Compliance Testing, LLC
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http://www.ComplianceTesting.com
info@ComplianceTesting.com

Test Report

Prepared for: Tehama Wireless Design Group Inc.

Model: RPT TW223

Description:Repeater

Serial Number:N/A

FCC ID: TS4-TW223
IC: 6214A-TW223

To

FCC Part 15.247 DTS
&
RSS 247, Issue 2

Date of Issue:April 23, 2019

On the behalf of the applicant:	**Tehama Wireless Design Group Inc.** **2607 7th Street** **Suite G** **Berkeley,CA94710**
Attention of:	**Laurence Plouvier** **Ph: (415)906-4403** **Email: lplouvier@tehamawireless.com**

Prepared By
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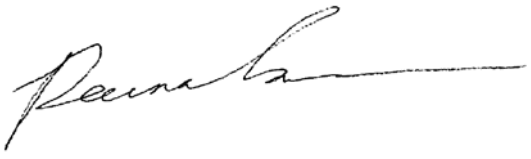
Project No: p18c0010



Poona Saber
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	March 21, 2019	Poona Saber	Original Document
2.0	April 18.2019	Poona Saber	Added antenna gain on page 6 Revised tables on page 12 and page 13 Revised Annex A-2 Revised Annex A-3 Revised Annex B-1 Revised Annex B-2 Revised page 19 and 20 for dwell time FSK and FHSS
3.0	May 30, 2019	Poona Saber	Revised page 13 to reflect KHz instead of MHz Annex A-1 modified Page 6 modified with statement for non-simultaneous transmission Page 9 tables modified
4.0	June 19, 2019	Poona Saber	Added Note on Page 14

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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.htmlfor 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
Product Marketing Name: RPT TW223
HVIN: TW-191A, TW-191S, & TW-195S
Description: Repeater
Firmware: N/A
Software: N/A
Serial Number: N/A

Additional Information:
TW-223 unit is a 902-928 MHz diversity transceiver consisting of a single PCB with two identical RFIC transceivers each with a PCB trace whip antenna of 2 dBi simulated gain and both controlled by a common integrated microprocessor. There are 3 model numbers variants depending on:

1. Power supplies
   The TW-195A is line powered by an external 5V AC/DC transformer
   Both TW-191S and TW-195S are powered by the combination of a 10 W solar panel and 2 pack rechargeable lithium batteries 7.2 V 6 Ah.

2. RF modes:
   Both TW-195A and TW-195S are using a combination of FHSS Lora and DTS LoraWan modes. The TW-191S uses the FSK mode.

The two transceivers do not transmit simultaneously and the worst case result of the two has been reported.

EUT Operation during Tests
EUT was put on test mode for both continuous transmission on low, mid and high channels and hopping mode for FHSS and FSK.

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	5V AC/DC transformer	Computer technology Co	SYS1475-0505-W2	N/A
1	2 pack lithium battery 7.4V	N/A	N/A	N/A

Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Ferrite Y/N
1	USB to serial Converter	<3	N/A	N/A	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 Results Summary

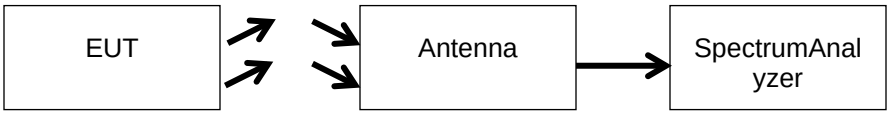
FCC Part 15.247 Specification	ISED RSS-247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	RSS 247 Section 5.4(d)	Peak Output Power	Pass	
15.247(b)	RSS 247 Section 5.5, RSS GEN	Radiated Spurious Emissions in non-restricted band	Pass	
15.247(d), 15.209(a), 15.205	RSS 247 Section 5.5, RSS GEN	Radiated Spurious Emissions in restricted band	Pass	
15.247(d), 15.209(a), 15.205	RSS 247 Section 5.5, RSS GEN	Emissions At Band Edges	Pass	
15.247(a)(2)	RSS 247 Section 5.2(a)	Occupied Bandwidth	Pass	
15.247(e)	RSS 247 Section 5.2(b)	Transmitter Power Spectral Density	Pass	
15.207	RSS-GEN Section 8.8	A/C Powerline Conducted Emissions	Pass	
15.247(a)	RSS 247 5.1 (c)	Carrier separation Frequency	Pass	
15.247(a)	RSS 247 5.1 (c)	Dwell Time	Pass	
15.247(a)	RSS 247 5.1 (c)	Number of Hopping Channels	Pass	

Peak Output Power
Engineer: Poona Saber
Test Date:3/16/19

Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was maximized for highest emission per X,Y,Z axes and set to transmit on the lowest, middle and highest frequencies at the maximum power level. The peak readings were taken, and the result was then compared to the limit.

Test Setup



Transmitter Peak Output Power

DTS Mode

Tuned Frequency (MHz)	Measured Value EIRP (dBm)	Antenna gain (dBi)	Output power conducted (dBm)	Specification Limit EIRP	Result
906	19.92	2	17.92	30 dBm	Pass
915.1	19.9	2	17.9	30 dBm	Pass
924	19.61	2	17.61	30 dBm	Pass

FSK Mode

Tuned Frequency (MHz)	Measured Value (dBm)	Antenna gain (dBi)	Output power conducted (dBm)	Specification Limit	Result
906	21.84	2	19.84	30 dBm	Pass
915.1	21.95	2	19.95	30 dBm	Pass
924	22.06	2	20.06	30 dBm	Pass

FHSS Mode

Tuned Frequency (MHz)	Measured Value (dBm)	Antenna gain (dBi)	Output power conducted (dBm)	Specification Limit	Result
906	21.34	2	19.34	30 dBm	Pass
915.1	21.36	2	19.36	30 dBm	Pass
924	22.23	2	20.23	30 dBm	Pass

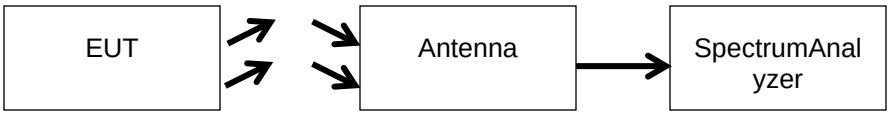
Radiated Spurious Emissionin Non-Restricted Frequency Bands
Engineer: Poona Saber
Test Date: 3/18/19

Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was maximized for highest emission per X, Y, Z axes and set to transmit on the lowest, middle and highest frequencies at the maximum power level.

