Project 07020-10

Freescale
Model ZStar USB Stick

Electromagnetic Emission Test Report

Prepared for:

Freescale Semiconductor
6501 William Cannon Drive West
Austin, Texas 78735

By

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October 27, 2006

Rev 4

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

Table of Contents

Revision History

Rev 2 – 2006-10-18 EL
The description of the site locations was revised to specify test sites as were actually used.
Re-measured the 99% 20dB bandwidth using the Industry Canada method that references the entire bandwidth peak power.
Re-measured power with correct bandwidth of instrument, revised affected tables & forms.
Revised incorrect test measurement distances for tests above 1 GHz, incorrectly listed 3 meters.
Investigated adjacent restricted bands and reported measurements.
Re-measured transmit harmonics/spurious, including average detection measurements.
Further explained/justified no measurements of receive/standby mode spurious emissions.
More precisely named the applicant/client and EUT.

Rev 3 – 2006-10-19 EL
Revised references to 3 meter distances in the procedures that should have reported 1 meter distance.
Removed invalid/superfluous statement in section 11 regarding modifications, there were none.

Rev 4 – 2006-10-27 EL
New peak power, PSD, adjacent restricted bands, and harmonic/spurious measurements added. Affected tables revised.
New 6 & 20 dB bandwidth measurements taken and affected tables revised.
Superfluous plots of 20 dB bandwidth that did not reference peak power measurements were removed.

Applicant:	Freescale Semiconductor
Applicant's Address:	6501 William Cannon Drive West
	Austin, TX 78735
FCC ID:	RUNZU
IC Number:	6744A-ZU
Project Number:	07020-10
Test Dates:	25 May 2006 to 26 October 2006

The **Freescale Model ZStar USB Stick 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	0.19266	44.9 dBµV		64.8 dBµV	-19.9
Transmitter: Radiated Spurious	4960	82.1 dBµV /m		83.5 dBµV /m	-1.4
Transmitter: Peak Power @ 1 m	2405	-7.57 dBm	0.175 mW	+30 dBm	-37.6
Transmitter: Power Spectral Density	2405	-22.97 dBm / 3 kHz		8 dBm / 3 kHz	-31
Receiver: Mains Conducted	Not applicable.				
Receiver: Radiated Spurious	Not applicable.				

Occupied Bandwidth		Emission Designator	Emission Designator
6 dB	20 dB	FCC (6 dB BW)	IC (20 dB BW)
1.56 MHz	1.89 MHz	1M56G1D	1M89G1D

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 Freescale. 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 Freescale Model ZStar USB Stick ZigBee radio (EUT) is a high performance, low power, 2.4 GHz ISM band transceiver. The EUT is 1 item in a kit of 2 radios sold to developers as a demonstration of the integrated circuits manufactured by Freescale Semiconductor. The EUT is tested in actual use with the companion sensor radio.

The companion sensor radio is a XYZ ZStar Triaxial Accelerometer Sensor that communicates with the ZStar USB radio. It is tested and submitted separately from the EUT herein.

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
Freescale	ZStar USB	RUNZU	6744A-ZU

Supporting Equipment	Description
Dell Latitude PP01L, S/N 3B1Q411 -IC6-3776	Notebook computer
Dell ADP-70EB, S/N TH-0K8302-17971-4B5	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

Measurements of EUT characteristics below 1 GHz 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. Measurements above 1 GHz were performed indoors at a distance of 1 meter or less with directional antennas.

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 1 meter 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

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 20 dB bandwidth measurements are referenced to peak power measurements taken at the entire bandwidth for RBW, then using 1% RBW with a span as close as possible to the expected bandwidth to measure the final 20 dB bandwidth.

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 report the 99% power bandwidth for RSS-210.

5.0 Power Spectral Density

Power spectral density measurements were performed on the EUT 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 1 meter 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 1 meter 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. 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 not possible for either a receive or standby mode. The EUT initiated transmissions to seek out the companion Sensor unit (submitted separately) as soon as it received power from the USB host.

The transmitter duty cycle is low, which means the receiving mode was active most of the time during the transmit mode spurious and harmonic measurements.

11.0 Modifications

The 3rd harmonic emissions exceeded peak levels. Programmed transmit power was changed in firmware by Freescale to reduce power by approximately 6 dB. The result was harmonics were reduced sufficiently to satisfy the criteria. Measurements of peak power, power spectral density, bandwidth, and adjacent restricted band emissions were repeated and reported herein.

12.0 Test Equipment

Mains Conducted Emissions

Asset #	Manufacturer	Model #	Description	Calibration Due
C025	Belden	RG223	Coaxial Cable	Calibrate Before Use
0081	Elgar	1751SL	Variable AC Power Source	Calibrate Before Use
0572	PTI	CISPR16	High Pass Filter	26 Sep 2006
0759	Solar	8012	LISN	5 Oct 2006
0027	EMCO	3825/2	Auxiliary LISN	11 Jul 2006
0045	HP	85662A	Spectrum Analyzer Display	Not Required
0237	HP	8568B	Spectrum Analyzer	14 Dec 2006
0239	HP	85650A	Quasi-peak Adapter	14 Dec 2006
0990	HP	85685A	RF Preselector	14 Dec 2006
0474	PTI	3dB	Limiter	16 Sep 2006

< 1 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due

C005	None	None	Underground Coaxial Cable	8 Dec 2006
1494	EMCO	3110B	Biconical Dipole Antenna	20 Apr 2007
0290	EMCO	3146	Log Periodic Antenna	22 May 2007
0483	HP	8447D	Preamplifier, < 1 GHz	12 Jan 2007
0043	HP	8567A	Spectrum Analyzer	28 Mar 2007
0044	HP	85662A	Spectrum Analyzer Display	28 Mar 2007
0085	HP	85650A	Spectrum Analyzer QP Adapter	26 Sep 2006
0483	Tektronix	2706	RF Preselector	27 Oct 2007

> 1 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due
C025	Belden	RG223	Coaxial Cable	Calibrate Before Use
0081	Elgar	1751SL	Variable AC Power Source	Calibrate Before Use
1525	HP	8566B	Spectrum Analyzer	10 Jul 2007
1526	HP	8566B	Spectrum Analyzer Display	28 Jun 2007
0950	HP	8566B	Spectrum Analyzer	30 May 2007
0949	HP	8566B	Spectrum Analyzer Display	30 May 2007
0897	Miteq	-	Preamplifier, > 1 GHz	16 May 2007
0582	EMCO	3115	Horn 1 – 18 GHz	21 Jul 2007
0910	HP	11971T	Harmonic Mixer Set	CBU
1057	HP	11517A	Mixer, 12.4 – 40 GHz	CBU
0989	MicroTronics	HPM50111	2.5 GHz High Pass Filter	CBU

