Project 06112-10

Ten X Technology
Model 763

Electromagnetic Emission Test Report

Prepared for:

Ten X Technology
13091 Pond Springs Road
Suite B200
Austin, Texas 78729

By

Professional Testing (EMI), Inc.
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September 28, 2006
Rev 3

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

Table of Contents

Revision History

Rev 1 of 2006-09-18
Page 4 – Spurious transmit limit corrected.
Page 23, Page 4 – Corrected the power spectral density data & power calculation. Data was from an invalid source.

Rev 2 of 2006-09-19
Field to power calculations applied incorrectly; result was erroneously higher than correct power.

Rev 3 of 2006-09-26
Add 26 dB bandwidth plots, revised procedure and related tables accordingly.
Corrected test dates (wrong year), all tests were in 2006, none in 2005.
Explained cal date of asset 0483 preamplifier.
Corrected peak power measurements, measure the EBW (6dB) for RBW=3 MHz (analyzer maximum). Revise procedure and related tables.

Applicant:	Ten X Technology
Applicant's Address:	13091 Pond Springs Road, Suite B200
	Austin, TX 78729
FCC ID:	TTPA0076300
IC Number:	6221A-A0076300
Project Number:	06112-10
Test Dates:	January 10th – February 16th, 2006

The **Ten X Technology Model 763 ZigBee Transceiver** 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	0.54680	40.2 dBμV	46.0 dBμV	-5.8
Transmitter: Radiated Spurious	4810	41.5 dBμV /m	74.0 dBμV /m	-32.5
Transmitter: Peak Power @ 1 m	2405	-7.77 dBm (0.167 mW)	+30 dBm	-37.8
Transmitter: Power Spectral Density	2440	-37.4 dBm / 3 kHz	8 dBm / 3 kHz	-45.4
Receiver: Mains Conducted	0.57494	44.4 dBμV	46 dBμV	-1.6
Receiver: Radiated Spurious	None detected above noise floor.			

Occupied Bandwidth		Emission Designator FCC (6 dB BW)	Emission Designator IC (26 dB BW)
6 dB	26 dB		
1.64 MHz	4.51 MHz	1M64G1D	4M51G1D

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 Ten X Technology. 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 Ten X Technology Model 763 USB ZigBee dongle (EUT) is a high performance, low power, 2.4 GHz ISM band transceiver. It is based on the EMBER EM2420 family of 802.154.14 transceivers and provides a cost-effective method of adding wireless sensing to any device that supports USB. The EUT is initially programmed with an IEEE 802.15.4 sniffer application. This works in conjunction with the Ten X Windows based sniffer application provided on CD with the EUT.

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
Ten X Technology	763	TTPA0076300	6221A-A0076300

Supporting Equipment	Description
Dell Inspiron PP08L (Serial: CN-0W0941-12961-36Q-2697)	Notebook computer
AC Adapter PA-1131-02D (Serial: CN-09Y819-48010-377--07EE)	Notebook 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 & 26 dB

Occupied bandwidth measurements were performed on the Ten X Technology ZigBee Module Model 763 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 dB occupied bandwidth of the EUT. The 26 dB bandwidth is measure in a similar fashion or by directly measuring the plotted 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 26 dB bandwidth is used to report the 99% power bandwidth.

5.0 Power Spectral Density

Power spectral density measurements were performed on the Ten X Technology ZigBee Module Model 763 to determine compliance with FCC 15.247(d) and RSS-210.

5.1 Test Procedure

The fundamental emission of the EUT is maximized and the spectrum analyzer is tuned to the highest point as measured in max-hold with peak detection. The analyzer is then centered on the maximum peak and set with the following parameters: RBW = 3 kHz, VBW > RBW, span = 300 kHz, and sweep time = 100s. The peak level is obtained after the sweep completes. The test setup is included in Appendix A.

5.2 Test Criteria

According to section FCC 15.247(d) and RSS-210 the maximum power spectral density is +8 dBm in any 3 kHz bandwidth.

6.0 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.

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 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.

6.2 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.

7.0 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.

7.1 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.

7.2 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.

8.0 Antenna Requirements

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

8.1 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.

8.2 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.

9.0 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.

9.1 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.

9.2 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.

10.0 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.

10.1 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.

10.1.1 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.

10.1.2 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.

10.2 Spurious Radiated Emissions

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

10.2.1 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.

10.2.2 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)	Field Strength (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.

11.0 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.

12.0 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.

FIGURE 1: Radiated Emissions Test Setup

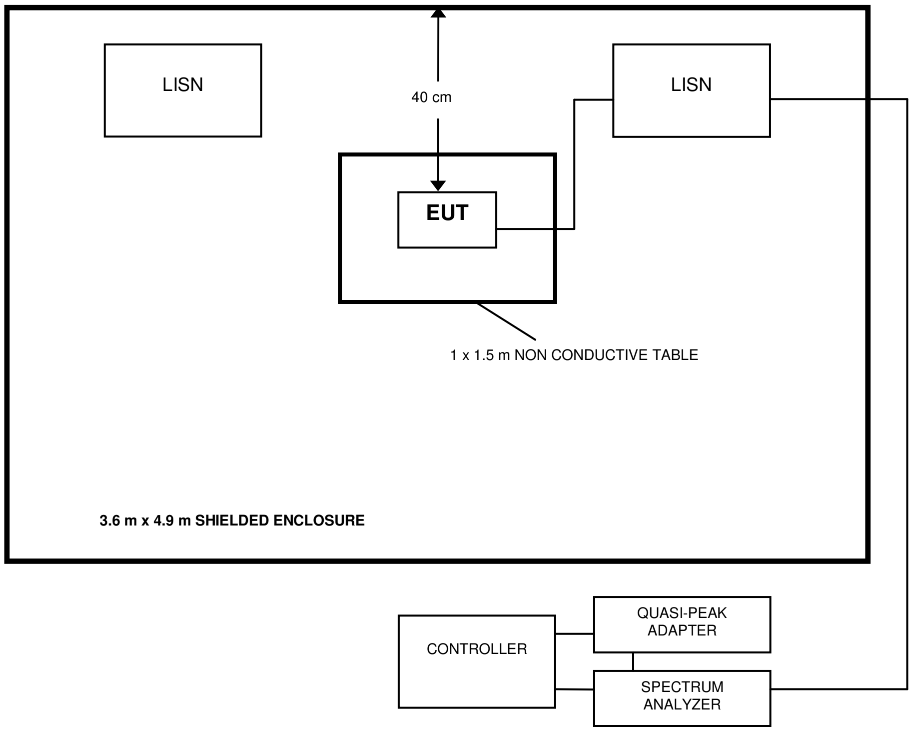


FIGURE 2: Radiated Emissions Test Setup
Peak Power, Occupied Bandwidth, Power Spectral Density, Timing Assessment, Band Edge Spurious

