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ELECTROMAGNETIC COMPATIBILITY TEST REPORT

Report Reference Number:	E10402-1902-Tantalus-Streetlight Controller-**Rev-1.0**
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Laboratory Accreditations (per ISO/IEC 17025:2005)

American Association for Laboratory Accreditation Certificate Number: 3657.02

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Manufacturer:	**Tantalus Systems Corp.**
Address:	200-3555 Gilmore Way, Burnaby, BC, Canada | V5G 0B3
Phone:	604-299-0458
Applicable Test Standards:	FCC Title 47 CFR Part 15: Subpart B FCC Title 47 CFR Part 15: Subpart C - FCC Title 47 CFR Part15.247 - FCC Title 47 CFR Part15.212 ICES-003 Issue 6 RSS-247 Issue 2 RSS-Gen Issue 5
Equipment Tested:	**Streetlight Controller**
Tantalus Part Number:	SC-6611/SC-6411
FCC ID:	OZFNICSC6X01
IC Certification Number:	3669A-NICSC6X01

REVISION HISTORY

Date	Report Number	Details	Author's Initials
May 8, 2019	E10402-1902-Tantalus-Streetlight Controller-**Rev-1.0**	Final	BB
April 26, 2019	E10402-1902-Tantalus-Streetlight Controller-**Rev-0.0**	Draft	BB
All previous versions of this report have been superseded by the latest dated revision as listed in the above table.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 equipment provided by Tantalus Systems Corp. Tests were conducted on the sample equipment as requested by Tantalus Systems Corp. for the purpose of demonstrating compliance with FCC Title 47 CFR Part 15: Subpart B, FCC Title 47 CFR Part 15: Subpart C, ICES-003 Issue 6, RSS-247 Issue 2, and RSS-Gen Issue 5 as agreed upon by Tantalus Systems Corp. as per Quote 19SH02125.

Tantalus Systems Corp. is responsible for the tested product configuration, continued product compliance, and for the appropriate auditing of subsequent products as required. This report may comprise partial list of tests that are required for FCC and IC Declaration of Conformity and 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

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Section I: EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of "SC-6611/ SC-6411" as per Sections 1.2 & 1.3 of this report.

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 19SH02125:

- **FCC CFR 47 Part 15 –** Radio Frequency Devices, Subpart B – Unintentional Radiators
- **FCC CFR 47 Part 15 –** Radio Frequency Devices, Subpart C – Intentional Radiators
  -15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5875 MHz
- **ICES-003 Issue 6 –** Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement
- **RSS-247 Issue 2 –** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- **RSS-Gen Issue 5 –** General Requirements and Information for the Certification of Radio Apparatus

The tests documented in this report were performed in accordance with ANSI C63.4-2014, ANSI C63.10-2013, RSS-Gen Issue 5 and FCC KDB 558074 D01 DTS Meas. Guidance v05r02.

1.3 Summary of Results

The following tests demonstrate the testimony to "FCC and IC" Mark Electromagnetic compatibility testing for "Streetlight Controller - SC-6611/ SC-6411" manufactured by Tantalus Systems Corp.

The following testing was performed pursuant to the FCC and IC Radio and RF Emissions Standards:

Test or Measurement	Applicable FCC and IC Standard	Clause	Result
AC Mains Conducted Emissions	FCC Title 47 CFR Part 15: Subpart C	§15.207	Complies
Unintentional Radiated Spurious Emissions	FCC Title 47 CFR Part 15: Subpart B	§15.109	Complies
	ICES-003 Issue 6 RSS-Gen Issue 5	6.2 7.1	
Intentional Radiated Spurious Emissions	FCC Title 47 CFR Part 15: Subpart C	§15.209 §15.205	Complies
	RSS-Gen Issue 5	8.9 8.10	
Antenna Requirement	FCC Title 47 CFR Part 15: Subpart C	§15.203	Complies
	RSS-Gen Issue 5	8.3	
RF Peak Power Output	FCC Title 47 CFR Part 15: Subpart C	§15.247 (b)(2)	Complies
	RSS-247 Issue 2	5.4 (1)	
20dB Occupied Bandwidth	FCC Title 47 CFR Part 15: Subpart C	§15.247 (a)(1)(i)	Complies
	RSS-247 Issue 2	5.1 (3)	
Out-of-Band Emissions (Band Edge)	FCC Title 47 CFR Part 15: Subpart C	§15.247 (d)	Complies
	RSS-247 Issue 2	5.5	
Channel Separation	FCC Title 47 CFR Part 15: Subpart C	§15.247 (a)(1)	Complies
	RSS-247 Issue 2	5.1 (2)	
Number of Hopping Channels	FCC Title 47 CFR Part 15: Subpart C	§15.247 (a)(1)(i)	Complies
	RSS-247 Issue 2	5.1 (3)	
Dwell Time	FCC Title 47 CFR Part 15: Subpart C	§15.247 (a)(1)(i)	Complies
	RSS-247 Issue 2	5.1 (3)	
Time Occupancy	FCC Title 47 CFR Part 15: Subpart C	§15.247 (a)(1)(i)	Complies
	RSS-247 Issue 2	5.1 (3)	