The EUT was verified for spurious emissions of part 15.247 (d) and the frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed.
If the maximum peak conducted output power procedure was used to determine compliance, then the peak output power measured in any 100 kHz bandwidth outside ofthe authorized frequency band shall be attenuated by at least 20 dB relative to the maximumin-band peak PSD level in 100 kHz (i.e. 20 dBc) which is done by reference level measurements per 11.11.2 of C63.10-2013 and emission level measurement of 11.11.3.

Test Setup



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

See Annex A-1, A-2 and A-3 for test results for DTS, FSK and FHSS respectively.

Radiated Spurious Emissions in Restricted Frequency Bands
Engineer: Poona Saber
Test Date:3/20/19

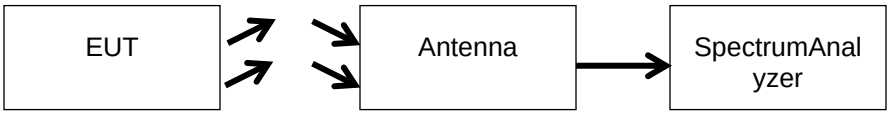
Test Procedure
Radiated Spurious Emissions: 30 – 1000 MHz

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 generalRadiated Emissions limits of 15.209 if emissions fall in 15.205 restricted band. 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 levelswere 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

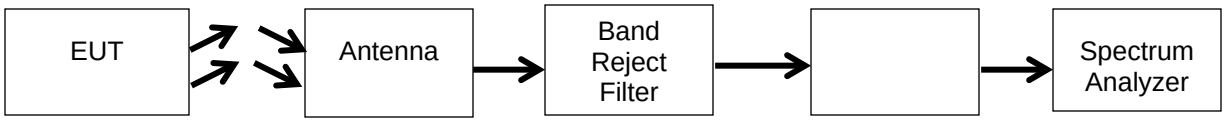
Test Setup



Test Procedure for
Radiated Spurious Emissions above 1 GHz

The EUT was 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.

Test Setup



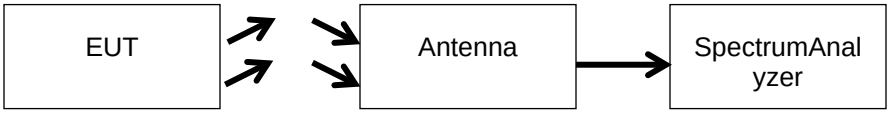
Detector Settings	RBW (MHz)	VBW (MHz)	Span
Peak	1	3	As Necessary
Average	1	3	As Necessary

See Annex B-1, B-2 and B-3 for test results for DTS, FSK and FHSS respectively

DTS Bandwidth
Engineer: Poona Saber
Test Date:3/14/19

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. Procedures on ANSI C63.10 subclause 11.8 were followed. 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

DTS

Frequency (MHz)	Measured Bandwidth (KHz)	Specification Limit (kHz)	Result
906	845.19	≥ 500	Pass
915.1	800.4	≥ 500	Pass
924	837.58	≥ 500	Pass

20 dB Occupied Bandwidth Summary

FSK

Frequency (MHz)	Measured Bandwidth (KHz)	Specification Limit (kHz)	Result
906	155.27	≤ 500	Pass
915.1	155.26	≤ 500	Pass
924	154.92	≤ 500	Pass

FHSS

Frequency (MHz)	Measured Bandwidth (KHz)	Specification Limit (kHz)	Result
906	140.6	≤ 500	Pass
915.1	142.33	≤ 500	Pass
924	140.78	≤ 500	Pass

99% Bandwidth Summary

DTS

Frequency (MHz)	Measured Bandwidth (KHz)	Result
906	897.24	Pass
915.1	864.76	Pass
924	888.96	Pass

FSK

Frequency (MHz)	Measured Bandwidth (KHz)	Result
906	163.37	Pass
915.1	161.89	Pass
924	154.2	Pass

FHSS

Frequency (MHz)	Measured Bandwidth (KHz)	Result
906	125.54	Pass
915.1	125.45	Pass
924	125.6	Pass

See Annex C for Test Plots

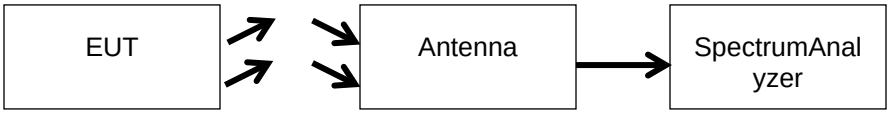
Transmitter Power Spectral Density (PSD)
Engineer: Poona Saber
Test Date:3/15/19

Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna.The test was performed per section 11.10 of C63.10:2013 “Procedure for determining PSD for DTS devices”

Note: measured data in plots below are compensated for antenna gain so they represent the conducted data.

