



Test Report

Prepared for: Sensys Networks, Inc.

Model: FLEX-RAD-CM

Description: FLEXRADIO Cabinet

Serial Number: NA

FCC ID: TDB-FLEXRAD
IC: 9498A-FLEXRAD

To

FCC Part 15.247

And

IC RSS-247

Date of Issue: July 7, 2017

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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Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	June 27, 2017	Poona Saber	Original Document
2.0	June 5, 2017	Poona Saber	On page 12 removed the summary table wording, Revised annex A and added a note on conducted spurious emissions
3.0	June 7, 2017	Poona Saber	Updated Annex A, 30MHz-1GHz 209 plots



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ILAC / A2LA

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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: FLEX-RAD-CM

Description: FLEXRADIO Cabinet

Firmware: N/A

Software: TrafficDOT2

Serial Number: N/A

Additional Information:

The FlexRadio Cabinet is the communications edge gateway for the Sensys Networks VDS240 Wireless Vehicle Detection System. The FlexRadio Cabinet uses its DSSS ISM band radio to communicate to battery operated sensors and then relay the information over RS-422 on Cat5 cables to either an APCC or FlexControl to process the data and provide vehicle detection information to a traffic signal controller or remote traffic management center.

The EUT operates in the 2406 – 2480MHz band and incorporates DSSS O-QPSK modulation in an 802.15.4 PHY protocol.

The EUT incorporates a 4.5 dBi antenna and can you up to 6 dBi Antenna.

EUT Operation during Tests

The manufacturer supplied software which enabled the EUT to be placed in to a test mode which transmitted high, mid and low channels with a continuous CW tone or a modulated signal.



Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Laptop	Lenovo	T420	N/A
1	Magnetometer Interface Card	Sensys Network	APCC-M-E	558

Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Ferrite Y/N
2	Ethernet	<3m	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 Summary

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

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



Output Power

Engineer: Poona Saber

Test Date: 6/21/2017

Test Procedure

The EUT was connected to Spectrum analyzer through the antenna port and procedures of KDB 558074 D01 v04 was followed to measure the Peak conducted power.

The Spectrum Analyzer was set to the following:

RBW = \geq DTS bandwidth

VBW \geq 3 x RBW

Peak Detector

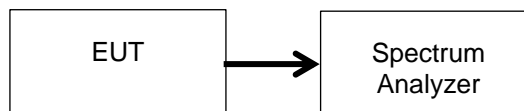
Trace mode = max hold

Sweep = auto

Span \geq 3 x RBW

The EUT was set to continuous transmit on the lowest, middle and highest frequencies at the maximum power level. The RF output power was measured using the spectrum analyzer's channel power function

Test Setup



Transmitter Output Power

Tuned Frequency (MHz)	Measured Value (dBm)	Specification Limit	Result
2406	4.83	1 W (30 dBm)	Pass
2440	5.90	1 W (30 dBm)	Pass
2480	-13.5	1 W (30 dBm)	Pass



Radiated Spurious Emissions

Engineer: Poona Saber

Test Date: 6/26/2017

Test Procedure Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The Antenna port on EUT got terminated into a 50 Ohms Load. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. 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.

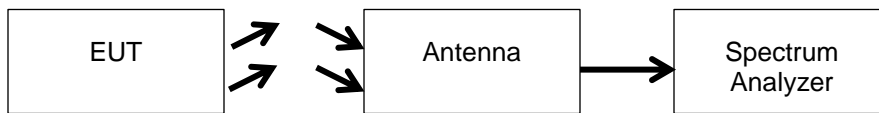
Correction factors were input into the spectrum analyzer before recording “Measured Level”.

