



## Test Report

Prepared for: Haven Lock Inc.

Model: HL1-CNT-001

Description: Bluetooth Connected Smart Lock

Serial Number: N/A

FCC ID: 2ARFQHL1CNT001  
IC: 24389-HL1CNT001

To

FCC Part 15.247 DTS  
And  
IC RSS-247

Date of Issue: November 8, 2018

On the behalf of the applicant:

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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**

<b>Revision</b>	<b>Date</b>	<b>Revised By</b>	<b>Reason for Revision</b>
1.0	October 15, 2018	Poona Saber	Original Document
2.0	October 7, 2018	Poona Saber	Page 1 changed model number Page 8 Added RSS section numbers Added Measurement uncertainty to report



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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:** HL1-CNT-001

**Description:** Bluetooth Connected Smart Lock

**Firmware:** N/A

**Software:** N/A

**Serial Number:** N/A

**Additional Information:** EUT is a high-strength, Bluetooth enabled smart lock working with BLE technology at the frequency range of 2402-2480 MHz. The HLU board inside of the smart lock is tested at low, mid and high frequencies and controlled through an interface UART PCB board plus a debugger with a smart RF flash programmer 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. Two boards are provided to satisfy both conducted and radiated measurements. The conducted sample has u,fl connector for testing.



**Accessories:**

Qty	Description	Manufacturer	Model	S/N
1	Xds debugger	olimex	TMS320-XDS100v3	N/A
1	UART pcb board	Unikey technologies	N/A	N/A
1	USB 12V AC adapter	PHIHONG	PSAA05A-050QL6	N/A
1	Laptop	Toshiba	Satellite	N/A

**Cables:**

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Ferrite Y/N
1	FPC flat ribbon cable	<1	N	N	N
1	Ufl to SMA connector	<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

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





**Peak Output Power**

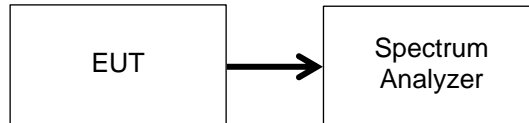
**Engineer:** Poona Saber

**Test Date:** 10/10/2018

**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 Peak Output Power**

Tuned Frequency (MHz)	Measured Value (dBm)	Specification Limit	Result
2402	4.55	1 W (30 dBm)	Pass
2440	4.22	1 W (30 dBm)	Pass
2480	4	1 W (30 dBm)	Pass



## Conducted Spurious Emissions in Non-Restricted frequency band

**Engineer:** Poona Saber

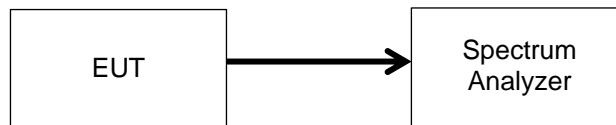
**Test Date:** 10/10/2018

### 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 10<sup>th</sup> 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:** 10/11/2018

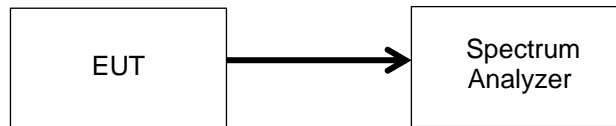
### Test Procedure

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 10<sup>th</sup> 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:** 10/11/18

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.

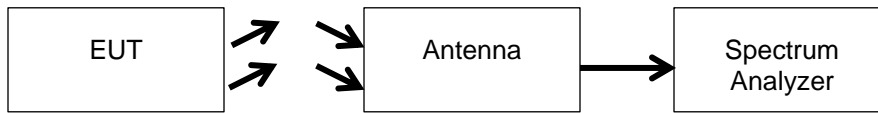
Correction factors were input into the spectrum analyzer before recording “Measured Level”.

