

Test Report # 318011 A

Equipment Under Test: Sensorhead Phase 2

Test Date(s): 1/25/18 – 4/8/2020

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Report Issued by: Shane Dock, EMC Engineer

Signature:



Date: 4/14/2020

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 4/14/2020

Report Constructed by: Shane Dock, EMC Engineer

Signature:



Date: 12/4/2019

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Laird Connectivity Test Services in Review

The Laird Connectivity, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025:2017 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

Scope of accreditation includes all test methods listed herein unless otherwise noted



Federal Communications Commission (FCC) – USA

Accredited Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers



Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

Company: Leviton Manufacturing Co., Inc.	Page 3 of 29	Name: Sensorhead Phase 2
Report: 318011A		Model: ZL00J-T0W
Job: C-2913		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **1/25/18 – 4/8/2020** the Equipment Under Test (EUT), **Sensorhead Phase 2**, as provided by **Leviton Manufacturing Co., Inc.** was tested to the following requirements:

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) IC: RSS-247 5.2 (a)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Pass
FCC: 2.1049 IC: RSS-GEN 6.7	Occupied Bandwidth	Reported	ANSI C63.10	Pass
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (e) IC: RSS-247 5.2 (b)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Pass
FCC: 2.1055 (d) IC: RSS-GEN 6.11	Frequency Stability	Reported	ANSI C63.10	Pass
FCC: 15.207 IC: RSS-GEN 8.8	AC Power Line Conducted Emissions	0.150-30 MHz	ANSI C63.10	Pass

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	Leviton Manufacturing Co., Inc.
Contact Person	Dmitriy Moskovkin
Address	20497 SW Teton Ave Tualatin, OR 97062

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Sensorhead Phase 2
Model Number	ZL00J-T0W
Serial Number	Engineering Sample
FCC/IC Number	FCC: 2ASLN-ZL00J IC: 25037-ZL00J

2.2 Product Description

Intellect Intelligent Sensor for double-d mount inside fixture

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Additional Information

Unit powered up with 5.5 VDC. Power Setting for all channels set to 16. Channels tested are 11, 18, and 26. EUT has a Zigbee radio, programmed with Simplicity Studio 4 through a serial connection.

Low – Channel 11 – 2405 MHz

Mid – Channel 18 – 2440 MHz

High – Channel 26 – 2480 MHz

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15	-	2020
ANSI C63.10	-	2013
RSS-247	2	2017
RSS GEN	5	2018

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of $k = 2$.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty \pm
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

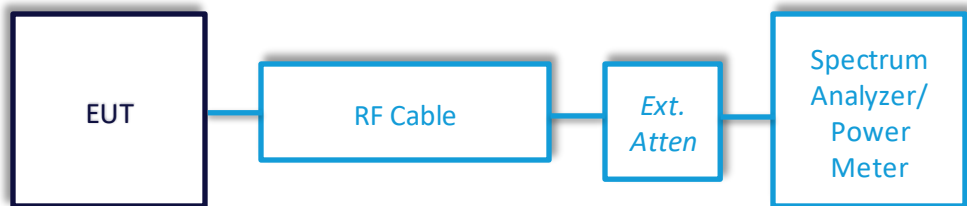
Parameter	ETSI U.C. \pm	U.C. \pm
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	<p>The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter.</p> <p>The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.</p>
Example Calculations	<p>Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm)</p> <p>Margin (dB) = Limit (dBm) – Corrected Reading (dBm)</p>

Block Diagram



5.1.1 Antenna Port Conducted Emissions – DTS/99% Bandwidth

Operator	Shane Dock
Test Date	1/31/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/ 36% RH
Requirement	FCC 15.247 (a)(2) IC: RSS-247 5.2 (a)
Method	ANSI C63.10 Section 6.9.2, 11.8

Limits:

Minimum 6 dB BW (MHz)
0.5

Test Parameters

Frequency	2405 - 2480 MHz
EUT	Unit Tested on Low, Mid, and High Channel

Instrumentation



Date : 24-Jan-2018 Test : Conducted Power Output Job : C-2913
 PE : Shane Dock Customer : Leviton LES Quote : 318011

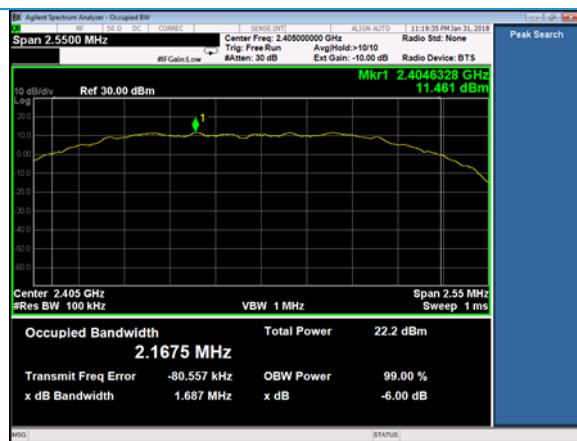
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/15/2017	11/15/2018	Active Verification
2	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	1/11/2018	1/11/2019	Active Calibration

Table

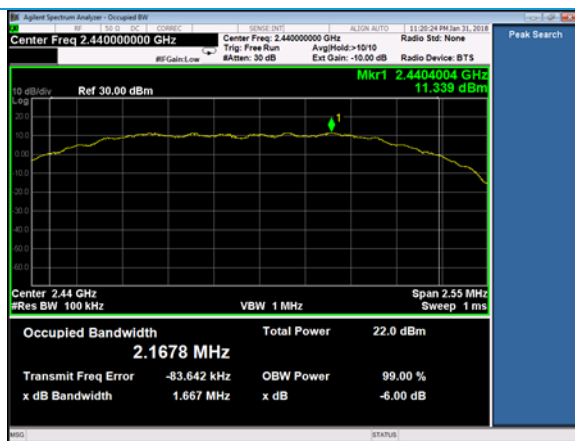
Channel	Low	Mid	High
6 db BW (kHz)	1687	1667	1677
99% BW (kHz)	2247.4	2250.5	2259.6

