

ELECTROMAGNETIC COMPATIBILITY TEST REPORT



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Laboratory Accreditations (per ISO/IEC 17025:2017)



American Association for Laboratory Accreditation Certificate Number: 3657.02

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Manufacturer: Douglas Lighting Controls
Address: 280 – 3605 Gilmore Way
Burnaby, BC V5G 4X5, Canada
Equipment Tested: In-fixture controller with BLE capability
Model Number(s): BT-IFC-A
FCC ID: 2AV38-BTIFXA
ISED ID: 25994-BTIFXA
ISED PMN: BT-IFC-A (also referred to as a Douglas Intelligent Fixture Controller)



REVISION HISTORY

Date	Report Number	Details	Author's Initials
May 5, 2020	E10783-2001_Douglas Lighting_BT-IFC-A_FCC-ISED_Rev-1.0	RE: Class A	MK
April 28, 2020	E10783-2001_Douglas Lighting_BT-IFC-A_FCC-ISED_Rev-1.0	Final	MK
January 17, 2020	E10783-2001_Douglas Lighting_BT-IFC-A_FCC-ISED_Rev-0.0	Draft	MK
All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.			

REPORT AUTHORIZATION

The data documented in this report is for the test equipment provided by the manufacturer. The tests were conducted on the sample equipment as requested by the manufacturer for the purpose of demonstrating compliance with the standards outlined in Section I of this report as agreed upon by the Manufacturer under the quote 19SH12231.

The Manufacturer is responsible for the tested product configurations, continued product compliance, and for the appropriate auditing of subsequent products as required.

This report may comprise a partial list of tests that are required for FCC and ISSED Declaration of Conformity can only be produced by the manufacturer.

This is to certify that the following report is true and correct to the best of our knowledge.



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QAI EMC ACCREDITATION

QAI EMC is your one-stop regulatory compliance partner for electromagnetic compatibility (EMC) and electromagnetic interference (EMI). Products are tested to the latest and applicable EMC/EMI requirements for domestic and international markets. QAI EMC goes above and beyond being a testing facility—we are your regulatory compliance partner. QAI EMC has the capability to perform RF Emissions and Immunity for all types of electronics manufacturing including Industrial, Scientific, Medical, Information Technology, Telecom, Wireless, Automotive, Marine and Avionics.

EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
Burnaby, BC, Canada	CA9543	21146-1	3657.02

EMC Facility Burnaby BC, Canada



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Section I: SUMMARY OF APPLICABLE STANDARDS

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of BT-IFC-A as per Sections 1.2 & 1.3.

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 19SH12231:

FCC Title 47 Part 15 - Radio Frequency Devices, Subpart C – Intentional Radiators.
• 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz.

CFR Title 47 FCC Part 15 - Radio Frequency Devices, Subpart B – Unintentional Radiators.

RSS-247 Issue 2 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen Issue 5 – General Requirements and Information for the Certification of Radio Apparatus

ICES-003 Issue 6 – Information Technology Equipment (Including Digital Apparatus) – Limits and Methods of Measurement

The tests documented in this report were performed in accordance with ANSI C63.4-2014, ANSI C63.10-2013, FCC KDB 558074 D01 DTS Meas Guidance v05 and KDB 447498 D01 General RF Exposure Guidance v06.

1.3 Summary of Standards and Results

The following tests were performed pursuant to the FCC/IC Unintentional Radiated Emissions, Intentional Radiated Emissions, and Radio Testing Standards:

No.	Test Description	Standard Clause	Result
1	Antenna Requirement	FCC 47 CFR Part 15.203 IC RSS-Gen Issue 5 Section 7.1.2	Complies
2	6-dB Bandwidth	FCC Title 47 CFR Part 15: Subpart C - §15.247 (2) RSS-247 Issue 2: 5.2 (a)	Complies
3	RF Peak Output Pwer	FCC Title 47 CFR Part 15: Subpart C - §15.247 (b)(3) RSS-247 Issue 2 (5.4)(b)	Complies
4	Power Spectral Density	FCC Title 47 CFR Part 15: Subpart C §15.247 (e), RSS-247 Issue 2: 5.2 (b)	Complies
5	Out-of-Band Emissions (Bandedge)	FCC Title 47 CFR Part 15: Subpart C - §15.247 (d) RSS-247-Issue 2: 5.5	Complies
6	Radiated Unintentional/Spurious Emissions	FCC Subpart C §15.205(a), §15.209 (a) & §15.247 (d) FCC Title 47 CFR Part 15: Subpart B - §15.109 RSS-Gen Issue 5 (8.9),(8.10) ICES-003 Issue 6	Complies
7	Spurious Emimssions – Receiver Mode	FCC Title 47 CFR Part 15: Subpart B - §15.109 ICES-003 Issue 6	Complies
8	AC Mains Conducted Emissions	FCC Title 47 CFR §15.207(a) ICES-003 Issue 6.1	Complies
9	Frequency Stability	FCC 47 CFR §2.1055 , §15.215 (c) RSS_Gen Issue 5 (8.8)	Complies
10	RF Exposure Evaluation	FCC 47 CFR §2.1093 (e) & 1.1310 (d) KDB 447498 D01 v06 RSS-102 (2.5.1)	Complies

Section II: GENERAL INFORMATION

2.1 Product Description

The information provided in this section is for the Equipment Under Test (EUT) and the corresponding Auxiliary Equipment needed to perform the tests as a complete system.

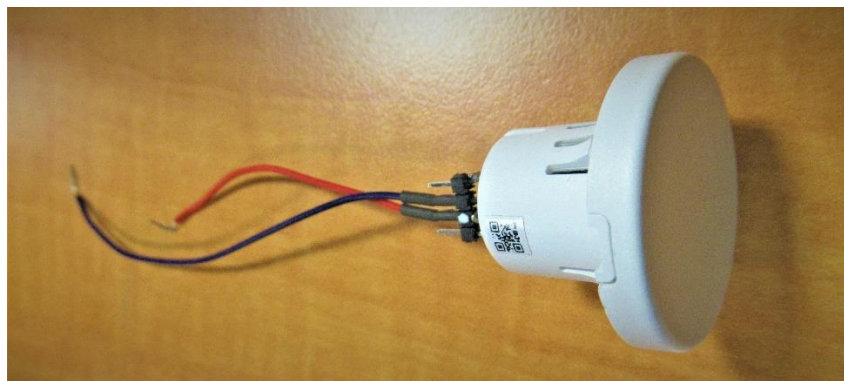


Photo of EUT

Equipment Under Test (EUT) Information

Equipment	Item/Description	Manufacturer	Model No.
BLE controller	In-Fixture Controller: Assembled into a commercial lighting luminaire in order to control the luminaire based on communication from other Bluetooth mesh devices.	Douglas Lighting Controls	BT-IFC-A
Note: Clock frequency generated or tuned upon within the EUT: 32.768 kHz and 16 MHz Highest frequency generated or tuned upon within the EUT: 2.48 GHz			

Test Units

ID	Serial #	Test	Antenna – Test type	Test Modes
xx	xx	Unintentional and intentional emissions	Integrated - Radiated	FW-configured

EUT Test Channels

Channel	Frequency (MHz)
Low	2402 – modulated & CW
Mid	2440 – modulated & CW
High	2480 – modulated & CW

Equipment Under Test (EUT) Information

FCC ID	2AV38-BTIFXA
ISED ID	25994-BTIFXA
ISED PMN	BT-IFC-A (also referred to as a Douglas Intelligent Fixture Controller)
Transmitter Type	Bluetooth Low Energy 4.1
Operating Frequency	2402 MHz to 2480 MHz
Transmit Power	9 dBm
Modulation Type	GFSK
Adaptive	No
Test Channels	2402, 2440 and 2480 MHz
Data Rate	28kbps, 1Mbps, 2Mbps
Antenna Type	SMT, integral
Antenna Gain	-2 dBi
Input Voltage	10.8 – 26.5 VDC

EUT Ports

Type	Count	Number of Pins	Pins Used
--	1	4	2: DC input

Auxiliary Equipment Information

Equipment	Testing	Count	Specification	Manufacturer	Model No.	Serial No.
AC/DC adaptor	Unintentional Emissions	1	Input: 100-240 V 50/60Hz, Output: 12VDC-5.0A	AOYUAN	AY060A-ZF122	N//A
Battery	Intentional Radiator	1	12V 4.5 AH – lead acid	C-Power	CS12-4.5	N/A

2.2 Environmental Conditions

The equipment under test was operated and tested under the following environmental conditions:

Parameter	Conditions
Location	Indoors
Temperature	21°C
Relative Humidity	39.4%
Atmospheric Pressure	101 kPa

2.3 Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 dB
Conducted Emissions, 0.15MHz-30MHz	± 2.82 dB
Radio Frequency	±1.5 x 10 ⁻⁵ MHz
Total RF Power Conducted	±1.36 dB
Spurious Emissions, Conducted	±1.36 dB
RF Power Density, Conducted	±1.36 dB
Temperature	±1°C
Humidity	±5 %
DC and low frequency voltages	±3 %

2.4 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rhodes & Schwarz. Transducer factors like Antenna factors, Cable Losses and Amplifier gains were stored in the test templates which are used to perform the emissions measurements. After test is finished, data is generated from the EMC32 consisting of product details, emission plots and final data tables as shown below.