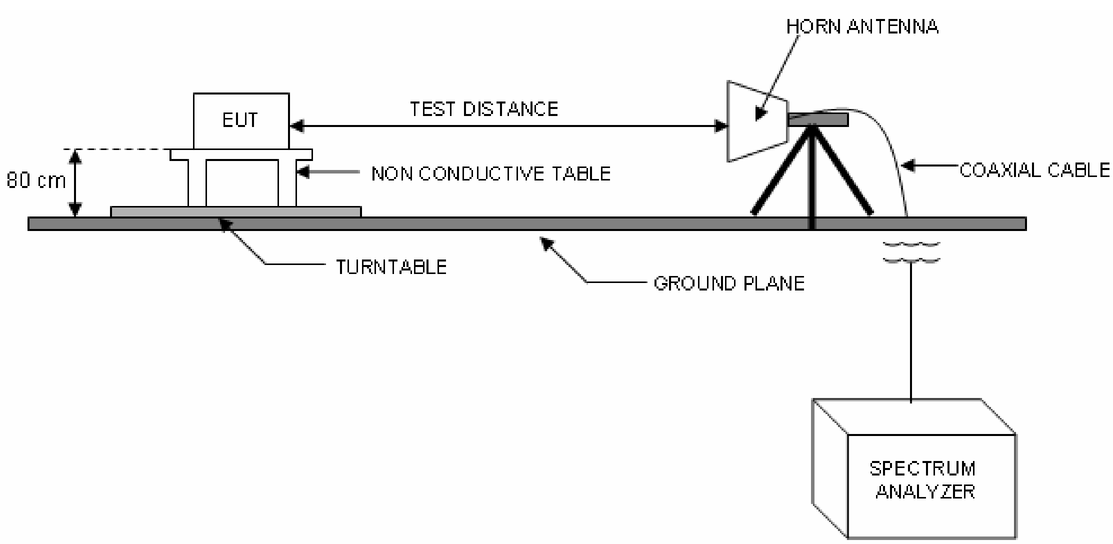


FIGURE 3: Radiated Emissions Test Setup - Spurious

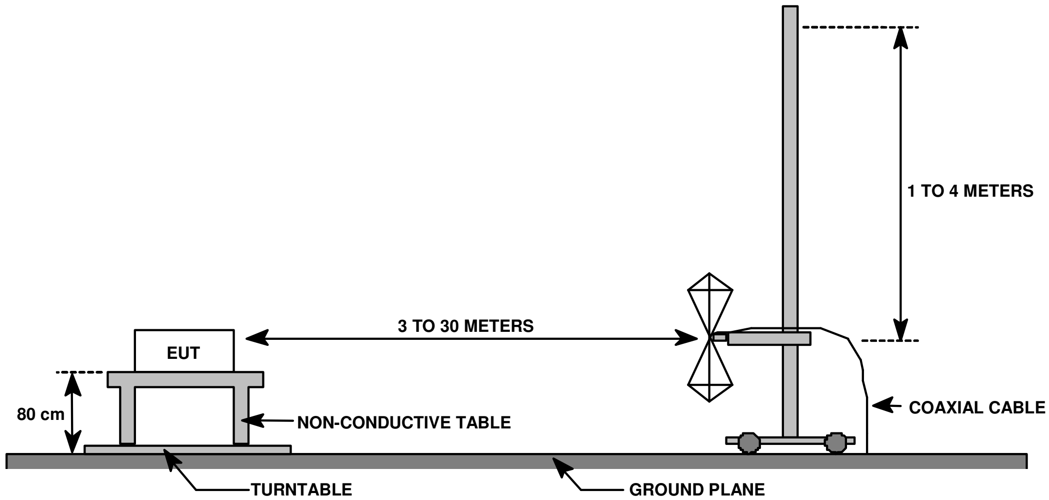
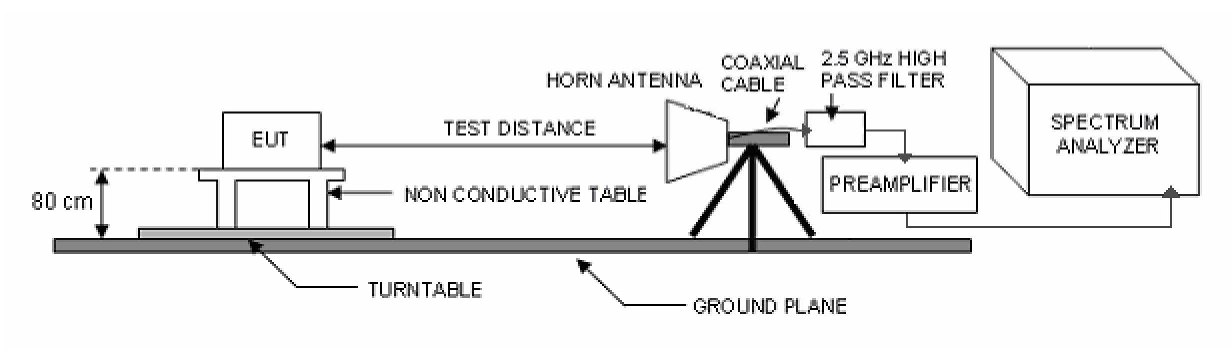


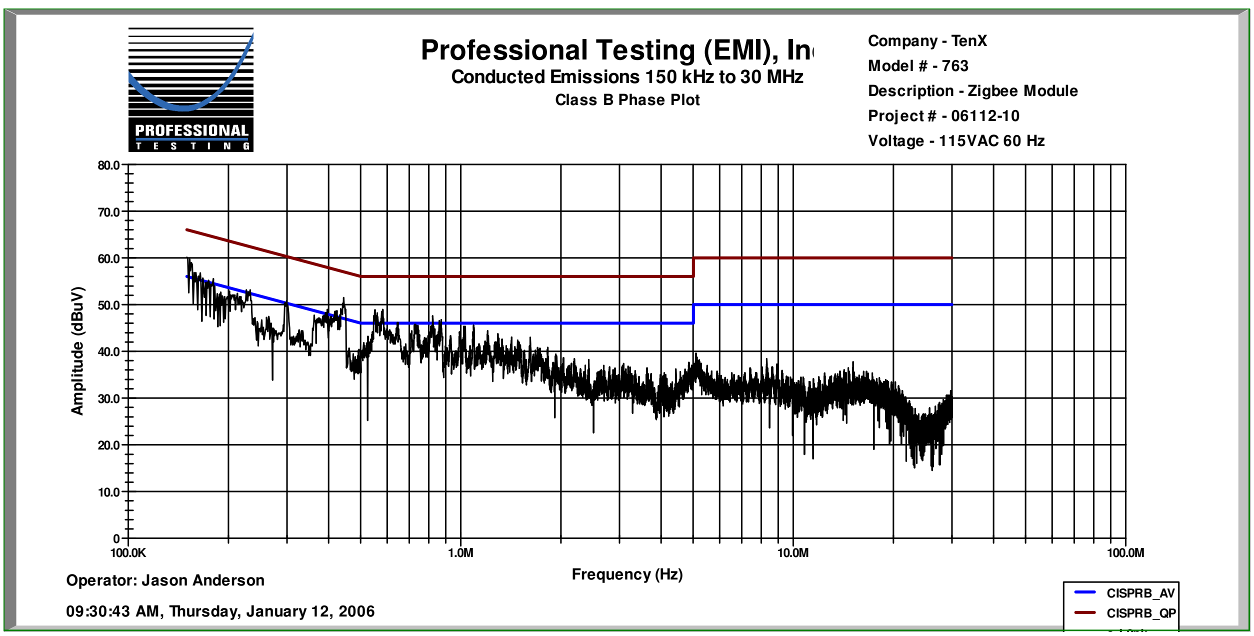
FIGURE 4: Radiated Emissions Test Setup – Harmonics & Spurious > $f_{(o)}$



Power line Conducted Emissions
Ten X Technology ZigBee Module Model 763
Quasi-Peak Detection, RBW = 9 kHz

Test Date: January 12, 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**
0.150084	54.7	42.9	66	-11.3	56	-13.1	Within Limits
0.150307	54.8	43.2	66	-11.2	56	-12.8	Within Limits
0.150374	54.8	44	66	-11.2	56	-12	Within Limits
0.150708	55.4	43	66	-10.6	56	-12.9	Within Limits
0.15312	54.5	43.5	65.9	-11.4	55.9	-12.4	Within Limits
5.12373	35.1	28.1	60	-24.9	50	-21.9	Within Limits
5.50860	31.3	25.6	60	-28.7	50	-24.4	Within Limits
8.34997	33.2	27.5	60	-26.8	50	-22.5	Within Limits
8.94900	32.7	26.9	60	-27.3	50	-23.1	Within Limits
15.0745	29.7	22.6	60	-30.3	50	-27.4	Within Limits

