



Test Report

Prepared for: **Centralite Systems**

Model: 3146

Description: Villa 3-Button In-Wall Relay

Serial Number: N/A

FCC ID: T3L-SS041
IC: 12192A-SS041

To

FCC Part 15.247 DTS

And

RSS-247

Date of Issue: July 3, 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 | May 3, 2017 | Poona Saber | Original Document |
| 2.0 | June 30, 2017 | Poona Saber | Page 14 modification, revised asset date on page 23 |
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| | | | |



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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) |
| 24.4 | 26.8 | 966.2 |

EUT Description

Model: 3146

Description: Villa 3-Button In-Wall Relay

Firmware: N/A

Software: N/A

Serial Number: N/A

The EUT is a wall mounted switched intended to control lighting in a residential environment. It incorporates a 2.4 GHz radio which spans from 2405MHz – 2480MHz with an emissions designator 2M52F7D

EUT Operation during Tests

The EUT was placed in a test mode using manufacturer provided software. The test modes enabled the device to transmit continuously with CW or modulated signals.



Accessories:

| Qty | Description | Manufacturer | Model | S/N |
|-----|--------------------|--------------|-------|-----|
| 1 | Communication Unit | Silicon Labs | ISA3 | N/A |

Cables:

| Qty | Description | Length (M) | Shielding Y/N | Shielded Hood Y/N | Ferrite Y/N |
|-----|---------------|------------|---------------|-------------------|-------------|
| 1 | Ten Pin Cable | <3m | N | N | N |

Modifications: N/A

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) | Peak Output Power | Pass | |
| 15.247(b) | Conducted Spurious Emissions | N/A | EUT incorporates an integral antenna |
| 15.247(d), 15.209(a), 15.205 | Radiated Spurious Emissions | Pass | |
| 15.247(d), 15.209(a), 15.205 | Emissions At Band Edges | Pass | |
| 15.247(a)(2) | Occupied Bandwidth | Pass | |
| 15.247(e) | Transmitter Power Spectral Density | Pass | |
| 15.207 | A/C Powerline Conducted Emissions | Pass | |
| RSS-Gen §7 | Receiver Spurious Emission Limits | Pass | |

Average Output Power

Engineer: Poona Saber

Test Date: 4/27/16

Test Procedure

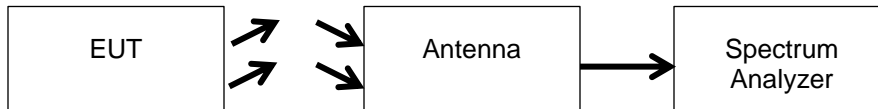
The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Peak Output Power. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised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

The following equations were used to determine the EIRP from the field strength values.

$E[\text{dB}\mu\text{V}/\text{m}] = \text{EIRP}[\text{dBm}] - 20 \log(d[\text{meters}]) + 104.77$, where E = field strength and d = 3m

$E[\text{dB}\mu\text{V}/\text{m}] = \text{EIRP}[\text{dBm}] + 95.2$, for d = 3 meters.

Test Setup



Transmitter Average Output Power

| Tuned Frequency (MHz) | Measured Value (dBm) | Specification Limit | Result |
|-----------------------|----------------------|---------------------|--------|
| 2405 | 2.76 | 1 W (30 dBm) | Pass |
| 2440 | 3.08 | 1 W (30 dBm) | Pass |
| 2480 | -19.76 | 1 W (30 dBm) | Pass |



Radiated Spurious Emission 15.247(d)

Engineer: Poona Saber

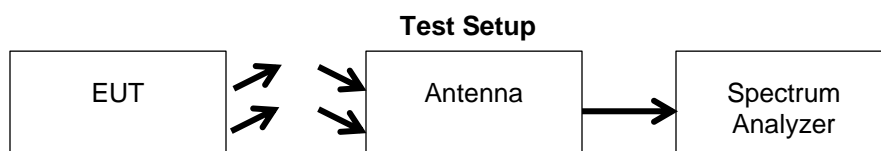
Test Date: 4/28/17

Test Procedure

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 Spurious. 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 25 GHz were examined; only the plots below measured emissions. Measured Level includes antenna and receiver cable correction factors. Correction factors were input into the spectrum analyzer before recording “Measured Level”.

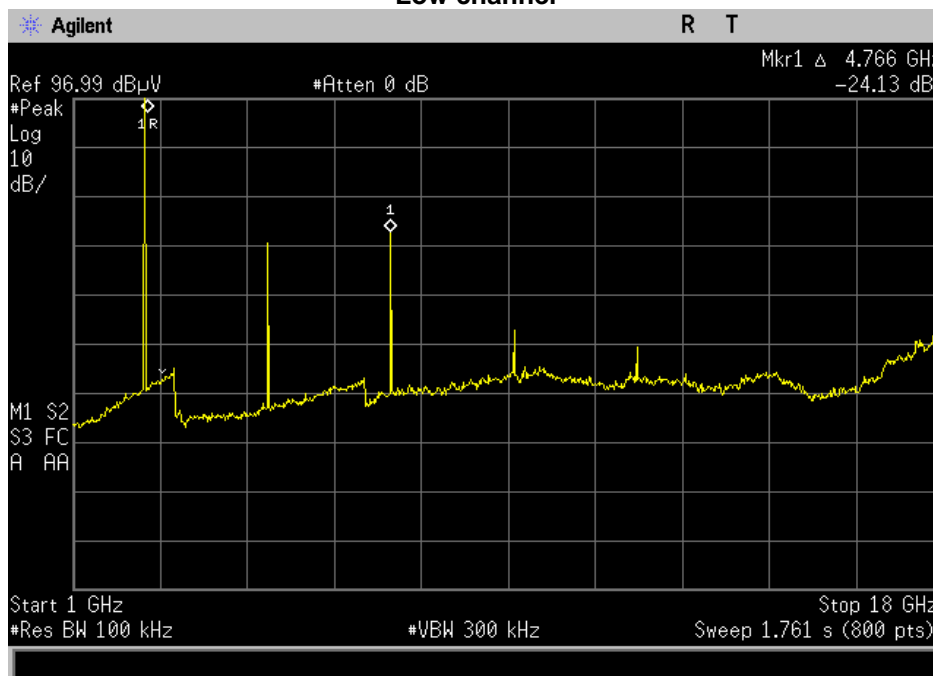
RBW = 100 KHz
VBW = 300 KHz
Detector –Peak



