	Avg	24.8	26.2	45.5	54.0	8.5	
8	3656.8	Horn	H/V	-69.1	Pk	27.5	26.1	39.2	54.0	14.8	noise
9	4571.0	Horn C	H/V	-65.2	Pk	24.5	26.1	40.2	54.0	13.8	noise
10	5485.2	Horn C	H/V	-61.7	Pk	24.8	26.1	44.0	54.0	10.0	noise
11	6399.4	Horn XN	H/V	-60.0	Pk	24.4	26.1	45.4	54.0	8.6	noise
12	7313.6	Horn XN	H/V	-60.7	Pk	25.2	26.1	45.4	54.0	8.6	noise
13	8227.8	Horn X	H/V	-62.4	Pk	27.0	26.1	45.6	54.0	8.4	noise
14	9142.0	Horn X	H/V	-60.8	Pk	27.5	26.0	47.7	54.0	6.3	noise
15											
16											
17	Note:	It was determined (as explained in the the test report) that the worst case harmonic emissions									
18		come during the XM Terrestrial Stimulus (5.4) due to its higher input power level.									
19											
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Table 6.5 Highest Conducted Emissions Measured

												Delphi SDARS; FCC/CISPR 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	0.16	Lo	54.8	55.5	0.7	47.0	65.5	18.5	20.6	55.5	34.9	
2	0.16	Lo	54.7	55.4	0.7	46.9	65.4	18.5	20.5	55.4	34.9	
3	0.17	Lo	54.4	55.0	0.6	46.6	65.1	18.5	20.0	55.0	35.0	
4	0.18	Lo	53.8	54.6	0.8	46.2	64.6	18.4	19.8	54.6	34.8	
5	0.20	Lo	52.9	53.6	0.7	45.0	63.6	18.6	18.8	53.6	34.8	
6	0.22	Lo	52.3	52.9	0.6	44.3	62.9	18.6	18.3	52.9	34.6	
7	0.24	Lo	51.5	52.1	0.6	49.4	62.2	12.8	17.8	52.1	34.3	
8	0.25	Lo	50.9	51.7	0.8	42.9	61.8	18.9	17.5	51.7	34.2	
9	0.27	Lo	50.6	51.2	0.6	42.4	61.3	18.9	17.1	51.2	34.1	
10	0.29	Lo	50.0	50.6	0.6	41.6	60.7	19.1	16.7	50.6	33.9	
11	0.30	Lo	49.2	50.1	0.9	41.1	60.2	19.1	16.6	50.1	33.5	
12	0.35	Lo	48.1	49.0	0.9	39.6	59.0	19.4	16.0	49.0	33.0	
13	0.36	Lo	48.0	48.8	0.8	39.5	58.8	19.3	15.9	48.8	32.9	
14	0.38	Lo	47.2	48.1	0.9	38.6	58.2	19.6	15.8	48.1	32.3	
15	0.40	Lo	46.8	47.9	1.1	38.2	58.0	19.8	15.7	47.9	32.2	
16	0.40	Lo	46.5	47.9	1.4	38.2	57.9	19.7	15.7	47.9	32.2	
17	0.41	Lo	46.1	47.7	1.6	37.8	57.7	19.9	15.6	47.7	32.1	
18	0.45	Lo	45.3	46.9	1.6	36.9	57.0	20.1	15.6	46.9	31.3	
19	0.53	Lo	44.1	46.0	1.9	35.3	56.0	20.7	15.0	46.0	31.0	
20	0.67	Lo	42.9	46.0	3.1							
21	0.90	Lo	39.6	46.0	6.4							
22	1.13	Lo	34.2	46.0	11.8							
23	7.95	Lo	39.0	50.0	11.0							
24	13.73	Lo	37.3	50.0	12.7							
25	21.75	Lo	31.2	50.0	18.8							
26	23.93	Lo	34.1	50.0	15.9							
27												
28	0.11	Hi	56.7	58.9	**2.2**							
29	0.33	Hi	46.1	49.5	3.4							
30	0.36	Hi	44.9	48.7	3.8							
31	0.57	Hi	40.2	46.0	5.8							
32	0.55	Hi	39.3	46.0	6.7							
33	0.72	Hi	38.8	46.0	7.2							
34	0.80	Hi	36.7	46.0	9.3							
35	0.76	Hi	36.2	46.0	9.9							
36	1.50	Hi	32.2	46.0	13.8							
37	8.02	Hi	38.2	50.0	11.8							
38	13.65	Hi	34.8	50.0	15.2							
39	21.68	Hi	33.5	50.0	16.5							
40	24.00	Hi	32.5	50.0	17.5							
41												
42	Note:	Worst case emissions measured. No observed change to digital emissions										
40		for different modes of operation.										