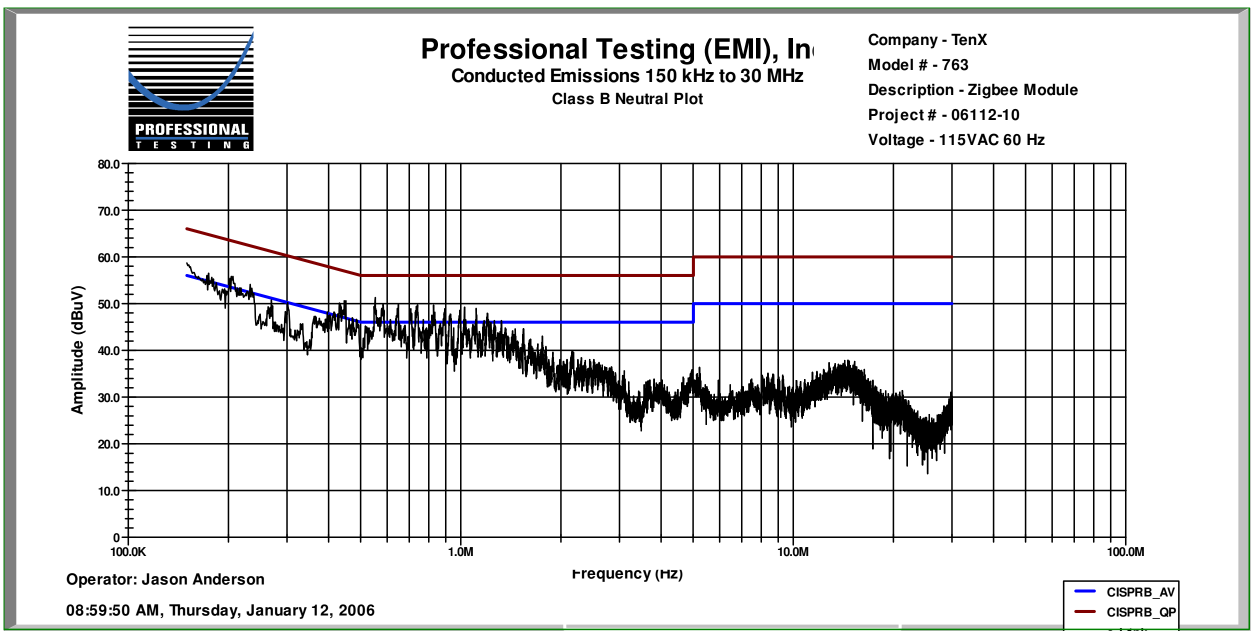


The data presented here in graphical form is for overview only. Detailed and precise data is in the table above.

Power line Conducted Emissions
Ten X Technology ZigBee Module Model 763
Quasi-Peak Detection, RBW = 9 kHz

Test Date: February 24, 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
0.150509	55	37.2	66	-10.9	56	-18.8	Within Limits
0.20272	51.7	44.4	64.5	-12.8	54.5	-10.1	Within Limits
0.26616	47.2	41.5	62.7	-15.5	52.7	-11.2	Within Limits
0.43395	47	40.2	57.9	-10.9	47.9	-7.7	Within Limits
0.54680	48.5	40.2	56	-7.5	46	-5.8	Within Limits
12.8382	31.3	24.8	60	-28.7	50	-25.2	Within Limits
13.3688	31.7	25.1	60	-28.3	50	-24.9	Within Limits
14.2805	31.9	24.2	60	-28.1	50	-25.8	Within Limits
14.5669	31.8	24.5	60	-28.2	50	-25.5	Within Limits
15.2856	32	24.6	60	-28	50	-25.4	Within Limits



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

Peak Power
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 3 MHz

Test Date: September 28, 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)
2405	180	1	68.2	0.0	28.2	0.6	97.0
2440	180	1	65.0	0.0	28.2	0.6	93.8
2480	200	1	64.2	0.0	28.3	0.6	93.1

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)
2405	97.0	0.167 mW (-7.77 dBm)	30
2440	93.8	0.080 mW (-11.0 dBm)	30
2480	93.1	0.068 mW (-11.7 dBm)	30

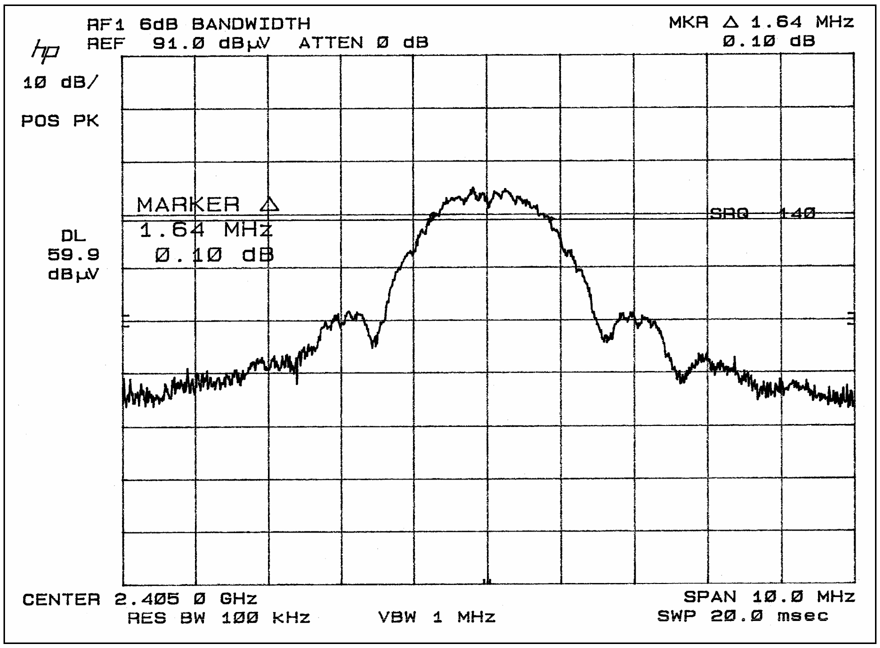
Result: PASS

Test Engineer: Eric Lifsey

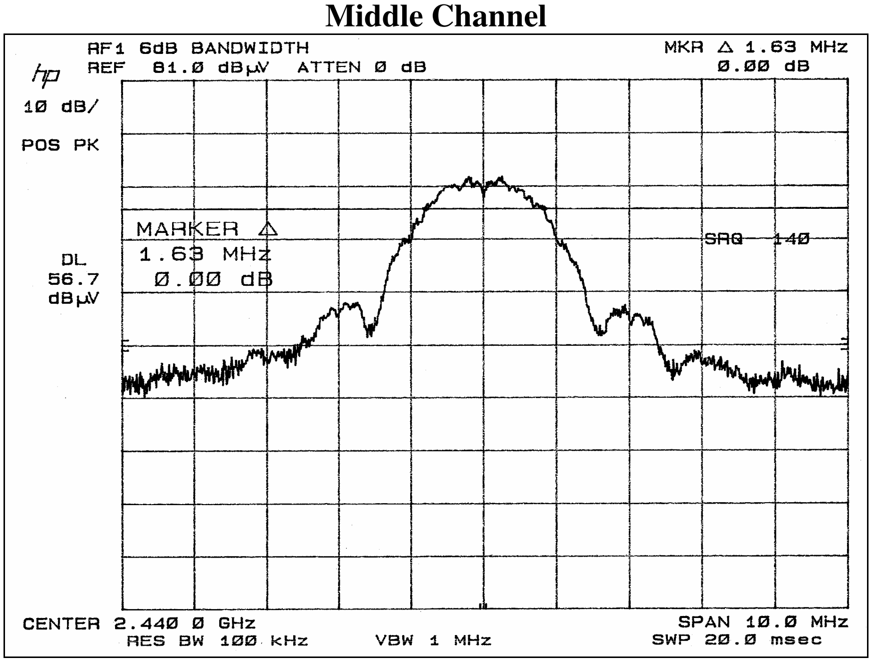
Occupied Bandwidth 6 dB
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 100 kHz