Conducted Spurious Emissions Summary Test Table

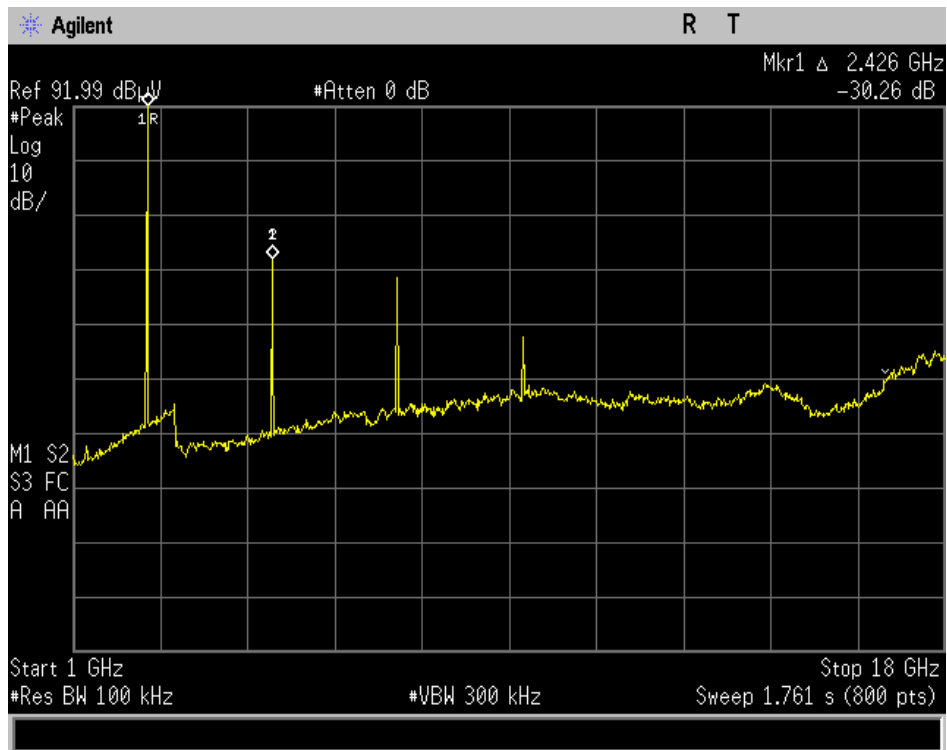
| Tuned Frequency (MHz) | Emission Frequency (MHz) | Measurement (dBc) | Specification Limit (dBc) | Result |
|-----------------------|--------------------------|-------------------|---------------------------|--------|
| 2405 | 4810 | -24.13 | -20 | Pass |
| 2440 | 4880 | -30.26 | -20 | Pass |
| 2480 | 14550 | -22.28 | -20 | Pass |

Low channel

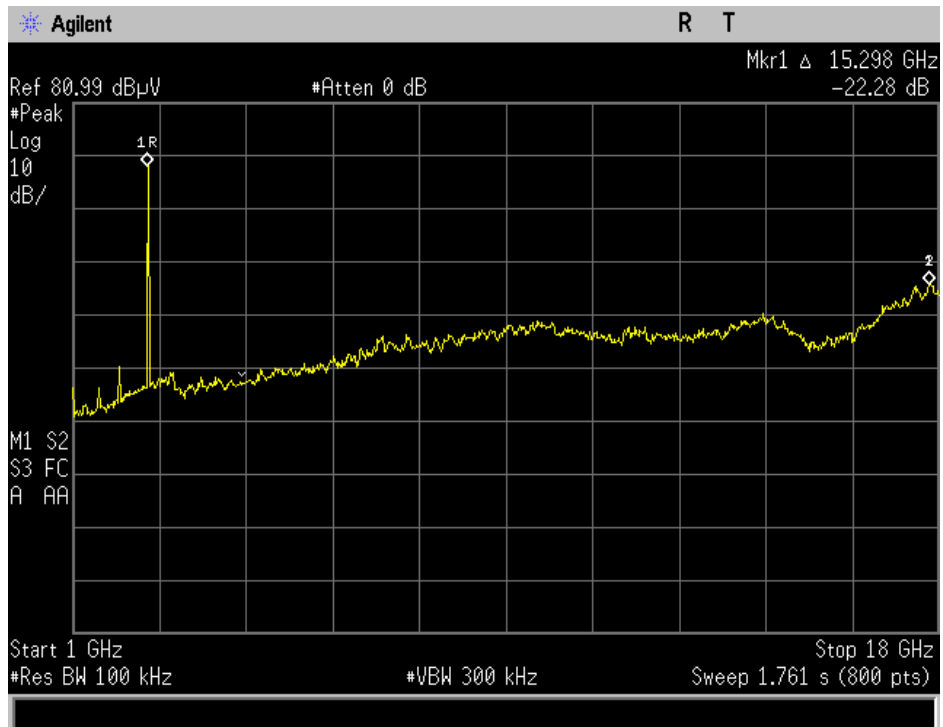




Mid Channel



High Channel





Radiated Spurious Emissions

Engineer: Poona Saber

Test Date: 4/28/17

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.

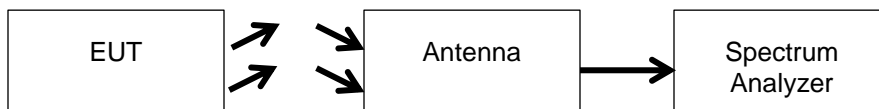
Correction factors were input into the spectrum analyzer before recording “Measured Level”.

RBW = 100 KHz

VBW = 300 KHz

Detector –Peak

Test Setup



See Annex A for test results

Note: For the emissions below 150 MHz further investigation was done. Device was put on standby mode to make sure the emission observed are not coming from the radio portion. Below are the testing results below 1GHz; shows compliance with the 15.209/109 limit.

| Frequency | Measured Level | Limit | Margin | Antenna Height | Antenna Polarity | Turntable Position | Detector |
|-----------|----------------|-------|--------|----------------|------------------|--------------------|------------|
| MHz | dBuV | dBuV | dB | cm | H vor V | degrees | QP, Pk, Av |
| 45.34 | 37.76 | 40 | -2.24 | 100 | H | 51 | QP |
| 144.8 | 43.2 | 43.5 | -0.3 | 100 | H | 100 | QP |
| 125.1 | 39.96 | 43.5 | -3.54 | 100 | H | 207 | QP |
| 147.34 | 42.56 | 43.5 | -0.94 | 100 | H | 95 | QP |
| 140.54 | 41.3 | 43.5 | -2.2 | 100 | H | 78 | QP |
| 500.11 | 40.67 | 46 | -5.33 | 100 | V | 254 | QP |

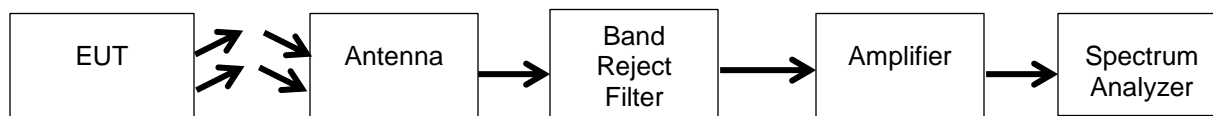


Test Procedure for Radiated Spurious Emissions above 1 GHz

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.