Worst Case Margin = Closest Measurement – Limit = 1667 kHz – 500kHz = 1167 kHz

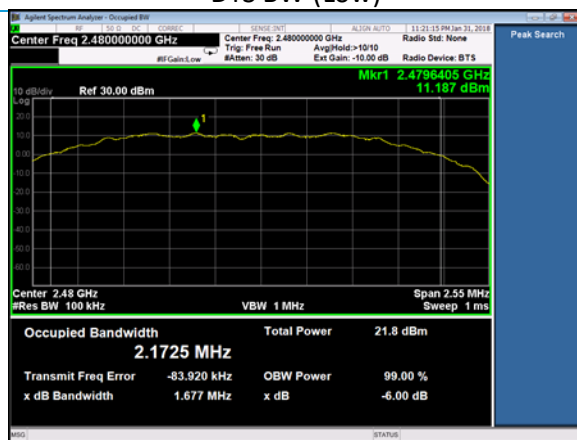
Plots



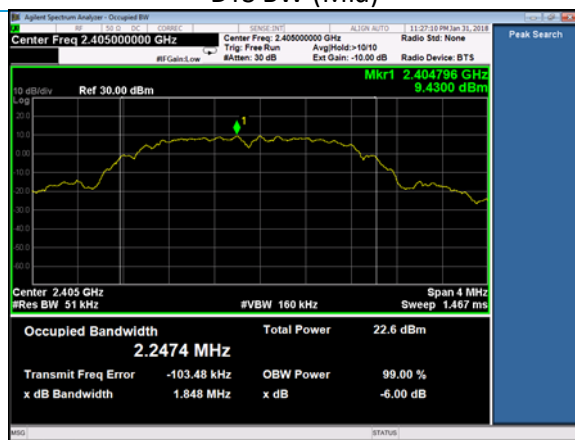
DTS BW (Low)



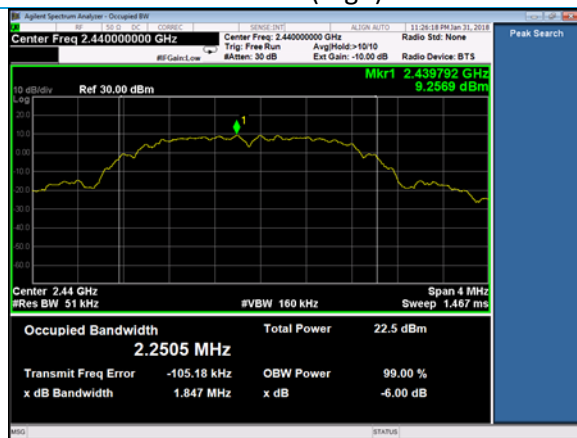
DTS BW (Mid)



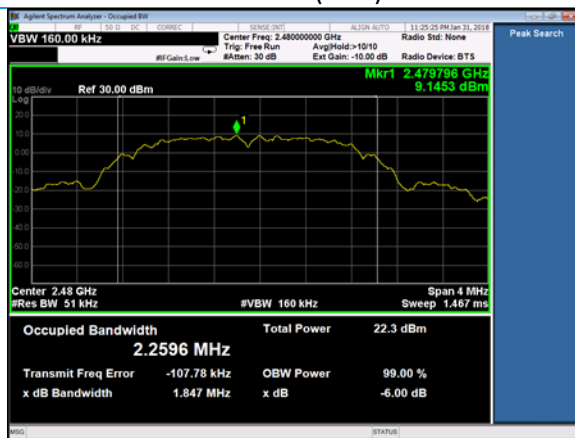
DTS BW (High)



99% BW (Low)



99% BW (Mid)



99% BW (High)

5.1.2 Antenna Port Conducted Emissions – Conducted Output Power

Operator	Shane Dock
Test Date	1/31/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/ 36% RH
Requirement	FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)
Method	ANSI C63.10 Section 11.9.1.1

Limits: (Measured as Average)

Maximum Conducted Output Power (dBm)	Maximum Conducted Output Power (watts)
30	1

Test Parameters

Frequency	2405-2480 MHz
Settings	Low, Mid, and High Channels Measured
Settings	Unit measured at full power

