Project 06384-10

3M CMD
Model 965AMSBT

Electromagnetic Emission Test Report

Prepared for:
3M CMD
6801 Riverplace Blvd.
Bldg. A142-5N-01

Austin, TX 78726

By

Professional Testing (EMI), Inc.
1601 FM 1460, Suite B
Round Rock, Texas 78664

October 2, 2006
Rev 0

Reviewed by	Written by
Jason Anderson Regulatory Department Manager	Eric Lifsey EMC Engineer

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Revision History

Rev

Applicant:	3M CMD
Applicant's Address:	6801 Riverplace Blvd. Bldg. A142-5N-01
	Austin, TX 78726
FCC ID:	T52965AMSBT
IC Number:	458D-965AMSBT
Project Number:	06384-10
Test Dates:	March 17, 2006 – March 22, 2006

The **3M CMD Model 965AMSBT** was tested to and found to be in compliance with FCC 47 CFR Part 15 and IC RSS-210.

The highest emissions generated by the above equipment are listed below:

Parameter	Frequency (MHz)	Level	Limit	Margin (dB)
Transmitter: Mains Conducted	13.7774	29.2 dBµV	50.0 dBµV	-20.8
Transmitter: Radiated Spurious	192	20.4 dBµV /m	40.0 dBµV /m	-19.6
Transmitter: Peak Power @ 1 m	2441	-10.9 dBm (0.081 mW)	+30 dBm	-40.9
Receiver: Mains Conducted	14.6202	29.6 dBµV	50 dBµV	-20.4
Receiver: Radiated Spurious	456	26.9 dBµV	47 dBµV	-20.1

Occupied Bandwidth		Emission Designator FCC (6 dB BW)	Emission Designator IC (26 dB BW)
6 dB	26 dB		
0.536 MHz	1.44 MHz	536KG1D	1M44G1D

I, Jason Anderson, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measured data and this report. I believe them to be true and accurate.

Jason Anderson
Regulatory Department Manager

This report has been reviewed and accepted by 3M CMD. The undersigned is responsible for ensuring that this device will continue to comply with the FCC and IC rules.

1.0 Introduction

1.1 Scope

This report describes the extent of the Equipment Under Test (EUT) conformance to the Electromagnetic Compatibility requirements of the USA and Canada.

1.2 EUT Description

The 3M CMD Model 965AMSBT is a portable telecom line diagnostic tester built for network providers and contractors. It provides all the essential lineman test equipment for twisted pair lines in a battery operated portable hand-held device. A wireless feature using the Bluetooth 2.4 GHz protocols allows the operator to download test data to another computing device for reporting or archiving test data. It operates at the lowest power tier for Bluetooth.

The EUT was provided with diagnostic software allowing direct control of the radio functions.

1.3 EUT Operation

The EUT was tested while in a continuous transmit mode. The EUT was tuned to a low, middle, and high channel to perform power, occupied bandwidth, and spurious/harmonic tests. For conducted emissions the device was tuned to its center frequency. The EUT continuously transmitted at maximum power a pulsed, DSSS modulated packet with a 125 byte payload. The system tested consisted of the following:

Manufacturer	Model	FCC ID Number	IC Identifier
3M CMD	965AMSBT	T52965AMSBT	458D-965AMSBT

Supporting Equipment	Description
3M (APX Technologies) S/N 02811589	Charger/power Supply

The following rules apply to the operation of the EUT:

Guidelines	FCC Rules	IC Rules	
	Part 15	RSS-GEN Issue 1	RSS-210 Issue 6
Transmitter Characteristics	15.247	4.1-4.6, 7	2.2, 2.6-2.7, A2.9, A8, A9
Spurious Radiated Power	15.209	4.2, 4.7, 4.8, 6, 7	2.2, 2.6-2.7, A2.9, A8, A9
Power Line Conducted	15.207	4.2, 4.7, 7.2	
Antenna Requirement	15.203	7.1, 7.1.4	

1.4 Test Site

Unless otherwise stated, all measurements of EUT characteristics were made at the Professional Testing "Open Field" Site 3, located in Round Rock, Texas, USA. This site was registered with the FCC under section 2.948 of CFR 47. The site is also listed with Industry Canada IC-3036-3.

1.5 Test Results

The data collected for this report are presented entirely in Appendix B.

2.0 Power Line Conducted Emissions

Conducted emissions measurements were made on the Class II Power Supply mains terminals of the EUT to determine the line-to-ground radio noise emitted from each power-input terminal.

2.1 Test Procedure

The EUT AC mains conducted emissions were measured using a LISN and spectrum analyzer. Peripheral equipment was powered from an auxiliary LISN. Excess lengths of power or interface cable were separately bundled in a non-inductive arrangement at the approximate center of the cable with the bundle 30 to 40 centimeters in length to limit total length to 1 meter.

Measurements are performed in a fully shielded room. The EUT is placed on a wood table 0.4 meters from the vertical reference plane and 0.8 meters above the horizontal reference plane.

2.2 Test Criteria

The limits of FCC Part 15 Class B were applied.

Frequency (MHz)	Conducted Limits (dBµV)	
	Average	Quasi-Peak
0.15 – .50	66-56	56 - 46
.50 - 5	56	46
5 – 30	60	50

The tighter limit shall apply at the edge between two frequency bands.
*The limit decreases with the logarithm of the frequency.

3.0 Peak Output Power

Peak power measurements were made on selected fundamental transmit frequencies of the EUT for the lowest, most center, and highest transmit frequency.

Tests of the fundamental emissions of the EUT also determined the worse case polarization of the device. The emissions of the device were measured with the EUT in three orthogonal axes.

3.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable, which allows 360-degree rotation. For measurements of the fundamental signal, a measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. Rotating the EUT maximized the emissions.

A spectrum analyzer with peak detection was used to find the maximum field strength during the variability testing. Resolution bandwidth (RBW) is chosen to encompass the entire 6 dB bandwidth of the fundamental signal, up to 3 times the bandwidth if possible. RBW used is recorded. A calculation was then made to determine the peak power at the antenna terminal. A drawing showing the test setup is given in Appendix A.

3.2 Test Criteria

The maximum peak output power is 30 dBm for DSSS devices operating in the frequency range 2400-2483.5 MHz according to FCC 15.247(b)(3) and RSS-210.

4.0 Occupied Bandwidth: 6 dB, 20 dB & 26 dB

Occupied bandwidth measurements were performed on the 3M CMD Bluetooth Module Model 965AMSBT to determine compliance with FCC 15.247(a)(2) and RSS-210.

4.1 Test Procedure

The occupied bandwidth was measured with a spectrum analyzer connected to a double-ridged guide horn while the EUT was operating in continuous transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency. Display line and marker delta functions were used to measure the 6 and 20 dB occupied bandwidth of the EUT. The 26 dB bandwidth is measured in a similar fashion or by directly measuring from the plotted 6 dB curve. Measurements were made at three frequencies. A drawing showing the test setup is given in Appendix A.

4.2 Test Criteria

The minimum 6 dB occupied bandwidth for the EUT is 500 kHz as stated in 15.247(a)(2) and RSS-210. The 20 dB bandwidth is used to verify channel to channel spacing. The 26 dB bandwidth is used to report the 99% power bandwidth.

5.0 Band Edge Spurious Emissions

Band edge spurious emissions measurements were performed on the EUT to determine compliance to FCC 15.247(c) and RSS-210.

5.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable, which allows 360-degree rotation. For measurements of the fundamental signal, a measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. Rotating the EUT maximized the emissions.

The spectrum analyzer was set for peak detection using a 100 kHz resolution bandwidth. The span is set to 10 MHz with the center of the display at the frequency of the band edge. Measurement is made at the band edge using the marker delta method while transmitting on the channels nearest the band edge to determine if the EUT meets the test criteria. The test setup is included in Appendix A.

5.2 Test Criteria

According to FCC 15.247(c) and RSS-210 the band edge spurious emissions must be 20 dB below the highest peak in the operating band in any 100 kHz bandwidth. If the frequency falls in the restricted bands of 15.205 the maximum permitted average must be below the field strength listed in 15.209.

Alternatively, the band edge spurious emissions will meet criteria if they are attenuated below the limits specified in FCC 15.209 or RSS-210 Table 3.

6.0 Out of Band Spurious Emissions

Out of band spurious/harmonic emissions measurements were performed on the EUT to determine compliance to FCC sections 15.247(c), 15.209 and RSS-210.

6.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized rotating turntable. For measurements of the fundamental signal, the measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. Rotating the EUT maximized the emissions.

For spurious emissions below 1 GHz quasi-peak detection is used with a resolution bandwidth of 120 kHz.

Spurious/harmonic emissions above 1 GHz peak are measured with average and peak detection with a resolution bandwidth of 1 MHz. Average detection is used to determine compliance of the EUT if the peak does not meet the average limit. A resolution bandwidth of 1 MHz and video bandwidth of (1/transmitter "on-time") Hz is used for average detection of pulsed emissions. A peak to average calculation is also employed for averaging pulsed harmonic emissions. Non-harmonic emissions must satisfy the average limit and the peak limit (20 dB above average). The test setup is included in Appendix A.

Above 1 GHz testing was completed at 3 transmit frequencies to determine compliance.

6.2 Test Criteria

The radiated limits of FCC 15.209 and RSS-210 are shown below. The limits specified are at 3 meters. The limits are quasi-peak for emissions below 1 GHz and average for emissions above 1 GHz. Also above 1 GHz the peak limit is 20 dB above the average limit.

Frequency MHz	Test Distance (Meters)	Field Strength	
		(µV/m)	(dBµV/m)
30 to 88	3	100	40.0
88 to 216	3	150	43.5
216 to 960	3	200	46.0
Above 960	3	500	54.0

Note: Emissions above 1 GHz were measured at a distance of 1 meter. The limit was increased by 9.5 dB. Emissions above 18 GHz were measured at a distance of 10 cm and the limit increased by 29.5 dB.

