Project 08026-10

Freescale Semiconductor
Model ZStar Triaxial Accelerometer

Electromagnetic Emission Test Report

Prepared for:

Freescale Semiconductor
6501 William Cannon Drive West
Austin, Texas 78735

By

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

January 3, 2008

Reviewed by	**Written by**
Jason Anderson Regulatory Department Manager	Jesse Banda EMC Technician

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Applicant: Freescale Semiconductor

Applicant's Address: 6501 William Cannon Drive West
Austin, TX 78735

FCC ID: RUNZT2

IC Number: 6744A-ZT2

Project Number: 00826-10

Test Dates: 18 June 2007 to 13 September 2007

The **Freescale Semiconductor Model ZStar Triaxial Accelerometer** was tested to and found to be in compliance with FCC 47 CFR Part 15 and IC RSS-210 issue 7.

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

Parameter	Frequency (MHz)	Level		Limit	Margin (dB)
Transmitter: Mains Conducted	Not applicable, battery powered.				
Transmitter: Radiated Spurious	7440	72.9 dBµV/m @ 1 m		83.5 dBµV/m	-10.6
Transmitter: Peak Power @ 1 m	2405	-19.27 dBm	0.012 mW	+30 dBm	-49.3
Transmitter: Power Spectral Density	2480	-38.7dBm / 3 kHz		8 dBm / 3 kHz	-46.7
Receiver: Mains Conducted	Not applicable, battery powered.				
Receiver: Radiated Spurious	Not applicable.				

Occupied Bandwidth		Emission Designator FCC (6 dB BW)	Emission Designator IC (20 dB BW)
6 dB	20 dB		
1.61 MHz	1.93 MHz	1M55G1D	1M91G1D

I, Michael Royer, 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.

Michael Royer
Compliance Engineering Consultant

This report has been reviewed and accepted by Freescale Semiconductor. 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 Semiconductor Model ZStar Triaxial Accelerometer, a ZigBee radio (EUT), is a high performance, low power, solely battery operated, 2.4 GHz ISM band transceiver. The EUT is 1 item in a kit of 2 radios that provide a demonstration of the integrated circuits for actual or potential customers of Freescale Semiconductor, the chip manufacturer. The EUT is tested in actual use with the companion ZStar USB Stick radio. This EUT is stand-alone does not connect to a computer.

The companion ZStar USB Stick ZigBee radio receives accelerometer data from the ZStar Triaxial Accelerometer. 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 Semiconductor	ZStar Triaxial Accelerometer	RUNZT2	6744A-ZT2

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 (Not applicable.)	4.2, 4.7, 7.2 (Not applicable.)	
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 Indoor Semi-Anechoic Chamber at Site 45, located in Austin, Texas, USA. This site was registered with the FCC under section 2.948 of CFR 47. The site is also listed with Industry Canada as IC-3036-3 and in this report used at 10 meters. Measurements above 1 GHz were performed indoors at a distance of 1 meter or less with directional antennas and care exercised to minimize unwanted effects of the surroundings.

1.5 Test Results

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

2.0 Power Line Conducted Emissions

EUT is entirely battery operated. Battery is coin-style non-rechargeable lithium. This test does not apply.

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 EUT 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. However, the 20 dB bandwidth is referenced to a peak power measurement taken at the entire bandwidth or more for RBW, then using 1% RBW for 20 dB bandwidth. This is used to report the 99% power bandwidth for RSS-210.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.

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. For this test the adjacent restricted band measurement included measurements of the band edge emissions and compared to 15.209.

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 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 and measured at a distance of 10 meters.

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.

The transmitter duty cycle is low such that the peak averaging factor exceeded the maximum of 20 dB. Consequently, the receiving mode was active most of the time during the transmit mode spurious and harmonic measurements.

11.0 Modifications

12.0 Test Equipment

< 1 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due
239	HP	85650A	Quasi-peak Adapter (high band)	1/21/09
1526	HP	85662A	Spectrum Analyzer Display (high band)	NCR
1525	HP	8566B	Spectrum Analyzer (high band)	8/13/08
1035	HP	85685A	RF Preselector (high band)	1/21/09
1280	HP	85650A	Quasi-peak Adapter (low band)	May 29, 2008
45	HP	85662A	Spectrum Analyzer Display (low band)	NCR
237	HP	8568B	Spectrum Analyzer (low band)	December 26, 2008
990	HP	85685A	RF Preselector (low band)	3/18/09
1455	HP	8447D	RF Preamplifier	4/30/08
1389	Emco	3108	Biconical Antenna	9/15/08
1486	Emco	3147	Log Periodic Dipole Araay Antenna	4/18/08
C026	none	none	Coaxial Cable (low band)	7/1/08
C027	none	none	Coaxial Cable (high band)	7/1/08

> 1 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due
XXXX	Pasternack	LLS	2 sections, total 12ft	June 13, 2008
0077	EMCO	3115	Ridge Guide Antenna	August 23, 2008
1594	Miteq	AFS44-00102650	Microwave Preamplifier (preamp 1)	5/28/08
1342	Rohde & Schwarz	ESMI	EMI Test Receiver	October 26, 2008
1343	Rohde & Schwarz	ESMI	EMI Test Receiver Display	October 26, 2008
1542	AH Systems	SAS-572	Horn Antenna, Standard Gain, 20 dB	NCR

Note that no mains conducted emission equipment appears above because those tests were not required.