Table

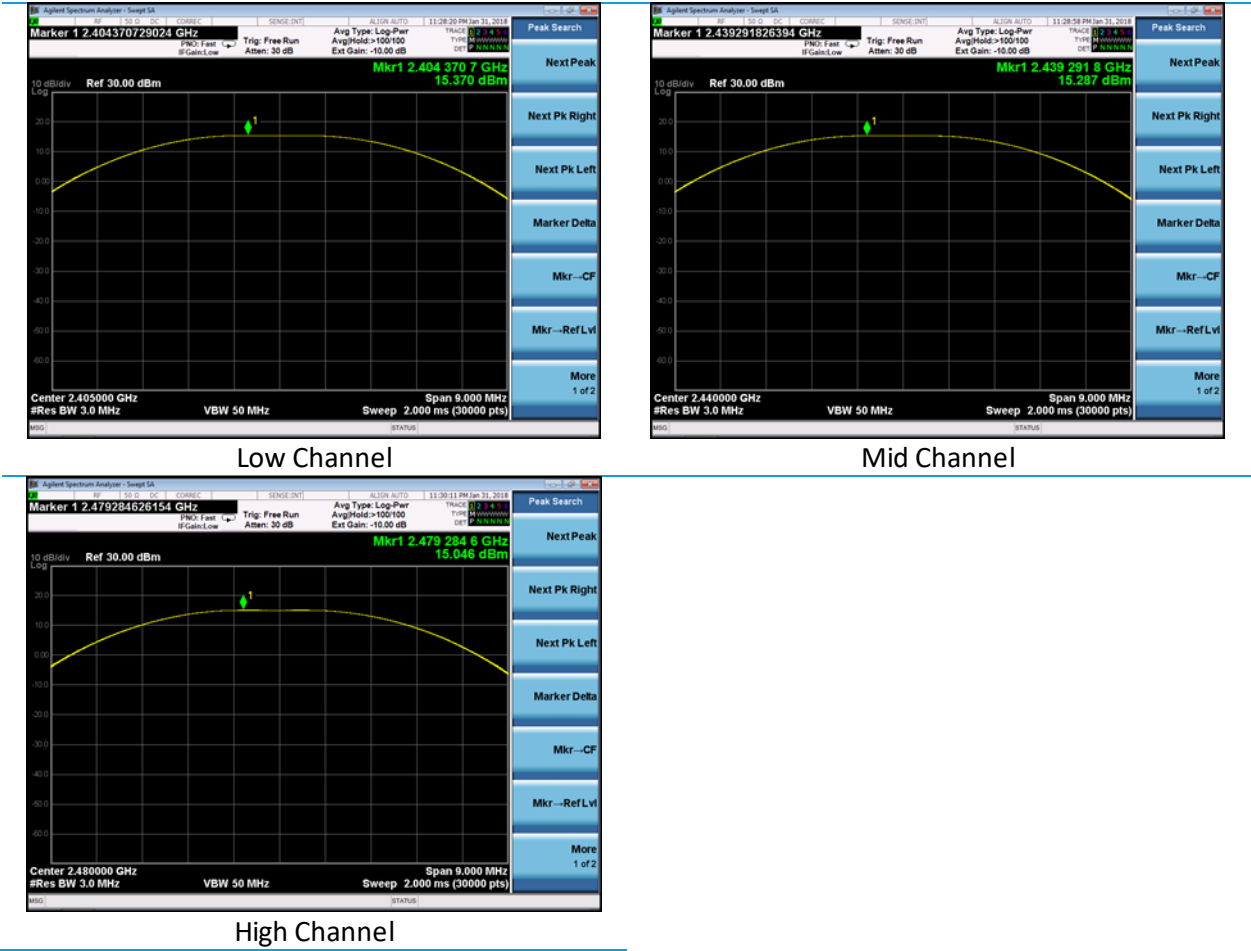
Max Power (dBm)

Channel	Low	Mid	High
Power Setting (dBm)	16	16	16
Output Power (dBm)	15.370	15.287	15.046

Worst Case Margin = Limit - Closest Measurement = 30.0 dBm – 15.370 dBm = 14.630 dB

Plots

Maximum Power



5.1.3 Antenna Port Conducted Emissions – Power Spectral Density

Operator	Shane Dock
Test Date	1/31/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/36% RH
Requirement	FCC: 15.247 (e) IC: RSS-247 5.2 (b)
Method	ANSI C63.10 Section 11.10.2

Limits:

Power Spectral Density (dBm/ 3 kHz)
8

Test Parameters

Frequency	2405-2480 MHz
Settings	Low, Mid, and High Channels Measured
Settings	Unit measured at full power

Table

Maximum Power

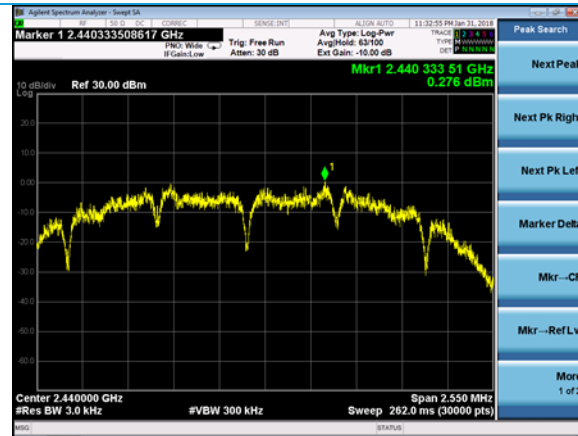
Channel (dBm)	Low	Mid	High
Power	16	16	16
Setting (dBm)			
PSD (dBm)	0.002	0.276	-0.372

Worst Case Margin = Limit - Closest Measurement = 8 dBm – (0.276) dBm = 7.724 dB

Maximum Power



Low Channel



Mid Channel



High Channel

5.1.4 Antenna Port Conducted Emissions – Tx Conducted Spurious

Operator	Shane Dock
Test Date	1/31/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/36% RH
Requirement	FCC: 15.247 (d) IC: RSS-247 5.5
Method	ANSI C63.10 Section 11.11

Limits:

Spurious Emissions Limit (dBc from Reference Point)
20

Test Parameters

Frequency	30-25000 MHz
Settings	100k RBW/ 300k RBW
EUT	Low, Mid, High Checked at Max and Min Power

