LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
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www.lsr.com

TEST REPORT # 311239 TX
LSR Job #: C-1273

Compliance Testing of:
T:Slim

Test Date(s):
August 11th to September 16th 2011
April 2nd 2012

Prepared For:
Tandem Diabetes
11045 Roselle Street, Suite 200
San Diego, CA 92121

This Test Report is issued under the Authority of:
Khairul Aidi Zainal, Senior EMC Engineer

Signature:  Date: 4/9/12

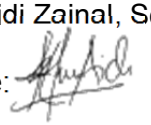
Test Report Reviewed by:	Project Engineer:
Adam Alger, EMC Engineer	Khairul Aidi Zainal, Senior EMC Engineer.
Signature:  Date: 4-5-12	Signature:  Date: 4/9/12

TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 RSS GEN issue 3 and RSS 210 issue 8 Annex 8
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	Measurement of Digital Transmission Systems Operating under Section 15.247. March 23, 2005
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 – Normative References

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2010-10	Code of Federal Regulations - Telecommunications
RSS 210 Issue 8 Annex 8	2010-12	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	2010-01	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
DTS measurement	March 23, 2005	Measurement of Digital Transmission Systems Operating under Section 15.247.

1.3 - LS Research, LLC Test Facility

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) as conforming to ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. Accreditation status can be verified at A2LA's web site: www.a2la.net.

1.4 – Location of Testing

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

List of Facilities Located at LS Research, LLC:

Compact Chamber
Semi-Anechoic Chamber
Open Area Test Site (OATS)

1.5 – Test Equipment Utilized

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to the SI standard.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Tandem Diabetes
Address:	11045 Roselle Street, Suite 200 San Diego, CA 92121
Contact Name:	Chad Eastridge

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	T:Slim
Model Number:	N/A
Serial Number:	Engineering Unit

2.3 - Associated Antenna Description

The antenna associated with the EUT is a Johanson ceramic chip antenna, P/N 2450AT18A100, with a peak gain of 0.5 dBi.

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2402MHz – 2480MHz
RF Power in Watts (Conducted measurement)	
Minimum:	0.0031Watts
Maximum:	0.0034Watts
Max Conducted Output Power (in dBm)	5.3 dBm
Field Strength at 3 meters (Maximum)	Not Applicable
Occupied Bandwidth (99% BW)	1.21 MHz
Type of Modulation	GFSK
Emission Designator	1M21F1D
Transmitter Spurious (worst case) at 3 meters	35.06dBµV/m at 4882.1MHz
Stepped (Y/N)	N
Step Value:	
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	CC2540
Antenna Information	
Detachable/non-detachable	Non-detacheable
Type	Ceramic Chip antenna
Gain (From data sheet)	Peak = 0.5dBi
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.247
EUT will be operated under RSS Rule Part(s)	RSS 210
Modular Filing	☐ Yes ☒ No
Portable or Mobile?	Portable

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	X	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
Duty Cycle used in evaluation: 100 %
Standard used for evaluation: OET 65
Measurement Distance: 20 cm
RF Value: **0.00756** ☐ V/m ☐ A/m ☒ W/m^2
☐ Measured ☐ Computed ☒ Calculated

2.5 - Product Description

The T-Slim ambulatory pump is intended to be used for continuous subcutaneous insulin infusion therapy in persons requiring insulin for the management of diabetes.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70 -71° F
Humidity:	32-42%
Pressure:	728-741mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.4	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247 (a)(1) IC : RSS 210 A8.1 (a)	20 dB Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(2) IC: RSS 210 A8.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC:15.247 (d) IC: RSS 210 A8.2 (b)	Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS GEN Section 7.2.2	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.		

3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☒ None ☐ Yes (explain below)

3.4 - Deviations & Exclusions From Test Specifications

☒ None ☐ Yes (explain below)

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210, Issue 8 (2010), Annex 8.

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit mode for final testing using power as provided by USB connected to an off the shelf laptop PC. The unit has the capability to operate on 3 channels, controllable via instructions on 'Hyperterminal'.

The applicable limits apply at a 3 meter distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (2402MHz), middle (2440MHz) and high (2480MHz) to comply with FCC Part 15.31(m). The unit has the capability to operate on 3 channels, controllable via instructions on 'Hyperterminal'.

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz while a standard gain horn antenna was used in the 18 GHz to 25 GHz range. The maximum radiated RF emissions between 30MHz to 4 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. Between 4GHz to 25GHz, the sense antenna was raised and lowered between 1 and 1.8 meters in height.

The EUT was positioned in 3 orthogonal orientations.

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at a calibration laboratory accredited to ISO 17025, and are traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz).

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 8 (2010), Annex 8 for an DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 - Calculation of Radiated Emissions Limits and reported data.

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dBµV/m).

As specified in 15.247 (d) and RSS 210 A8.5, radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2 of RSS 210 for IC, must comply with the general emissions limit.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS GEN.

Frequency (MHz)	3 m Limit µV/m	3 m Limit (dBµV/m)	1 m Limit (dBµV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength (µV/m to dBµV/m):
dBµV/m = 20 $\log_{10}$ (100)= 40 dBµV/m (from 30-88 MHz)

5.6 - Radiated Emissions Test Data Chart

Manufacturer:	Tandem Diabetes					
Date(s) of Test:	September 7th and 8th 2011					
Project Engineer(s):	Khairul Aidi Zainal					
Test Engineer(s):	Khairul Aidi Zainal and Shane Rismeyer					
Voltage:	5.0 VDC					
Operation Mode:	continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 70° F Relative Humidity: 32%					
EUT Power:		Single Phase 120VAC		3 Phase ___VAC		
		Battery	X	Other: USB from generic laptop		
EUT Placement:	X	80cm non-conductive pedestal		10cm Spacers		
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS		
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:	X	Peak	X	Quasi-Peak	X	Average

Emissions that are present but not a function of the transmitter:

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
246.5	1.00	0	24	46.0	22.0	H	V
982.3	1.00	0	30	54.0	24.0	H	V

Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.

RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of radiated emissions of channel 2402 MHz in the restricted band:

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Height (cm)	Azimuth (°)	Limit (dBuV/m)	Margin (dB)	EUT Orientation
H	4804.0	Note 4						
H	12010.0	Note 4						
H	4806.1	52.6	43.7	103.8	10	63.5	19.8	V
H	19216.0	Note 4						

Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.
4. Emission buried in system noise floor

The following table depicts the level of significant radiated emissions of channel 2440 MHz in the restricted band:

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Height (cm)	Azimuth (°)	Limit (dBuV/m)	Margin (dB)	EUT Orientation
H	4880.0	Note 4						
H	7320.0	Note 4						
H	12200.0	Note 4						
H	4882.1	51.0	44.6	100.0	24	63.5	18.9	S
H	19520.0	Note 4						

Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.
4. Emission buried in system noise floor

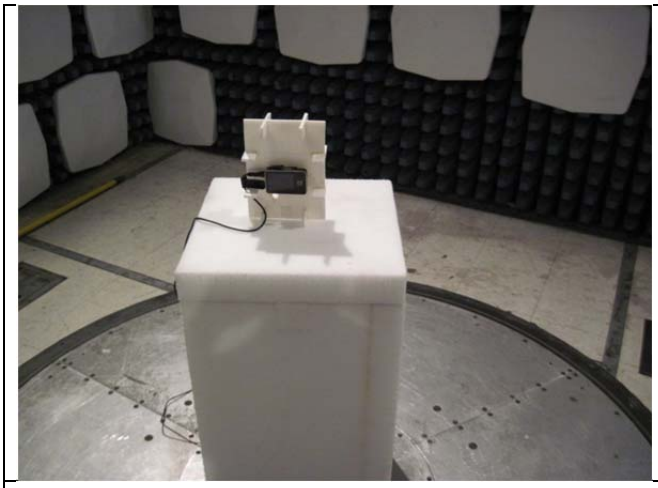
The following table depicts the level of significant radiated emissions of channel 2480 MHz in the restricted band:

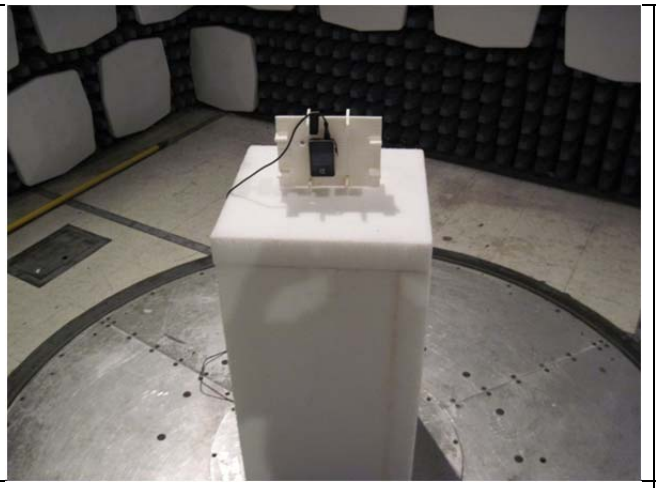
Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Height (cm)	Azimuth (°)	Limit (dBuV/m)	Margin (dB)	EUT Orientation
H	4960.0	Note 4						
H	7440.0	Note 4						
H	12400.0	Note 4						
H	4958.1	51.4	44.0	100.1	28	63.5	19.5	S
H	19840.0	Note 4						
H	22320.0	Note 4						