Appendix A Test Setup Diagrams

FIGURE 1: Radiated Emissions Test Setup > 1 GHz
Peak Power, Occupied Bandwidth, Power Spectral Density, Timing Assessment, Band Edge Spurious, Adjacent Restricted Band Emissions

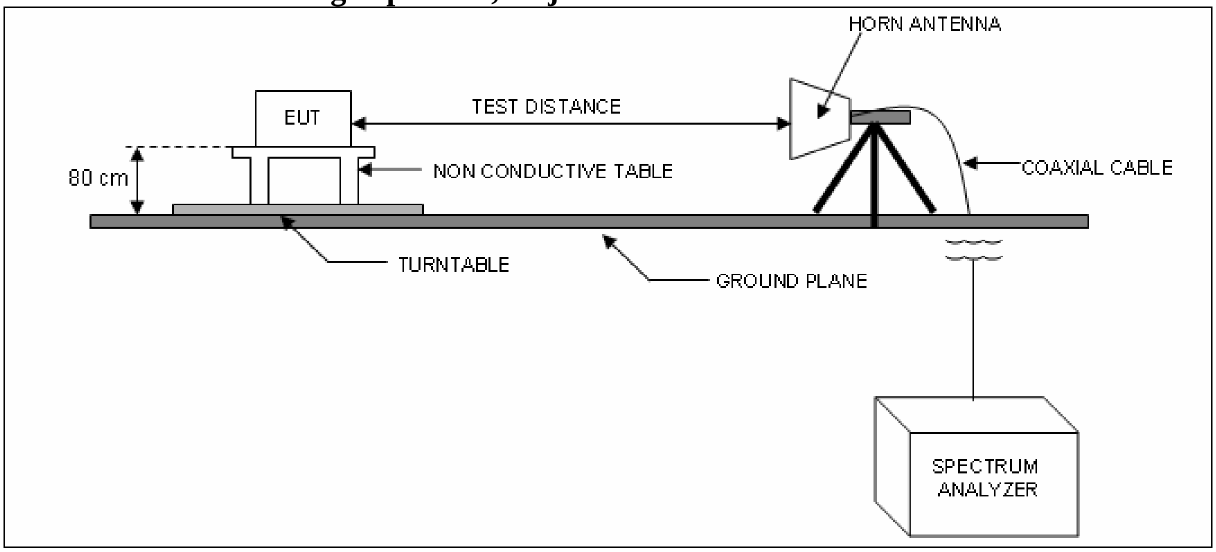


FIGURE 2: Radiated Emissions Test Setup – Spurious < 1 GHz

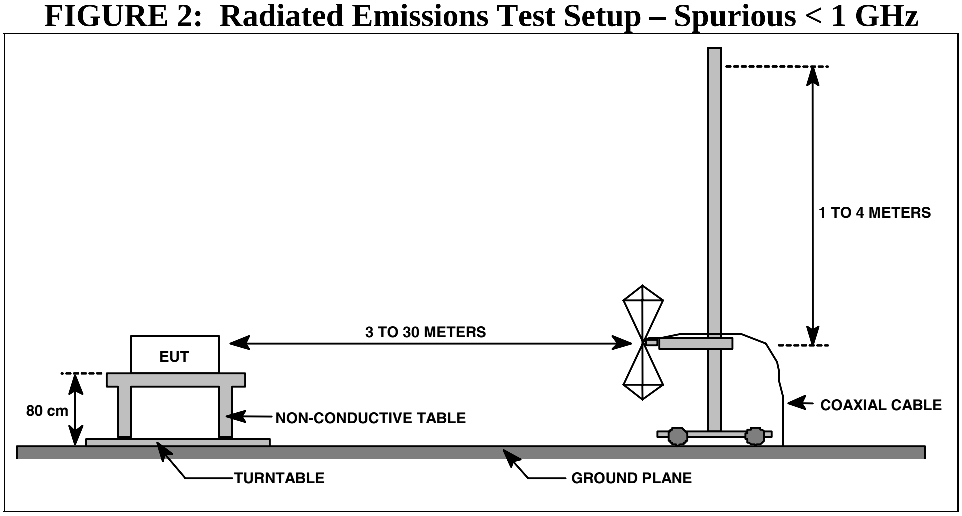
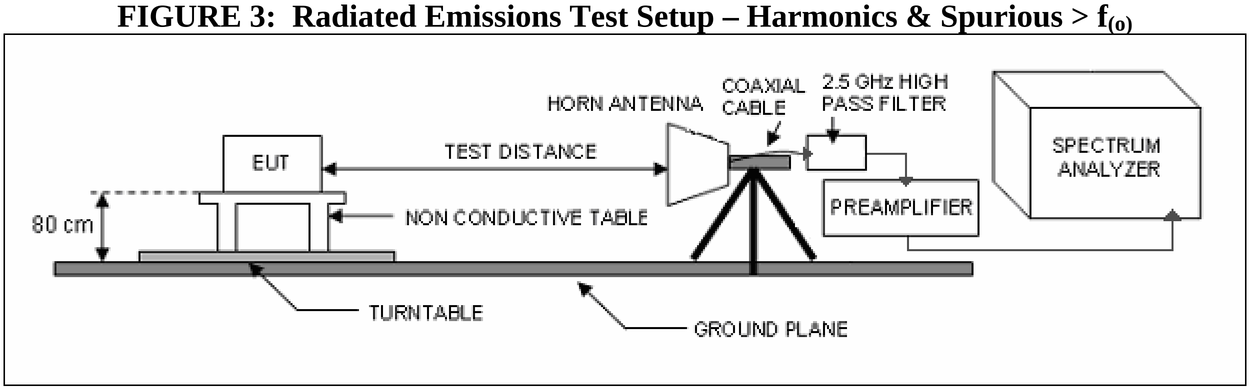