Appendix A Test Setup Diagrams

FIGURE 1: Radiated Emissions Test Setup

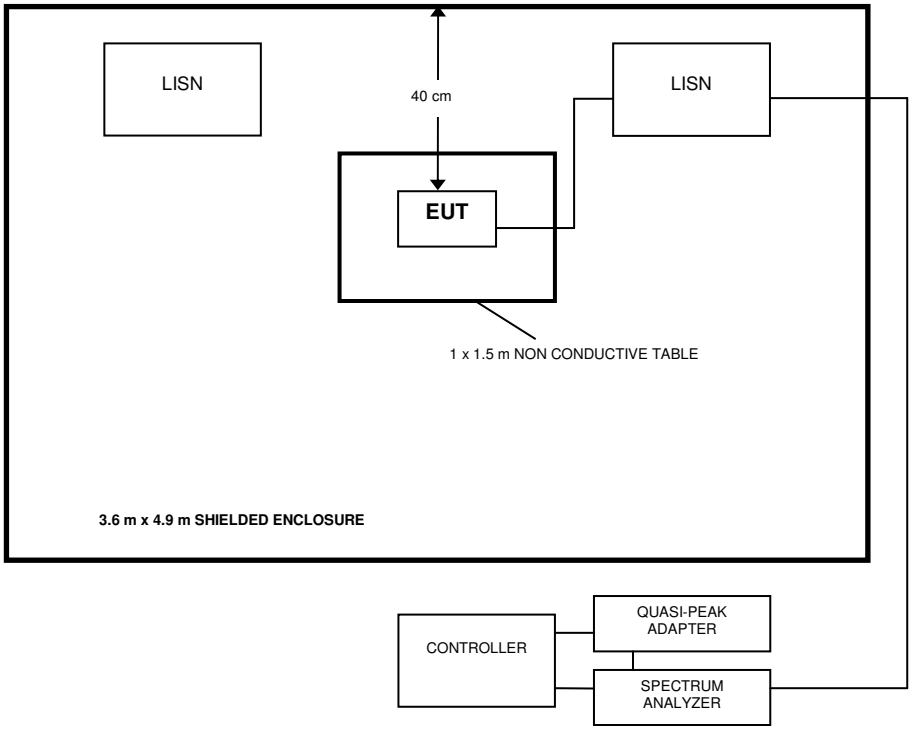


FIGURE 2: Radiated Emissions Test Setup
Peak Power, Occupied Bandwidth, Power Spectral Density, Timing Assessment, Band Edge Spurious

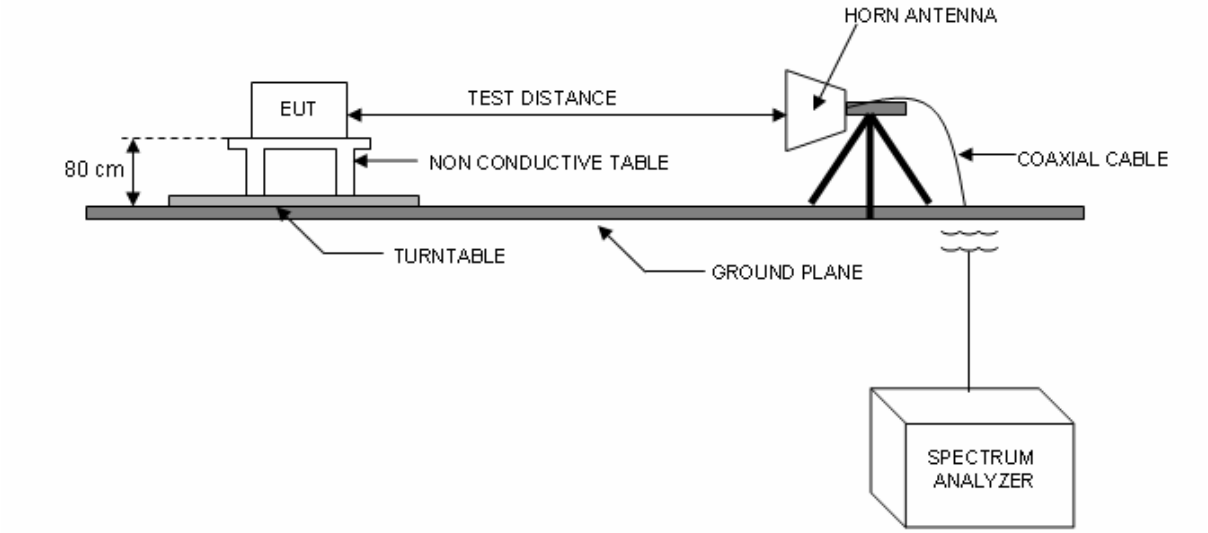


FIGURE 3: Radiated Emissions Test Setup - Spurious

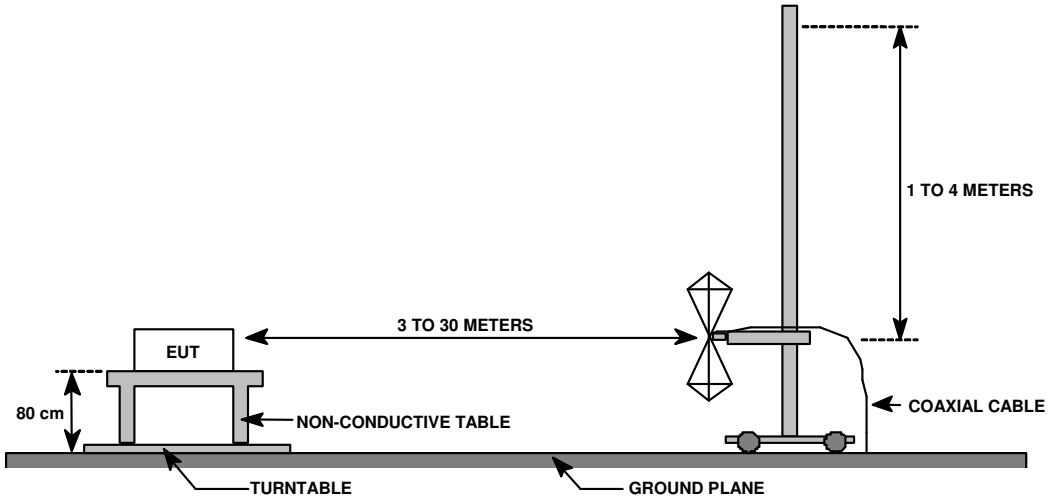
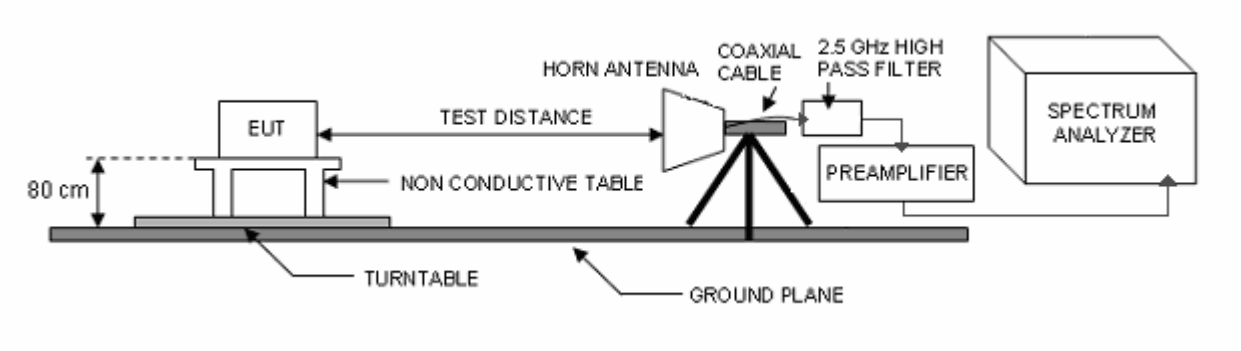