7.0 Antenna Requirements

An antenna evaluation was performed on the EUT determine compliance with FCC sections 15.203, 15.247(b) and RSS-210.

7.1 Evaluation Procedure

The design of the EUT antenna is evaluated for conformance to engineering requirements for gain and to prevent substitution of unapproved antennae. Gain of the antenna is assessed by reviewing the antenna manufacturer's data sheet.

7.2 Evaluation Criteria

The antenna design must meet at least one of the following criteria:

a) Antenna is permanently attached to the unit.
b) Antenna must use a unique type of connector to attach to the EUT.
c) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Section 15.247(b)(4)(i) states that if the transmitting antenna has a directional gain greater than 6 dBi the power shall be reduced the amount in dB that the directional gain is greater than 6 dBi.

8.0 Timing Assessment

The timing between transmissions and duration of each transmission on the EUT was assessed to determine an appropriate peak to average correction factor for typical operation.

8.1 Test Procedure

Using a spectrum analyzer set in zero span two pulses are captured on the screen. The ratio of on-time to off-time is calculated and converted to the dB scale. The test setup is included in Appendix A.

8.2 Test Criteria

There are no criteria associated with this assessment. This correction factor is used to determine the averaged peak value of a harmonic emission if the measured peak emission exceeds the peak limit.

9.0 Hopping Channels & Separation

9.1 Test Procedure

The hopping channel separation was measured with a spectrum analyzer connected to a double-ridged guide horn while the EUT was operating in continuous transmit mode on a single channel. The analyzer was placed in max hold mode on trace A to capture the emission. The EUT was then tuned to the next adjacent channel. The analyzer was set to max hold mode again to capture the emission. The separation of the peaks was measured using marker delta function.

Using a wider span, the entire band is divided into four sub-bands and the hopping mode is enabled and all channels are captured on the spectrum analyzer in max hold mode. Peaks are counted and compared against the requirements for the protocol.

9.2 Test Criteria

According to 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Bluetooth channels should total 79 for the 2.4 GHz band.

10.0 Dwell Time On Each Channel and Hop Rate

10.1 Test Procedure

To measure the duration of one pulse the spectrum analyzer is set to the center frequency of any one channel. The resolution bandwidth is set to 100 kHz and video bandwidth is greater than resolution bandwidth. The analyzer is set to zero span with 5 ms sweep time. The duration of one pulse is captured and measured with marker delta functions.

The number of hops rate must also be measured. A ridge guide horn connected through a zero bias schotky diode detector to an oscilloscope was used to measure the number of hops in an interval. The result is then extrapolated to determine the number of hops in one second.

10.2 Test Criteria

For frequency hopping systems in the 2400-2483.5 MHz band the average time occupied on one channel may not be greater than 0.4 seconds in a time frame of 0.4 seconds times the number of hopping channels according to 15.247 (a)(1)(iii). The result of section 5 determined the number of hopping channels used. The number of hopping channels is 79. 0.4 seconds times 79 hopping channels results in a 31.6 second period. The average time occupied on any one channel shall not be greater than 0.4 seconds in a 31.6 second period.

11.0 Receiver Requirements

Emissions measurements were made with the EUT in a receive/standby mode and presented here to create a comprehensive technical report. Receivers operating above 960 MHz are only subject to verification by FCC part 15 and Industry Canada RSS-210. The FCC Class B limits and RSS-210 limits for receivers are the same and are applied to receiver measurements.

11.1 Power line Conducted Emissions

Conducted emissions measurements were made on the mains terminals of the EUT to determine the line-to-ground radio noise emitted from each power-input terminal.

11.1.1 Test Procedure

The procedure here is consistent with the procedure stated in section 2.1 for Power line Conducted Emissions except the EUT is operated in a receive/standby mode.

11.1.2 Test Criteria

The FCC 15.107 and RSS-210 conducted emissions limits are given below.

Frequency (MHz)	Conducted Limits (dBµV)	
	Average	Quasi-Peak
0.15 – .50	66-56	56 - 46
.50 - 5	56	46
5 – 30	60	50

The lower limit shall apply at the transition frequency.

11.2 Spurious Radiated Emissions

Radiated emission measurements were made of the spurious emission levels for the EUT receiver**.**

11.2.1 Test Procedure

The procedure here is consistent with the procedure stated in section 7.1 for Spurious Radiated Emissions except the EUT is operated in a receive/standby mode.

11.2.2 Test Criteria

The radiated limits of FCC 15.109 and RSS-210 are shown below. The limits specified are at 3 meters. The limits are quasi-peak for emissions below 1 GHz and average for emissions above 1 GHz. Also above 1 GHz the peak limit is 20 dB above the average limit.

Frequency MHz	Test Distance (Meters)	Field Strength	
		(µV/m)	(dBµV/m)
30 to 88	3	100	40.0
88 to 216	3	150	43.5
216 to 960	3	200	46.0
Above 960	3	500	54.0

Note: Emissions above 1 GHz were measured at a distance of 1 meter. The limit was increased by 9.5 dB.
Emissions above 18 GHz were measured at a distance of 10 cm and the limit increased by 29.5 dB.

12.0 Modifications

RF shielding was added to isolate the RF portion of the device. The device was modified to ensure compliance with the modular approval requirements. A photo of the modification was taken.

13.0 Test Equipment

Test equipment used to complete the testing included in this report is listed below.

List of Test Equipment				
Asset #	**Manufacturer**	**Model #**	**Description**	**Calibration Due**
C031	None	None	1.5 meter Coaxial RF Cable	November 24, 2006
C005	None	None	Underground Coaxial Cable	December 8, 2006
C025	Belden	RG223	Coaxial Cable	Calibrate Before Use
0027	EMCO	3825/2	Auxiliary LISN	July 11, 2006
0045	HP	85662A	Spectrum Analyzer Display	Not Required
0081	Elgar	1751SL	Variable AC Power Source	Calibrate Before Use
0237	HP	8568B	Spectrum Analyzer	December 14, 2006
0238	HP	85685A	RF Preselector	March 24, 2006
0239	HP	85650A	Quasi-peak Adapter	December 14, 2006
0267	EMCO	3115	Ridge Guide Antenna	July 16, 2006
0275	HP	85650A	Quasi-peak Adapter	March 24, 2006
0474	PTI	3dB	Limiter	September 16, 2006
0483*	HP	8447D	RF Preamplifier	January 12, 2007
0572	PTI	CISPR16	High Pass Filter	September 16, 2006
0754	Compliance Design	B100	Biconical Antenna	June 3, 2006
0755	EMCO	3146	Log Periodic Dipole Array Antenna	June 8, 2006
0759	Solar	8012	LISN	October 5, 2006
0897	Miteq	None	Microwave Preamplifier (preamp 2)	May 16, 2006
0949	HP	8566B	Spectrum Analyzer Display	March 24, 2006
0950	HP	8566B	Spectrum Analyzer	March 24, 2006
0990	HP	85685A	RF Preselector	December 14, 2006
0989	Micro-Tronics	HPM50111	2.5 GHz High Pass Filter	CBU

* 0483 preamplifier was calibrated on-site and placed back into service the same day.

Appendix A Test Setup Diagrams

FIGURE 1: Radiated Emissions Test Setup

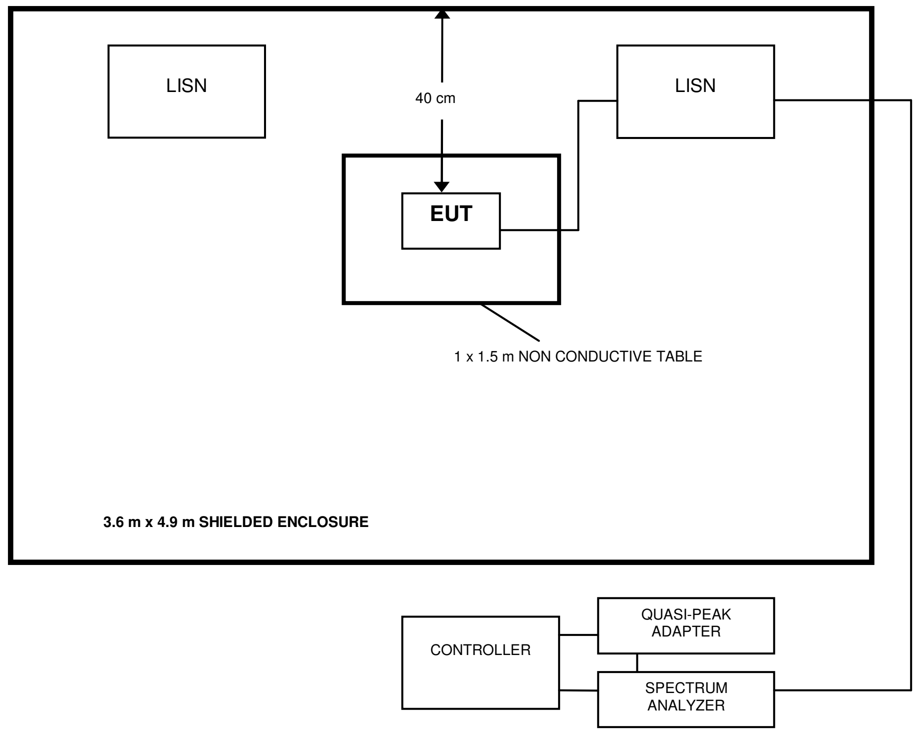


FIGURE 2: Radiated Emissions Test Setup
Peak Power, Occupied Bandwidth, Power Spectral Density, Timing Assessment, Band Edge Spurious