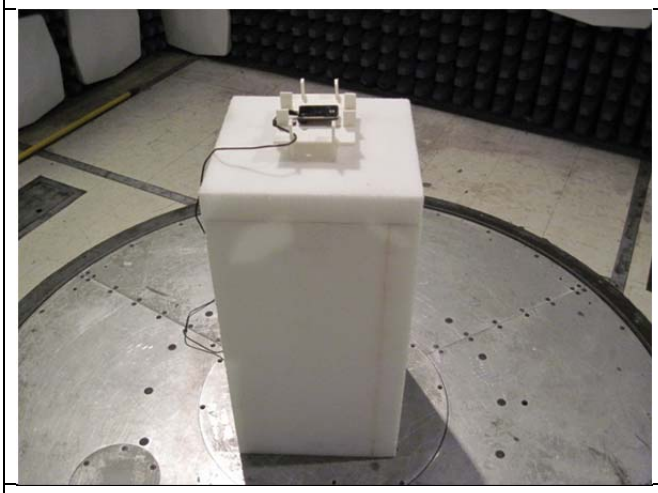
Notes:

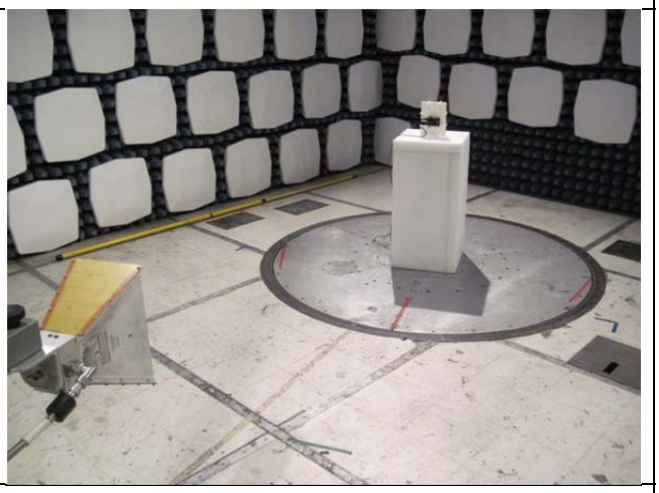
1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.
4. Emission buried in system noise floor

5.7 - Test Setup Photo(s) – Radiated Emissions Test





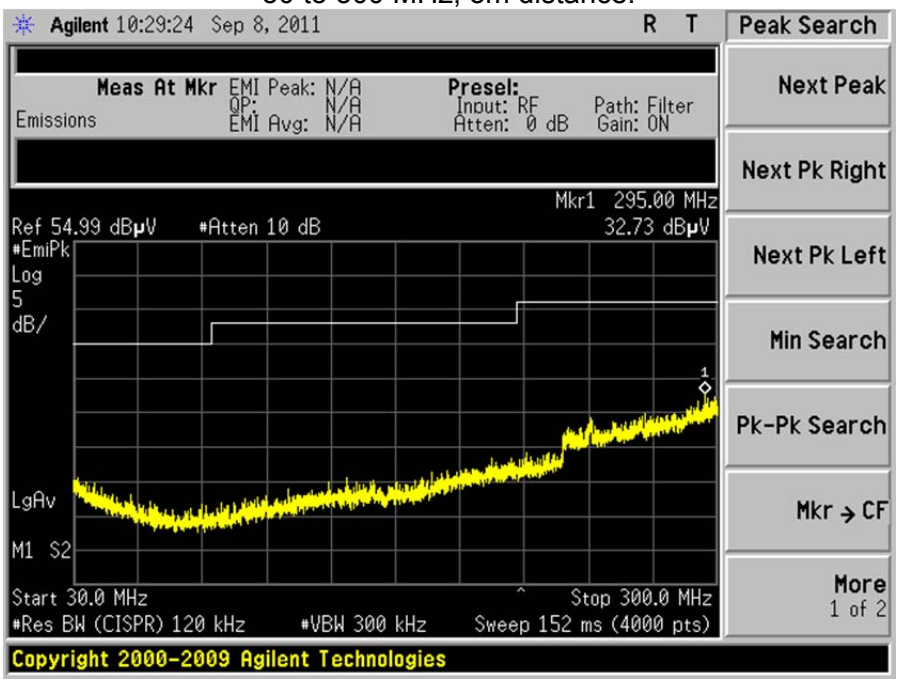




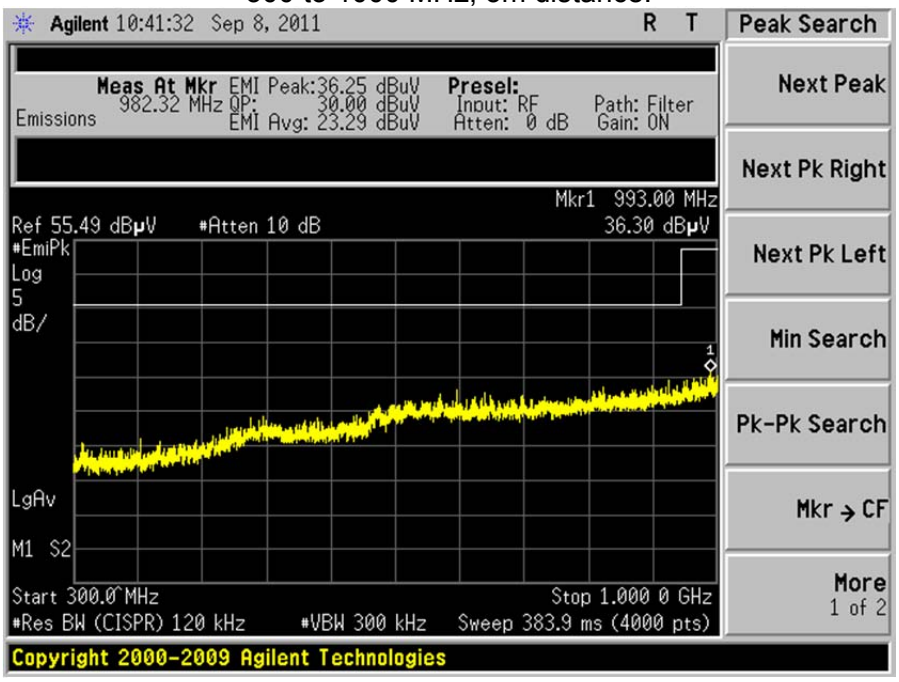
5.8 – Screen Captures.

The screen captures below are those using the Peak detector of the analyzer and represent the worst case of the investigated spectrum.

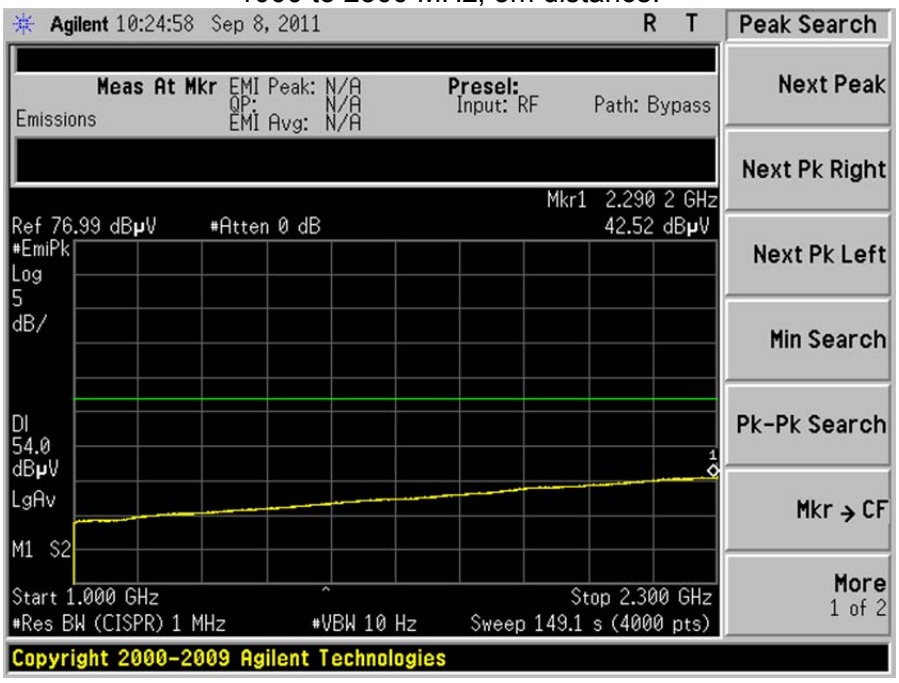
30 to 300 MHz, 3m distance.



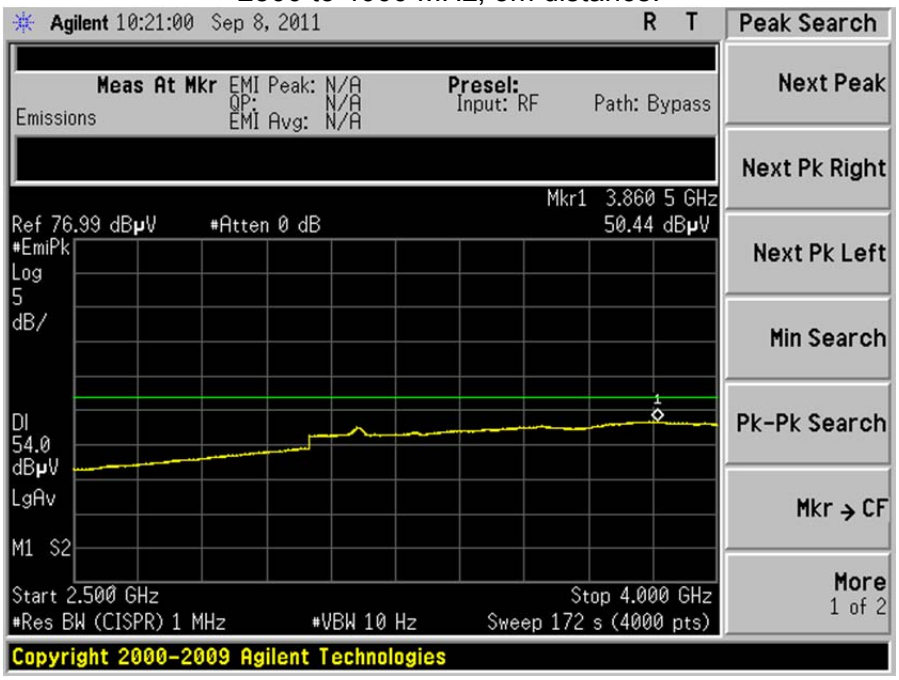
300 to 1000 MHz, 3m distance.



