LSR a Laird Business
ACCREDITED
TESTING CERT #1255.01
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TEST REPORT # 316153
LSR Job #: C-2462

Compliance Testing of:
Valve Box

Test Date(s):
6/20/16 – 7/13/16

Prepared For:
Attn: Jeffrey Barnum
Select Comfort Corporation
9800 59th Avenue North
Minneapolis, MN 55442

This Test Report is issued under the Authority of:
Shane Dock, EMC Engineer

Signature: Date: 7/21/16

Test Report Reviewed by:	**Project Engineer:**
Khairul Aidi Zainal, Engineering Manager – Test Services	Shane Dock, EMC Engineer
Signature: Date: 7/21/16	Signature: Date: 7/21/16

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 RSS GEN issue 4 and RSS 247
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15.
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	FCC KDB 558074 D01 DTS Measurement Guidance v03r05 ANSI C63.10 ANSI C63.4
Environmental Classification:	Residential

1.2 – Normative References

Publication	Year	Title
FCC CFR Parts 0-15	2016	Code of Federal Regulations – Telecommunications
ANSI C63.4	2014	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.
ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Measurement Guidance v03r05	2016	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §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.a2la2.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:	Select Comfort Corporation
Address:	9800 59th Avenue North Minneapolis, MN 55442
Contact Name:	Jeffrey Barnum

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	Valve Box
Model Number:	SIQIT02SE00
Serial Number:	Engineering Sample

2.3 - Associated Antenna Description

The BLE antenna is a PCB Printed PIFA antenna. It has a gain of 5.30 dBi.

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2400MHz – 2483.5MHz
Type of Modulation	GFSK (BLE)
Transmitter Spurious (worst case) at 3 meters	40.5 dBuV/m (average)/ 46.4 dBuV/m (peak) at 4804 MHz
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	NXP k20
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	PCB Printed PIFA (BLE)
Gain	5.3 dBi (BLE)
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.247
Modular Filing	☐ Yes ☒ No

	BLE
Maximum Conducted Output Power (dBm)	-0.26
Maximum Conducted Output Power (watts)	0.001
Minimum Conducted Output Power (dBm)	-0.940
Minimum Conducted Output Power (watts)	0.001
99% BW (MHz)	1.063
6 dB Bandwidth (MHz)	0.7096

2.5 - Product Description

OPERATIONAL DESCRIPTION

1. Overview

The control unit adjusts the pressure in a Select Comfort it™ Mattress in response to commands from a Bluetooth Low Energy device or through the USB connection. The it™ Mattress system is managed through two assemblies, one that houses the power supply along with the sleep expert diagnostic hardware (referred to as the "PS or power supply box"), the other houses valves for pressure adjustment and a Bluetooth radio (referred to as the "VB or valve box"). A microcontroller manages all control functions and communications to the identified interfaces. The valve box control board will be equipped with two pressure sensors for a dual chamber mattress system. The valve box control board can operate both valves simultaneously, one for each mattress chamber. A Sleep Expert circuit board is consolidated in the power supply circuit board and is used to analyze pressure changes in real time and connect to the cloud via WiFi.

2. Operational Details

The valve box control board is a 24V powered device that operates a BT radio at a frequency of 2.4 GHz and supports both USB and serial UART wired interfaces. The onboard microcontroller communicates over a UART channel to a Texas Instruments CC2541 programmable Bluetooth 4.0 compliant radio.

- The Texas Instruments CC2541 radio supports 2 Mbps Gaussian Frequency Shift Keying (GFSK) data in 2MHz channels between the frequency range of 2.402 GHz and 2.480 GHz. The over-the-air frequency is generated with a phase-locked loop from a 32MHz crystal. The CC2541 radio chip operates under the Bluetooth 4.0 protocol and a board etched Omni-directional meandered PCB Printed PIFA antenna creates a gain of approximately 5.3 dBi.

The sleep expert portion of the circuit board is a USB powered device that operates on frequencies between 2.412 GHz and 2.462 GHz. The onboard microcontroller communicates over an SDIO channel to a TI WLink8 Module WiFi module operating in WiFi mode only. This radio module supports up to 72Mbps under the 802.11 b/g/n protocol. The over-the-air frequency is generated within the WiLink 8 module and transmitted to the TDK WLAN ceramic chip antenna creating a gain of approximately 2.27 dBi peak.

The EUT was programmed with calibrator commands via Putty. For the EUT, the BLE channels represent low, mid, and high as 2402 MHz, 2440 MHz, and 2480 MHz.
Sample Command:

Low Channel Transmit
>ble fcc 4
Mid Channel Transmit
>ble fcc 5
High Channel Transmit
>ble fcc 6

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70 -74° F
Humidity:	30-42%
Pressure:	728-741mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247 (a)(1)	99% Bandwidth	Yes
FCC : 15.247(b) & 1.1310	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
FCC :15.247(d)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC:15.247 (d)	Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes

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.

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.

LSR, 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. UNWANTED EMISSIONS INTO THE RESTRICTED FREQUENCY BANDS.

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.10-2013. The EUT was placed on a 150 cm high non-conductive pedestal (80 cm for measurements under 1 GHz), 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. The unit has the capability to operate on 3 channels, controllable via proprietary software provided by the manufacturer.

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 to comply with FCC Part 15.31(m).

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 200 MHz, and a Log Periodic Antenna was used to measure emissions from 200 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 25 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. A tilt gear was utilized to keep the EUT within the cone of radiation for measurements above 1 GHz.

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 at least 300 kHz), and a resolution bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of at least 3 MHz). For some plots, a reduced video bandwidth was used in order to identify spurious emissions (The relevant plots are labeled as such). In these cases, the standard video bandwidth was used with the appropriate detectors for measurement.

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 1 for a 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	-
960-40,000	500	54.0	63.5

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

5.6 - Data:

Manufacturer:	BAM Labs						
Date(s) of Test:	6/29/16 – 7/13/16						
Project Engineer(s):	Shane Dock						
Test Engineer(s):	Shane Dock						
Voltage:	120 VAC, 60 Hz						
Operation Mode:	Continuous transmit, modulated						
Environmental Conditions in the Lab:	Temperature: 70-74° F Relative Humidity: 30-42%						
EUT Power:	X	Single Phase 120VAC		3 Phase ___VAC			
		Battery		Other: Bench DC Supply			
EUT Placement:	X	150 cm non-conductive pedestal (80 cm for <1 GHz)		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	

Measurements below 1 GHz:

BLE

Frequency (MHz)	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit A (dBµV/m)	Margin A (dB)	Antenna Polarity	EUT orientation
58.56	100.10	337.00	34.26	40.00	5.74	V	H
35.94	100.00	256.80	34.32	40.00	5.68	V	H
58.98	100.00	280.00	35.65	40.00	4.35	V	H
35.28	100.00	224.20	33.96	40.00	6.04	V	H
395.54	100.00	0.00	32.00	46.00	14.00	H	H
875.78	100.00	137.00	30.82	46.00	15.18	H	H

Emission at 395.54 MHz is not a function of the EUT.

