Compliance Testing, LLC
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Test Report

Prepared for: Sensys Networks, Inc.

Model: APCC-SPP & ASENSE-RADIO

Description: Traffic Sensor System

Serial Number: 20151

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

To

FCC Part 15.247

Date of Issue: June 13, 2017

On the behalf of the applicant:

Sensys Networks, Inc.
2560 Ninth St.
Suite 219
Berkeley, CA 94710

Attention of:

Sebastian Lodahl, Hardware Engineer
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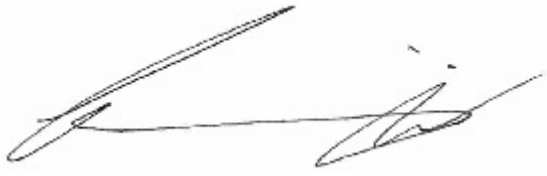
Project No: p1750012



Alex Macon
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	May 30, 2017	Alex Macon	Original Document
2.0	June 6, 2017	Alex Macon	Added operational band detail to page 6 Updated the references on page 8 Updated the test procedure on page 9, 11 and 14 Added more detail in Annex A and page 6 regarding the measurement method during average radiated spurs. Added AC line conducted emissions
3.0	June 12, 2017	Alex Macon	Updated 1.1310 report to show EIRP instead of conducted. This was a template error. Updated 15.247 to include more information under additional information page 6

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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**

ACCREDITED
TESTING CERT
#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 (ºC)	**Humidity (%)**	**Pressure (mbar)**
23.3	28.9	967

EUT Description
Model: APCC-SPP & ASENSE-RADIO
Description: Traffic Sensor System
Firmware: N/A
Software: TrafficDOT2
Serial Number: 20151
Additional Information:
The EUT is a traffic sensor which is powered by POE and operates in the 2406 – 2480MHz band
The EUT incorporates DSSS O-QPSK modulation in an 802.15.4 PHY protocol.
The EUT incorporates a 5dBi ceramic patch 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 with a duty cycle of around 4.256ms / 500ms.

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	POE Device	Sensys Networks	APCC	558
2	Traffic Flow Sensor	Sensys Networks	VSN240-F-2	83902, 83561

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:

X	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	N/A	The EUT does not incorporate a temporary or permanent antenna connector
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: Alex Macon
Test Date: 5/20/17

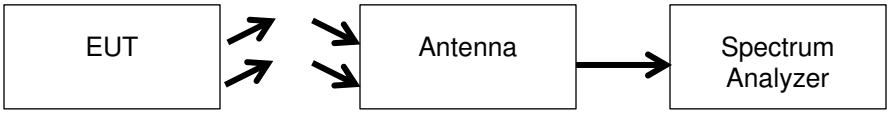
Test Procedure

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 Output Power. 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.
The Spectrum Analyzer was set to the following:

RBW = ≥ DTS bandwidth
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto
Span ≥ 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)	Antenna Gain (dBi)	Value at Antenna Port (dBm)	Specification Limit	Result
2406	5.131	5.5	-0.369	1 W (30 dBm)	Pass
2440	6.136	5.5	0.636	1 W (30 dBm)	Pass
2480	6.283	5.5	0.783	1 W (30 dBm)	Pass

As per KDB 558074 D01 v04, the formula E = EIRP – 20log D + 104.8 was utilized to convert the measured radiated field strength into power measurements.