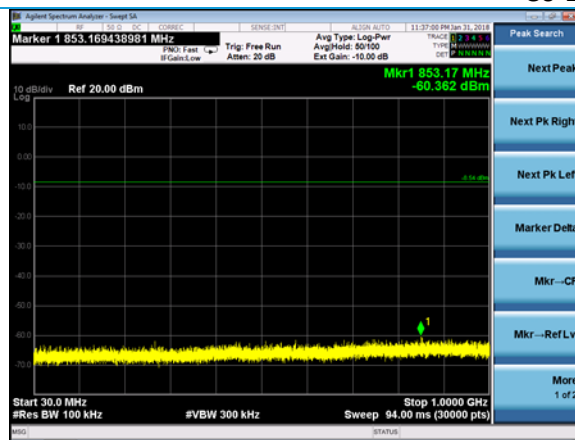
Worst Case Margin = Limit - Closest Measurement = (11.461 dBm – 20 dB) – (-34.697 dBm) = -8.539 dBm – (-34.697 dBm) = 26.158 dB

Plots

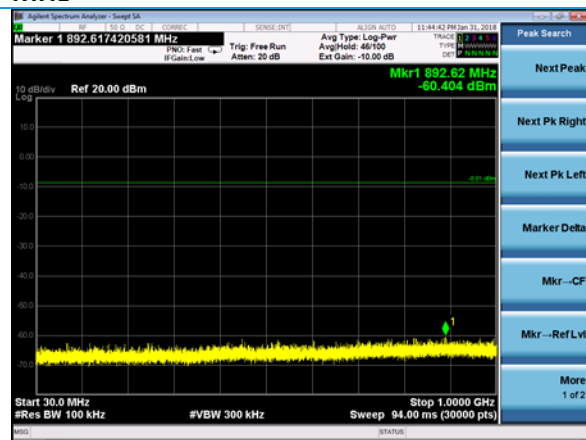
Reference Levels



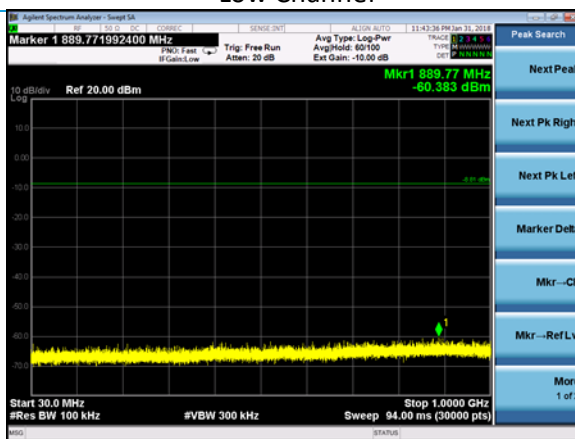
30-1000 MHz



Low Channel

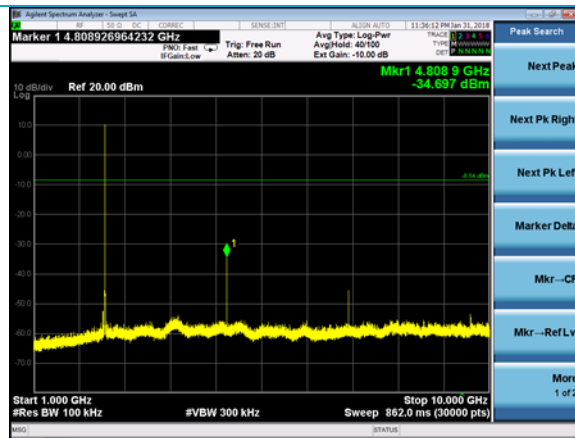


Mid Channel

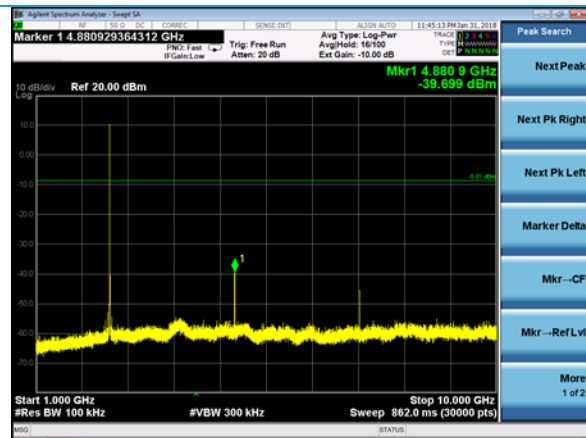


High Channel

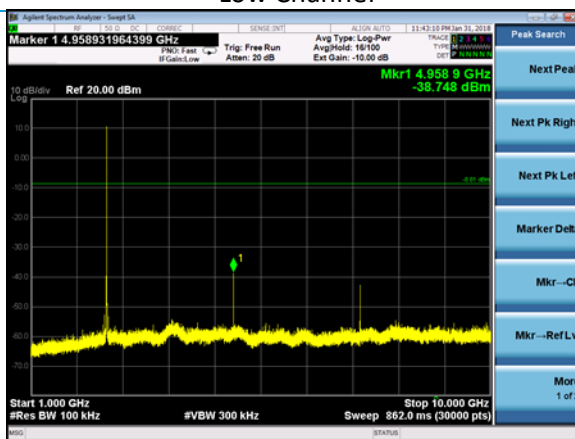
1000-10000 MHz



Low Channel

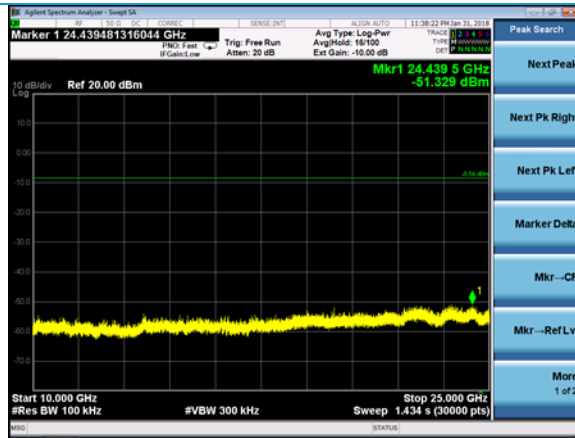


Mid Channel

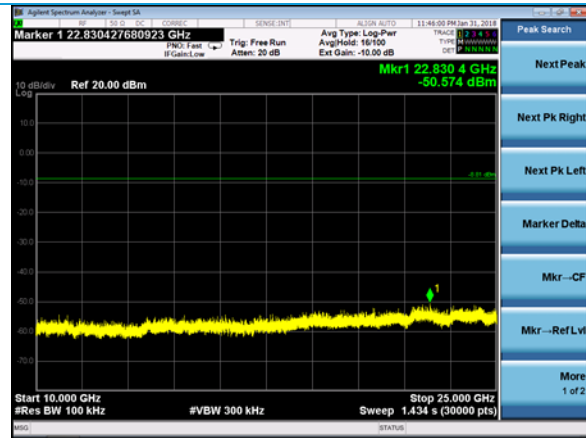


High Channel

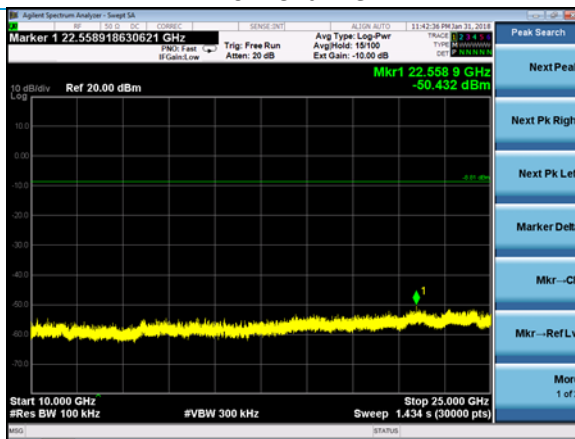
10000-25000 MHz



Low Channel

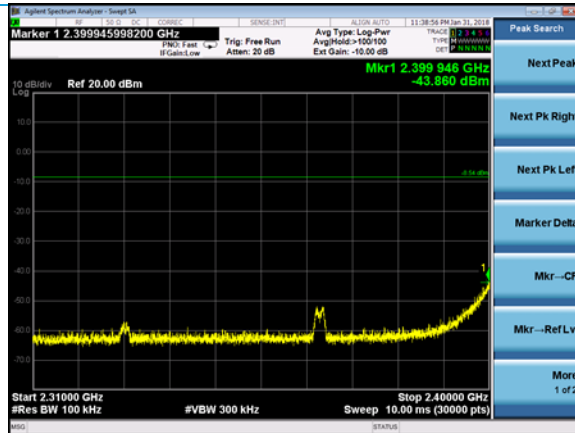


Mid Channel

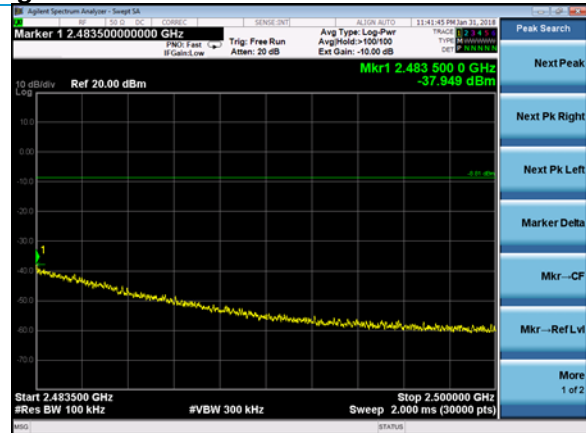


High Channel

Band Edges



Low Channel



High Channel

5.1.5 Antenna Port Conducted Emissions – Frequency Stability

Operator	Shane Dock
Test Date	2/21/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/36% RH
Requirement	FCC: 2.1055 (d) IC: RSS-GEN 6.11
Method	ANSI C63.10 Section 6.8

Test Parameters

Frequency	2405, 2440, 2480 MHz
Settings	Power Setting of 16 utilized. CW Tx used to measure deviation.

Table