Measurements above 1 GHz:

Note: Table below shows the emissions from each channel in the restricted band in their worst-case orientations.

BLE

Channel	Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
Low	4804	209.85	33.75	46.4	40.5	54.0	13.5	Vertical	Flat
Mid	4880	241.95	43	45.4	38.5	54.0	15.5	Vertical	Flat
High	4960	218.9	179.25	45.7	39.9	54.0	14.1	Vertical	Flat

5.7 – Screen Captures.

The screen captures below are those using the Peak detector of the analyzer. In addition, the screen captures presented are those which were deemed to be an appropriate representation of the spectrum scan.

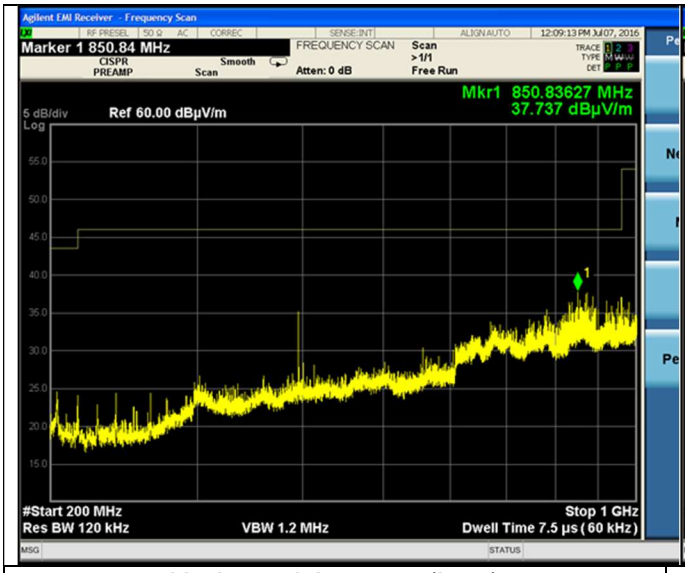
BLE

30 to 200 MHz, 3m distance

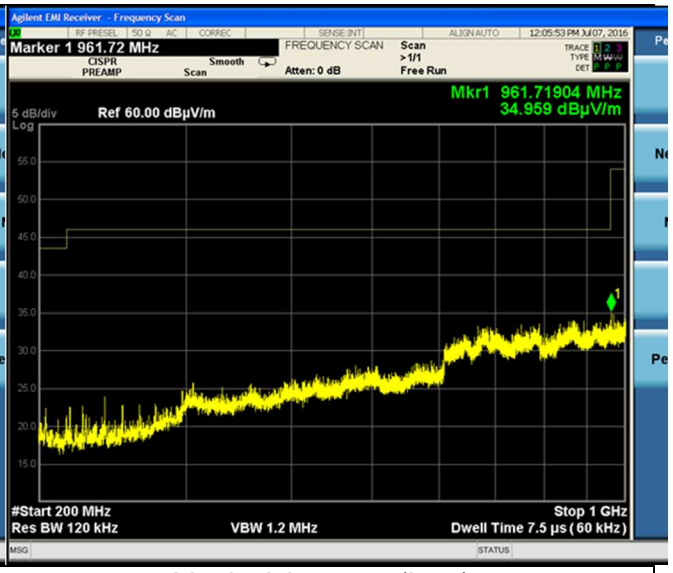
Horizontal Antenna (Low)

Vertical Antenna (Low)

200 to 1000 MHz, 3m distance.

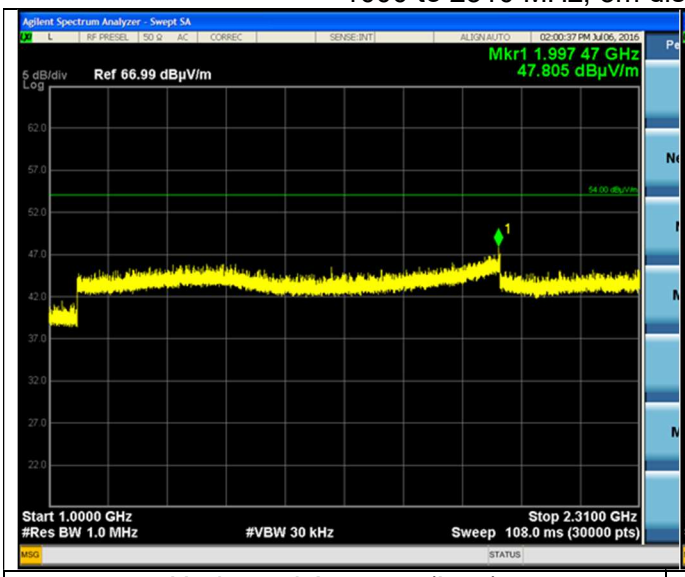


Horizontal Antenna (Low)

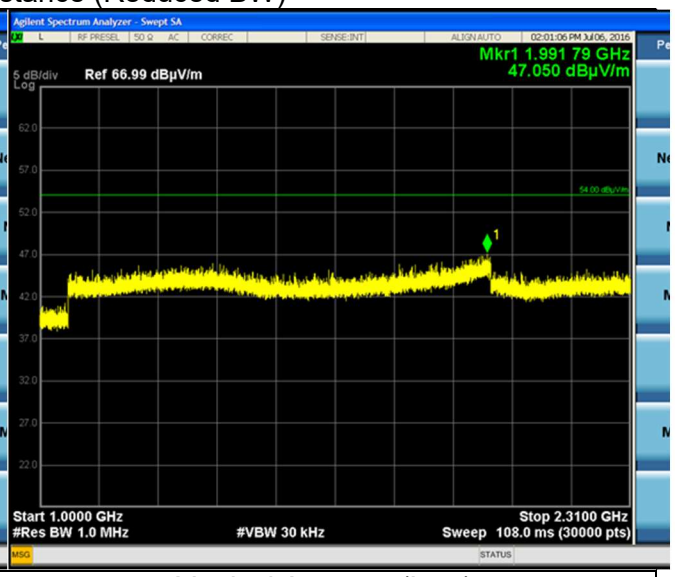


Vertical Antenna (Low)

1000 to 2310 MHz, 3m distance (Reduced BW)



Horizontal Antenna (Low)



Vertical Antenna (Low)