RBW = 1 MHz
VBW \geq 3 MHz
Detector – Peak

Test Setup



See Annex A for test results

Emissions at Band Edges

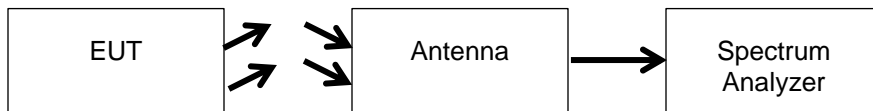
Engineer: Poona Saber

Test Date: 4/28/17

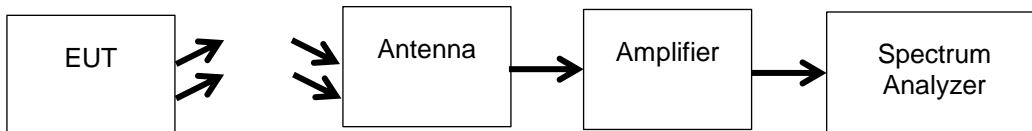
Test Procedure

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 band edge and restricted band for both peak and average measurements. The cable and antenna correction factors were input into the analyzer as a reference level offset to ensure accurate readings. For the restricted band the amplifier and band reject filter correction factors were also input to the spectrum analyzer.

Band Edge Test Setup

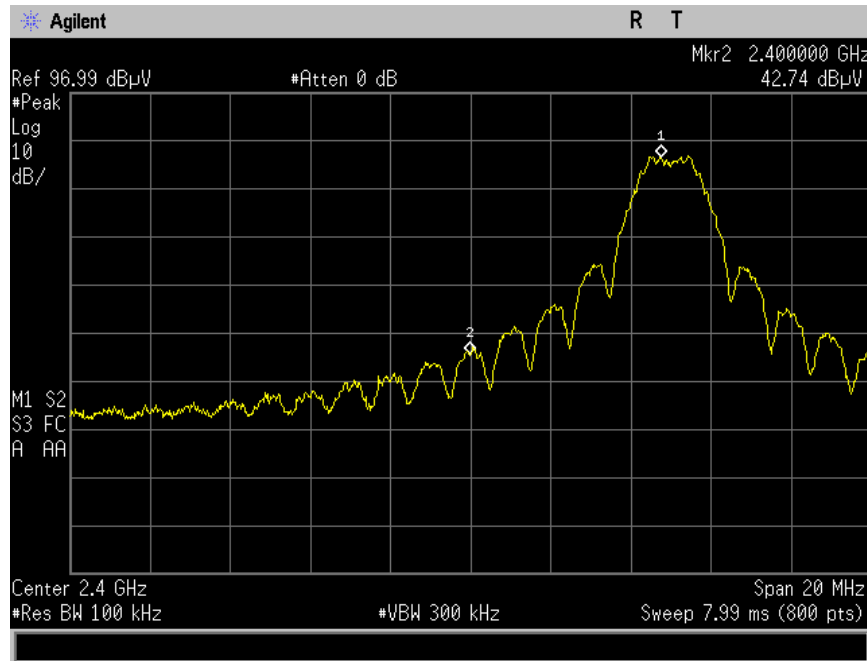


Restricted Band Test Setup

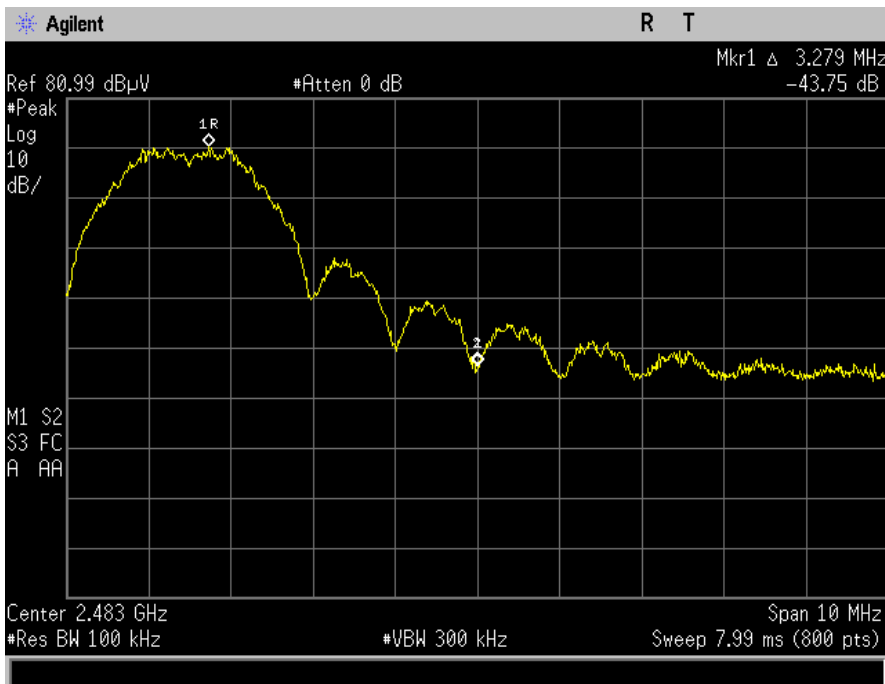




Band Edge 2400 MHz Tuned Freq = 2405 MHz

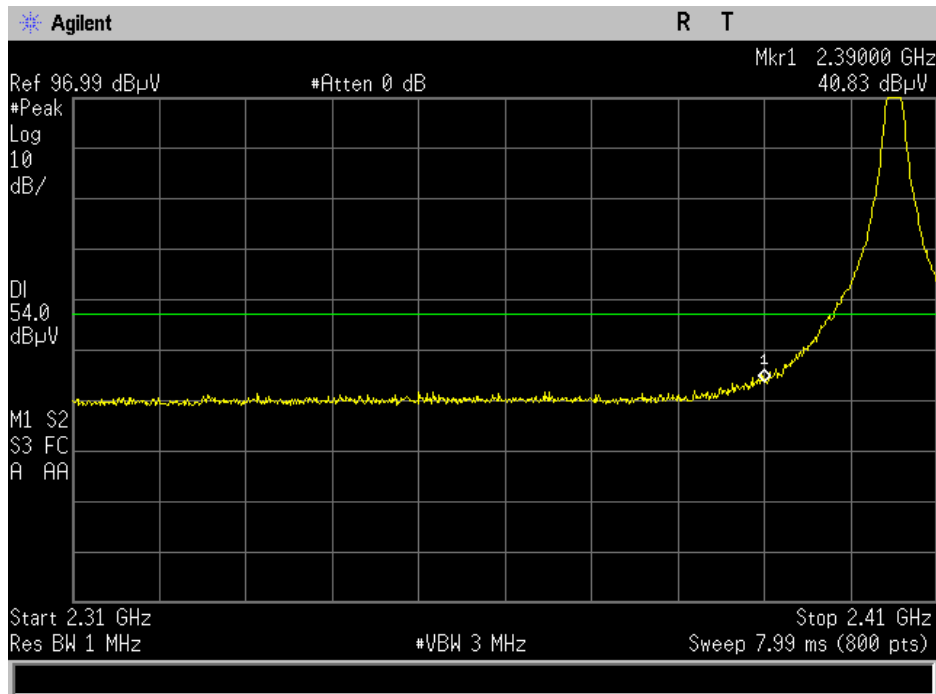