1000 to 2300 MHz, 3m distance.

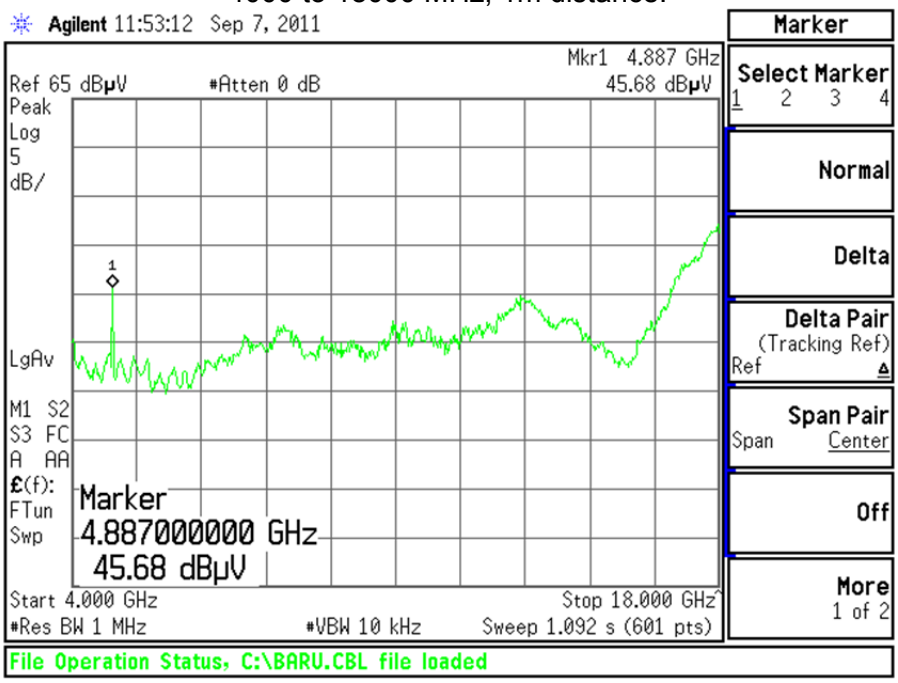


2500 to 4000 MHz, 3m distance.



Note: The range of 2300 to 2400 MHz and 2483.5 to 2500 MHz is in section 8 of this report (Band-edges).

4000 to 18000 MHz, 1m distance.



18000 to 25000 MHz, 1m distance.

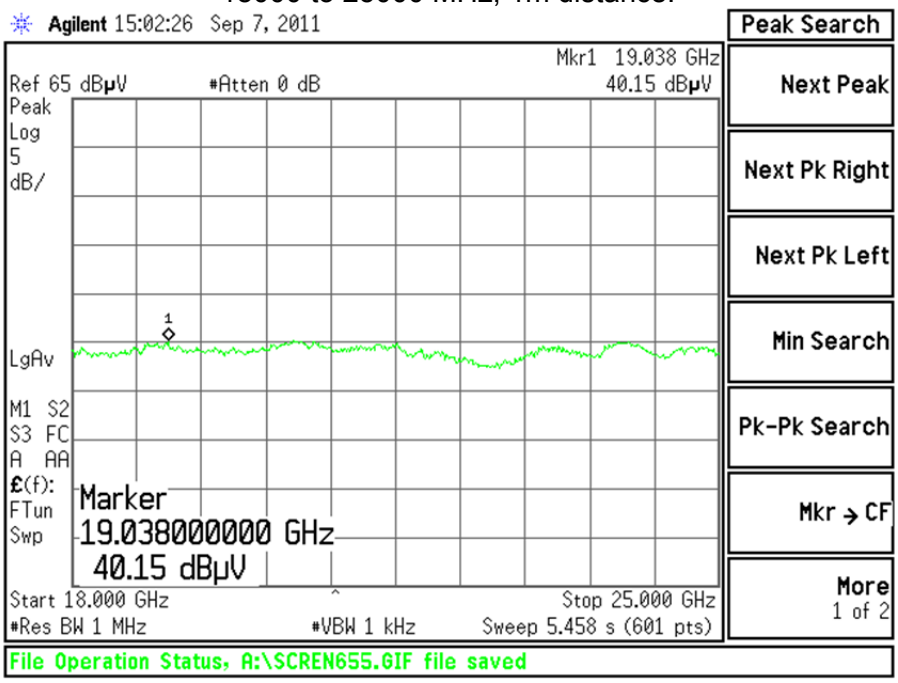


EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

6.1 Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT was connected to a USB port of a generic laptop and set to transmit. The Generic laptop power supply was then plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to EMI receiver System. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

6.2 Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

This test was performed on the EUT while it was powered using the manufacturer supplied wall outlet AC to DC adaptor.

6.3 Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. Calibrations of the LISN and Limiter were performed at an IEC/ISO 17025 accredited calibration laboratory, traceable to the SI standard. All cables are calibrated and checked periodically for conformance. The emissions are measured on the EMI System, which has automatic correction for all factors stored in memory and allows direct readings to be taken.

6.4 Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 and RSS GEN 7.2.2 for Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

6.5 FCC Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBµV)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

6.6 CONDUCTED EMISSIONS TEST DATA CHART

Frequency Range inspected: 150 KHz to 30 MHz

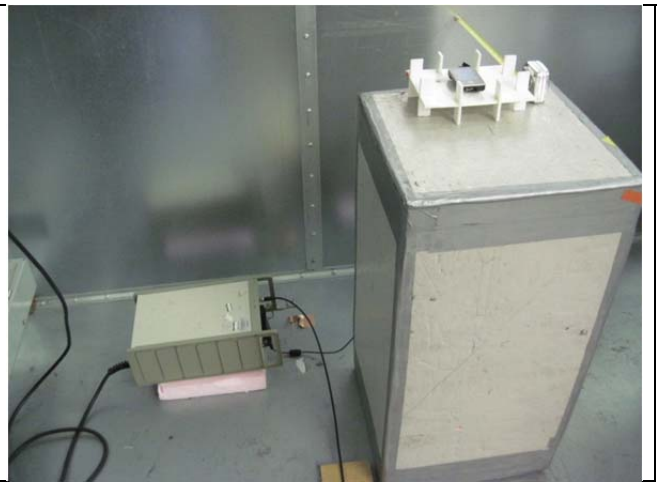
Manufacturer:	Tandem Diabetes					
Date(s) of Test:	September 16th 2011					
Project Engineer:	Khairul Aidi Zainal					
Test Engineer:	Khairul Aidi Zainal					
Voltage:	120 VAC					
Operation Mode:	Continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 40%					
Test Location:	X	AC Mains Test area				Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane				10cm Spacers
	X	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:		Peak	X	Quasi-Peak	X	Average

		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµ V)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµ V)	Average Margin (dB)
0.175	1.0	42.2	64.7	22.5	24.1	54.7	30.6
0.199	1.0	38.1	63.7	25.6	19.8	53.7	33.9
7.070	1.0	34.8	60.0	25.2	22.3	50.0	27.7
0.184	2.0	41.9	64.3	22.4	30.0	54.3	24.3
0.622	2.0	37.6	56.0	18.4	29.7	46.0	16.3
10.700	2.0	31.4	60.0	28.6	16.3	50.0	33.7

Notes:

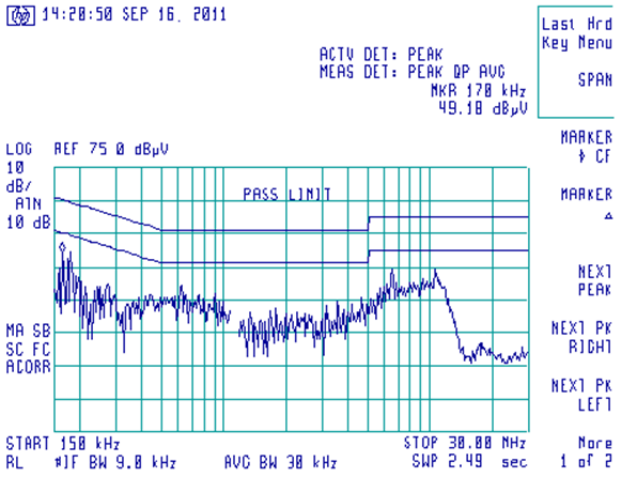
1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

6.7 Test Setup Photo(s) – Conducted Emissions Test

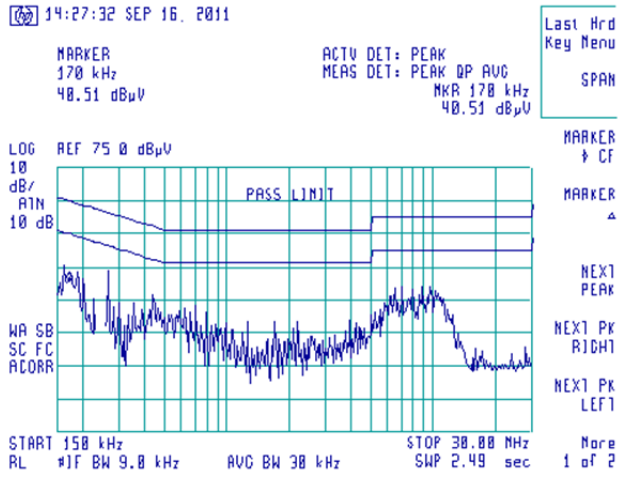


6.8 Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).