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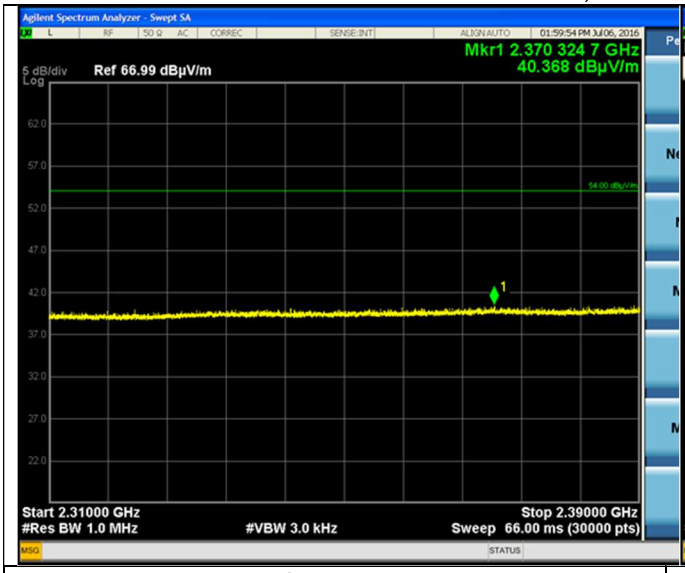
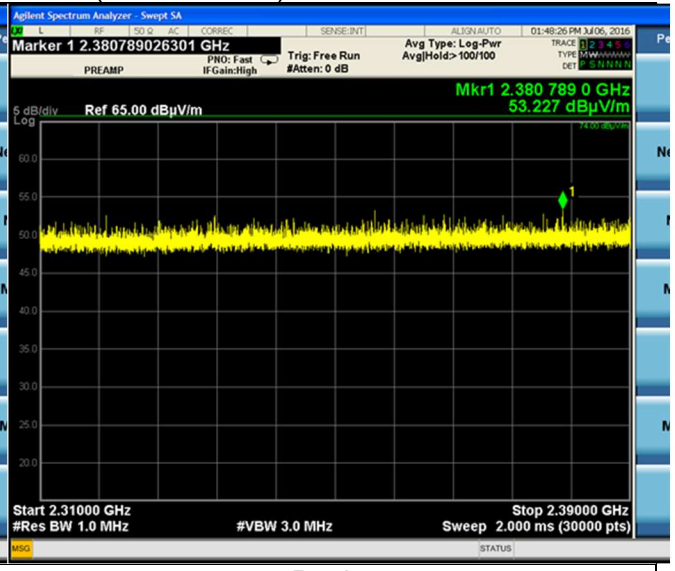
2310 to 2390 MHz, 3m distance (Reduced BW)



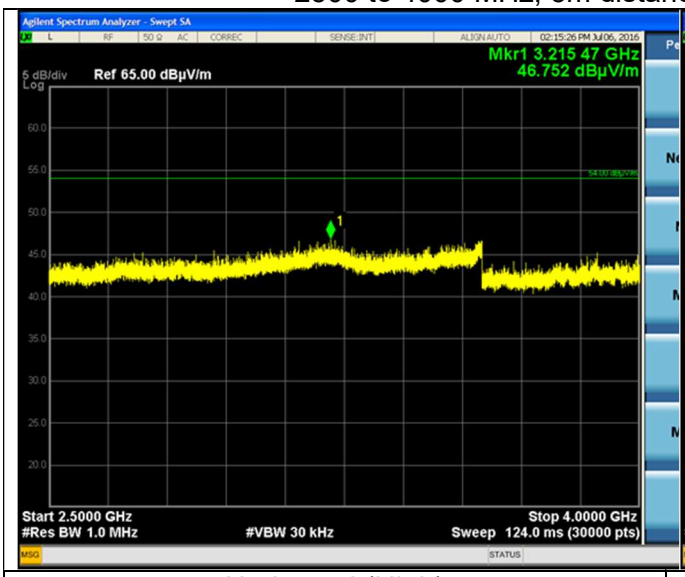
Average



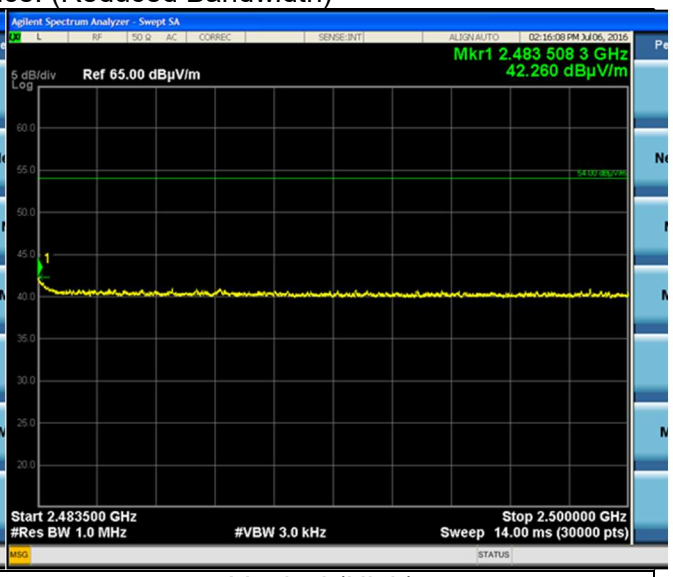
Peak

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

2500 to 4000 MHz, 3m distance. (Reduced Bandwidth)

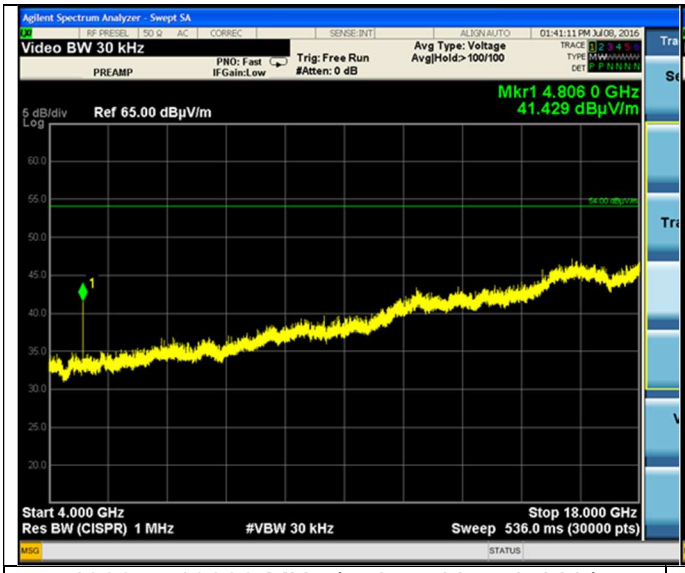


Horizontal (High)

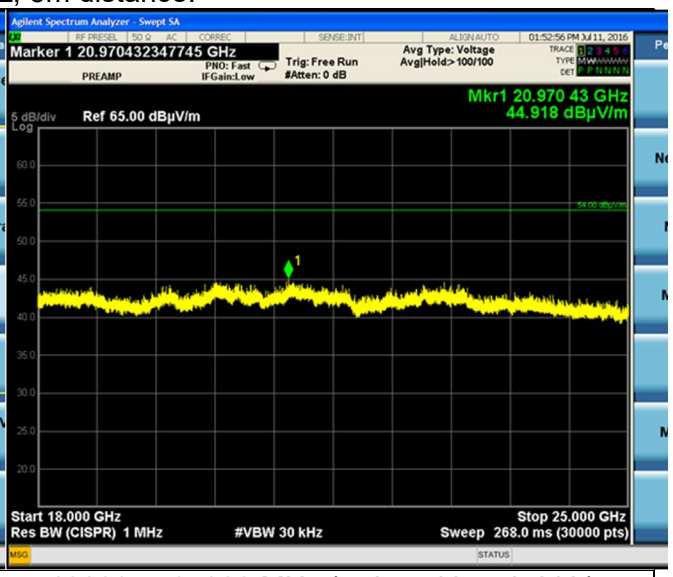


Vertical (High)

4000 to 25000 MHz, 3m distance.