FIGURE 4: Radiated Emissions Test Setup – Harmonics & Spurious > $f_{(o)}$

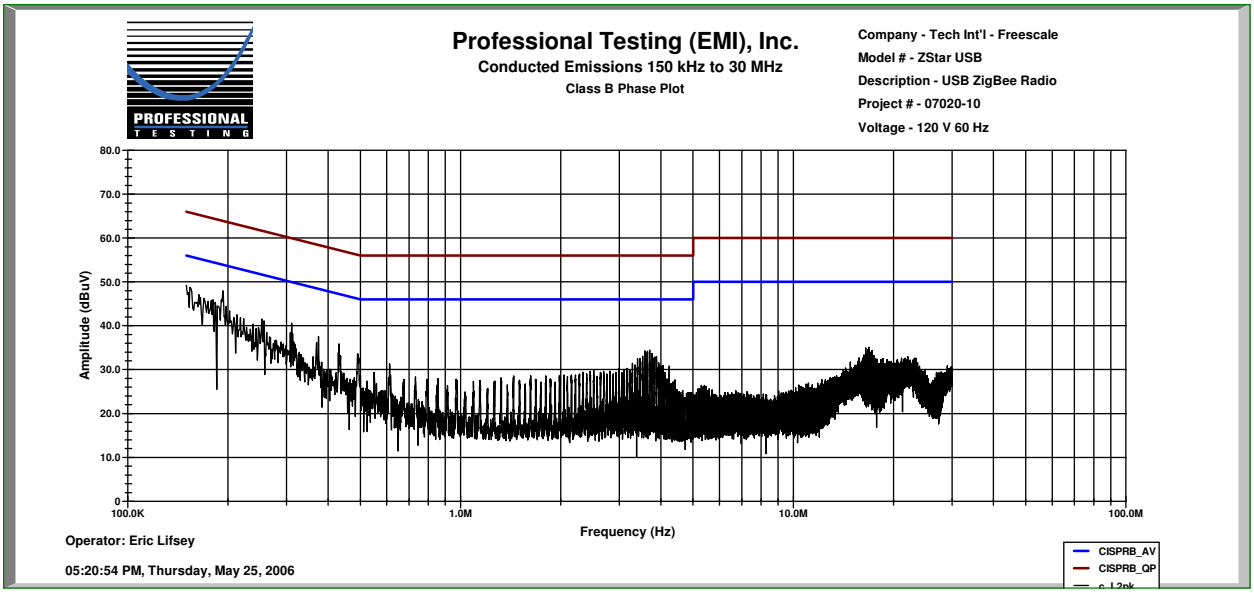


Appendix B Test Results

Power line Conducted Emissions
Freescale Model ZStar USB Stick
Quasi-Peak Detection, RBW = 9 kHz
Transmitting

Test Date: May 25, 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
0.150515	42.2	12.2	66.0	-23.8	56.0	-43.8	Pass
0.150865	42.3	12.6	66.0	-23.7	56.0	-43.4	Pass
0.1887	44.4	34.0	64.9	-20.5	54.9	-20.9	Pass
0.19088	44.3	33.8	64.8	-20.5	54.8	-21.0	Pass
0.1943	44.3	33.9	64.7	-20.4	54.7	-20.8	Pass
16.468	29.3	22.3	60.0	-30.7	50.0	-27.7	Pass
16.7048	30.1	23.2	60.0	-29.9	50.0	-26.8	Pass
16.881	29.8	22.8	60.0	-30.2	50.0	-27.2	Pass
16.942	30.0	22.6	60.0	-30.0	50.0	-27.4	Pass
17.2398	29.9	22.5	60.0	-30.1	50.0	-27.5	Pass

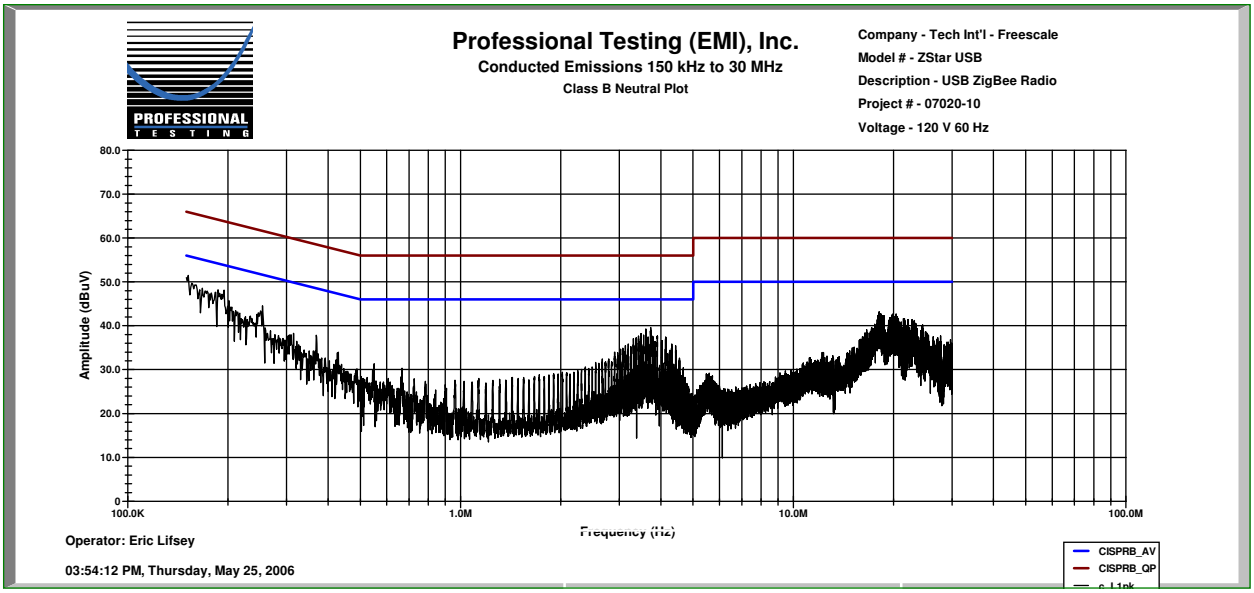


The data presented here in graphical form is for overview only. Detailed and precise data is in the table above.

Power line Conducted Emissions
Freescale Model ZStar USB Stick
Quasi-Peak Detection, RBW = 9 kHz
Transmitting

Test Date: May 25, 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
0.152177	45.4	14.9	65.9	-20.5	55.9	-41.0	Pass
0.18681	44.0	33.3	64.9	-20.9	54.9	-21.7	Pass
0.19266	44.9	33.6	64.8	-19.9	54.8	-21.2	Pass
0.19341	44.3	33.5	64.8	-20.4	54.8	-21.3	Pass
0.25169	39.8	30.5	63.1	-23.3	53.1	-22.6	Pass
18.0705	37.0	29.6	60.0	-23.0	50.0	-20.4	Pass
18.3127	37.3	30.0	60.0	-22.7	50.0	-20.0	Pass
19.7698	37.3	29.7	60.0	-22.7	50.0	-20.3	Pass
19.9278	36.4	29.0	60.0	-23.6	50.0	-21.0	Pass
20.3079	36.0	29.0	60.0	-24.0	50.0	-21.0	Pass



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

Peak Power
Freescale Model ZStar USB Stick
Peak Detection, RBW = 3 MHz

Test Date: October 26, 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	1	68.4	0.0	28.2	0.6	97.2
2440	max	1	67.0	0.0	28.2	0.6	95.8
2480	max	1	67.4	0.0	28.3	0.6	96.3

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)
		dBm	mW	
2405	97.2	-7.57	0.175	30
2440	95.8	-8.97	0.127	30
2480	96.3	-8.47	0.142	30

Result: PASS

Test Engineer: Eric Lifsey

Power Spectral Density
Freescale Model ZStar USB Stick
Peak Detection, RBW = 3 kHz
Test Distance 1 meters

Test Date: October 26, 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	1	53.0	0.0	28.2	0.6	81.8
2440	Max	1	49.7	0.0	28.2	0.6	78.5
2480	Max	1	52.5	0.0	28.3	0.6	81.4

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

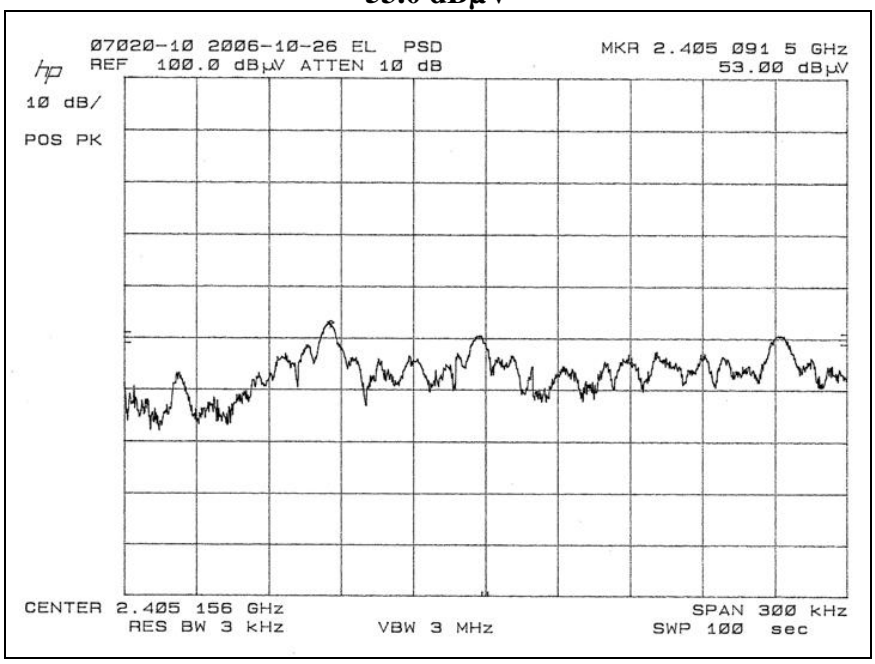
Calculated Result

Frequency (MHz)	Field Strength (dBµV / 3 kHz)	E.I.R.P (dBm / 3 kHz)	Limit (dBm / 3 kHz)
2405	81.8	-22.97	8
2440	78.5	-23.47	8
2480	81.4	-26.27	8