**Average limit* Meas. 4/18/2005; U of Mich.

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

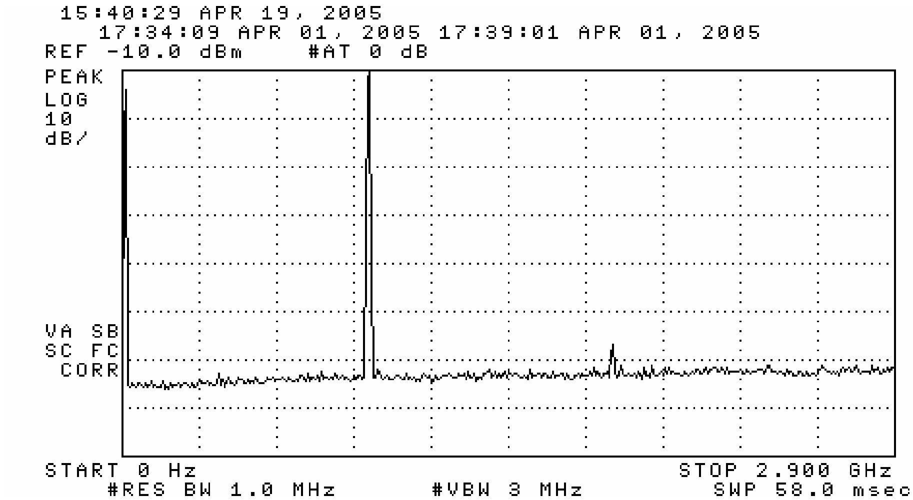


Figure 6.1. Emission spectrum of the DUT. The amplitudes are only indicative (not calibrated).