Line 1



Line 2

EXHIBIT 7. OCCUPIED BANDWIDTH

Test Engineer(s): Khairul Aidi Zainal

7.1 - Limits

For a DTS system operating in the 2400 to 2483.5 MHz band, the 6dB emission bandwidth limit is 500 kHz.

7.2 - Method of Measurements

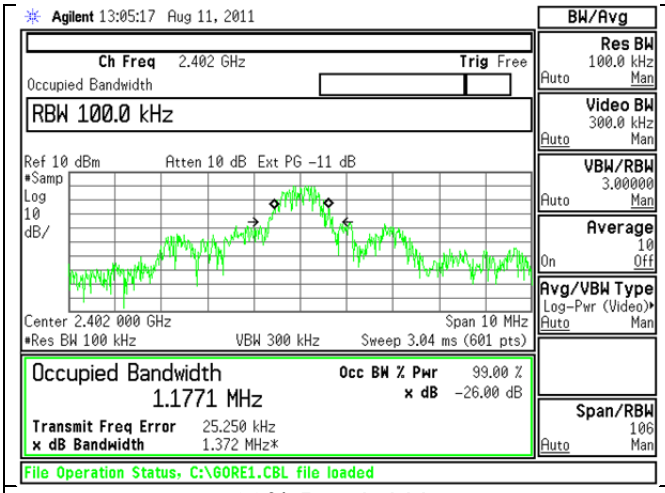
Industry Canada (IC RSS GEN 4.6.1) also requires the measurement of the 99% bandwidth in addition to the 6dB emission bandwidth. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. A bandwidth measurement function that is built into the spectrum analyzer was used to measure the 99 % bandwidth while the 6dB bandwidth was measured using FCC measurement method.

7.3 - Test Data

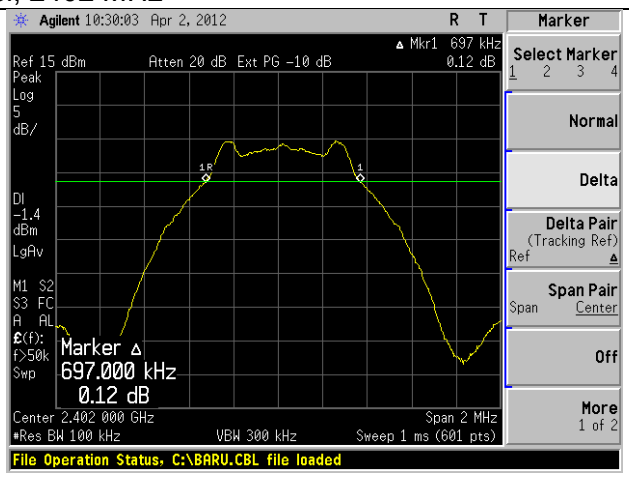
Channel (MHz)	99% (MHz)	6dB (kHz)
2402	**1.18**	**697.00**
2440	**1.14**	**700.00**
2480	**1.21**	**700.00**

7.4 – Screen Captures

Lowest Channel, 2402 MHz

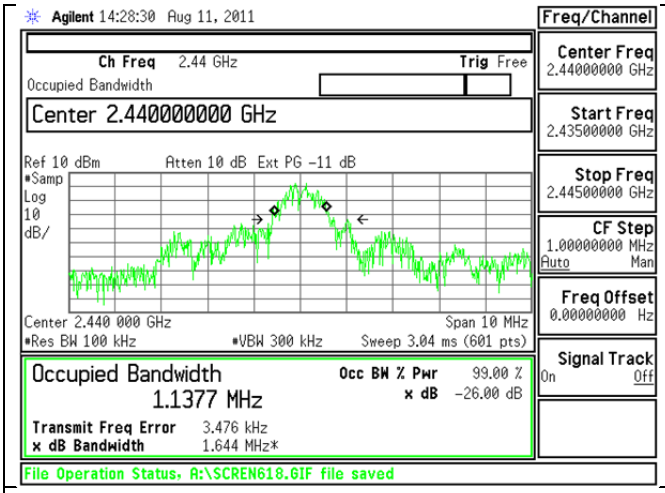


99% Bandwidth

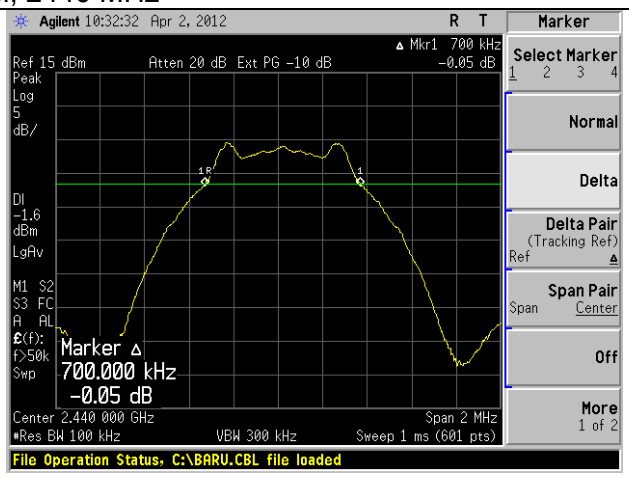


6dB bandwidth

Middle Channel, 2440 MHz

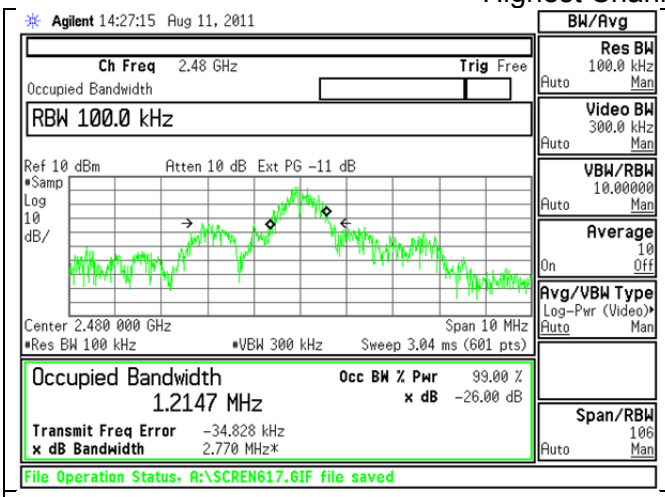


99% Bandwidth

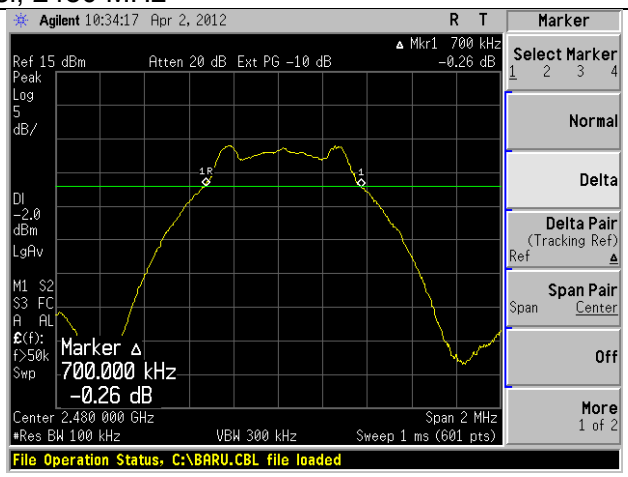


6dB bandwidth

Highest Channel, 2480 MHz



99% Bandwidth



6dB bandwidth

EXHIBIT 8. BAND EDGE MEASUREMENTS

Test Engineer(s): Khairul Aidi Zainal and Shane Rismeyer.

8.1 - Method of Measurements

FCC 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in RSS GEN and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the 2400 – 2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

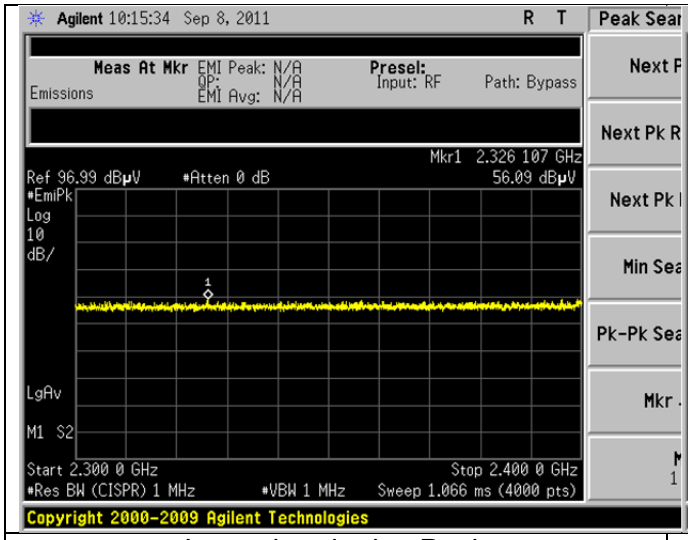
The Band-edge measurements were performed conducted and radiated. The measurement of band-edge was performed to satisfy FCC 15.247(d).