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

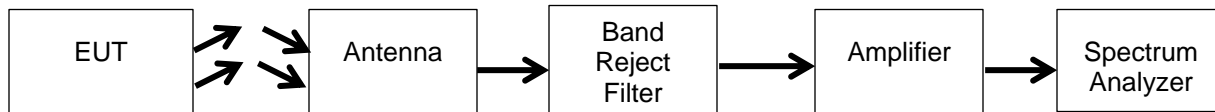
#### Test Setup



### 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**

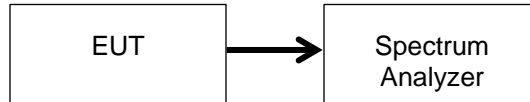
**Engineer:** Poona Saber

**Test Date:** 10/10/18

**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**

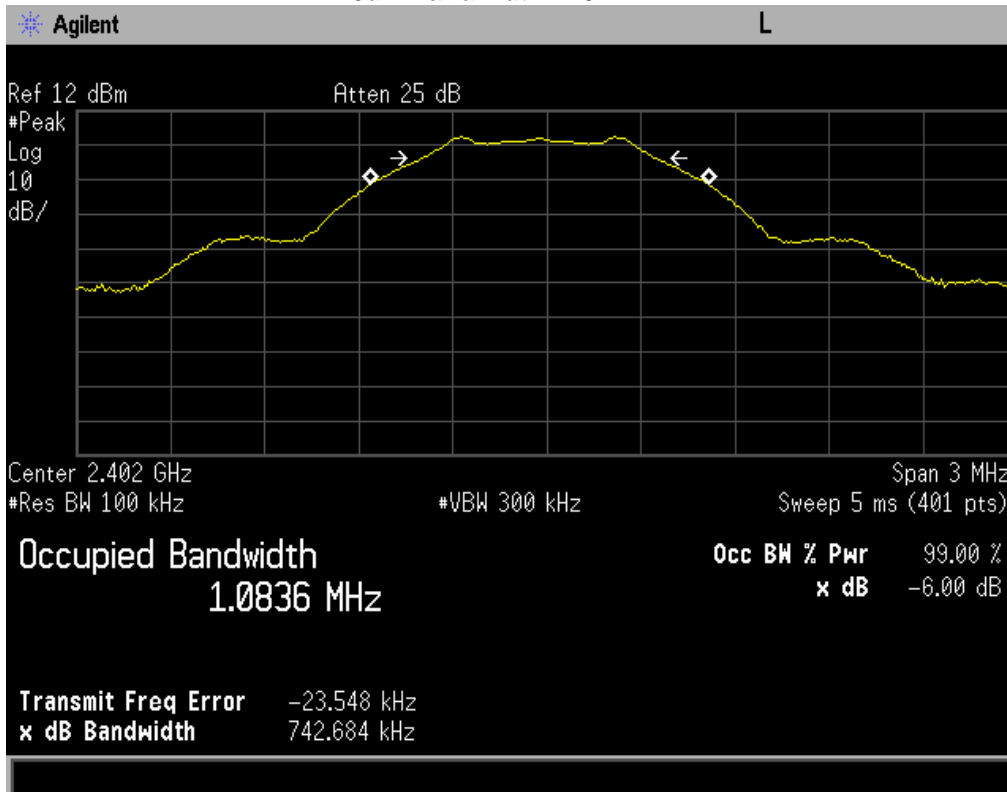
Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2402	0.742	≥ 500	Pass
2440	0.761	≥ 500	Pass
2480	0.760	≥ 500	Pass