Test Date: January 11, 2006

Low Channel



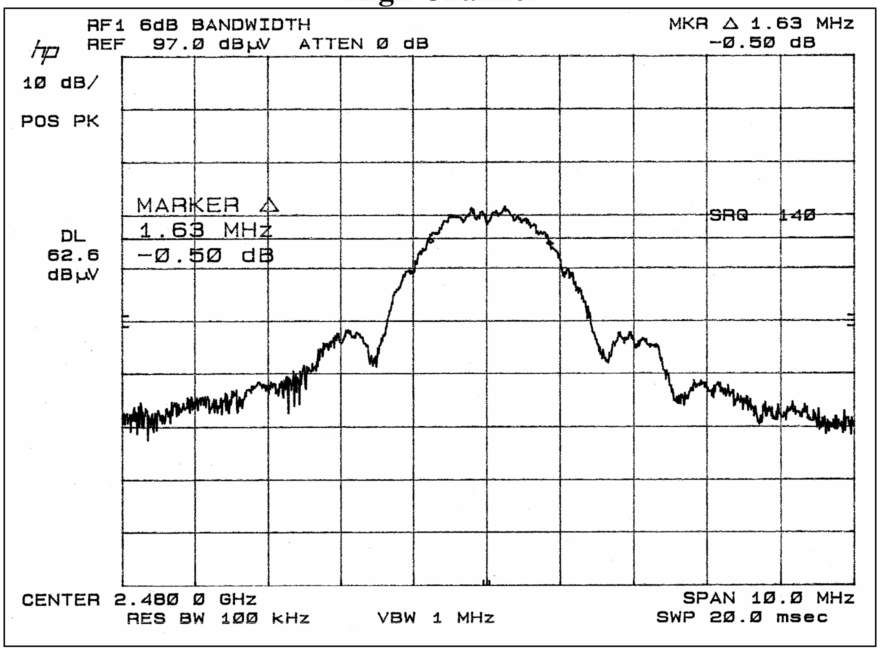
Middle Channel



Occupied Bandwidth 6 dB
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 100 kHz

Test Date: January 11, 2006

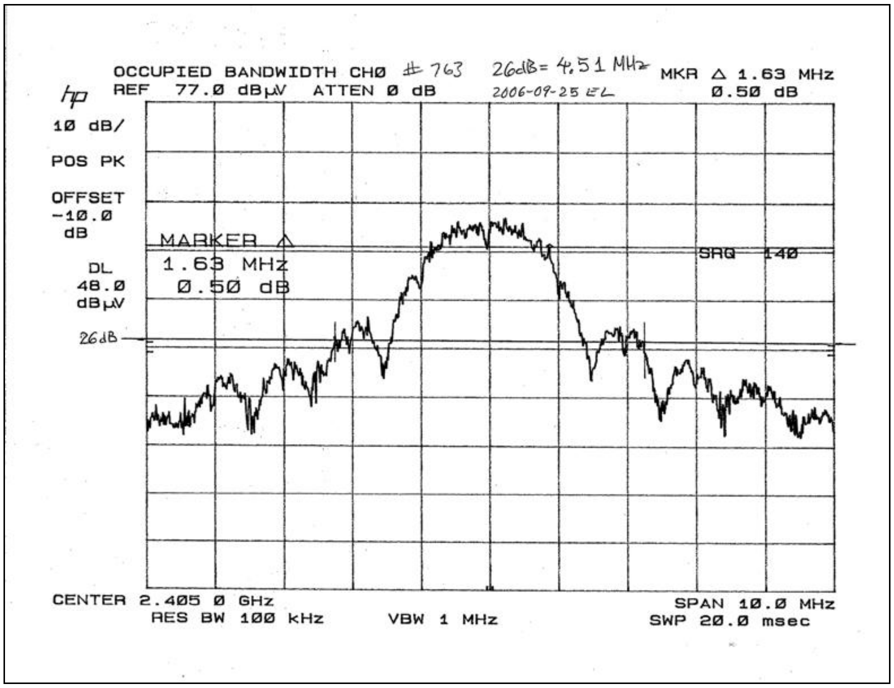
High Channel



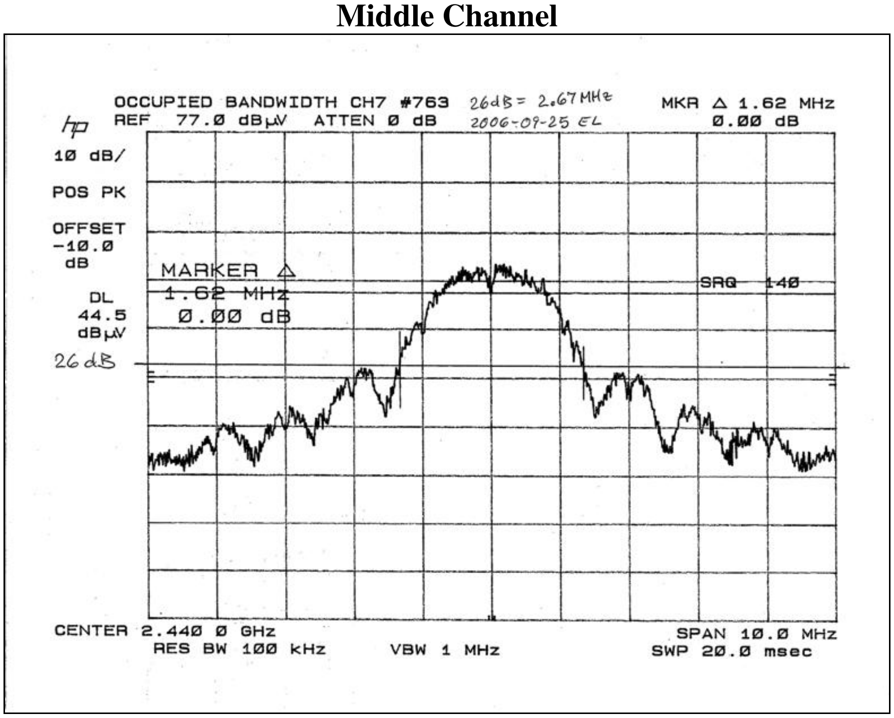
Occupied Bandwidth 26 dB
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 100 kHz

Test Date: January 11, 2006

Low Channel



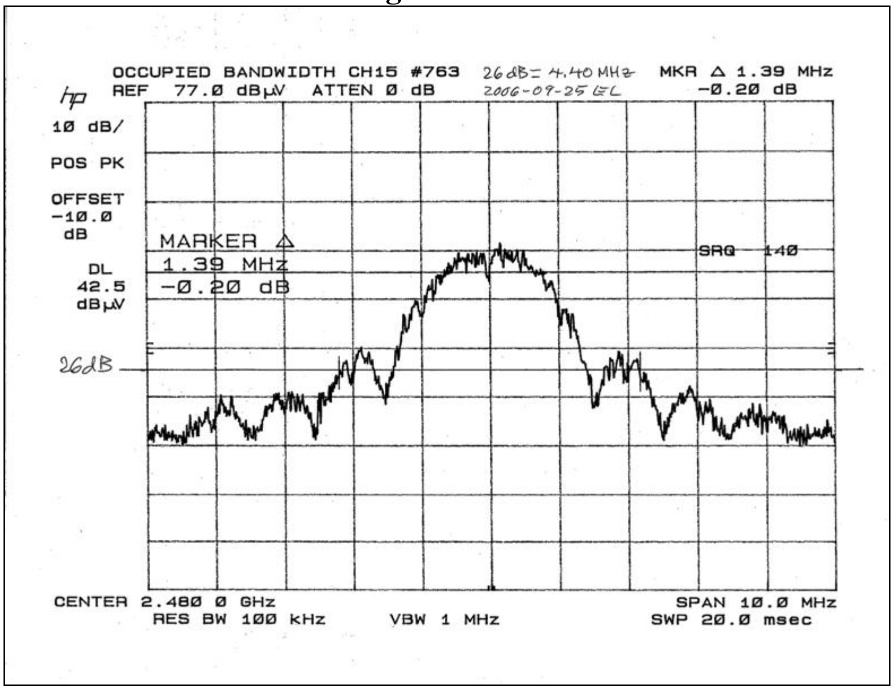
Middle Channel



Occupied Bandwidth 26 dB
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 100 kHz