Radiated Spurious Emissions
Engineer: Alex Macon
Test Date: 5/20/17

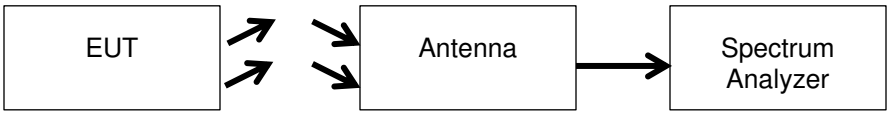
Test Procedure
Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The 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

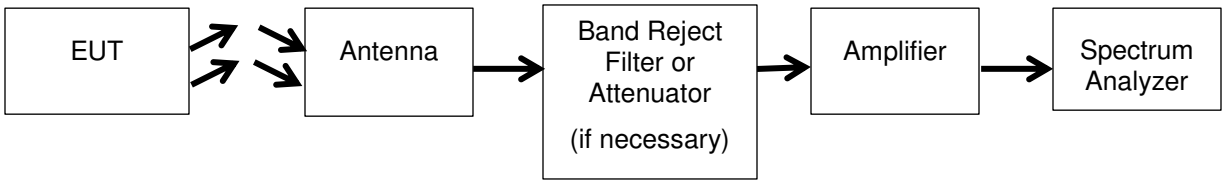
Test Setup



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



See Annex A for Test Data

DTS Bandwidth
Engineer: Alex Macon
Test Date: 5/20/17

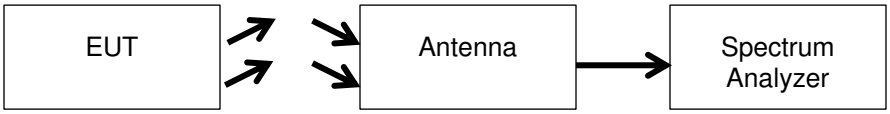
Test Procedure

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 DTS Bandwidth. 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.
The Spectrum Analyzer was set to the following:

RBW = 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple
Span = 1.5 x EBW

The EUT was set to transmit at the lowest, middle and highest channels of the band at the maximum power levels. The maximum width of the emission that was determined by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that were attenuated by 6db and this value was used to determine the width of the carrier. Alternatively the spectrum analyzer's automatic bandwidth capability was used.

Test Setup



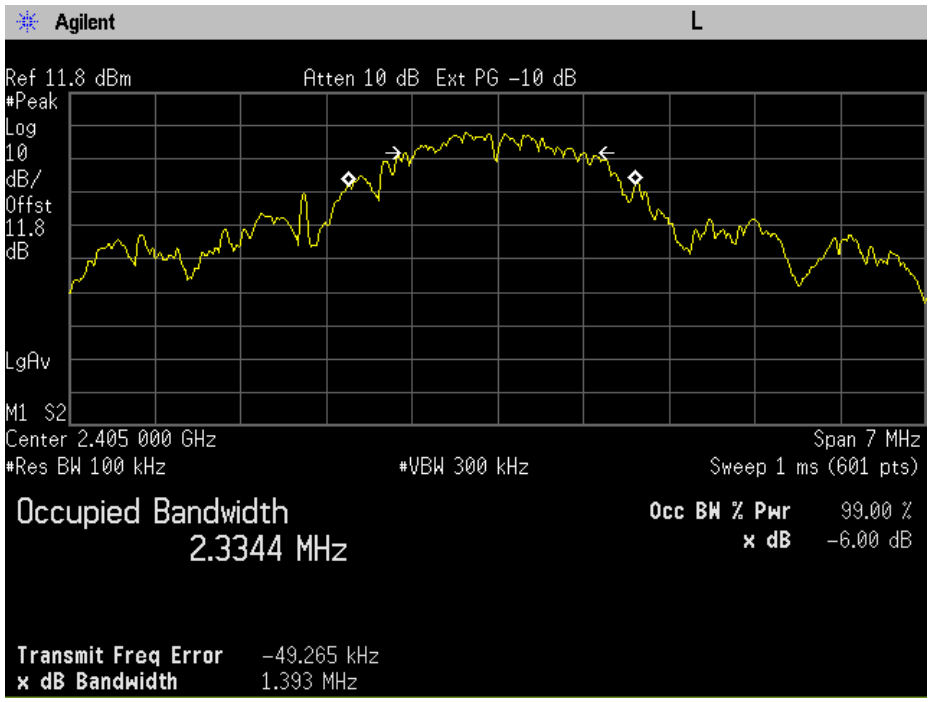
6 dB Occupied Bandwidth Summary

Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2406	1.393	≥ 500	Pass
2440	1.282	≥ 500	Pass
2480	1.563	≥ 500	Pass