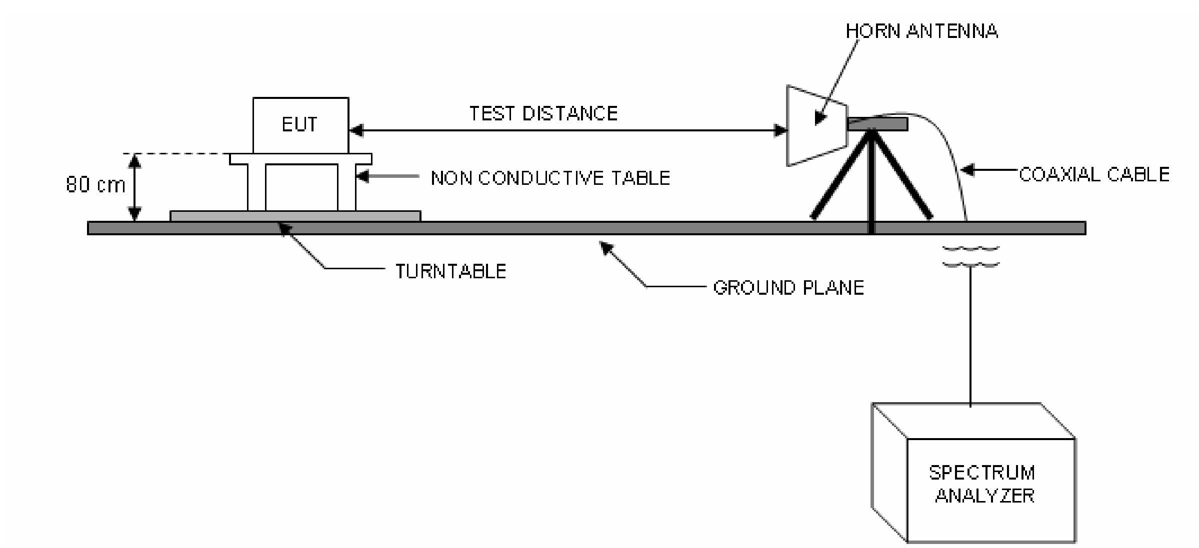


FIGURE 3: Radiated Emissions Test Setup - Spurious

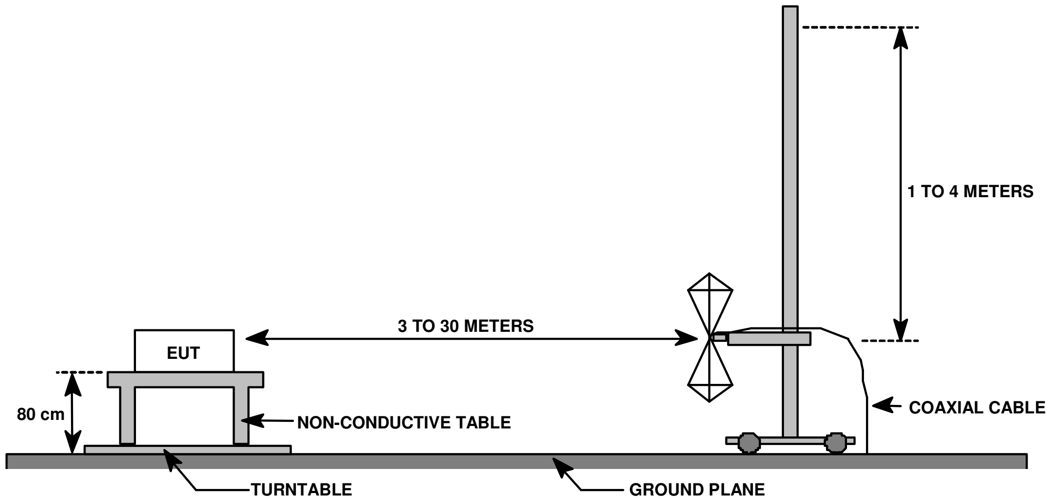
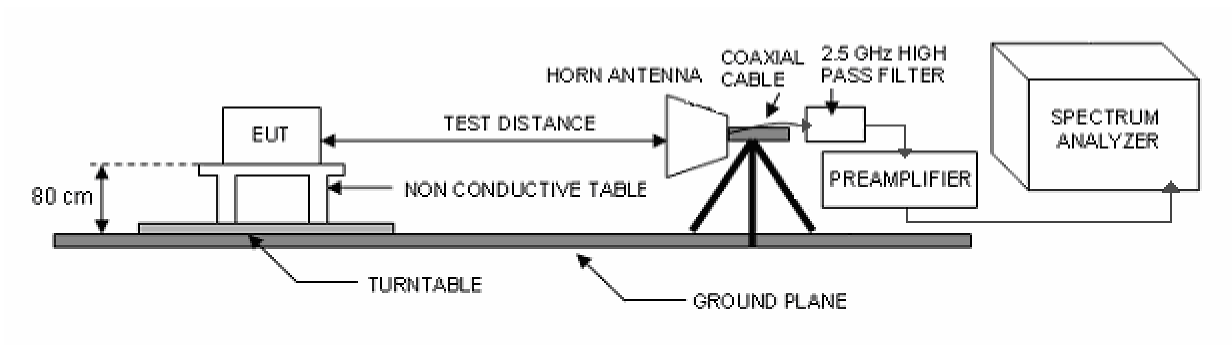


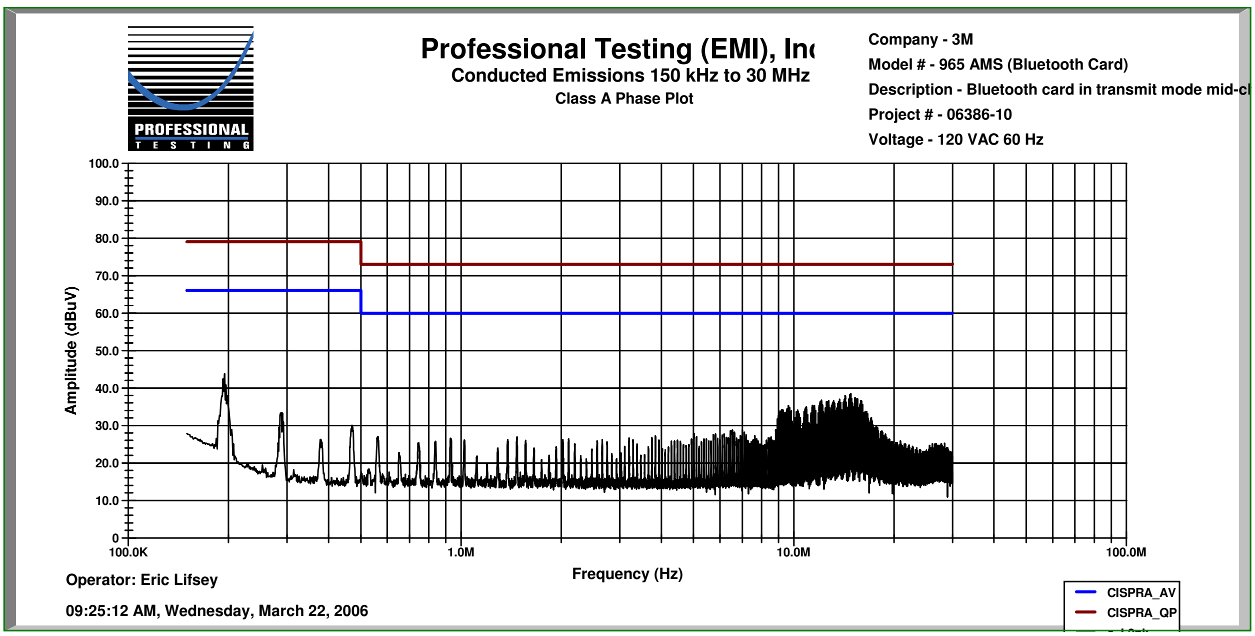
FIGURE 4: Radiated Emissions Test Setup – Harmonics & Spurious > $f_{(o)}$



Power line Conducted Emissions
3M CMD Bluetooth Module Model 965AMSBT
Quasi-Peak Detection, RBW = 9 kHz
Transmitting

Test Date: March 22, 2006
Line Selection: Phase

Frequency Reading (MHz)	**Quasi-peak Reading** (dBµV)	**Average Reading** (dBµV)	**Quasi-peak Limit** (dBµV)	**Quasi-peak Margin (dB)**	**Average Limit** (dBµV)	**Average Margin (dB)**	**Test Results**
0.19557	43.0	31.0	64.7	-21.7	54.7	-23.7	Pass
0.28676	32.0	22.9	62.1	-30.1	52.1	-29.1	Pass
0.46920	28.2	25.3	56.9	-28.6	46.9	-21.5	Pass
0.56143	25.2	21.8	56.0	-30.8	46.0	-24.2	Pass
3.84006	25.9	21.4	56.0	-30.1	46.0	-24.6	Pass
13.7774	34.9	29.2	60.0	-25.1	50.0	-20.8	Pass
14.2362	35.0	28.4	60.0	-25.0	50.0	-21.6	Pass
14.6966	31.8	24.9	60.0	-28.2	50.0	-25.1	Pass
14.7931	34.9	26.9	60.0	-25.1	50.0	-23.1	Pass
15.2527	29.0	23.0	60.0	-31.0	50.0	-27.0	Pass