Frequency (MHz)	Q-Peak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable Position (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

Quasi-Peak reading shown in the table above is already corrected by the software using correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

$$\text{Corr. (dB)} = \text{Antenna factor} + \text{Cable loss}$$

Or

$$\text{Corr. (dB)} = \text{Antenna factor} + \text{Cable Loss} - \text{Amp gain (if pre-amplifier was used)}$$

The final Quasi peak reading shown in the data is calculated by the software using following equation:

$$\text{Corrected Quasi-Peak (dBμV/m)} = \text{Raw Quasi-Peak Reading} + \text{Antenna factor} + \text{Cable loss}$$

To obtain the final Quasi-Peak or Average reading during power line conducted emissions, transducer factors are included in the final measurement as shown below.

Frequency (MHz)	Q-Peak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150	44.3	1000.000	9.000	GND	0.6	21.7	66.0

Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150	27.2	1000.000	9.000	GND	0.6	28.8	56.0

Quasi Peak or Average reading shown in above table is already corrected by the software using the correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

$$\text{Corr. (dB)} = \text{Antenna factor} + \text{Cable loss}$$

The final Quasi-peak or Average reading shown in the data is calculated by the software using following equation:

$$\text{Corr. Quasi-Peak/Average Reading (dBμV)} = \text{Raw Quasi-Peak/Average Reading} + \text{Antenna factor} + \text{Cable loss}$$

The allowable margin from the limits, as per the standards, were calculated for both radiated and conducted emissions:

$$\text{Margin (dB)} = \text{Limit} - \text{Quasi-Peak or Average reading}$$

2.5 Test Equipment List

The tables below contain all the equipment used by QAI Laboratories in conducting all tests on the Equipment Under Test (EUT) as per Section 1.

Emissions Test Equipment

Sl. NO.	Manufacturer	Model	Description	Serial No.	S/W Version	Calibration Due Date
1	ETS Lindgren	2165	Turntable	00043677	N/A	N/A
2	ETS Lindgren	2125	Mast	00077487	N/A	N/A
3	Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A042004	N/A	2020-Nov-10
4	ETS-Lindgren	3117	Horn Antenna 1GHz-18GHz	75944	N/A	2020-Aug-29
5	EMCO	3160-09	Pyramidal Antenna 18 - 26.5 GHz	9701-1071	N/A	2020-Sep-13
6	Rohde & Schwarz	ESU40	EMI Receiver	100011	EMC32 v10.35.10/ FV 4.73 SP4	2021-Sep-20
7	Hewlett Packard	8449B OPT H02	Preamplifier (1-26.5GHz)	2933A00198	N/A	2022-Jun-22
8	Rohde & Schwarz	FSP	Spectrum Analyzer 9 kHz – 67 GHz	100184	N/A	2021-Mar-16
9	ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A

Note: Equipment listed above have 3 years calibration interval.

Measurement Software List

Sl. No.	Manufacturer	Model	Version	Description
1	Rhode & Schwarz	EMC 32	6.20.0	Emissions Test Software

Section III: DATA & TEST RESULTS

3.1 Antenna Requirements

- **Test Standard:** FCC 47 CFR Part 15.203 and RSS-Gen Issue 5 (7.1.2)
- **Requirement:**

The purpose of this requirement is to make certain that no other antenna, except for that provided by the responsible party, shall be used with the Equipment-Under-Test (EUT) as defined in FCC CFR 47 Part 15.203 & RSS-Gen Issue 5:

“An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited.” ... “the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.”

- **Antenna Information:**

Manufacturer	Johanson Technology
Part number	2450AT14A0100T
Max. RF power	2 Watts CW
Compact size	1.60(L) x 0.80(W) x 0.40(T) mm
Antenna type	Mini chip antenna
Return loss	Typical 9.5 dB
RoHS	N/A
Frequency range	2.4 – 2.48 GHz
Average gain	-2 dBi
Impedance	50 Ohms
Average efficiency	48 %

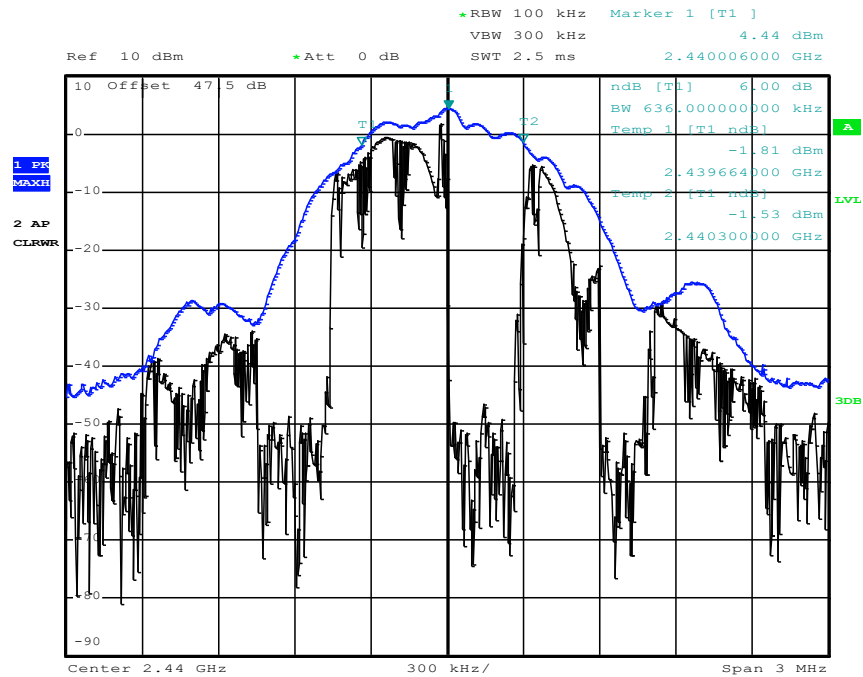
Result: An integrated antenna is used on this product and is not field-replaceable. EUT Complies.

3.2 6-dB Bandwidth

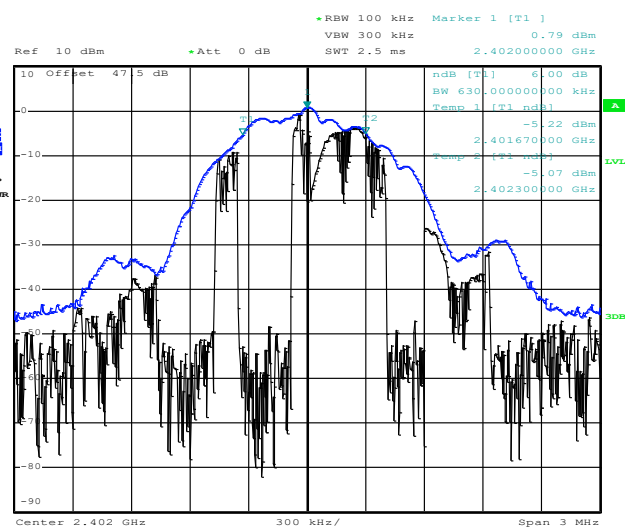
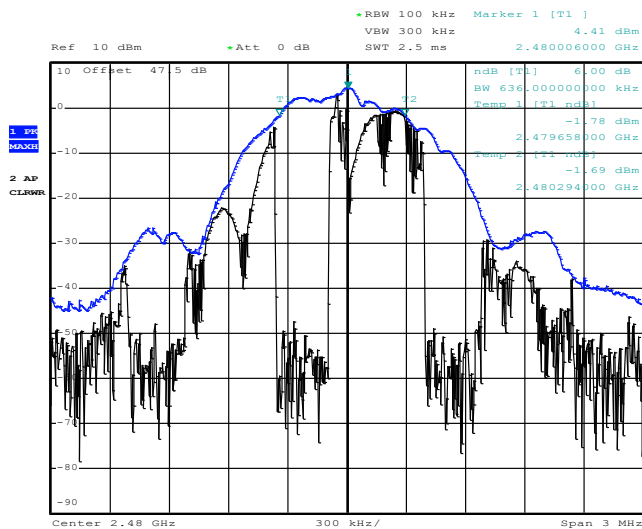
- **Date Performed:** January 13, 2020
- **Test Standard:** FCC Title 47 CFR Part 15: Subpart C - §15.247 (2), RSS-247 Issue 2 (5.2)(a)
- **Test Requirement:**
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.
- **Test Set-up:**
Radiated measurements in semi-anechoic chamber using spectrum analyzer.
- **Modifications:**
EUT configured using firmware to transmit modulated signal at selected channels.
- **Result:**
The EUT complies with the applicable standard.
- **Data:**