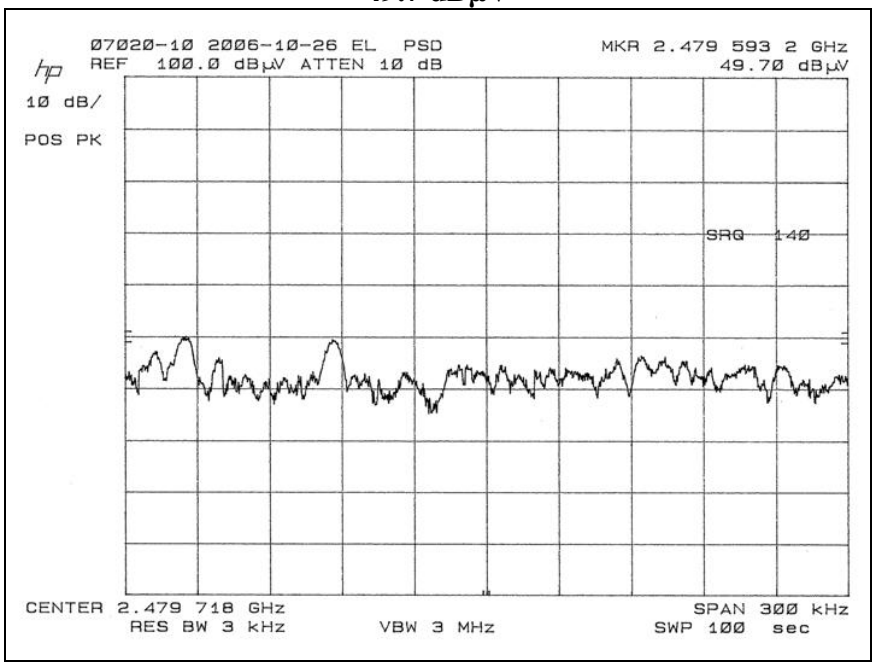
Result: PASS

Test Engineer: Eric Lifsey

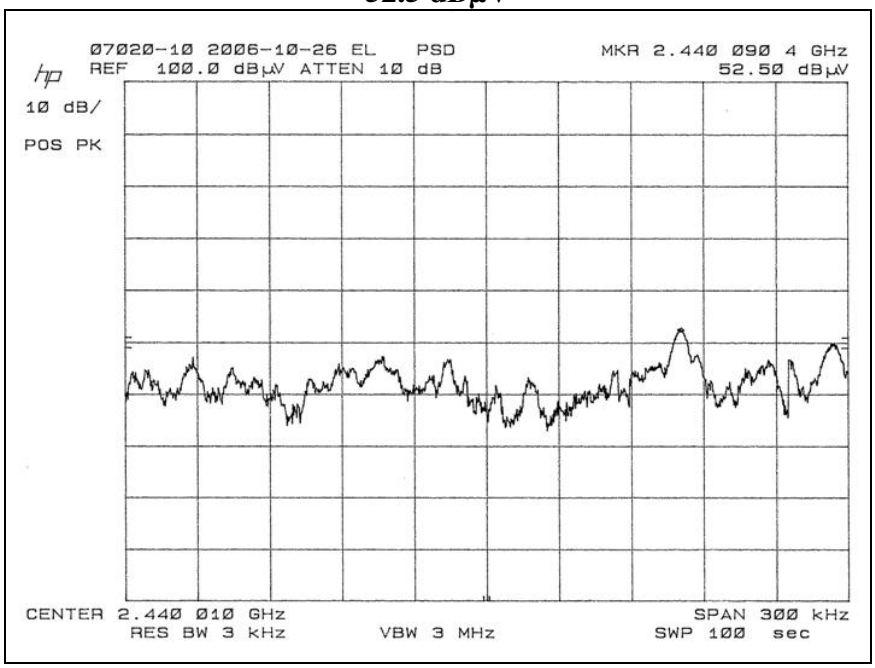
PSD Plot Low Channel
53.0 dBµV



PSD Plot Center Channel
49.7 dBµV



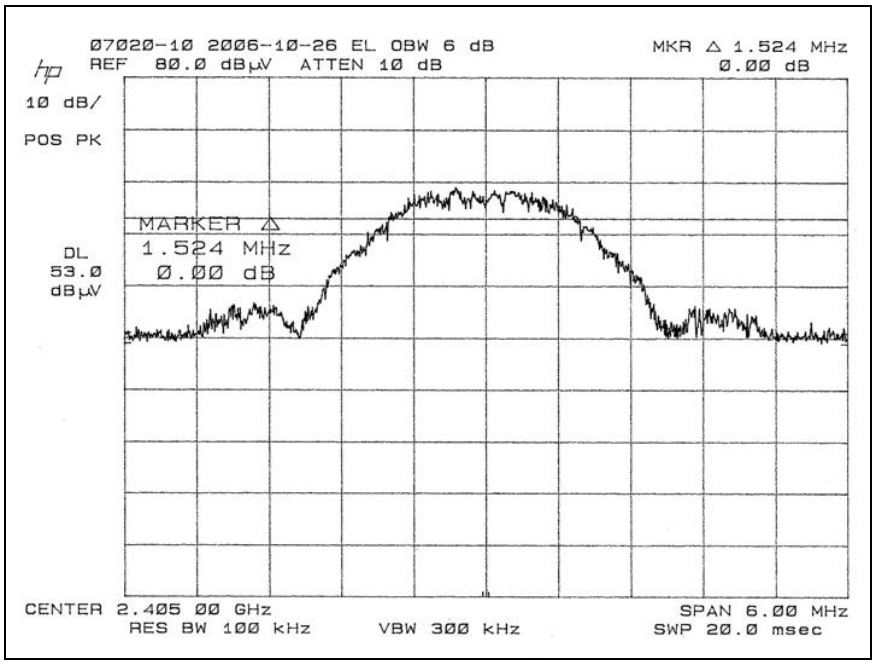
PSD Plot Center Channel
52.5 dBµV



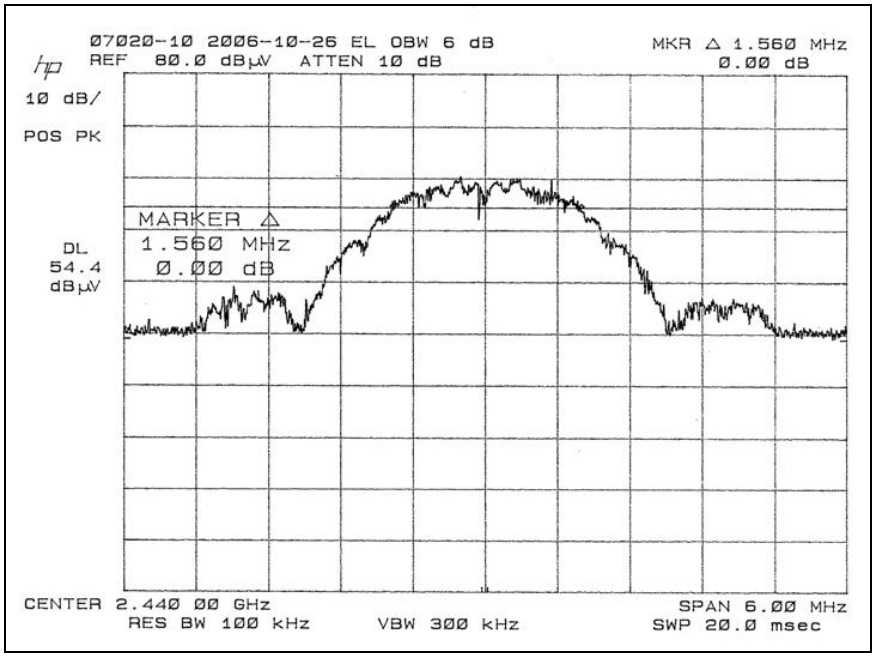
Occupied Bandwidth 6 dB
Freescale Model ZStar USB Stick
Peak Detection, RBW = 100 kHz

