



Test Report

Prepared for: Haven Lock Inc.

Model: HL2-FOB-001

Description: Bluetooth Connected Smart Lock Key Fob

Serial Number: N/A

FCC ID: 2ARFQHL2FOB001
IC: 24389-HL2FOB001

To

FCC Part 15.247
and
IC RSS-247 Issue 2

Date of Issue: November 12, 2018

On the behalf of the applicant:

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Attention of:

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Poona Saber
Project Test Engineer

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All results contained herein relate only to the sample tested.



Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	October 30, 2018	Poona Saber	Original Document



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ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.

Testing Certificate Number: **2152.01**



FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.



Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (°C)	Humidity (%)	Pressure (mbar)
23.3	28.9	967

EUT Description

Model: HL2-FOB-001

Description: Bluetooth Connected Smart Lock Key Fob

Firmware: N/A

Software: N/A

Serial Number: N/A

Additional Information:

EUT is a battery operated key Fob using BLE technology to connect with Haven lock product at the frequency range of 2402-2480 MHz. The HFY board inside of the FOB is tested at low, mid and high frequencies and controlled through an interface UART PCB board plus a Jlink debugger with adapter to control the channels and power setting.

EUT Operation during Tests

EUT is put at modulated continuous transmit mode at low, mid and high channels. It has a SMA connector to facilitate conducted testing. The highest gain of the Chip Antenna on the board is 2.5 dBi.



Accessories:

Qty	Description	Manufacturer	Model	S/N
1	USB 12V AC adapter	PHIHONG	PSAA05A-050QL6	N/A
1	Laptop	Toshiba	Satellite	N/A
1	Jlink-debugger	Segger	Jlink-Base	N/A
1	Jlink adapter	Segger	CortexM	N/A

Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Ferrite Y/N
2	FPC flat ribbon cable	<1	N	N	N
1	USB-B cable	<1	N	N	N

Modifications: None

15.203: Antenna Requirement:

- The antenna is permanently attached to the EUT
- The antenna uses a unique coupling
- The EUT must be professionally installed
- The antenna requirement does not apply



Test Results Summary

FCC 15.247 Specification	RSS-247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Section 5.4(d)	Peak Output Power	Pass	
15.247(d)	Section 5.5	Conducted Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Radiated Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Emissions At Band Edges	Pass	
15.247(a)(2)	Sections 5.2(a)	Occupied Bandwidth	Pass	
15.247(e)	Section 5.2(b)	Transmitter Power Spectral Density	Pass	
15.207	RSS-GEN Section 8.8	A/C Powerline Conducted Emissions	N/A	Unit is Battery operated

References	Description
CFR47, Part 15, Subpart B	Unintentional Radiators
CFR47, Part 15, Subpart C	Intentional Radiators
ANSI C63.10-2013	American National standard for testing Unlicensed Wireless Devices
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ISO/IEC 17025:2005	General requirements for the Competence of Testing and Calibrations Laboratories
KDB 558074 D01 v04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247



Conducted Output Power

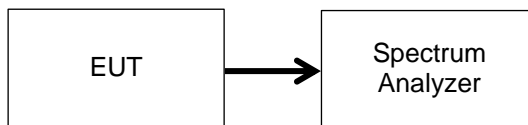
Engineer: Poona Saber

Test Date: 10/30/18

Test Procedure

The EUT was connected directly to spectrum analyzer input through the antenna port. The peak readings were taken and the result was then compared to the limit of 15.247.

Test Setup



Transmitter Output Power

Tuned Frequency (MHz)	Measured Value (dBm)	Specification Limit	Result
2402	2.614	1 W (30 dBm)	Pass
2440	2.419	1 W (30 dBm)	Pass
2480	2.001	1 W (30 dBm)	Pass



Conducted Spurious Emissions in Non-Restricted Frequency Band

Engineer: Poona Saber

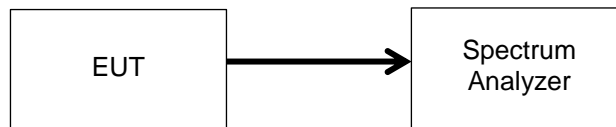
Test Date: 10/30/2018

Test Procedure

The EUT was connected to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions and it was verified for spurious emissions of part 15.247 (d) and the frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed.