99% Bandwidth Summary

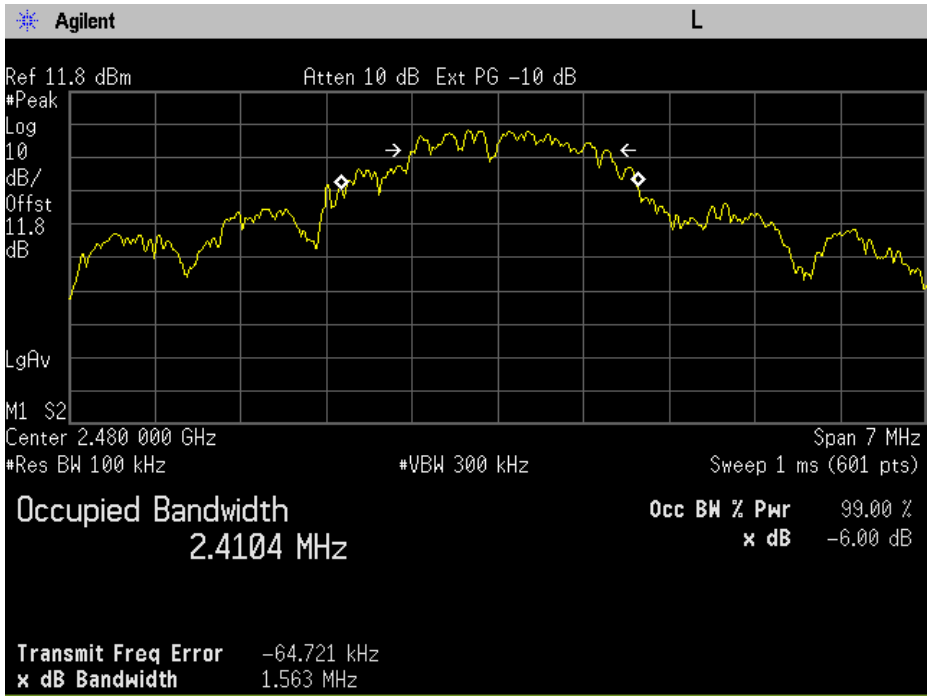
Frequency (MHz)	Measured Bandwidth (MHz)	Result
2406	2.334	Pass
2440	2.394	Pass
2480	2.410	Pass

Low channel Occupied Bandwidth



Mid channel Occupied Bandwidth

High channel Occupied Bandwidth



Transmitter Power Spectral Density (PSD)
Engineer: Alex Macon
Test Date: 5/20/17

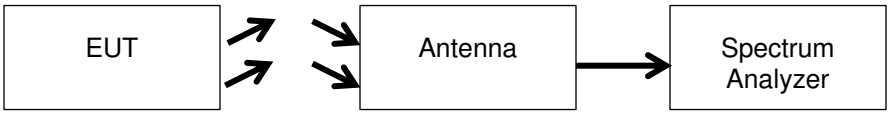
Test Procedure

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 Transmitter Power Spectral Density. 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. . The Spectrum Analyzer was set to the following:

DTS channel center frequency
Span 1.5 x DTS bandwidth
RBW =3 kHz ≤ RBW ≤ 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Sweep time = auto couple
Trace mode = max hold

The EUT was set to transmit at the lowest, middle and highest channels of the band at the maximum power levels. Once the trace has stabilize the peak marker was used to determine the peak power spectral density.