Channel	4.50 VDC Frequency (Hz)	5.00 VDC Frequency (Hz)	6.00 VDC Frequency (Hz)	7.00 VDC Frequency (Hz)	7.70 VDC Frequency (Hz)	Deviation (Hz)
Low	2404915580	2404911580	2404908250	2404910580	2404899750	15830
Mid	2439892250	2439900250	2439898080	2439906910	2439897250	14660
High	2479886580	2479908910	2479900750	2479912750	2479904080	26170

5.2 Radiated Emissions

Description of Measurement	<p>The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna.</p> <p>The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values.</p> <p>The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.</p>
Example Calculations	<p>Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m)</p> <p>Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m)</p> <p>Example at 4000 MHz: Reading = 40 dBμV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBμV/m Average Limit = 20 log (500) = 54 dBμV/m Margin = 54 dBμV/m - 50.8 dBμV/m = 3.2 dB</p>

Block Diagram



5.2.1 Radiated Emissions

Operator	Shane Dock
Test Date	1/25/18
Location	Chamber 5
Temp. / R.H.	73 degrees F/32% RH
Requirement	FCC: 15.247 (d) IC: RSS-GEN 8.10
Method	ANSI C63.10 Sections 6.3, 6.5, 6.6

Limits at 3m:

	30-88 MHz	88-216 MHz	216 – 960 MHz	960+ MHz
Field Strength ($\mu\text{V}/\text{m}$)	100	150	200	500
Field Strength (dB $\mu\text{V}/\text{m}$)	40.0	43.5	46.0	54.0