If the maximum peak conducted output power procedure was used to determine compliance then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc) which is done by reference level measurements per 11.11.2 of C63.10-2013 and emission level measurement of 11.11.3.

Test Setup



See Annex A for test results



Conducted Spurious Emissions in Restricted Frequency Band

Engineer: Poona Saber

Test Date: 10/30/2018

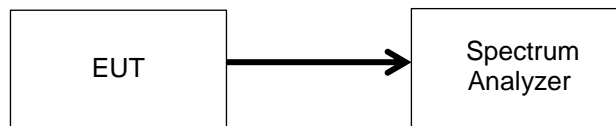
Test Procedure

The EUT was connected to a spectrum analyzer to verify that the EUT met the requirements for general Radiated Emissions limits of 15.209 if emissions fall in 15.205 restricted band of emissions.

All emissions from 30 MHz up to 10th harmonic of the fundamental transmitter were investigated while transmitter was set to transmit at low, mid and high channels.

Procedures of subpart 11.12 and 11.13 were followed for measurements below and above 1 GHz and also the band edges.

Test Setup



See Annex B for test results

Radiated Spurious Emissions out of the cabinet

Engineer: Poona Saber

Test Date: 10/30/18

For these cabinet radiated spurious emission measurements, the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in 6.3, 6.5, and 6.6. All detected emissions shall comply with the applicable requirements.

Test Procedure Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized.

All emissions from 30 MHz to 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

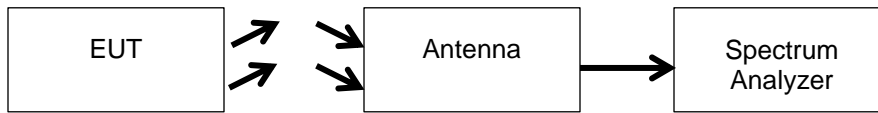
Correction factors were input into the spectrum analyzer before recording “Measured Level”.

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

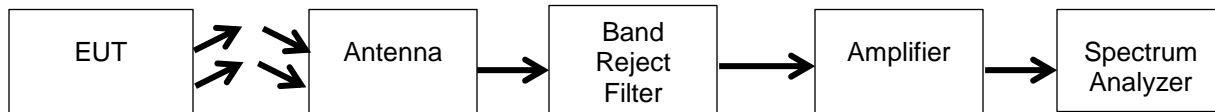
Test Setup



Test Procedure for Radiated Spurious Emissions above 1 GHz

The EUT was tested in a semi anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions. The antenna, band reject filter, amplifier and cable correction factors were input into the spectrum analyzer before recording the Measured Level to ensure accurate readings. The spectrum for each tuned frequency was examined to the 10th harmonic.

Test Setup



Detector Settings	RBW (MHz)	VBW (MHz)	Span
Peak	1	3	As Necessary
Average	1	3	As Necessary

See Annex C for test results



Occupied Bandwidth

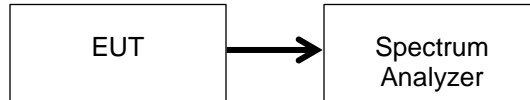
Engineer: Poona Saber

Test Date: 10/30/18

Test Procedure

The EUT was connected directly to a spectrum analyzer. The Span was set wide enough to capture the entire transmit spectrum and the resolution bandwidth was set to at least 1% of the span. The analyzer was set to max hold and when the entire spectrum was captured the 6dB and 99% bandwidths were measured to verify the bandwidth met the specification.