Conducted measurements of the spurious emission were performed with a measurement bandwidth of 100kHz.

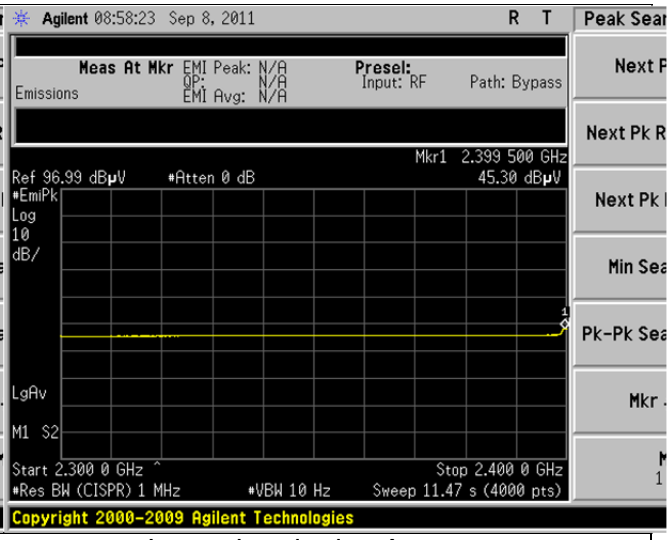
8.2. Band edge captures.

Radiated Band-edge:

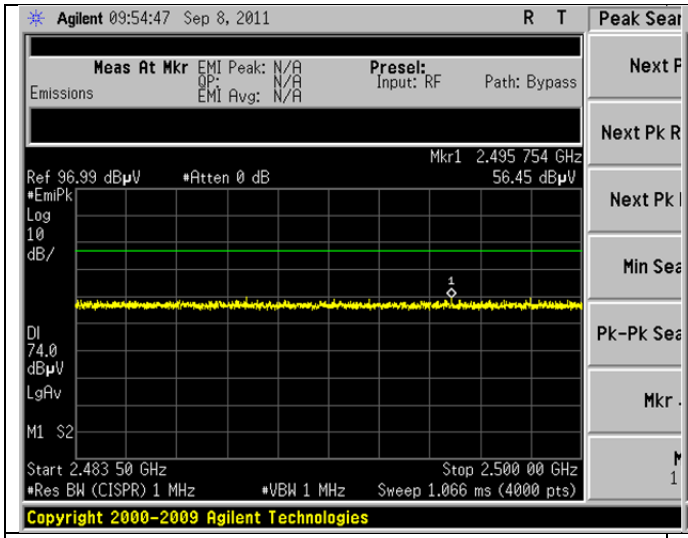
A. Continuously transmitting and modulated.



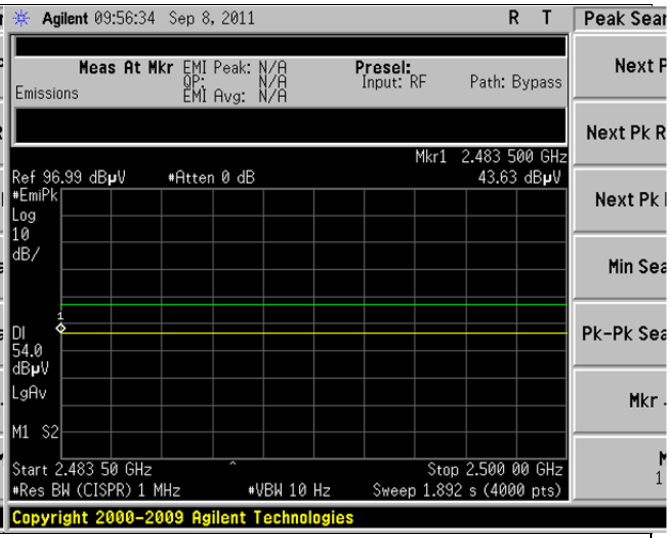
Lower band edge Peak



Lower band edge Average



Upper band edge Peak

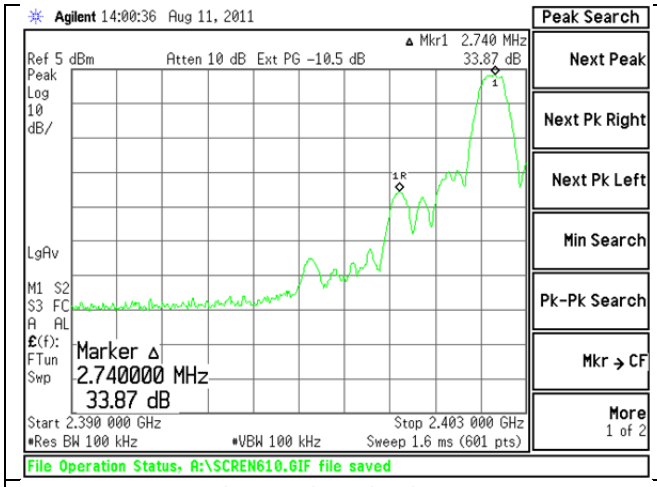


Upper band edge Average

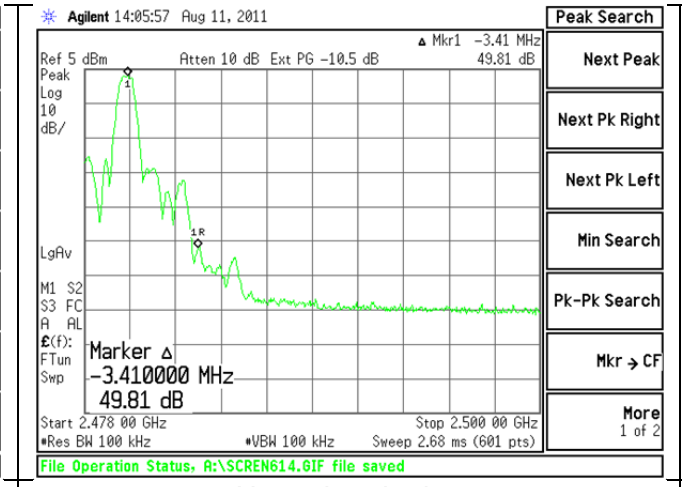
Note: The limits are: 74dBuV/m for Peak and 54dBuV/m for Average

Conducted Band-edge:

A. Continuously transmitting and modulated.



Lower band edge



Upper band edge

Note: The limits are: 20 dB below the carrier.

EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

Test Engineer(s): Khairul Aidi Zainal

9.1 - Method of Measurements

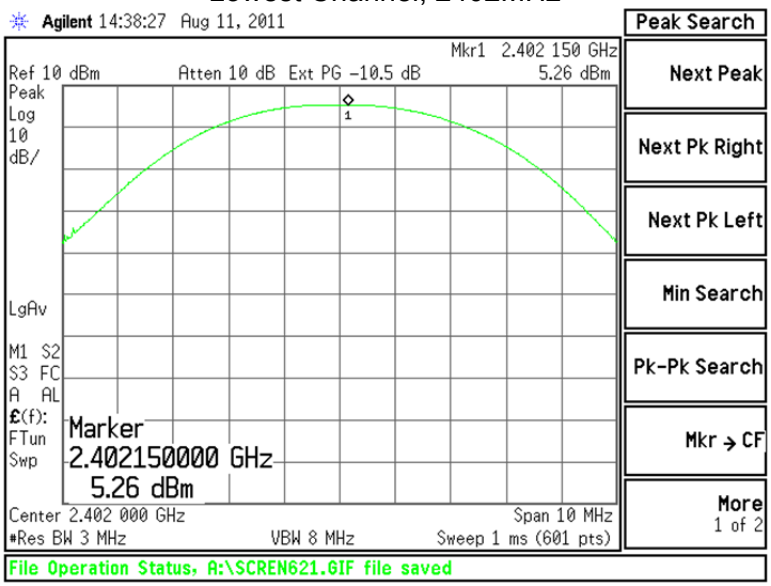
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with the appropriate resolution bandwidth, with measurements from a peak detector presented in the chart below.

9.2 - Test Data

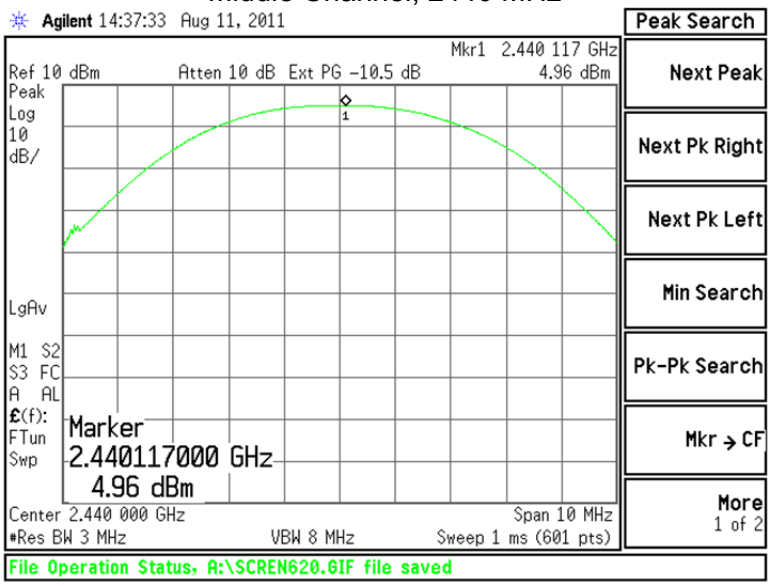
FREQUENCY (MHz)	Power (dBm) (dBm)	Limit (dBm)	Margin (dB)
2402	**5.3**	30.0	24.7
2440	**5.0**	30.0	25.0
2480	**4.9**	30.0	25.1

9.3 – Screen Captures.