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

Test Setup



Test Procedure for Radiated Spurious Emissions above 1 GHz

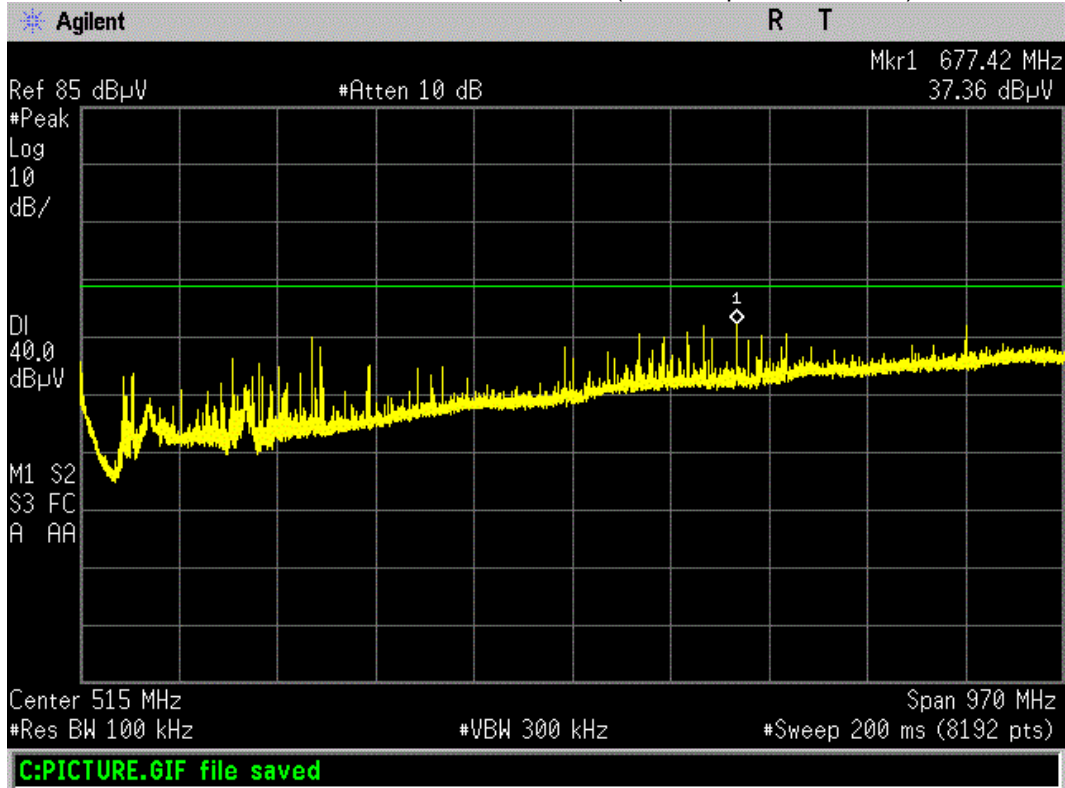
The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested 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. Emissions were investigated up to the 10th harmonic. Only noise floor was observed past 10 GHz.