Test Setup



6 dB Occupied Bandwidth Summary

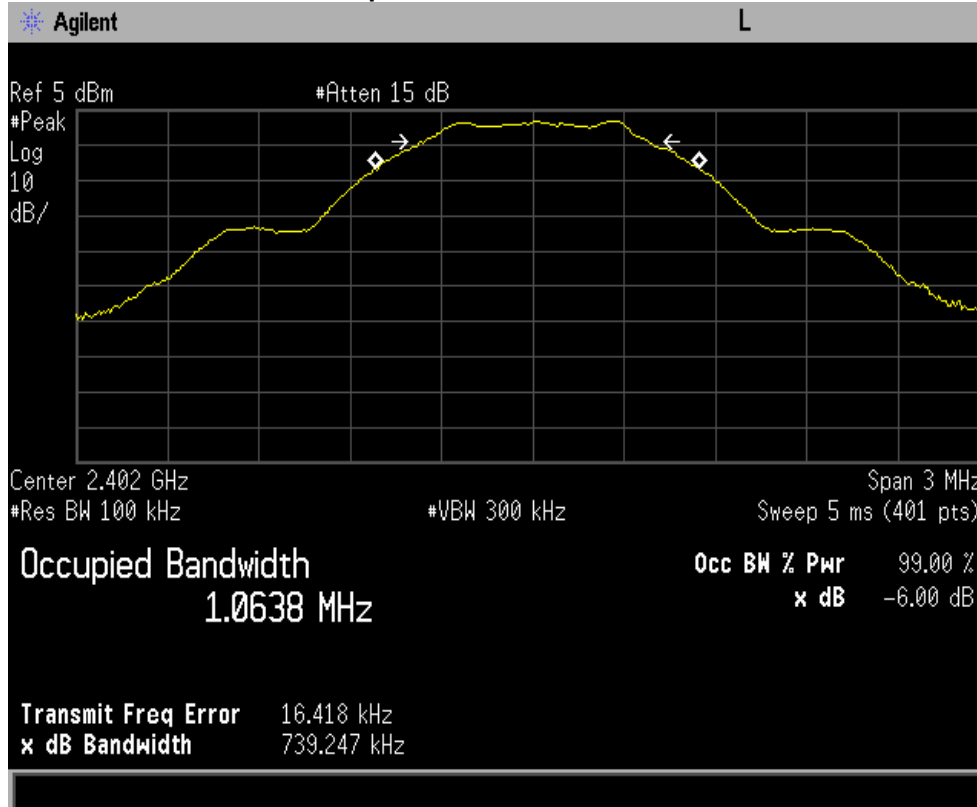
Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2402	0.739	≥ 500	Pass
2440	0.745	≥ 500	Pass
2480	0.739	≥ 500	Pass

99% Bandwidth Summary

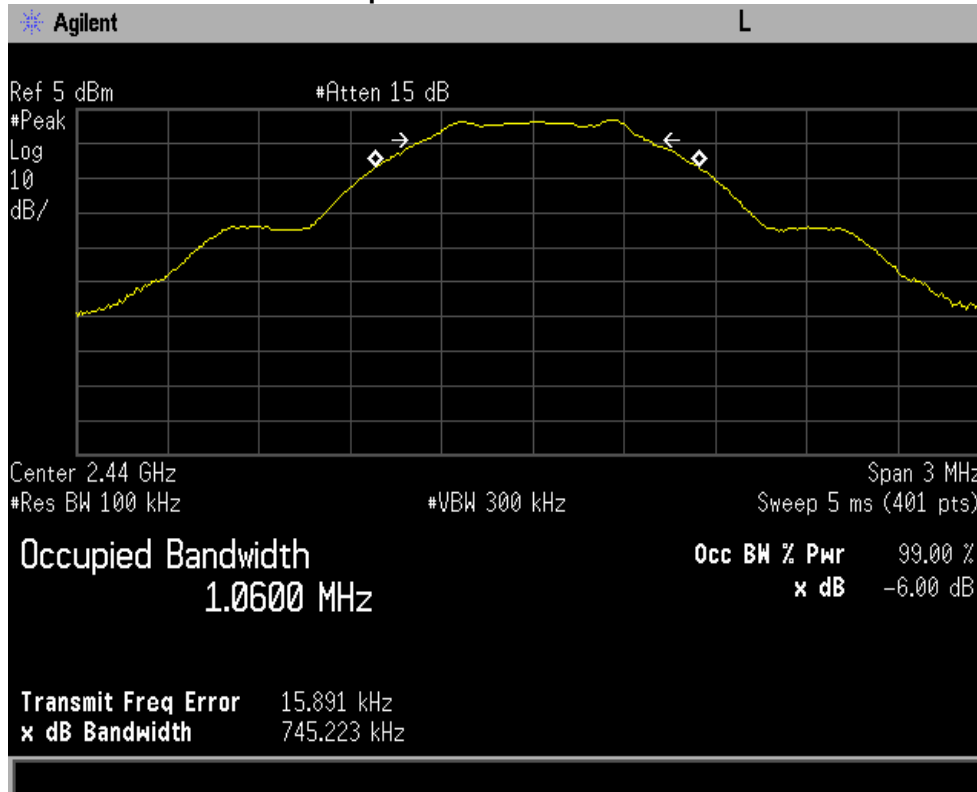
Frequency (MHz)	Measured Bandwidth (MHz)	Result
2402	1.063	Pass
2440	1.06	Pass
2480	1.064	Pass