Test Date: October 26, 2006

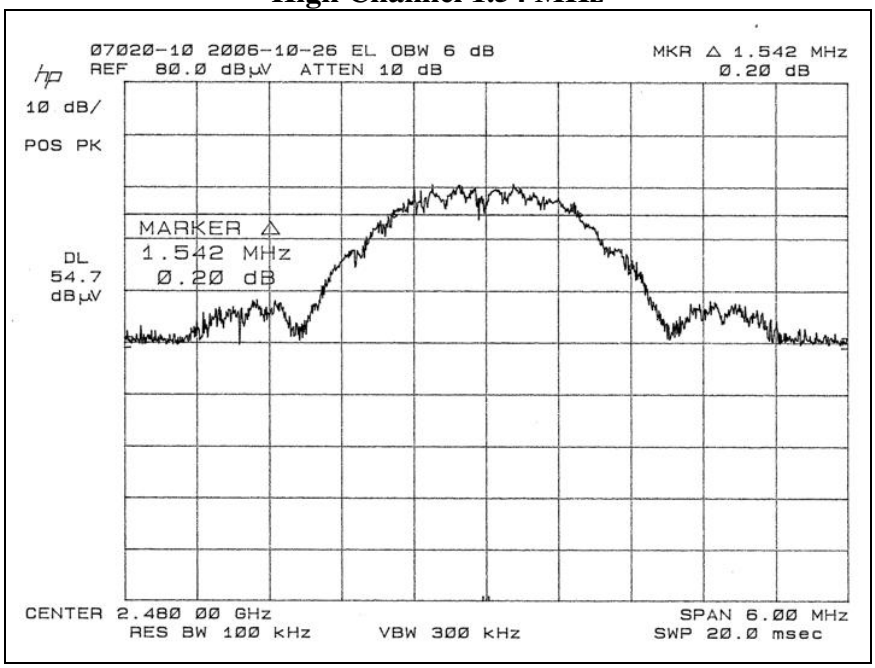
Low Channel 1.52 MHz



Middle Channel 1.56 MHz



High Channel 1.54 MHz

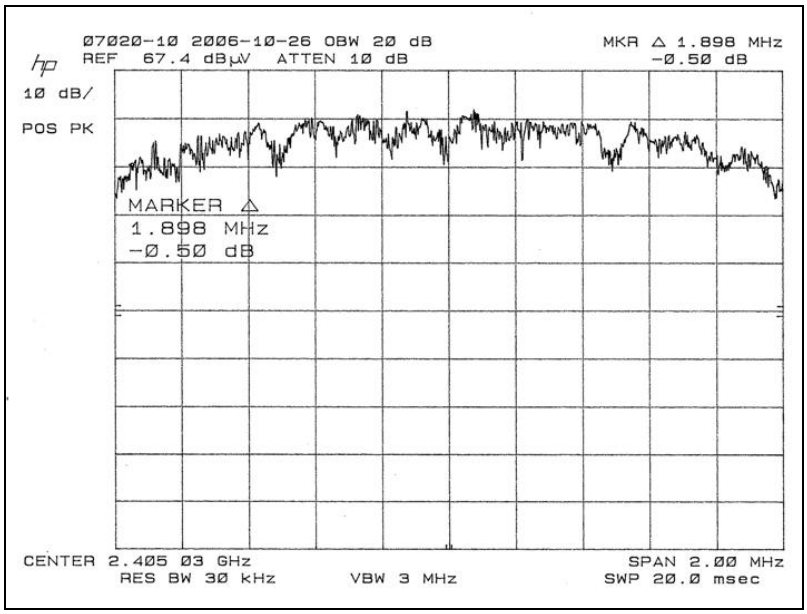


Test Engineer: Eric Lifsey

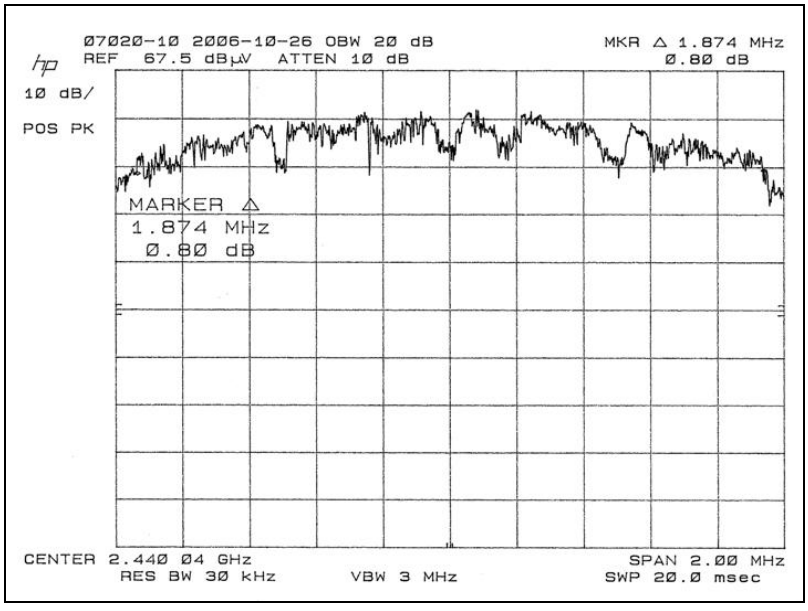
Occupied Bandwidth 20 dB
Freescale Model ZStar USB Stick
Peak Detection, RBW = 30 kHz
Referenced to 3 MHz RBW/VBW Peak

