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Measured Radio Frequency Emissions
From

College Park iPECS DCM
FCC ID: YYU104441
IC: 9356A-104441

Test Report No. 417124-592
December 10, 2010

For:
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Summary

Tests for compliance with FCC Regulations, CFR 47, Part 15 and with Industry Canada RSS-210/Gen, were performed on a College Park, FCC ID: YYU104441, IC: 9356A-104441. This device under test (DUT) is subject to the rules and regulations as a Transceiver.

In testing completed on November 15, 2010, the DUT tested met the allowed specifications for fundamental radiated emissions by 3.1 dB. Band edge and restricted band radiated emissions met the specified limit by more than 0.4 dB. Emissions from digital circuitry met the FCC Class A emissions limits by more than 19.8 dB. AC mains power emissions meet the allowed specifications for conducted emissions by 4.4 dB.

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1. Introduction

This College Park Transceiver 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. 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". 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. 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
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500	HP11970U1
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179	HP11970W1
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26	PMPGMA1
S-Band Std. Gain Horn	X	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		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)	X	Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)	X	FXR, Inc., K638KF	KBAND1
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A	KABAND1
U-band horn (40-60 GHz)		Custom Microwave, HO19	UBAND1
W-band horn(75-110 GHz)		Custom Microwave, HO10	WBAND1
G-band horn (140-220 GHz)		Custom Microwave, HO5R	GBAND1
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)	X	Avantek	AVAMP4
LISN Box	X	University of Michigan	UMLISN1
Signal Generator		Hewlett-Packard 8657B	HPSG1

3. Device Under Test

3.1 Description & Block Diagram
The DUT is a low power transceiver operating in the 2400 - 2483.5 MHz band. The DUT measures 14 x 6 x 19 cm and is sold for commercial/research use with either an internal whip monopole antenna or one of a number of external patch antennas. The DUT was designed and manufactured by College Park Industries Inc., 17505 Helro Drive, Fraser, MI 48026.

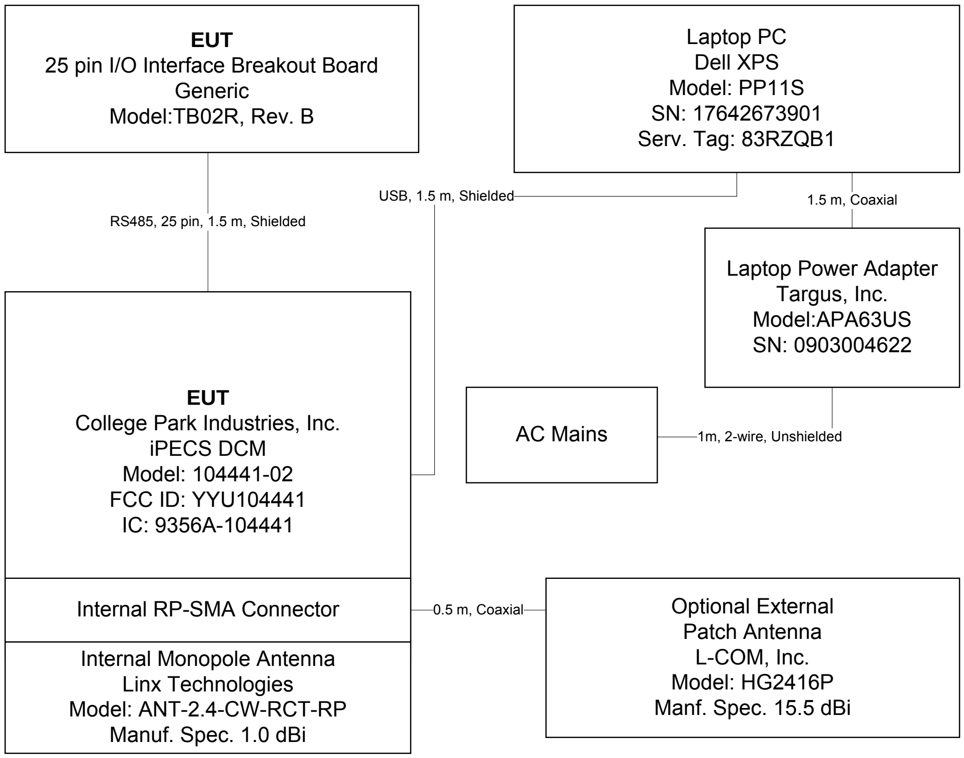

Figure 3.1 Block Diagram of DUT as Tested

Device	[Make], Model	SN	EMC Consideration
DUT	[College Park], 104441-02	EMC#1	FCC 15.249 IC RSS-210 Commercial Product
Internal Monopole	[Linx Tech], ANT-2.4-CW-RCT-RP		Manuf. Spec. 1.0 dBi
External Patch Antenna	[l-COM, Inc.], HG2416P		Manf. Spec. 15.5 dBi

3.2 Variants & Samples
There is only a single variant of the DUT with a range of antenna configurations, as listed below. One normal operating test sample was provided along with a monopole and the highest gain patch antenna with which the product will be sold. Test software and the laptop computer were provided to power and control the device’s channel selection and data rate for testing purposes.

3.3 Modes of Operation
This device operates in only a single mode, data transmission and reception, and is for use in commercial research facilities. The operating mode of this transceiver does not influence peak output power. There is only one transmitter which is driven by identical input parameters regardless of DUT data rate. Maximum

DUT on time in a 100 ms window occurred at the highest data rate, as tested for both maximum-gain antennas provided.