Occupied Bandwidth 2402 MHz

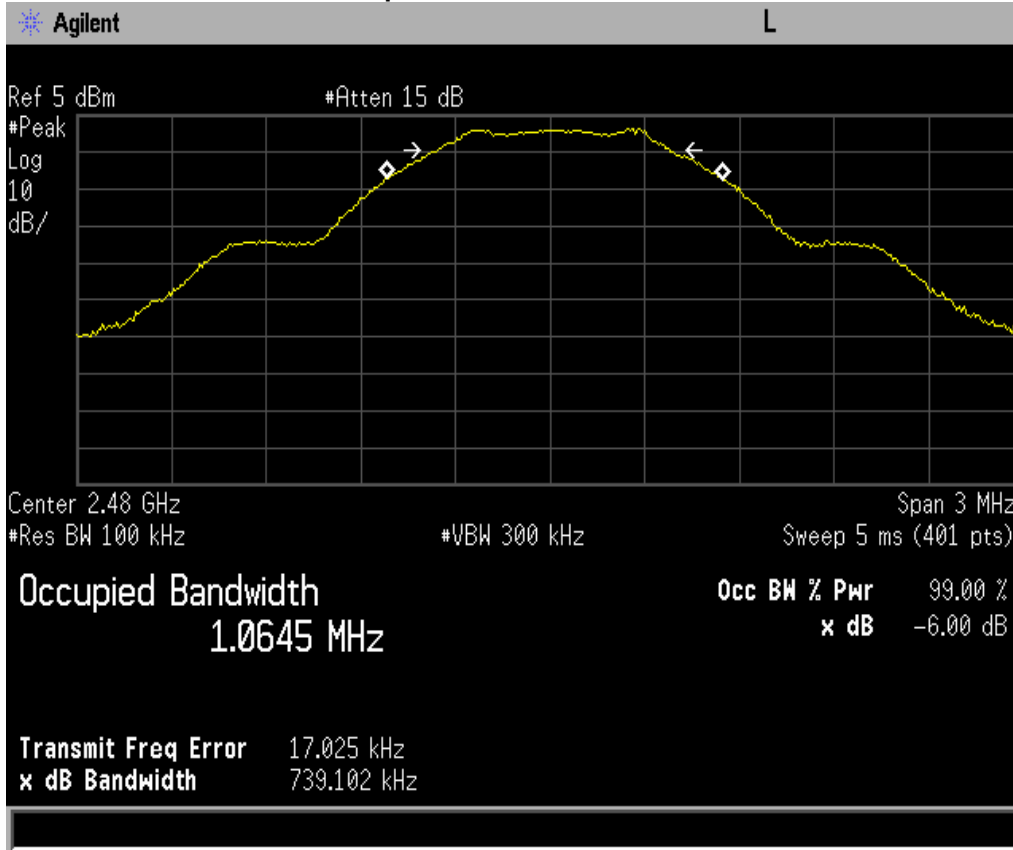


Occupied Bandwidth 2440 MHz





Occupied Bandwidth 2480 MHz





Transmitter Power Spectral Density (PSD)

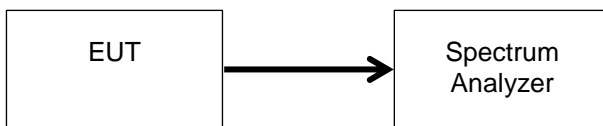
Engineer: Poona Saber

Test Date: 10/30/18

Test Procedure

The EUT was connected directly to a spectrum analyzer. The test was performed per section 11.10 of C63.10:2013 "Procedure for determining PSD for DTS devices".