4000 to 18000 MHz (reduced bandwidth)



18000 to 25000 MHz (reduced bandwidth)

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. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The power supply was then plugged into a 50Ω (ohm) 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.

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 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:	Bam Labs					
Date(s) of Test:	7/12/16					
Project Engineer:	Shane Dock					
Test Engineer:	Shane Dock					
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

Note: All points measured below were measured with both radios transmitting on mid channel simultaneously, as this is worst case.

TX		Quasi-Peak			Average		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
0.150	1	52.7	66.0	13.3	40.2	56.0	15.8
0.173	1	49.2	64.8	15.6	35.5	54.8	19.3
0.208	1	45.6	63.3	17.7	33.1	53.3	20.2
0.613	1	40.1	56.0	15.9	30.9	46.0	15.1
25.181	1	36.3	60.0	23.7	30.1	50.0	19.9
0.154	2	51.4	65.8	14.4	31.9	55.8	23.9
0.173	2	48.8	64.8	16.0	27.9	54.8	26.9
0.253	2	41.1	61.6	20.5	24.9	51.6	26.7
0.582	2	37.9	56.0	18.1	30.5	46.0	15.5
25.055	2	37.9	60.0	22.1	31.6	50.0	18.4

6.7 Test Setup Photo(s) – Conducted Emissions Test

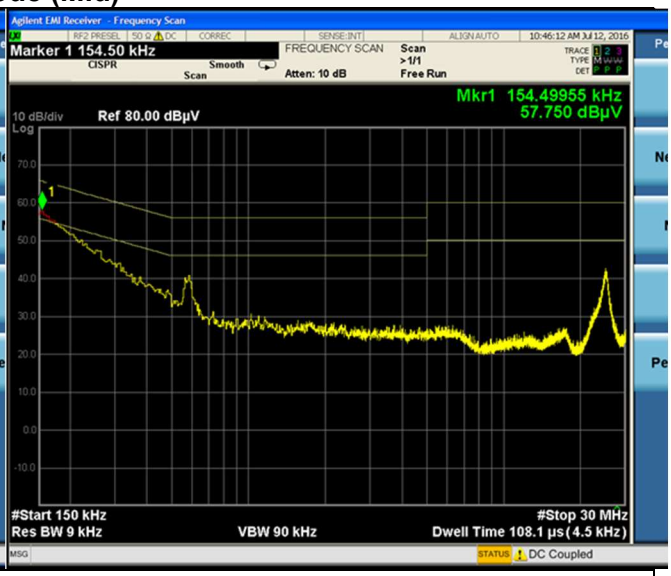
Prepared For: Select Comfort Corporation	Model #: SIQIT02SE00	Report #: 316153
EUT: Valve Box	Serial #: Engineering Sample	LSR Job #: C-2462

6.8 Screen Captures – Conducted Emissions Test

These screen captures represent the worst-case Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized.

Transmit Mode (Mid)

Line 1



Line 2

EXHIBIT 7. OCCUPIED BANDWIDTH

Test Engineer(s): Shane Dock

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

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 20dB/emission bandwidth while the 6dB bandwidth was measured using **FCC OET KDB 558074 section 8 option 2.**

7.3 - Test Data

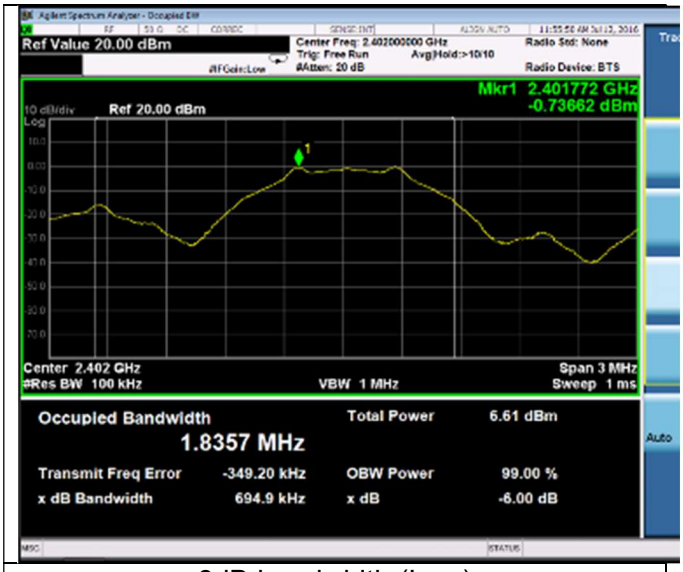
BLE

Channel	6 db BW (kHz)	99% BW (kHz)
Low	694.9	1054.9
Mid	697.4	1063.1
High	709.6	1054.2

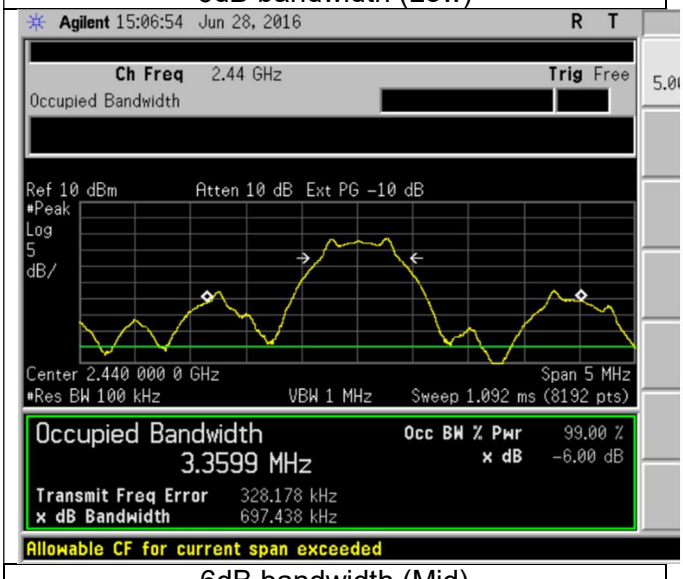
7.4 – Screen Captures

Examples of bandwidth measurements:

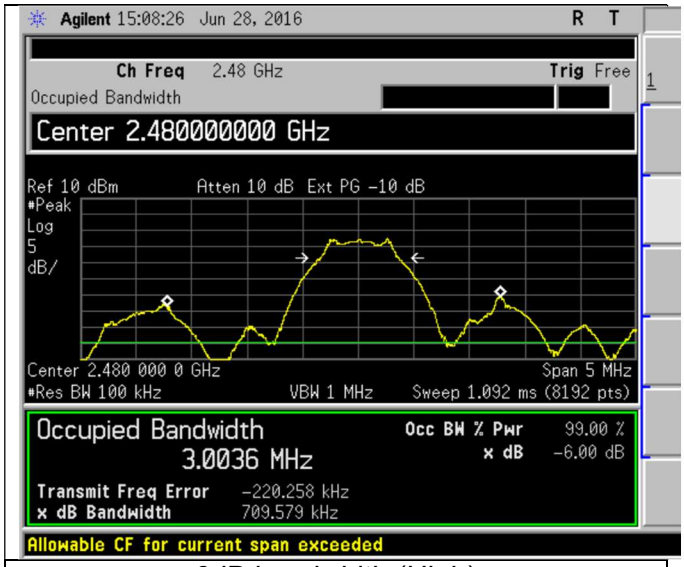
BLE



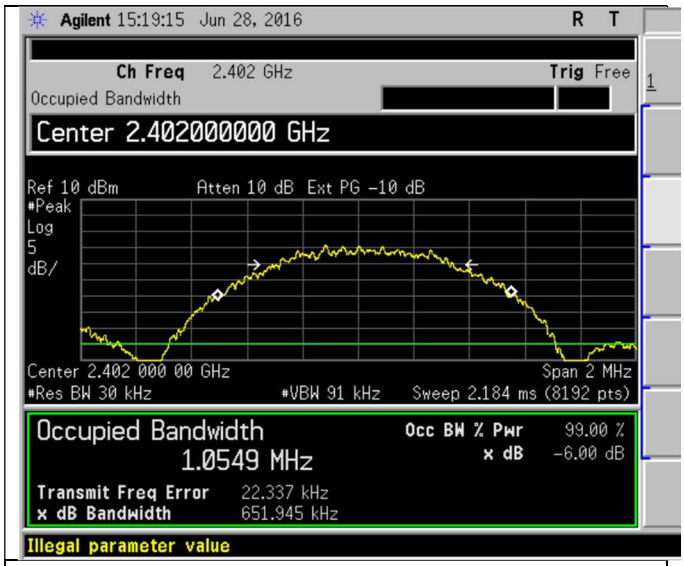
6dB bandwidth (Low)



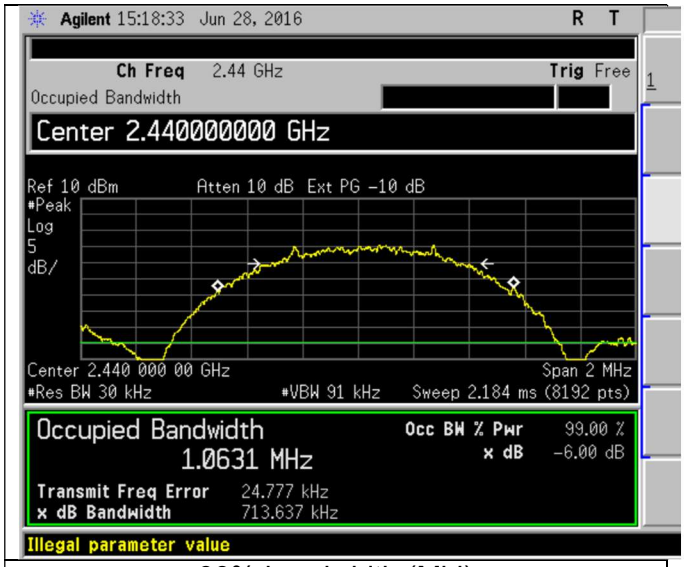
6dB bandwidth (Mid)



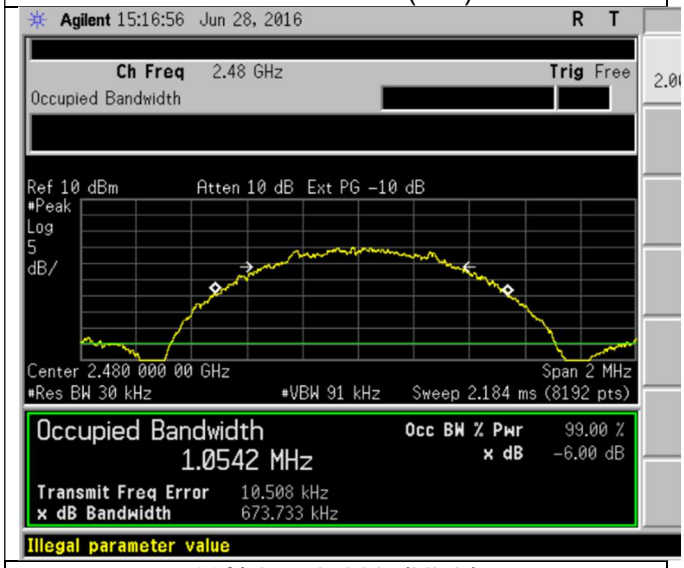
6dB bandwidth (High)



99% bandwidth (Low)



99% bandwidth (Mid)



99% bandwidth (High)

EXHIBIT 8. BAND EDGE MEASUREMENTS

Test Engineer(s): Shane Dock

8.1 - Method of Measurements

FCC 15.247 require a measurement of spurious emission levels at the restricted band to be compliant to the general emissions limit, in particular at the Band-Edges where the intentional radiator operates. 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 (100kHz bandwidth) and radiated. The measurement of band-edge was performed to satisfy FCC 15.247(d).

Per FCC KDB 558074 D01 Measurement Guidance v03r05 (section 11), conducted measurements were performed with 100 kHz bandwidth for all emissions outside of the band of operation. Emissions in the restricted band, a bandwidth of 120kHz (below 1000MHz) and 1MHz (above 1000MHz) were used in accordance with C63.4 and was performed radiated.