**99% Bandwidth Summary**

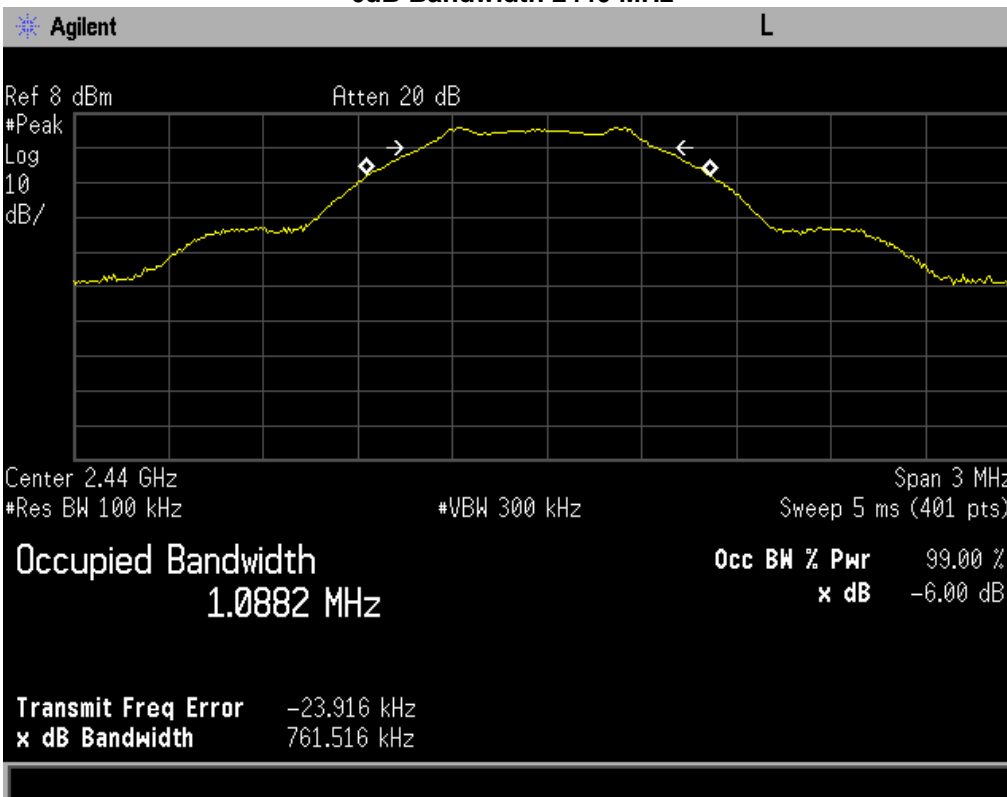
Frequency (MHz)	Measured Bandwidth (MHz)	Result
2402	1.083	Pass
2440	1.088	Pass
2480	1.095	Pass