Test Setup

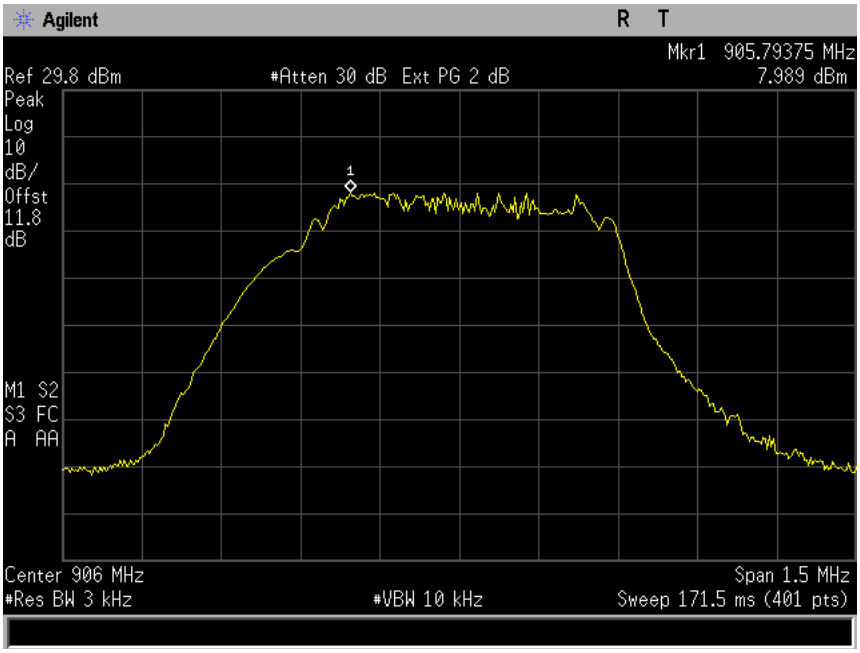


PSD Summary

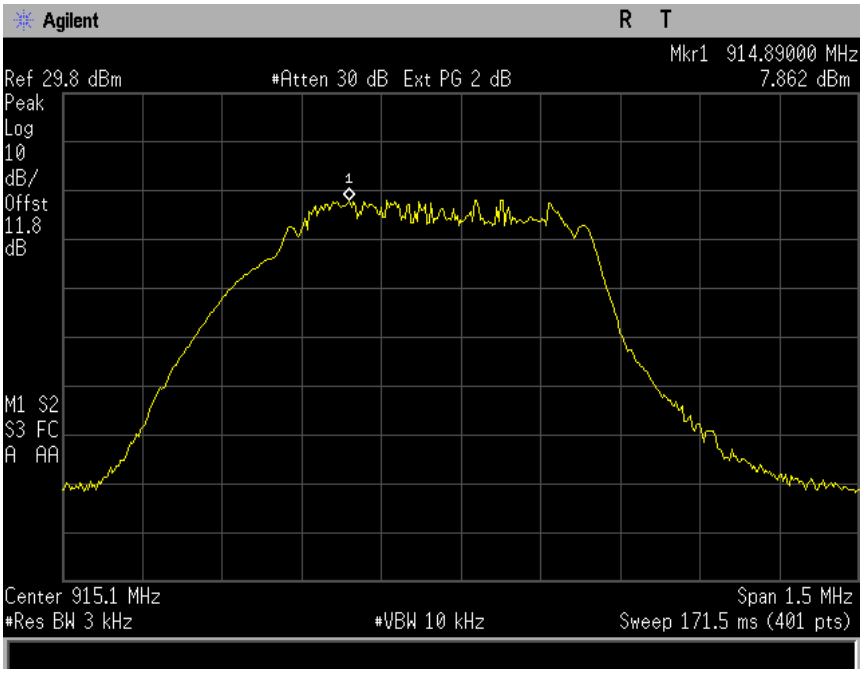
DTS mode

Frequency (MHz)	Measured Data Conducted (dBm)	Specification Limit (dBm)	Result
906	7.98	8	Pass
915.1	7.86	8	Pass
924	7.82	8	Pass