Test Date: January 11, 2006

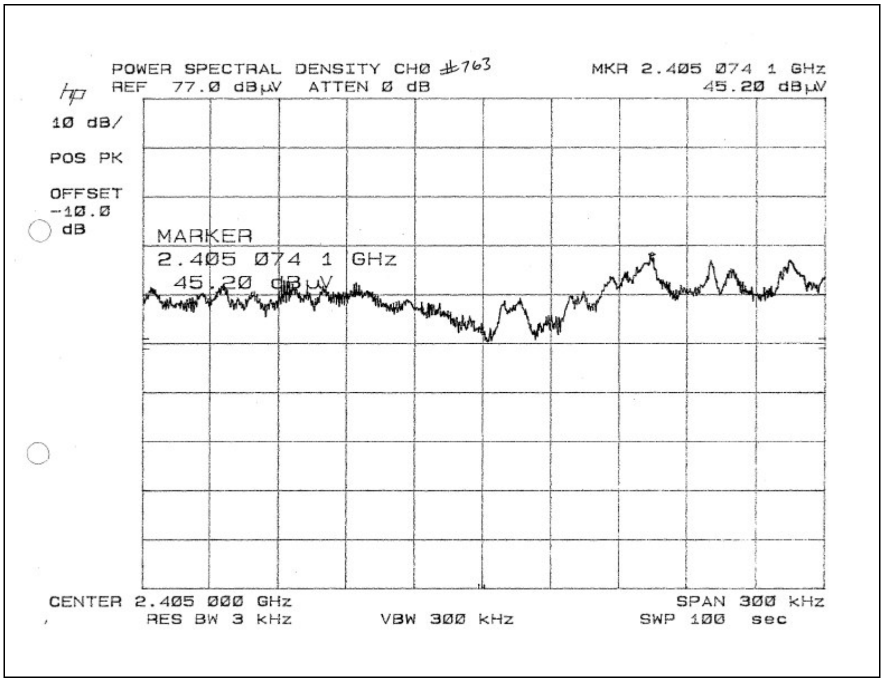
High Channel



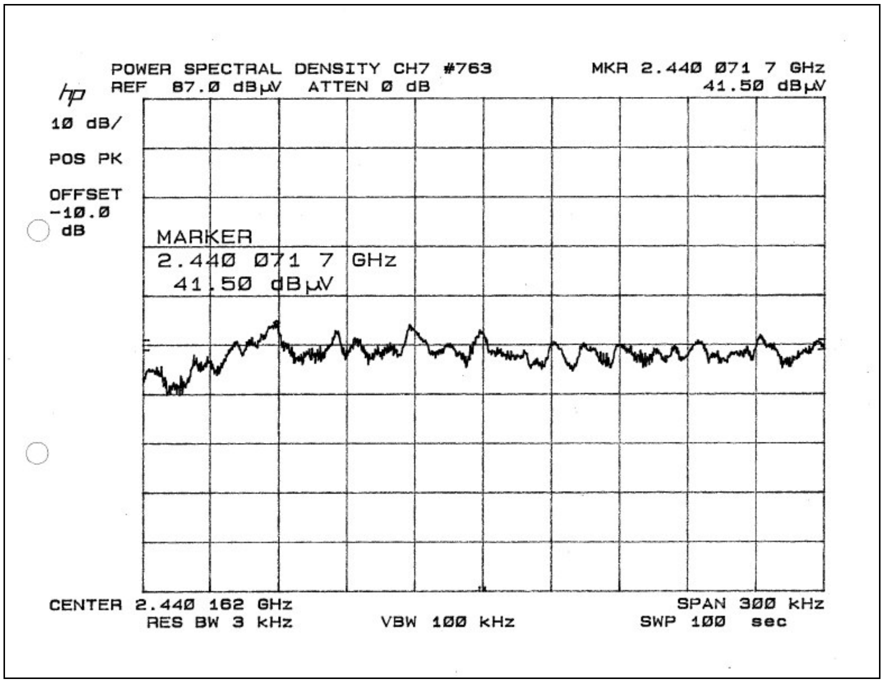
Power Spectral Density
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 3 kHz
Test Distance 1 meters

Test Date: January 11, 2006

Low Channel



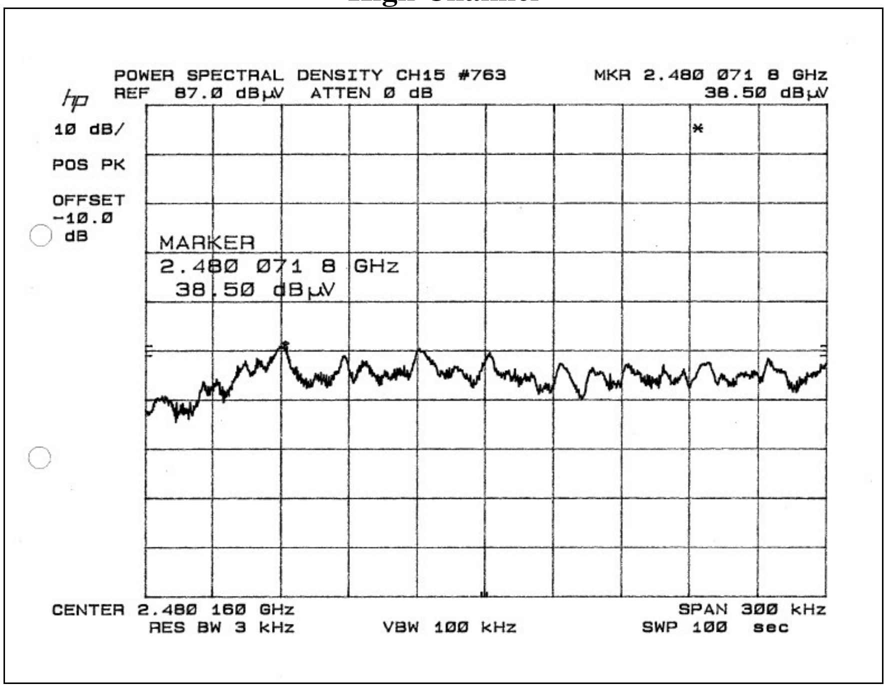
Middle Channel



Power Spectral Density
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 3 kHz

Test Date: January 11, 2006
Test Distance 1 meters

High Channel



Power Spectral Density
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 3 kHz

Test Date: January 10, 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)**
2405	Max	763	45.2	0.0	28.2	0.6	74.0
2440	Max	763	41.5	0.0	28.2	0.6	70.3
2480	Max	763	38.5	0.0	28.3	0.6	67.4

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

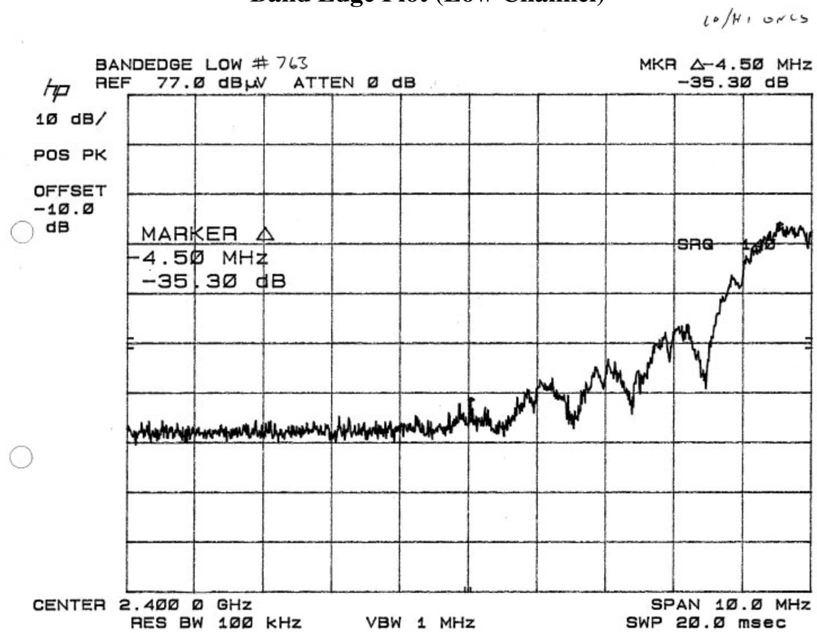
Frequency (MHz)	Field Strength (dBμV)	E.I.R.P (dBm / 3 kHz)	Limit (dBm / 3 kHz)
2405	74.0	-30.8	8
2440	70.3	-34.5	8
2480	67.4	-37.4	8