3.4 List of Antennas

The manufacturer intends to sell this product with a range of antenna options as listed below. The worst-case antennas (highest gain) of both types have been tested and results of this testing are reported herein. The operating frequencies that may be employed by this system when using the antennas below are also listed in this configuration table. The EUT employs an internal RP-SMA connector, antennas are professionally installed.

<table>
<tr><th>Antenna Type</th><th>[Make], Model</th><th>Manufacturer Gain</th><th>Operating Channels</th></tr>
<tr><td>Integral Monopole</td><td>[Linx Tech], ANT-2.4-CW-RCT-RP</td><td>1.0 dBi</td><td>2402-2480 MHz</td></tr>
<tr><td>External Patch</td><td>[L-COM, Inc.], HyperGain HG2416P</td><td>15.5 dBi</td><td rowspan="6">2404-2480 MHz</td></tr>
<tr><td>External Patch</td><td>[L-COM, Inc.], HyperGain HG2409P</td><td>9 dBi</td></tr>
<tr><td>External Patch</td><td>[L-COM, Inc.], HyperGain HG2409PCL</td><td>8 dBic (5 dBi)</td></tr>
<tr><td>External Patch</td><td>[L-COM, Inc.], HyperGain HG2409PCR</td><td>8 dBic (5 dBi)</td></tr>
<tr><td>External Patch</td><td>[L-COM, Inc.], HyperGain HG2408P</td><td>8 dBi</td></tr>
<tr><td>External Patch</td><td>[L-COM, Inc.], HyperGain RE06P</td><td>6 dBi</td></tr>
</table>

3.5 Exemptions

None.

3.6 EMC Relevant Modifications

No EMI relevant modifications were performed by this test laboratory.

4. Emissions Limits

4.1 Radiated Emissions Limits

The DUT tested falls under the category of an Intentional Radiator. The applicable testing frequencies and corresponding emission limits set by both the FCC and IC are given in Tables 4.1 and 4.2 below.

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

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (μV/m)
902.0 – 928.0	50	500
2400 - 2483.5	50	500
5725.0 – 5875.0	50	500
24000.0 – 24250.0	250	2500

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. (15.35)

Table 4.2. Spurious Emission Limits (FCC: 15.33, .35, .109/209; IC: RSS-210 2.7, T2)

Freq. (MHz)	E_{lim} (3m) μV/m	E_{lim} dB(μV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW), Quasi-Peak readings apply to 1000 MHz (120 kHz RBW), PRF of intentional emissions > 20 Hz for QPK to apply.

4.2 Power Line Conducted Emissions Limits

Table 4.3 Emission Limits (FCC:15.107 (CISPR); IC: RSS-Gen, 7.2.2 T2).

Frequency (MHz)	Class A (dBμV)		Class B (dBμV)	
	Quasi-peak	Average	Quasi-peak	Average
.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 0.15-0.50 MHz:
   *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

5. Measurement Procedures

5.1 Semi-Anechoic Chamber Radiated Emissions

To become familiar with the radiated emission behavior of the DUT, the device is first studied and measured in our 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.

The DUT is laid on the test table as shown in the included block diagram and/or photographs. A shielded loop antenna is employed when studying emissions from 9 kHz to 30 MHz. Above 30 MHz and below 250 MHz a biconical antenna is employed. Above 250 MHz a ridge or and standard gain horn antennas are used. The spectrum analyzer resolution and video bandwidths are set so as to measure the DUT emission without decreasing the emission bandwidth (EBW) of the device. Emissions are studied for all orientations (3-axes) of the DUT and all test antenna polarizations. In the chamber, spectrum and modulation characteristics of intentional carriers are recorded. Receiver spurious emissions are measured with an appropriate carrier signal applied. Associated test data is presented in subsequent sections.

5.2 Outdoor Radiated Emissions

After measurements are performed indoors, emissions on our outdoor 3-meter Open Area Test Site (OATS) are made. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. Any intentionally radiating elements are placed on the test table flat, on their side, and on their end (3-axes) and worst case emissions are recorded. For each configuration the DUT is rotated 360 degrees about its azimuth and the receive antenna is raised and lowered between 1 and 4 meters to maximize radiated emissions from the device. Receiver spurious emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, our shielded loop antenna at a 1 meter received height is used. Low frequency field extrapolation to the regulatory limit distance is employed as needed. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or biconical antennas. Care is taken to ensure that the RBW and VBW used meet the regulatory requirements, and that the EBW of the DUT is not reduced. The Photographs included in this report show the DUT on the OATS.

5.3 Radiated Field Computations

To convert the dBm values measured on the spectrum analyzer to dB(μV/m), we use expression

$$E3(dB\mu V/m) = 107 + PR + KA - KG + KE - CF$$

where	PR	=	power recorded on spectrum analyzer, dB, measured at 3 m
	KA	=	antenna factor, dB/m
	KG	=	pre-amplifier gain, including cable loss, dB
	KE	=	duty correction factor, dB
	CF	=	distance conversion (employed only if limits are specified at alternate distance), dB

When presenting the data at each frequency, the highest measured emission under all of the possible DUT orientations (3-axes) is given.

5.4 Indoor Power Line Conducted Emissions

When applicable, power line conducted emissions are measured in our semi-anechoic chamber. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration.

The conducted emissions measured with the spectrum analyzer and recorded (in dBμV) from 0-2 MHz and 2-30 MHz for both the ungrounded (Hi) and grounded (Lo) conductors. The spectrum analyzer is set to peak-hold mode in order to record the highest peak throughout the course of functional operation. Only when the emission exceeds or is near the limit are quasi-peak and average detection used.