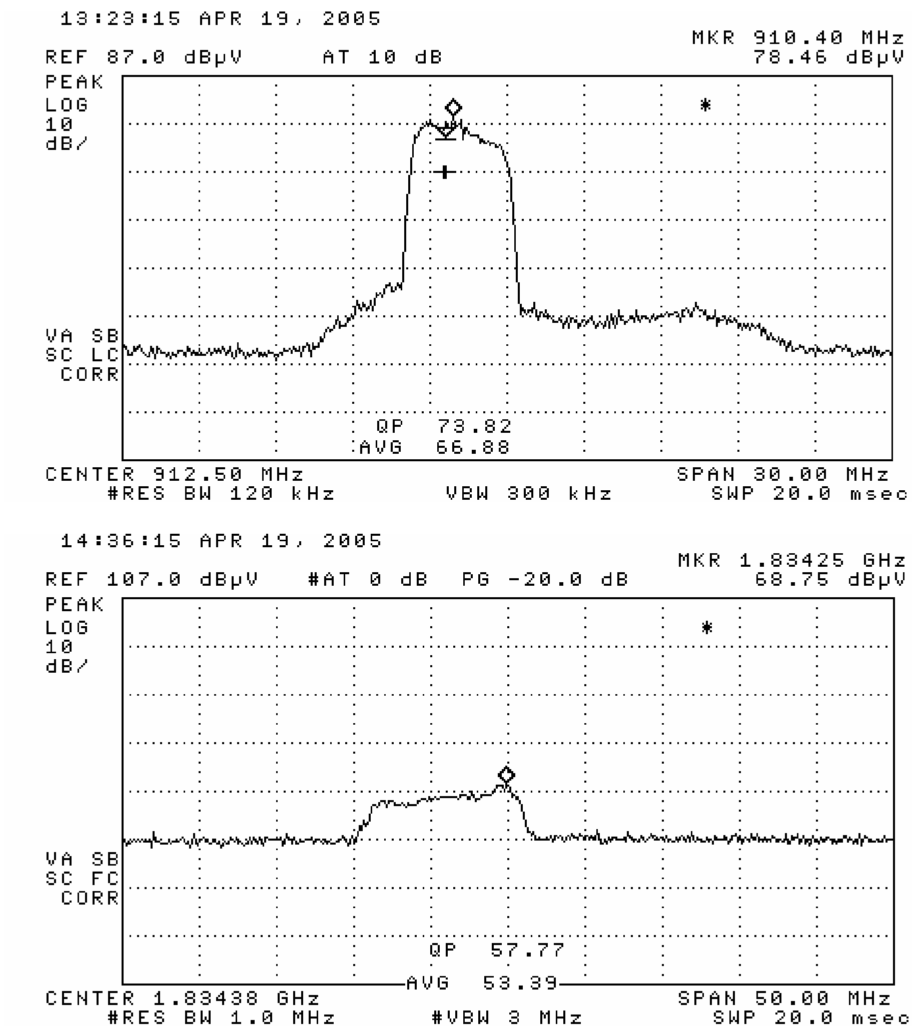
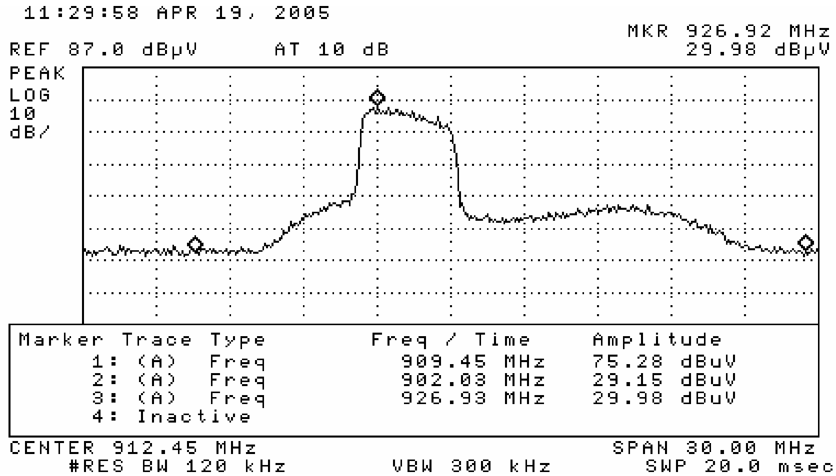
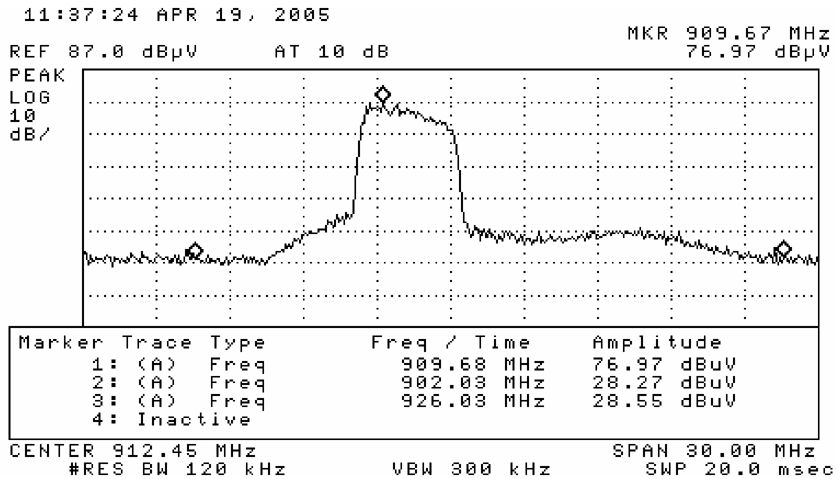
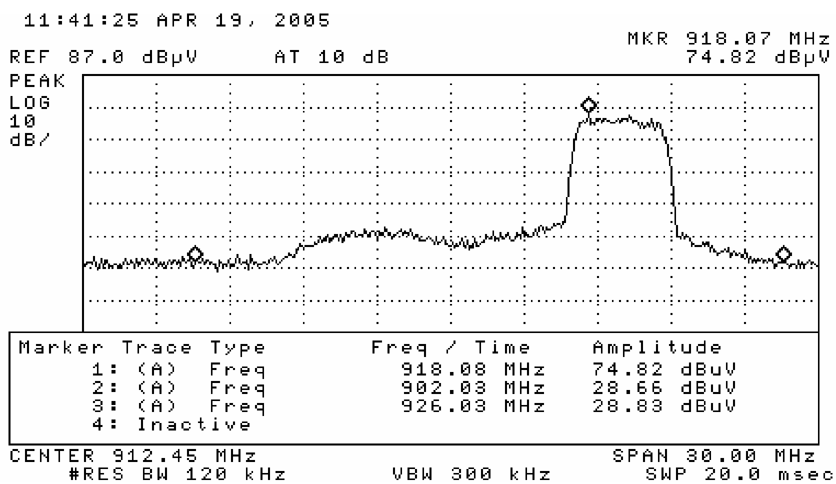