FIGURE 3: Radiated Emissions Test Setup – Harmonics & Spurious > $f_{(o)}$



For the tests in this report, the transmitter power was sufficiently low as to not require a high pass filter.

Peak Power
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Peak Detection, RBW = 3 MHz, VBW = 3 MHz

Test Date: April 24, 2008
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	0	1	94.2	40.6	29.1	2.8	85.5
2440	0	1	93.4	40.6	29.2	2.8	84.8
2480	0	1	94	40.6	29.2	2.8	85.4

Note – 2405 & 2440 peak power measurements are as shown, the same level.

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	85.5	-19.27	0.012	30
2440	84.8	-19.97	0.010	30
2480	85.4	-19.37	0.012	30

Result: PASS

Test Technician: Jesse Banda

Power Spectral Density
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Peak Detection, RBW = 3 kHz, VBW = 300 kHz
Test Distance 1 meter

Test Date: April 24, 2008
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	75.42	40.6	29.1	2.8	66.8
2440	90	1	73.94	40.6	29.2	2.8	65.3
2480	0	1	76.9	40.6	29.2	2.8	68.3

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 / 3 kHz)	E.I.R.P (dBm / 3 kHz)	Limit (dBm / 3 kHz)
2405	66.8	-37.97	8
2440	65.3	-39.47	8
2480	68.3	-36.47	8

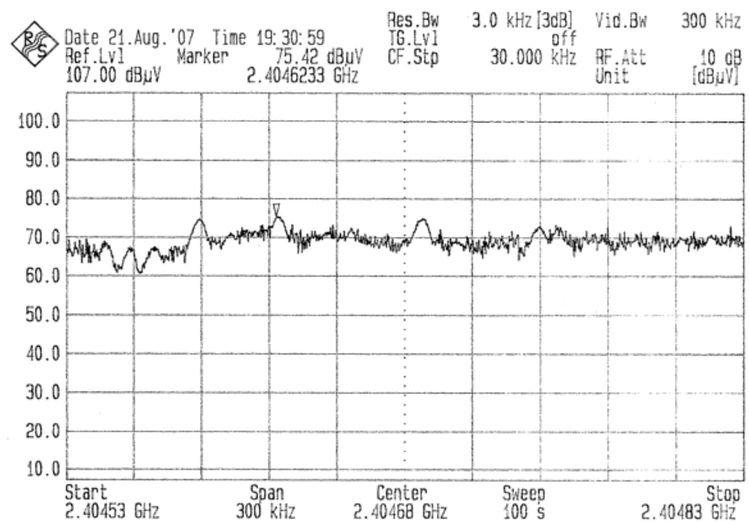
Plots of PSD measurements are presented on the following pages.

Result: PASS

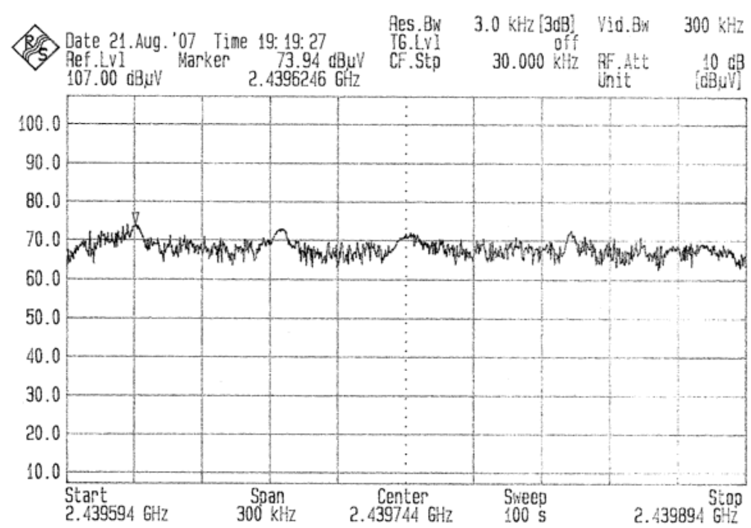
Test Technician: Jesse Banda

Power Spectral Density
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Peak Detection, RBW = 3 kHz, VBW = 300 kHz
Span 300 kHz, 100 second sweep
Test Distance 1 meter