For both conducted and radiated measurements, correction factors and the cable loss factors were entered into the EMI Receiver database. **As a result, the plots taken from the EMI Receiver accounts for all applicable correction factor as well as cable loss, and can therefore be entered into the database as a corrected meter reading.**

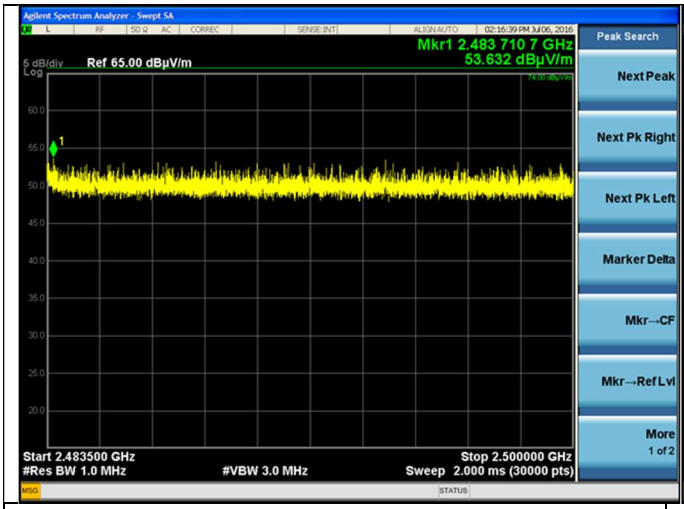
8.2. Band edge screen captures.

The data presented below are samples selected from the various data rates and channels tested.

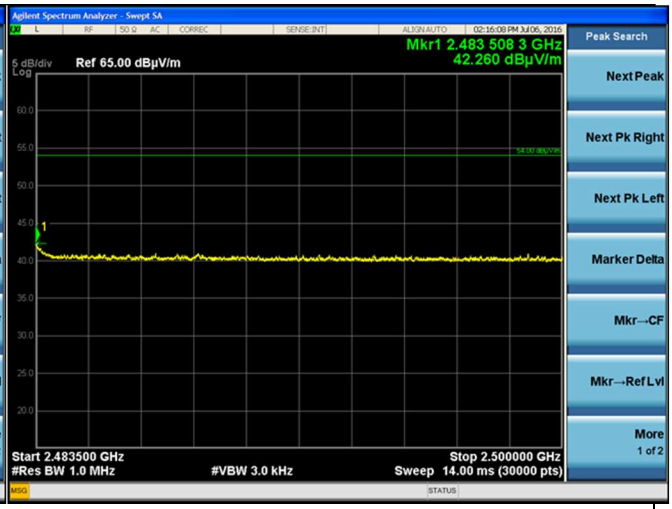
Band-edge in Restricted Band-

Radiated Band-edge in Restricted Band:

2483.5 to 2500 MHz Restricted band
BLE



Upper band edge Peak (High)

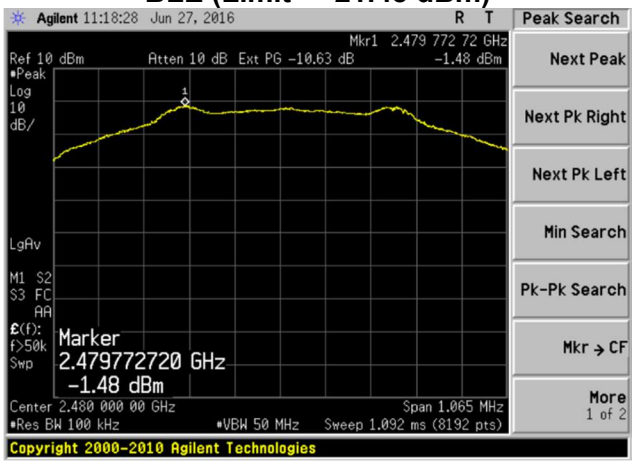


Upper band edge Average (High)

Conducted Band Edge Reference Picture

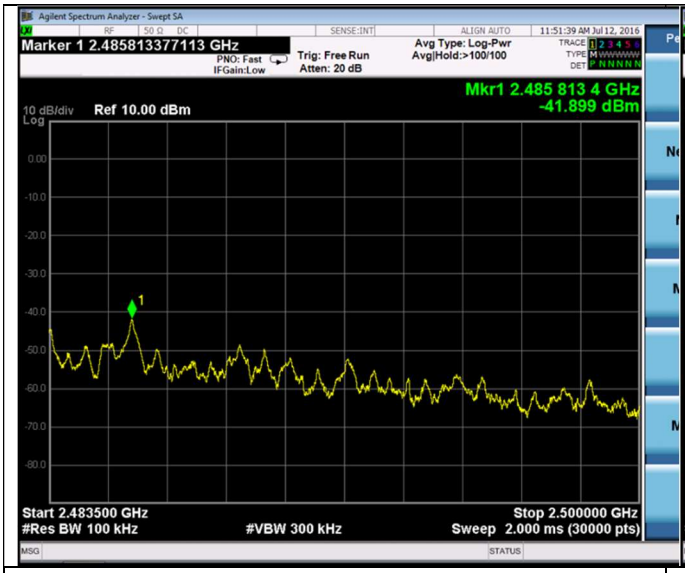
Refer to picture below for reference point for emissions. Display lines on spurious pictures do not represent limit line.

BLE (Limit = -21.48 dBm)

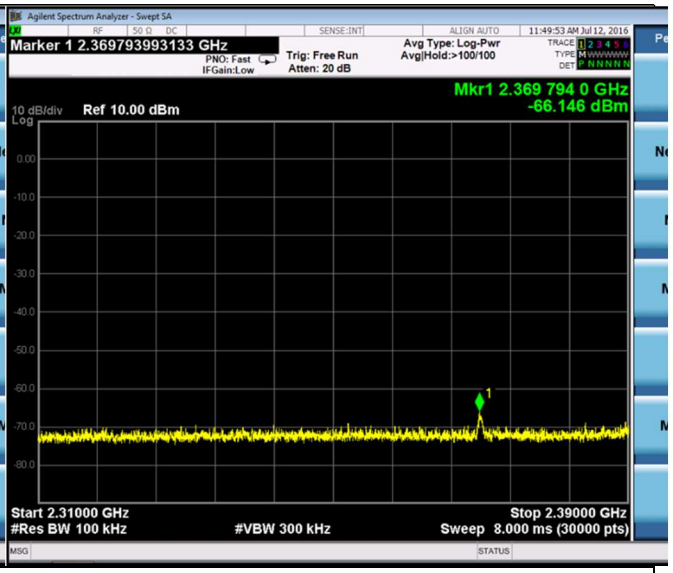


Band-edge in 100kHz bandwidth (Conducted Band Edge)

BLE



Upper band-edge (High)



Lower band-edge (Low)

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

Test Engineer(s): Shane Dock

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.

Measurement procedure used was FCC OET KDB 558074 D01 Measurement Guidance v03r05 section 9.1.1 for BLE.