Lowest Channel, 2402MHz



Middle Channel, 2440 MHz



Highest Channel, 2480 MHz

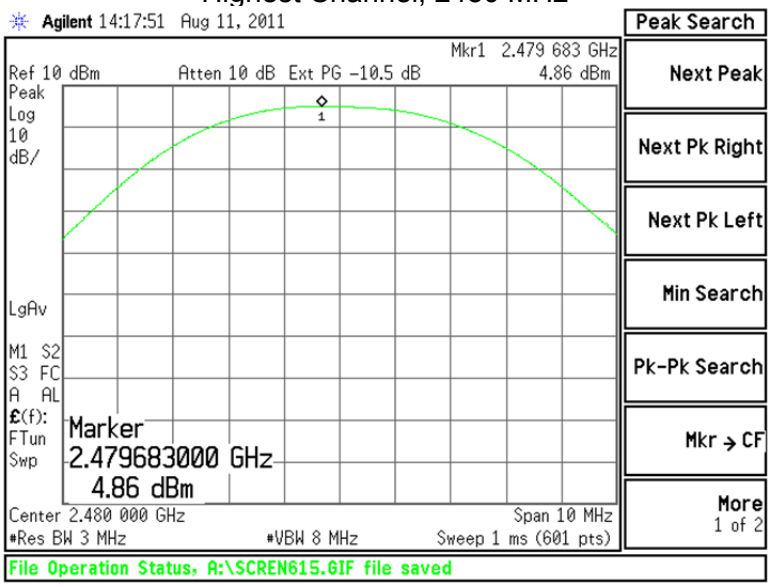


EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

Test Engineer(s): Khairul Aidi Zainal

10.1 - Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

10.2 – Conducted Harmonic And Spurious RF Measurements

FCC Part 15.247(d) and IC RSS 210 A8.5 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

10.3 - Test Data

	Channel low	Channel middle	Channel high
Fundamental	3.1	3.0	2.9
2nd Harmonic	-55.7	-55.7	-56.3
3rd Harmonic	-54.1	-52.4	-51.6
4th Harmonic	-58.1	-57.2	-58.9
5th Harmonic	-68.8	-69.1	-69.1
6th Harmonic	-61.3	-62.2	-68.9
7th Harmonic	Note 2	Note 2	Note 2
8th Harmonic	Note 2	Note 2	Note 2
9th Harmonic	Note 2	Note 2	Note 2
10th Harmonic	Note 2	Note 2	Note 2

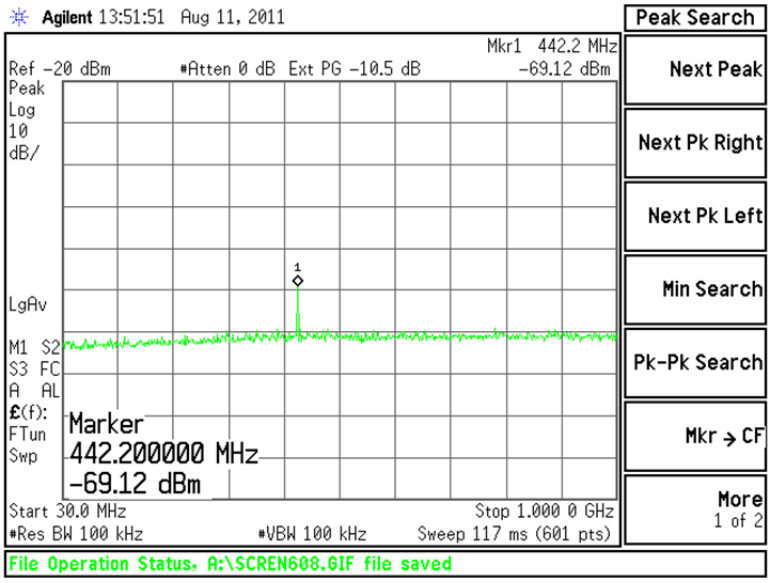
Note:
1. **All reported data are in dBm**.
2. **Spurious emission buried within system noise floor**.

The table below lists other notable spurious emissions other than the harmonics.

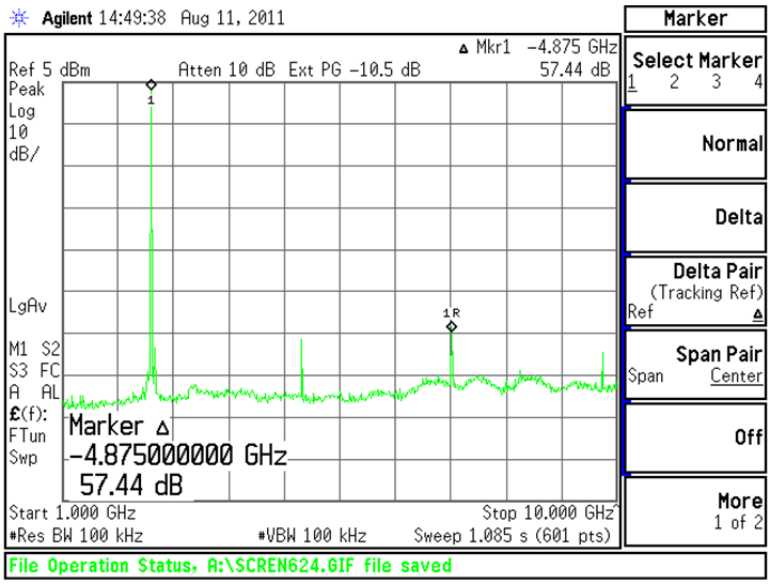
Freq(MHz)	Channel	level(dBm)
442.20	LOW	-69.1
4806.05	LOW	-67.4
9612.07	LOW	-64.4
4958.05	HIGH	-65.4
9916.07	HIGH	-63.7
4882.05	MIDDLE	-69.1
9764.08	MIDDLE	-64.6
479.40	MIDDLE	-73.4

10.4 – Screen Captures – Spurious Radiated Emissions

30 MHz to 1000 MHz



1000 MHZ to 10000 MHz



10000 MHZ to 25000 MHz

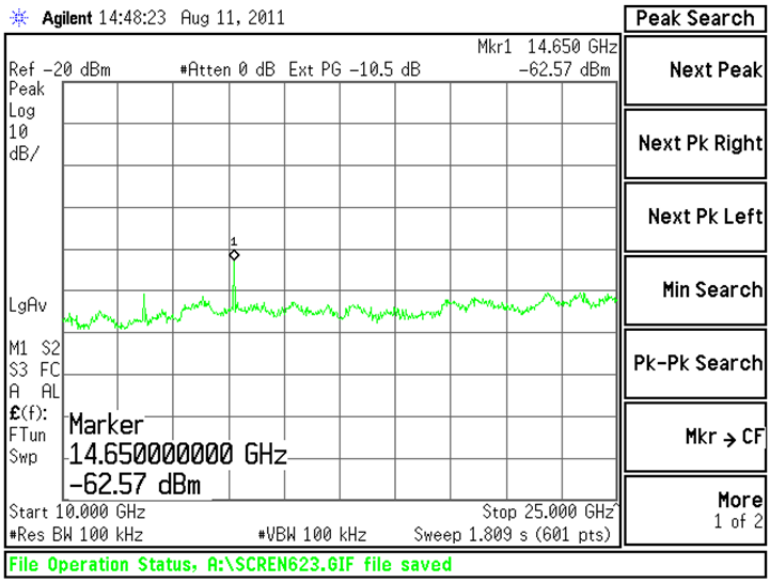


EXHIBIT 11. POWER SPECTRAL DENSITIES: 15.247(e)

11.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

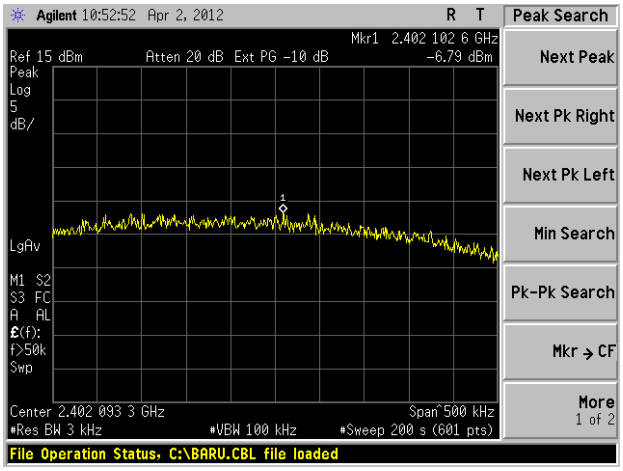
In accordance with FCC Part 15.247(e) and RSS 210 A8.2(b), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed. The highest density was found to be no greater than -6.7 dBm, which is under the allowable limit by 14.7 dB.