Result: PASS

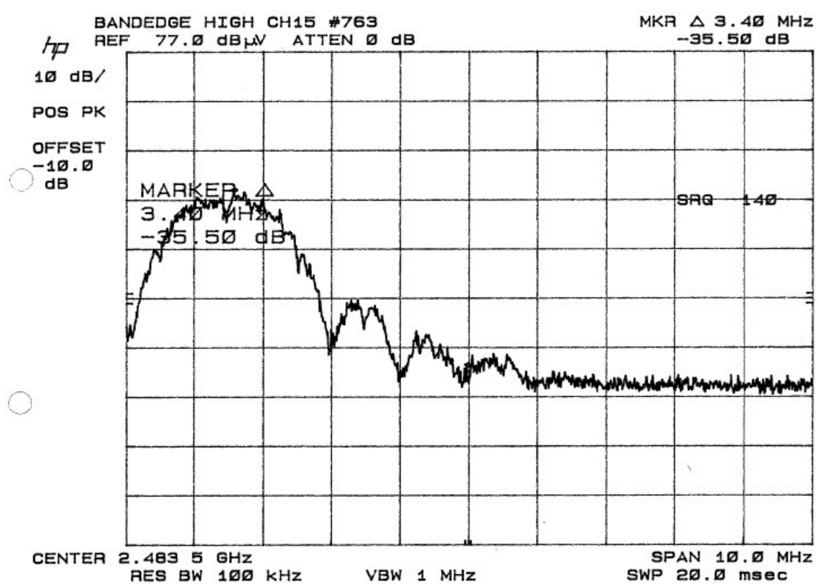
Band Edge Spurious Emissions
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 100 kHz

Test Date: January 11, 2006
Test Distance 1 meters

Band Edge Plot (Low Channel)



Band Edge Plot (High Channel)



Spurious Radiated Emissions Data Sheet
Emissions 30 MHz … 1 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06112-10	12 Jan 2006	CISPR B	3 m	Bicon	Log	CISPR 120 kHz	1 MHz	QP

COMMENT	Transmitting

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)
168	noise	floor	35.7	26.7	14.6	3.6	27.1	43.5	-16.4
280	noise	floor	34.6	26.9	14.4	4.8	26.8	46	-19.2
450	noise	floor	36.2	27.3	16.6	6.4	31.9	46	-14.1
625	noise	floor	35.6	26.8	19.3	7.8	35.9	46	-10.1
780	noise	floor	33.5	26.1	21.1	9.0	37.4	46	-8.6
910	noise	floor	35.3	26.2	22.6	9.5	41.2	46	-4.8

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)
168	noise	floor	35.7	26.7	14.6	3.6	27.1	43.5	-16.4
280	noise	floor	34.6	26.9	14.4	4.8	26.8	46	-19.2
450	noise	floor	36.2	27.3	16.6	6.4	31.9	46	-14.1
625	noise	floor	35.6	26.8	19.3	7.8	35.9	46	-10.1
780	noise	floor	33.5	26.1	21.1	9.0	37.4	46	-8.6
910	noise	floor	35.3	26.2	22.6	9.5	41.2	46	-4.8

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06112-10	11 Jan 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting Low Channel

Vertical

Freq. (MHz)	Detector Function	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Distance Correction (dB)	Corrected Level (dBμV /M)	Limit 3 Meters (dBμV)	Margin (dB)
4810	peak	1	34.7	23.5	34.0	3.8	9.5	39.6	74	-34.4
7215	peak	1	23.9	22.1	36.7	4.4	9.5	33.5	74	-40.5
9620	noise	floor	21.3	21.4	37.8	4.5	9.5	32.7	74	-41.3
12025	noise	floor	22.4	22.4	39.1	5.0	9.5	34.6	54	-19.4
14430	noise	floor	23.5	22.7	41.2	4.8	9.5	37.4	54	-16.6
16835	noise	floor	22.5	20.8	41.4	5.1	9.5	38.7	54	-15.3
19240	noise	floor	39.8	0.0	37.0	0.0	29.5	47.3	54	-6.7
21645	noise	floor	38.9	0.0	37.0	0.0	29.5	46.4	54	-7.6
24050	noise	floor	39.5	0.0	37.0	0.0	29.5	47.0	54	-7.0

Horizontal

Freq. (MHz)	Detector Function	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Distance Correction (dB)	Corrected Level (dBμV /M)	Limit 3 Meters (dBμV)	Margin (dB)
4810	peak	1	36.6	23.5	34.0	3.8	9.5	41.5	74	-32.5
7215	peak	1	24.5	22.1	36.7	4.4	9.5	34.1	74	-39.9
9620	noise	floor	21.8	21.4	37.8	4.5	9.5	33.2	74	-40.8
12025	noise	floor	23	22.4	39.1	5.0	9.5	35.2	54	-18.8
14430	noise	floor	22.8	22.7	41.2	4.8	9.5	36.7	54	-17.3
16835	noise	floor	23	20.8	41.4	5.1	9.5	39.2	54	-14.8
19240	noise	floor	39.8	0.0	37.0	0.0	29.5	47.3	54	-6.7
21645	noise	floor	38.9	0.0	37.0	0.0	29.5	46.4	54	-7.6
24050	noise	floor	39.5	0.0	37.0	0.0	29.5	47.0	54	-7.0

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

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06112-10	11 Jan 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting Middle Channel

Vertical

Freq. (MHz)	Detector Function	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Distance Correction (dB)	Corrected Level (dBµV /M)	Limit 3 Meters (dBµV)	Margin (dB)
4880	peak	1	29.9	23.4	34.2	3.8	9.5	35.0	74	-39.0
7320	peak	1	23.6	22.0	36.9	4.4	9.5	33.4	74	-40.6
9760	noise	floor	21.9	21.4	37.9	4.5	9.5	33.4	74	-40.6
12200	noise	floor	21.6	22.6	39.4	5.0	9.5	33.8	54	-20.2
14640	noise	floor	21.3	22.6	40.5	4.8	9.5	34.5	54	-19.5
17080	noise	floor	21.3	20.4	42.7	5.2	9.5	39.3	54	-14.7
19520	noise	floor	39.6	0.0	37.0	0.0	29.5	47.1	54	-6.9
21960	noise	floor	39.3	0.0	37.0	0.0	29.5	46.8	54	-7.2
24400	noise	floor	38.4	0.0	37.0	0.0	29.5	45.9	54	-8.1

Horizontal

Freq. (MHz)	Detector Function	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Distance Correction (dB)	Corrected Level (dBµV /M)	Limit 3 Meters (dBµV)	Margin (dB)
4880	peak	1	34.7	23.4	34.2	3.8	9.5	39.8	74	-34.2
7320	peak	1	24.5	22.0	36.9	4.4	9.5	34.3	74	-39.7
9760	noise	floor	21.8	21.4	37.9	4.5	9.5	33.3	74	-40.7
12200	noise	floor	22.2	22.6	39.4	5.0	9.5	34.4	54	-19.6
14640	noise	floor	22.7	22.6	40.5	4.8	9.5	35.9	54	-18.1
17080	noise	floor	21.9	20.4	42.7	5.2	9.5	39.9	54	-14.1
19520	noise	floor	39.6	0.0	37.0	0.0	29.5	47.1	54	-6.9
21960	noise	floor	39.3	0.0	37.0	0.0	29.5	46.8	54	-7.2
24400	noise	floor	38.4	0.0	37.0	0.0	29.5	45.9	54	-8.1

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

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06112-10	11 Jan 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting High Channel