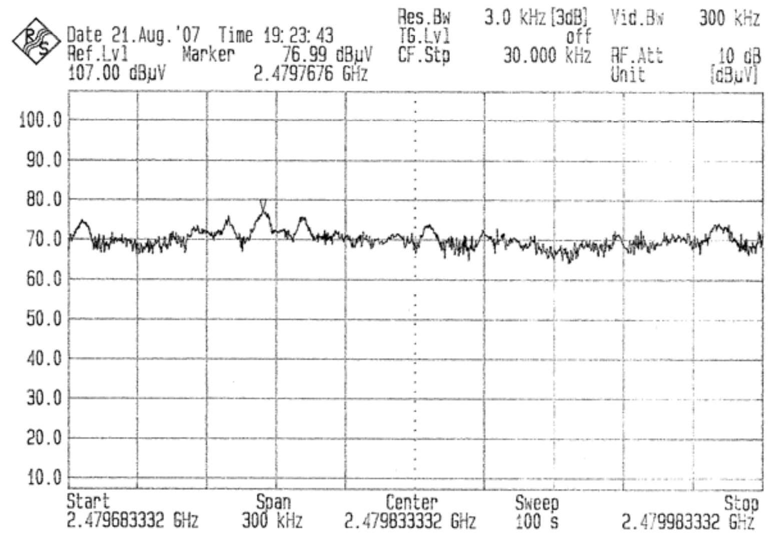
Low Channel



Mid Channel



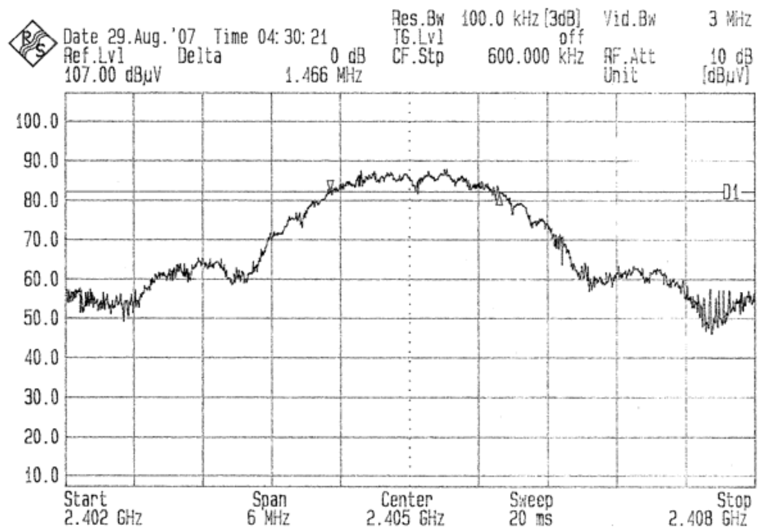
High Channel



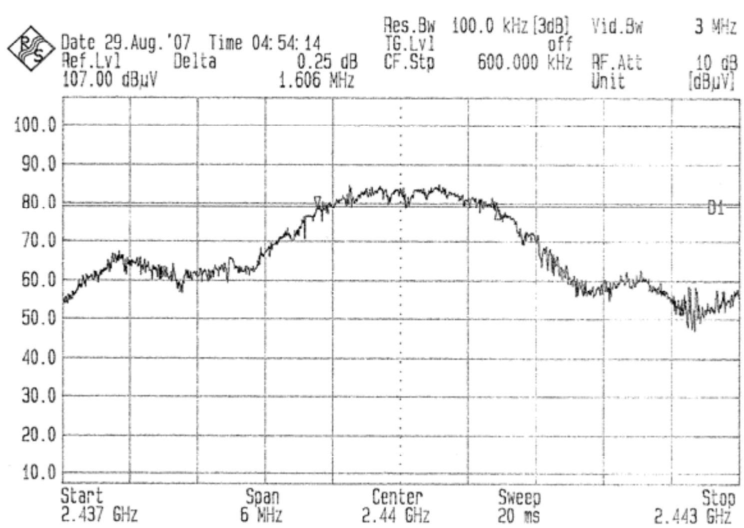
Occupied Bandwidth 6 dB
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Peak Detection, RBW = 100 kHz