9.2 - Test Data

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 (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

9.2.1. Maximum conducted peak power:

Maximum conducted (peak) output power (BLE): (Sample Screenshot below)

Channel	Peak Pout (dBm)
Low	-0.26
Mid	-0.57
High	-0.94

Mid Channel Pout

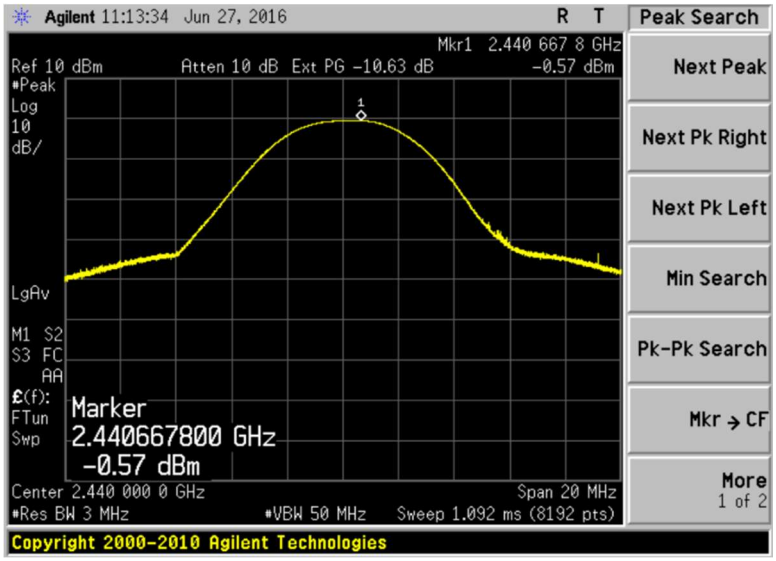


EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

Test Engineer(s): Shane Dock

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 247 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.

Measurement procedure used was FCC OET KDB 558074 D01 Measurement Guidance v03r05 section 11.

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

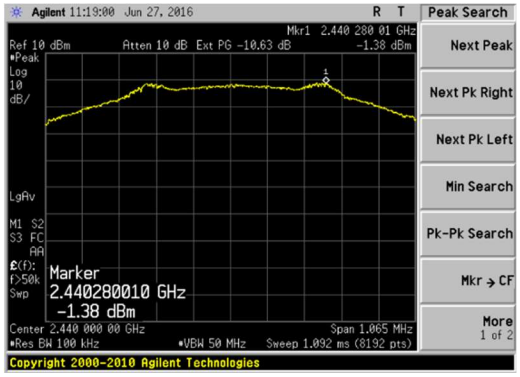
Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

10.3 - Test Data

BLE Mid Channel fundamental in 100 kHz:



Limit = -21.38 dBm

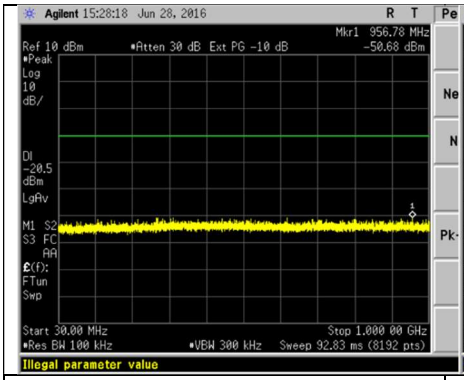
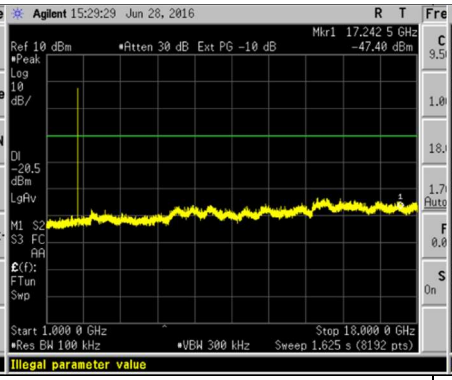
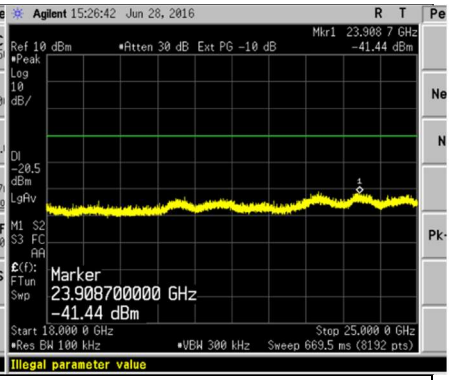
		
30 to 1000 MHz	1000 to 18000 MHz	18000 to 25000 MHz

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 247, 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.

Measurement procedure used was FCC OET KDB 558074 D01 Measurement Guidance v03r05 section 10.2 for BLE.

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 (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

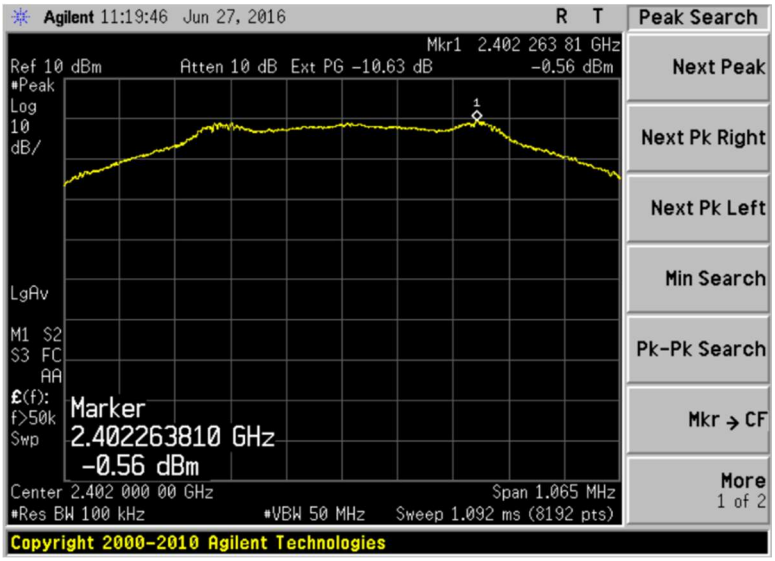
11.2 Test Data

BLE

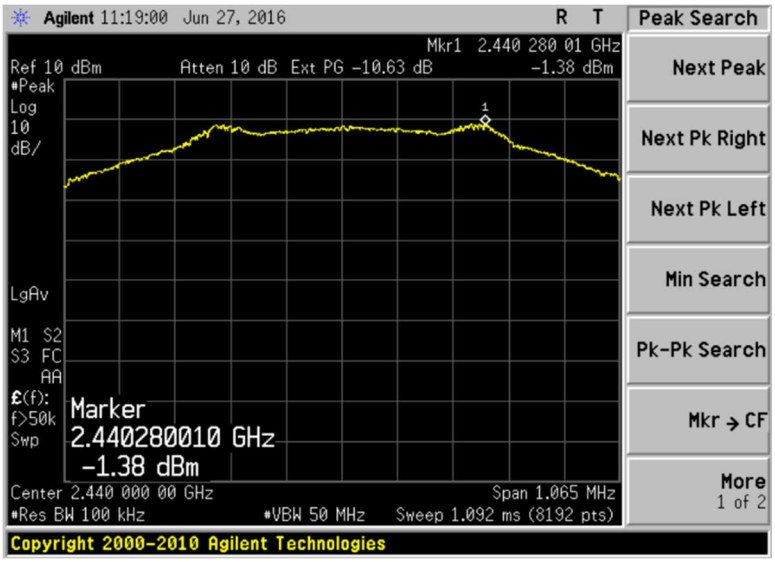
Channel	PSD (dBm)
Low	-0.56
Mid	-1.38
High	-1.48