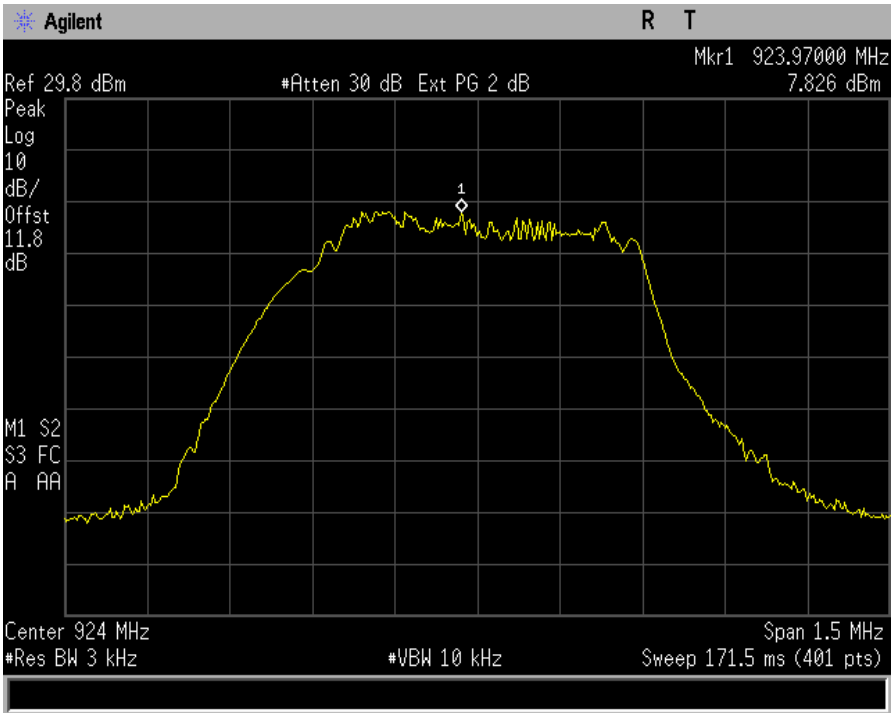
PSD 906 MHz



PSD 915.1MHz



PSD 924 MHz

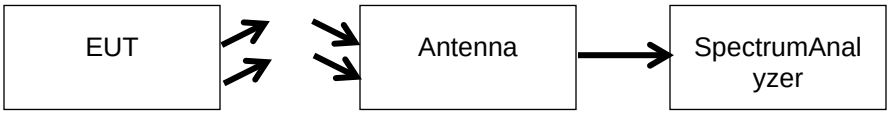


Carrier Frequency Separation
Engineer: PoonaSaber
Test Date: 3/16/2018

Test Procedure

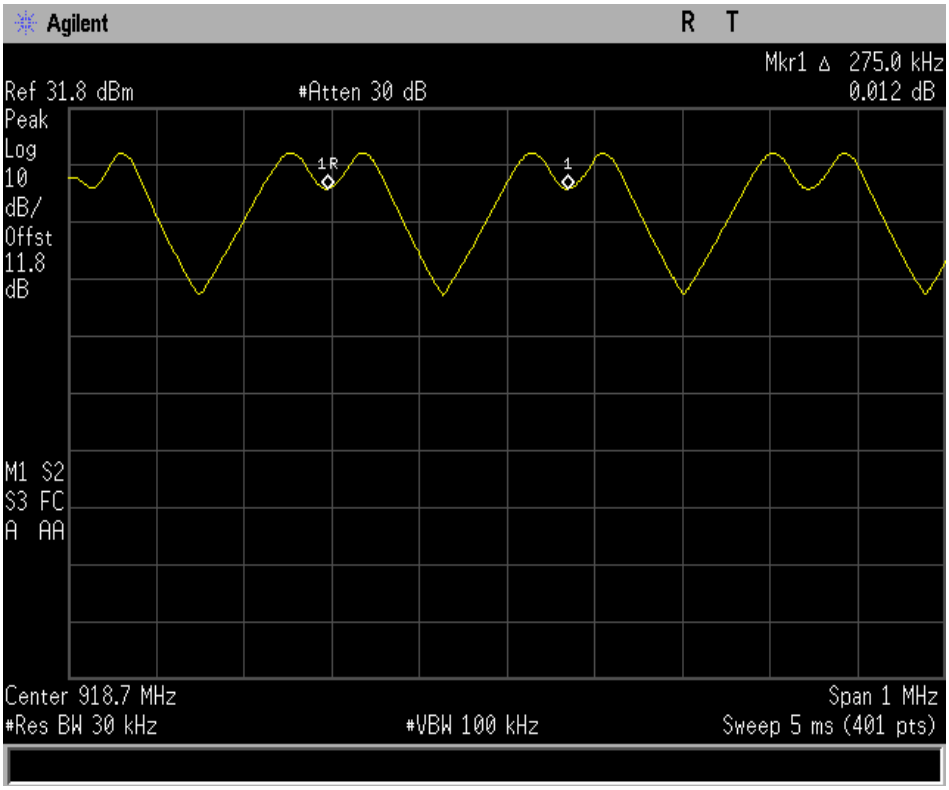
Per 15.247 (a) requirements the frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Setup

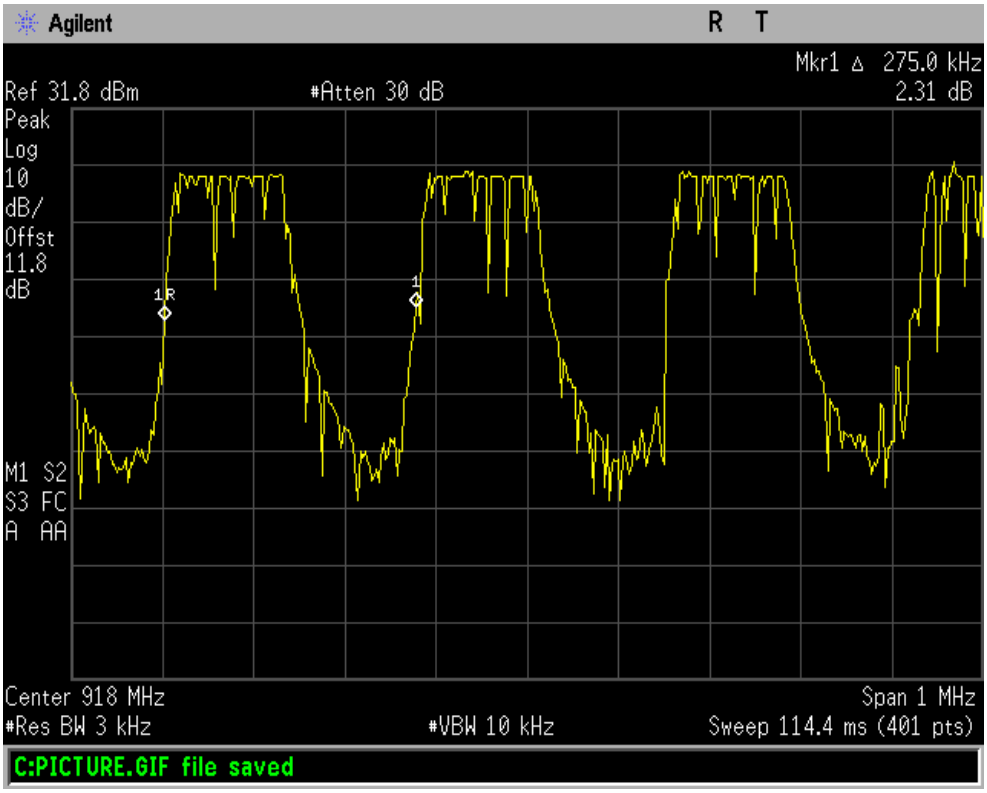


Test Results

FSK



FHSS


Agilent
R T
Mkr1 Δ 275.0 kHz
2.31 dB
Ref 31.8 dBm
#Atten 30 dB
Peak
Log
10
dB/
Offst
11.8
dB
1R
1
M1 S2
S3 FC
A AA
Center 918 MHz
#Res BW 3 kHz
#VBW 10 kHz
Span 1 MHz
Sweep 114.4 ms (401 pts)
C:PICTURE.GIF file saved

Dwell Time

Engineer: Poona Saber

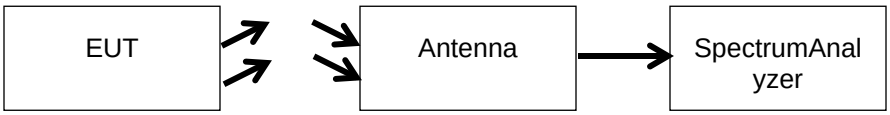
Test Date: 3/16/18

Test Procedure

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna.
The EUT was set to hopping mode with the spectrum analyzer set to a 0 Hz span. A single transmission was capturedand the dwell time was recorded.
For frequency hopping systems operating in the 902-928 MHz band:
if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period. if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period