Vertical

Freq. (MHz)	Detector Function	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Distance Correction (dB)	Corrected Level (dBμV /M)	Limit 3 Meters (dBμV)	Margin (dB)
4960	peak	1	35.5	23.4	34.4	3.8	9.5	40.8	74	-33.2
7440	peak	1	22.6	21.9	37.1	4.4	9.5	32.7	74	-41.3
9920	noise	floor	21.7	21.4	38.0	4.5	9.5	33.3	74	-40.7
12400	noise	floor	22.6	22.8	39.7	4.9	9.5	34.9	54	-19.1
14880	noise	floor	22.3	22.7	39.4	4.9	9.5	34.4	54	-19.6
17360	noise	floor	21.5	19.7	44.6	5.0	9.5	41.9	54	-12.1
19840	noise	floor	39.7	0.0	37.0	0.0	29.5	47.2	54	-6.8
22320	noise	floor	40.2	0.0	37.0	0.0	29.5	47.7	54	-6.3
24800	noise	floor	39.8	0.0	37.0	0.0	29.5	47.3	54	-6.7

Horizontal

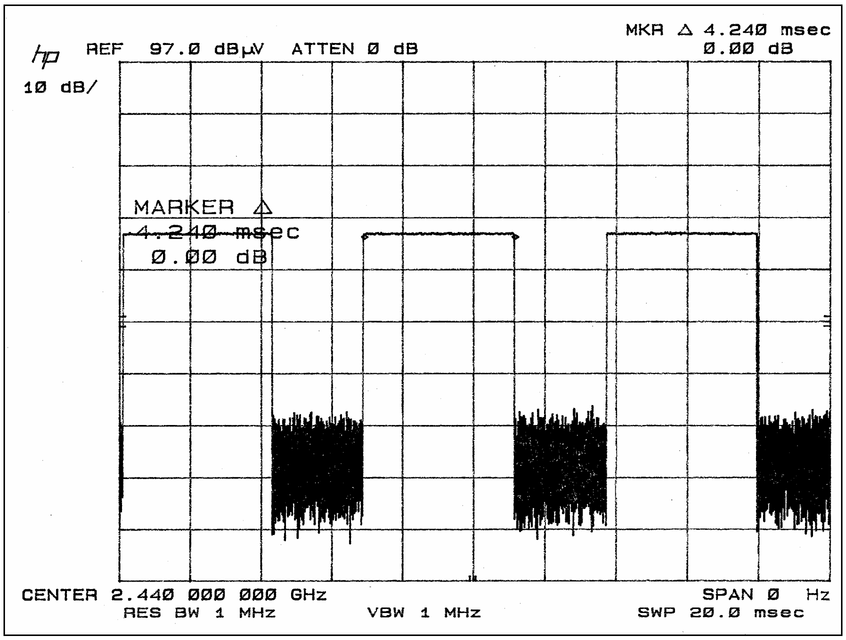
Freq. (MHz)	Detector Function	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/M)	Cable Loss (dB)	Distance Correction (dB)	Corrected Level (dBμV /M)	Limit 3 Meters (dBμV)	Margin (dB)
4960	peak	1	34.8	23.4	34.4	3.8	9.5	40.1	74	-33.9
7440	peak	1	23.2	21.9	37.1	4.4	9.5	33.3	74	-40.7
9920	noise	floor	21.4	21.4	38.0	4.5	9.5	33.0	74	-41.0
12400	noise	floor	22.8	22.8	39.7	4.9	9.5	35.1	54	-18.9
14880	noise	floor	22	22.7	39.4	4.9	9.5	34.1	54	-19.9
17360	noise	floor	21.1	19.7	44.6	5.0	9.5	41.5	54	-12.5
19840	noise	floor	39.7	0.0	37.0	0.0	29.5	47.2	54	-6.8
22320	noise	floor	40.2	0.0	37.0	0.0	29.5	47.7	54	-6.3
24800	noise	floor	39.8	0.0	37.0	0.0	29.5	47.3	54	-6.7

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

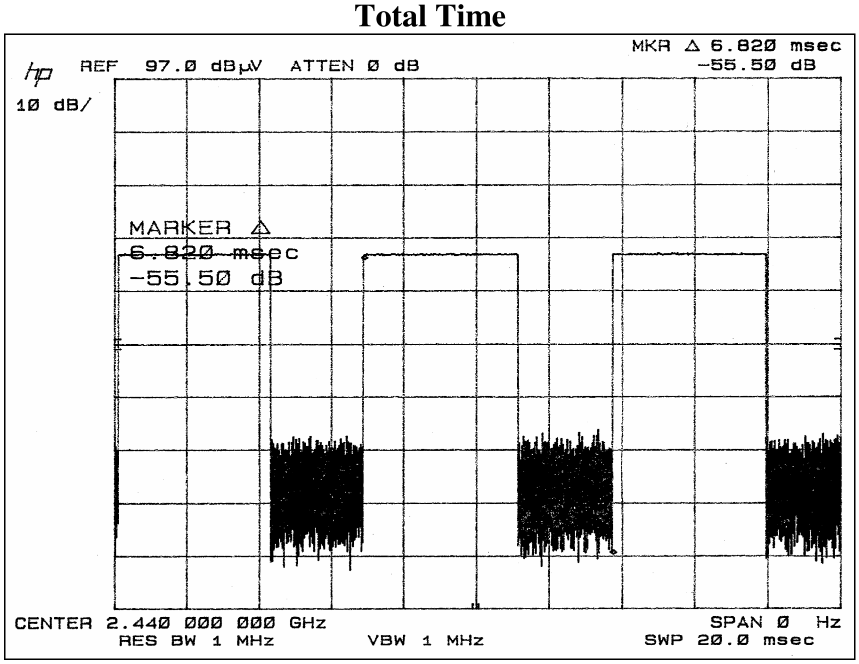
Timing Assessment
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 1 MHz

Test Date: January 11, 2006

Pulse Duration



Total Time



Timing Assessment
Ten X Technology ZigBee Module Model 763
Calculations

Duty Cycle

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

$$DutyCycle = \frac{4.24mS}{6.82mS} = 62.2\%$$

Peak Averaging Correction Factor

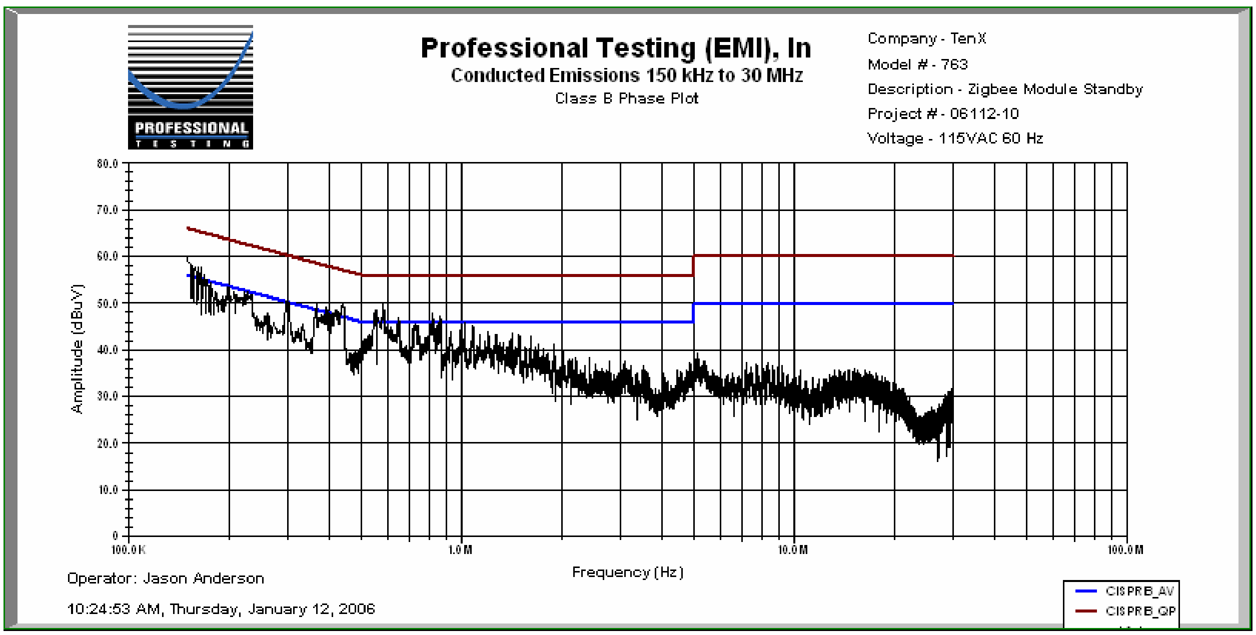
$$CorrFact = 20 * \log(DutyCycle)$$

$$CorrFact = 20 * \log(.622) = -4.1dB$$

Receiver Power line Conducted Emissions
Ten X Technology ZigBee Module Model 763
Quasi-Peak Detection, RBW = 9 kHz
Stand By