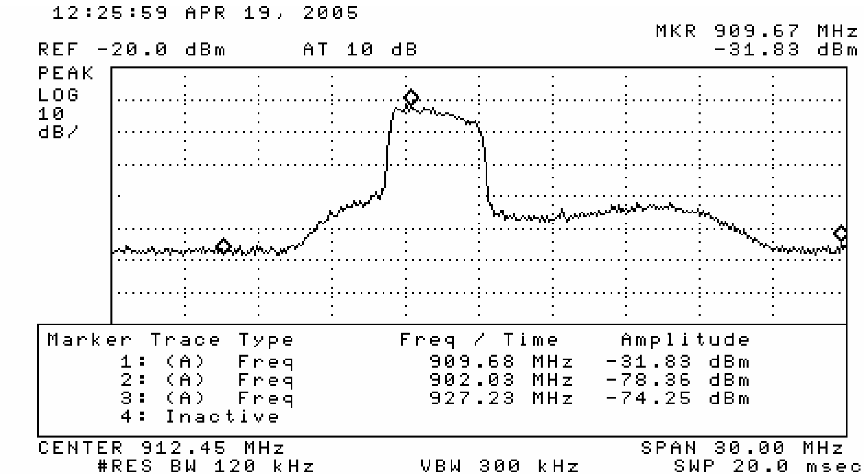
Figure 6.2-6.3. Peak to QPk / Avg. Ratio (1) Fundamental, (2) Harmonics (Scenario (5.4))