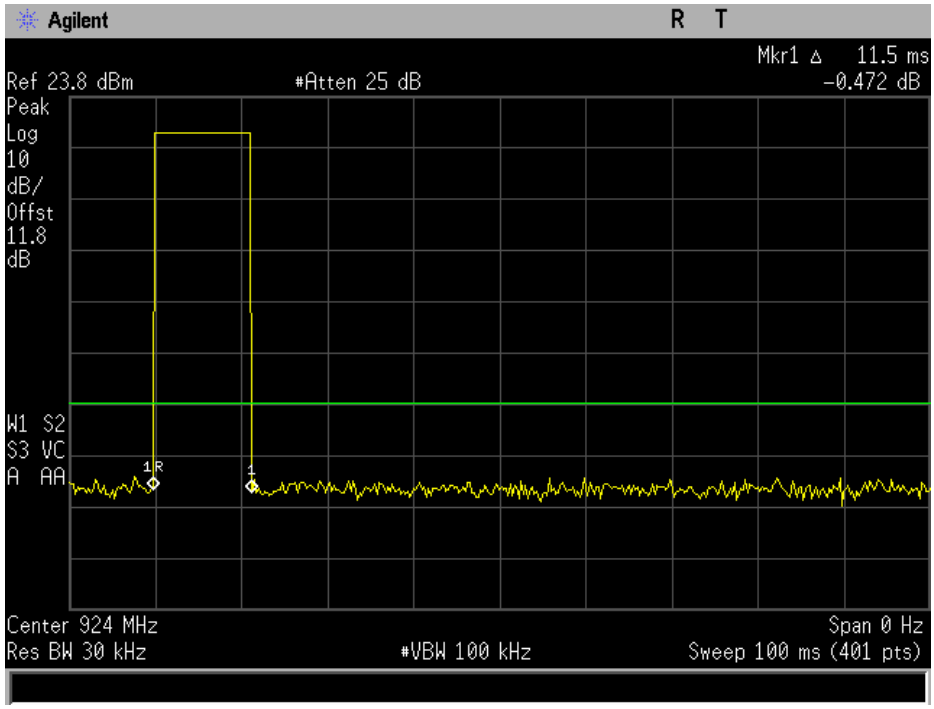
For frequency hopping systems operating in the 2400-2483.5 MHz band:
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Setup