Frequency MHz	System Loss (dB)	6-dB BW (kHz)	Min. Limit (kHz)	Results
2402	47.5	630	500	PASS
2440	47.5	636	500	PASS
2480	47.5	636	500	PASS

6-dB Bandwidth Plots

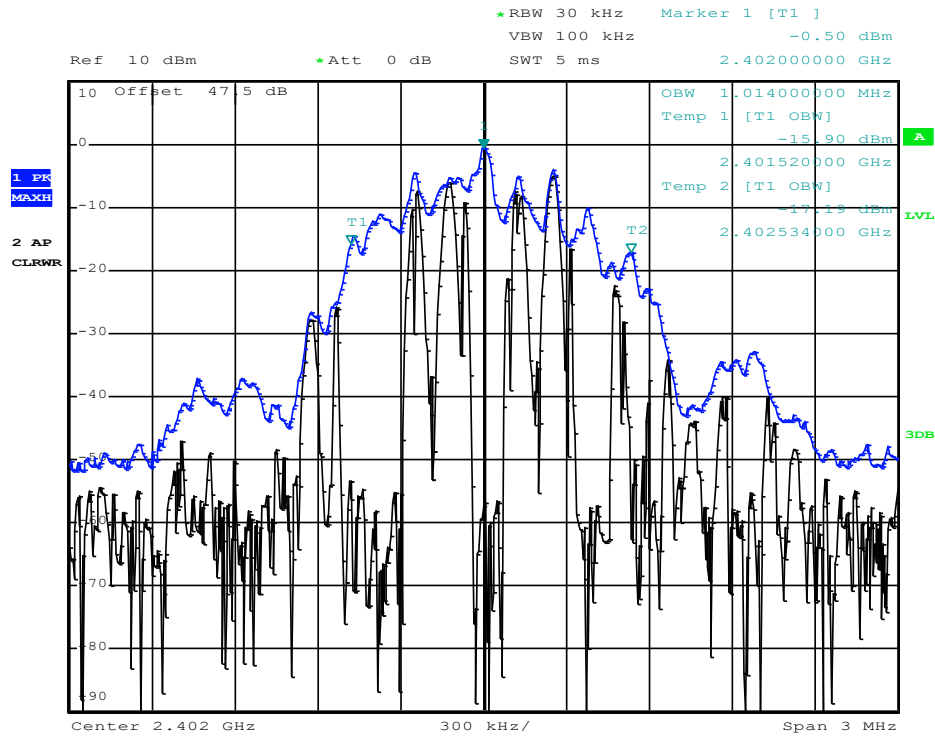


Mid Channel

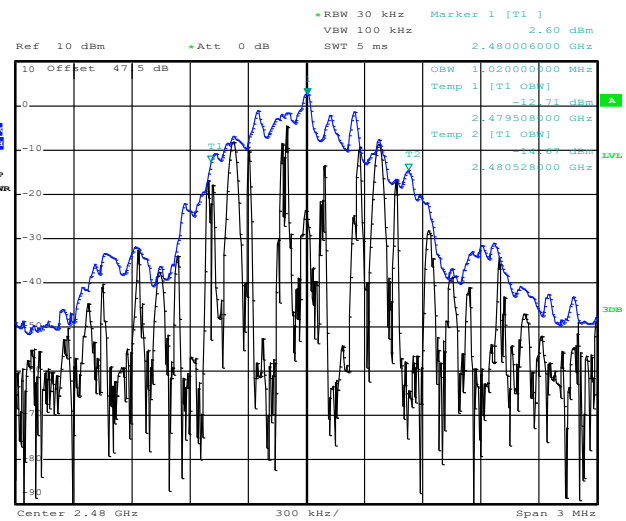
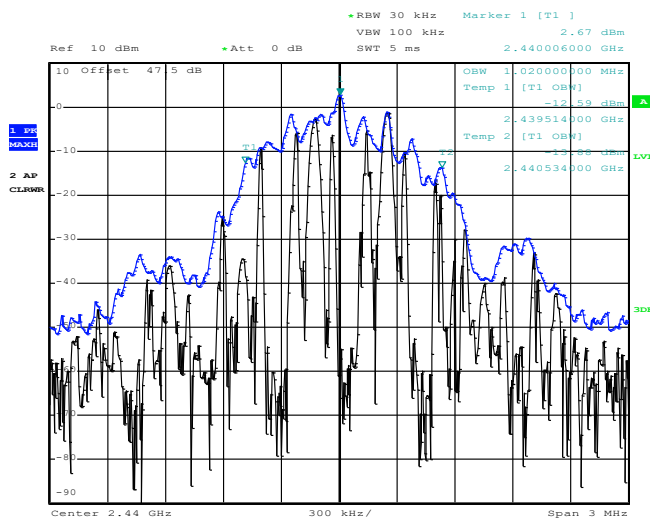


High(L) and Low (R) Channels

99% Occupied Bandwidth Plots – for reference



Low Channel



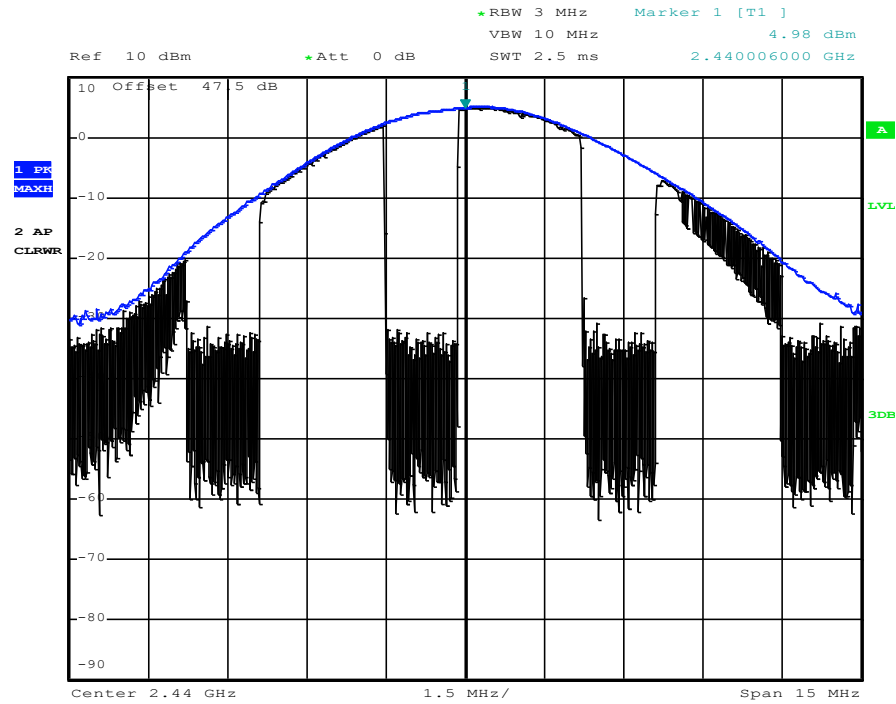
Mid (L) and High (R) Channels

3.3 RF Peak Output Power

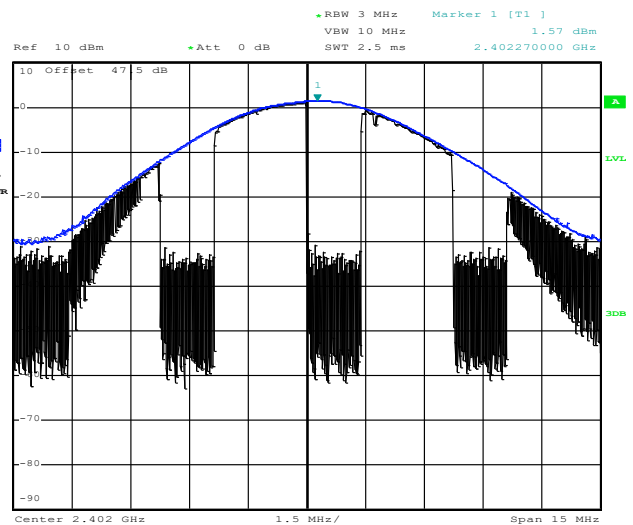
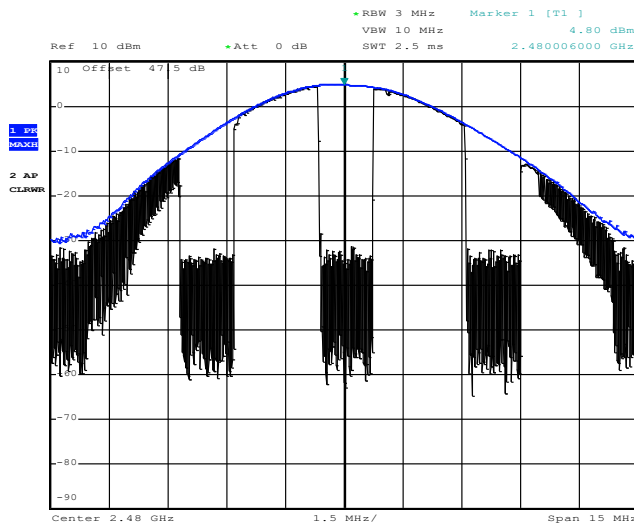
- **Date Performed:** January 13, 2020
- **Test Standard:** FCC Title 47 CFR Part 15: Subpart C - §15.247 (b)(3), RSS-247 Issue 2 (5.4)(b)
- **Test Requirement:**
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 W (30dBm).
- **Test Set-up:**
Radiated measurements in semi-anechoic chamber using spectrum analyzer.
- **Modifications:**
EUT configured using firmware to transmit modulated signal at selected channels.
- **Result:**
The EUT complies with the applicable standard.
- **Data:**

Frequency MHz	System Loss (dB)	E.I.R.P (dBm)	Antenna Gain (dBi)	RF Peak Output Power (dBm)	RF Peak Output Power (Watts)	Limit (dBm)	Results
2402	47.5	1.57	-2	3.57	0.002	30	PASS
2440	47.5	4.98	-2	6.98	0.005	30	PASS
2480	47.5	4.80	-2	6.80	0.005	30	PASS

RF Peak Output Power Plots



Mid Channel



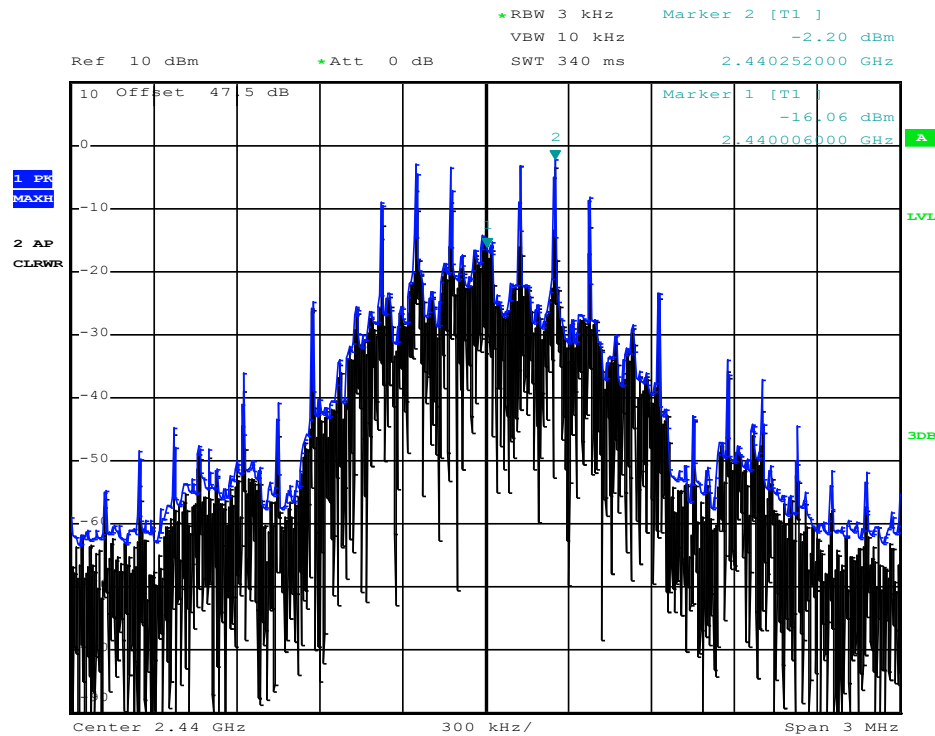
High (L) and Mid (R) Channels

3.4 Power Spectral Density (PSD)

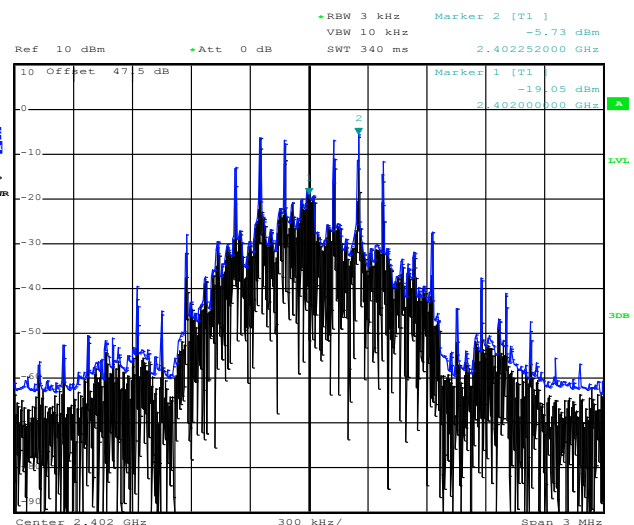
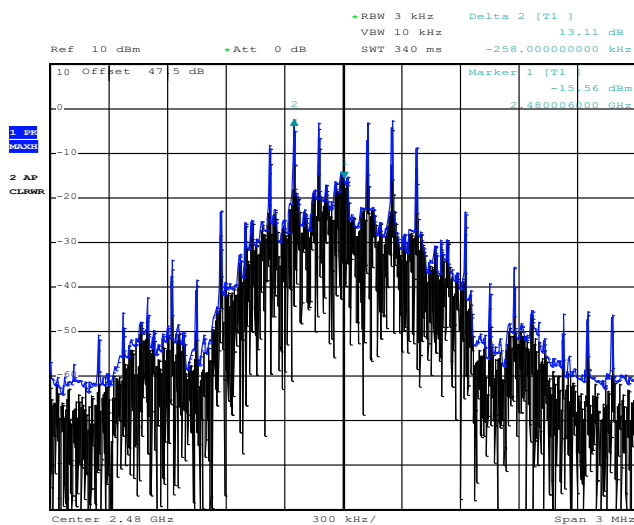
- **Date Performed:** January 13, 2020
- **Test Standard:** FCC Title 47 CFR Part 15: Subpart C - §15.247 (e), RSS-247 Issue 2 (5.2)(b)
- **Test Requirement:**
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.
- **Test Set-up:**
Radiated measurements in semi-anechoic chamber using spectrum analyzer.
- **Modifications:**
EUT configured using firmware to transmit modulated signal at selected channels.
- **Result:**
The EUT complies with the applicable standard.
- **Data:**

Frequency MHz	System Loss (dB)	E.I.R.P (dBm)	Antenna Gain (dBi)	PSD (dBm)	Limit (dBm)	Results
2402	47.5	-5.73	-2	-3.73	8	PASS
2440	47.5	-2.20	-2	-0.20	8	PASS
2480	47.5	-2.45	-2	-0.45	8	PASS

Power Spectral Density Plots



Mid Channel



High(L) and Low (R) channels

3.5 Out-of-Band Emissions (Bandedge)

- **Date Performed:** January 13, 2020
- **Test Standard:** FCC Title 47 CFR Part 15: Subpart C - §15.247 (d), RSS-247-Issue 2 (5.5)
- **Test Method:** ANSI C63.10:2013
- **Test Requirement:**

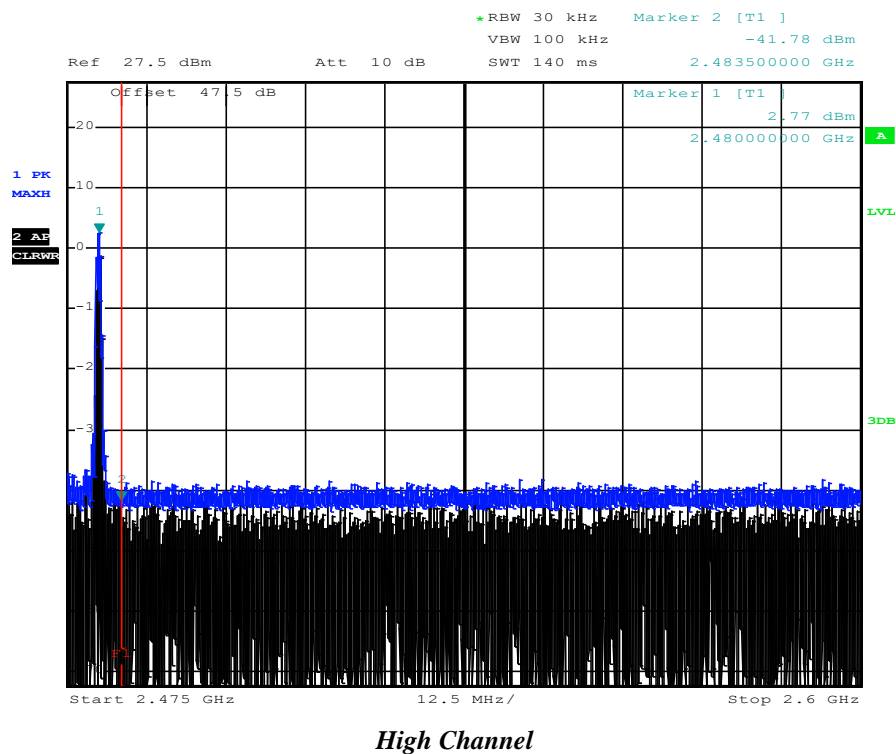
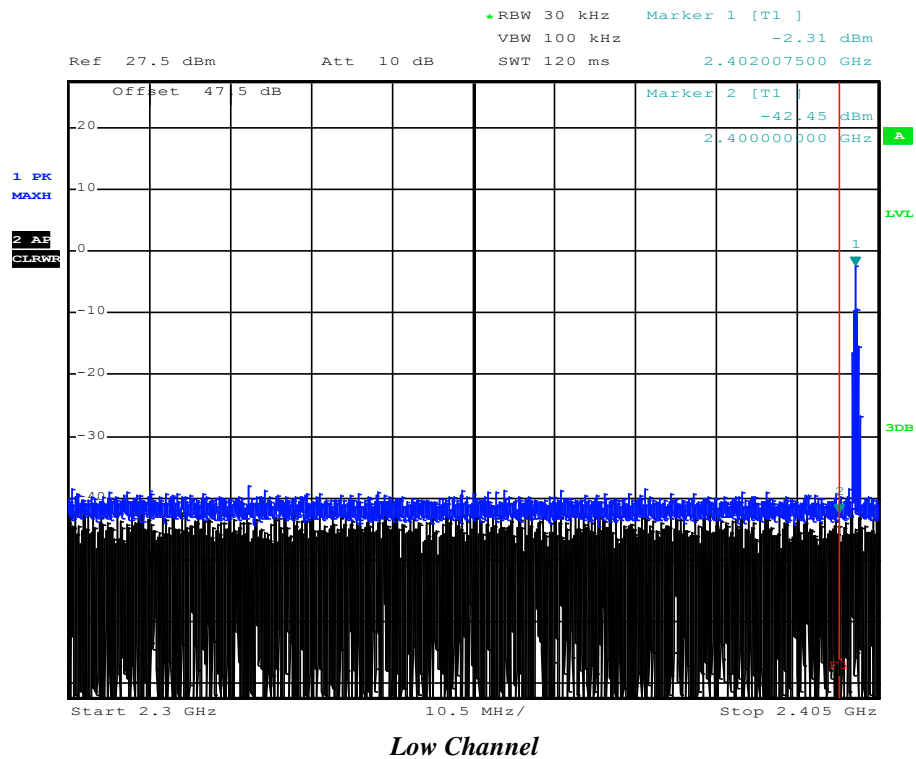
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required.

- **Test Set-up:**
Radiated measurements in semi-anechoic chamber using spectrum analyzer.
- **Modifications:**
EUT configured using firmware to transmit modulated signal at selected channels.
- **Result:**
No emissions observed above the noise floor.
The EUT complies with the applicable standard.
- **Data:**

Carrier Frequency (MHz)	System Loss (dB)	Num. Of pts.	Bandedge (MHz)	Results
2402	47.5	8001	2400	PASS
2480	47.5	8001	2483.5	PASS

Out-of-Band Emissions Plots

Bandedge frequency: vertical line/Marker 2 on noise floor



3.6 Spurious Emissions

▪ Test Standards:

Test or Measurement	Applicable Standards	Description
Radiated Emissions	ICES-003 Issue 6 CFR Title 47 FCC Part 15 Subpart B	The radiated emissions are measured in the 30-1000MHz range or upto 5x the highest EUT frequency whichever is higher.
	RSS-247-Issue 2, RSS-Gen Issue 5 (8.9) & (8.10) FCC Subpart C §15.205 (a), 15.209 (a) & 15.247 (d)	

▪ Required Limits:

1) Radiated emission limits; general requirements (Class A);

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency, <i>f</i> (MHz)	Maximum Field strength Quasi-peak (dBμV/m at 3 m)
0.009 – 0.490	2400/F(kHz)
0.490 – 1.705	24000/F(kHz)
1.705 – 30.0	49.5
30 – 88	50.0
88 – 216	53.5
216 – 960	56.0
above 960	64.0

Note 1: The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.
Note 2: The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

Maximum Field Strength (dB mV/m at 3 m)		
Frequency (GHz)	Peak	Average
1-40	80	60

Note 1: The lower limit shall apply at the transition frequency
Note 2: Additional provisions may be required for cases where interference occurs

2) Restricted bands of operation:

Unwanted emissions that fall into the restricted bands specified on the table below shall comply with the limits specified on the table limits above as per §15.209 and Clause 8.9 of RSS-Gen.

MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Restricted Bands – RSS Gen Issue 5

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(2)
13.36-13.41			

Restricted Bands – FCC Part

Measurement Method:

The EUT was positioned at the edge of the turntable in the 3m SAC with all cables draped down the side, 40 cm off the ground plate. Emissions were measured in the frequency range of 30 MHz – 25 GHz using the appropriate receivers, antennas, amplifiers, attenuators and filters. 30 MHz- 18 GHz measurements were made using an EMI receiver. 18-25 GHz measurements were made using a spectrum analyzer.

Emissions in both horizontal and vertical polarizations and antenna height ranging 1-4 m were measured while rotating the Equipment Under Test (EUT) 360° on the turntable, to maximize measured emissions.

Refer to Section 1.4 of this report for Sample Calculations of Emissions Data.

▪ Test Configurations:

Input power	1) Battery, 2) AC/DC adaptor
Test channels	2402, 2440, 2480 MHz
Test voltage	1) 12 VDC, 2) 120V 60Hz
EUT orientation	xy, yz and xz planes

▪ Modifications:

EUT with integrated antenna configured using firmware to transmit at fixed test frequencies - modulated.

Result: The EUT complies with the applicable standards.

Measurement Data:

Only data for settings in Test Configurations yielding the worst case presented for each section.

Part 1 - 30 MHz – 1 GHz

- **Date performed:** January 10, 2020
- **Worst case:** Mid channel, battery.

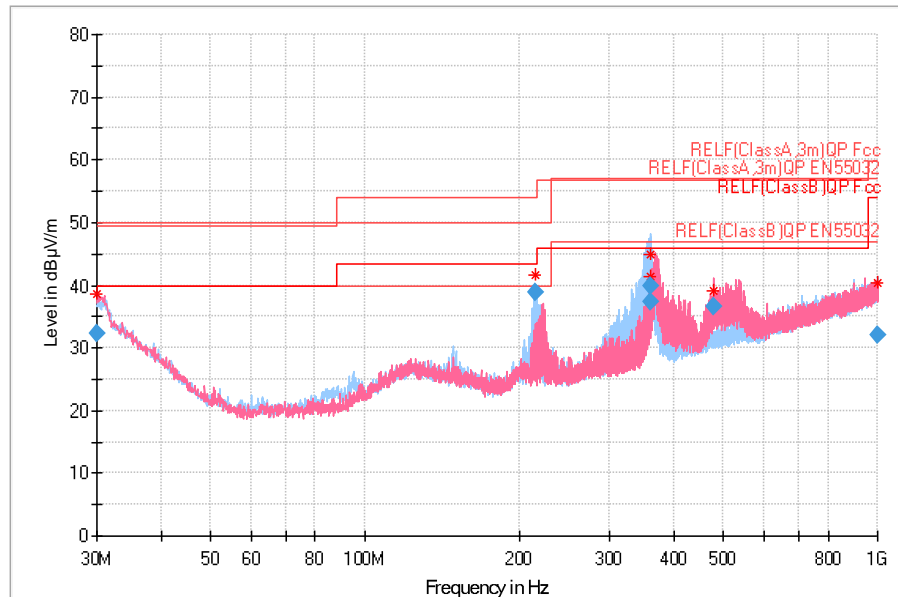


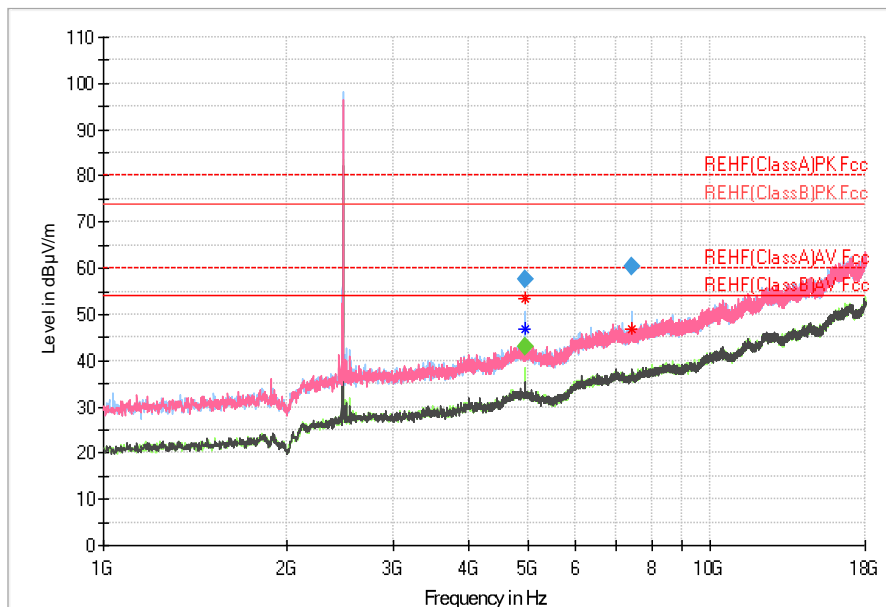
Figure 1: Radiated Emissions measured at 3m-FCC /ISED Class A Limit-for reference only

Table 1: Quasi-Peak Data of Radiated Emissions measured at 3m-FCC /ISED Class A Limit

Frequency (MHz)	Quasi Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.009479	32.21	50.00	17.79	1000.0	120.000	402.0	H	33.0	27.8
215.561600	38.93	50.00	11.07	1000.0	120.000	124.0	H	331.0	17.3
360.020400	39.97	57.00	17.03	1000.0	120.000	113.0	H	138.0	21.0
361.636680	37.43	57.00	19.57	1000.0	120.000	253.0	H	0.0	21.0
478.096960	36.49	57.00	20.51	1000.0	120.000	121.0	V	30.0	24.4
999.799543	32.01	57.00	24.99	1000.0	120.000	164.0	H	119.0	31.7

Part 2 - 1 – 18 GHz

- **Date performed:** January 10, 2020
- **Worst case:** high channel, AC/DC adaptor.



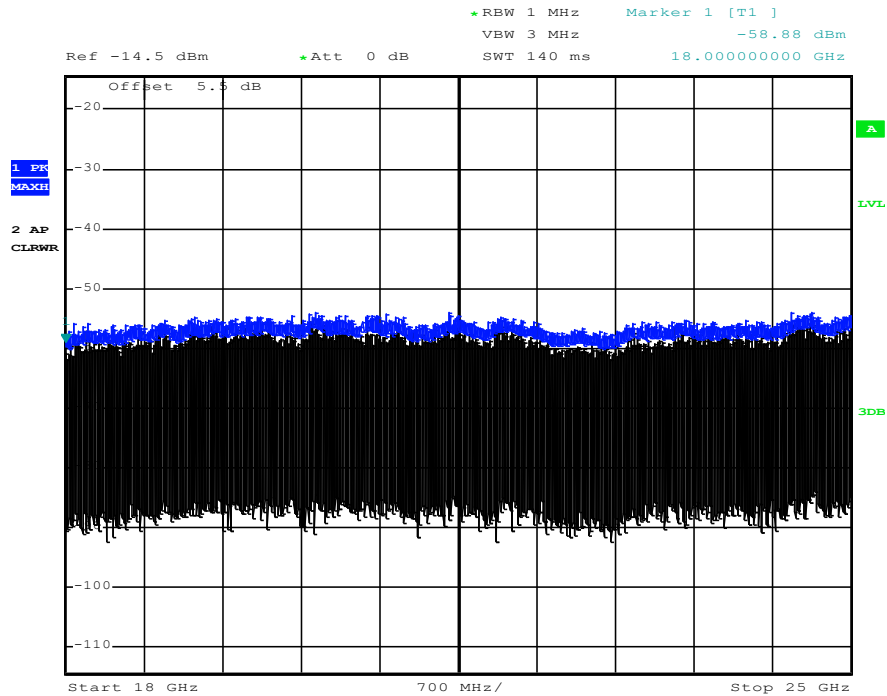
Radiated Emissions measured at 3m–FCC /ISED Class A Limit—for reference only

Table 2: Max-peak and Average Data of Radiated Emissions measured at 3m–FCC /ISED Class A Limit

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
4959.496400	---	43.18	60.00	16.82	1000.0	1000.000	6.8
4959.988400	57.43	---	80.00	22.57	1000.0	1000.000	6.8
7439.996400	60.38	---	80.00	16.62	1000.0	1000.000	10.8

Part 3 - 18 – 25 GHz

- **Date performed:** January 14, 2020
- **Worst Case:** results for the three channels comparable.
- **Results:** No emissions observed above the noise floor.



No emissions observed above the noise floor

3.7 Spurious Emissions – Receiver Mode

▪ **Date Performed:**

N/A

▪ **Test Standard:**

FCC Title 47 CFR Part 15: Subpart B - §15.109
ICES-003 Issue 6

▪ **Test Method:**

ANSI C63.4-2014

▪ **Required Limit:**

The field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency, <i>f</i> (MHz)	Field strength (dBμV/m)
30 – 88	50.0
88 – 216	53.5
216 – 960	56.0
above 960	64.0
<p>Note 1: The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.</p> <p>Note 2: The emissions limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz Radiated emission limits in these three bands are based on measurements employing an average detector.</p>	

▪ **Method of Measurement:**

N/A

Test Setup:

Transmitter was not tested with transmitter of the EUT turned off.

▪ **Result:**

EUT in transmitter mode complies with limits for receiver mode.
EUT complies with the applicable standard.

3.8 AC Mains Conducted Emissions

- **Date Performed:**

January 10, 2020

- **Test Standard:**

FCC Title 47 CFR §15.207 – Class A
ICES-003 Issue 6 – Class A

- **Test Method:**

ANSI C63.10-2013

- **Input Voltage:** 120V 60Hz

- **Required Limit:**

The radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the following limits

Frequency (MHz)	Conducted Limit (dB μ V)	
	Quasi-Peak	Average
0.15 – 0.50	79	66
0.50 – 5	73	60
5.0 – 30.0	73	60
<i>Note 1: The lower limit shall apply at the transition frequencies.</i>		

Class A Limits

- **Method of Measurement:**

Measurements were made using an EMI receiver with 9kHz bandwidth, CISPR Quasi-Peak and Average detector.

- **Modifications:**

No HW modifications required for this test. Plot is over-reported as extra 10dB correction applied. Table modified to show correct values.

- **Result:**

The EUT complies with the applicable standard.

Measurement Data:

Worst case: All channel comparable.

Line 1:

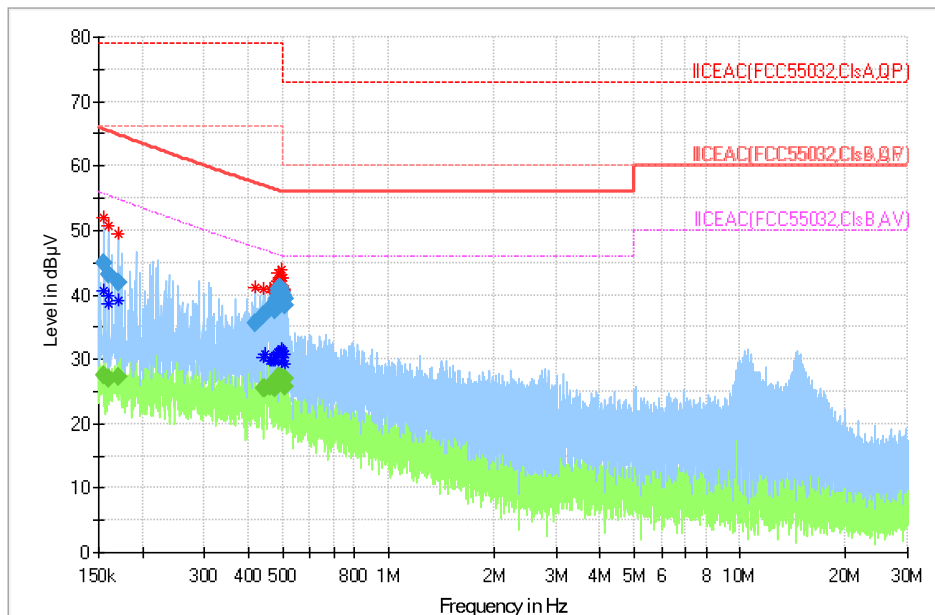


Figure for reference only - AC Mains Conducted Emissions – L1

Frequency (MHz)	Quasi Peak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)
0.155	---	17.53	55.7	38.2	1000	9.0	GND	10
0.155	34.8	---	65.7	30.9	1000	9.0	GND	10
0.159	---	17.03	55.4	38.4	1000	9.0	GND	10
0.160	---	17.01	55.4	38.4	1000	9.0	GND	10
0.160	33.1	---	65.4	32.3	1000	9.0	GND	10
0.170	---	17.19	54.9	37.7	1000	9.0	GND	10
0.170	32	---	64.9	32.9	1000	9.0	GND	10
0.420	25.7	---	57.3	31.7	1000	9.0	GND	10
0.443	26.9	---	56.9	30	1000	9.0	GND	10
0.443	---	15.4	46.9	31.5	1000	9.0	GND	10
0.445	---	15.42	46.9	31.5	1000	9.0	GND	10
0.462	---	15.69	46.6	30.9	1000	9.0	GND	10
0.462	27.9	---	56.6	28.7	1000	9.0	GND	10
0.468	---	16.11	46.5	30.4	1000	9.0	GND	10
0.471	---	15.83	46.4	30.6	1000	9.0	GND	10
0.475	27.7	---	56.4	28.7	1000	9.0	GND	10
0.475	---	15.52	46.4	30.9	1000	9.0	GND	10
0.478	27.9	---	56.3	28.4	1000	9.0	GND	10
0.482	29.3	---	56.3	27	1000	9.0	GND	10
0.482	---	16.44	46.3	29.8	1000	9.0	GND	10
0.485	29.9	---	56.2	26.3	1000	9.0	GND	10
0.487	---	17.22	46.2	29	1000	9.0	GND	10
0.487	30.5	---	56.2	25.7	1000	9.0	GND	10
0.488	---	17.12	46.2	29.1	1000	9.0	GND	10

Line 2:

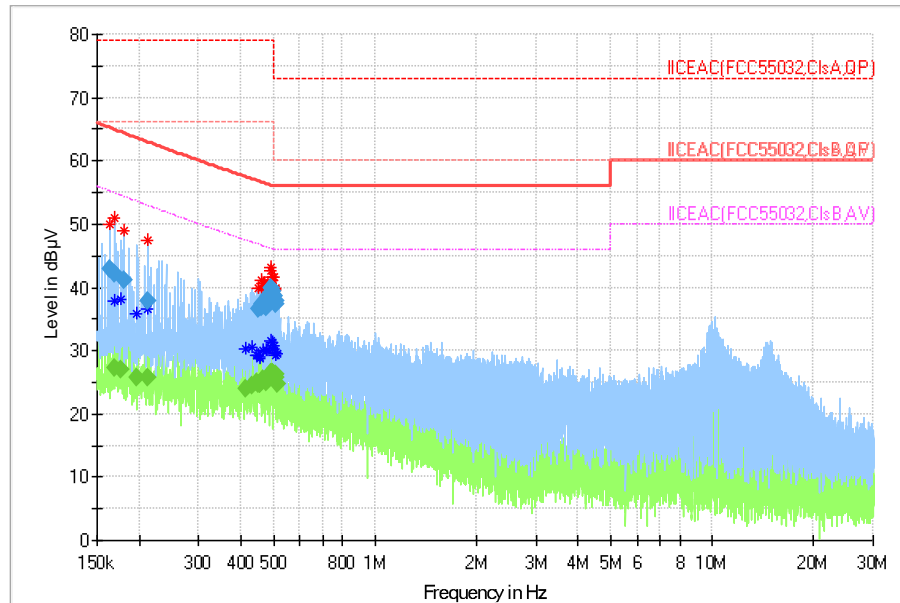


Figure for reference only - AC Mains Conducted Emissions – L2

Frequency (MHz)	Quasi Peak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	PE	Corr. (dB)
0.163	32.8	22.8	65.2	32.4	1000	9.0	GND	10
0.170	---	---	54.9	37.6	1000	9.0	GND	10
0.170	32.2	22.2	64.9	32.7	1000	9.0	GND	10
0.177	---	---	54.5	37.5	1000	9.0	GND	10
0.180	31.1	21.1	64.4	33.2	1000	9.0	GND	10
0.196	---	---	53.6	37.8	1000	9.0	GND	10
0.212	---	---	52.9	37.1	1000	9.0	GND	10
0.212	27.9	17.9	62.9	35	1000	9.0	GND	10
0.412	---	---	47.5	33.6	1000	9.0	GND	10
0.431	---	---	47.1	32.7	1000	9.0	GND	10
0.448	---	---	46.8	31.9	1000	9.0	GND	10
0.453	---	---	46.7	32	1000	9.0	GND	10
0.453	26.5	16.5	56.8	30.3	1000	9.0	GND	10
0.455	---	---	46.7	32	1000	9.0	GND	10
0.456	---	---	46.7	31.9	1000	9.0	GND	10
0.459	26.8	16.8	56.7	29.8	1000	9.0	GND	10
0.463	27.5	17.5	56.6	29.1	1000	9.0	GND	10
0.465	27.4	17.4	56.6	29.2	1000	9.0	GND	10
0.465	---	---	46.6	31.1	1000	9.0	GND	10
0.472	27	17	56.4	29.4	1000	9.0	GND	10
0.474	26.8	16.8	56.4	29.6	1000	9.0	GND	10
0.474	---	---	46.4	31.3	1000	9.0	GND	10
0.475	27	17	56.4	29.4	1000	9.0	GND	10

3.9 Frequency Stability

▪ **Date Performed:**

January 16, 2020

▪ **Test Standard:**

FCC 47 CFR §2.1055, §15.215 (c)

▪ **Test Method:**

ANSI C63.10 2013
CISPR 11:2009/A1:2010

▪ **Required Limit:**

The carrier frequency stability shall be maintained within band. The carrier frequency shall be maintained over a temperature variation of -20C to +55C.

▪ **Method of Measurement:**

The equipment was operated and tested while in “Continuous Transmit” mode of operation. The fundamental was monitored while the temperature was varied from 0C to +50C in an environmental chamber and appropriate data reported.

▪ **Test Set-up:**

Radiated measurement using a spectrum analyzer and a sniffer probe.
Temperature stabilization time: 5 minutes.
EUT battery powered.

▪ **Modifications:**

EUT configured using firmware to transmit at fixed frequency CW.
Manufacturer specified operating temperature range of the EUT: 0 - +50C.

▪ **Result:** EUT complies with the applicable standard.

Data:

Temperature (°C)	Channel Freq. (MHz)	Carrier freq. (MHz)	Applicable band limit (MHz)	Results
0	2402	2402.007500	2400	Drift within band
	2480	2480.0011250	2483.5	Drift within band
+10	2402	2402.006750	2400	Drift within band
	2480	2480.007500	2483.5	Drift within band
+20	2402	2402.000000	2400	Drift within band
	2480	2480.000000	2483.5	Drift within band
+30	2402	2401.992500	2400	Drift within band
	2480	2479.992125	2483.5	Drift within band
+40	2402	2401.984625	2400	Drift within band
	2480	2479.984625	2483.5	Drift within band
+50	2402	2401.980875	2400	Drift within band
	2480	2479.979750	2483.5	Drift within band

3.10 RF Exposure Evaluation

- **Date Performed:** January 15, 2020
- **Test Standard:** FCC 47 CFR §1.1310: RSS-102 Section 2.5.2

CC CFR 47 §1.1310:

Radiofrequency radiation exposure limits for General Population/Uncontrolled Exposure at Frequency range 1500 - 100000 MHz: 1.0 mW/cm².

RSS-102 Section 2.5.2:

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

-at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

MPE Results:

The calculation below is used to consider situations in which simultaneous exposure to fields of different frequencies occur. The calculation is performed by the sum of each relative exposure for each equipment according to the following criteria

$$\text{Power Density} = \frac{\text{EIRP}}{4\pi r^2} \text{ mW/cm}^2$$

Carrier Frequency	EIRP	EIRP	Spherical Surface Area at 20 cm	Power Density	Limit	Result
MHz	dBm	mW	cm ²	mW/cm ²	mW/cm ²	
2402	3.57	2.28	5026	0.0005	1.0	Exempt
2440	6.98	4.99	5026	0.001	1.0	Exempt
2480	6.80	4.79	5026	0.00096	1.0	Exempt

Note:

EUT is mounted on ceilings. Distance of 20 cm is considered for a worst-case evaluation.

Appendix A: Test Set-up Photos

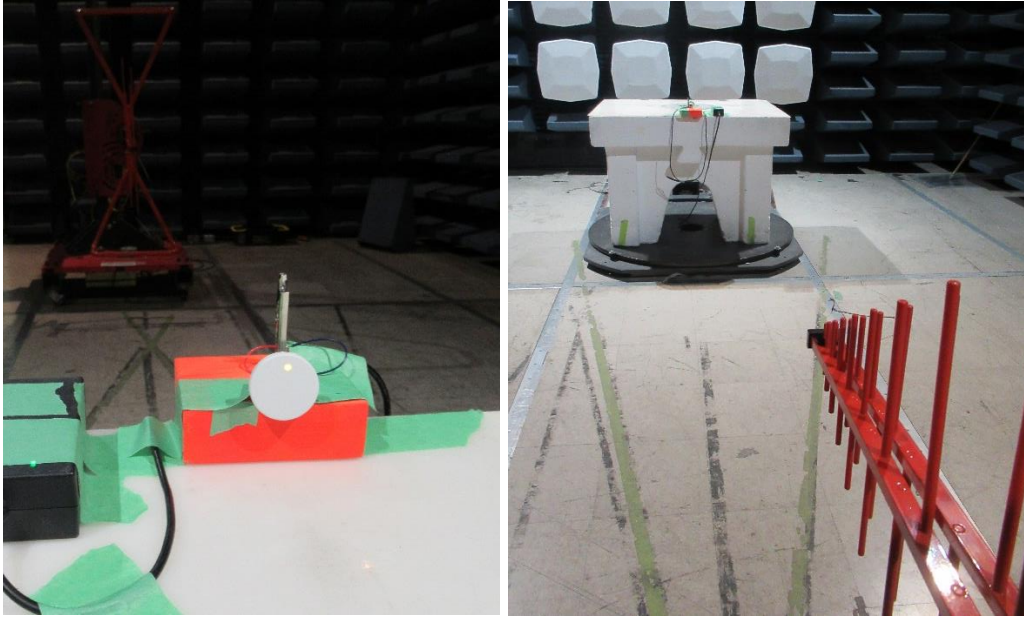


Figure 1: Radiated Emissions (30 MHz – 1 GHz)

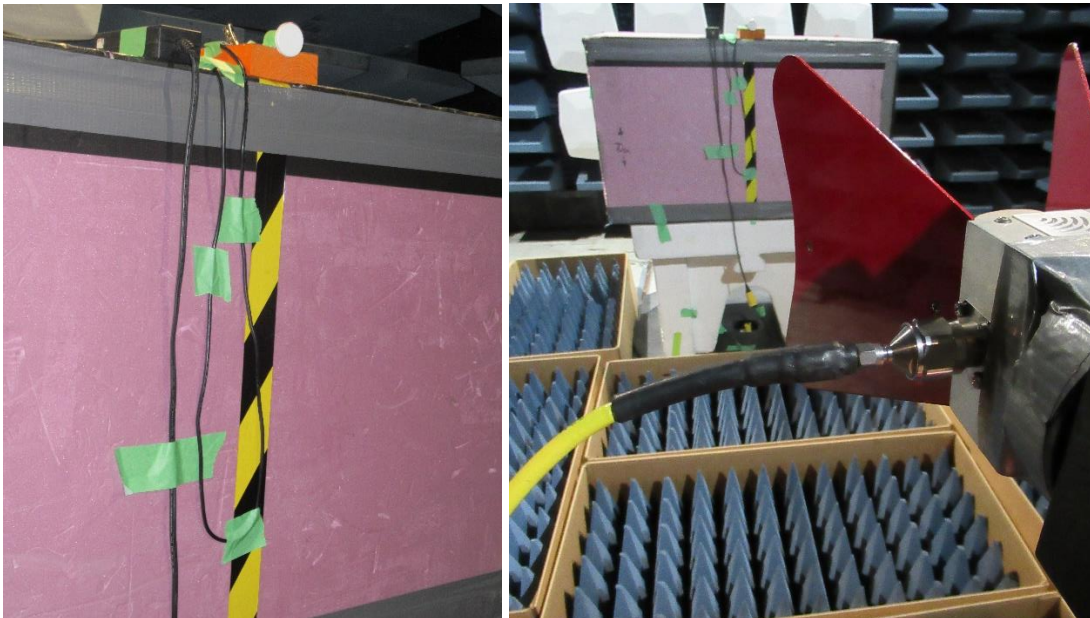


Figure 2: Radiated Emissions (1 – 18 GHz)

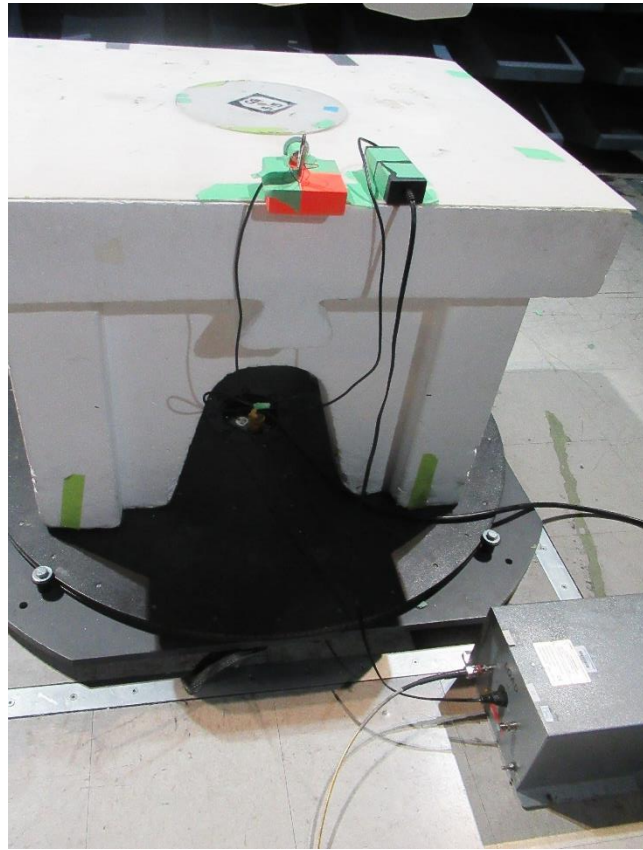


Figure 3: AC Mains Conducted Emissions



Figure 4: Frequency Stability

Appendix B: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
AM	Amplitude Modulation
BW	Bandwidth
CE	European Conformity
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
CW	Continuos Wave
DC	Direct Current
EFT	Electrical Fast Transient
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FCC	Federal Communications Commission
FW	Firmware
HW	Hardware
IC	Industry Canada
ICES	Interference Causing Equipment Standard
IEC	International Electrotechnical Commission
LISN	Line Impedance Stabilizing Network
OATS	Open Area Test Site
RF	Radio Frequency
RMS	Root-Mean-Square
SAC	Semi-Anechoic Chamber
SW	Software

END OF REPORT