Test Setup

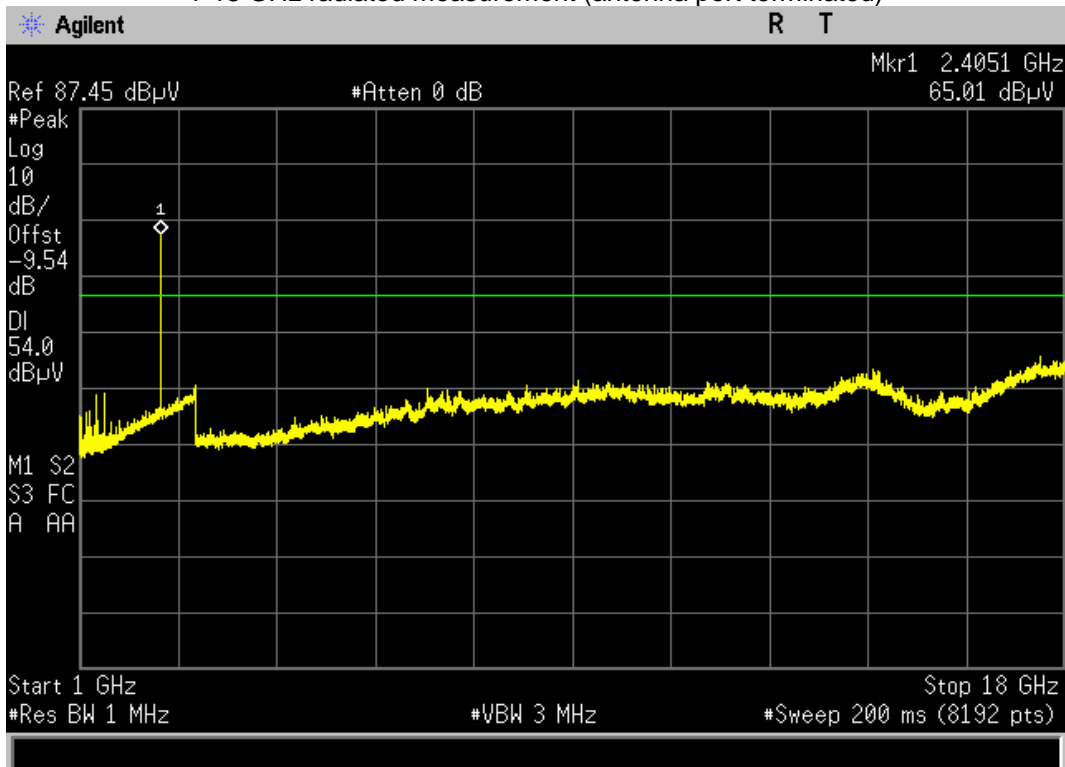




30 MHz- 1GHz radiated measurement (antenna port terminated)



1-18 GHz radiated measurement (antenna port terminated)





Conducted Spurious Emission

Engineer: Poona Saber

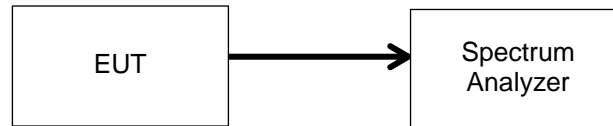
Test Date: 6/21/2017

Test Procedure

The EUT was connected to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions of part 15.247 (d) and 15.209 for restricted band emissions. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed. Only detectable spurious emissions were recorded and plotted. The peak output power is added to the recorded measurement to provide the corrected spurious level dBc.

Only the worst case is recorded in the Conducted Spurious Emissions Summary Test Table.

Test Setup



Note: For conducted measurements in restricted bands per KDB 558074 a maximum ground reflection factor of 4.7 dB is added to EIRP level for frequencies between 30 MHz and 1000 MHz.

See Annex A for test results



DTS Bandwidth

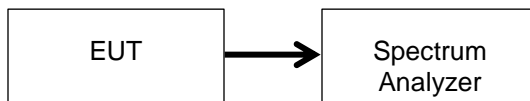
Engineer: Poona Saber

Test Date: 6/21/2017

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

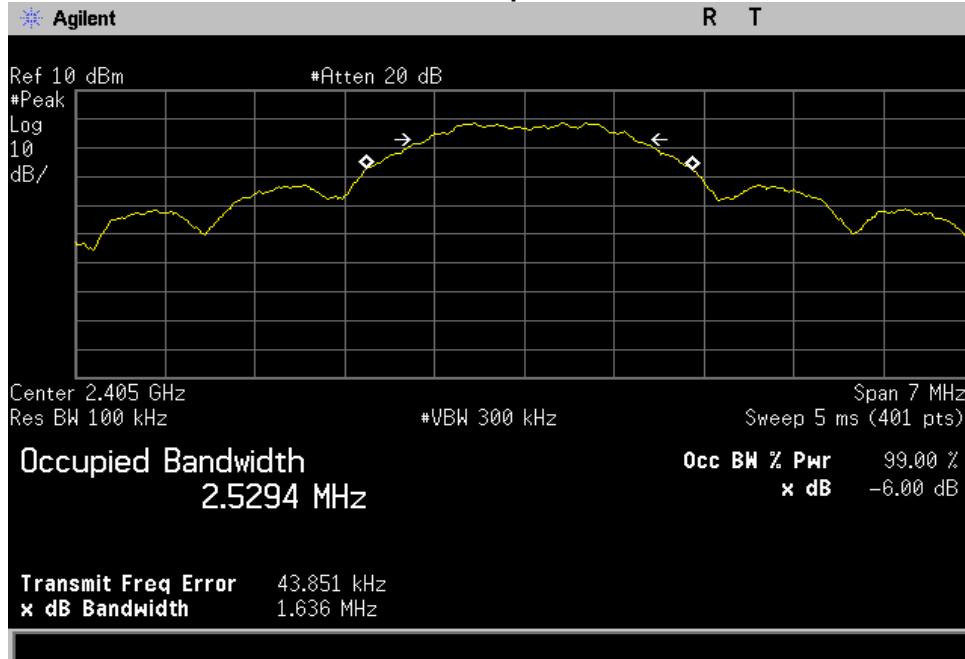
Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2406	1.63	≥ 500	Pass
2440	1.54	≥ 500	Pass
2480	1.53	≥ 500	Pass