11.2 Test Data

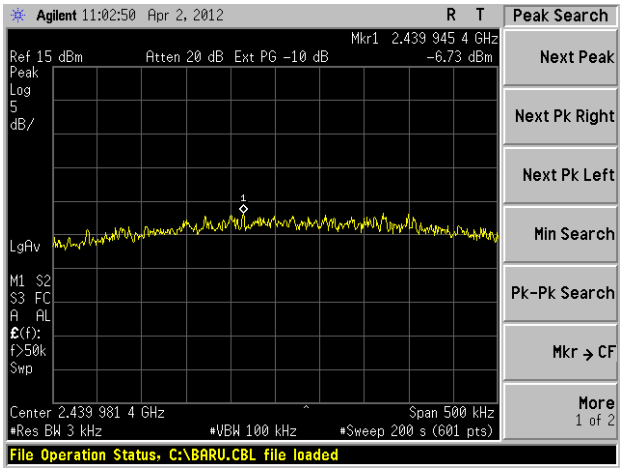
Transmitter Channel	Frequency (MHz)	RF Power Level In 1Hz BW (dBm/Hz)	RF Power Level In 3kHz BW (dBm/3kHz)	Limit (dBm/3 kHz)	Margin (dB)
Low	2402.0	N/A	-6.8	8.0	14.8
Middle	2440.0	N/A	-6.7	8.0	14.7
High	2480.0	N/A	-7.1	8.0	15.1

11.4 Screen Captures – Power Spectral Density

Low Channel



Middle Channel



High Channel

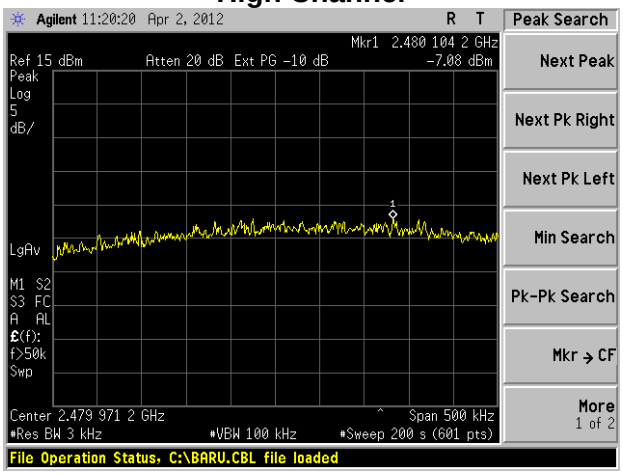


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

Test Engineer(s): Khairul Aidi Zainal

The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied ±15% from the nominal.

2.55		3.0		3.45	
Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)
5.3	2402019455	**5.3**	2402018972	**5.3**	2402018405
5.2	2440019300	**5.0**	2440018440	**5.1**	2440019140
4.9	2480020867	**4.9**	2480018650	**4.9**	2480017666

Channel	max	min	freq drift (Hz)
LOW	2402019455	2402018405	1050
MID	2440019300	2440018440	860
HIGH	2480020867	2480017666	3201

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.

EXHIBIT 13. MPE CALCULATIONS

The following MPE calculations are based on a measured conducted RF power of +5.3 dBm as presented to the antenna. The peak gain of this antenna, based on the data sheet is 0.5 dBi.

Prediction of MPE limit at a given distance

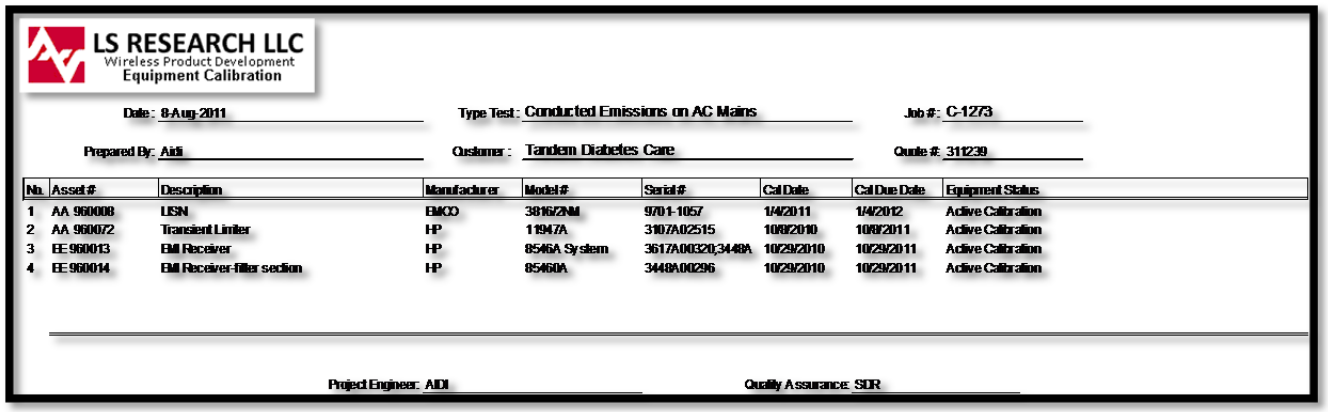
Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	5.30	(dBm)
Maximum peak output power at antenna input terminal:	3.388	(mW)
Antenna gain(typical):	0.5	(dBi)
Maximum antenna gain:	1.122	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2405	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.000756	(mW/cm^2)
Maximum allowable antenna gain:	31.7	(dBi)
Margin of Compliance at 20 cm =	31.2	dB

APPENDIX A – Test Equipment List



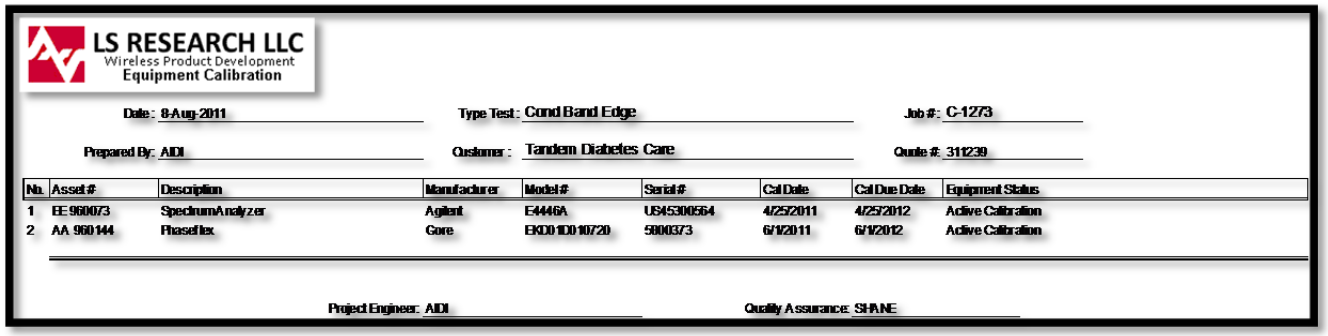
LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Conducted Emissions on AC Mains Job #: C-1273

Prepared By: Aidi Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960008	LISN	EMCO	3816/2NM	9701-1057	1/4/2011	1/4/2012	Active Calibration
2	AA 960072	Transient Limiter	HP	11947A	3107A02515	10/8/2010	10/8/2011	Active Calibration
3	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	10/29/2010	10/29/2011	Active Calibration
4	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	10/29/2010	10/29/2011	Active Calibration

Project Engineer: AIDI Quality Assurance: SDR



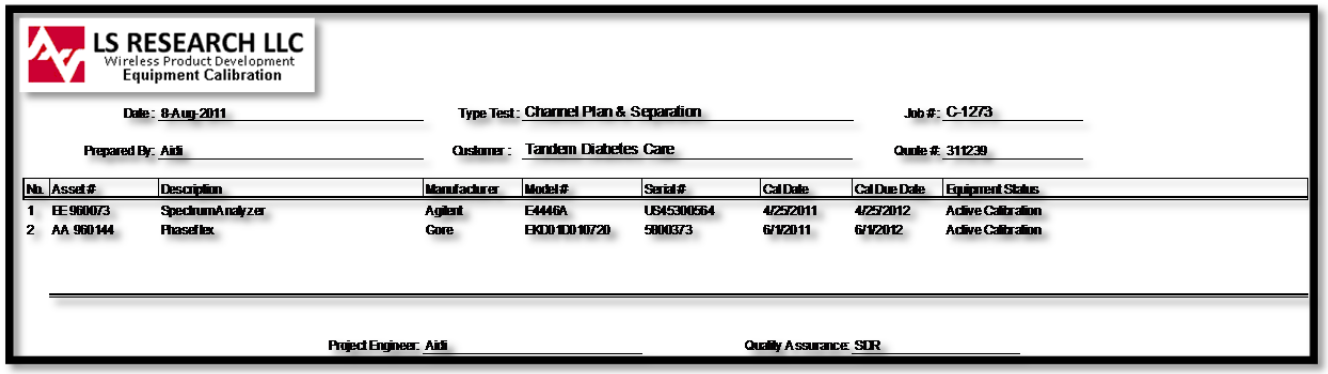
LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Cond Band Edge Job #: C-1273

Prepared By: AIDI Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: AIDI Quality Assurance: SHANE