5.5 Supply Voltage Variation
Measurements of the variation in the fundamental radiated emission were performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value. For battery operated equipment, tests were performed using a fully charged battery, and worst case emissions are re-checked employing a fully charged battery.

6. Test Results

6.1 Radiated Emissions

6.1.1 Peak to Average Ratio
The DUT in normal operating mode is capable of a number of data rates depending on the number of commands sent from the DCM to the iPECS Sensor by the software user. However, the worst case (maximum on-time) transmission rate is limited to a packet width of 288 us with a packet period of 1.1704 ms. All other transmission rates exhibit a shorter packet width with the same or reduced packet period. See Figure 6.1. This results in a worst case duty cycle of:

$$K_E = 0.288 \text{ ms} / 1.1704 \text{ ms} = 0.246 = -12.2 \text{ dB}.$$

6.1.2 Emission Bandwidth
The emission bandwidth of the signal is shown in Figure 6.2. Therein the worst case 99% emission bandwidth was measured to 1.725 MHz.

6.1.3 Supply Voltage and Supply Voltage Variation
The DUT has been designed to be powered over a 5 VDC USB cable from a Commercial Personal Computer. For this test, relative radiated power was measured at the fundamental as input to the laptop power adapter was varied from 90 to 140 VAC. The emission variation is shown in Figure 6.3.

6.2 Conducted Emissions
Results of AC mains conducted emissions are depicted in Table 6.3. Emissions were measured with the DUT in a charging state drawing maximum current.

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Table 6.1(a) Highest Emissions Measured

Radiated Emission - RF											CPI, DCM+Monopole; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr(Pk) dBm	Pr(Avg) Used	Ka dB/m	Kg dB	E3* dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	2402.0	Horn S	H	-35.7	-47.9	21.5	- 1.2	81.8	94.0	12.2	low channel
2	2441.0	Horn S	H	-32.5	-44.7	21.5	- 1.2	85.0	94.0	9.0	mid channel
3	2480.0	Horn S	H	-30.8	-43.0	21.5	- 1.2	86.7	94.0	**7.3**	high channel
4											
5	4804.0	Horn C	H	-49.3	-61.5	24.6	21.1	49.0	54.0	5.0	low channel
6	4882.0	Horn C	H	-44.9	-57.1	24.6	20.9	53.6	54.0	**0.4**	mid channel
7	4960.0	Horn C	H	-49.0	-61.2	24.6	20.7	49.8	54.0	4.2	high channel
8	7206.0	Horn XN	H	-56.8	-69.0	25.1	21.7	41.4	54.0	12.6	low channel, noise
9	7323.0	Horn XN	H	-52.4	-64.6	25.2	21.9	45.7	54.0	8.3	mid channel
10	7440.0	Horn XN	H	-55.0	-67.2	25.3	22.1	43.0	54.0	11.0	high channel, noise
11	9608.0	Horn X	H	-59.9	-72.1	27.8	18.0	44.7	54.0	9.3	low channel, noise
12	9764.0	Horn X	H	-59.8	-72.0	27.9	17.9	45.0	54.0	9.0	mid channel, noise
13	9920.0	Horn X	H	-60.0	-72.2	28.0	17.9	44.8	54.0	9.2	high channel, noise
14	12010.0	Horn X	H	-59.9	-72.1	31.7	17.0	49.6	54.0	4.4	low channel, noise
15	12205.0	Horn X	H	-60.3	-72.5	31.8	16.6	49.8	54.0	4.2	mid channel, noise
16	12400.0	Horn X	H	-60.3	-72.5	32.0	16.2	50.2	54.0	3.8	high channel, noise
17	14412.0	Horn Ku	H	-57.1	-69.3	33.2	20.7	50.2	54.0	3.8	low channel, noise
18	14646.0	Horn Ku	H	-56.2	-68.4	33.3	20.9	51.0	54.0	3.0	mid channel, noise
19	14880.0	Horn Ku	H	-56.7	-68.9	33.4	21.1	50.4	54.0	3.6	high channel, noise
20	16814.0	Horn Ku	H	-57.6	-69.8	34.6	21.9	49.9	54.0	4.1	low channel, noise
21	17087.0	Horn Ku	H	-57.7	-69.9	34.8	22.0	49.9	54.0	4.1	mid channel, noise
22	17360.0	Horn Ku	H	-57.4	-69.6	35.0	22.2	50.2	54.0	3.8	high channel, noise
23	19216.0	Horn K	H	-56.0	-68.2	32.2	21.6	49.4	54.0	4.6	low channel, noise
24	19528.0	Horn K	H	-56.2	-68.4	32.3	20.2	50.7	54.0	3.3	mid channel, noise
25	19840.0	Horn K	H	-56.8	-69.0	32.3	17.8	52.5	54.0	1.5	high channel, noise
26	21618.0	Horn K	H	-51.0	-63.2	32.7	40.0	36.5	54.0	17.5	low channel, noise
27	21969.0	Horn K	H	-51.4	-63.6	32.8	40.0	36.2	54.0	17.8	mid channel, noise
28	22320.0	Horn K	H	-50.5	-62.7	32.8	40.0	37.1	54.0	16.9	high channel, noise
29	24020.0	Horn K	H	-50.9	-63.1	33.2	40.0	37.1	54.0	16.9	low channel, noise
30	24410.0	Horn K	H	-50.0	-62.2	33.3	40.0	38.1	54.0	15.9	mid channel, noise
31	24800.0	Horn K	H	-48.7	-60.9	33.3	40.0	39.4	54.0	14.6	high channel, noise
32											
33											
34											
35											
36											
37											
38											
39											

* Average data computed from peak measured data using 12.2 dB Duty Cycle. Meas. 10/29/2010; U of Mich.