Band Edge 2483.5 MHz Tuned Freq = 2480 MHz

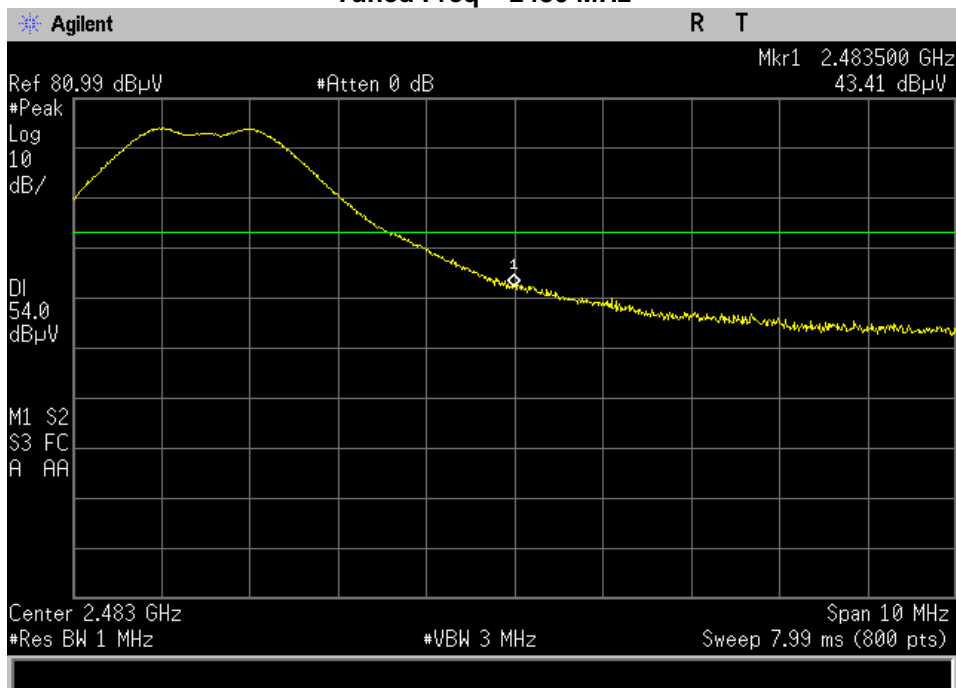




Restricted Band 2300 – 2390 MHz – Peak
Tuned Freq = 2405 MHz



Restricted Band 2483.5 – 2500 MHz – Peak
Tuned Freq = 2480 MHz





Occupied Bandwidth

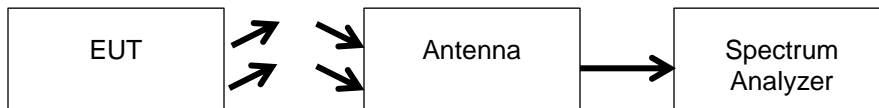
Engineer: Poona Saber

Test Date: 4/28/2017

Test Procedure

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 Occupied Bandwidth. The cable and antenna correction factors were input into the analyzer as a reference level offset to ensure accurate readings.

Test Setup



6 dB Occupied Bandwidth Summary

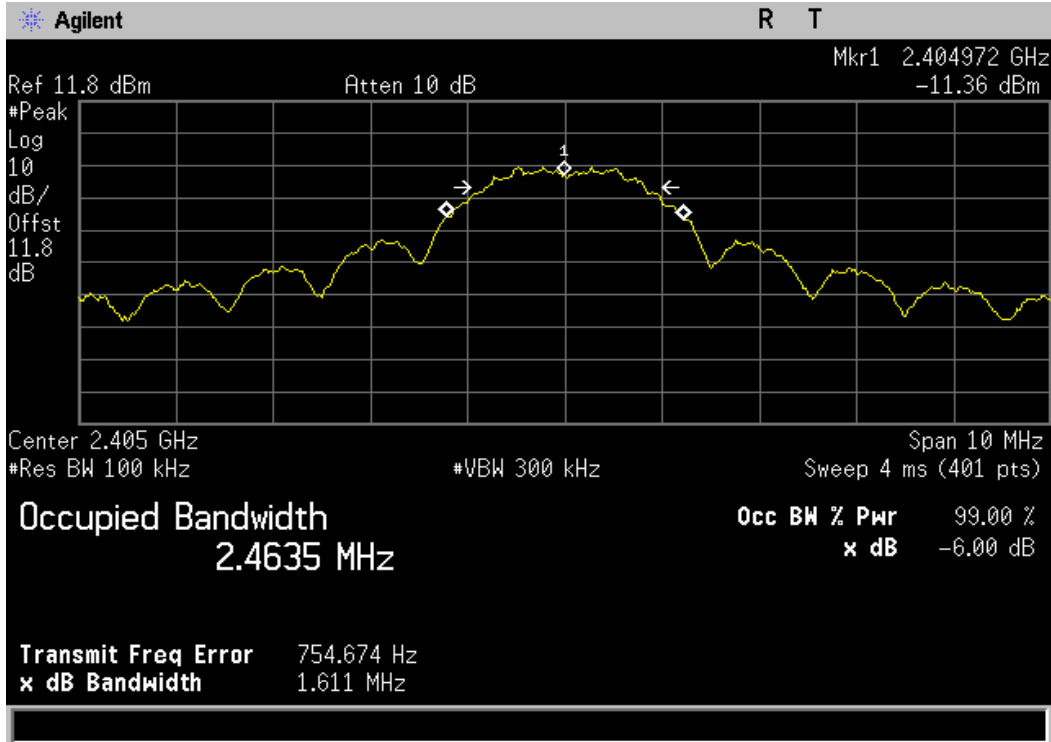
| Frequency (MHz) | Measured Bandwidth (MHz) | Specification Limit (kHz) | Result |
|-----------------|--------------------------|---------------------------|--------|
| 2405 | 1.61 | ≥ 500 | Pass |
| 2440 | 1.57 | ≥ 500 | Pass |
| 2480 | 1.60 | ≥ 500 | Pass |

99% Bandwidth Summary

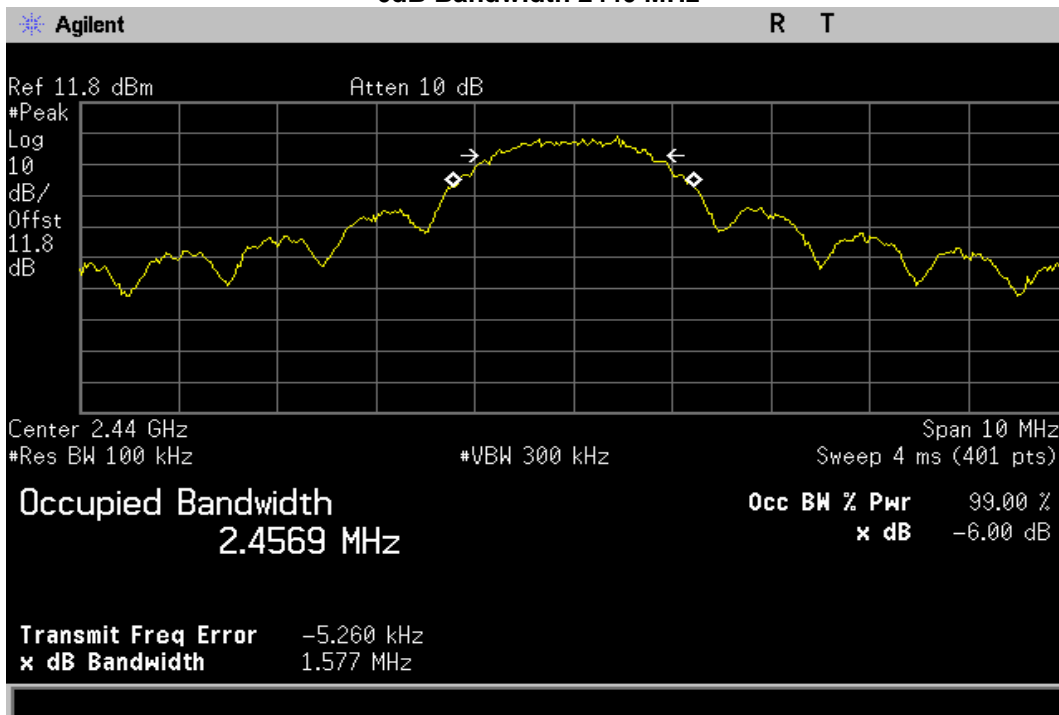
| Frequency (MHz) | Measured Bandwidth (MHz) | Result |
|-----------------|--------------------------|--------|
| 2405 | 2.46 | Pass |
| 2440 | 2.45 | Pass |
| 2480 | 2.57 | Pass |



6dB Bandwidth 2405 MHz

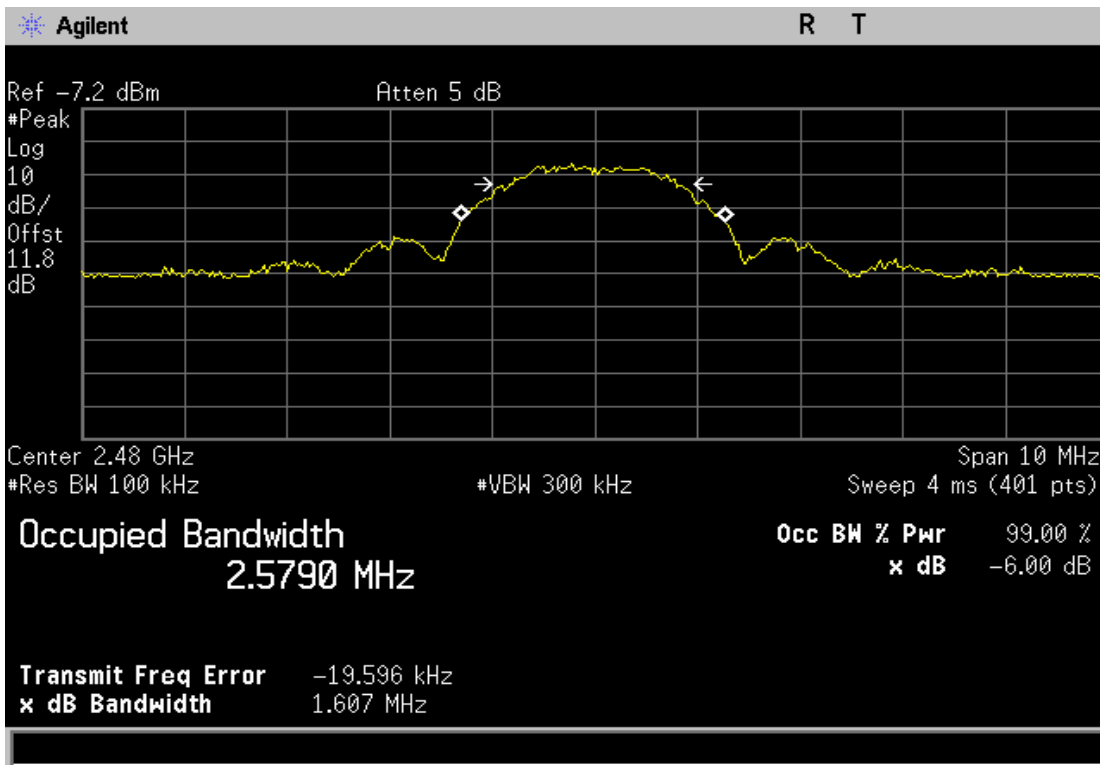


6dB Bandwidth 2440 MHz





6dB Bandwidth 2480 MHz





Transmitter Power Spectral Density (PSD)

Engineer: Poona Saber

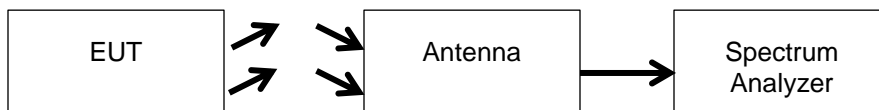
Test Date: 4/28/17

Test Procedure

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 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 following equations were used to determine the EIRP from the field strength values.
 $E[\text{dB}\mu\text{V}/\text{m}] = \text{EIRP}[\text{dBm}] - 20 \log(d[\text{meters}]) + 104.77$, where E = field strength and d = 3m
 $E[\text{dB}\mu\text{V}/\text{m}] = \text{EIRP}[\text{dBm}] + 95.2$, for d = 3 meters.

Test Setup

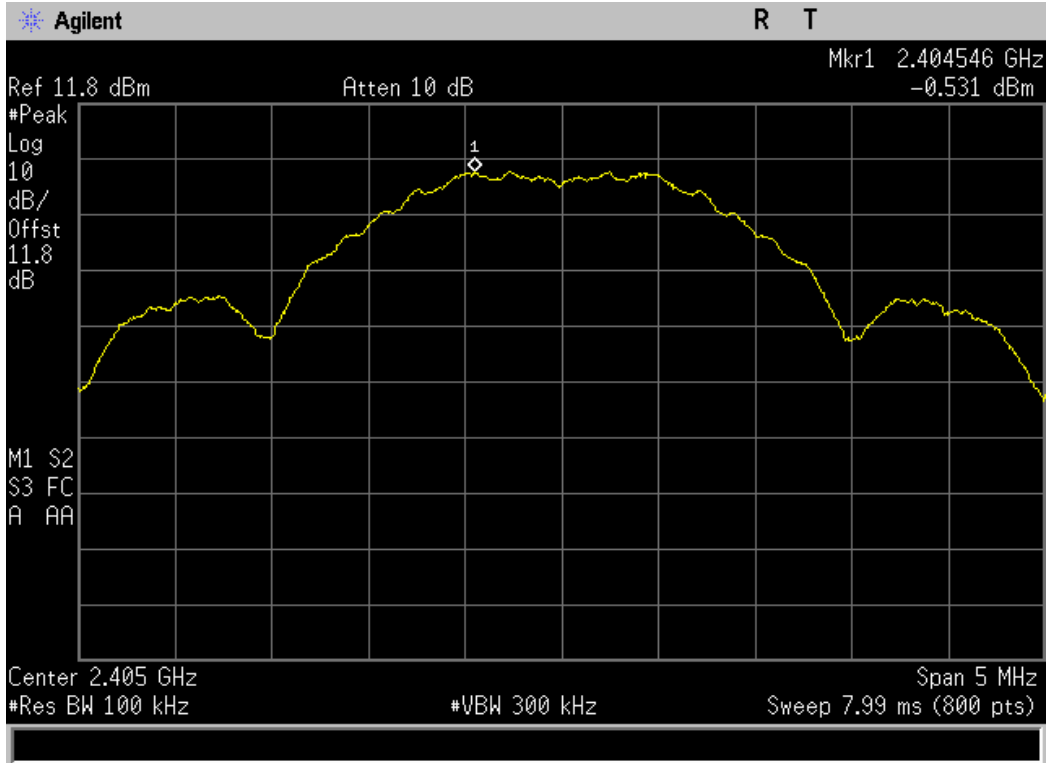


PSD Summary

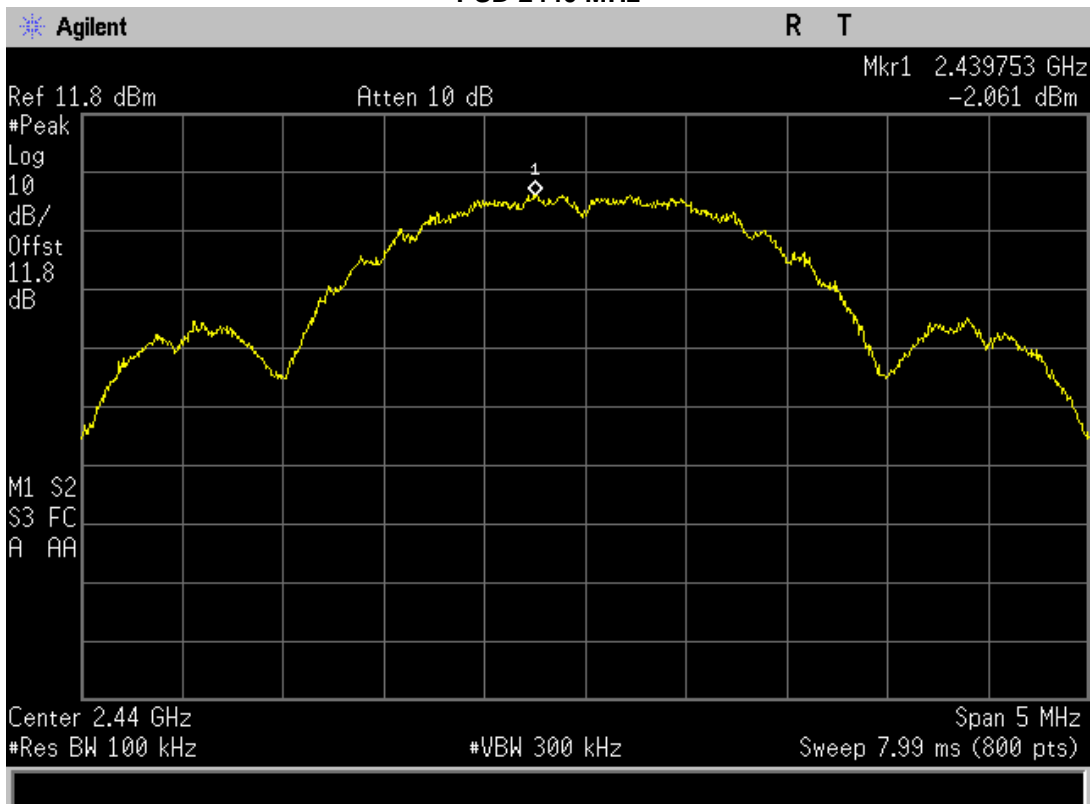
| Frequency (MHz) | Measured Data (dBm) | Specification Limit (dBm) | Result |
|-----------------|---------------------|---------------------------|--------|
| 2405 | -0.53 | 8 | Pass |
| 2440 | -2.06 | 8 | Pass |
| 2480 | -23.67 | 8 | Pass |



PSD 2405 MHz

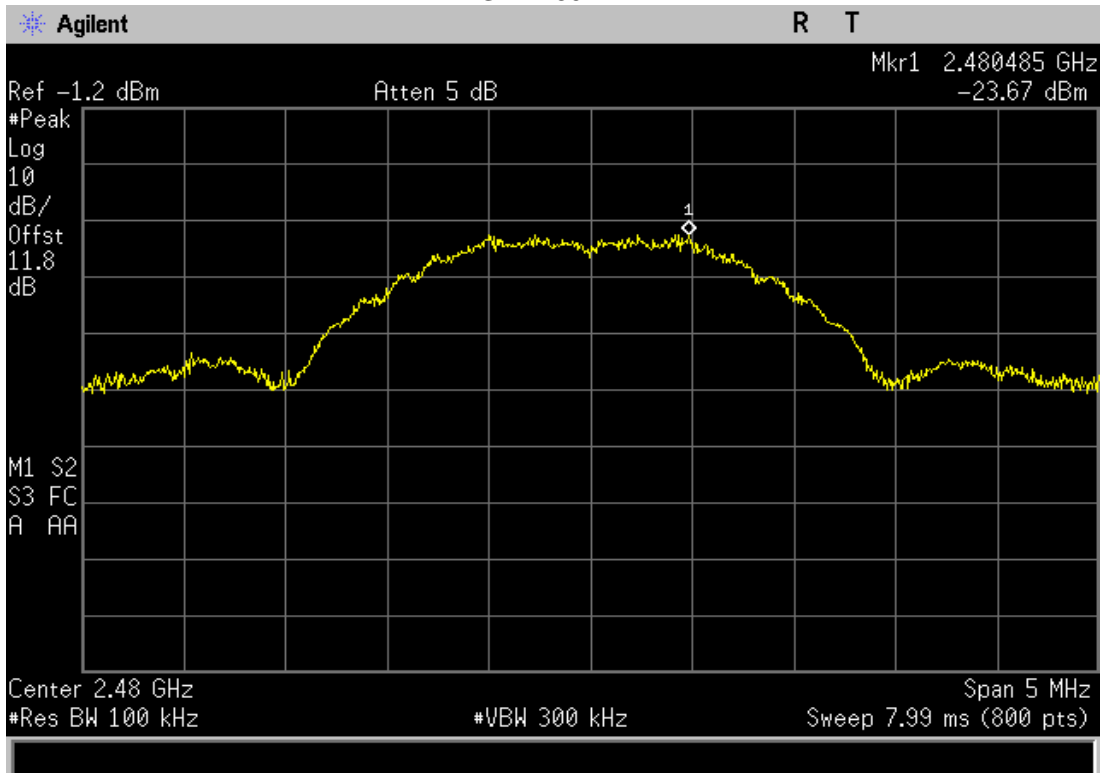


PSD 2440 MHz





PSD 2480 MHz





A/C Powerline Conducted Emission

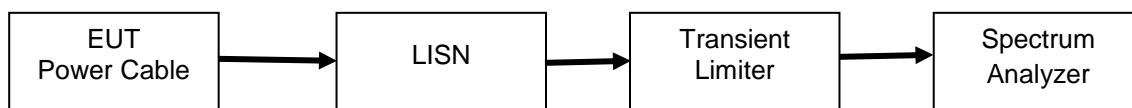
Engineer: Poona Saber

Test Date: 4/28/17

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

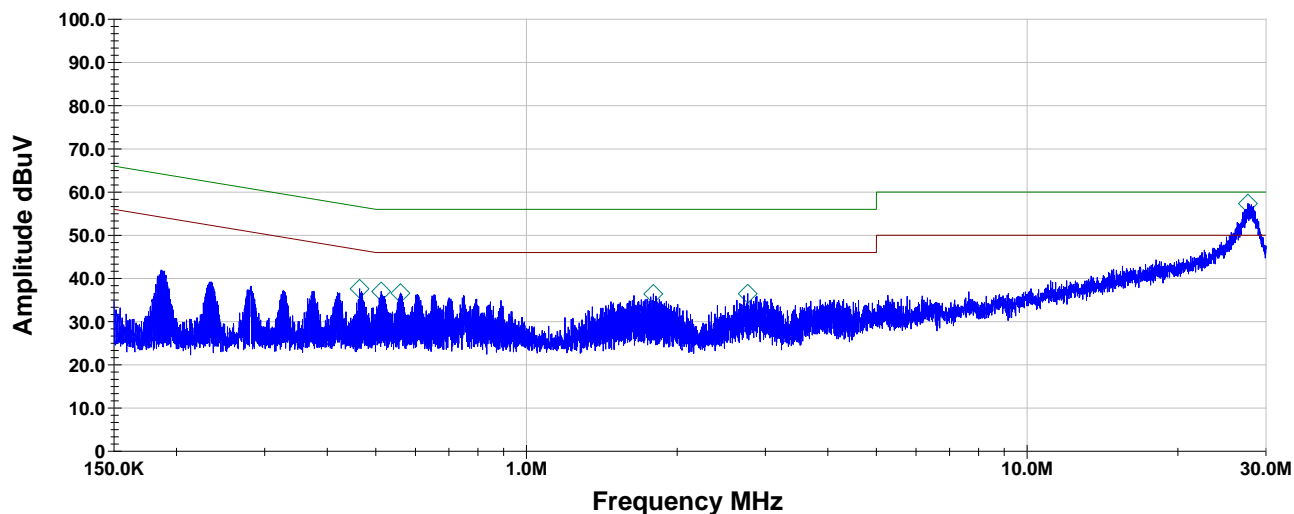


Conducted Emission Test Results

Line 1 Peak Plot

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

- ◇ Points of Interest
- Corrected Peak Data
- CISPRB_QP
- CISPRB_AV



Operator: PH

EN55022 Class B_85462 EMI Rec_V7_ACTIVE.til

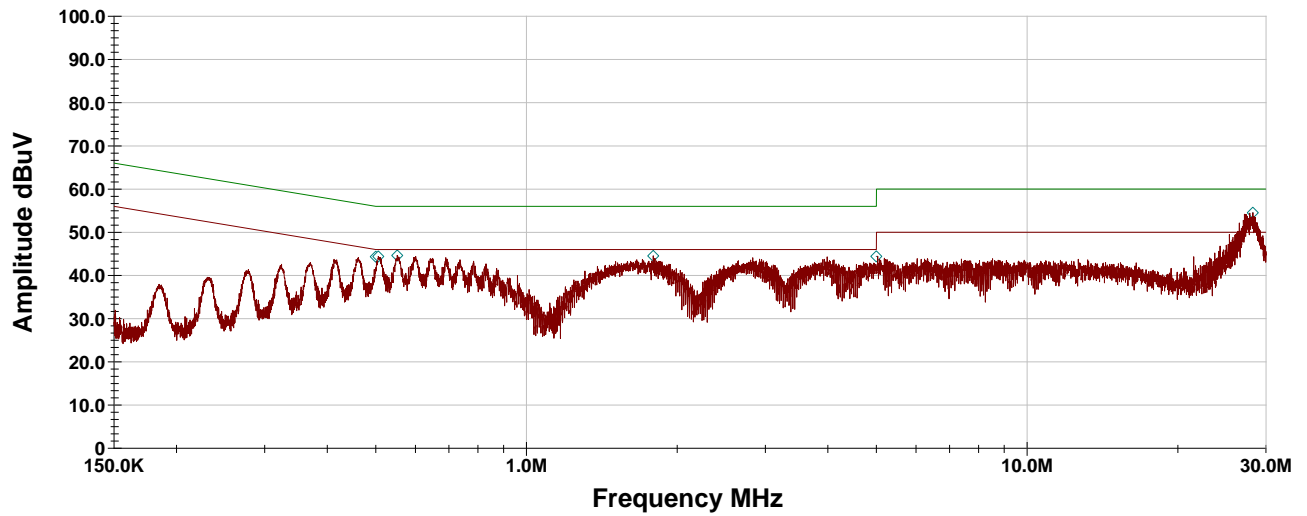
Job #:



Line 2 Peak Plot

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

- ◆ Points of Interest
- Corrected Peak Data
- CISPRB_QP
- CISPRB_AV



Operator: PH

EN55022 Class B_85462 EMI Rec_V7_ACTIVE.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) |
|------------|-----------------------|-----------------------------|-----------------|------------------------|-------------------|--------------|-----------------|
| 466.83 KHz | 9.08 | 0.1 | 0.03 | 10.1 | 19.307 | 46.948 | -27.641 |
| 512.05 KHz | 9.06 | 0.1 | 0.03 | 10.1 | 19.293 | 46 | -26.707 |
| 560.29 KHz | 8.15 | 0.1 | 0.03 | 10.1 | 18.377 | 46 | -27.623 |
| 1.7959 MHz | 7.61 | 0 | 0.06 | 10.1 | 17.77 | 46 | -28.23 |
| 2.7656 MHz | 11.51 | 0 | 0.07 | 10.1 | 21.683 | 46 | -24.317 |
| 27.597 MHz | 36.2 | 0.2 | 0.25 | 10.4 | 47.046 | 50 | -2.954 |

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) |
|------------|-----------------------|-----------------------------|-----------------|------------------------|-------------------|--------------|-----------------|
| 504.7 KHz | 29.68 | 0.1 | 0.03 | 10.1 | 39.913 | 46 | -6.087 |
| 506.86 KHz | 30.34 | 0.1 | 0.03 | 10.1 | 40.567 | 46 | -5.433 |
| 551.99 KHz | 29.99 | 0.1 | 0.03 | 10.1 | 40.223 | 46 | -5.777 |
| 1.7908 MHz | 24.03 | 0 | 0.06 | 10.1 | 34.19 | 46 | -11.81 |
| 4.9864 MHz | 23.04 | 0 | 0.1 | 10.2 | 33.337 | 46 | -12.663 |
| 28.233 MHz | 33.38 | 0.2 | 0.252 | 10.4 | 44.235 | 50 | -5.765 |

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) |
|------------|-----------------------|-----------------------------|-----------------|------------------------|-------------------|--------------|----------------|
| 466.83 KHz | 24.1 | 0.1 | 0.03 | 10.1 | 34.33 | 56.948 | -22.618 |
| 512.05 KHz | 23.91 | 0.1 | 0.03 | 10.1 | 34.14 | 56 | -21.86 |
| 560.29 KHz | 22.88 | 0.1 | 0.03 | 10.1 | 33.11 | 56 | -22.89 |
| 1.7959 MHz | 19.19 | 0 | 0.06 | 10.1 | 29.35 | 56 | -26.65 |
| 2.7656 MHz | 19.72 | 0 | 0.07 | 10.1 | 29.89 | 56 | -26.11 |
| 27.597 MHz | 42.11 | 0.2 | 0.25 | 10.4 | 52.96 | 60 | -7.04 |

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) |
|------------|-----------------------|-----------------------------|-----------------|------------------------|-------------------|--------------|----------------|
| 504.7 KHz | 32.38 | 0.1 | 0.03 | 10.1 | 42.61 | 56 | -13.39 |
| 506.86 KHz | 32.48 | 0.1 | 0.03 | 10.1 | 42.71 | 56 | -13.29 |
| 551.99 KHz | 32.51 | 0.1 | 0.03 | 10.1 | 42.74 | 56 | -13.26 |
| 1.7908 MHz | 29.65 | 0 | 0.06 | 10.1 | 39.81 | 56 | -16.19 |
| 4.9864 MHz | 29.31 | 0 | 0.1 | 10.2 | 39.61 | 56 | -16.39 |
| 28.233 MHz | 39.09 | 0.2 | 0.252 | 10.4 | 49.942 | 60 | -10.058 |



Test Equipment Utilized

| Description | Manufacturer | Model # | CT Asset # | Last Cal Date | Cal Due Date |
|-------------------------------|--------------|-------------------------------|------------|----------------------|--------------|
| EMI Receiver | HP | 8546A | i00033 | 3/28/17 | 3/28/18 |
| High Pass Filter | Trilithic | 4HX3400-3-XX | i00177 | Verified on: 4/28/17 | |
| 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 | 6/9/2017 | 6/9/2018 |
| Voltmeter | Fluke | 87III | i00319 | 4/11/16 | 4/11/19 |
| 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