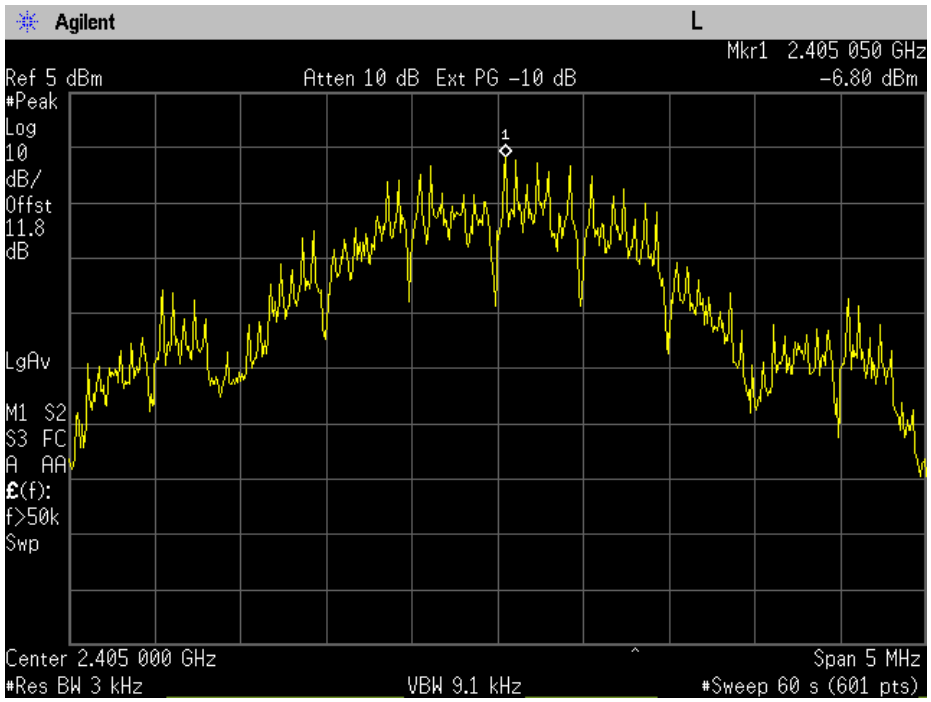
Test Setup



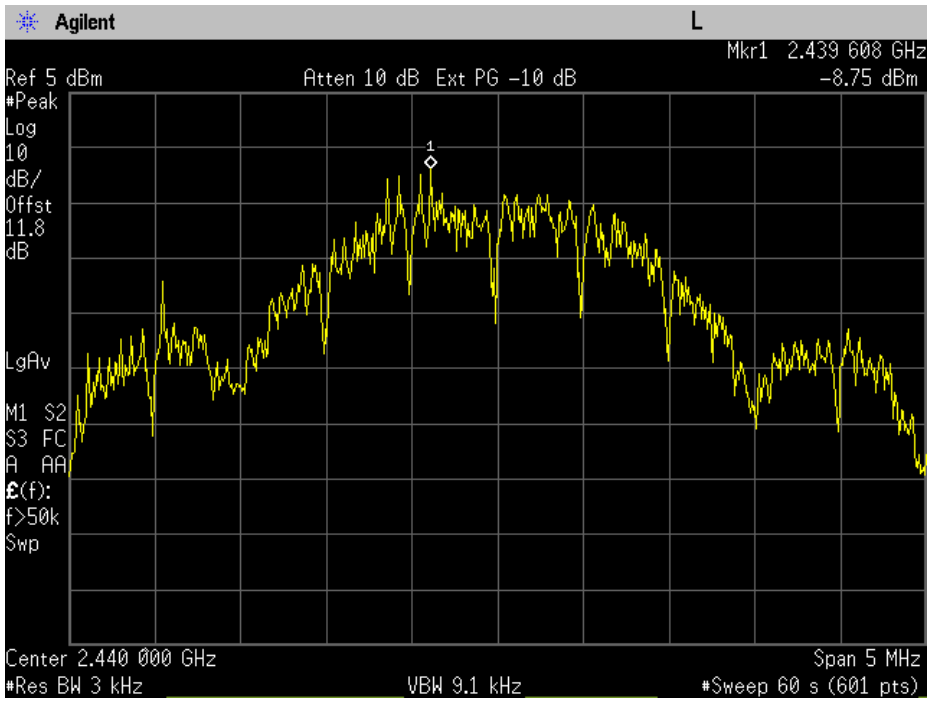
PSD Summary

Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2405	-6.80	8	Pass
2440	-8.75	8	Pass
2480	-6.77	8	Pass