Table 6.1(b) Highest Emissions Measured

Radiated Emission - RF											CPI, DCM+Patch; 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	2404.0	Horn S	H	-26.6	-38.8	21.5	- 1.2	90.9	94.0	3.1	low channel
2	2441.0	Horn S	H	-26.7	-38.9	21.5	- 1.2	90.8	94.0	3.2	mid channel
3	2480.0	Horn S	H	-26.8	-39.0	21.5	- 1.2	90.7	94.0	3.3	high channel
4											
5	4808.0	Horn C	H	-55.2	-67.4	24.6	21.1	43.1	54.0	10.9	low channel
6	4882.0	Horn C	H	-46.9	-59.1	24.6	20.9	51.6	54.0	2.4	mid channel
7	4960.0	Horn C	H	-53.2	-65.4	24.6	20.7	45.6	54.0	8.4	high channel
8	7212.0	Horn XN	H	-54.8	-67.0	25.1	21.7	43.4	54.0	10.6	low channel, noise
9	7323.0	Horn XN	H	-55.3	-67.5	25.2	21.9	42.8	54.0	11.2	mid channel, noise
10	7440.0	Horn XN	H	-59.9	-72.1	25.3	22.1	38.1	54.0	15.9	high channel, noise
11	9616.0	Horn X	H	-60.5	-72.7	27.8	18.0	44.1	54.0	9.9	low channel, noise
12	9764.0	Horn X	H	-61.2	-73.4	27.9	17.9	43.6	54.0	10.4	mid channel, noise
13	9920.0	Horn X	H	-61.4	-73.6	28.0	17.9	43.4	54.0	10.6	high channel, noise
14	12020.0	Horn X	H	-59.9	-72.1	31.7	17.0	49.6	54.0	4.4	low channel, noise
15	12205.0	Horn X	H	-60.3	-72.5	31.8	16.6	49.8	54.0	4.2	mid channel, noise
16	12400.0	Horn X	H	-60.3	-72.5	32.0	16.2	50.2	54.0	3.8	high channel, noise
17	14424.0	Horn Ku	H	-57.1	-69.3	33.2	20.7	50.2	54.0	3.8	low channel, noise
18	14646.0	Horn Ku	H	-56.2	-68.4	33.3	20.9	51.0	54.0	3.0	mid channel, noise
19	14880.0	Horn Ku	H	-56.7	-68.9	33.4	21.1	50.4	54.0	3.6	high channel, noise
20	16828.0	Horn Ku	H	-57.6	-69.8	34.6	21.9	49.9	54.0	4.1	low channel, noise
21	17087.0	Horn Ku	H	-57.7	-69.9	34.8	22.0	49.9	54.0	4.1	mid channel, noise
22	17360.0	Horn Ku	H	-57.4	-69.6	35.0	22.2	50.2	54.0	3.8	high channel, noise
23	19232.0	Horn K	H	-56.0	-68.2	32.2	21.5	49.5	54.0	4.5	low channel, noise
24	19528.0	Horn K	H	-56.2	-68.4	32.3	20.2	50.7	54.0	3.3	mid channel, noise
25	19840.0	Horn K	H	-56.9	-69.1	32.3	17.8	52.4	54.0	**1.6**	high channel, noise
26	21636.0	Horn K	H	-52.2	-64.4	32.7	40.0	35.3	54.0	18.7	low channel, noise
27	21969.0	Horn K	H	-51.3	-63.5	32.8	40.0	36.3	54.0	17.7	mid channel, noise
28	22320.0	Horn K	H	-50.2	-62.4	32.8	40.0	37.4	54.0	16.6	high channel, noise
29	24040.0	Horn K	H	-51.0	-63.2	33.2	40.0	37.0	54.0	17.0	low channel, noise
30	24410.0	Horn K	H	-49.9	-62.1	33.3	40.0	38.2	54.0	15.8	mid channel, noise
31	24800.0	Horn K	H	-47.7	-59.9	33.3	40.0	40.4	54.0	13.6	high channel, noise
32											
33											
34											
35											
36											
37											
38											
39											

* Average data computed from peak measured data using 12.2 dB Duty Cycle.

Meas. 10/29/2010; U of Mich.

