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Test Report

Prepared for: Garmin International, Inc.

Model: A03070/A03071

Description: Short Range Transceiver

Serial Number: N/A

FCC ID: IPH-03070 & FCC ID: IPH-03071
IC: 1792A-03070 & IC: 1792A-03071

To

FCC Part 15.247
IC RSS-247

Date of Issue: December 12, 2017

On the behalf of the applicant:	**Garmin International, Inc.** **1705 S. Research Loop** **Tucson, AZ 85710**
Attention of:	**Rick Waybright, Regulatory Manager** **Ph: (520)290-6000** **E-Mail: Rick.Waybright@garmin.com**

Prepared By
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Project No: p1780018

Alex Macon
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	September 29, 2017	Alex Macon	Original Document
2.0	December 11, 2017	Alex Macon	Included 10dB attenuator into setup diagram on page 9 and 11 Updated additional information section with antenna gain statement. Updated 99% BW table. Updated AC power line section with tabular data

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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.

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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)**
23.4 – 24.5	32.1 – 35.8	966 - 968

EUT Description
Model: A03070/A03071
Description: Short Range Transceiver
Firmware: N/A
Software: N/A
Serial Number: N/A
Additional Information:
The system consists of a base unit intended to be operated by the end user and a roaming device which is intended to be moving at various locations near the base unit. These devices are described as Base Unit (A03070) and Roaming Device (A03071). The devices utilize Zigbee, ANT, and BLE protocols for communication. The ANT and BLE emissions are identical so only one emission is included within the report. The Base Unit incorporates a MIMO configuration for the Zigbee communication. Both ports have been measured and the data is included below.
An antenna gain of 2dBi is used throughout the testing of each modulation.

EUT Operation during Tests
The devices were placed into test modes using manufacturer supplied software. Continuous output in both CW and modulated tones were possible for high mid and low channels.

Accessories: None

Cables: None

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 Results Summary

FCC 15.247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Peak Output Power	Pass	
15.247(b)	Conducted Spurious Emissions	Pass	
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	

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

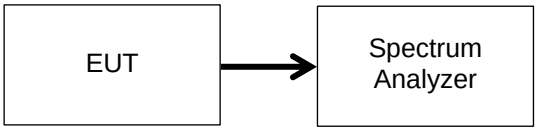
Conducted Output Power
Engineer: Alex Macon
Test Date: 9/13/17

Test Procedure

The EUT was connected directly to a spectrum analyzer. For BLE and ANT emissions, section 9.1.1 of KDB 558074 was followed. For the Zigbee emission, section 9.2.2.1 a) of KDB 558074 was followed.

The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level.

Test Setup



Transmitter Output Power

Base Unit

Tuned Frequency (MHz)	Modulation	Measured Value (dBm)	Specification Limit	Result
2402	BLE	4.22	1 W (30 dBm)	Pass
2441	BLE	4.3	1 W (30 dBm)	Pass
2480	BLE	4.2	1 W (30 dBm)	Pass

Tuned Frequency (MHz)	Modulation	Port 0 (dBm)	Port 1 (dBm)	Total Summer Power (dBm)	Specification Limit	Result
2405	Zigbee	19.8	19.6	22.7	1 W (30 dBm)	Pass
2445	Zigbee	19.0	18.8	21.9	1 W (30 dBm)	Pass
2470	Zigbee	18.4	17.9	21.2	1 W (30 dBm)	Pass

Roaming Device

Tuned Frequency (MHz)	Modulation	Measured Value (dBm)	Specification Limit	Result
2405	Zigbee	2.47	1 W (30 dBm)	Pass
2445	Zigbee	2.13	1 W (30 dBm)	Pass
2470	Zigbee	1.46	1 W (30 dBm)	Pass
2402	BLE	1.24	1 W (30 dBm)	Pass
2441	BLE	2.05	1 W (30 dBm)	Pass
2480	BLE	-1.7	1 W (30 dBm)	Pass

Conducted RF Measurements (15.209)
Engineer: Alex Macon
Test Date: 9/18/17

Test Procedure

Antenna-port conducted measurements were performed as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands for 15.209.

The following offsets were added to the measurements:
The maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level
A maximum ground reflection factor to the EIRP level, 6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000MHz.

The following equations were used to determine the field strength from the conducted values.
E[dBµV/m] = EIRP[dBm] - 20 log(d[meters]) + 104.77, where E = field strength and d = 3m
E[dBµV/m] = EIRP[dBm] + 95.2, for d = 3 meters.

The Spectrum Analyzer was set to the following:

The Spectrum Analyzer was set to the following for emissions > 1000MHz:

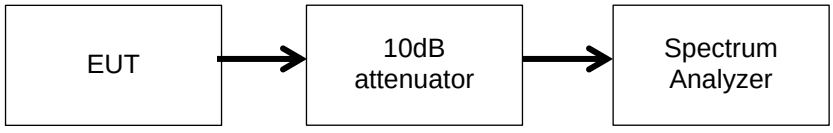
a. RBW = 1 MHz
b. VBW ≥ 3 MHz
c. Detector = Peak.
d. Sweep time = auto
e. Trace mode = max hold
    1. Note: For emissions where the peak exceeded that of the average 15.209 emission limit the following was performed.
f. RBW = 1 MHz
g. VBW ≤ RBW/100 (i.e., 10 kHz) but not less than 10 Hz

For emissions below 1000MHz the Spectrum Analyzer settings were as follows:

a. RBW = 100 kHz
b. VBW ≥ 300 kHz
c. Detector = Peak
d. Sweep time = auto
e. Trace mode = max hold

The EUT was connected to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was investigated. Only noise floor was observed past 18GHz

Test Setup



See Annex A1 and A2 for test data

Radiated Spurious Emissions
Engineer: Alex Macon
Test Date: 8/30/17

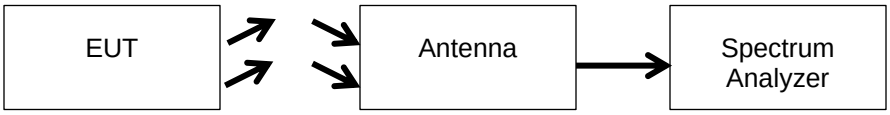
Test Procedure
Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The output of the transmitter was connected to a non-radiating balance 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

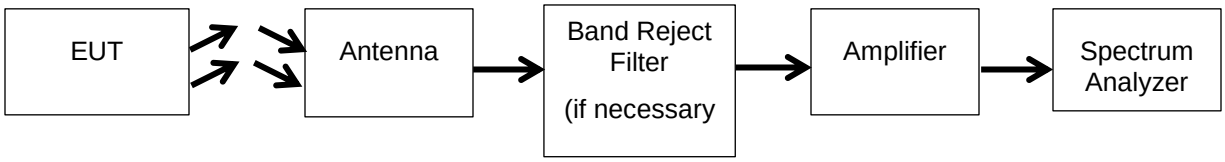
Test Setup



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 output of the transmitter was connected to a non-radiating balance 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. Only noise floor was observed past 18GHz

Test Setup



See Annex B1 and B2 for Test Data

15.247 Spurious Emissions
Engineer: Alex Macon
Test Date: 8/28/17

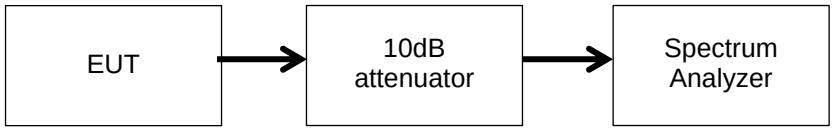
Test Procedure

For the Base Unit, The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

RBW = 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple
Frequency Range = 30MHz – 10th Harmonic of the fundamental

The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The trace was allowed to stabilize. All emissions were investigated to insure they were attenuated from the peak fundamental by at least 20dB. If the average power levels were measured then the out-of-band emissions needed to be attenuated by 30dB. In addition emissions were investigated at the band edges to insure all out-of-band emissions were attenuated 20 or 30dB as necessary.

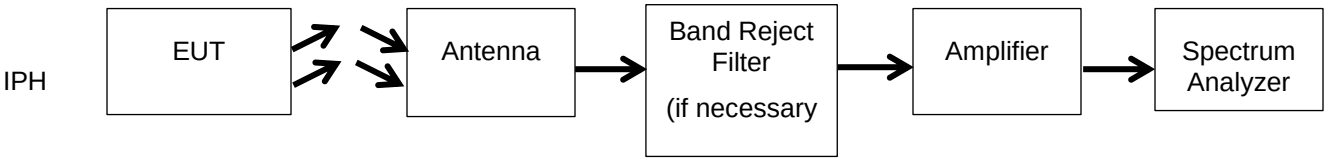
Test Setup



Test Procedure for the Roaming Device

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The output of the transmitter was connected to a non-radiating balance 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. Only noise floor was observed past 18GHz

Test Setup



See Annex A2 and B1 for test data

DTS Bandwidth
Engineer: Alex Macon
Test Date: 9/11/17

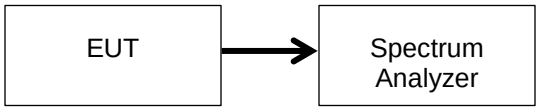
Test Procedure

The EUT was connected directly to a spectrum analyzer. 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



Roaming Device

6 dB Occupied Bandwidth Summary

Frequency (MHz)	Modulation	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2405	Zigbee	1.48	≥ 500	Pass
2445	Zigbee	1.49	≥ 500	Pass
2470	Zigbee	1.47	≥ 500	Pass
2402	BLE/ANT	0.5	≥ 500	Pass
2441	BLE/ANT	0.5	≥ 500	Pass
2480	BLE/ANT	0.5	≥ 500	Pass

99% Bandwidth Summary

Frequency (MHz)	Modulation	Measured Bandwidth (MHz)
2405	Zigbee	2.35
2445	Zigbee	2.42
2470	Zigbee	2.40
2402	BLE/ANT	0.999
2441	BLE/ANT	0.995
2480	BLE/ANT	0.995

See Annex C1 and C2 for Test Data

Base Unit

6 dB Occupied Bandwidth Summary

Frequency (MHz)	Modulation	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2405	Zigbee	1.56	≥ 500	Pass
2445	Zigbee	1.58	≥ 500	Pass
2470	Zigbee	1.55	≥ 500	Pass
2402	BLE/ANT	0.516	≥ 500	Pass
2441	BLE/ANT	0.513	≥ 500	Pass
2480	BLE/ANT	0.515	≥ 500	Pass

99% Bandwidth Summary

Frequency (MHz)	Modulation	Measured Bandwidth (MHz)
2405	Zigbee	2.34
2445	Zigbee	2.38
2470	Zigbee	2.39
2402	BLE/ANT	0.990
2441	BLE/ANT	0.991
2480	BLE/ANT	0.992

See Annex C1 and C2 for Test Data

Transmitter Power Spectral Density (PSD)
Engineer: Alex Macon
Test Date: 9/13/17

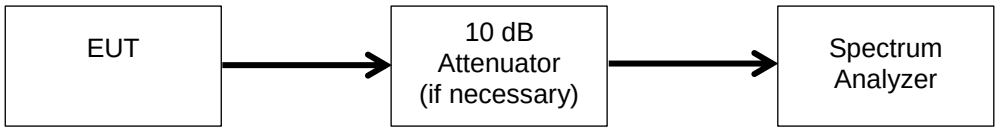
Test Procedure

The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

DTS channel center frequency
Span 1.5 x DTS bandwidth
RBW =3 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



Base Unit

Tuned Frequency (MHz)	Modulation	Measured Value (dBm)	Specification Limit	Result
2402	BLE	-5.56	8 dBm	Pass
2441	BLE	-5.99	8 dBm	Pass
2480	BLE	-5.56	8 dBm	Pass

Tuned Frequency (MHz)	Modulation	Port 0 (dBm)	Port 1 (dBm)	Total Summer Power (dBm)	Specification Limit	Result
2405	Zigbee	3.5	4.2	6.9	8 dBm	Pass
2445	Zigbee	2.0	1.1	4.6	8 dBm	Pass
2470	Zigbee	1.3	1.3	4.3	8 dBm	Pass

Roaming Device

Tuned Frequency (MHz)	Modulation	Measured Value (dBm)	Specification Limit	Result
2405	Zigbee	-14.1	8 dBm	Pass
2445	Zigbee	-14.29	8 dBm	Pass
2470	Zigbee	-15.75	8 dBm	Pass
2402	BLE	-8.54	8 dBm	Pass
2441	BLE	-7.74	8 dBm	Pass
2480	BLE	-11.87	8 dBm	Pass

A/C Powerline Conducted Emission

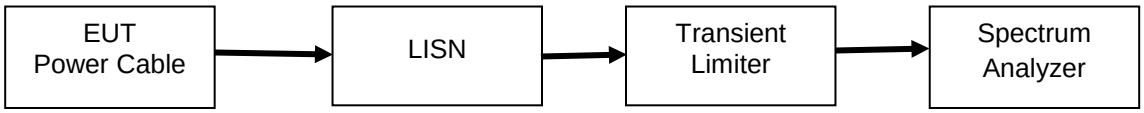
Engineer: Alex Macon

Test Date: 9/20/17

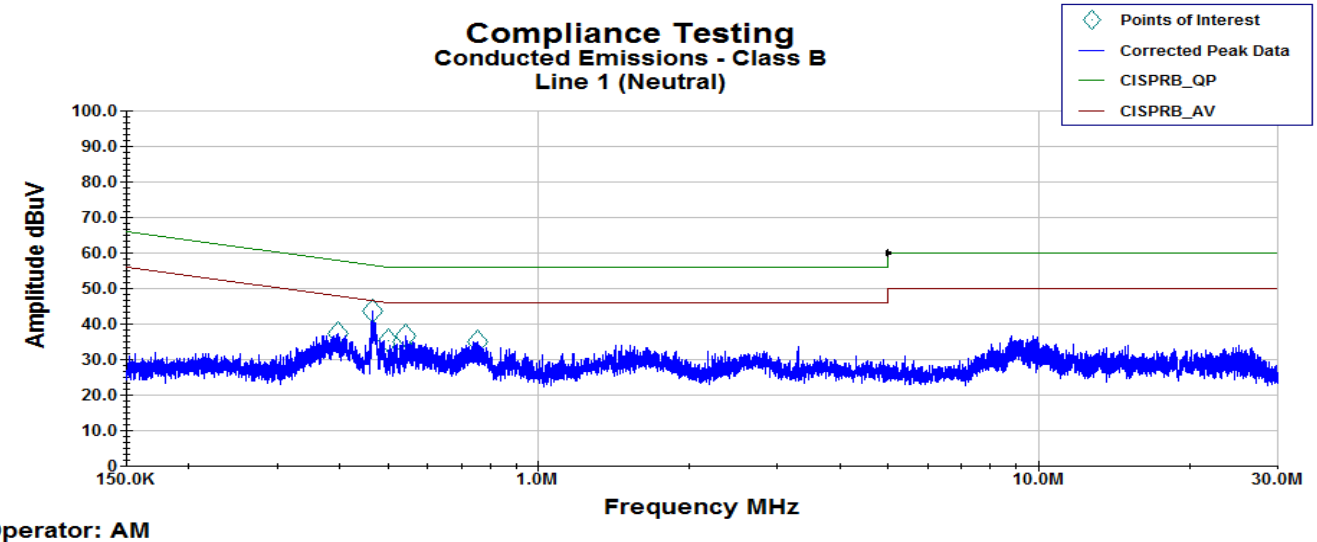
Test Procedure

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



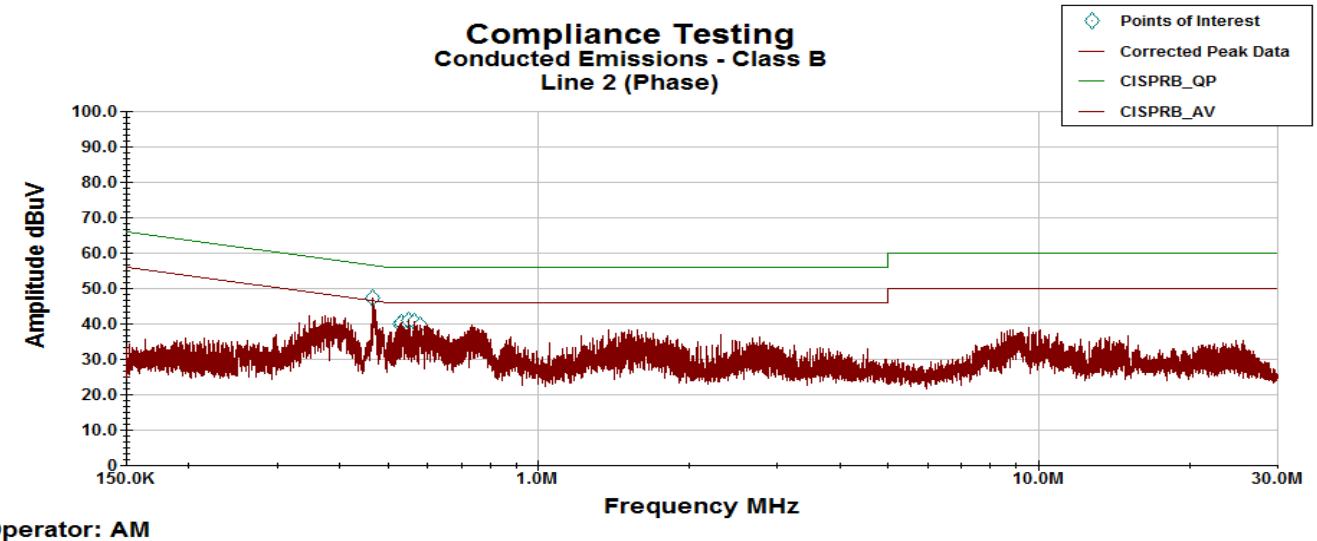
Line 1



Operator: AM

EN55032 Class B_p1780018.til **Job #: p1780018**

Line 2



Operator: AM

EN55032 Class B_p1780018.til **Job #: p1780018**

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)
392.11 KHz	18.74	0.10	0.030	10.100	28.977	49.083	-20.106
469.64 KHz	23.00	0.10	0.030	10.100	33.227	46.867	-13.641
513.0 KHz	9.28	0.10	0.030	10.100	19.510	46.000	-26.490
526.81 KHz	11.10	0.10	0.030	10.100	21.330	46.000	-24.670
528.42 KHz	11.77	0.10	0.030	10.100	22.000	46.000	-24.000
752.13 KHz	14.34	0.02	0.038	10.100	24.502	46.000	-21.498

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)
461.67 KHz	15.00	0.10	0.030	10.100	25.227	47.095	-21.868
536.92 KHz	14.23	0.10	0.030	10.100	24.457	46.000	-21.543
542.04 KHz	13.38	0.10	0.030	10.100	23.610	46.000	-22.390
551.98 KHz	15.30	0.10	0.030	10.100	25.533	46.000	-20.467
554.65 KHz	12.49	0.10	0.030	10.100	22.720	46.000	-23.280
581.34 KHz	16.46	0.10	0.030	10.100	26.693	46.000	-19.307

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)
392.11 KHz	23.870	0.104	0.030	10.100	34.104	59.083	-24.979
469.64 KHz	27.610	0.100	0.030	10.100	37.840	56.867	-19.027
513.0 KHz	18.030	0.100	0.030	10.100	28.260	56.000	-27.740
526.81 KHz	18.930	0.100	0.030	10.100	29.160	56.000	-26.840
528.42 KHz	18.260	0.100	0.030	10.100	28.490	56.000	-27.510
752.13 KHz	20.170	0.024	0.038	10.100	30.332	56.000	-25.668

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)
461.67 KHz	29.30	0.10	0.030	10.100	39.530	57.095	-17.565
536.92 KHz	25.25	0.10	0.030	10.100	35.480	56.000	-20.520
542.04 KHz	24.30	0.10	0.030	10.100	34.530	56.000	-21.470
551.98 KHz	25.34	0.10	0.030	10.100	35.570	56.000	-20.430
554.65 KHz	24.44	0.10	0.030	10.100	34.670	56.000	-21.330
581.34 KHz	26.31	0.10	0.030	10.100	36.540	56.000	-19.460

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
Preamplifier	HP	8447D	i00055	Verified on:9/20/17	
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	6/9/17	6/9/18
Spectrum Analyzer	Agilent	E4407B	i00331	10/19/16	10/19/17
Data Logger	Fluke	Hydra Data Bucket	i00343	5/25/17	5/25/18
Vector Signal Generator	Agilent	E4438C	i00348	5/5/17	5/5/18
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	8/3/16	8/3/18
AC Power Source	Behlman	BL 6000	i00362	Verified on:9/20/17	
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	9/6/17	9/6/19
Voltmeter	Fluke	179	i00488	3/1/17	3/1/18
Signal Generator	Agilent	E4437B	i00489	5/5/17	5/5/18
Spectrum Analyzer	Rohde & Schwarz	FSU26	i00501	3/27/17	3/27/18
Network Analyzer	HP	8753D	i00505	6/8/17	6/8/18
Audio Analyzing DMM	Keithley	2015-P	i00506	5/26/17	5/26/18
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