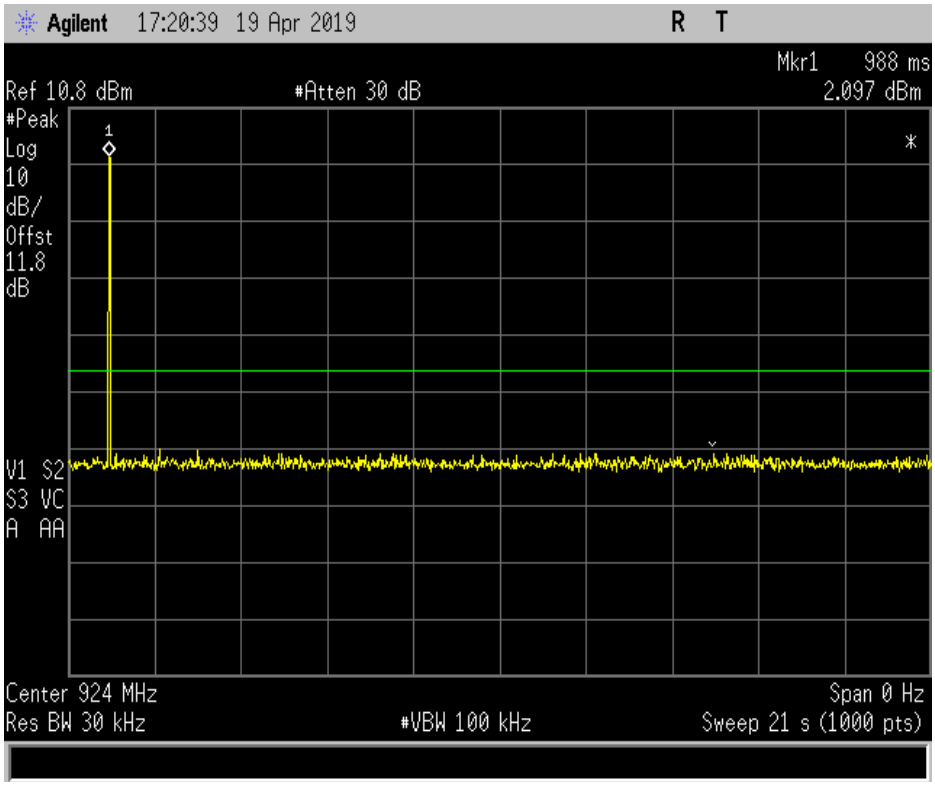


Dwell TimeFSK

1

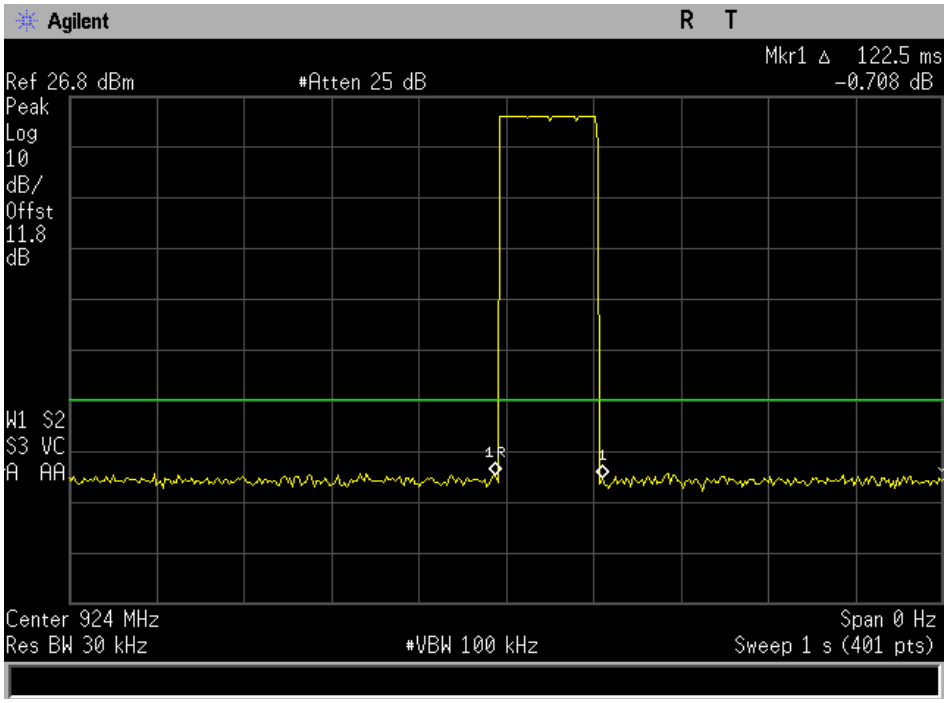


20 s Dwell time

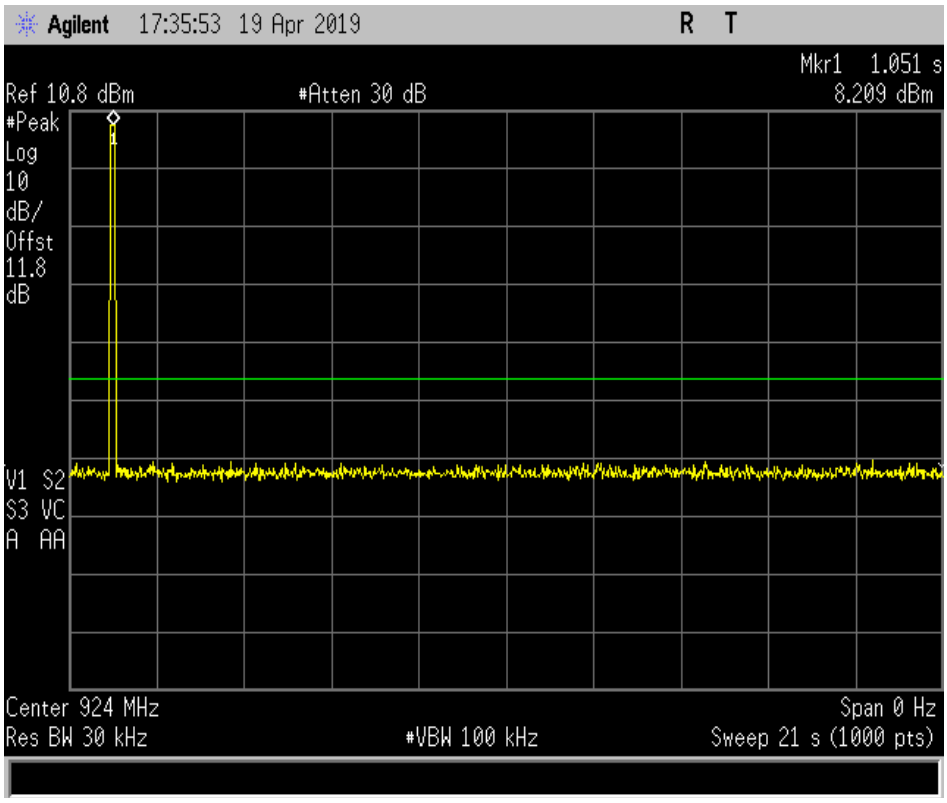


Dwell Time FHSS

1



2

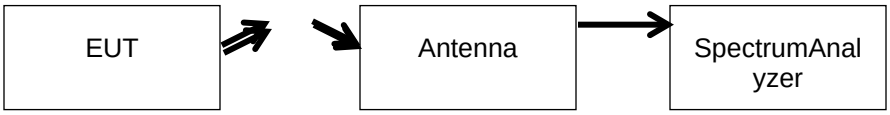


Number of Hopping Channels
Engineer: Poona Saber
Test Date: 3/16/18

Test Procedure

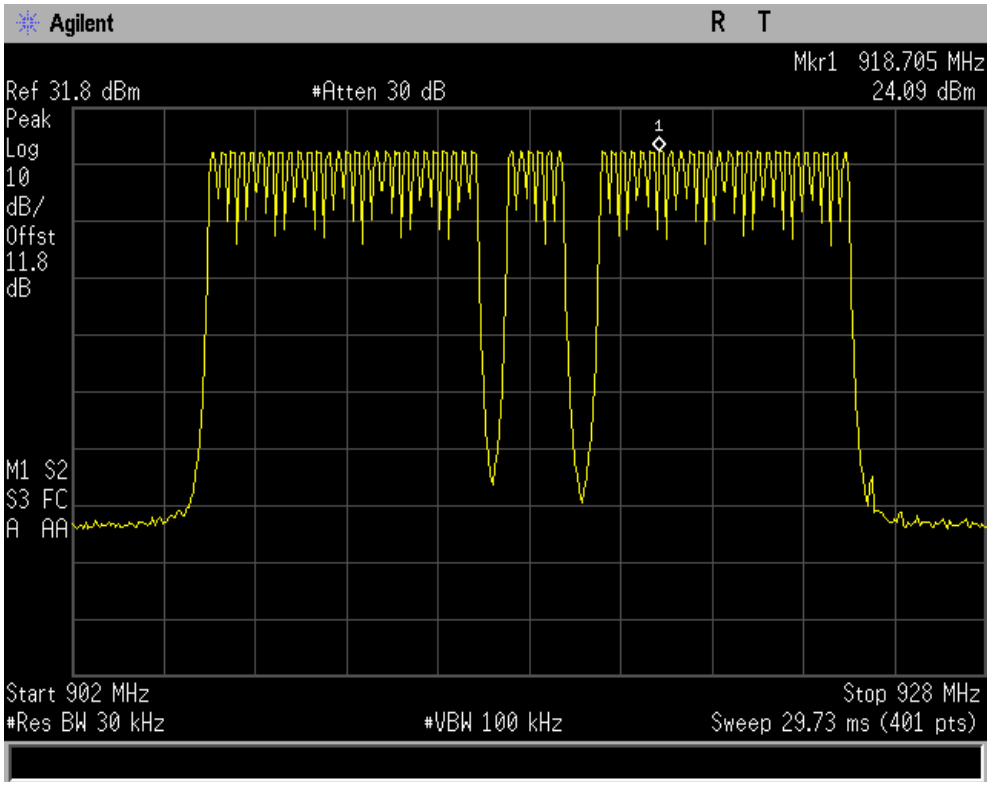
The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The Span was set to the specified band end points. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies. The EUT was then set to operate in hopping mode. The MAX HOLD function of the spectrum analyzer was utilized to verify the number of hopping cannels.