99% Bandwidth Summary

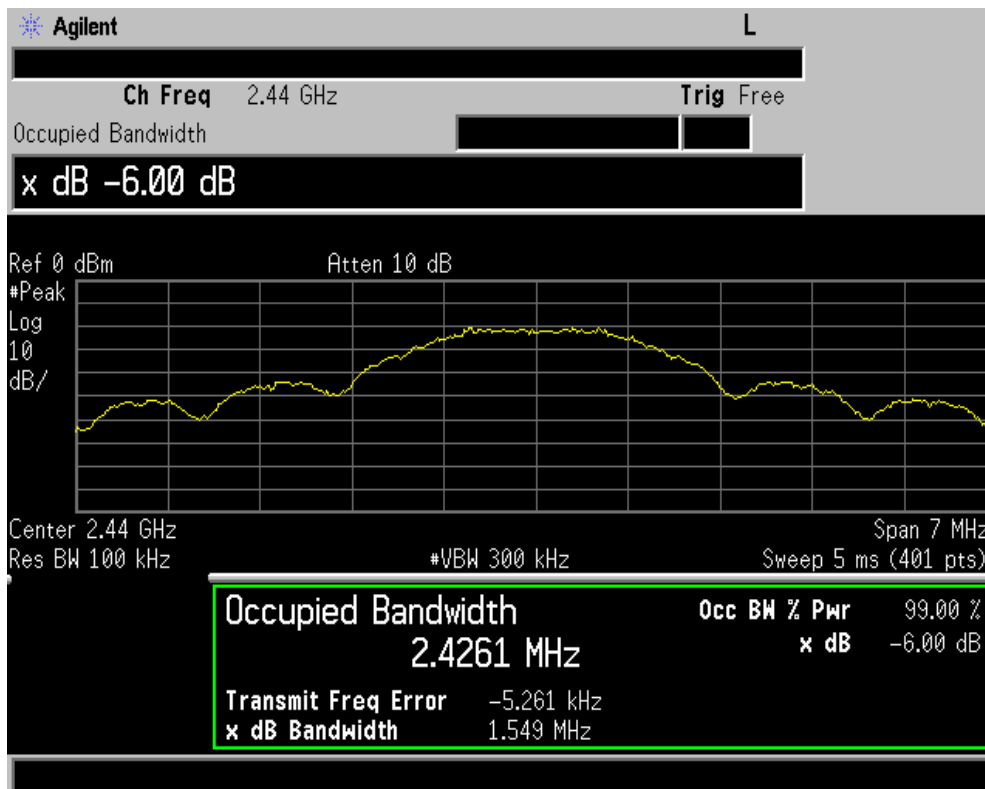
Frequency (MHz)	Measured Bandwidth (MHz)	Result
2406	2.52	Pass
2440	2.44	Pass
2480	2.50	Pass