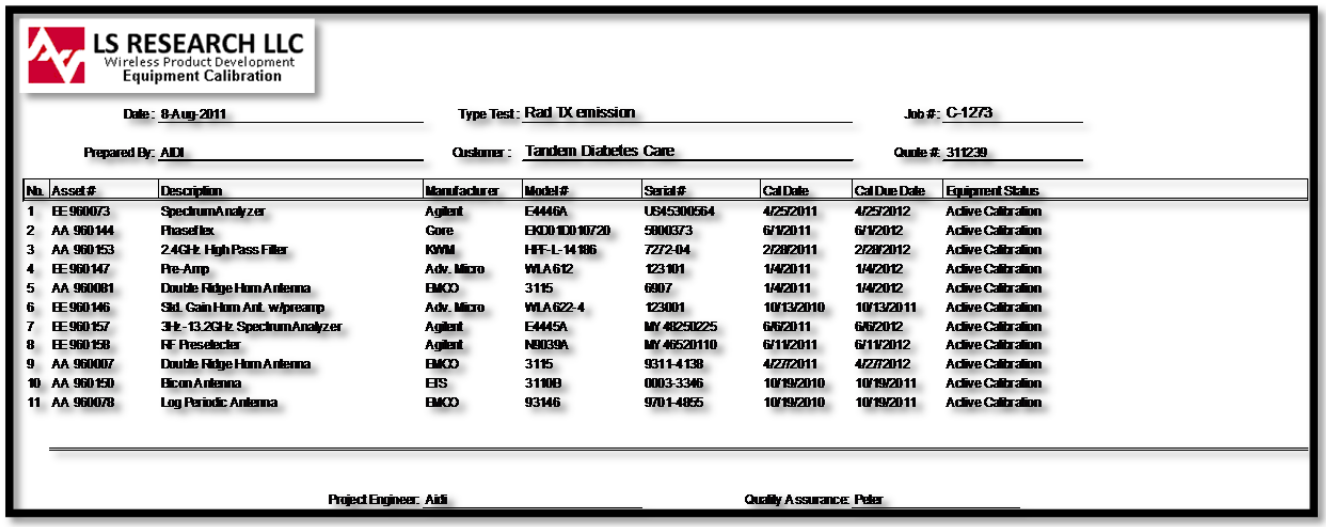
LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Channel Plan & Separation Job #: C-1273

Prepared By: Aidi Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: Aidi Quality Assurance: SDR



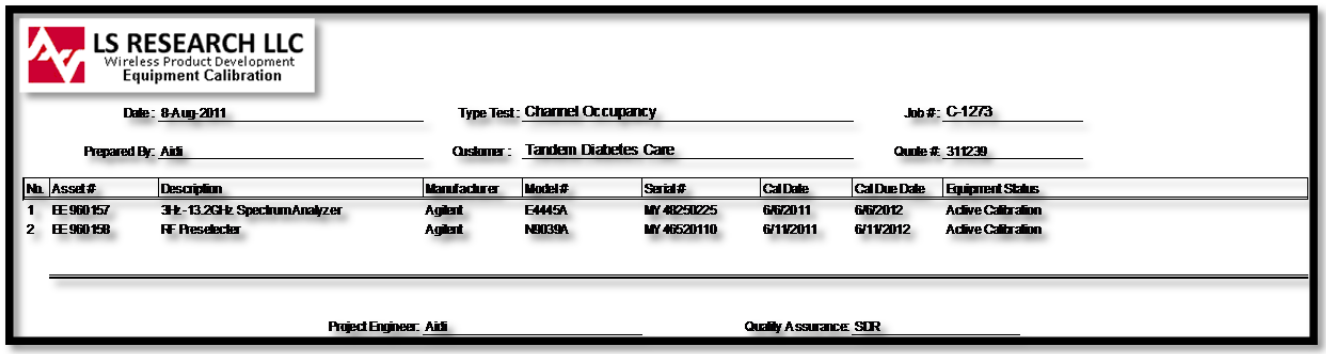
LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Rad TX emission Job #: C-1273

Prepared By: AIDI Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration
3	AA 960153	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-04	2/28/2011	2/28/2012	Active Calibration
4	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	1/4/2011	1/4/2012	Active Calibration
5	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/4/2011	1/4/2012	Active Calibration
6	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro	WLA622-4	123001	10/13/2010	10/13/2011	Active Calibration
7	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY 48250225	6/6/2011	6/6/2012	Active Calibration
8	EE 960158	RF Preselecter	Agilent	N9039A	MY 46520110	6/11/2011	6/11/2012	Active Calibration
9	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	4/27/2011	4/27/2012	Active Calibration
10	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	10/19/2010	10/19/2011	Active Calibration
11	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/19/2010	10/19/2011	Active Calibration

Project Engineer: Aidi Quality Assurance: Peter



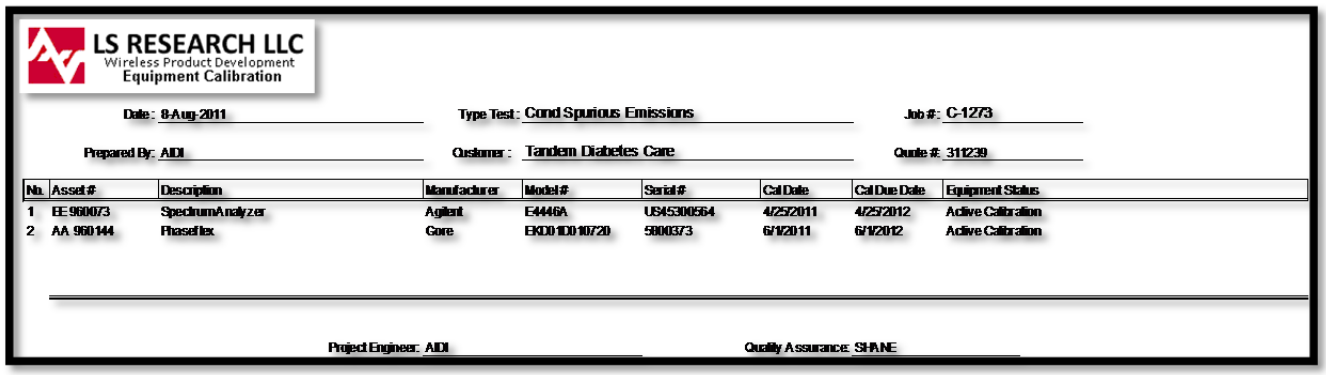
LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Channel Occupancy Job #: C-1273

Prepared By: Aidi Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY 48250225	6/6/2011	6/6/2012	Active Calibration
2	EE 960158	RF Preselecter	Agilent	N9039A	MY 46520110	6/11/2011	6/11/2012	Active Calibration

Project Engineer: Aidi Quality Assurance: SDR



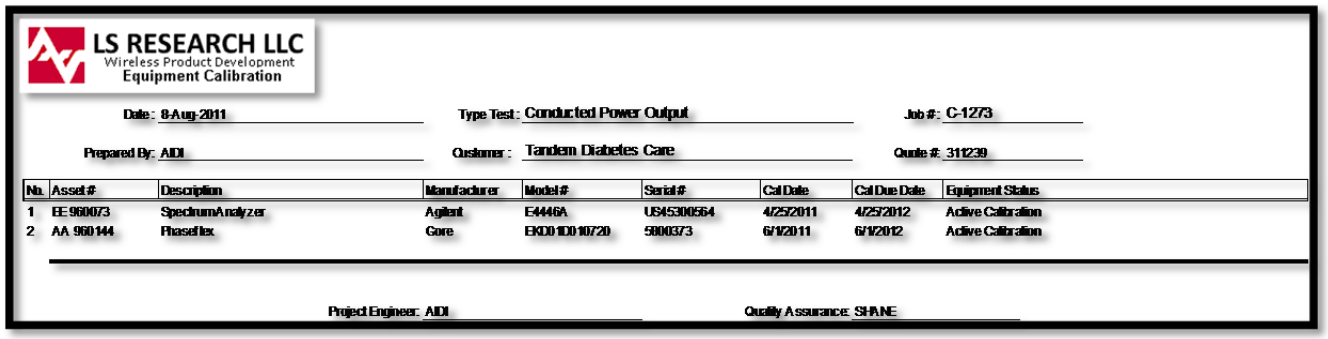
LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Cond Spurious Emissions Job #: C-1273

Prepared By: AIDI Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: AIDI Quality Assurance: SHANE



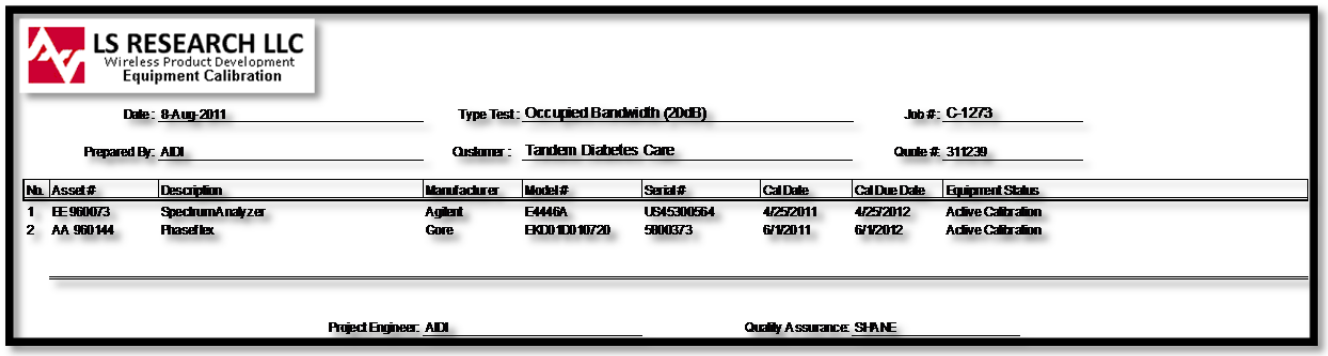
LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Conducted Power Output Job #: C-1273

Prepared By: AIDI Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: AIDI Quality Assurance: SHANE



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 8-Aug-2011 Type Test: Occupied Bandwidth (20dB) Job #: C-1273

Prepared By: AIDI Customer: Tandem Diabetes Care Quote #: 311239

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: AIDI Quality Assurance: SHANE

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2009		
RSS GEN	2010		
RSS 210	2010		

APPENDIX C - Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V