Test Parameters

Frequency	30-25000 MHz
Distance	3 meters
Settings	Unit tested at low, mid, and high channels. Average measurements taken by video bandwidth reduction method with the BW set to 10 Hz.
Settings	RBW = 120kHz, VBW = 1.2 MHz (<1 GHz) RBW = 1 MHz, VBW = 3 MHz (>1 GHz) , 3 kHz for average measurements
EUT	Unit tested and measured in three orientations.
Notes	Measurements taken in restricted bands. For measurements above 1 GHz, antenna used with a tilt gear to keep EUT within the cone of radiation. Absorbers were also added to the floor of the chamber while measuring emissions above 1 GHz. Emissions below 200 MHz are not a function of the EUT. RVBW = Reduced Video Bandwidth
Example Calculation	Limit (dB μV) = 20* Log[Limit (μV)] 40 = 20* log (100) Raw Data + Antenna Factor + Cable Factor = Reported Data 19.77 dB μV + 12.50 dB/m + 0.93 dB = 33.20 dB $\mu\text{V}/\text{m}$

Company: Leviton Manufacturing Co., Inc.	Page 22 of 29	Name: Sensorhead Phase 2
Report: 318011 A		Model: ZL00J-TOW
Job: C-2913		Serial: Engineering Sample

Instrumentation



Date : 24-Jan-2018

Test : Radiated Emissions

Job : C-2913

PE : Shane Dock

Customer : Leviton LES

Quote : 318011

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
2	AA 960150	Antenna - Biconical	ETS Lindgren	3110B	0003-3346	3/3/2017	3/3/2018	Active Calibration
3	AA 960078	Antenna - Log Periodic	EMCO	93146	9701-4855	4/17/2017	4/17/2018	Active Calibration
4	AA 960007	Antenna - Double Ridge Horn	EMCO	3115	9311-4138	8/30/2017	8/30/2018	Active Calibration
5	AA 960171	Cable	A.H. Systems, Inc	SAC-26G-6	386	11/15/2017	11/15/2018	Active Verification
6	AA 960153	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-04	5/2/2017	5/2/2018	Active Calibration
7	AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	5/1/2017	5/1/2018	Active Calibration
8	EE 960160	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	977711030	8/30/2017	8/30/2018	Active Calibration

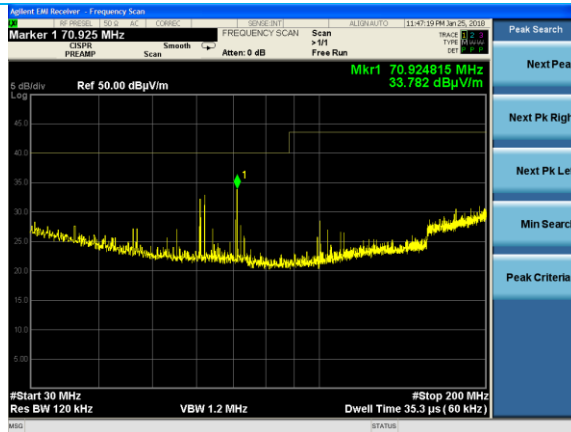
Table

Frequency (MHz)	Height (cm)	Azimuth (degrees)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dBμV/m)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dBμV/m)	Antenna Polarity	EUT orientation	Channel
4810.00	128.79	206.00	58.2	74.0	15.8	51.6	54.0	2.4	V	V	11
4810.00	313.42	127.50	57.4	74.0	16.6	50.9	54.0	3.1	H	V	11
4810.00	152.00	163.70	56.0	74.0	18.0	49.3	54.0	4.7	V	H	11
4810.00	151.28	288.25	57.7	74.0	16.3	51.2	54.0	2.8	H	H	11
4810.00	100.19	141.50	59.3	74.0	14.7	52.7	54.0	1.3	V	F	11
4810.00	105.58	216.00	56.9	74.0	17.1	50.4	54.0	3.6	H	F	11
4880.00	110.69	135.00	58.1	74.0	15.9	51.6	54.0	2.4	V	F	18
4960.00	111.60	51.25	55.8	74.0	18.2	49.2	54.0	4.8	V	F	26
2518.87	150.00	247.50	52.0	74.0	22.0	43.2	54.0	10.8	V	F	26

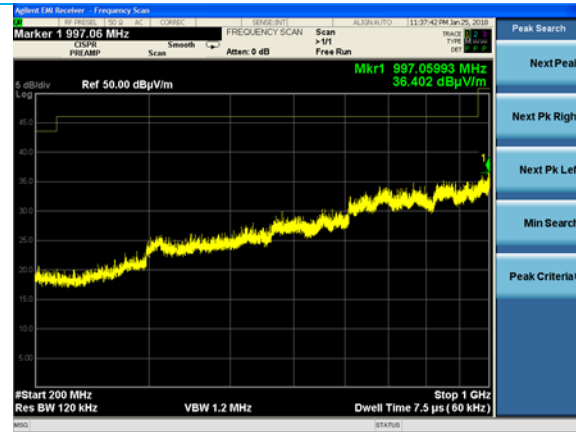
Band Edges

Band Edge	Peak Frequency (MHz)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Frequency (MHz)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)
Lower	2367.1	52.3	74.0	21.7	2366.9	41.3	54.0	12.7
Upper	2483.5	64.6	74.0	9.4	2483.5	53.5	54.0	0.5