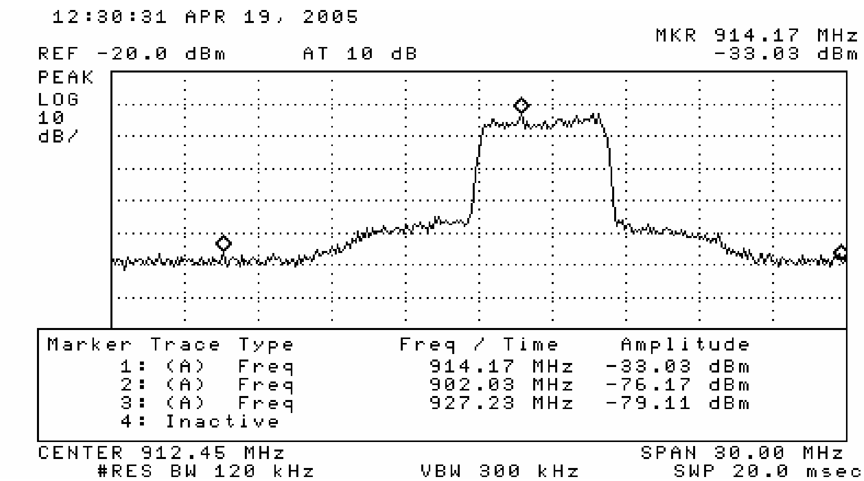


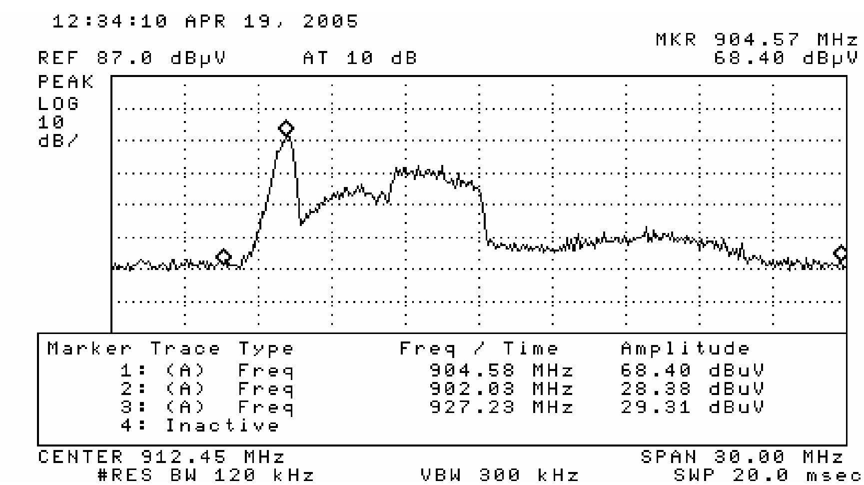




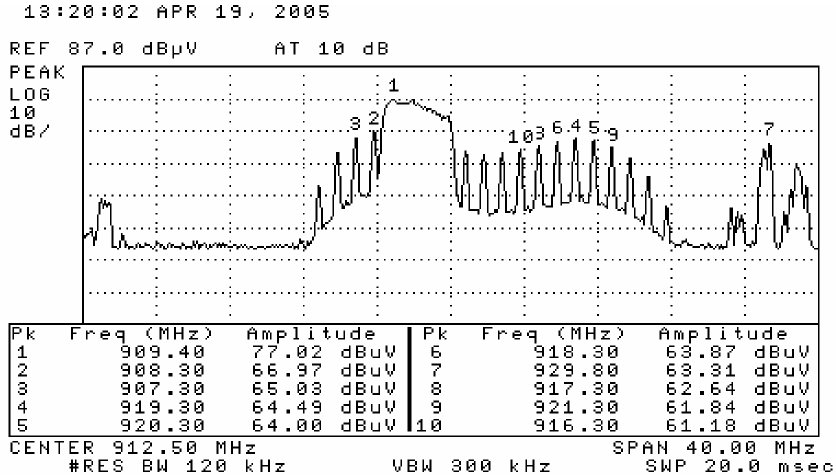
Figures 6.4-6.6. (Scenario (5.1)), (Scenario (5.2A)), (Scenario (5.2B)). Note: The 928 MHz band edge was determined to be lower than 926 MHz measurement for all modes in Anechoic Chamber measurements. OATS measurements demonstrating compliance near 928 MHz were not possible due to ambient noise.