Low channel Occupied Bandwidth

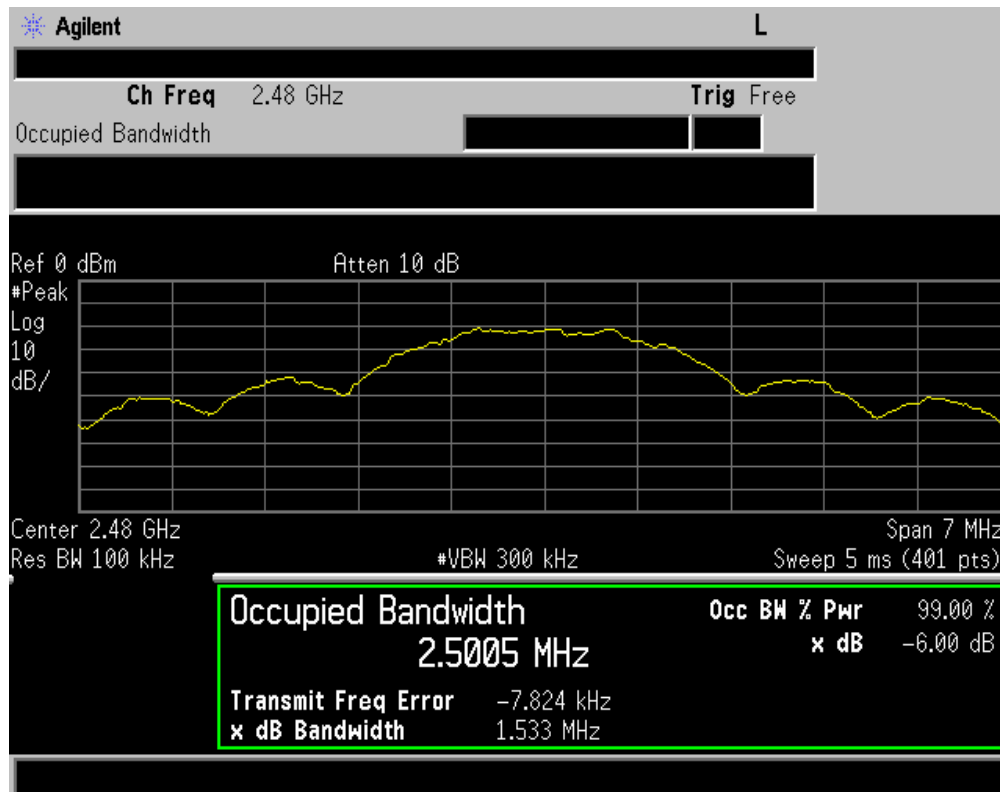


Mid channel Occupied Bandwidth





High channel Occupied Bandwidth





Transmitter Power Spectral Density (PSD)