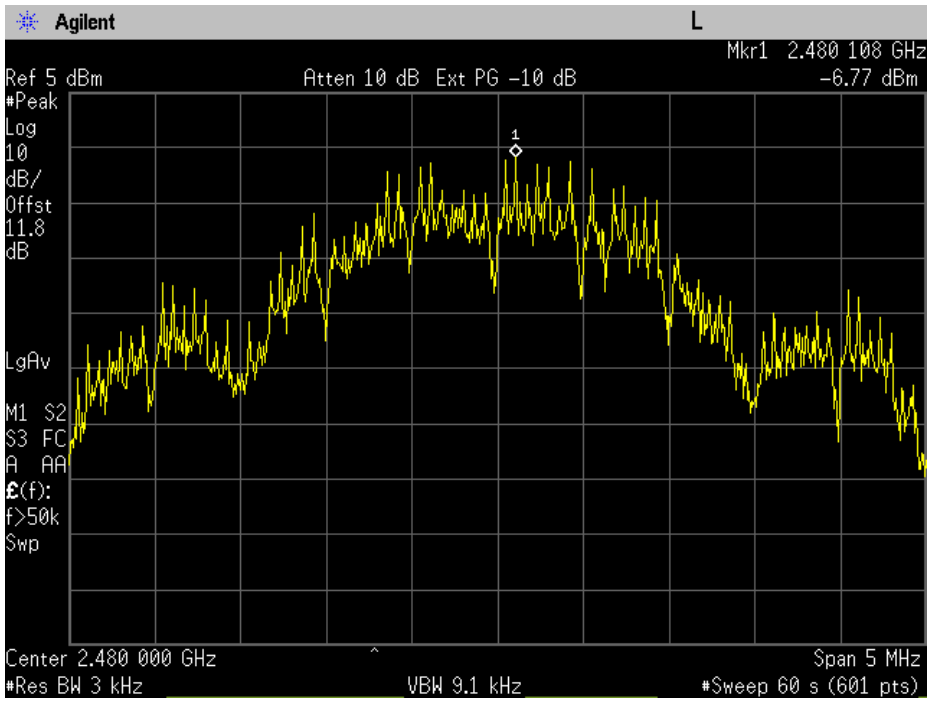
Low Channel PSD



Mid Channel PSD



High Channel PSD

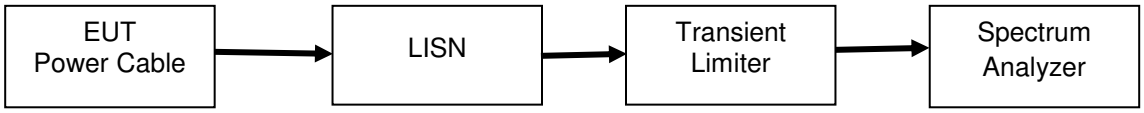


A/C Powerline Conducted Emission