Test Date: **April 24, 2008**

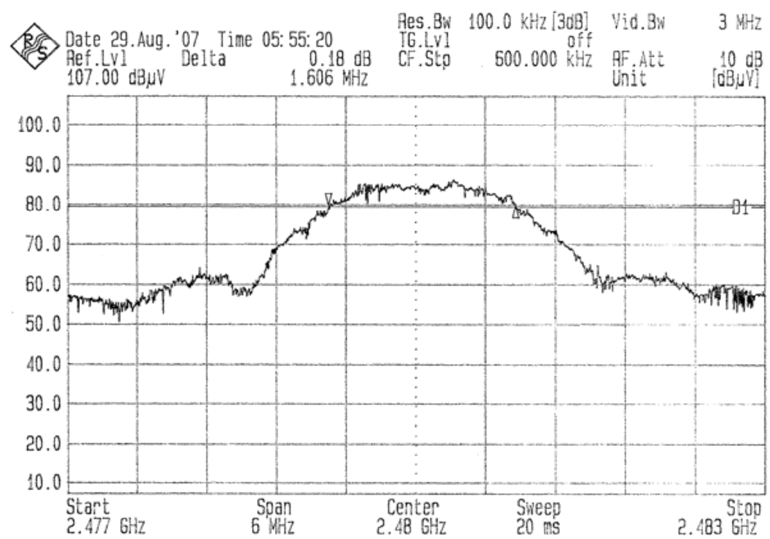
Low Channel



Middle Channel



High Channel

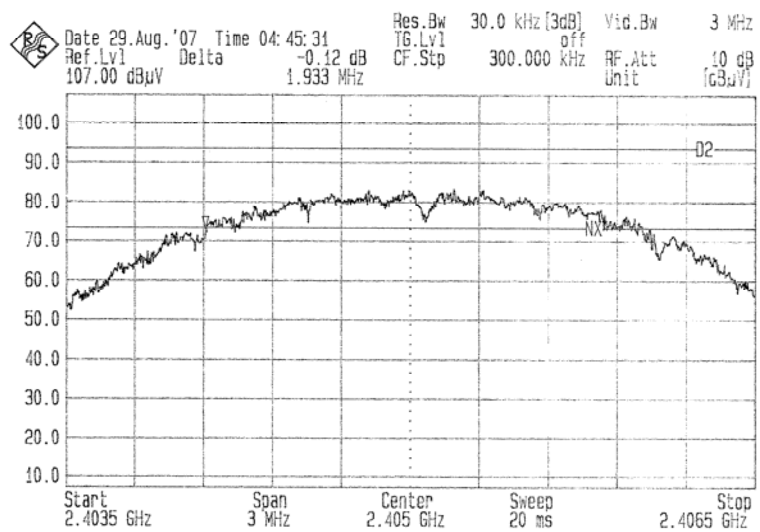


Test Technician: Jesse Banda

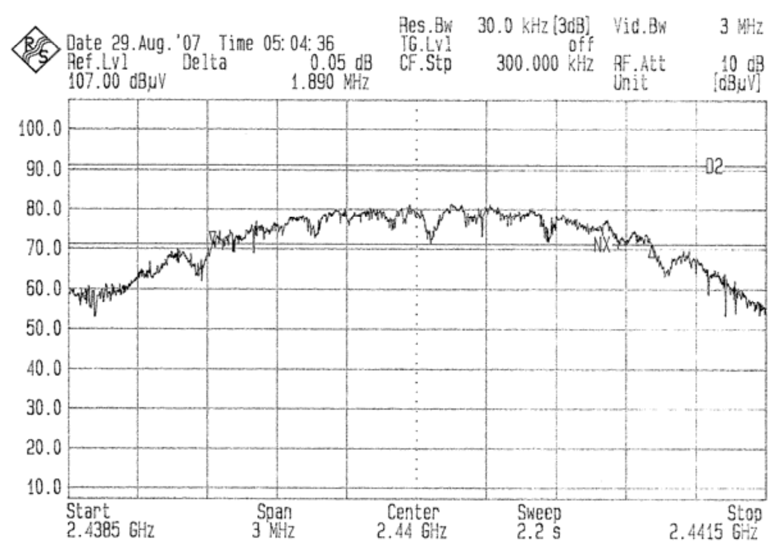
Occupied Bandwidth 20 dB
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Peak Detection, RBW = 30 kHz
Reference Levels Based on 3 MHz RBW Peak Measurement