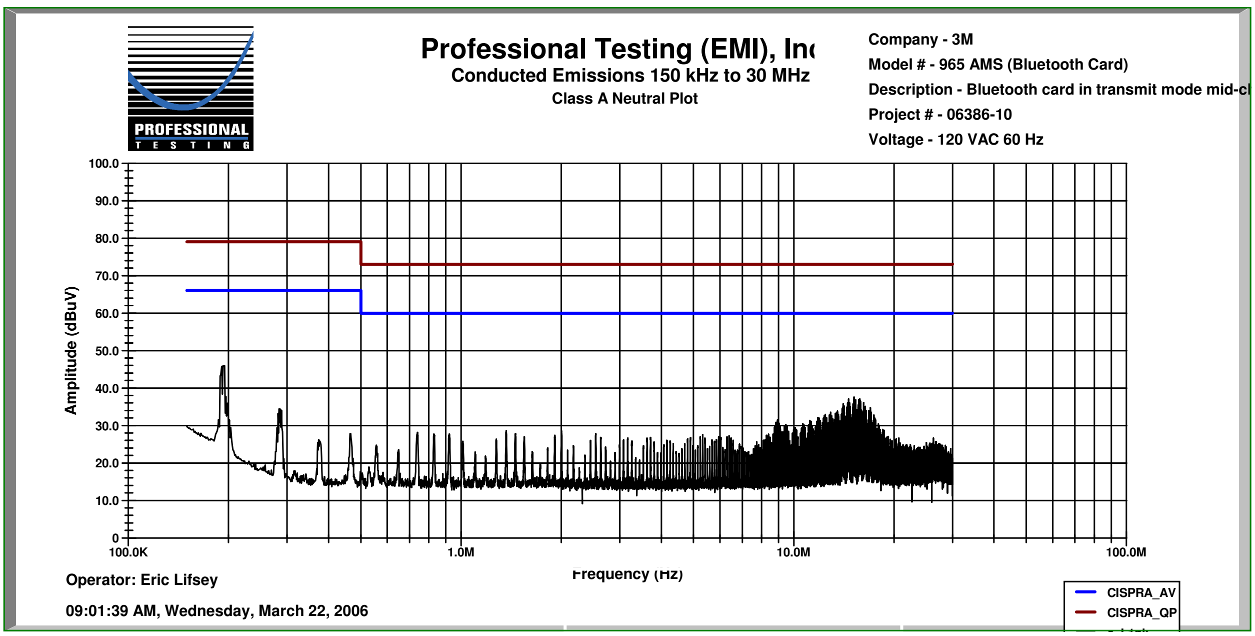


The data presented here in graphical form is for overview only. Detailed and precise data is in the table above.

Power line Conducted Emissions
3M CMD Bluetooth Module Model 965AMSBT
Quasi-Peak Detection, RBW = 9 kHz
Transmitting

Test Date: March 22, 2006
Line Selection: Neutral

Frequency Reading (MHz)	Quasi-peak Reading (dBμV)	Average Reading (dBμV)	Quasi-peak Limit (dBμV)	Quasi-peak Margin (dB)	Average Limit (dBμV)	Average Margin (dB)	Test Results
0.19378	44.9	32.5	79.0	-34.1	66.0	-33.5	Pass
0.19399	45.1	32.6	79.0	-33.9	66.0	-33.4	Pass
0.28616	33.0	22.4	79.0	-46.0	66.0	-43.6	Pass
1.36988	27.7	22.1	73.0	-45.3	60.0	-37.9	Pass
2.00685	27.6	21.7	73.0	-45.4	60.0	-38.3	Pass
14.5944	33.1	22.3	73.0	-39.9	60.0	-37.7	Pass
15.1526	31.2	20.2	73.0	-41.8	60.0	-39.8	Pass
15.255	33.5	23.9	73.0	-39.5	60.0	-36.1	Pass
15.7158	28.9	16.9	73.0	-44.1	60.0	-43.1	Pass
15.8132	32.3	19.7	73.0	-40.7	60.0	-40.3	Pass



The data presented here in graphical form is for overview only. Detailed and precise data is in the table above.

Peak Power
3M CMD Bluetooth Module Model 965AMSBT
Peak Detection, RBW = 1 MHz

Test Date: March 20, 2006
Test Distance 1 meters

All Orientations

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV /m)
2402.0	180.0	1	97.8	34.7	28.2	0.6	91.9
2441.0	180.0	1	99.8	34.8	28.2	0.6	93.8
2480.0	180.0	1	99	34.9	28.3	0.6	93.0

Calculations

$$P = \frac{(E * d)^2}{30 * G}$$

P=Power in watts, E=measured maximum field strength in V/m, d=distance in meters, G=numeric gain of transmitting antenna

Distance=1 meters
Gain=0 dBi

Calculated Result

Frequency (MHz)	Field Strength (dBµV)	E.I.R.P	Limit (dBm)
2402.0	91.9	0.051 mW (-12.9 dBm)	30
2441.0	93.8	0.081 mW (-10.9 dBm)	30
2480.0	93.0	0.066 mW (-11.8 dBm)	30

Result: PASS

Test Engineer: Eric Lifsey

Occupied Bandwidth 6 dB
3M CMD Bluetooth Module Model 965AMSBT
Test Date: March 20, 2006 | Peak Detection | RBW = 100 kHz

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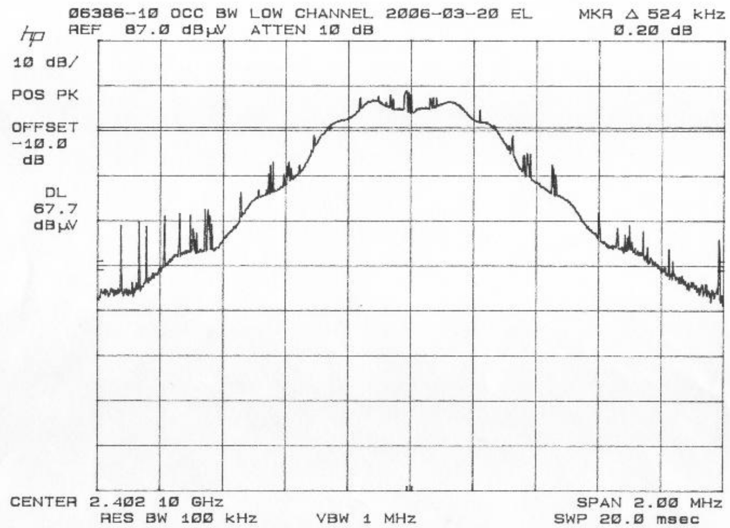
<tr><td>Low Channel</td><td>
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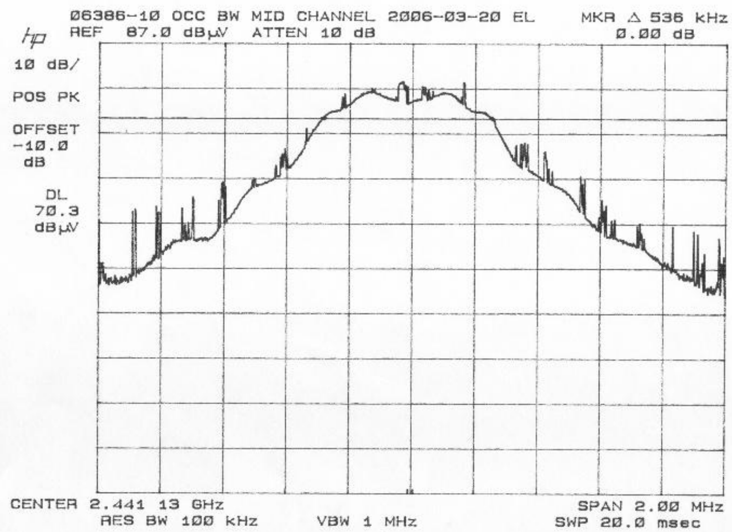
Highest Measured
0.536 MHz</td><td>
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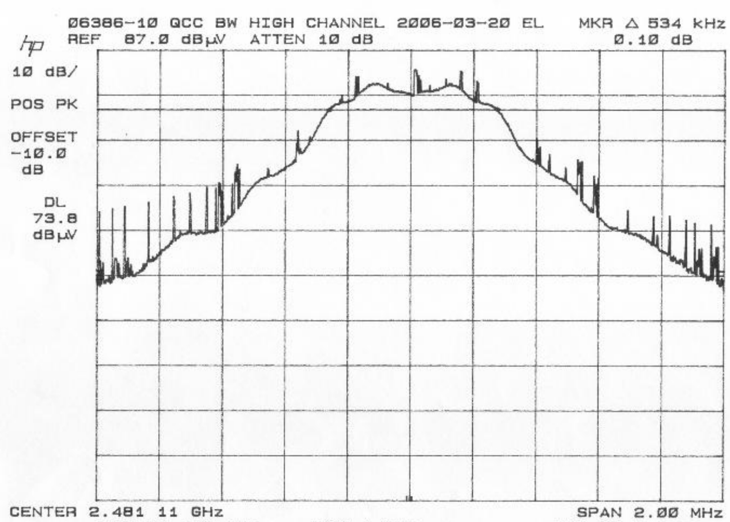
<tr><td>High Channel</td><td>
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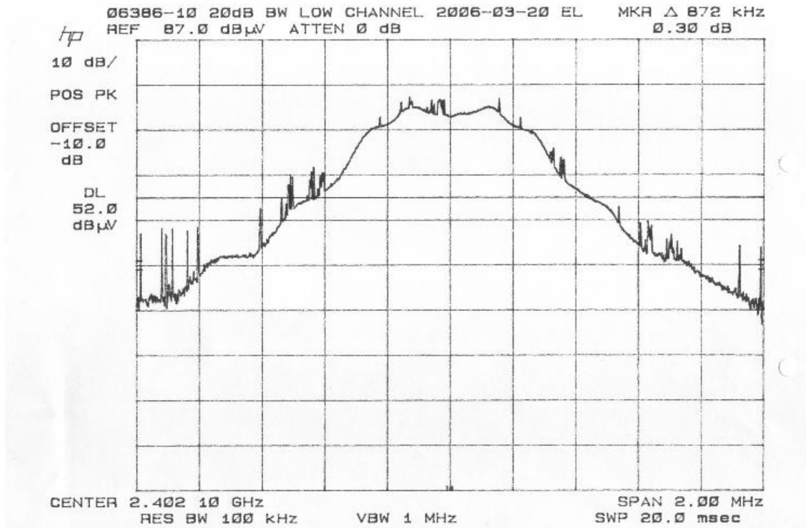
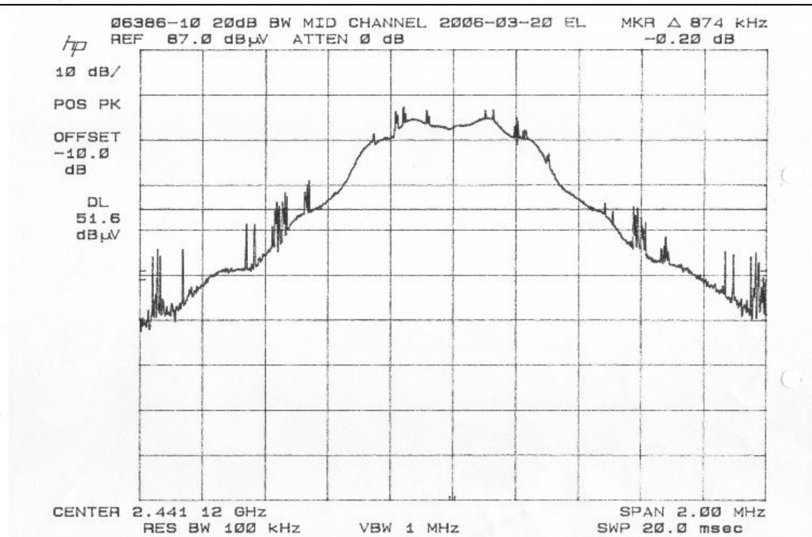
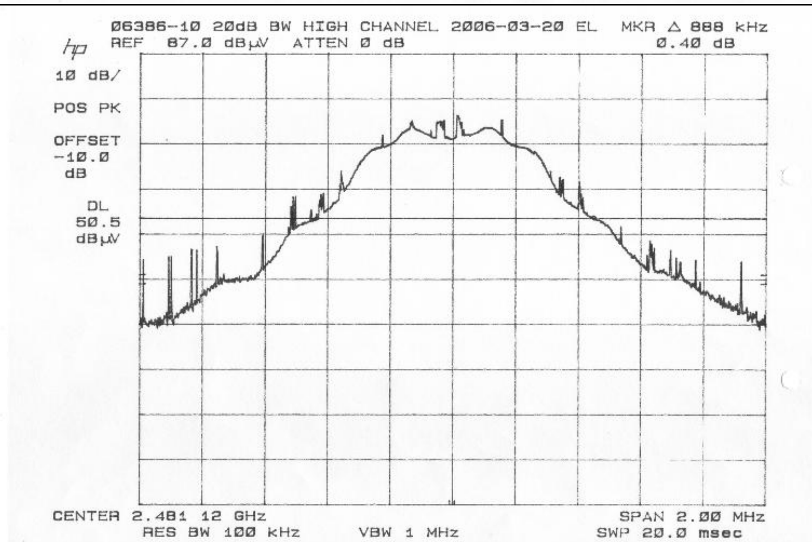
Occupied Bandwidth 20 dB
3M CMD Bluetooth Module Model 965AMSBT
Test Date: March 20, 2006 | Peak Detection | RBW = 100 kHz