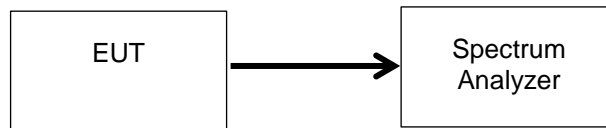
Engineer: Poona Saber

Test Date: 6/21/2017

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

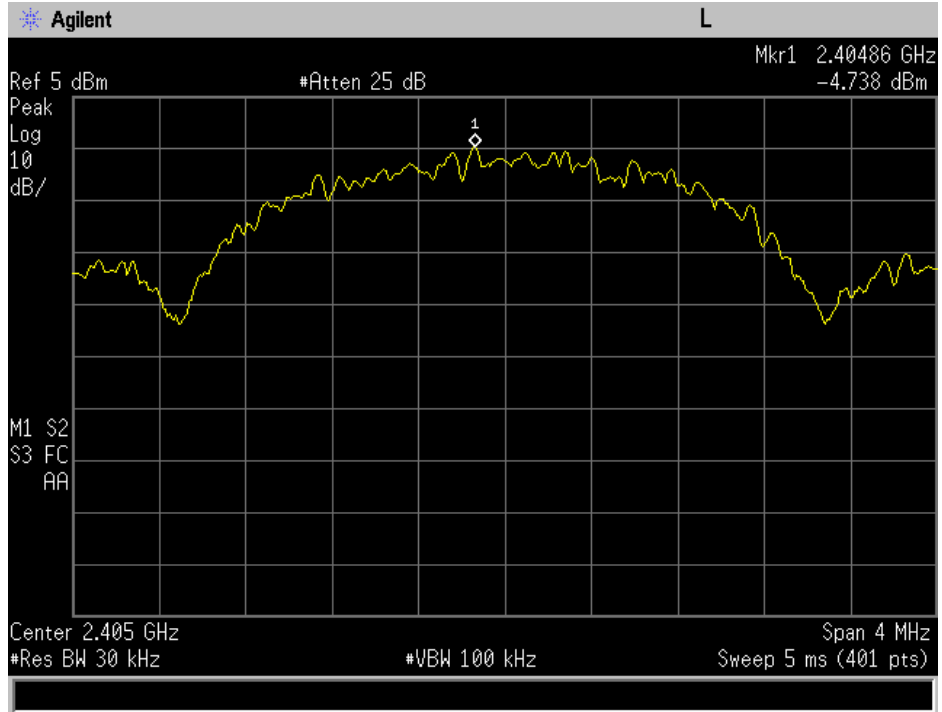


PSD Summary

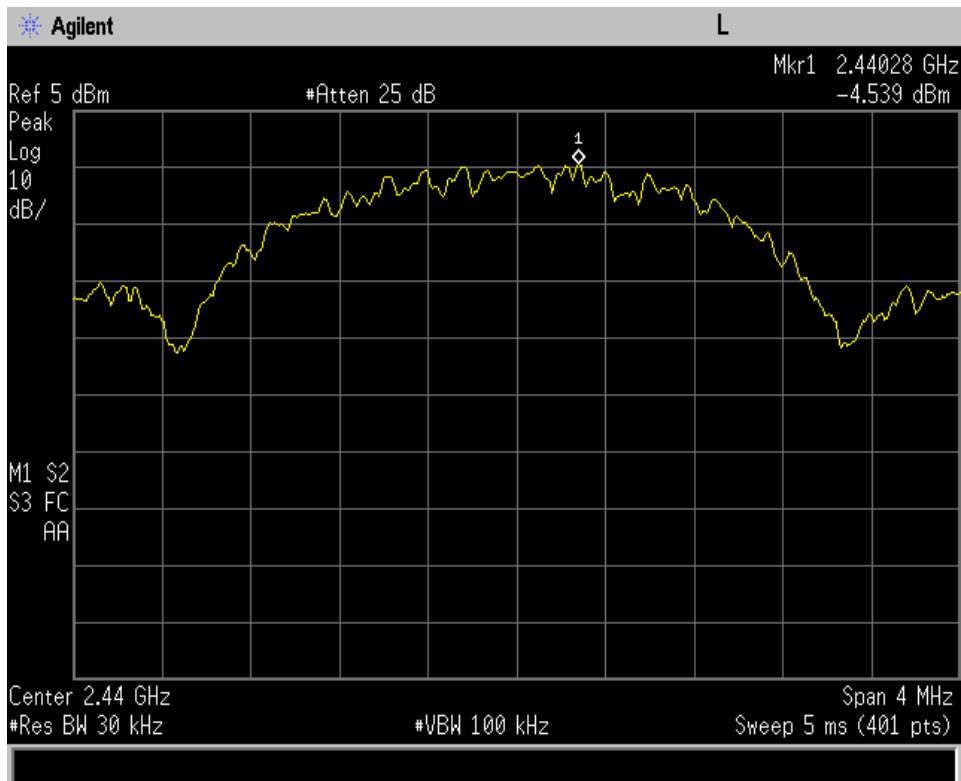
Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2405	-4.73	8	Pass
2440	-4.53	8	Pass
2480	-25.02	8	Pass