Test Date: January 12, 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
0.150259	54.8	45.1	66	-11.2	56	-10.9	Within Limits
0.150322	54.8	43.9	66	-11.2	56	-12.1	Within Limits
0.150463	54.8	44.1	66	-11.2	56	-11.9	Within Limits
0.150921	54.9	45	66	-11.1	56	-10.9	Within Limits
0.151062	54.7	44.7	66	-11.2	56	-11.3	Within Limits
5.11463	35.3	28.5	60	-24.7	50	-21.5	Within Limits
7.14302	31.2	25.3	60	-28.8	50	-24.7	Within Limits
7.73175	32.1	26.3	60	-27.9	50	-23.7	Within Limits
8.34285	33.3	27.4	60	-26.7	50	-22.6	Within Limits
9.21067	32.4	26.3	60	-27.6	50	-23.7	Within Limits

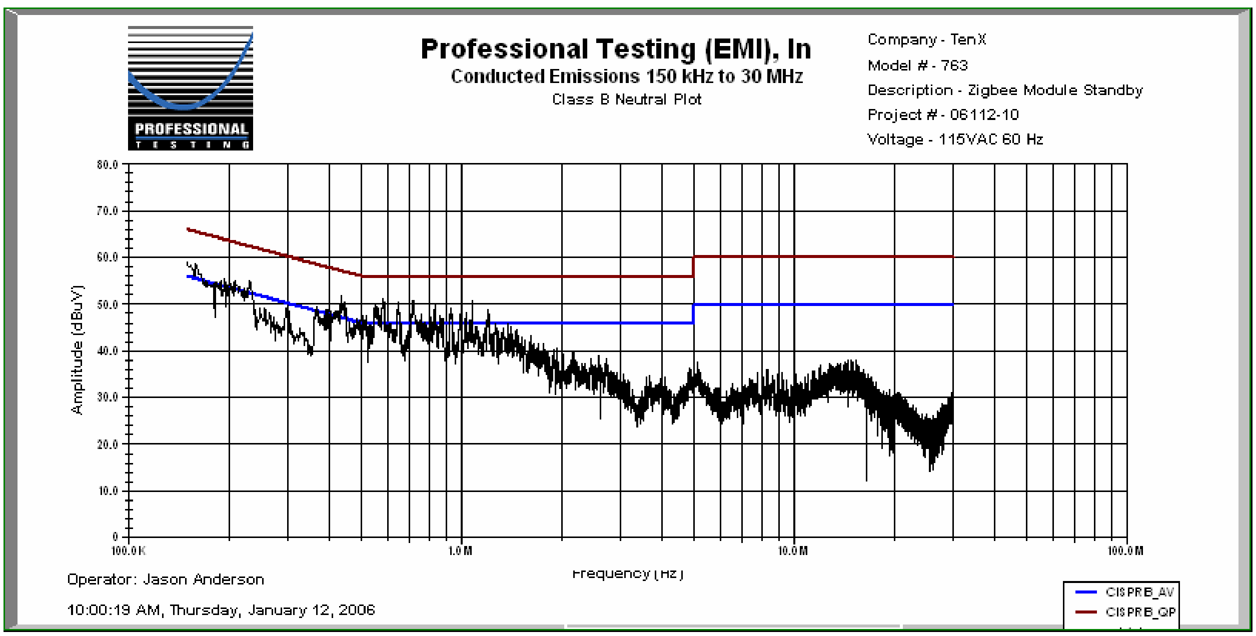


The data presented here in graphical form is for overview only. Detailed and precise data is in the table above.

Receiver Power line Conducted Emissions
Ten X Technology ZigBee Module Model 763
Quasi-Peak Detection, RBW = 9 kHz
Stand By

Test Date: January 12, 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
0.150804	55.2	40.5	66	-10.7	56	-15.5	Within Limits
0.23105	52	46.1	63.7	-11.7	53.7	-7.5	Within Limits
0.44258	47.5	38.6	57.6	-10.2	47.6	-9.1	Within Limits
0.57494	47.1	44.4	56	-8.9	46	-1.6	Within Limits
1.08249	44.4	36.2	56	-11.6	46	-9.8	Within Limits
5.09257	32.4	26	60	-27.6	50	-24	Within Limits
14.2358	31.8	23.8	60	-28.2	50	-26.2	Within Limits
14.5168	32	24.3	60	-28	50	-25.7	Within Limits
14.9054	31.9	23.9	60	-28.1	50	-26.1	Within Limits
15.304	31.5	24.1	60	-28.5	50	-25.9	Within Limits



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
Ten X Technology ZigBee Module Model 763
Quasi-Peak Detection, RBW = 120 kHz

Test Date: January 12, 2006
Test Distance 3 meters
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)
168	noise	floor	35.7	26.7	14.6	3.6	27.1	43.5	-16.4
280	noise	floor	34.6	26.9	14.4	4.8	26.8	46	-19.2
450	noise	floor	36.2	27.3	16.6	6.4	31.9	46	-14.1
625	noise	floor	35.6	26.8	19.3	7.8	35.9	46	-10.1
780	noise	floor	33.5	26.1	21.1	9.0	37.4	46	-8.6
910	noise	floor	35.3	26.2	22.6	9.5	41.2	46	-4.8

Test Date: January 12, 2006
Test Distance 3 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)
168	noise	floor	35.7	26.7	14.6	3.6	27.1	43.5	-16.4
280	noise	floor	34.6	26.9	14.4	4.8	26.8	46	-19.2
450	noise	floor	36.2	27.3	16.6	6.4	31.9	46	-14.1
625	noise	floor	35.6	26.8	19.3	7.8	35.9	46	-10.1
780	noise	floor	33.5	26.1	21.1	9.0	37.4	46	-8.6
910	noise	floor	35.3	26.2	22.6	9.5	41.2	46	-4.8

Receiver Spurious Emissions
1 to 25 GHz
Ten X Technology ZigBee Module Model 763
Peak Detection, RBW = 1 MHz

Test Date: January 25, 2006
Test Distance 1 meter
Vertical

Frequency (MHz)	Detector Function	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)
1200	pk	noise	floor	46.6	29.5	24.2	0.5	41.8	83.5	-41.7
1800	pk	noise	floor	44.9	33.7	26.6	0.6	38.4	83.5	-45.1
2440	pk	noise	floor	47.0	33.8	28.2	0.6	42.0	83.5	-41.5
4880	pk	noise	floor	42.2	30.4	34.2	0.8	46.8	83.5	-36.7
10000	pk	noise	floor	47.0	28.9	38.1	1.5	57.7	83.5	-25.8
12200	pk	noise	floor	46.4	28.7	39.4	2.0	59.0	83.5	-24.5

Test Date: January 25, 2006
Test Distance 1 meter
Horizontal

Frequency (MHz)	Detector Function	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)
1200	pk	noise	floor	45.1	29.5	24.2	0.5	40.3	83.5	-43.2
1800	pk	noise	floor	44.8	33.7	26.6	0.6	38.3	83.5	-45.2
2440	pk	noise	floor	46.2	33.8	28.2	0.6	41.2	83.5	-42.3
4880	pk	noise	floor	43.7	30.4	34.2	0.8	48.3	83.5	-35.2
10000	pk	noise	floor	47.1	28.9	38.1	1.5	57.8	83.5	-25.7
12200	pk	noise	floor	45.7	28.7	39.4	2.0	58.3	83.5	-25.2

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