Test Setup

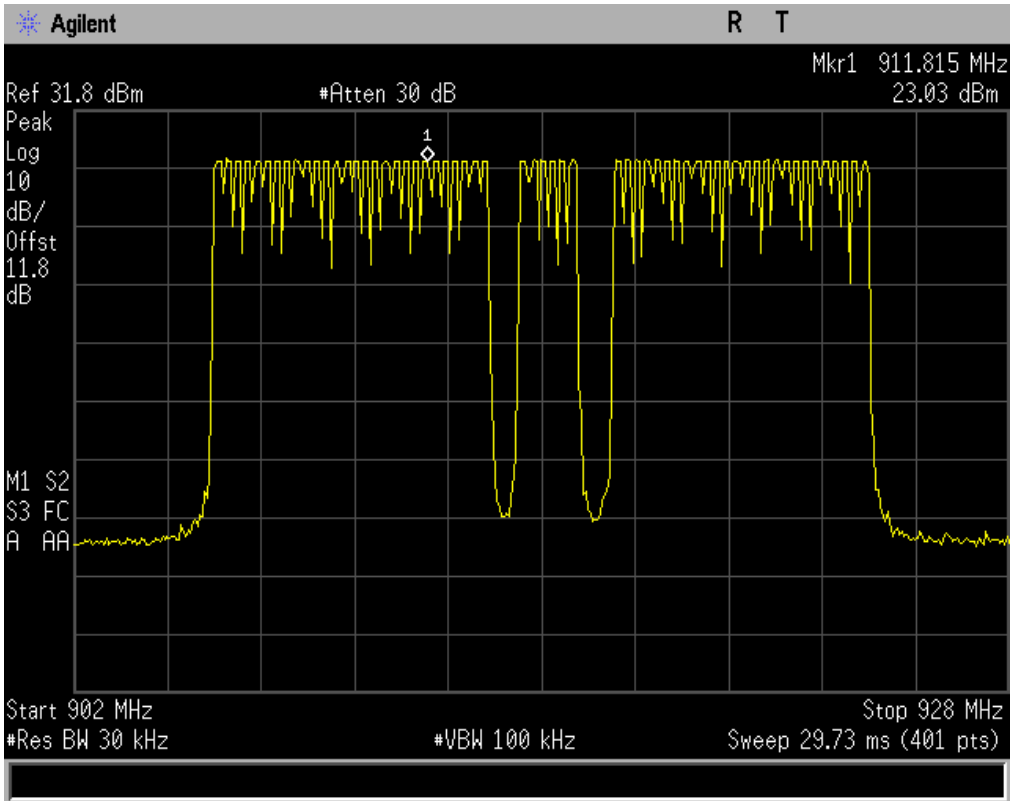


Number of Hopping Channels

FSK



FHSS


Agilent
R T
Mkr1 911.815 MHz
23.03 dBm
Ref 31.8 dBm
#Atten 30 dB
Peak
Log
10
dB/
Offst
11.8
dB
M1 S2
S3 FC
A AA
Start 902 MHz
#Res BW 30 kHz
#VBW 100 kHz
Stop 928 MHz
Sweep 29.73 ms (401 pts)

A/C Powerline Conducted Emission

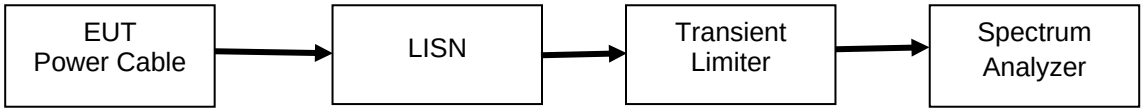
Engineer: Poona Saber

Test Date:3/21/19

Test Procedure

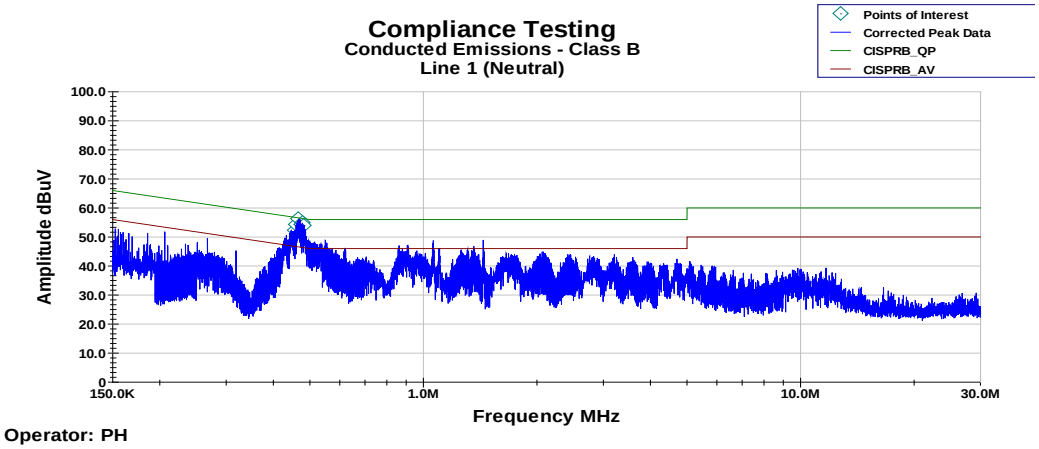
The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