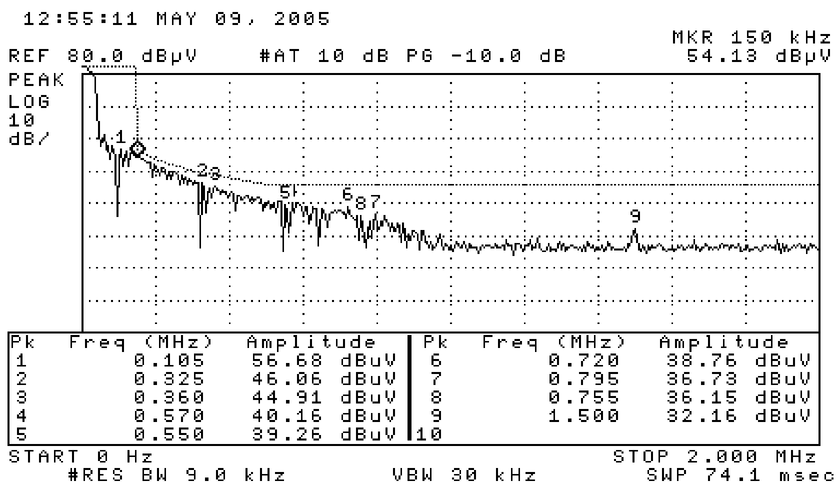


Figures 6.7-6.9. (Scenario (5.3)), (Scenario (5.4)), (Scenario (5.5)). Note: The 928 MHz band edge was determined to be lower than 926 MHz measurement for all modes in Anechoic Chamber measurements. OATS measurements demonstrating compliance near 928 MHz were not possible due to ambient noise.

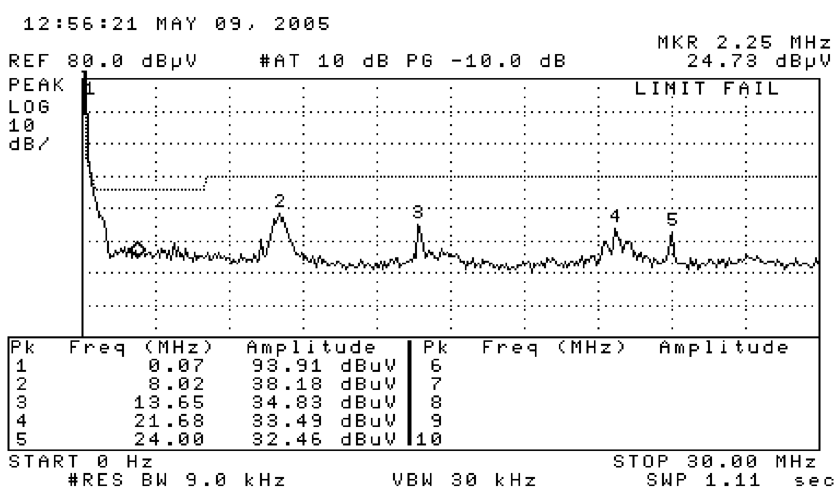


Pk	Freq (MHz)	Amplitude	Pk	Freq (MHz)	Amplitude
1	909.40	77.02 dBuV	6	918.30	63.87 dBuV
2	908.30	66.97 dBuV	7	929.80	63.31 dBuV
3	907.30	65.03 dBuV	8	917.30	62.64 dBuV
4	919.30	64.49 dBuV	9	921.30	61.84 dBuV
5	920.30	64.00 dBuV	10	916.30	61.18 dBuV

Figures 6.10. (Scenario (5.6) Max Hold), Note: The 928 MHz band edge was determined to be lower than 926 MHz measurement in Anechoic Chamber measurements. OATS measurements demonstrating compliance near 928 MHz were not possible due to ambient noise (as demonstrated - point 7).



Pk	Freq (MHz)	Amplitude	Pk	Freq (MHz)	Amplitude
1	0.105	56.68 dBuV	6	0.720	38.76 dBuV
2	0.325	46.06 dBuV	7	0.795	36.73 dBuV
3	0.360	44.91 dBuV	8	0.755	36.15 dBuV
4	0.570	40.16 dBuV	9	1.500	32.16 dBuV
5	0.550	39.26 dBuV	10		



Pk	Freq (MHz)	Amplitude	Pk	Freq (MHz)	Amplitude
1	0.07	93.91 dBuV	6		
2	8.02	38.18 dBuV	7		
3	13.65	34.83 dBuV	8		
4	21.68	33.49 dBuV	9		
5	24.00	32.46 dBuV	10		

Figure 6.11-6.12. Conducted Emissions (5.4), HI line – (0-2 MHz) (0-30 MHz)

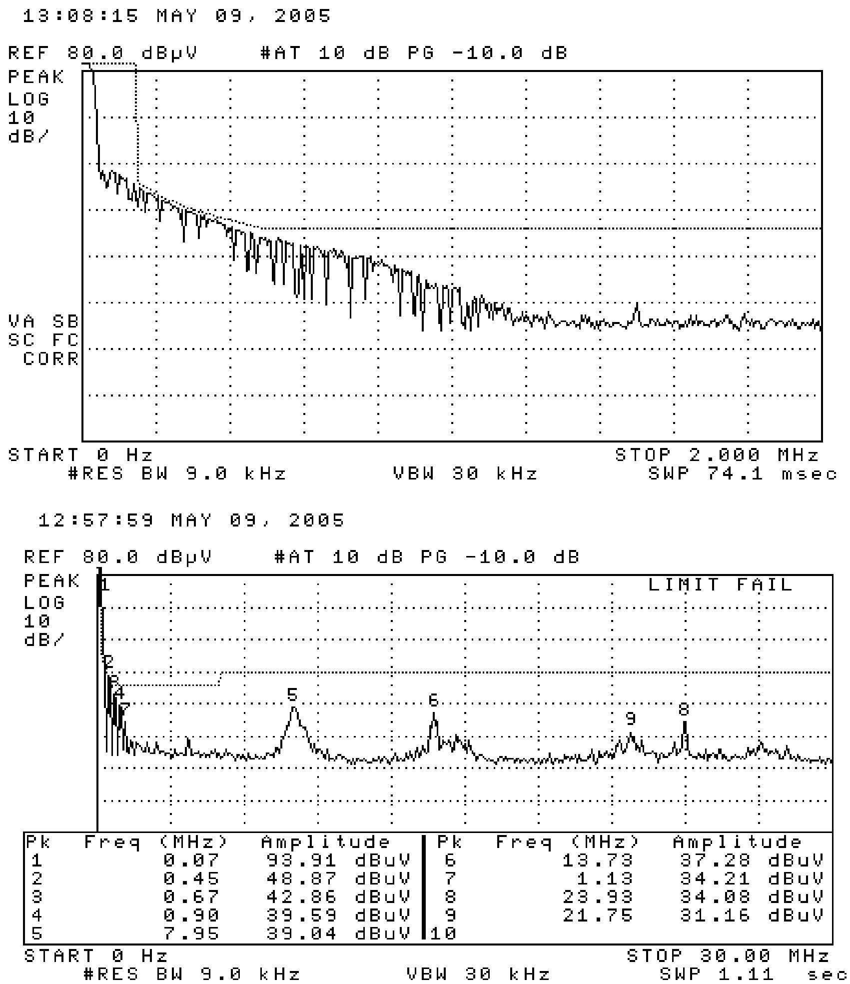


Figure 6.13-6.14. Conducted Emissions (5.4) LO line – (0-2 MHz) (0-30 MHz)

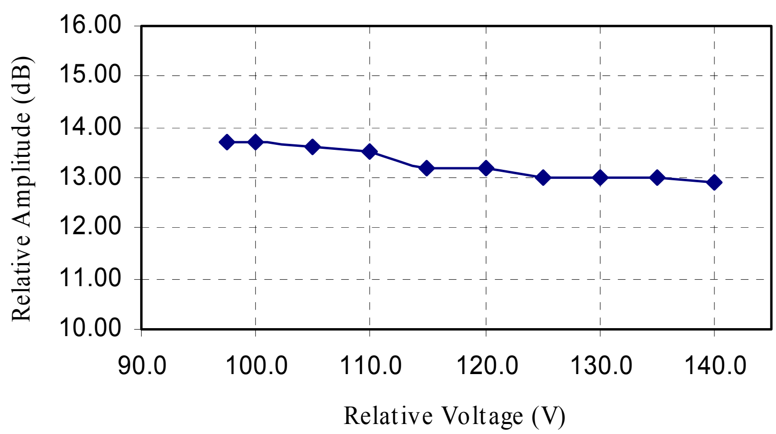


Figure 6.15. Relative emission at fundamental (f_M) vs. supply voltage (5.4).