Low Channel	
Middle Channel	
High Channel Highest Measured 0.888 MHz	

Occupied Bandwidth 26 dB
3M CMD Bluetooth Module Model 965AMSBT
Test Date: March 20, 2006 | Peak Detection | RBW = 100 kHz

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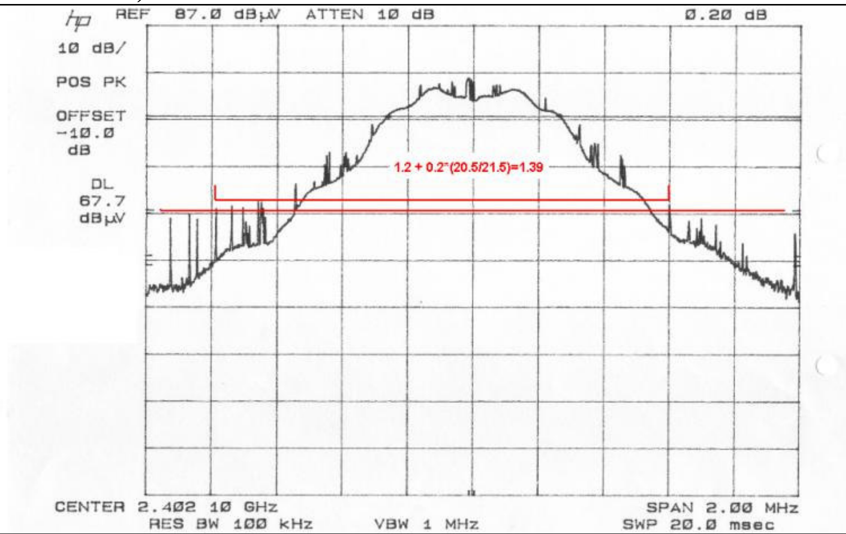
1.39 MHz</td><td>
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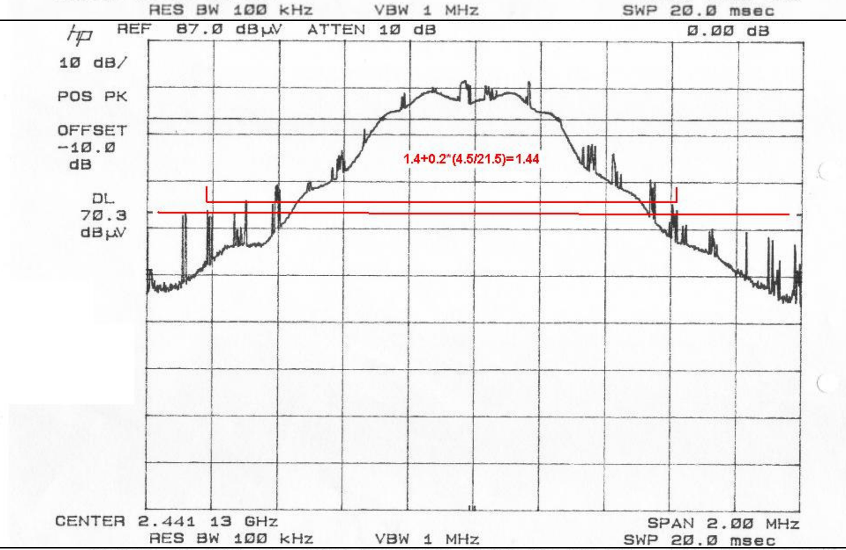
1.44 MHz</td><td>
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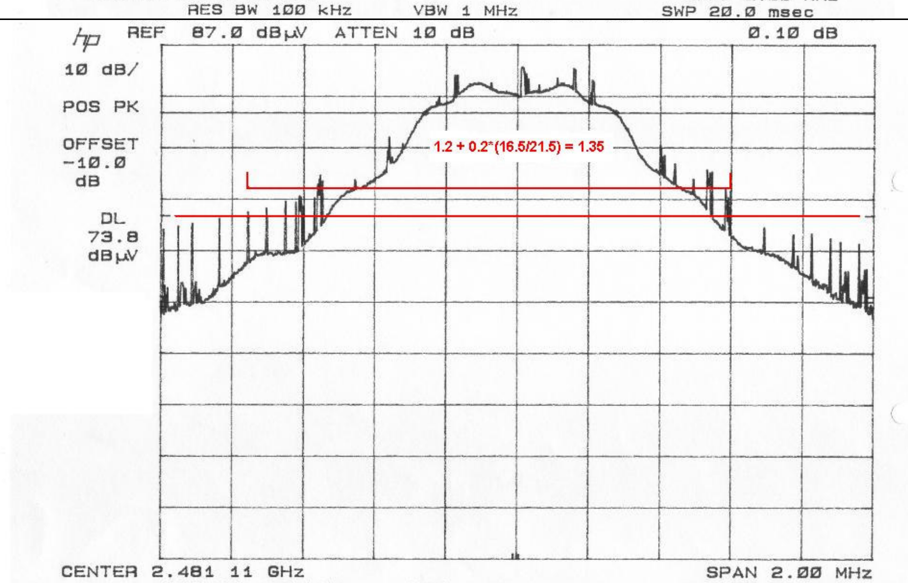
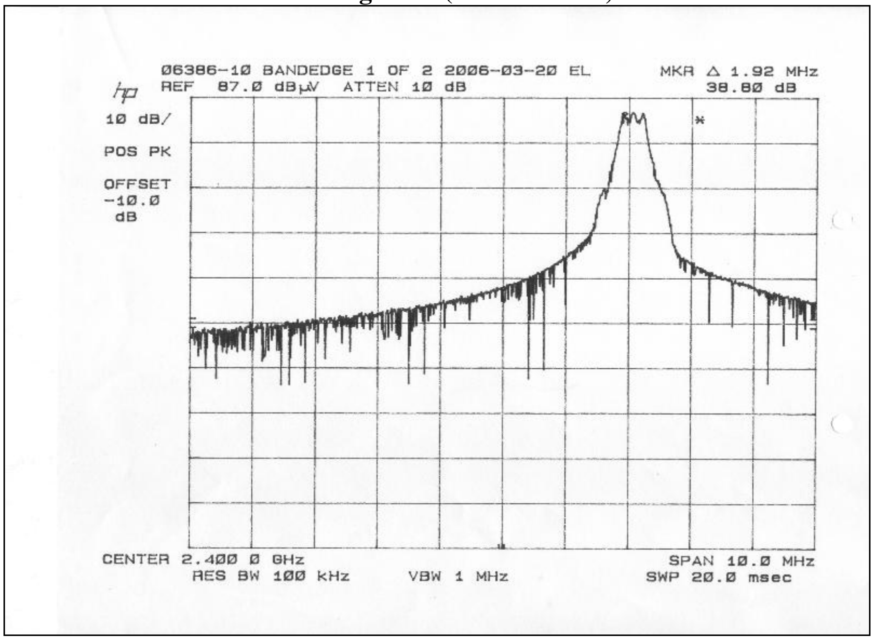
1.35 MHz</td><td>
</td></tr>
</table>

Note, the 26 dB plots were derived from 6 dB plots.