Test Setup



Conducted Emission Test Results

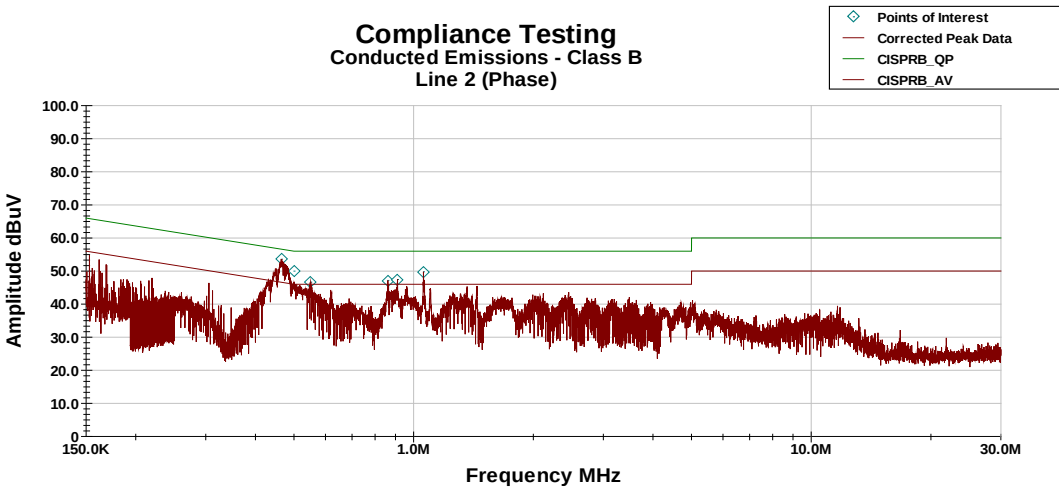
Line 1 Peak Plot



Operator: PH

EN55032 Class B_85462 EMI Rec_V7_ACTIVE.til **Job #:**

Line 2 Peak Plot



Operator: PH

EN55032 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)
465.49 KHz	29.37	0.1	0.03	10.1	39.603	46.986	-7.383
467.32 KHz	27.44	0.1	0.03	10.1	37.667	46.934	-9.267
471.17 KHz	23.78	0.1	0.03	10.1	34.007	46.824	-12.817
472.82 KHz	22.79	0.1	0.03	10.1	33.02	46.777	-13.757
474.27 KHz	23.36	0.1	0.03	10.1	33.59	46.735	-13.145
465.83 KHz	28.87	0.1	0.03	10.1	39.1	46.976	-7.876

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)
463.49 KHz	29.48	0.1	0.03	10.1	39.71	47.043	-7.333
486.55 KHz	21.6	0.1	0.03	10.1	31.827	46.384	-14.558
551.06 KHz	20.65	0.1	0.03	10.1	30.88	46	-15.12
858.27 KHz	18.58	0	0.04	10.1	28.723	46	-17.277
909.62 KHz	20.59	0	0.04	10.1	30.73	46	-15.27
1.0594 MHz	24.7	0	0.04	10.1	34.837	46	-11.163

Line 1 Neutral QP Detector

Frequency	Measured Value (dBuV)	LISNCorrection Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
465.49 KHz	42.05	0.1	0.03	10.1	52.28	56.986	-4.706
467.32 KHz	41.25	0.1	0.03	10.1	51.48	56.934	-5.454
471.17 KHz	39.07	0.1	0.03	10.1	49.3	56.824	-7.524
472.82 KHz	38.67	0.1	0.03	10.1	48.9	56.777	-7.877
474.27 KHz	38.37	0.1	0.03	10.1	48.6	56.735	-8.135
465.83 KHz	41.92	0.1	0.03	10.1	52.15	56.976	-4.826

Line 2 Phase QP Detector

Frequency	Measured Value (dBuV)	LISNCorrection Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
463.49 KHz	40.86	0.1	0.03	10.1	51.09	57.043	-5.953
486.55 KHz	35.4	0.1	0.03	10.1	45.63	56.384	-10.754
551.06 KHz	33.38	0.1	0.03	10.1	43.61	56	-12.39
858.27 KHz	31.33	0	0.04	10.1	41.47	56	-14.53
909.62 KHz	32.94	0	0.04	10.1	43.08	56	-12.92
1.0594 MHz	35.83	0	0.04	10.1	45.97	56	-10.03

Test Equipment Utilized

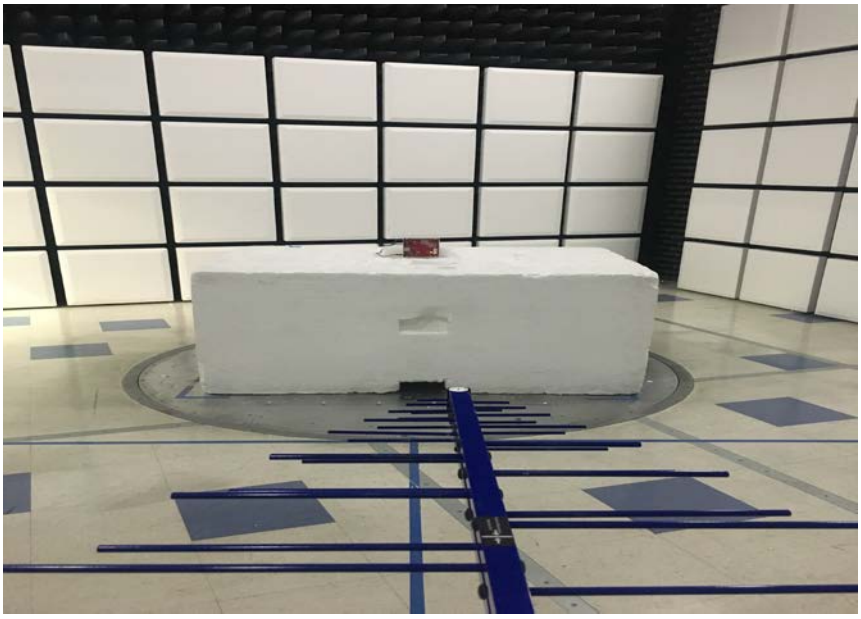
Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	6/16/18	6/16/20
Horn Antenna, Amplified	ARA	MWH-1826/B	i00273	5/22/18	5/22/21
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	6/29/18	6/29/19
Spectrum Analyzer	Agilent	E4407B	i00331	12/4/19	12/4/20
Bi-Log antenna	Chase	CBL6111C	i00267	3/8/18	3/8/20
EMI Analyzer	Agilent	E7405A	i00379	2/13/18	2/13/19
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	8/15/16	8/15/19
Preamplifier	Miteq	AFS44 00101 400 23-10P-44	i00509	N/A	N/A
EMI Receiver	HP	8546A	i00033	3/26/18	3/26/19
Transient Limiter	Com-Power	LIT-153	i00123	Verified on: 3/21/19	
AC Power Source	Behlman	BL 6000	i00362	Verified on: 3/21/19	
LISN	COM-Power	LI-125A	i00447	9/11/17	9/11/19
LISN	COM-Power	LI-125A	i00449	9/11/17	9/11/19

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

RF Radiated 30 MHz-1 GHz

RF Radiated 1-18 GHz



A/C Powerline Conduction #1