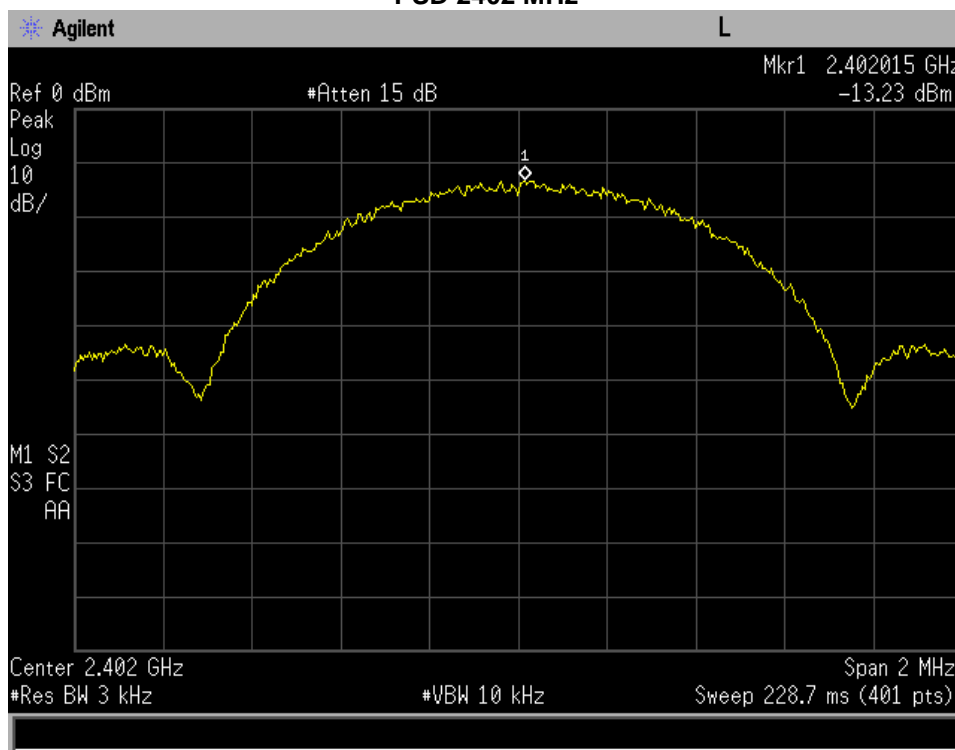
Test Setup



PSD Summary

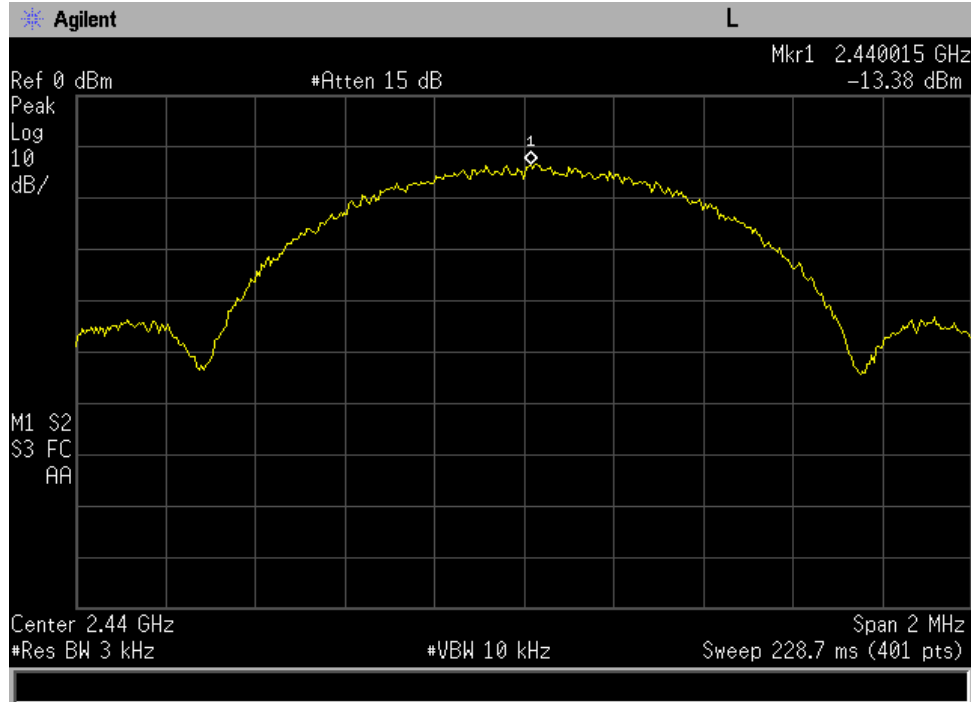
Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2402	-13.23	8	Pass
2440	-13.38	8	Pass
2480	-13.67	8	Pass