Table 6.1(c) Highest Emissions Measured

	Band Edge Radiated Emissions - RF										CPI, DCM; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr(Pk) dBm	Pr(Avg)* Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	**Monopole Antenna - Low Side Band Edge**										
2	2400.0	Horn S	H	-81.2	-93.4	21.5	- 1.2	36.3	54.0	17.7	channel 2402, Δmeth per Line 3
3	"Delta Method", Pr(Pk) = -35.7 dBm in (3MHz/3MHz), band-edge delta = (-41.1 dBm - -86.6 dBm) in (30 kHz / 3MHz).										
4	2400.0	Horn S	H	-80.3	-92.5	21.5	- 1.2	37.2	54.0	16.8	channel 2403, Δmeth per Line 5
5	"Delta Method", Pr(Pk) = -35.1 dBm in (3MHz/3MHz), band-edge delta = (-42.7 dBm - -87.9 dBm) in (30 kHz / 3MHz).										
6	2400.0	Horn S	H	-78.4	-90.6	21.5	- 1.2	39.1	54.0	14.9	channel 2404, Δmeth per Line 7
7	"Delta Method", Pr(Pk) = -34.7 dBm in (3MHz/3MHz), band-edge delta = (-42.5 dBm - -86.2 dBm) in (30 kHz / 3MHz).										
8	2400.0	Horn S	H	-64.1	-76.3	21.5	- 1.2	53.4	54.0	**0.6**	band edge, 2405
9	**Monopole Antenna - High Side Band Edge**										
10	2483.5	Horn S	H	-65.2	-77.4	21.5	- 1.2	52.3	54.0	**1.7**	band edge, 2477
11	2483.5	Horn S	H	-82.4	-94.6	21.5	- 1.2	35.1	54.0	18.9	channel 2478, Δmeth per Line 12
12	"Delta Method", Pr(Pk) = -31.0 dBm in (3MHz/3MHz), band-edge delta = (-38.9 dBm - -90.3 dBm) in (30 kHz / 3MHz).										
13	2483.5	Horn S	H	-81.0	-93.2	21.5	- 1.2	36.5	54.0	17.5	channel 2479, Δmeth per Line 14
14	"Delta Method", Pr(Pk) = -31.9 dBm in (3MHz/3MHz), band-edge delta = (-38.2 dBm - -87.3 dBm) in (30 kHz / 3MHz).										
15	2483.5	Horn S	H	-75.0	-87.2	21.5	- 1.2	42.5	54.0	11.5	channel 2480, Δmeth per Line 16
16	"Delta Method", Pr(Pk) = -30.8 dBm in (3MHz/3MHz), band-edge delta = (-35.6 dBm - -79.8 dBm) in (30 kHz/3MHz).										
17											
18	**Patch Antenna - Low Side Band Edge**										
19	2400.0	Horn S	H	-77.1	-89.3	21.5	- 1.2	40.4	54.0	13.6	channel 2404, Δmeth per Line 20
20	"Delta Method", Pr(Pk) = -28.1 dBm in (3MHz/3MHz), band-edge delta = (-33.7 dBm - -82.7 dBm) in (30 kHz / 3MHz).										
21	2400.0	Horn S	H	-79.5	-91.7	21.5	- 1.2	38.0	54.0	16.0	channel 2405, Δmeth per Line 22
22	"Delta Method", Pr(Pk) = -27.9 dBm in (3MHz/3MHz), band-edge delta = (-34.3 dBm - -89.5 dBm) in (30 kHz / 3MHz).										
23	2400.0	Horn S	H	-82.1	-94.3	21.5	- 1.2	35.4	54.0	18.6	channel 2406, Δmeth per Line 24
24	"Delta Method", Pr(Pk) = -26.8 dBm in (3MHz/3MHz), band-edge delta = (-36.9 dBm - -92.2 dBm) in (30 kHz / 3MHz).										
25	2400.0	Horn S	H	-65.9	-78.1	21.5	- 1.2	51.6	54.0	**2.4**	band edge, 2407
26	**Patch Antenna - High Side Band Edge**										
27	2483.5	Horn S	H	-64.9	-77.1	21.5	- 1.2	52.6	54.0	**1.4**	band edge, 2477
28	2483.5	Horn S	H	-75.3	-87.5	21.5	- 1.2	42.2	54.0	11.8	channel 2478, Δmeth per Line 29
29	"Delta Method", Pr(Pk) = -26.9 dBm in (3MHz/3MHz), band-edge delta = (-31.9 dBm - -80.3 dBm) in (30 kHz / 3MHz).										
30	2483.5	Horn S	H	-76.1	-88.3	21.5	- 1.2	41.4	54.0	12.6	channel 2478, Δmeth per Line 31
31	"Delta Method", Pr(Pk) = -26.9 dBm in (3MHz/3MHz), band-edge delta = (-32.2 dBm - -81.4 dBm) in (30 kHz / 3MHz).										
32	2483.5	Horn S	H	-67.9	-80.1	21.5	- 1.2	49.6	54.0	4.4	channel 2480, Δmeth per Line 33
33	"Delta Method", Pr(Pk) = -26.8 dBm in (3MHz/3MHz), band-edge delta = (-31.7 dBm - -72.8 dBm) in (30 kHz / 3MHz).										
34											
35	NOTE: For Delta Method measurements, Peak data requires a 3 MHz RBW. Delta method can be employed upto 2 x										
36	RBW = 6 MHz from the band edge.										
37	* Average data computed from peak measured data using 12.2 dB Duty Cycle.										
38											
39											

Meas. 10/29-30/2010; U of Mich.

Table 6.1(d) Highest Radiated Digital & Receiver Spurious Emissions Measured

					Digital Emissions						CPI, iPEC DCM; FCC/IC Class A
#	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	49.0	Bic	H	-74.9	Pk	9.2	39.6	1.7	49.5	47.8	noise
2	49.0	Bic	V	-75.0	Pk	9.2	39.6	1.6	49.5	47.9	noise
3	73.4	Bic	H	-74.2	Pk	7.6	39.0	1.4	49.5	48.1	noise
4	73.4	Bic	V	-74.1	Pk	7.6	39.0	1.4	49.5	48.1	noise
5	84.5	Bic	H	-76.6	Pk	7.7	38.7	-0.7	49.5	50.2	noise
6	84.5	Bic	V	-76.7	Pk	7.7	38.7	-0.7	49.5	50.2	noise
7	110.2	Bic	H	-79.6	Pk	9.2	38.3	-1.8	54.0	55.8	noise
8	110.2	Bic	V	-79.4	Pk	9.2	38.3	-1.6	54.0	55.6	noise
9	118.0	Bic	H	-80.3	Pk	9.8	38.1	-1.5	54.0	55.5	noise
10	118.0	Bic	V	-80.8	Pk	9.8	38.1	-2.1	54.0	56.1	noise
11	144.9	Bic	H	-79.7	Pk	12.1	37.6	1.7	54.0	52.3	noise
12	144.9	Bic	V	-79.4	Pk	12.1	37.6	2.0	54.0	52.0	noise
13	165.0	Bic	H	-78.9	Pk	13.4	37.5	4.1	54.0	49.9	noise
14	165.0	Bic	V	-78.6	Pk	13.4	37.5	4.4	54.0	49.6	noise
15	170.0	Bic	H	-78.9	Pk	13.7	37.3	4.5	54.0	49.5	noise
16	170.0	Bic	V	-78.0	Pk	13.7	37.3	5.4	54.0	48.6	noise
17	234.0	Bic	H	-73.2	Pk	14.7	36.2	12.3	56.9	44.6	noise
18	234.0	Bic	V	-72.8	Pk	14.7	36.2	12.7	56.9	44.2	noise
19	240.0	Bic	H	-73.3	Pk	14.7	36.2	12.2	56.9	44.7	noise
20	240.0	Bic	V	-72.4	Pk	14.7	36.2	13.1	56.9	43.8	noise
21	270.0	Sbic	H	-73.1	Pk	16.6	36.0	14.5	56.9	42.4	noise
22	270.0	Sbic	V	-72.9	Pk	16.6	36.0	14.6	56.9	42.3	noise
23	320.0	Sbic	H	-69.9	Pk	18.7	35.2	20.6	56.9	36.3	noise
24	320.0	Sbic	V	-69.8	Pk	18.7	35.2	20.7	56.9	36.2	noise
25	345.0	Sbic	H	-70.5	Pk	19.5	34.9	21.2	56.9	35.7	noise
26	345.0	Sbic	V	-70.8	Pk	19.5	34.9	20.9	56.9	36.0	noise
27	366.0	Sbic	H	-70.6	Pk	20.2	34.4	22.2	56.9	34.7	noise
28	366.0	Sbic	V	-70.1	Pk	20.2	34.4	22.7	56.9	34.2	noise
29	402.0	Sbic	H	-70.5	Pk	21.2	33.5	24.2	56.9	32.7	noise
30	402.0	Sbic	V	-70.9	Pk	21.2	33.5	23.9	56.9	33.0	noise
31	563.0	Sbic	H	-70.2	Pk	24.2	31.0	30.0	56.9	26.9	noise
32	563.0	Sbic	V	-70.1	Pk	24.2	31.0	30.1	56.9	26.8	noise
33	803.0	Sbic	H	-69.4	Pk	27.5	28.0	37.1	56.9	19.8	noise
34	803.0	Sbic	V	-69.4	Pk	27.5	28.0	37.1	56.9	**19.8**	noise
				Rx Spurious Emissions (VCO - 4800 to 4966 MHz)							
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det.* Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments
35	4800.0	Horn C	H	-59.8	Pk	24.6	24.6	47.2	54.0	6.8	noise
36	4850.0	Horn C	H	-59.1	Pk	24.6	24.6	47.9	54.0	6.1	noise
37	4900.0	Horn C	H	-59.3	Pk	24.6	24.6	47.7	54.0	6.3	noise
38	4950.0	Horn C	H	-59.2	Pk	24.6	24.6	47.8	54.0	6.2	noise
39	* Measured with RBW = 3 MHz, VBW = 3 MHz.										
40											

Meas. 10/20/2010; U of Mich.

Table 6.2 Highest AC Power Line Conducted Emissions Measured

												College Park, IPEC DCM; FCC/IC/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	0.37	Lo	44.1	48.5	**4.4**		58.6			48.5		
2	0.25	Lo	43.3	51.8	8.5		61.9			51.8		
3	0.96	Lo	41.2	46.0	4.8		56.0			46.0		
4	1.38	Lo	41.1	46.0	4.9		56.0			46.0		
5	0.67	Lo	40.3	46.0	5.7		56.0			46.0		
6	0.55	Lo	40.2	46.0	5.8		56.0			46.0		
7	1.81	Lo	39.6	46.0	6.4		56.0			46.0		
8	0.61	Lo	39.2	46.0	6.8		56.0			46.0		
9	1.44	Lo	39.2	46.0	6.8		56.0			46.0		
10	0.91	Lo	39.1	46.0	6.9		56.0			46.0		
11	0.36	Lo	43.4	48.7	5.2		58.7			48.7		
12	0.51	Lo	40.3	46.0	5.7		56.0			46.0		
13	1.33	Lo	39.3	46.0	6.7		56.0			46.0		
14	1.04	Lo	39.2	46.0	6.8		56.0			46.0		
15	2.60	Lo	38.4	46.0	7.6		56.0			46.0		
16	3.05	Lo	38.1	46.0	7.9		56.0			46.0		
17	2.16	Lo	37.9	46.0	8.1		56.0			46.0		
18	2.45	Lo	36.3	46.0	9.7		56.0			46.0		
19	3.72	Lo	33.3	46.0	12.7		56.0			46.0		
20	24.85	Lo	28.1	50.0	21.9		60.0			50.0		
21												
22	0.25	Hi	43.8	51.8	8.0		61.9			51.8		
23	0.37	Hi	41.7	48.5	6.8		58.6			48.5		
24	0.19	Hi	40.8	54.1	13.4		64.2			54.1		
25	0.31	Hi	39.1	50.0	10.9		60.1			50.0		
26	0.96	Hi	38.8	46.0	7.2		56.0			46.0		
27	1.86	Hi	38.6	46.0	7.4		56.0			46.0		
28	0.67	Hi	38.4	46.0	7.6		56.0			46.0		
29	1.38	Hi	38.3	46.0	7.8		56.0			46.0		
30	0.61	Hi	37.8	46.0	8.2		56.0			46.0		
31	1.44	Hi	37.7	46.0	8.3		56.0			46.0		
32	1.93	Hi	38.7	46.0	7.3		56.0			46.0		
33	1.48	Hi	38.0	46.0	8.0		56.0			46.0		
34	0.66	Hi	37.5	46.0	8.5		56.0			46.0		
35	0.96	Hi	37.3	46.0	8.7		56.0			46.0		
36	3.05	Hi	36.1	46.0	9.9		56.0			46.0		
37	3.50	Hi	35.69	46	10.31		56			46		
38	2.68	Hi	35.5	46.0	10.5		56.0			46.0		
39	4.17	Hi	34.6	46.0	11.4		56.0			46.0		
40	5.07	Hi	32.2	50.0	17.8		60.0			50.0		
41	4.62	Hi	32.2	46.0	13.8		56.0			46.0		
42	12.61	Hi	29.5	50.0	20.5		60.0			50.0		
43												

**Average limit* Meas. 11/15/2010; U of Mich.

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

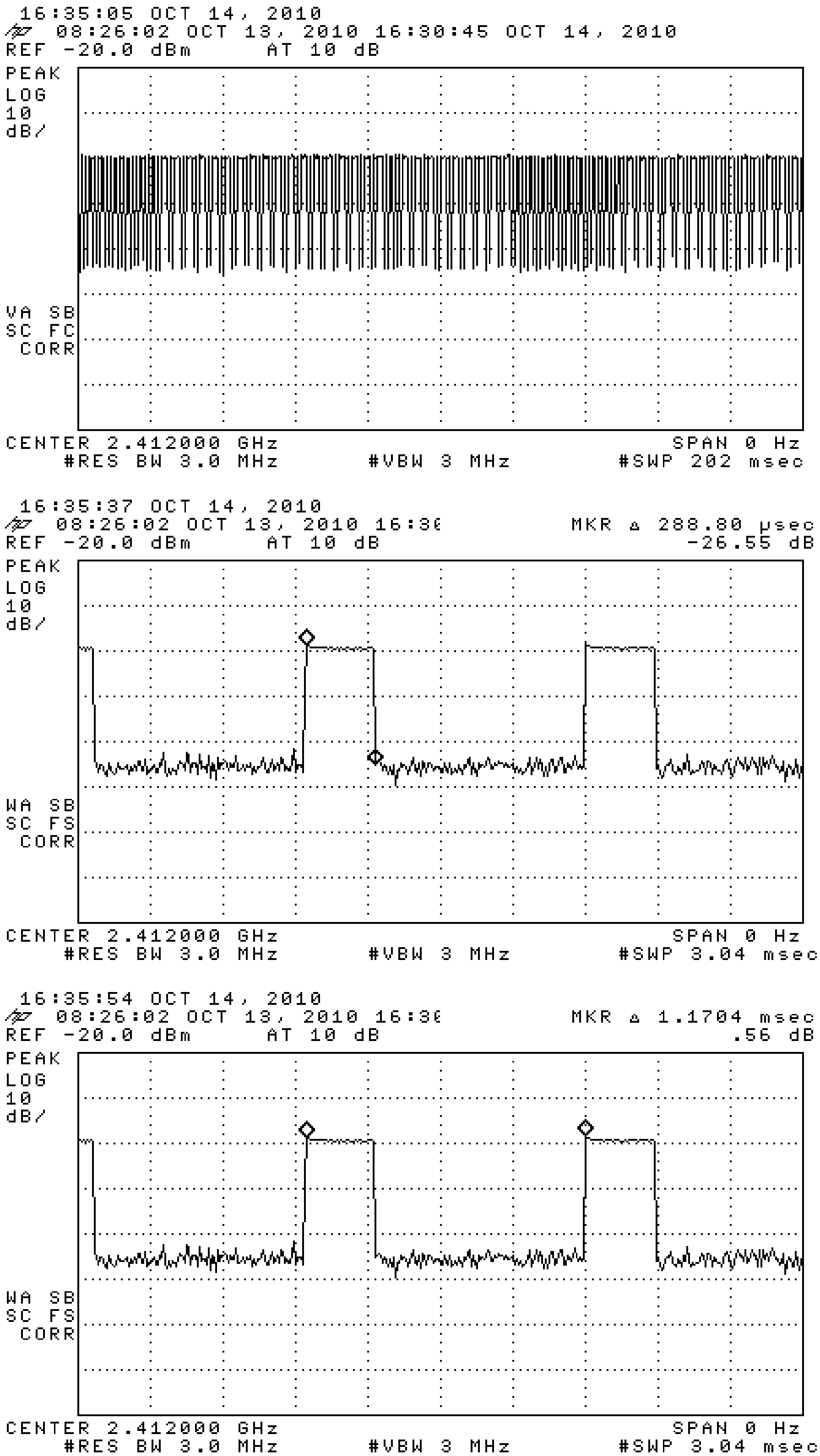

Figure 6.1. Transmission modulation characteristics. (top) continuous transmission on a single channel, (middle) maximum packet on-time, (bottom) packet period. (same for all channels)