11.3 Screen Captures – Power Spectral Density

BLE
Low



Mid



High

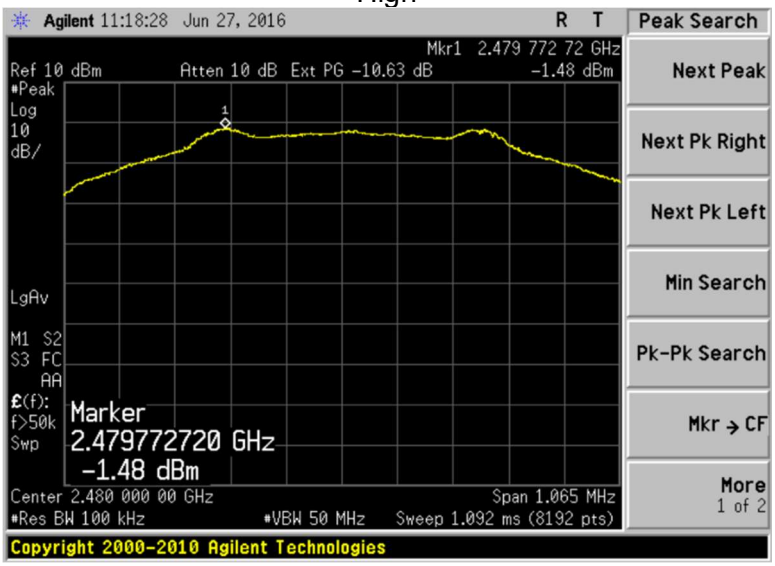

Agilent 11:18:28 Jun 27, 2016
R T
Peak Search
Mkr1 2.479 772 72 GHz
Ref 10 dBm
Atten 10 dB Ext PG -10.63 dB
-1.48 dBm
Next Peak
#Peak
Log
10
dB/
Next Pk Right
Next Pk Left
Min Search
LgAv
M1 S2
S3 FC
AA
Pk-Pk Search
£(f):
f>50k
Swp
Marker
2.479772720 GHz
-1.48 dBm
Mkr → CF
More
1 of 2
Center 2.480 000 00 GHz
Span 1.065 MHz
#Res BW 100 kHz
#VBW 50 MHz
Sweep 1.092 ms (8192 pts)
Copyright 2000-2010 Agilent Technologies

EXHIBIT 12. FREQUENCY STABILITY OVER VOLTAGE VARIATIONS

Test Engineer(s): Shane Dock

The 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 RF output 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.

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. The stability was found to be better than the 100 ppm threshold.

BLE

Voltage (V)	20.4	24	27.6
Channel	Frequency (MHz)		
Low	2402.0124	2402.0319	2402.0176
Mid	2440.0396	2440.0424	2440.0333
High	2480.0402	2480.0346	2480.0179

APPENDIX A – Test Equipment List

LSR
a Laird Business

Date : 17-May-2016 Type Test : Conducted Radio Measurements Job # : C-2462

Prepared By: Shane Dock Customer : Bam Labs Quote #: 316153

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/26/2015	6/26/2017	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	10/25/2015	10/25/2016	Active Calibration
3	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/24/2017	Active Calibration
4	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration
5	EE 960087	44GHz EXA Spectrum Analyzer	Agilent	N9010A	MY53400296	12/18/2015	12/18/2016	Active Calibration
6	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	Verification	Verification	System

LSR
a Laird Business

Date : 17-May-2016 Type Test : Radiated Emissions Job # : C-2462

Prepared By: Shane Dock Customer : Bam Labs Quote #: 316153

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/24/2017	Active Calibration
2	AA 960005	Biconical Antenna	EMCO	93110B	9601-2280	1/14/2016	1/14/2017	Active Calibration
3	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	3/31/2016	3/31/2017	Active Calibration
4	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration
5	AA 960153	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-04	4/29/2016	4/29/2017	Active Calibration
6	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	2/4/2016	2/4/2017	Active Calibration
7	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	40201429	2/4/2016	2/4/2017	Active Calibration
8	AA 960171	Cable - low loss 1m	A.H. Systems, Inc.	SAC-26G-6	386	3/31/2016	3/31/2017	Active Calibration
9	AA 960174	Small Horn Antenna 18-40 GHz	ETS-Lindgren	3116C-PA	00206880	4/23/2016	4/23/2017	Active Calibration

Project Engineer: Shane Dock Quality Assurance:

LSR
a Laird Business

Date : 17-May-2016 Type Test : Conducted AC Emissions Job # : C-2462

Prepared By: Shane Dock Customer : Bam Labs Quote #: 316153

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960089	LISN - 15A	COM-POWER	LI-215A	191943	3/8/2016	3/8/2017	Active Calibration
2	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/24/2017	Active Calibration

Project Engineer: Shane Dock Quality Assurance:

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2014		
ANSI C63.10	2013		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2016		

APPENDIX C - Uncertainty Statement

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

Measurement Type	*Particular Configuration*	*Uncertainty Values*
Radiated Emissions	*3 – Meter chamber, Biconical Antenna*	*4.82 dB*
Radiated Emissions	*3-Meter Chamber, Log Periodic Antenna*	*4.88 dB*
Radiated Emissions	*3-Meter Chamber, Horn Antenna*	*4.85 dB*
Radiated Emissions	*10-Meter OATS, Biconical Antenna*	*4.32 dB*
Radiated Emissions	*10-Meter OATS, Log Periodic Antenna*	*3.63 dB*
Absolute Conducted Emissions	*Agilent PSA/ESA Series*	*1.38 dB*
AC Line Conducted Emissions	*Shielded Room/EMCO LISN*	*3.20 dB*
Radiated Immunity	*3 Volts/Meter in 3-Meter Chamber*	*2.05 Volts/Meter*
Conducted Immunity	*3 Volts level*	*2.33 V*
EFT Burst, Surge, VDI	*230 VAC*	*54.4 V*
ESD Immunity	*Discharge at 15kV*	*3200 V*
Temperature/Humidity	*Thermo-hygrometer*	*0.64° / 2.88 %RH*