### 6dB Bandwidth 2402 MHz

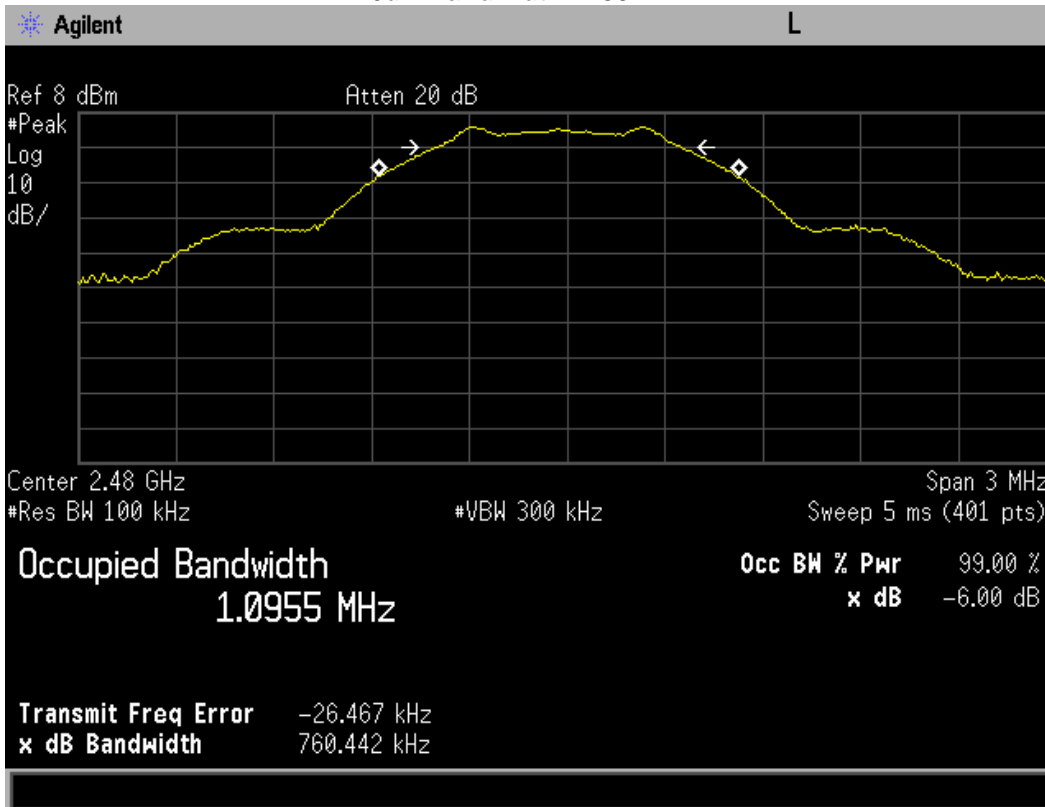


### 6dB Bandwidth 2440 MHz





### 6dB Bandwidth 2480 MHz





### Transmitter Power Spectral Density (PSD)

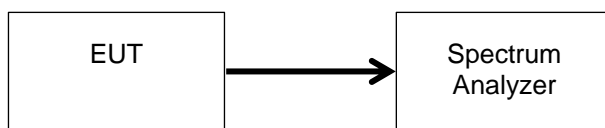
Engineer: Poona Saber

Test Date: 10/10/18

### 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".

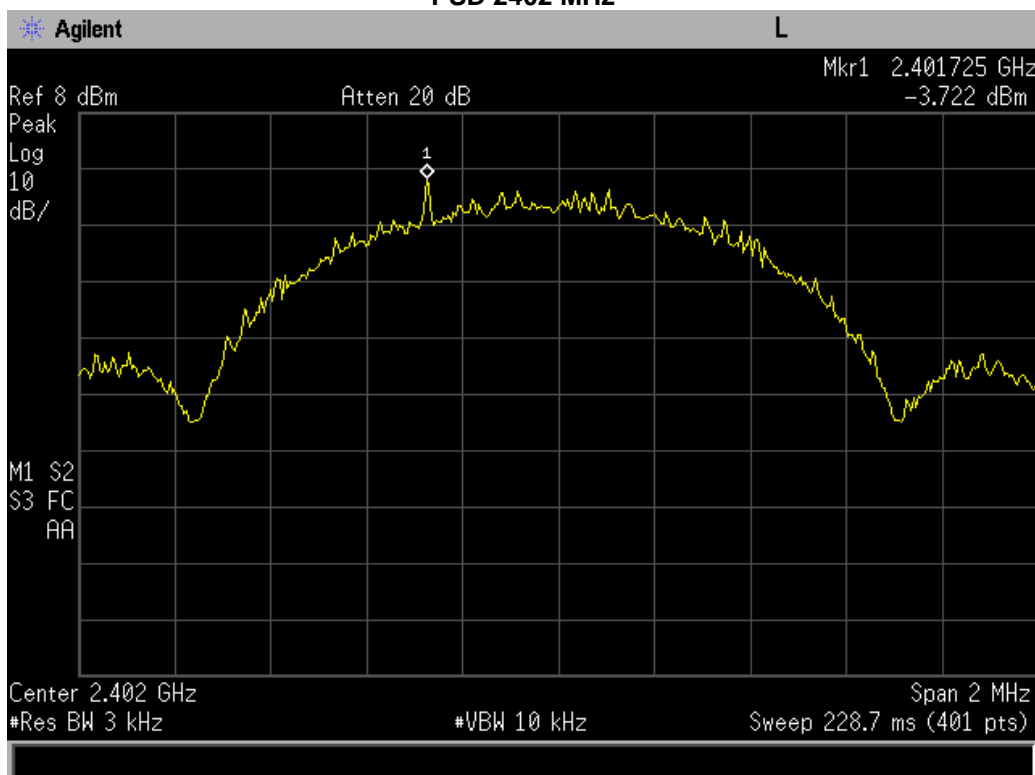
### Test Setup



### PSD Summary

Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2402	-3.722	8	Pass
2440	-4.271	8	Pass
2480	-5.291	8	Pass