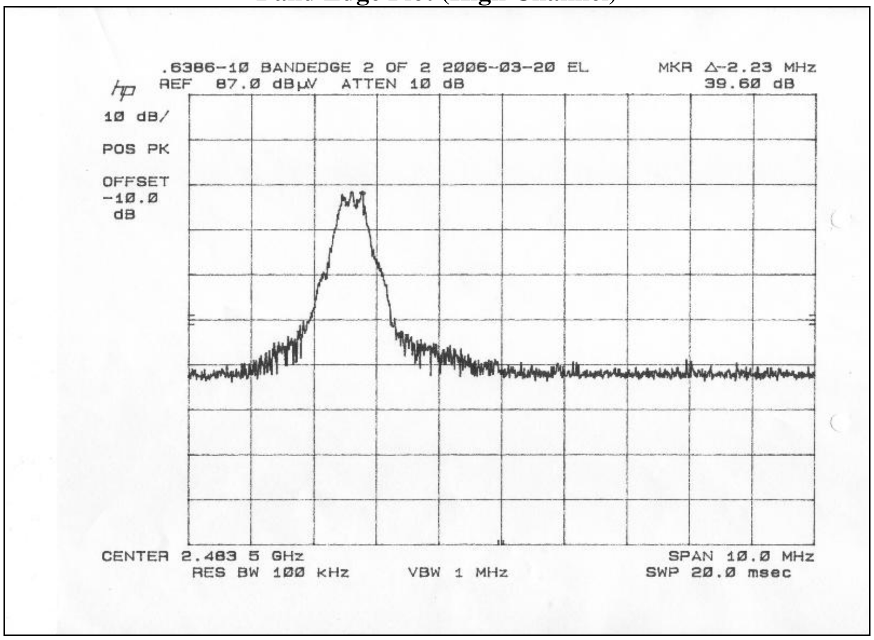
Band Edge Spurious Emissions
3M CMD Bluetooth Module Model 965AMSBT
Peak Detection, RBW = 100 kHz

Test Date: March 20, 2006
Test Distance 1 meters

Band Edge Plot (Low Channel)

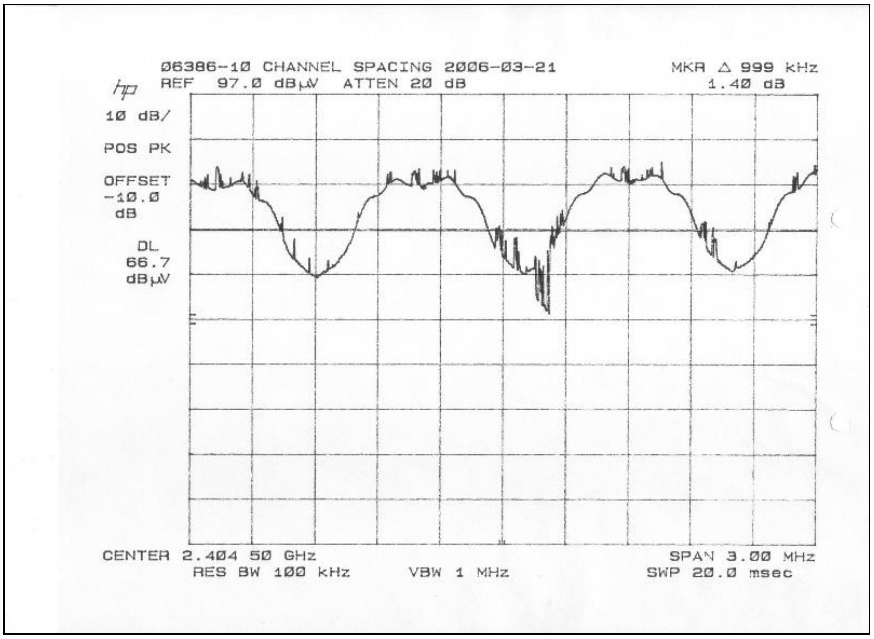


Band Edge Plot (High Channel)



Hopping Channel Separation
3M CMD Bluetooth Module Model 965AMSBT

Test Date: March 21, 2006



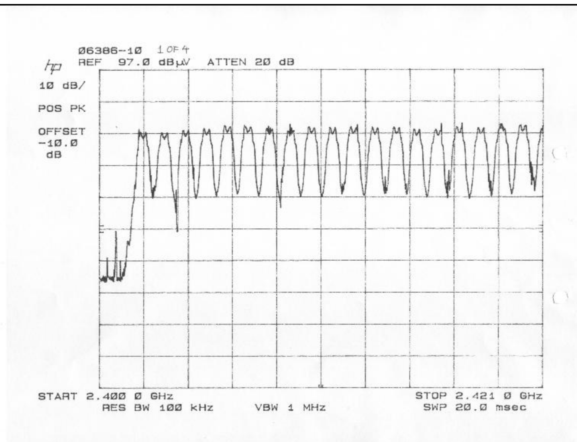
Measured Channel Separation = 0.999 MHz
Reference: Maximum 20 dB Occupied Bandwidth = 0.888 MHz
Reference: Minimum required separation = 0.025 MHz

Channel separation is greater than measured 20 dB bandwidth and greater than the minimum bandwidth.

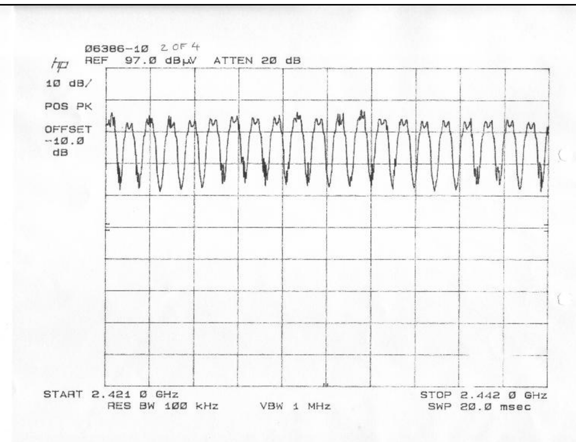
Channel separation satisfies the criteria.

Hopping Channel Count
3M CMD Bluetooth Module Model 965AMSBT

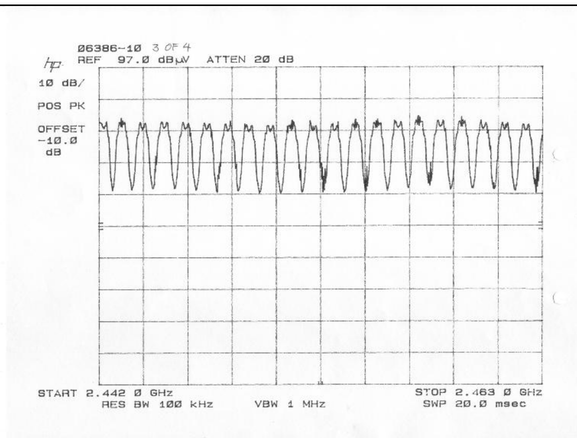
Test Date: March 21, 2006



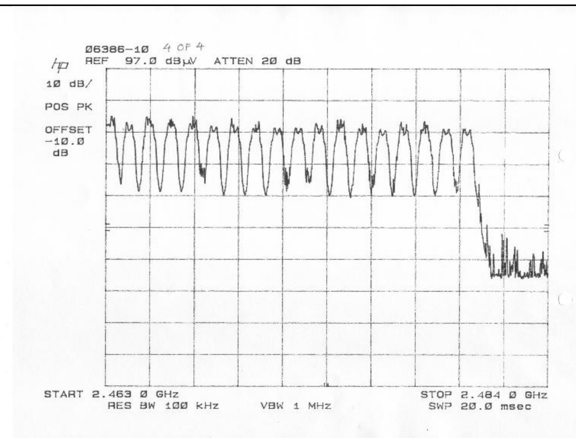
19 Channels



21 Channels



21 Channels



18 Channels

Total channels present: 19+21+21+18 = 79 Channels

Spurious Radiated Emissions Data Sheet
Emissions 30 MHz … 1 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06384-10	17 Mar 2006	CISPR B	10 m	Bicon | Log	CISPR 120 kHz	1 MHz	Peak

COMMENT	Transmitting / Hopping

Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)
132	270	4	31.2	26.8	11.6	4.1	20.2	40	-19.8
275	noise	floor	16.9	26.9	13.4	5.6	9.0	47	-38.0
350	noise	floor	18	27.3	14.9	6.6	12.3	47	-34.7
500	noise	floor	17.4	27.2	17.6	7.2	15.0	47	-32.0
750	noise	floor	17.8	26.1	21.1	9.0	21.8	47	-25.2
950	noise	floor	15.7	26.3	23.0	10.1	22.5	47	-24.5

Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)
84	0	1	35	26.6	8.5	3.0	19.9	40	-20.1
192	0	1.5	25.6	26.8	16.9	4.8	20.4	40	-19.6
228	0	1	29.5	26.8	11.0	5.3	19.0	40	-21.0
432	0	4	27.3	27.4	15.5	7.2	22.5	47	-24.5
444	270	4	27.4	27.3	15.6	7.2	22.8	47	-24.2
456	270	4	30.6	27.4	15.8	7.2	26.2	47	-20.8

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06384-10	20 Mar 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting / Hopping

Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector Function
1056	180	1	49	27.2	23.8	0.5	46.1	83.5	-37.4	peak
1080	180	1	49.7	27.5	23.9	0.5	46.6	83.5	-36.9	peak
1199	180	1	60.4	28.7	24.2	0.5	56.4	83.5	-27.1	peak
1948	180	1	62	33.7	27.4	0.6	56.2	83.5	-27.3	peak
3000	noise	floor	45.2	34.8	30.7	0.7	41.8	83.5	-41.7	peak
17000	noise	floor	50.6	31.2	42.2	2.2	63.8	83.5	-19.7	peak