Test Date: **April 24, 2008**

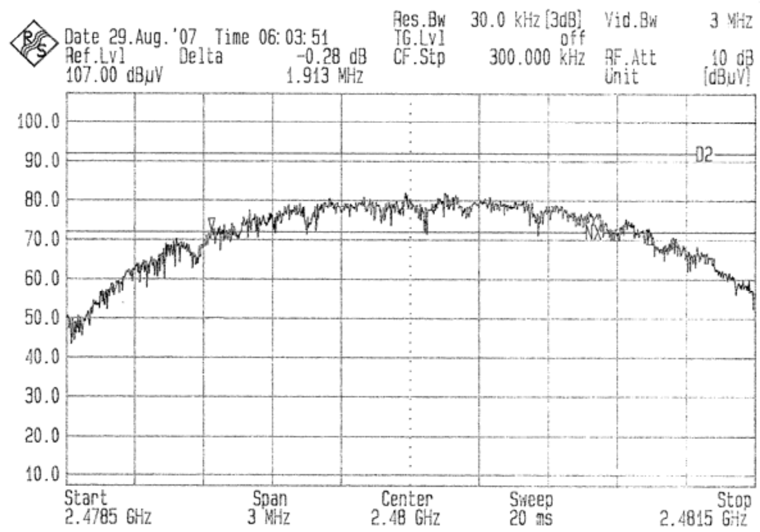
Low Channel



Middle Channel



High Channel

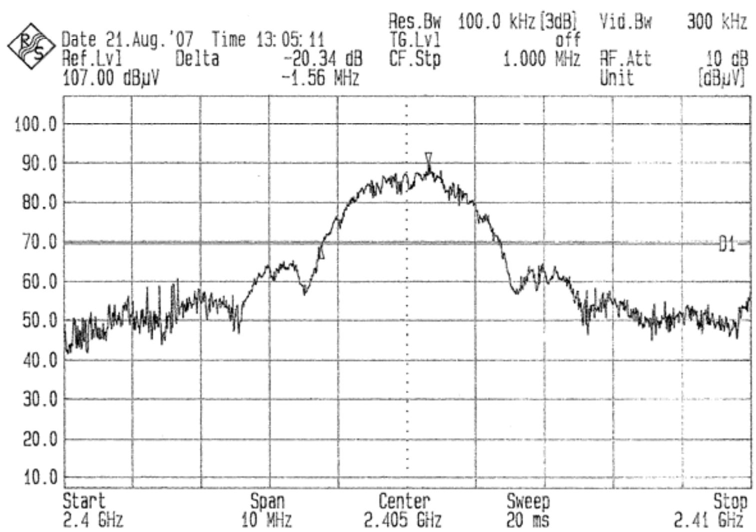


Band Edge Spurious Emissions
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Peak Detection, RBW = 100 kHz

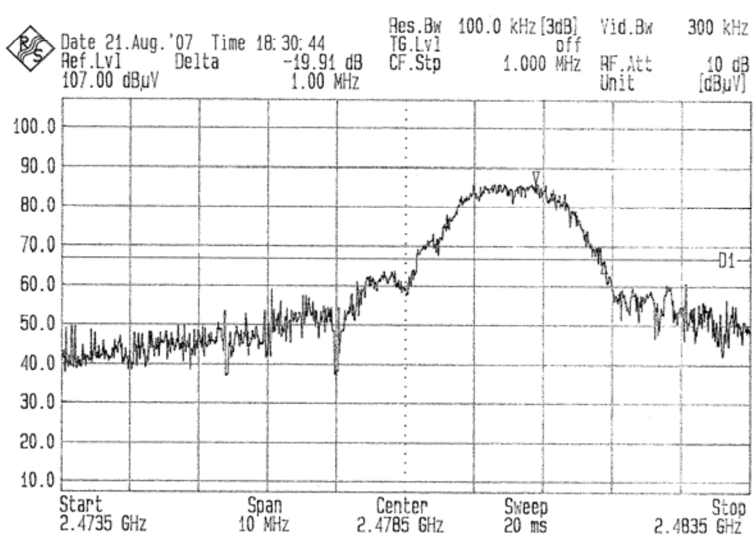
Test Date: April 24, 2008
Test Distance 1 meters

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
08026-10	April 24, 2008	FCC B	10 m	Bicon | Log	CISPR 120 kHz	1 MHz	As Noted

COMMENT	Transmitting

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
109	0	4	36	26.3	10.2	1.2	21.1	30	-8.9	QP
200	140	3.9	43.6	35.1	10.9	1.9	21.3	30	-8.7	QP
352	10	3.8	44.9	37.0	14.8	2.9	25.6	37	-11.4	QP
465	220	3.8	39.5	37.1	18.7	3.3	24.4	37	-12.6	QP
480	140	2.8	42	37.1	19.1	3.4	27.4	37	-9.6	QP
502	270	2	41.2	37.1	18.9	3.4	26.4	37	-10.6	QP

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
288	15	1	48	36.6	13.6	2.5	27.5	37	-9.5	QP
332	330	1.6	44.1	36.9	14.4	2.8	24.3	37	-12.7	QP
430	40	1.5	42.3	37.2	17.5	3.1	25.8	37	-11.2	QP
459	90	2	41.7	37.1	18.4	3.3	26.2	37	-10.8	QP
466	50	2	40	37.1	18.7	3.3	24.9	37	-12.1	QP
830	340	3.5	33.3	36.8	23.0	4.7	24.1	37	-12.9	QP

Test Technician: Jesse Banda

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
08026-10	April 24, 2008	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)	Applied Duty Cycle Average	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)	Detector Function
4810	90	1	74.7	41.7	33.6	4.2	0	70.8	63.5	7.3	Peak
4810	90	1	74.7	41.7	33.6	4.2	20	50.8	63.5	-12.7	Avg*
7215	270	1	70.2	42.5	36.0	5.0	0	68.7	63.5	5.2	Peak
7215	270	1	70.2	42.5	36.0	5.0	20	48.7	63.5	-14.8	Avg*
9620	90	1	57.2	39.0	37.4	4.6	0	60.3	63.5	-3.2	Peak
12025	NF	1	42.67	35.4	38.6	7.1	0	52.9	63.5	-10.6	Peak
14430	NF	1	42.4	39.7	39.6	7.7	0	50.0	63.5	-13.5	Peak
16835	NF	1	41.5	40.8	40.2	7.6	0	48.5	63.5	-15.0	Peak
19240	NF	1	39.8	43.2	36.6	8.8	0	42.0	63.5	-21.5	Peak
21645	NF	1	40.2	41.8	36.9	9.5	0	44.8	63.5	-18.7	Peak
24050	NF	1	43.6	42.2	37.1	10.4	0	48.9	63.5	-14.6	Peak

Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Applied Duty Cycle Average	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)	Detector Function
4810	270	1	66.16	41.7	33.6	4.2	0	62.3	63.5	-1.2	Peak
7215	90	1	63.8	42.5	36.0	5.0	0	62.3	63.5	-1.2	Peak
9620	90	1	52.1	39.0	37.4	4.6	0	55.2	63.5	-8.3	Peak
12025	NF	1	43	35.4	38.6	7.1	0	53.3	63.5	-10.2	Peak
14430	NF	1	41.5	39.7	39.6	7.7	0	49.1	63.5	-14.4	Peak
16835	NF	1	41.1	40.8	40.2	7.6	0	48.1	63.5	-15.4	Peak
19240	NF	1	39.6	43.2	36.6	8.8	0	41.8	63.5	-21.7	Peak
21645	NF	1	40.6	41.8	36.9	9.5	0	45.2	63.5	-18.3	Peak
24050	NF	1	44	42.2	37.1	10.4	0	49.3	63.5	-14.2	Peak

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 Technician: Jesse Banda

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
08026-10	April 24, 2008	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)	Applied Duty Cycle Average	Corrected Level (dBµV /m)	Limit (dBµV /m)	Margin (dB)	Detector Function
4880	90	1	70.1	41.7	33.6	4.2	0	66.2	63.5	2.7	Peak
4880	90	1	70.1	41.7	33.6	4.2	20	46.2	63.5	-17.3	Avg*
7320	0	1	73.1	42.5	36.0	5.1	0	71.7	63.5	8.2	Peak
7320	0	1	73.1	42.5	36.0	5.1	20	51.7	63.5	-11.8	Avg*
9760	180	1	57.5	38.9	37.4	5.0	0	60.9	63.5	-2.6	Peak
12200	0	1	44.2	35.6	38.7	5.6	0	53.0	63.5	-10.5	Peak
14640	NF	1	39.9	39.6	39.4	6.1	0	45.9	63.5	-17.6	Peak
17080	NF	1	41.9	42.2	40.6	7.6	0	47.9	63.5	-15.6	Peak
19520	NF	1	42.3	43.5	36.5	6.7	0	42.0	63.5	-21.5	Peak
21960	NF	1	41.9	40.6	36.9	10.4	0	48.6	63.5	-14.9	Peak
24400	NF	1	42.9	42.2	37.2	10.3	0	48.1	63.5	-15.4	Peak

Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Applied Duty Cycle Average	Corrected Level (dBµV /m)	Limit (dBµV /m)	Margin (dB)	Detector Function
4880	270	1	65.9	41.7	33.6	4.2	0	62.0	63.5	-1.5	Peak
7320	270	1	64.3	42.5	36.0	5.1	0	62.9	63.5	-0.6	Peak
9760	0	1	51.1	38.9	37.4	5.0	0	54.5	63.5	-9.0	Peak
12200	NF	1	40.3	35.6	38.7	5.6	0	49.1	63.5	-14.4	Peak
14640	NF	1	41	39.6	39.4	6.1	0	47.0	63.5	-16.5	Peak
17080	NF	1	43.1	42.2	40.6	7.6	0	49.1	63.5	-14.4	Peak
19520	NF	1	44.2	43.5	36.5	6.7	0	43.9	63.5	-19.6	Peak
21960	NF	1	42.7	40.6	36.9	10.4	0	49.4	63.5	-14.1	Peak
24400	NF	1	43.9	42.2	37.2	10.3	0	49.1	63.5	-14.4	Peak

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 Technician: Jesse Banda

Spurious/Harmonic Emissions
1 GHz … 25 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
08026-10	April 24, 2008	FCC B	1 m	Horn	1 MHz	1 MHz	As Noted

COMMENT	Transmitting High Channel Peak averaging factor -16.5 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)	Applied Duty Cycle Average	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)	Detector Function
4960	270	1	68.45	41.7	33.6	4.2	0	64.6	63.5	1.1	Peak
4960	270	1	68.45	41.7	33.6	4.2	20	44.6	63.5	-18.9	Avg*
7440	270	1	74.8	42.6	36.1	4.5	0	72.9	63.5	9.4	Peak
7440	270	1	74.8	42.6	36.1	4.5	20	52.9	63.5	-10.6	Avg*
9920	270	1	56.12	38.9	37.4	5.0	0	59.6	63.5	-3.9	Peak
12400	NF	1	41.9	37.1	38.9	6.2	0	49.8	63.5	-13.7	Peak
14880	NF	1	42.5	39.4	39.2	7.3	0	49.7	63.5	-13.8	Peak
17360	NF	1	42	41.5	41.2	8.7	0	50.3	63.5	-13.2	Peak
19840	NF	1	43.8	43.7	36.5	8.2	0	44.9	63.5	-18.6	Peak
22320	NF	1	43.7	40.5	37.1	9.4	0	49.7	63.5	-13.8	Peak
24800	NF	1	42.8	42.1	37.2	10.1	0	48.0	63.5	-15.5	Peak

Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Applied Duty Cycle Average	Corrected Level (dBμV /m)	Limit (dBμV /m)	Margin (dB)	Detector Function
4960	270	1	64.3	41.7	33.6	4.2		60.5	63.5	-3.0	Peak
7440	0	1	64.6	42.6	36.1	4.5		62.7	63.5	-0.8	Peak
9920	180	1	51.8	38.9	37.4	5.0		55.3	63.5	-8.2	Peak
12400	NF	1	42.1	37.1	38.9	6.2		50.0	63.5	-13.5	Peak
14880	NF	1	43.2	39.4	39.2	7.3		50.4	63.5	-13.1	Peak
17360	NF	1	43.2	41.5	41.2	8.7		51.5	63.5	-12.0	Peak
19840	NF	1	40.2	43.7	36.5	8.2		41.3	63.5	-22.2	Peak
22320	NF	1	43.6	40.5	37.1	9.4		49.6	63.5	-13.9	Peak
24800	NF	1	42.6	42.1	37.2	10.1		47.8	63.5	-15.7	Peak

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 Technician: Jesse Banda

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

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
08026-10	April 24, 2008	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
2310	90	1	50.2	40.5	28.8	2.8	41.2	63.5	-22.3	pk
2390	0	1	65.5	40.5	28.8	2.8	56.6	63.5	-6.9	pk

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
2310	90	1	57.7	40.5	28.8	2.8	48.7	63.5	-14.8	pk
2390	90	1	61.3	40.5	28.8	2.8	52.4	63.5	-11.1	pk

Test Technician: Jesse Banda

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

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
08026-10	April 24, 2008	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	0	1	78.3	40.6	29.2	2.8	69.7	63.5	6.2	pk
2483.5	0	1	78.3	40.6	29.2	2.8	49.7	63.5	-13.8	avg*
2500	0	1	50.3	40.6	29.2	2.8	41.7	63.5	-21.8	pk

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	90	1	77.5	40.6	29.2	2.8	68.9	63.5	5.4	pk
2483.5	90	1	77.5	40.6	29.2	2.8	48.9	63.5	-14.6	avg*
2500	270	1	52.7	40.6	29.2	2.8	44.1	63.5	-19.4	pk

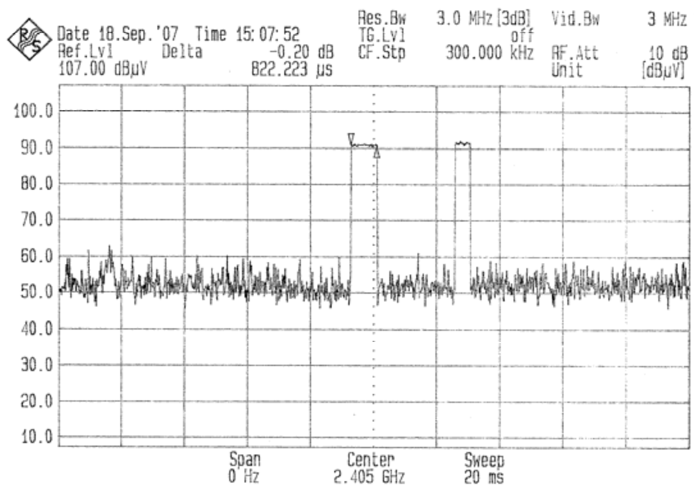
Note: When applied (*), peak average was calculated using a peak to average correction factor based on transmitter duty cycle. This is calculated in the timing assessment

Test Technician: Jesse Banda

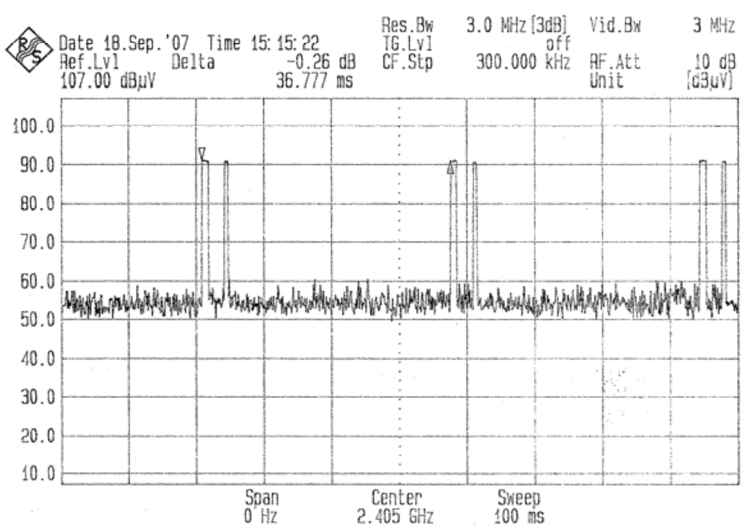
Timing Assessment
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Peak Detection, RBW = 3 MHz

Test Date: **April 25, 2008**

Pulse Duration 0.822 ms



Total Time 36.7 ms



Test Technician: Jesse Banda

Timing Assessment
Freescale Semiconductor Model ZStar Triaxial Accelerometer
Calculations

Duty Cycle

DutyCycle=Pulse Duartion/Total Time

DutyCycle =0.82mS/36.7mS

Peak Averaging Correction Factor

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

CorrFact=20*log(0.022)=-33.1dB

(Maximum allowed is -20 dB.)

Allowed Duty Cycle Factor
-20 dB

Test Technician: Jesse Banda

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