Test Date: October 27, 2006

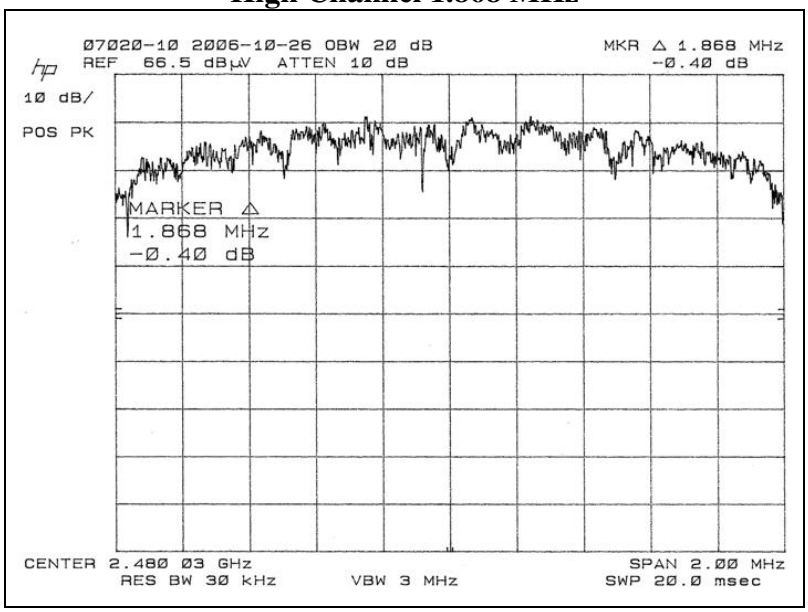
Low Channel 1.890 MHz



Center Channel 1.874 MHz



High Channel 1.868 MHz



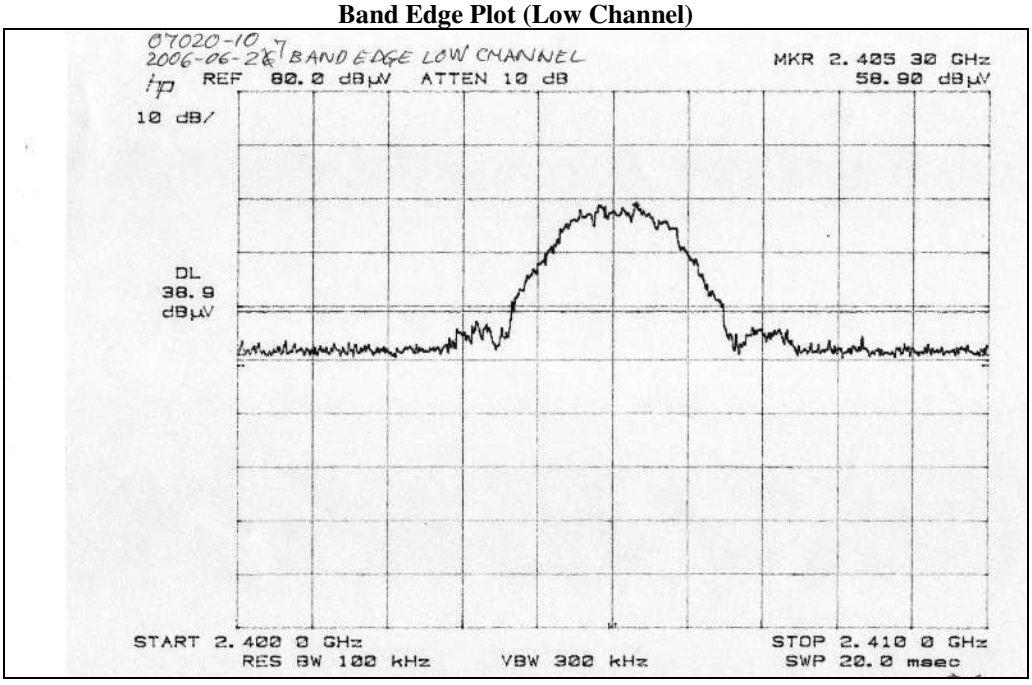
Eric Lifsey

Band Edge Spurious Emissions
Freescale Model ZStar USB Stick
Peak Detection, RBW = 100 kHz

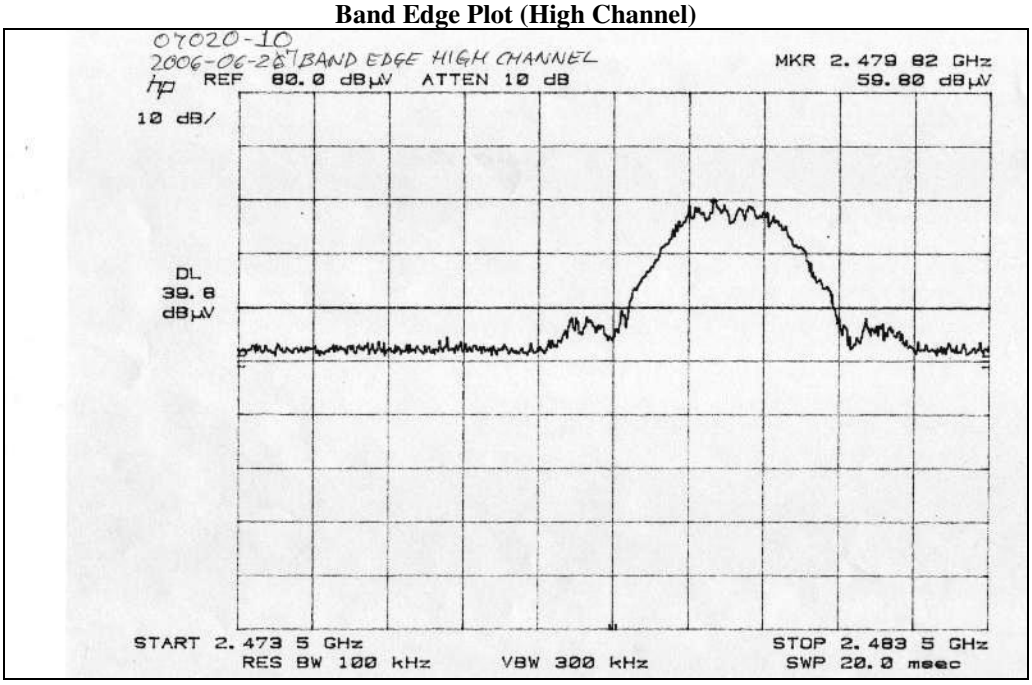
Test Date: June 27, 2006
Test Distance 1 meters

Please see Adjacent Restricted Bands tables for actual measurement of band edge levels.

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
07020-10	14 Jul 2006	FCC 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)
44	noise	floor	35.1	26.6	12.3	2.3	23.1	40	-16.9
164	noise	floor	29.5	26.8	13.9	4.9	21.5	43.5	-22.0
184	noise	floor	33.1	26.9	16.7	5.2	28.1	43.5	-15.4
204	noise	floor	33.5	26.9	11.5	4.8	22.9	43.5	-20.6
240	noise	floor	31.7	27.0	11.9	5.6	22.2	46	-23.8
890	noise	floor	32	26.2	22.5	9.9	38.3	46	-7.7

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)
45	noise	floor	31.4	26.6	12.5	2.3	19.6	40	-20.4
140	noise	floor	32.2	26.7	10.7	4.2	20.5	43.5	-23.0
194	noise	floor	30.9	26.9	16.7	4.7	25.5	43.5	-18.0
205	noise	floor	31.7	26.9	11.5	4.8	21.1	43.5	-22.4
240	noise	floor	31.6	27.0	11.9	5.6	22.1	46	-23.9
600	noise	floor	31.7	27.1	18.9	8.1	31.5	46	-14.5

Test Engineer: Eric Lifsey

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07020-10	26 Oct 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting Low Channel Peak averaging factor -20 dB. Harmonics and spurious investigated up to 24050 MHz.

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)	Applied Duty Cycle Average	Limit (dBµV /m)	Margin (dB)	Detector Function
4810	135	1	66.4	31.3	34.0	3.8	73.0	0.0	83.5	-10.5	pk
4810	135	1	33.5	31.3	34.0	3.8	40.1	0.0	63.5	-23.4	avg
7215	180	1	69.1	31.0	36.7	4.4	79.3	0.0	83.5	-4.2	pk
7215	135	1	36.2	31.0	36.7	4.4	46.4	0.0	63.5	-17.1	avg
9620	noise	floor	52	30.9	37.8	4.5	63.4	0.0	83.5	-20.1	pk
9620	noise	floor	34.3	30.9	37.8	4.5	45.7	0.0	63.5	-17.8	avg
12025	noise	floor	49	30.4	39.1	5.0	62.7	0.0	83.5	-20.8	pk
12025	noise	floor	33.4	30.4	39.1	5.0	47.1	0.0	63.5	-16.4	avg
14430	noise	floor	53	29.6	41.2	4.8	69.4	0.0	83.5	-14.1	pk
14430	noise	floor	38.1	29.6	41.2	4.8	54.5	0.0	63.5	-9.0	avg
16835	noise	floor	53.7	31.5	41.4	5.1	68.8	0.0	83.5	-14.7	pk
16385	noise	floor	37.9	31.5	39.6	5.0	51.0	0.0	63.5	-12.5	avg