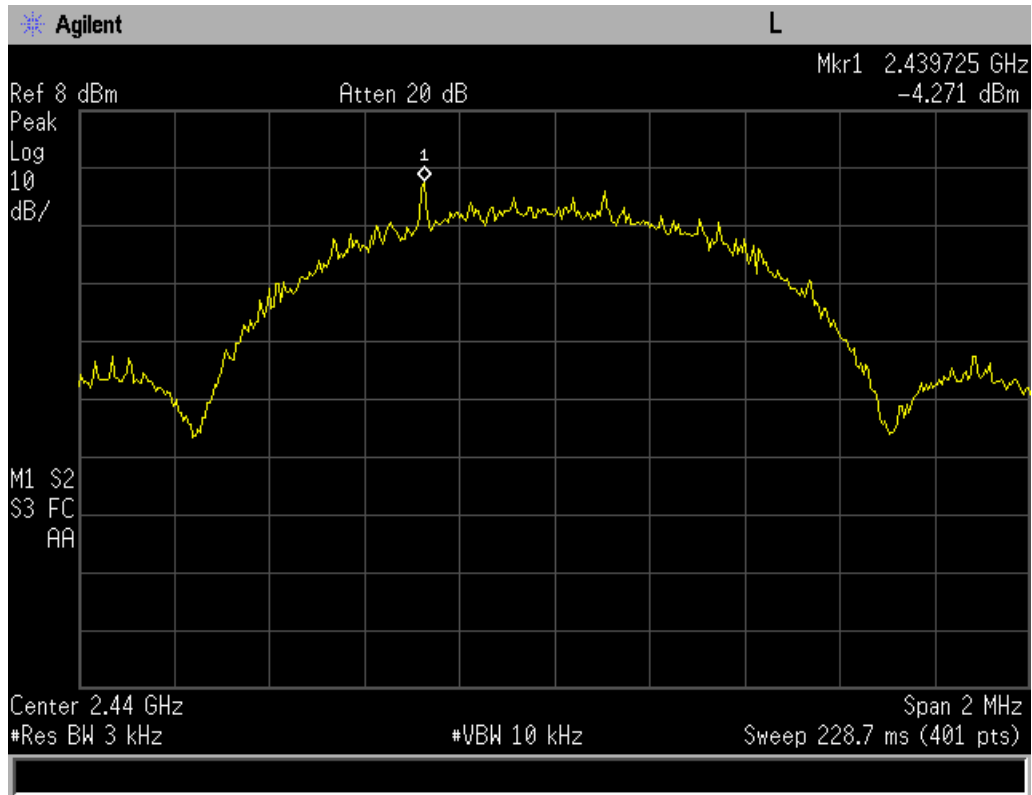
### PSD 2402 MHz



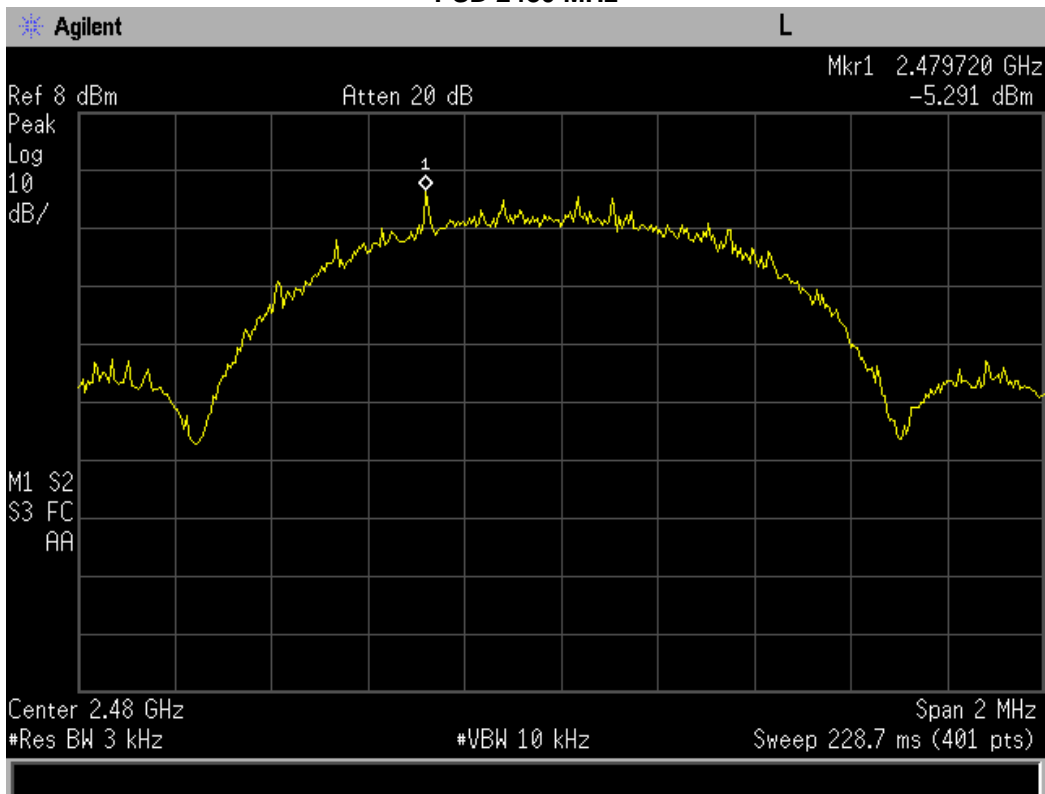




### PSD 2440 MHz



### PSD 2480 MHz





### A/C Powerline Conducted Emission

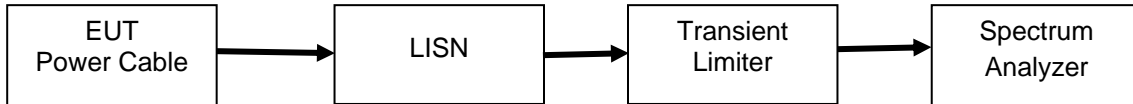
Engineer: Poona Saber

Test Date: 10/15/18

### Test Procedure

The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

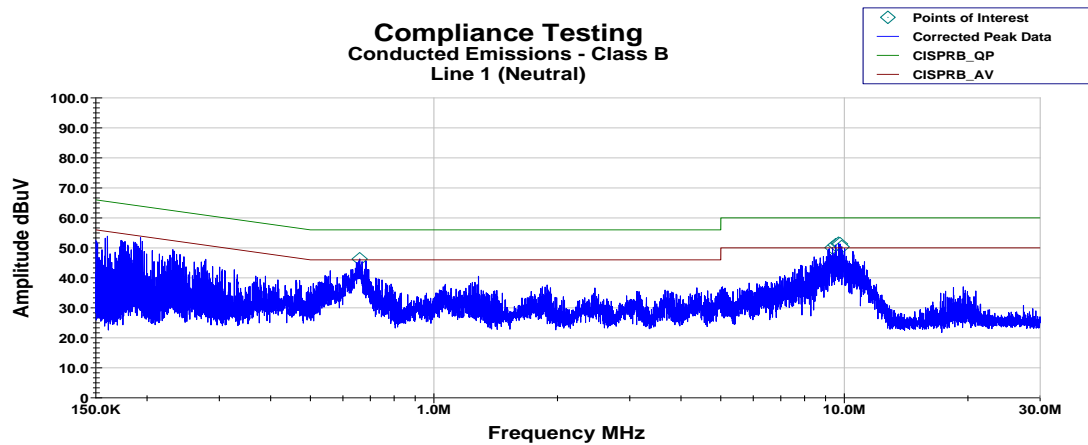
### Test Setup



### Conducted Emission Test Results

#### Line 1 Peak Plot

**Compliance Testing**  
Conducted Emissions - Class B  
Line 1 (Neutral)

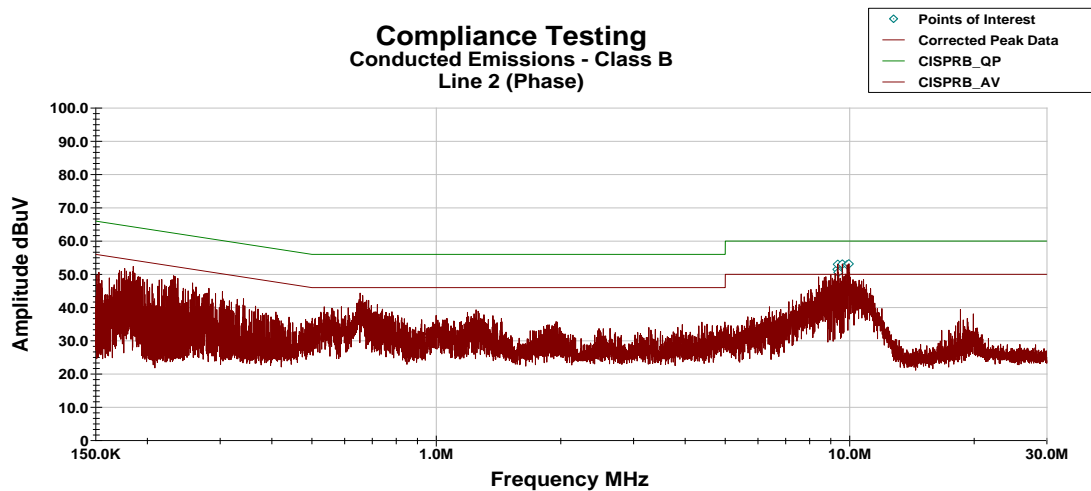


Operator: PS  
EN55032 Class B.til

Job #:

#### Line 2 Peak Plot

**Compliance Testing**  
Conducted Emissions - Class B  
Line 2 (Phase)



Operator: PS  
EN55032 Class B.til

Job #:



**Line 1 Neutral Avg Detector**

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