Engineer: Alex Macon
Test Date: 5/25/17

Test Procedure

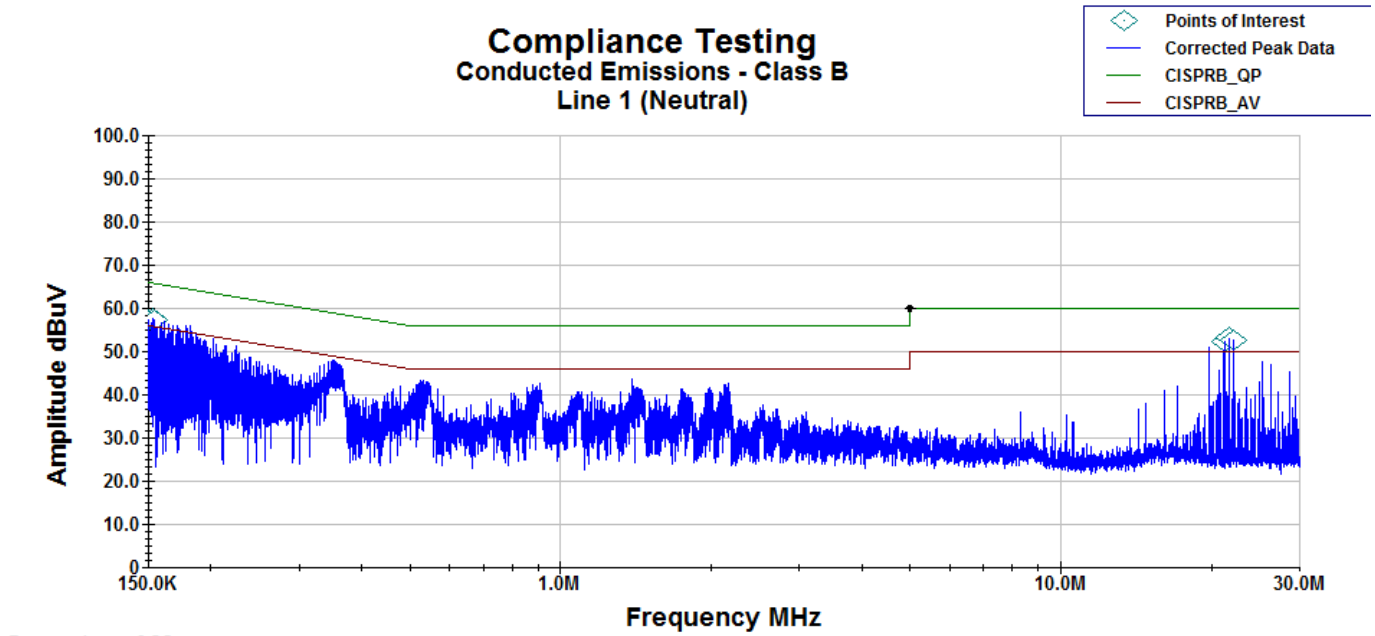
The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