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)	Applied Duty Cycle Average	Limit (dBµV /m)	Margin (dB)	Detector Function
4810	180	1	64.8	31.3	34.0	3.8	71.4	0.0	83.5	-12.1	pk
4810	180	1	33.6	31.3	34.0	3.8	40.2	0.0	63.5	-23.3	avg
7215	135	1	63.5	31.0	36.7	4.4	73.7	0.0	83.5	-9.8	pk
7215	135	1	35.7	31.0	36.7	4.4	45.9	0.0	63.5	-17.6	avg
9620	noise	floor	51.8	30.9	37.8	4.5	63.2	0.0	83.5	-20.3	pk
9620	noise	floor	34.2	30.9	37.8	4.5	45.6	0.0	63.5	-17.9	avg
12025	noise	floor	49	30.4	39.1	5.0	62.7	0.0	83.5	-20.8	pk
12025	noise	floor	33.4	30.4	39.1	5.0	47.1	0.0	63.5	-16.4	avg
14430	noise	floor	53	29.6	41.2	4.8	69.4	0.0	83.5	-14.1	pk
14430	noise	floor	38.1	29.6	41.2	4.8	54.5	0.0	63.5	-9.0	avg
16835	noise	floor	53.7	31.5	41.4	5.1	68.8	0.0	83.5	-14.7	pk
16835	noise	floor	37.8	31.5	41.4	5.1	52.9	0.0	63.5	-10.6	avg

Note: When applied (*), peak average was calculated using a peak to average correction factor based on transmitter duty cycle. This is calculated in the timing assessment.

Test Engineer: Eric Lifsey

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07020-10	26 Oct 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting Middle Channel Peak averaging factor -20 dB. Harmonics & spurious investigated up to 24400 MHz.

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)	Applied Duty Cycle Average	Limit (dBµV /m)	Margin (dB)	Detector Function
4880	270	1	74.6	31.1	34.2	3.8	81.5	0.0	83.5	-2.0	pk
4880	270	1	33.9	31.1	34.2	3.8	40.8	0.0	63.5	-22.7	avg
7320	135	1	68.8	30.9	36.9	4.4	79.2	0.0	83.5	-4.3	pk
7320	135	1	35.5	30.9	36.9	4.4	45.9	0.0	63.5	-17.6	avg
9760	noise	floor	47.6	30.8	37.9	4.5	59.2	0.0	83.5	-24.3	pk
9760	noise	floor	33.6	30.8	37.9	4.5	45.2	0.0	63.5	-18.3	avg
12200	noise	floor	48.5	30.4	39.4	5.0	62.4	0.0	83.5	-21.1	pk
12200	noise	floor	32.9	30.4	39.4	5.0	46.8	0.0	63.5	-16.7	avg
14640	noise	floor	52.5	29.3	40.5	4.8	68.5	0.0	83.5	-15.0	pk
14640	noise	floor	37.8	29.3	40.5	4.8	53.8	0.0	63.5	-9.7	avg
17080	noise	floor	54.1	31.3	42.7	5.2	70.7	0.0	83.5	-12.8	pk
17080	noise	floor	37	31.3	42.7	5.2	53.6	0.0	63.5	-9.9	avg

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)	Applied Duty Cycle Average	Limit (dBµV /m)	Margin (dB)	Detector Function
4880	180	1	68.1	31.1	34.2	3.8	75.0	0.0	83.5	-8.5	pk
4880	180	1	33.4	31.1	34.2	3.8	40.3	0.0	63.5	-23.2	avg
7320	90	1	63.3	30.9	36.9	4.4	73.7	0.0	83.5	-9.8	pk
7320	90	1	35	30.9	36.9	4.4	45.4	0.0	63.5	-18.1	avg
9760	noise	floor	47.9	30.8	37.9	4.5	59.5	0.0	83.5	-24.0	pk
9760	noise	floor	33.6	30.8	37.9	4.5	45.2	0.0	63.5	-18.3	avg
12200	noise	floor	46.3	30.4	39.4	5.0	60.2	0.0	83.5	-23.3	pk
12200	noise	floor	32.9	30.4	39.4	5.0	46.8	0.0	63.5	-16.7	avg
14640	noise	floor	51.4	29.3	40.5	4.8	67.4	0.0	83.5	-16.1	pk
14640	noise	floor	37.7	29.3	40.5	4.8	53.7	0.0	63.5	-9.8	avg
17080	noise	floor	50.7	31.3	42.7	5.2	67.3	0.0	83.5	-16.2	pk
17080	noise	floor	37.1	31.3	42.7	5.2	53.7	0.0	63.5	-9.8	avg

Note: When applied (*), peak average was calculated using a peak to average correction factor based on transmitter duty cycle. This is calculated in the timing assessment.

Test Engineer: Eric Lifsey

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07020-10	26 Oct 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting High Channel Peak averaging factor -20 dB. Harmonics & spurious investigated up to 24800 MHz.

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)	Applied Duty Cycle Average	Limit (dBµV /m)	Margin (dB)	Detector Function
4960	270	1	74.9	31.0	34.4	3.8	82.1	0.0	83.5	-1.4	pk
4960	270	1	34.2	31.0	34.4	3.8	41.4	0.0	63.5	-22.1	avg
7440	135	1	70.7	30.9	37.1	4.4	81.3	0.0	83.5	-2.2	pk
7440	135	1	35.2	30.9	37.1	4.4	45.8	0.0	63.5	-17.7	avg
9920	noise	floor	47	30.8	38.0	4.5	58.7	0.0	83.5	-24.8	pk
9920	noise	floor	33.4	30.8	38.0	4.5	45.1	0.0	63.5	-18.4	avg
12400	noise	floor	45.5	30.5	39.7	4.9	59.6	0.0	83.5	-23.9	pk
12400	noise	floor	32	30.5	39.7	4.9	46.1	0.0	63.5	-17.4	avg
14880	noise	floor	51.2	29.4	39.4	4.9	66.1	0.0	83.5	-17.4	pk
14880	noise	floor	32	29.4	39.4	4.9	46.9	0.0	63.5	-16.6	avg
17360	noise	floor	50.2	31.5	44.6	5.0	68.3	0.0	83.5	-15.2	pk
17360	noise	floor	36.8	31.5	44.6	5.0	54.9	0.0	63.5	-8.6	avg

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)	Applied Duty Cycle Average	Limit (dBµV /m)	Margin (dB)	Detector Function
4960	170	1	67.9	31.0	34.4	3.8	75.1	0.0	83.5	-8.4	pk
4960	170	1	33.7	31.0	34.4	3.8	40.9	0.0	63.5	-22.6	avg
7440	135	1	64.3	30.9	37.1	4.4	74.9	0.0	83.5	-8.6	pk
7440	135	1	34.9	30.9	37.1	4.4	45.5	0.0	63.5	-18.0	avg
9920	noise	floor	47	30.8	38.0	4.5	58.7	0.0	83.5	-24.8	pk
9920	noise	floor	33.5	30.8	38.0	4.5	45.2	0.0	63.5	-18.3	avg
12400	noise	floor	48.1	30.5	39.7	4.9	62.2	0.0	83.5	-21.3	pk
12400	noise	floor	33.5	30.5	39.7	4.9	47.6	0.0	63.5	-15.9	avg
14880	noise	floor	52.7	29.4	39.4	4.9	67.6	0.0	83.5	-15.9	pk
14880	noise	floor	37.3	29.4	39.4	4.9	52.2	0.0	63.5	-11.3	avg
17360	noise	floor	52.3	31.5	44.6	5.0	70.4	0.0	83.5	-13.1	pk
17360	noise	floor	36.8	31.5	44.6	5.0	54.9	0.0	63.5	-8.6	avg

Note: When applied (*), peak average was calculated using a peak to average correction factor based on transmitter duty cycle. This is calculated in the timing assessment.