PSD 2402 MHz

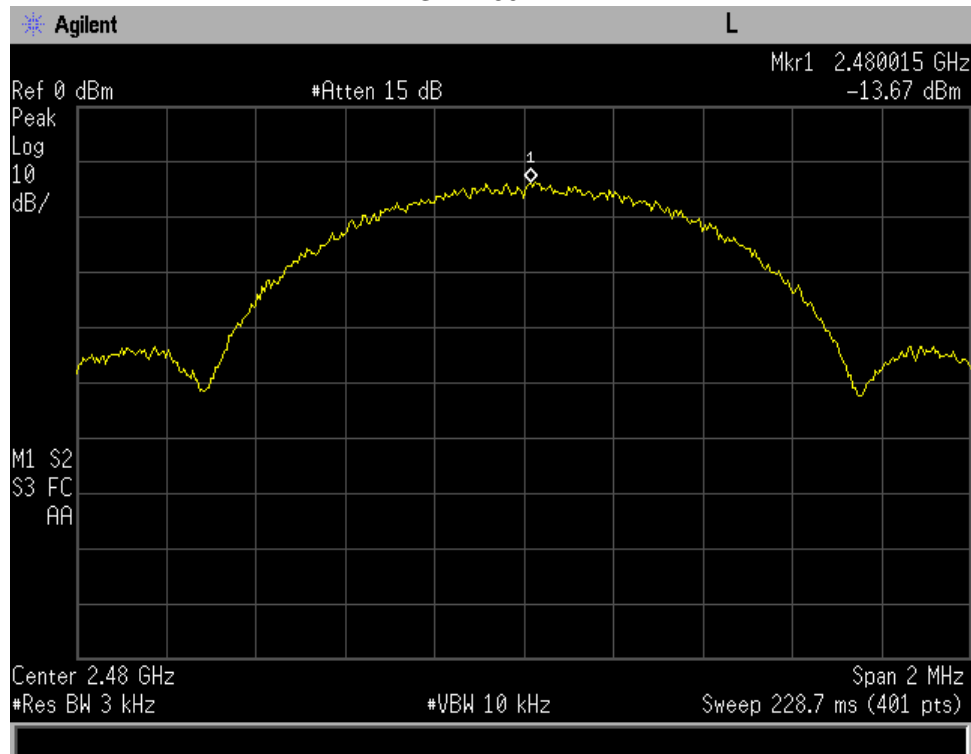




PSD 2440 MHz



PSD 2480 MHz





Measurement Uncertainty

Measurement Uncertainty (U_{lab}) for Compliance Testing is listed in the table below.
The reported expanded uncertainty $U_{lab}(dB)$ has been estimated at a 95% confidence level ($k=2$)

Measurement	U_{lab}
Radio Frequency	$\pm 1.0 \times 10^{-12}$
RF Power, conducted	± 0.43 dB
RF Power Density, conducted	$\pm .98$ dB
Spurious Emissions, Conducted	± 2.49 dB
All Emissions, radiated	± 5.7 dB
Temperature	± 1.0 deg C
Humidity	± 4.3 %
Dc voltage	$\pm .12$ %
Low Frequency voltages	± 2.3 %

The reported expanded uncertainty $\pm U_{lab}(dB)$ has been estimated at a 95% confidence level ($k=2$)

U_{lab} is less than or equal to U_{CISPR} therefore

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit
- Non-Compliance is deemed to occur if any measured disturbance exceeds the disturbance limit



Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	6/16/18	6/16/20
Horn Antenna, Amplified	ARA	MWH-1826/B	i00273	5/22/18	5/22/21
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	6/29/18	6/29/19
Spectrum Analyzer	Agilent	E4407B	i00331	11/21/17	11/21/18
Bi-Log antenna	Chase	CBL6111C	i00267	3/8/18	3/8/20
EMI Analyzer	Agilent	E7405A	i00379	2/13/18	2/13/19
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	8/15/16	8/15/19
Preamplifier	Miteq	AFS44 00101 400 23-10P-44	i00509	N/A	N/A
EMI Receiver	HP	8546A	i00033	3/26/18	3/26/19
Transient Limiter	Com-Power	LIT-153	i00123	Verified on: 9/17/18	
AC Power Source	Behlman	BL 6000	i00362	Verified on: 9/17/18	
LISN	COM-Power	LI-125A	i00447	9/11/17	9/11/19
LISN	COM-Power	LI-125A	i00449	9/11/17	9/11/19

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT