Test Report # 317204 B

Equipment Under Test:	Spot-r Cloud Pod
Test Date(s):	1/18/18 – 5/27/18
Prepared for:	Triax Technologies Attn: Justin Morgenthau 330 Roberts Street Suite 205 East Hartford, CT 06108, USA

Report Issued by: Shane Dock, EMC Engineer

Signature:

Date: 8/14/2018

Report Reviewed by: Adam Alger, Quality Manager

Signature:

Date: 08/14/2018

Report Constructed by: Shane Dock, EMC Engineer

Signature:

Date: 8/14/2018

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Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope
A2LA Certificate Number: 1255.01
Scope of accreditation includes all test methods listed herein, unless otherwise noted.

Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492

Government of Canada

Innovation, Science and Economic Development Canada

ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4
File Number: IC 3088A-2
File Number: IC 3088A-3

1 Test Report Summary

During **1/18/18 – 5/27/18** the Equipment Under Test (EUT), **Spot-r Cloud Pod**, as provided by **Triax Technologies** was tested to the following requirements:

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(1) IC: RSS-247 5.1	Channel Separation, Number of Hopping frequencies, Time of Occupancy	FHS	ANSI C63.10	Pass
FCC: 2.1049 IC: RSS-GEN 6.6	Occupied Bandwidth	Reported	ANSI C63.10	Pass
FCC: 15.247 (b)(1) IC: RSS-247 5.4 (a)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Pass
FCC: 15.207 IC: RSS-GEN 8.8	AC Power Line Conducted Emissions	0.150-30 MHz	ANSI C63.10	Pass

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	Triax Technologies
Contact Person	Justin Morgenthau
Address	330 Roberts Street Suite 205 East Hartford, CT 06108, USA

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Spot-r Cloud Pod
Model Number	CP-2
Serial Number	CCP0204-00003940
FCC/IC #	FCC: 2AGHICP01 IC: 21358-CP01

2.2 Product Description

The Spot-r Cloud Pod is a key component of the Spot-r network. It allows for the communication of all Spot-r device data to our cloud platform for viewing, storage and analysis via a cellular connection. It is mounted in a fixed location on a job site, though it can be easily moved over time as construction progresses and the site is developed.

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Additional Information

Unit tested on Channels 1, 32, and 64 (902.5 MHz, 914.9 MHz, 927.7 MHz). Unit programmed via serial connection with a terminal access program like PuTTY. Power setting of 15 used.

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15	-	2017
ANSI C63.10	-	2013
RSS-247	2	2017
RSS GEN	4	2014

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

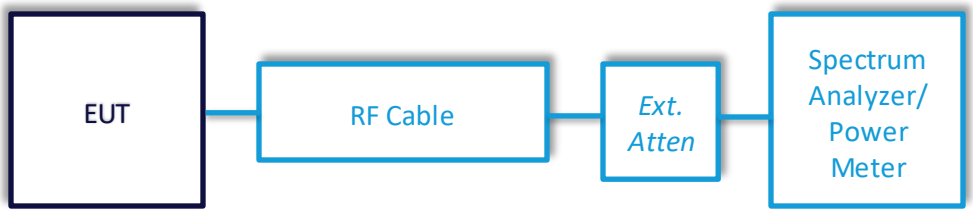
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



5.1.1 Antenna Port Conducted Emissions – Hopping Parameters

Operator	Shane Dock
Test Date	2/1/18 – 6/20/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/ 36% RH
Requirement	FCC: 15.247 (a)(1) IC: RSS-247 5.1
Method	ANSI C63.10 Sections 7.8.2, 7.8.3, 7.8.4

Limits:

Frequency Separation	Number of Hopping Channels	Maximum Occupancy Time
>25 kHz or 20 dB Bandwidth	>50	0.4 seconds per 20 sec. Period

Test Parameters

Frequency	902-928 MHz
Settings	Low, Mid, and High Checked
EUT	Hopping mode Utilized on EUT

Instrumentation

Laird
Smart Technology. Delivered.

Date : 18-Jul-2017 Test : Conducted RF Testing Job # : C-2757

PE: Shane Dock Customer : Triax Technologies Quote #: 317206

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Spectrum Analyzer	Agilent	N9010A	MY53400296	12/22/2016	12/22/2017	Active Calibration
2	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/29/2016	12/31/2017	Active Calibration

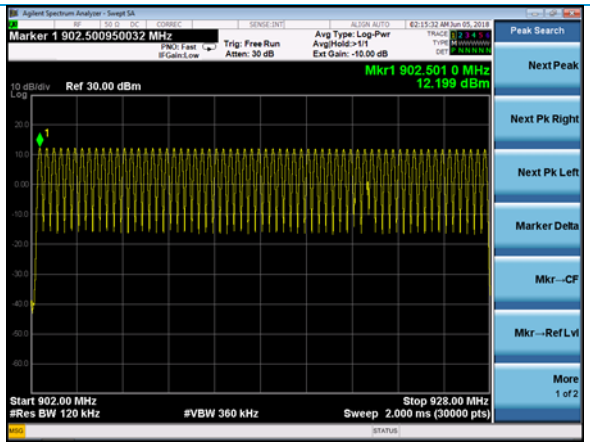
June Testing

1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/15/2017	11/15/2018	Active Verification

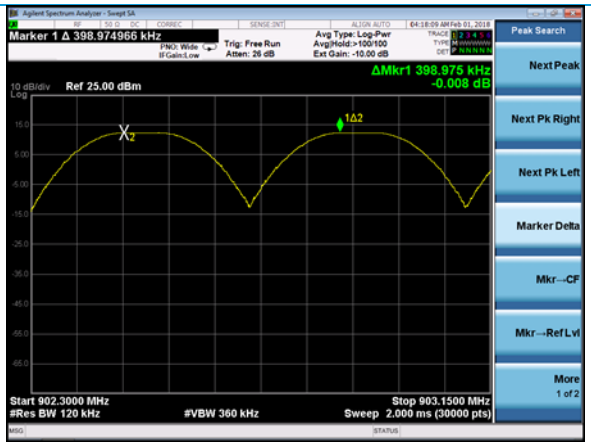
Table

Channel	Occupancy Time (ms)	Number of Transmissions	Occupancy time per 20s (ms)
Low	199.9	2	399.8
Mid	199.9	2	399.8
High	199.9	2	399.8

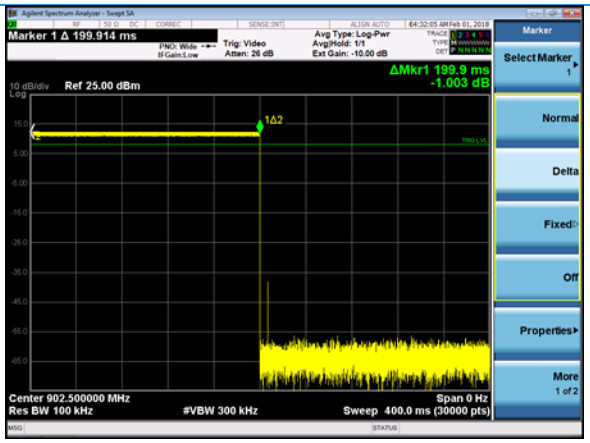
Plots



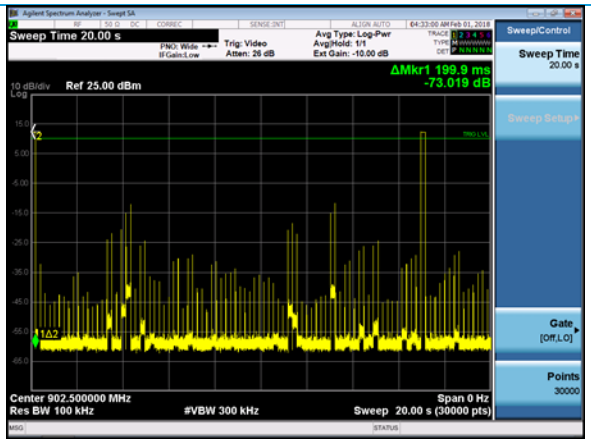
Number of Hopping Frequencies = 64



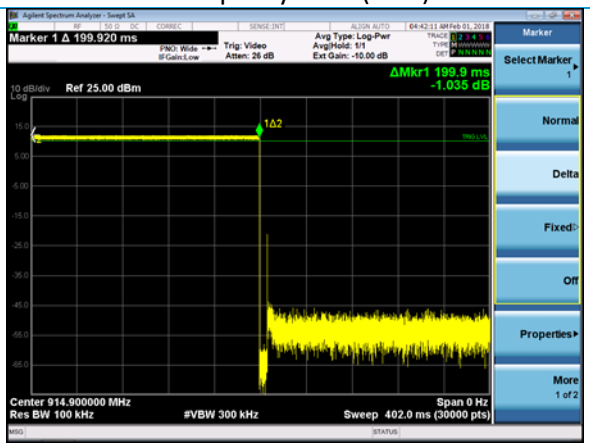
Carrier Frequency Separation = 400kHz



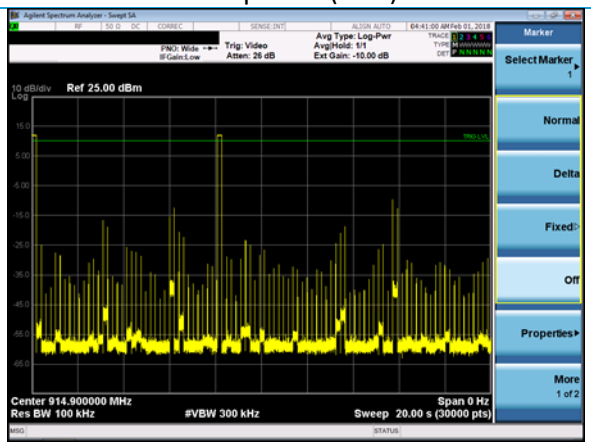
Occupancy Time (Low)



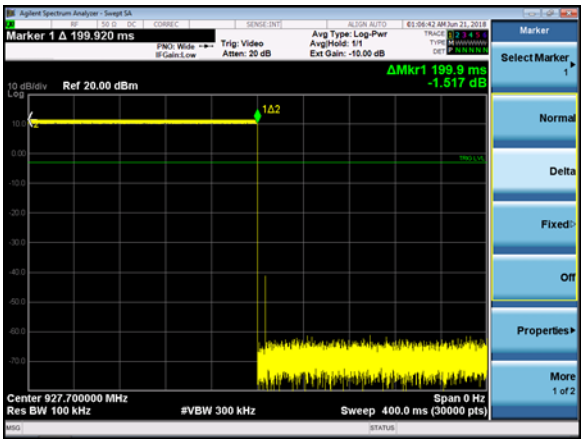
20s period (Low)



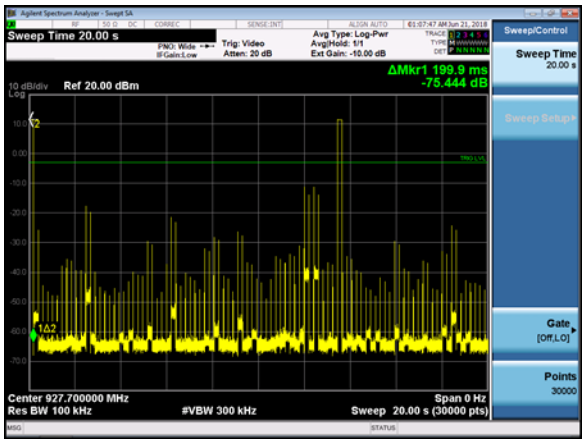
Occupancy Time (Mid)



20s period (Mid)



Occupancy Time (High)



20s period (High)

5.1.2 Antenna Port Conducted Emissions – Occupied Bandwidth

Operator	Shane Dock
Test Date	2/1/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/36% RH
Requirement	FCC: 2.1049 IC: RSS-GEN 6.6
Method	ANSI C63.10 Section 7.8.7

Limits:

20 dB BW (MHz)
< 500

Test Parameters

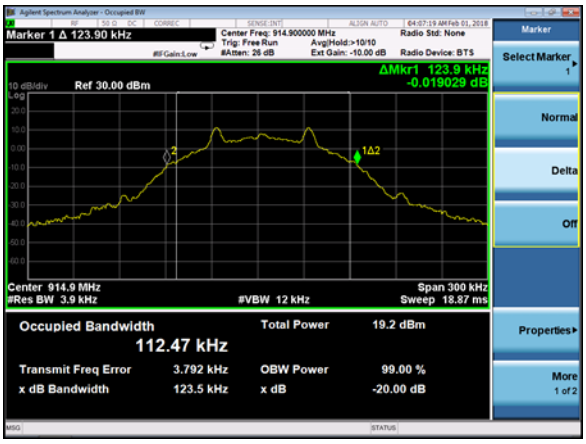
Channels	Low, Mid, High Channels Checked
Settings	99% and 20 dB BW recorded

Table

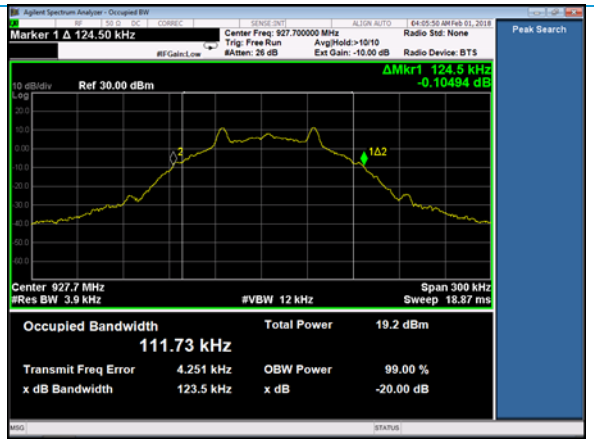
Channel	Low	Mid	High
20 dB BW (kHz)	122.4	123.5	123.5
99% BW (kHz)	118.5	123.9	124.5

Plots

Low



Mid



High

5.1.3 Antenna Port Conducted Emissions – Maximum Conducted Output Power

Operator	Shane Dock
Test Date	5/23/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/36% RH
Requirement	FCC: 15.247 (b)(1) IC: RSS-247 5.4 (b)
Method	ANSI C63.10 Section 7.8.5

Limits:

Maximum Conducted Output Power (watts)	Maximum Conducted Output Power (dBm)
1	30

Test Parameters

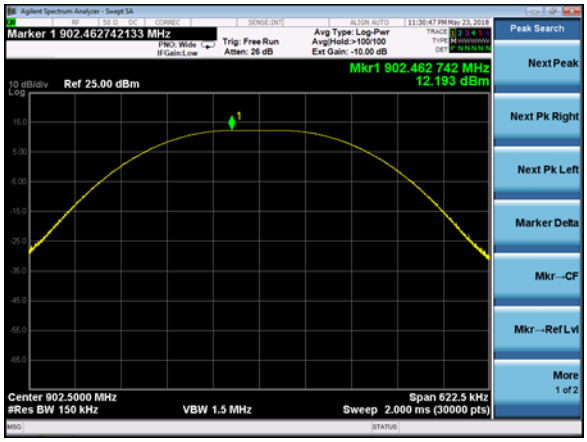
Channels	Low, Mid, High

Table

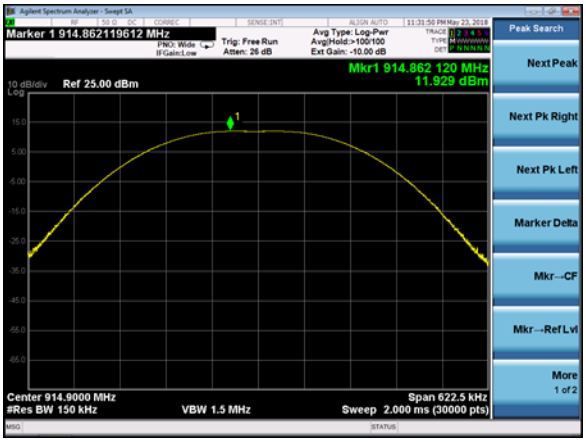
Channel	Low	Mid	High
Pout Conducted (dBm)	12.193	11.929	11.695

Worst Case Margin = 30.000 dBm – (12.193 dBm) = 17.807 dB

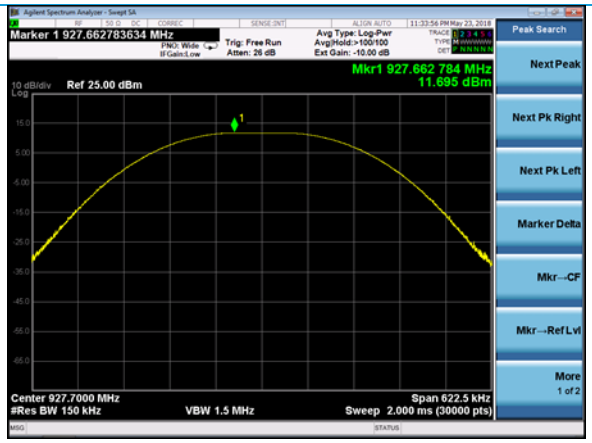
Plots



Low



Mid



High

5.1.4 Antenna Port Conducted Emissions – RF Spurious Emissions

Operator	Shane Dock
Test Date	5/23/18
Location	Conducted RF Area
Temp. / R.H.	72 degrees F/36% RH
Requirement	FCC: 15.247 (d) IC: RSS-247 5.5
Method	ANSI C63.10 Sections 7.8.6 and 7.8.8

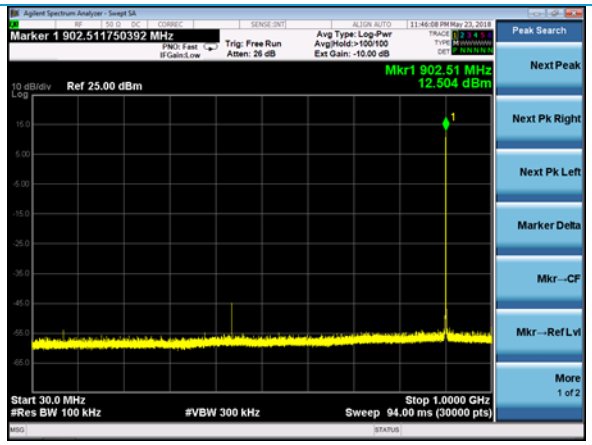
Limits:

RF Spurious Limit
20 dBc

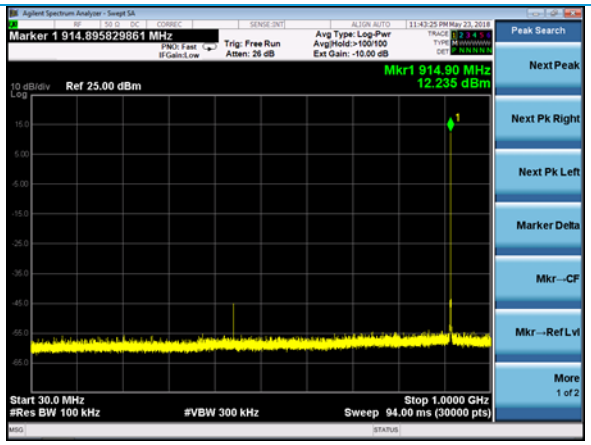
Test Parameters

Frequency	30-10000 MHz
Channels	Low, Mid, High
Notes	No emissions observed within 20 dB of limit.

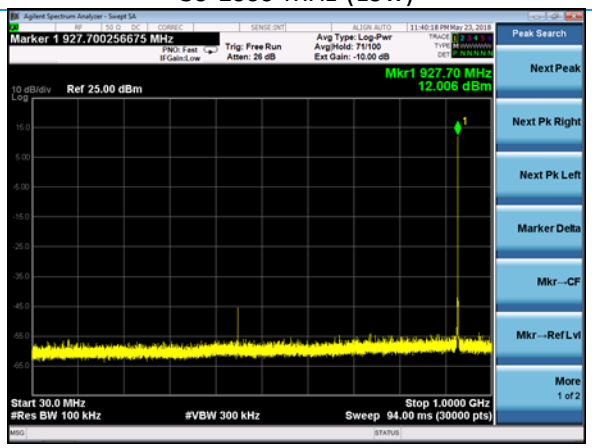
Plots



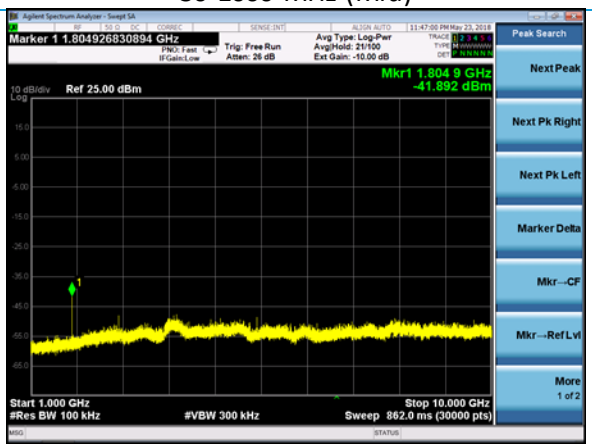
30-1000 MHz (Low)



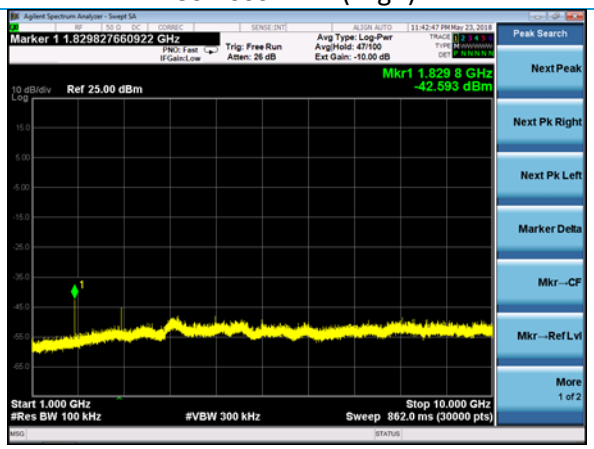
30-1000 MHz (Mid)



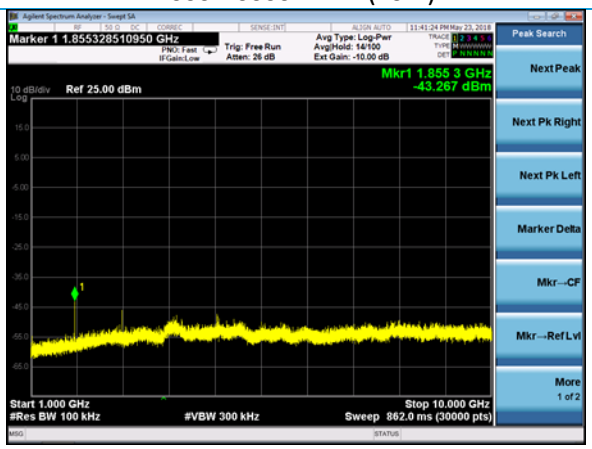
30-1000 MHz (High)



1000-10000 MHz (Low)

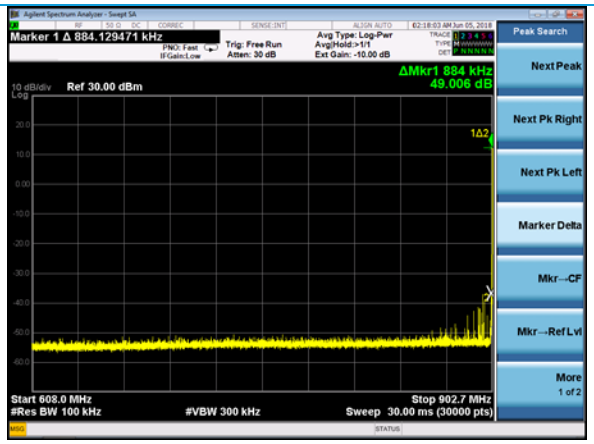


1000-10000 MHz (Mid)

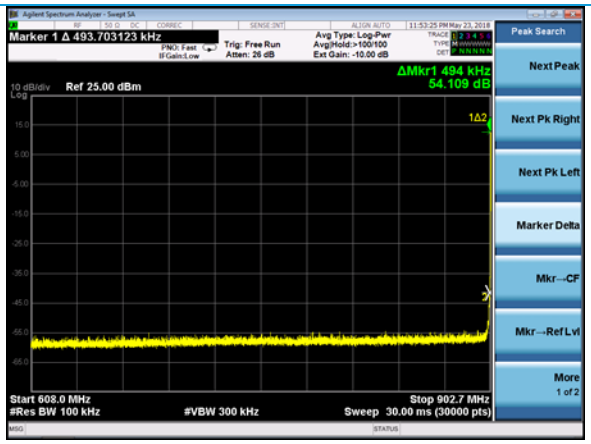


1000-10000 MHz (High)

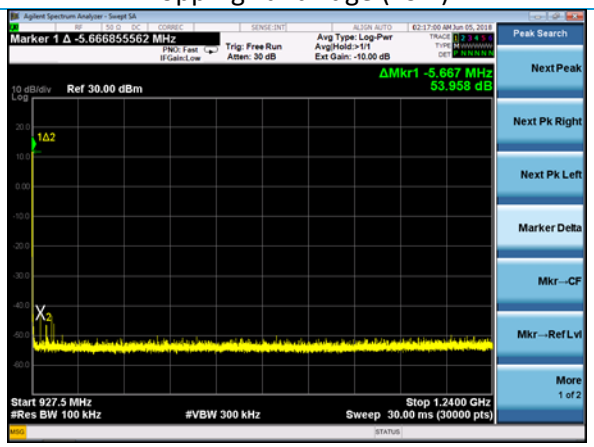
Band Edges



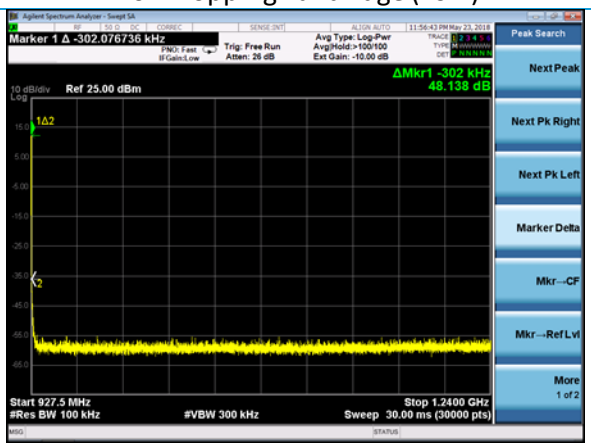
Hopping Band Edge (Low)



Non-Hopping Band Edge (Low)



Hopping Band Edge (High)



Non-Hopping Band Edge (High)

5.1.5 Antenna Port Conducted Emissions – Frequency Stability

Operator	Shane Dock
Test Date	6/5/18
Location	Conducted RF Area
Temp. / R.H.	71 degrees F/41% RH
Requirement	FCC: 2.1055 (d) IC: RSS-GEN 6.11
Method	ANSI C63.10 Section 6.8

Test Parameters

Channels	Low, Mid, High

Table (Values below listed in Hz at the given voltages) – Battery Voltage

	3.5 VDC	3.70 VDC	4.20 VDC	Deviation
Low Channel	902496711	902496836	902494096	2740
Mid Channel	914894470	914896275	914894719	1805
High Channel	927696670	927697500	927695777	1723

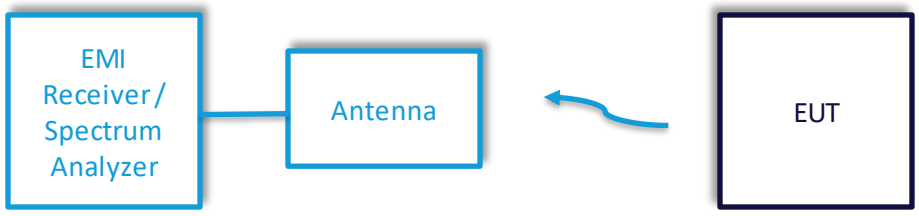
Table (Values below listed in Hz at the given voltages) – Input Voltage

	102 VAC	120 VAC	138VAC	Deviation
Low Channel	902496711	902496836	902494096	2740
Mid Channel	914894470	914896275	914894719	1805
High Channel	927696670	927697500	927695777	1723

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBµV/m) Margin (dB) = Limit (dBµV/m) - Corrected Reading (dBµV/m) Example at 4000 MHz: Reading = 40 dBµV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBµV/m Average Limit = 20 log (500) = 54 dBµV/m Margin = 54 dBµV/m - 50.8 dBµV/m = 3.2 dB

Block Diagram



5.2.1 Radiated Emissions

Operator	Shane Dock, Zach Wilson, Jon Dilley
Test Date	1/18/18 – 5/3/18
Location	Chamber 3, Chamber 5
Temp. / R.H.	70 degrees F/ 35% RH
Requirement	FCC: 15.247 (d)
Method	IC: RSS-GEN 8.10

Limits:

	30-88 MHz	88-216 MHz	216 – 960 MHz	960+ MHz
Field Strength (µV/m)	100	150	200	500
Field Strength (dBµV/m)	40.0	43.5	46.0	54.0

Test Parameters

Frequency	30-25000 MHz
Distance	3m
Settings	Unit tested at Low, Mid, High Channels
Settings	RBW = 120kHz, VBW 1.2 MHz (<1 GHz) RBW = 1 MHz, VBW = 3 MHZ (>1 GHz) VBW = 30 Hz for Average Measurements above 1 GHz
Notes	Measurements taken in restricted bands. For measurements above 1 GHz, antenna used with a tilt gear to keep EUT within the cone of radiation. Absorbers were also added to the floor of the chamber while measuring emissions above 1 GHz. Emissions below 400 MHz are not a function of the EUT.
Example Calculation	Limit (dBµV) = 20* Log[Limit (µV)] 40 = 20* log (100) Raw Data + Antenna Factor + Cable Factor = Reported Data 19.77 dBµV + 12.50 dB/m + 0.93 dB = 38.80 dBµV/m

Instrumentation

Date : 18-Jul-2017 Test : Spurious Emissions Job # : C-2755

PE: Shane Dock Customer : Triax Technologies Quote #: 317204

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	3/17/2017	3/17/2018	Active Calibration
2	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
3	AA 960155	High Pass Filter 900 MHz	KWM	HPF-L-14185	7272-03	5/2/2017	5/2/2018	Active Calibration
4	EE 960088	EMI Receiver	Agilent	N9038A	MY51210138	3/2/2017	3/2/2018	Active Calibration
5	AA 960150	Biconical Antenna	ETS Lindgren	3110B	0003-3346	3/3/2017	3/3/2018	Active Calibration
6	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	4/17/2017	4/17/2018	Active Calibration

Date : 19-Jul-2017 Test : Radiated Emissions Job # : C-2755

PE: Shane Dock Customer : Triax Technologies Quote #: 317204

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	4/16/2018	4/16/2019	Active Calibration
2	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/24/2018	4/24/2019	Active Calibration
3	AA 960155	Filter - High Pass Filter 900 MHz	KWM	HPF-L-14185	7272-03	4/25/2018	4/25/2019	Active Calibration
4	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/24/2018	4/24/2019	Active Calibration
5	AA 960150	Antenna - Biconical	ETS Lindgren	3110B	0003-3346	4/20/2018	4/20/2019	Active Calibration
6	AA 960078	Antenna - Log Periodic	EMCO	93146	9701-4855	4/20/2018	4/20/2019	Active Calibration

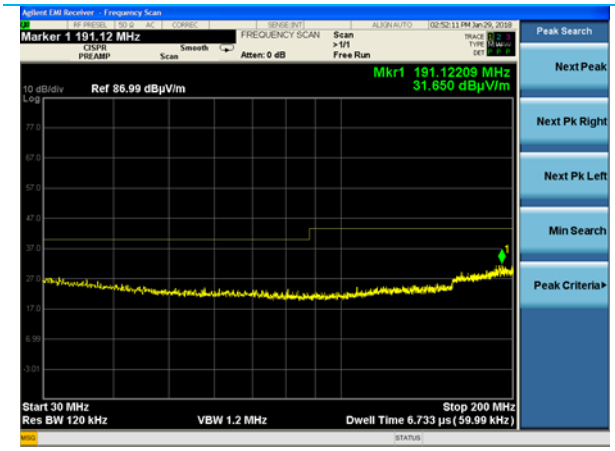
Table

Frequency (MHz)	Channel	Orientation	Azimuth (degrees)	Height (cm)	Peak Measure (dBuV/m)	Average Measure (dBuV/m)	Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Peak Margin (dB)	Average Margin (dB)
2783.17	64	FEUT H-Ant	160.3	213.0	49.1	47.5	74.0	54.0	24.9	6.5
2774.74	32	FEUT H-Ant	202.0	162.0	46.7	44.5	74.0	54.0	27.3	9.5
2707.49	1	FEUT H-Ant	227.0	205.0	46.3	43.9	74.0	54.0	27.7	10.1
4638.27	64	FEUT H-Ant	61.9	140.0	52.6	50.9	74.0	54.0	21.4	3.1
4574.62	32	FEUT H-Ant	109.3	110.0	47.7	44.9	74.0	54.0	26.3	9.1
4512.43	1	FEUT H-Ant	105.6	130.0	45.1	41.2	74.0	54.0	28.9	12.8
8349.30	64	SEUT H-Ant	26.2	175.0	47.3	38.6	74.0	54.0	26.7	15.4
8233.78	32	SEUT H-Ant	68.3	150.0	48.1	42.2	74.0	54.0	25.9	11.8
8122.90	1	SEUT H-Ant	23.3	220.0	48.8	44.5	74.0	54.0	25.2	9.5
3710.72	64	VEUT H-Ant	336.1	100.0	46.3	42.0	74.0	54.0	27.7	12.0
3659.59	32	VEUT H-Ant	333.0	233.0	44.2	39.9	74.0	54.0	29.8	14.1
3610.11	1	VEUT H-Ant	334.9	250.0	42.8	38.0	74.0	54.0	31.2	16.0
5415.05	1	FEUT H-Ant	48.1	160.0	48.0	44.3	74.0	54.0	26.0	9.7
5415.05	1	FEUT V-Ant	54.5	250.0	46.1	40.4	74.0	54.0	27.9	13.6
5415.05	1	SEUT H-Ant	53.9	168.0	47.7	43.7	74.0	54.0	26.3	10.3
5415.05	1	SEUT V-Ant	25.1	100.0	43.4	35.8	74.0	54.0	30.6	18.3
5415.05	1	VEUT H-Ant	335.8	330.0	43.8	35.3	74.0	54.0	30.2	18.7
5415.05	1	VEUT V-Ant	113.1	250.0	46.2	41.7	74.0	54.0	27.8	12.3

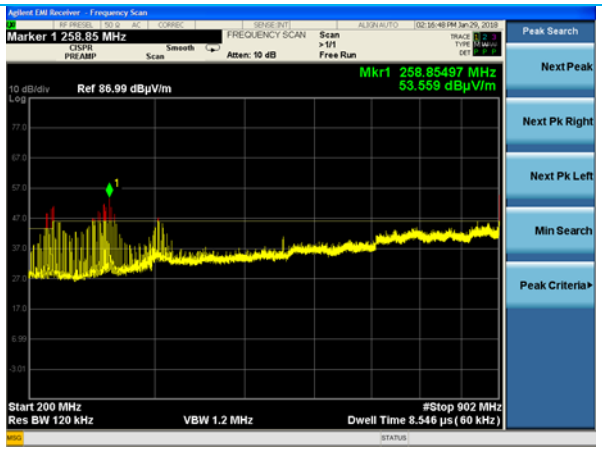
Note: FEUT, SEUT, and VEUT refer to the Flat, Side, and Vertical EUT orientations, respectively.

Frequency (GHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Average Reading (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Margin (dB)	Avg. Margin (dB)	Antenna Polarity	EUT orientation	Channel
1.024	1.50	163.6	41.1	33.9	74.0	54.0	32.9	20.1	Horizontal	Side	64

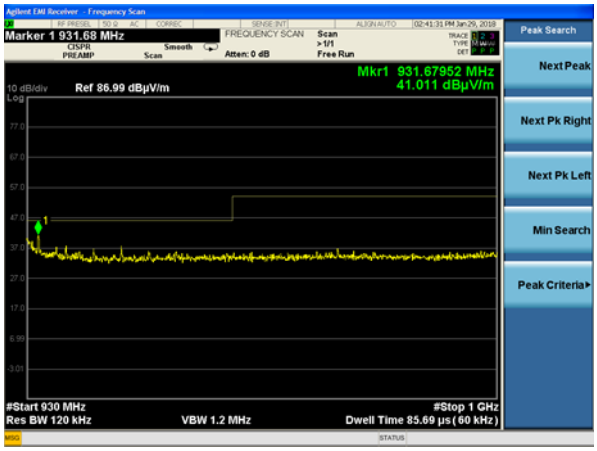
Plots – Spurious Emissions



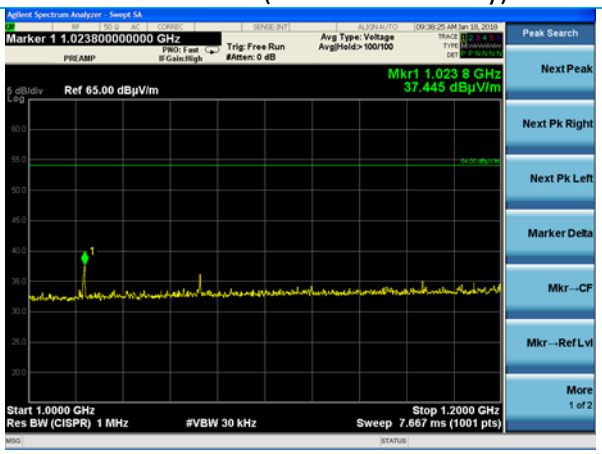
30-200 MHz (Horizontal Polarity)