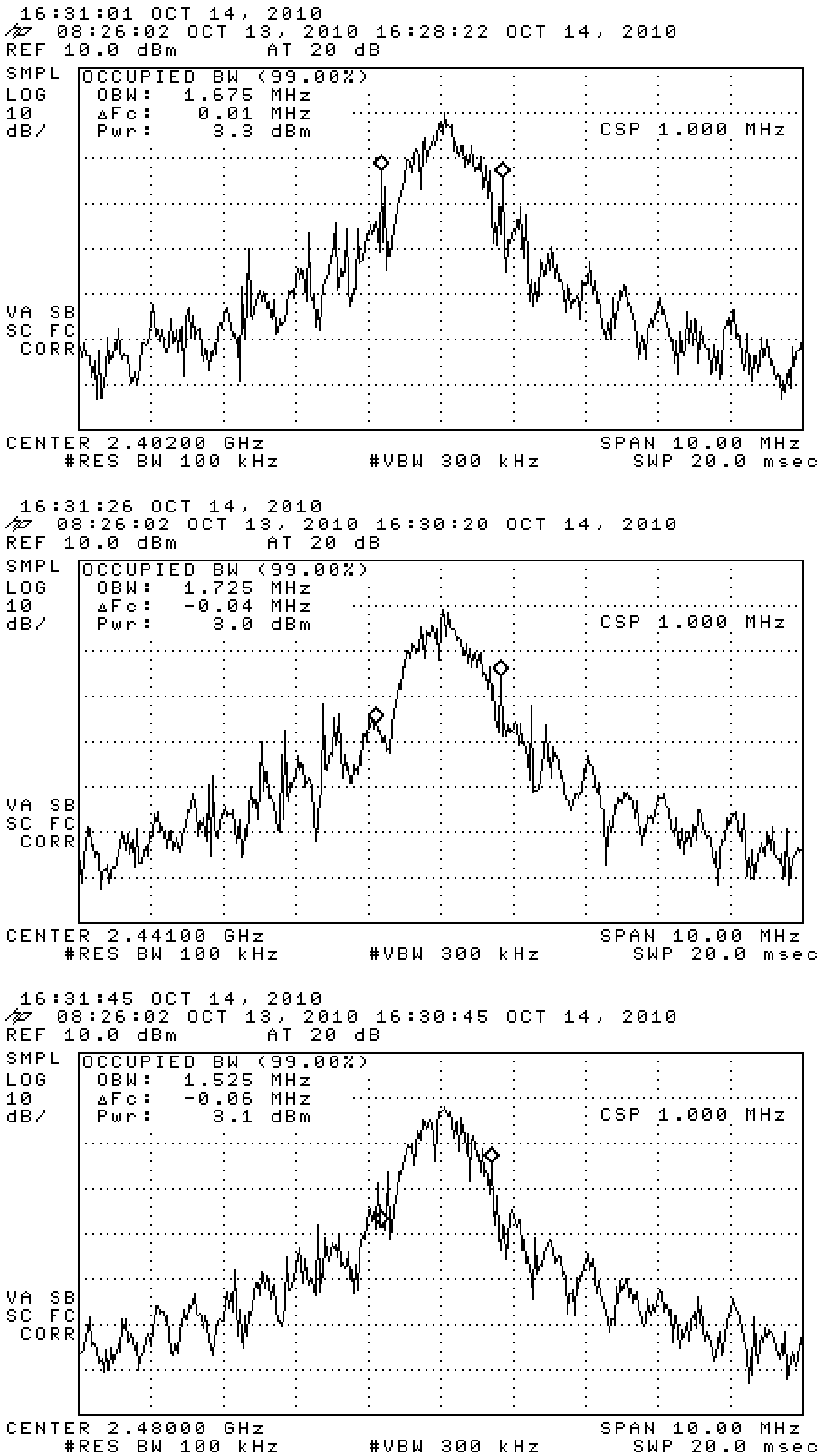

Figure 6.2. Measured emission bandwidth of the DUT (pulsed). (top) lowest channel, (middle) middle channel, (bottom) highest channel.

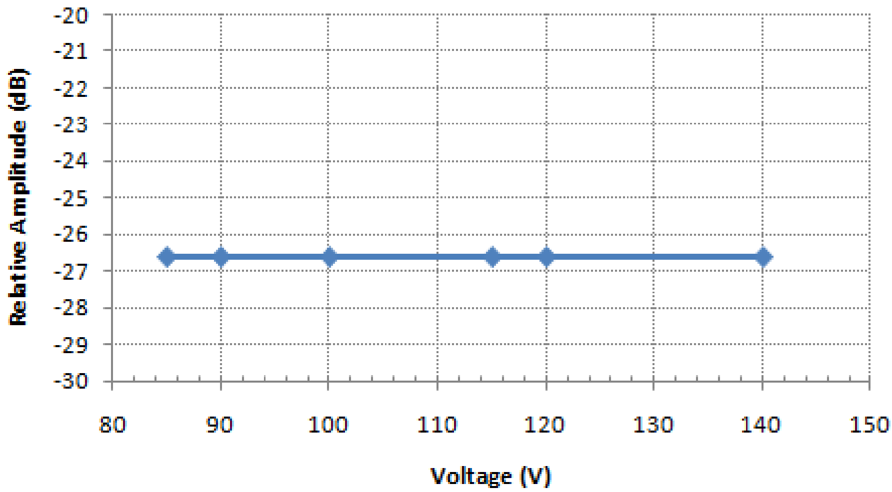

Figure 6.3. Relative emission at fundamental vs. supply voltage (pulsed).

Photograph 6.4. (left) DUT on OATS, (right) Close-up on OATS (one of three axes tested)

Photograph 6.5. (left) DUT on Conducted Emissions Table, (right) Indoor Setup (one of three axes tested)