Test Setup



Conducted Emission Test Results

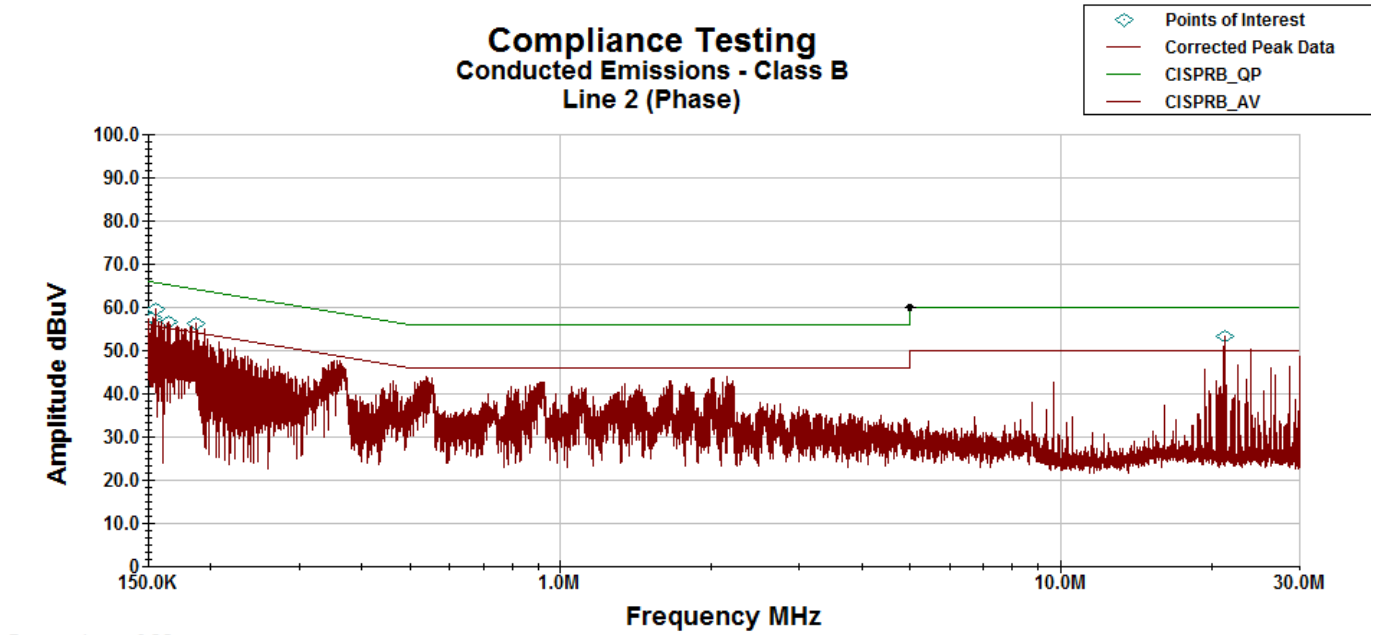
Line 1 Peak Plot



Operator: AM

EN55022 Class B_p1750012.til **Job #: p1750012**

Line 2 Peak Plot



Operator: AM

EN55022 Class B_p1750012.til **Job #: p1750012**

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)
150.48 KHz	14.05	0.3	0.02	10.2	24.57	55.986	-31.42
152.23 KHz	13.28	0.28	0.02	10.2	23.77	55.936	-32.16
154.0 KHz	13.6	0.26	0.02	10.2	24.08	55.886	-31.81
21.198 MHz	12.93	0.1	0.22	10.3	23.55	50	-26.45
21.656 MHz	13.68	0.1	0.22	10.3	24.30	50	-25.70
22.12 MHz	11.85	0.1	0.22	10.3	22.47	50	-27.53

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)
151.2 KHz	14.25	0.29	0.02	10.2	24.76	55.966	-31.21
152.68 KHz	14.39	0.27	0.02	10.2	24.89	55.923	-31.04
153.03 KHz	14.46	0.27	0.02	10.2	24.95	55.913	-30.97
154.23 KHz	14.24	0.26	0.02	10.2	24.72	55.879	-31.16
168.1 KHz	16.08	0.2	0.02	10.119	26.42	55.483	-29.06
21.197 MHz	13.33	0.1	0.22	10.3	23.95	50	-26.05

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)
150.48 KHz	37.6	0.295	0.02	10.2	48.12	65.986	-17.87
152.23 KHz	37.22	0.278	0.02	10.2	47.72	65.936	-18.22
154.0 KHz	39.72	0.26	0.02	10.2	50.20	65.886	-15.69
21.198 MHz	41.24	0.1	0.22	10.3	51.86	60	-8.14
21.656 MHz	41.23	0.1	0.22	10.3	51.85	60	-8.15
22.12 MHz	39.23	0.1	0.22	10.3	49.85	60	-10.15

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)
151.2 KHz	37.62	0.29	0.02	10.2	48.13	65.966	-17.84
152.68 KHz	37.50	0.27	0.02	10.2	47.99	65.923	-17.93
153.03 KHz	37.86	0.27	0.02	10.2	48.35	65.913	-17.56
154.23 KHz	37.52	0.26	0.02	10.2	48.00	65.879	-17.88
168.1 KHz	36.51	0.2	0.02	10.119	46.85	65.483	-18.63
21.197 MHz	42.67	0.1	0.22	10.3	53.29	60	-6.71

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	5/26/16	5/26/17
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