Vertical

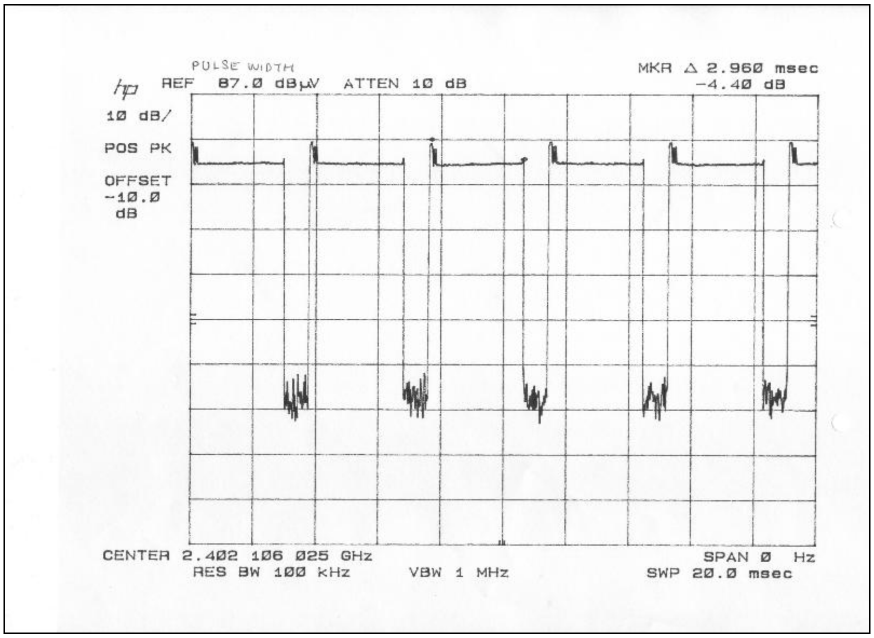
Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector Function
1056	180	1	48	27.2	23.8	0.5	45.1	83.5	-38.4	peak
1116	180	1	47.5	27.9	24.0	0.5	44.1	83.5	-39.4	peak
1466	90	1	60.5	31.6	25.1	0.5	54.5	83.5	-29.0	peak
1948	90	1	67.5	33.7	27.4	0.6	61.7	83.5	-21.8	peak
3000	noise	floor	45.1	34.8	30.7	0.7	41.7	83.5	-41.8	peak
17000	noise	floor	49.9	31.2	42.2	2.2	63.1	83.5	-20.4	peak

Note: Average was calculated using a peak to average correction factor. This is calculated in the timing assessment.

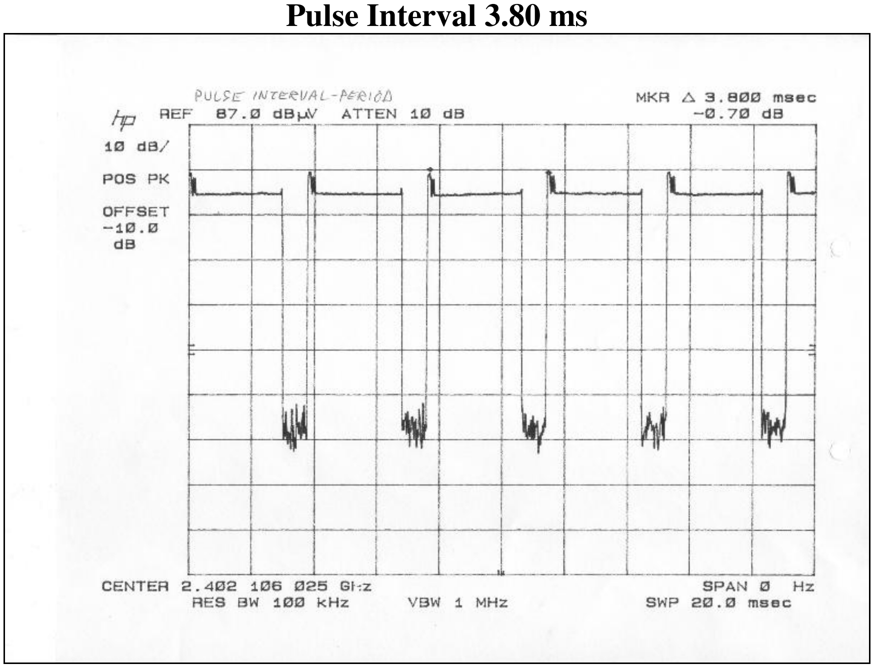
Timing Assessment
3M CMD Bluetooth Module Model 965AMSBT
Peak Detection, RBW = 1 MHz

Test Date: March 22, 2006

Pulse Duration 2.96 ms



Pulse Interval 3.80 ms



Timing Assessment
3M CMD Bluetooth Module Model 965AMSBT
Calculations

Duty Cycle

$$DutyCycle = \frac{PulseDuration}{TotalTime}$$

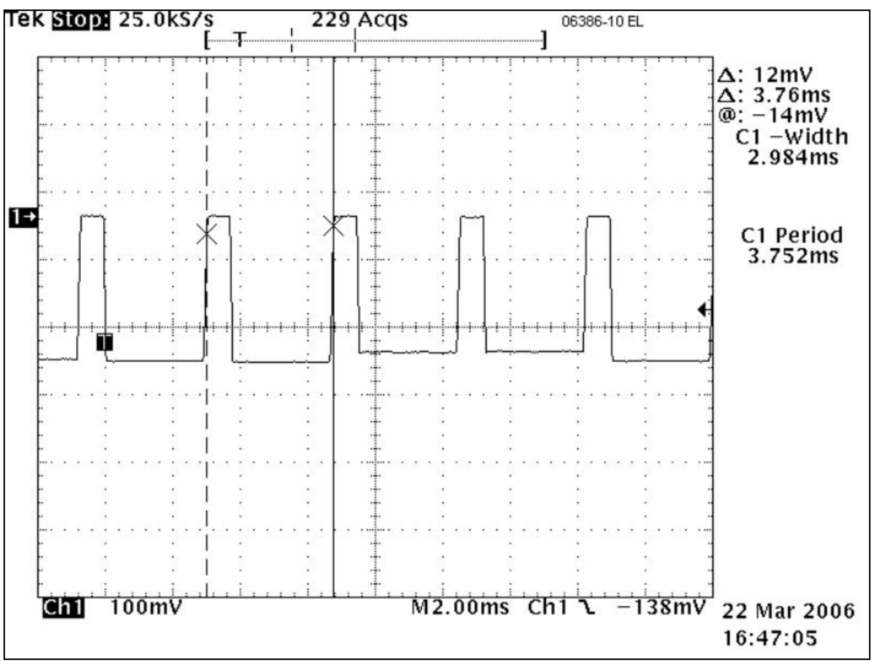
$$DutyCycle = \frac{2.96mS}{3.80mS} = 77.9\%$$

Peak Averaging Correction Factor

$$CorrFact = 20 * \log(DutyCycle)$$

$$CorrFact = 20 * \log(.779) = -2.2dB$$

Dwell Time Assessment



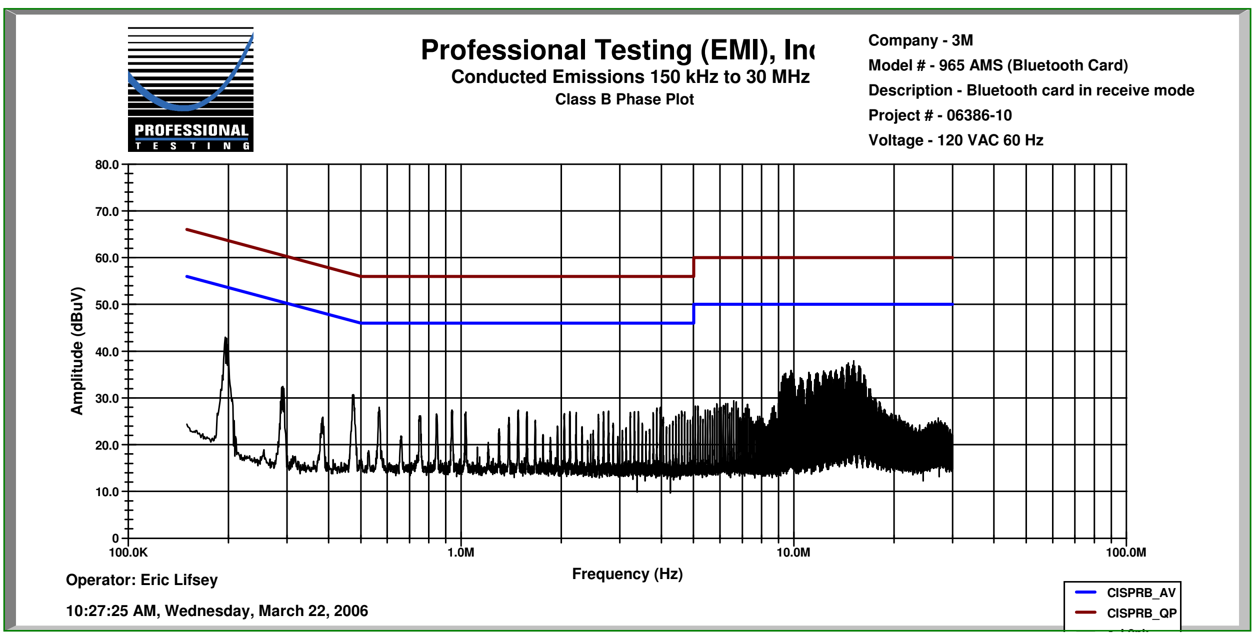
266.67	= Measured Hop-Rate (hops/second)
2.984	= Measured Dwell Time (ms)
79	= Number of Channels
0.4	= Dwell Time Criteria (seconds)
0.318297	= Calculated Time on Channel (seconds)

Channel dwell time satisfies criteria.