Low Channel PSD

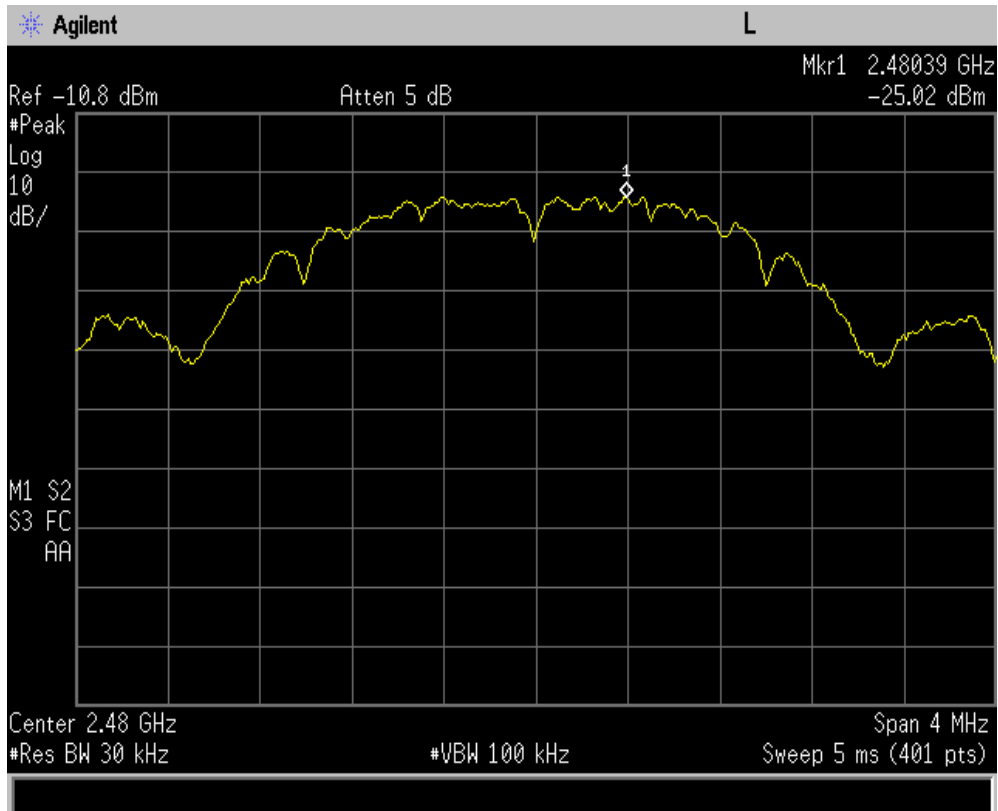


Mid Channel PSD





High Channel PSD





A/C Powerline Conducted Emission

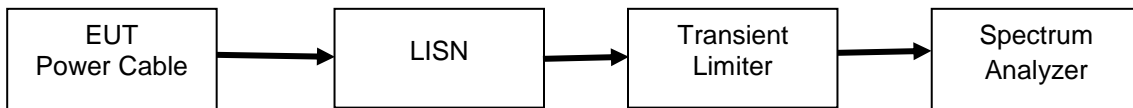
Engineer: Poona Saber

Test Date: 6/26/2017

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



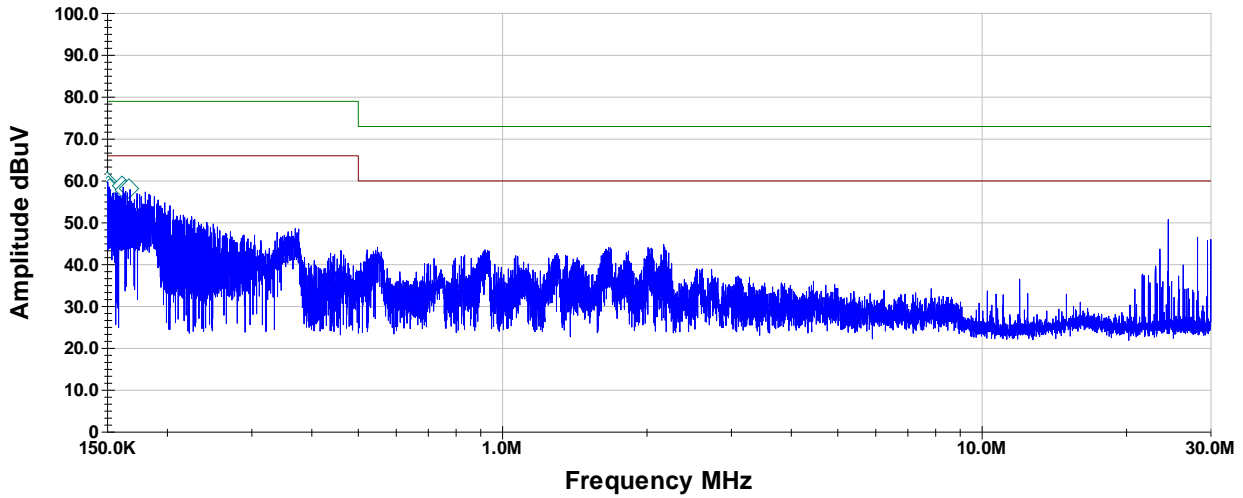


Conducted Emission Test Results

Line 1 Peak Plot

Compliance Testing Conducted Emissions - Class A Line 1 (Neutral)