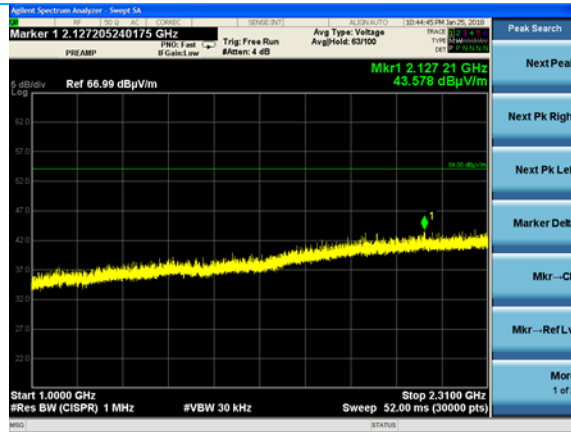
Plots – Worst Case Shown



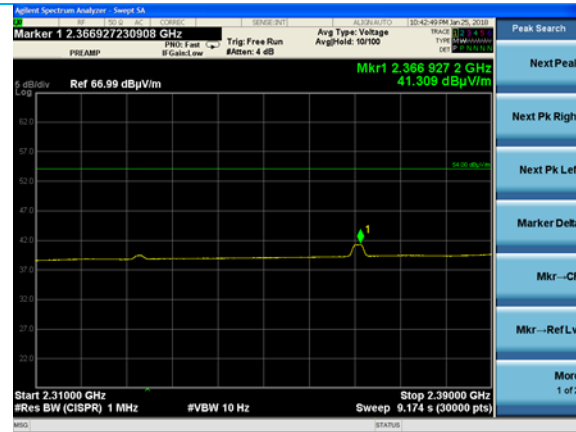
30-200 MHz Vertical Polarization



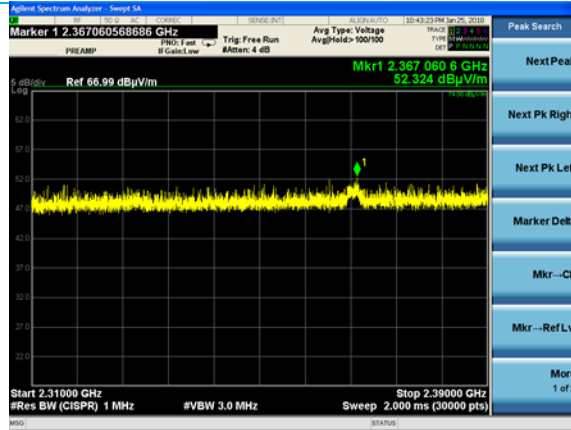
200-1000 MHz Vertical Polarization



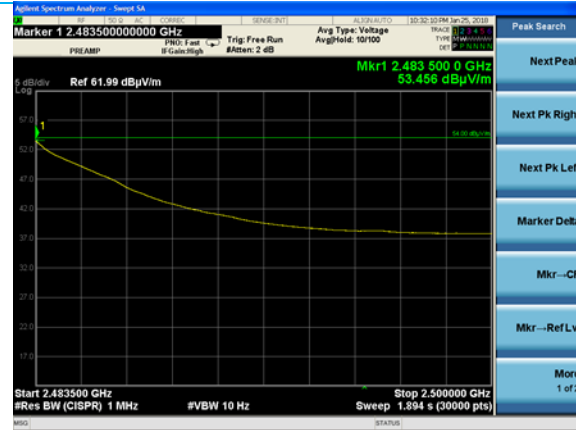
1.00-2.31 GHz Vertical Polarization



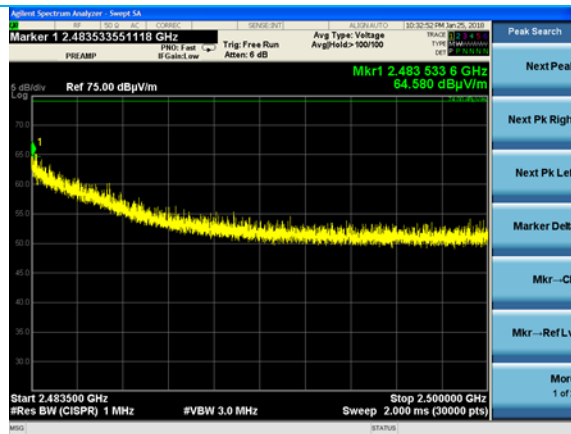
Lower Band Edge (Average)



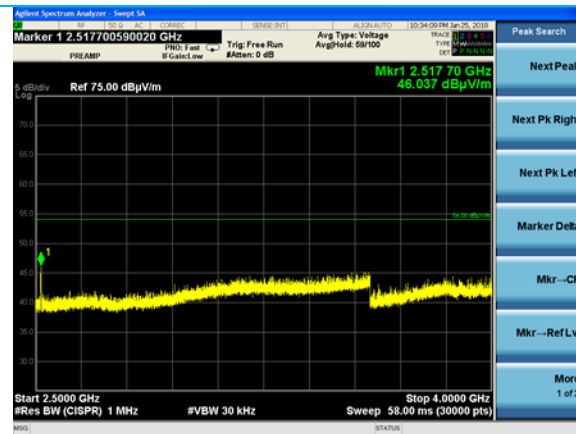
Lower Band Edge (Peak)



Upper Band Edge (Average)



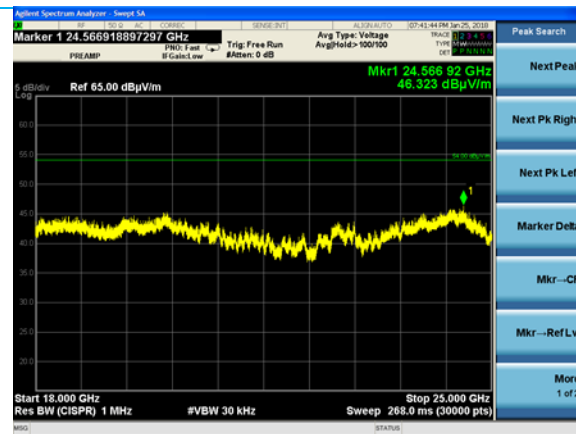
Upper Band Edge (Peak)



2.5 – 4.0 GHz Vertical Polarization



4-18 GHz Vertical Antenna



18- 25 GHz Horizontal Antenna

5.3 AC Mains Conducted Emissions

A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains.