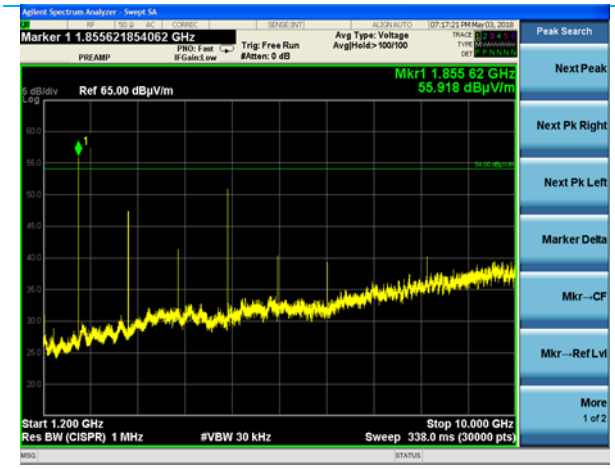
200-902 MHz (Horizontal Polarity)



930-1000 MHz (Horizontal Polarity)



1000-1200 MHz (Reduced BW) (Horizontal Polarity)

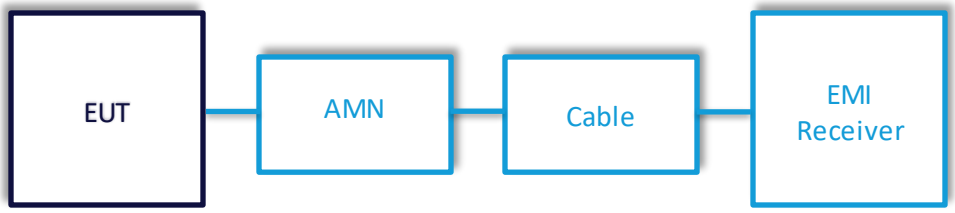


1.2-10 GHz (Reduced BW) (Horizontal Antenna)

5.3 AC Mains Conducted Emissions

Description of Measurement	A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains. The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values. Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBµV) Margin (dB) = Limit (dBµV) - Corrected Reading (dBµV)

Block Diagram



5.3.1 AC Mains Conducted Emissions

Operator	Jon Dilley
Test Date	5/21/18
Location	EMC Lab
Temp. / R.H.	71.1 degrees F/43.5% RH
Requirement	FCC: 15.207 IC: RSS-GEN 8.8
Method	ANSI C63.10 Section 6.2

Limits:

Frequency of Emission (MHz)	Quasi-Peak Limit (dBuV)	Average Limit (dBuV)
0.15 - 0.50	66 to 56	56 to 46
0.5 – 5	56	46
5-30	60	50

Test Parameters

Frequency	0.15 – 30 MHz
Settings	RBW 9 kHz
Settings	VBW 90 kHz
EUT Power	120V 60 Hz
Channel	Low Channel Tx mode (Found to be worst-case)

Instrumentation

Laird
Smart Technology. Delivered.

Date : 19-Jul-2017 Test : Conducted Emissions Job # : C-2755

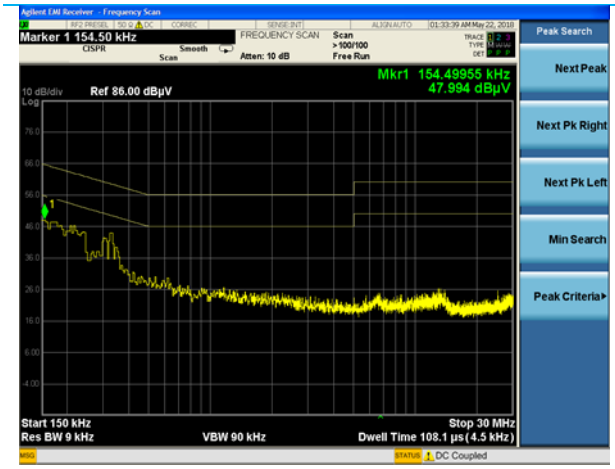
PE: Shane Dock Customer : Triax Technologies Quote #: 317204

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/24/2018	4/24/2019	Active Calibration
2	EE 960162	LISN	COM-POWER	LI-215A	191969	4/23/2018	4/23/2019	Active Calibration

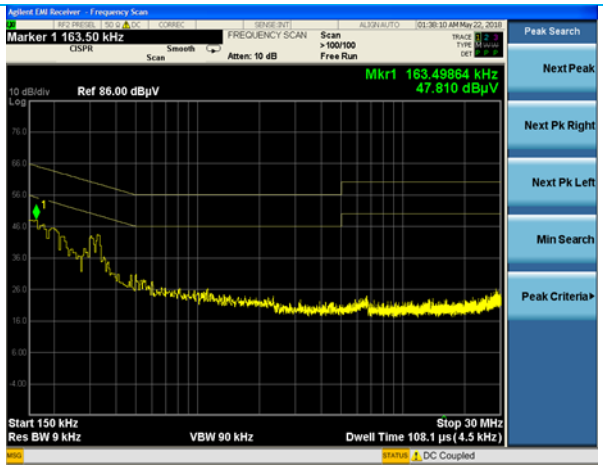
Table

Line	Frequency (MHz)	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
1	0.181	43.1	64.4	21.3	33.2	54.4	21.2
1	0.330	42.0	59.5	17.5	28.4	49.5	21.1
1	13.442	20.4	60.0	39.6	11.9	50.0	38.1
2	0.154	45.1	65.8	20.7	26.3	55.8	29.4
2	0.330	41.5	59.5	18.0	26.0	49.5	23.5
2	12.960	17.5	60.0	42.5	10.5	50.0	39.6

Plots



Line 1



Line 2

6 REVISION HISTORY

Version	Date	Notes	Person
V0	6/20/18	First Draft	Shane Dock
V1	8/13/18	Updated Draft	Shane Dock
V2	8/14/18	Final Draft	Shane Dock

END OF REPORT