- ◇ Points of Interest
- Corrected Peak Data
- CISPR_A_QP
- CISPR_A_AV



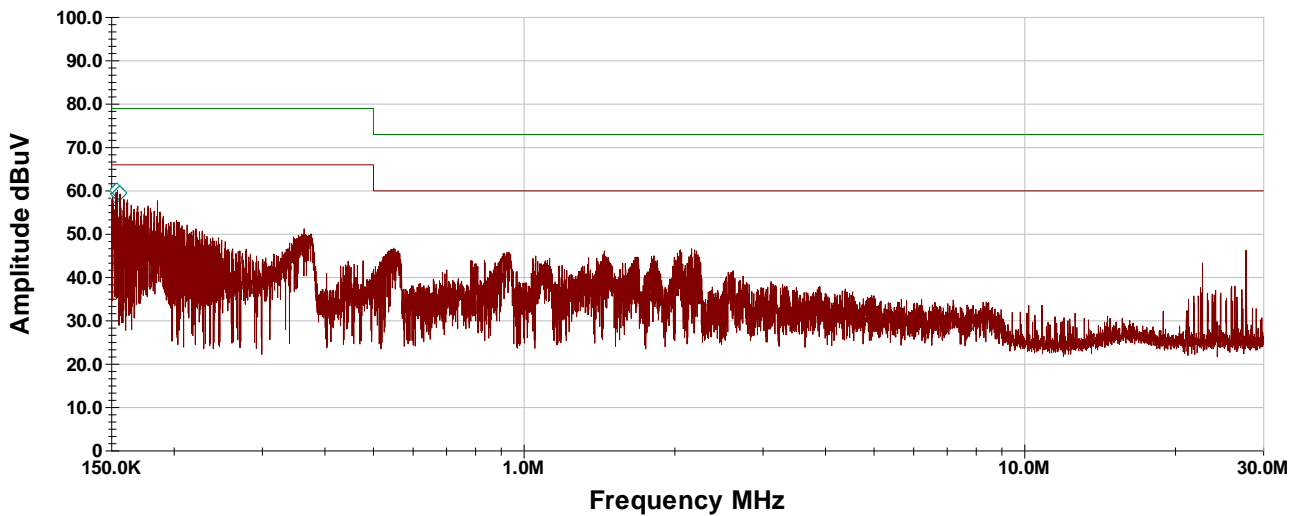
Operator: PS
EN55022 Class A.til

Job #:

Line 2 Peak Plot

Compliance Testing Conducted Emissions - Class A Line 2 (Phase)

- ◇ Points of Interest
- Corrected Peak Data
- CISPR_A_QP
- CISPR_A_AV



Operator: PS
EN55022 Class A.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)
150.25 KHz	14.473	0.298	0.02	10.2	24.991	66	-41.009
150.63 KHz	14.78	0.294	0.02	10.2	25.294	66	-40.706
154.13 KHz	14.53	0.259	0.02	10.2	25.009	66	-40.991
155.73 KHz	14.32	0.243	0.02	10.2	24.783	66	-41.217
156.01 KHz	14.39	0.24	0.02	10.2	24.85	66	-41.15
159.55 KHz	14.617	0.205	0.02	10.2	25.041	66	-40.959

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)
150.93 KHz	13.19	0.29	0.02	10.2	23.704	66	-42.296
152.43 KHz	13.5	0.28	0.02	10.2	23.996	66	-42.004
152.63 KHz	13.42	0.27	0.02	10.2	23.91	66	-42.09
154.2 KHz	13.67	0.26	0.02	10.2	24.151	66	-41.849
154.3 KHz	13.33	0.26	0.02	10.2	23.807	66	-42.193
157.45 KHz	13.5	0.23	0.02	10.2	23.949	66	-42.051

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)
150.25 KHz	38.68	0.298	0.02	10.2	49.197	79	-29.803
150.63 KHz	38.65	0.294	0.02	10.2	49.164	79	-29.836
154.13 KHz	38.73	0.259	0.02	10.2	49.209	79	-29.791
155.73 KHz	38.92	0.243	0.02	10.2	49.383	79	-29.617
156.01 KHz	38.92	0.24	0.02	10.2	49.38	79	-29.62
159.55 KHz	38.69	0.205	0.02	10.2	49.114	79	-29.886

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)
150.93 KHz	38.65	0.29	0.02	10.2	49.161	79	-29.839
152.43 KHz	38.91	0.28	0.02	10.2	49.406	79	-29.594
152.63 KHz	39.06	0.27	0.02	10.2	49.554	79	-29.446
154.2 KHz	38.95	0.26	0.02	10.2	49.428	79	-29.572
154.3 KHz	38.82	0.26	0.02	10.2	49.297	79	-29.703
157.45 KHz	39.08	0.23	0.02	10.2	49.525	79	-29.475



Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	6/16/16	6/16/18
Horn Antenna, Amplified	ARA	MWH-1826/B	i00273	4/22/15	4/22/18
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	6/9/17	6/9/18
Spectrum Analyzer	Agilent	E4407B	i00331	10/19/16	10/19/17
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	8/3/16	8/3/18
EMI Analyzer	Agilent	E7405A	i00379	2/22/17	2/22/18
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	8/15/16	8/15/19
PSA Spectrum Analyzer	Agilent	E4445A	i00471	8/30/16	8/30/17
Preamplifier	Miteq	AFS44 00101 400 23-10P-44	i00509	N/A	N/A

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