Description of Measurement

The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values.

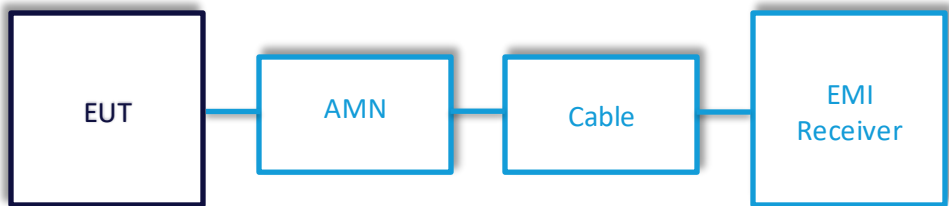
Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)

Example Calculations

$$\text{Measurement (dB}\mu\text{V)} + \text{Cable factor (dB)} + \text{Other (dB)} = \text{Corrected Reading (dB}\mu\text{V)}$$

$$\text{Margin (dB)} = \text{Limit (dB}\mu\text{V)} - \text{Corrected Reading (dB}\mu\text{V)}$$

Block Diagram



5.3.1 AC Mains Conducted Emissions

Operator	Shane Dock
Test Date	4/8/2020
Location	Conducted Bench Area
Temp. / R.H.	21.9 degrees C / 44.7% RH
Requirement	FCC 15.207 RSS-GEN Section 8.8
Method	ANSI C63.10 Section 6.2

Limits:

Frequency Range (MHz)	Quasi-Peak (dBμV)	Average (dBμV)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5.0	56	46
5.0 – 30.0	60	50

Test Parameters

Frequency	150kHz - 30 MHz
Detectors	Quasi-Peak, Average
Distance	40 cm from Vertical Ground Plane, 80 cm above Horizontal Ground Plane and any other conductive material
Settings	RBW=9kHz, VBW=90kHz
EUT	120VAC/60 Hz
Notes	EUT tested in Tx mode on Low Channel (Worst-Case)

Instrumentation



Date : 8-Apr-2020

Test : CE

Job : C-2913

PE : Shane Dock

Customer : Leviton LES

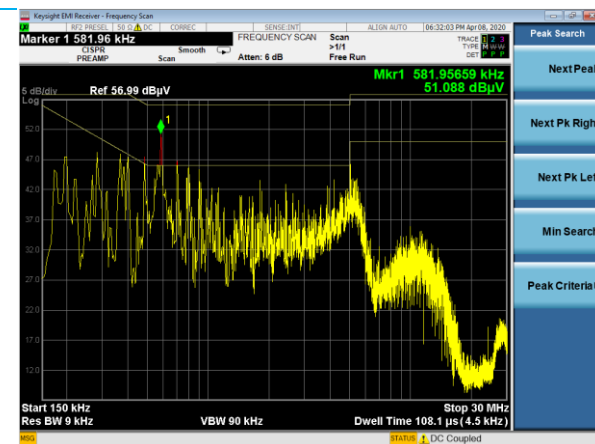
Quote : 318011

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/24/2019	4/24/2020	Active Calibration
2	LSC-200	Cable	Micro-Coax	UFB311A-0-1440-70	64639 224071-003	12/9/2019	12/9/2020	Active Verification
3	EE 960162	LISN	COM-POWER	LI-215A	191969	4/22/2019	4/22/2020	Active Calibration

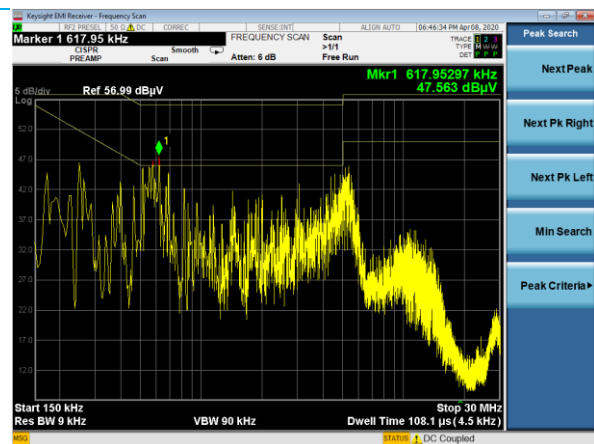
Table

Line	Frequency (MHz)	Q-Peak Reading (dBμV)	Q-Peak Limit (dBμV)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
1	0.577	40.4	56.0	15.6	28.7	46.0	17.3
1	0.469	31.1	56.5	25.4	14.4	49.5	35.2
1	4.879	33.0	56.0	23.0	14.7	46.0	31.3
1	5.185	33.9	60.0	26.1	15.1	50.0	34.9
2	0.577	40.9	56.0	15.1	25.8	46.0	20.2
2	0.388	32.7	58.1	25.4	11.6	51.1	39.5
2	5.333	35.4	60.0	24.6	13.0	50.0	37.0
2	4.955	33.9	56.0	22.1	12.1	46.0	33.9

Plots



Line 1



Line 2

6 REVISION HISTORY

Version	Date	Notes	Person
V0	5/22/18	Rough Draft	Shane Dock
V1	3/5/19	Updated Draft	Shane Dock
V2	12/4/19	Customer Info Added	Shane Dock
V3	2/13/20	Final Draft	Shane Dock
V4	4/9/2020	TCB Responses	Shane Dock
V5	4/14/2020	Further Revision	Shane Dock

END OF REPORT