Receiver Power line Conducted Emissions
3M CMD Bluetooth Module Model 965AMSBT
Quasi-Peak Detection, RBW = 9 kHz
Receiving

Test Date: March 22, 2006
Line Selection: Phase

Frequency Reading (MHz)	**Quasi-peak Reading** (dBμV)	**Average Reading** (dBμV)	**Quasi-peak Limit** (dBμV)	**Quasi-peak Margin (dB)**	**Average Limit** (dBμV)	**Average Margin (dB)**	**Test Results**
0.19819	42.2	30.2	64.6	-22.4	54.6	-24.4	Pass
0.28802	31.2	22.3	62.1	-30.9	52.1	-29.7	Pass
0.47204	29.4	25.9	56.8	-27.4	46.8	-20.9	Pass
0.56565	25.6	21.9	56.0	-30.4	46.0	-24.1	Pass
3.95894	25.8	19.8	56.0	-30.2	46.0	-26.2	Pass
14.4296	33.4	26.8	60.0	-26.6	50.0	-23.2	Pass
14.5237	34.9	28.5	60.0	-25.1	50.0	-21.5	Pass
14.6202	35.5	29.6	60.0	-24.5	50.0	-20.4	Pass
15.0744	34.4	26.9	60.0	-25.6	50.0	-23.1	Pass
15.1746	35.2	28.7	60.0	-24.8	50.0	-21.3	Pass

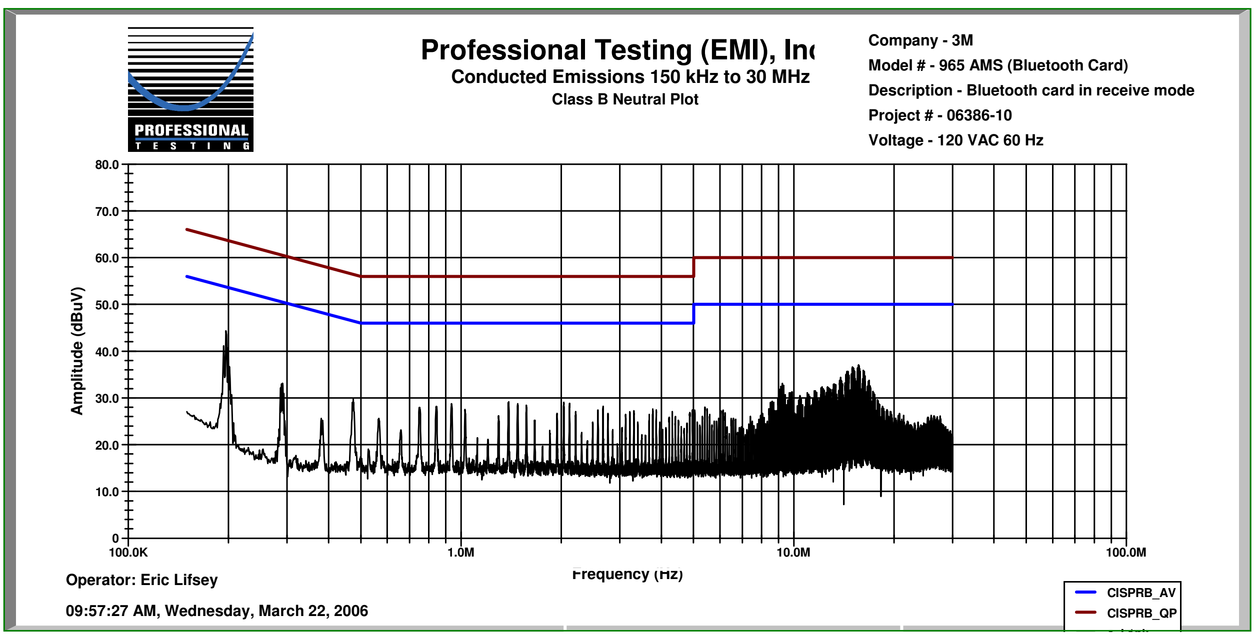


The data presented here in graphical form is for overview only. Detailed and precise data is in the table above.

Receiver Power line Conducted Emissions
3M CMD Bluetooth Module Model 965AMSBT
Quasi-Peak Detection, RBW = 9 kHz
Receiving

Test Date: March 22, 2006
Line Selection: Neutral

Frequency Reading (MHz)	Quasi-peak Reading (dBµV)	Average Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Average Limit (dBµV)	Average Margin (dB)	Test Results
0.19625	43.8	31.5	79.0	-35.2	66.0	-34.5	Pass
0.19651	43.8	31.5	79.0	-35.2	66.0	-34.5	Pass
0.19717	43.8	31.6	79.0	-35.2	66.0	-34.4	Pass
0.28825	31.7	21.4	79.0	-47.3	66.0	-44.6	Pass
0.47158	28.0	25.0	79.0	-51.0	66.0	-41.0	Pass
15.0265	33.7	24.6	73.0	-39.3	60.0	-35.4	Pass
15.0305	33.6	24.7	73.0	-39.4	60.0	-35.3	Pass
15.1261	34.1	25.8	73.0	-38.9	60.0	-34.2	Pass
15.6772	34.1	25.1	73.0	-38.9	60.0	-34.9	Pass
15.6782	34.3	25.0	73.0	-38.7	60.0	-35.0	Pass



The data presented here in graphical form is for overview only. Detailed and precise data is in the table above.

Receiver Spurious Emissions
30 to 1000 MHz
3M CMD Bluetooth Module Model 965AMSBT
Quasi-Peak Detection, RBW = 120 kHz

Test Date: March 17, 2006
Test Distance 10 meters

Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)
225	noise	floor	17.1	26.8	10.9	5.3	6.5	40	-33.5
275	noise	floor	16.9	26.9	13.4	5.6	9.0	47	-38.0
350	noise	floor	18	27.3	14.9	6.6	12.3	47	-34.7
500	noise	floor	17.4	27.2	17.6	7.2	15.0	47	-32.0
750	noise	floor	17.8	26.1	21.1	9.0	21.8	47	-25.2
950	noise	floor	15.7	26.3	23.0	10.1	22.5	47	-24.5

Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)
84	0	1	33.4	26.6	8.5	3.0	18.3	40	-21.7
228	0	1.5	27	26.8	11.0	5.3	16.5	40	-23.5
276	270	1.5	28.6	26.9	13.4	5.6	20.7	47	-26.3
408	0	4	25.9	27.4	15.3	6.8	20.6	47	-26.4
432	0	4	28.8	27.4	15.5	7.2	24.0	47	-23.0
444	270	4	28	27.3	15.6	7.2	23.4	47	-23.6
456	270	4	31.3	27.4	15.8	7.2	26.9	47	-20.1

Receiver Spurious Emissions
1 to 12 GHz
3M CMD Bluetooth Module Model 965AMSBT
Peak Detection, RBW = 1 MHz

Test Date: March 20, 2006
Test Distance 1 meter

Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector Function
1056	180	1	48	27.2	23.8	0.5	45.1	83.5	-38.4	peak
1080	180	1	49.3	27.5	23.9	0.5	46.2	83.5	-37.3	peak
1199	180	1	58.2	28.7	24.2	0.5	54.2	83.5	-29.3	peak
1948	180	1	61.3	33.7	27.4	0.6	55.5	83.5	-28.0	peak
3000	noise	floor	45.7	34.8	30.7	0.7	42.3	83.5	-41.2	peak
17000	noise	floor	50	31.2	42.2	2.2	63.2	83.5	-20.3	peak

Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector Function
1032	180	1	49.4	26.9	23.7	0.5	46.7	83.5	-36.8	peak
1116	180	1	49	27.9	24.0	0.5	45.6	83.5	-37.9	peak
1464	180	1	55.7	31.6	25.1	0.5	49.7	83.5	-33.8	peak
1948	180	1	65.6	33.7	27.4	0.6	59.8	83.5	-23.7	peak
3000	noise	floor	44.2	34.8	30.7	0.7	40.8	83.5	-42.7	peak
17000	noise	floor	49.7	31.2	42.2	2.2	62.9	83.5	-20.6	peak

Antenna Requirements
3M CMD Bluetooth Module Model 965AMSBT

The EUT antenna is a factory-installed and soldered component antenna on the wireless radio card. There is no antenna connector.

The antenna design therefore satisfies the criteria.

Appendix C Policy, Rationale and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy stated in Appendix E to NIST Technical Communications Program, Subchapter 4.09 of the Administrative Manual, as reproduced in Appendix C of NIST Technical Note (TN) 1297, 1994 Edition [1]1. The NIST policy is based on ISO Guide to the Expression of Uncertainty in Measurement [2] (herein after called the Guide), which shall take precedence in the event of disputes. The Guide is explained in TN 1297. Other notable explanations for the Guide are NAMAS Publications NIS 80 [3] and NIS 81 [4]; the latter being specifically for EMC measurements, and the easiest to understand. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11 [5], all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

Rationale and Summary of Expanded Uncertainty

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacture's statements or specifications of the calibration tolerances or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting state uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty discussed in TN 1297, NIS 81, and the Guide. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a-priori, or u-shaped) will be stated for each Type B evaluation.

[1] Numbers in square brackets identify documents listed in the reference section.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements if shown is Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1-1
Summary of Measurement Uncertainties

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Radiated Emissions, Site #1	30 to 200 MHz	3 m	4.7
		10 m	4.4
	200 to 1000 MHz	3 m	4.6
		10 m	4.0
	1 to 2.5 GHz	1 m	2.5
	2.5 to 12.5 GHz	1 m	3.6
	12.5 to 18 GHz	1 m	4.0
Radiated Emissions, Site #2	30 to 200 MHz	3 m	3.5
		10 m	3.7
	200 to 500 MHz	3 m	3.5
		10 m	3.1
	500 to 1000 MHz	3 m	4.0
		10 m	3.9
Radiated Emissions, Site #3	30 to 200 MHz	3 m	3.9
	200 to 500 MHz	3 m	4.0
	500 to 1000 MHz	3 m	4.3