Test Engineer: Eric Lifsey

Spurious/Harmonic Emissions
Adjacent Restricted Band (Lower)
2310 - 2390 MHz & 2390 - 2400 MHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07020-10	26 Oct 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting Low Channel

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
2390	180	1	60.1	33.9	28.1	0.6	55.0	83.5	-28.5	pk
2390	180	1	33.8	33.9	28.1	0.6	28.7	63.5	-34.8	avg
2395	180	1	63.2	33.9	28.2	0.6	58.1	83.5	-25.4	pk
2395	180	1	33.8	33.9	28.2	0.6	28.7	63.5	-34.8	avg
2400	180	1	70.4	33.9	28.2	0.6	65.3	83.5	-18.2	pk
2400	180	1	34.2	33.9	28.2	0.6	29.1	63.5	-34.4	avg

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
2390	90	1	55.8	33.9	28.1	0.6	50.7	83.5	-32.8	pk
2390	90	1	33.6	33.9	28.1	0.6	28.5	63.5	-35.0	avg
2395	90	1	55.3	33.9	28.2	0.6	50.2	83.5	-33.3	pk
2395	90	1	33.6	33.9	28.2	0.6	28.5	63.5	-35.0	avg
2400	90	1	61.1	33.9	28.2	0.6	56.0	83.5	-27.5	pk
2400	90	1	33.7	33.9	28.2	0.6	28.6	63.5	-34.9	avg

Test Engineer: Eric Lifsey

Spurious/Harmonic Emissions
Adjacent Restricted Band (Upper)
2483.5 - 2500 MHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07020-10	26 Oct 2006	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting High Channel

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
2483.5	180	1	75	33.8	28.3	0.6	70.1	83.5	-13.4	pk
2483.5	180	1	35	33.8	28.3	0.6	30.1	63.5	-33.4	avg
2485	180	1	70.2	33.8	28.3	0.6	65.3	83.5	-18.2	pk
2485	180	1	34.3	33.8	28.3	0.6	29.4	63.5	-34.1	avg
2491	100	1	63.1	33.8	28.3	0.6	58.2	83.5	-25.3	pk
2491	100	1	34.1	33.8	28.3	0.6	29.2	63.5	-34.3	avg

Vertical

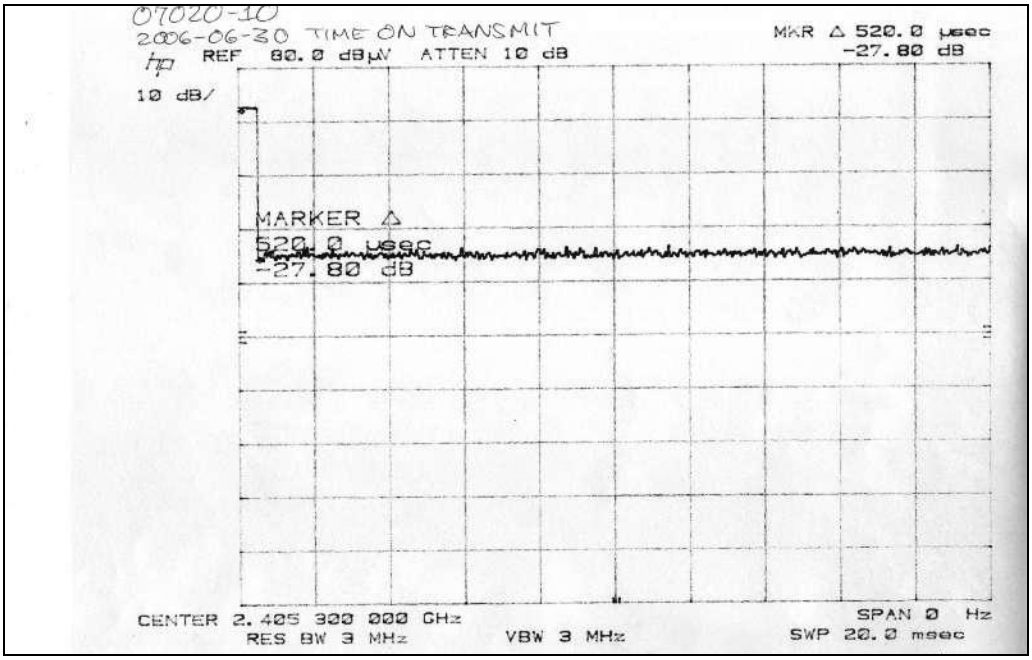
Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV /m)	Limit (dBµV /m)	Margin (dB)	Detector Function
2483.5	135	1	64	33.8	28.3	0.6	59.1	83.5	-24.4	pk
2483.5	135	1	34.4	33.8	28.3	0.6	29.5	63.5	-34.0	avg
2485	135	1	63.2	33.8	28.3	0.6	58.3	83.5	-25.2	pk
2485	135	1	33.6	33.8	28.3	0.6	28.7	63.5	-34.8	avg
2491	135	1	54	33.8	28.3	0.6	49.1	83.5	-34.4	pk
2491	135	1	33.6	33.8	28.3	0.6	28.7	63.5	-34.8	avg

Test Engineer: Eric Lifsey

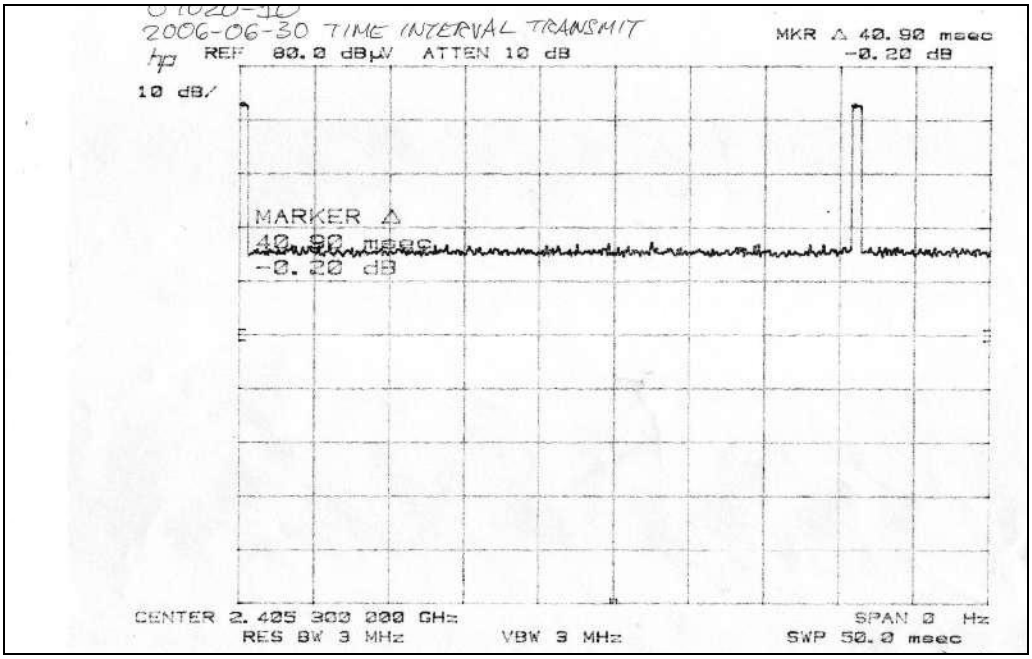
Timing Assessment
Freescale Model ZStar USB Stick
Peak Detection, RBW = 1 MHz

Test Date: June 30, 2006

Pulse Duration



Total Time



Test Engineer: Eric Lifsey

Timing Assessment
Freescale Model ZStar USB Stick
Calculations

Duty Cycle

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

$$DutyCycle = \frac{0.52mS}{40.9mS} = 1.3\%$$

Peak Averaging Correction Factor

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

$$CorrFact = 20 * \log(0.013) = -37.7dB$$

(Maximum allowed is -20 dB.)

Allowed Duty Cycle Factor
-20 dB

This factor is applied to peak measurements to calculate an average that is compared to the average limits.

Test Engineer: Eric Lifsey

Antenna Assessment

1. The antenna is embedded permanently into the circuit board.
2. No connector is provided for an external antenna.

Modification of the antenna is prevented by this design and it 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