657.85 KHz	15.7	0.07	0.033	10.1	25.907	46	-20.093
9.3598 MHz	14.06	0	0.15	10.2	24.41	50	-25.59
9.5472 MHz	13.48	0	0.15	10.2	23.827	50	-26.173
9.6877 MHz	14.77	0	0.15	10.2	25.123	50	-24.877
9.7736 MHz	15.09	0	0.15	10.2	25.44	50	-24.56
9.8396 MHz	15.68	0	0.15	10.2	26.027	50	-23.973

**Line 2 Phase Avg Detector**

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
9.3431 MHz	15.14	0	0.15	10.2	25.49	50	-24.51
9.3666 MHz	15.26	0	0.15	10.2	25.61	50	-24.39
9.3899 MHz	15.68	0	0.15	10.2	26.027	50	-23.973
9.6015 MHz	16.33	0	0.15	10.2	26.683	50	-23.317
9.8537 MHz	16.65	0	0.15	10.2	26.997	50	-23.003
9.9489 MHz	17.13	0	0.15	10.2	27.477	50	-22.523

**Line 1 Neutral QP Detector**

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
657.85 KHz	30.16	0.071	0.033	10.1	40.364	56	-15.636
9.3598 MHz	31.49	0	0.15	10.2	41.84	60	-18.16
9.5472 MHz	30.53	0	0.15	10.2	40.88	60	-19.12
9.6877 MHz	31.75	0	0.15	10.2	42.1	60	-17.9
9.7736 MHz	32.19	0	0.15	10.2	42.54	60	-17.46
9.8396 MHz	32.55	0	0.15	10.2	42.9	60	-17.1

**Line 2 Phase QP Detector**

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
9.3431 MHz	33.5	0	0.15	10.2	43.85	60	-16.15
9.3666 MHz	33.34	0	0.15	10.2	43.69	60	-16.31
9.3899 MHz	33.38	0	0.15	10.2	43.73	60	-16.27
9.6015 MHz	33.08	0	0.15	10.2	43.43	60	-16.57
9.8537 MHz	34.47	0	0.15	10.2	44.82	60	-15.18
9.9489 MHz	34.13	0	0.15	10.2	44.48	60	-15.52



## 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	$\pm 0.43$ dB
RF Power Density, conducted	$\pm .98$ dB
Spurious Emissions, Conducted	$\pm 2.49$ dB
All Emissions, radiated	$\pm 5.7$ dB
Temperature	$\pm 1.0$ deg C
Humidity	$\pm 4.3$ %
Dc voltage	$\pm .12$ %
Low Frequency voltages	$\pm 2.3$ %

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