Section II: GENERAL INFORMATION

2.1 Product Description

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

Equipment Under Test (EUT) Information

EUT	Streetlight Controller
Manufacturer	Tantalus Systems Corp.
Functional Description	Streetlight Controller
FCC ID	OZFNICSC6X01
IC Certification Number	3669A-NICSC6X01
Tantalus Part No.	SC-6411, SC-6611
Serial No.	0030845AD4

2.2 Environmental Conditions

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

Parameter	Conditions
Location	Indoors
Temperature	22-28ºC
Relative Humidity	39.7 - 54.4%

2.3 Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 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	±1ºC
Humidity	±5 %
DC and low frequency voltages	±3 %

2.4 Worst Test Case

Worst-case orientation was determined during the preliminary testing. The final radiated emissions were performed in the worst-case orientation.

2.5 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rohdes & 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:

Corr.(dB) = Antenna factor + Cable loss

Or

Corr.(dB) = Antenna factor + Cable Loss - Amp gain (if pre-amplifier was used)

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

Corrected Quasi-Peak (dBµV/m) = Raw Quasi-Peak Reading + Antenna factor + 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:

Corr.(dB) = Antenna factor + Cable loss

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

Corr. Quasi-Peak/Average Reading (dBµV) = Raw Quasi-Peak/Average Reading + Antenna factor + Cable loss

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

Margin(dB) = Limit – Quasi-Peak or Average reading

2.6 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	Sunol Sciences	SM46C	Turntable	051204-2	N/A	N/A
2	Sunol Sciences	TWR95	Mast	TREML0001	N/A	N/A
3	Sunol Sciences	JB1	Biconilog Antenna 30MHz – 2GHz	A070209	N/A	2020-Aug-16
4	Sunol Sciences	DRH-118	Horn Antenna 1GHz-18GHz	A050905	N/A	2020-Mar-10
5	ETS Lindgren	2165	Turntable	00043677	N/A	N/A
6	ETS Lindgren	2125	Mast	00077487	N/A	N/A
7	Rohde & Schwarz	ESU40	EMI Receiver	100011	EMC32 v10.35.10/ FV 4.73 SP4	2019-Dec-01
8	EMCO	3825/2	LISN (150kHz-30MHz)	9002-1601	N/A	2020-Aug-25
9	ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
10	AH Systems	PAM118	Amplifier (10KHz-18GHz)	189	N/A	Conditional Use
11	California Instruments	PACS-1	Harmonics and flicker analyzer	52117	CTS3.0 v3.2.0.35	2019-May-23
12	California Instruments	OMNI 1-18 I	Programmable Impedance Flicker test	--	N/A	2019-May-23
13	California Instruments	3001ix	Power supply	HK52117	N/A	2019-May-23

Note: All Equipment listed above have 3 years calibration interval.

Immunity Testing Equipment

Sl.No.	Manufacturer	Model	Description	Serial No.	S/W Version	Calibration Due Date
1	Ophir	5048FE	RF Amplifier 0.15-230 MHz	1035	N/A	N/A
2	Ophir	5125FE	RF Amplifier 20-1000 MHz	1030	N/A	N/A
3	Ophir	5163FE	RF Amplifier 0.8-4.2 GHz	1044	N/A	N/A
4	Amplifier Research	FP2080	Isotropic Field Probe 80 MHz to 40 GHz	17905/12002493-1/2	N/A	2020-Oct-11
5	Chase	emCELL	RF Immunity Chamber	1016	N/A	N/A
6	ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
7	HP	8648C	Signal Generator	3623A03622	N/A	2020-Feb-17
8	ThermoScientific	MiniZap	ESD Simulator:	0402265	N/A	2020-Oct-07
9	EMC Partner	CN-EFT1000	Capacitive Clamp	#408	N/A	2020-Jan-29
10	FCC	F-120-9A	Bulk Injection Clamp	399	N/A	N/A
11	Teseq	NSG 3060	EMC multifunction Generator 6kV with CDN and INA	184	WIN3000 v1.3.2 / FV V2.20	2020-March-05
12	Teseq	CDN 3061	Surge CDN	184	N/A	2020-March-05
13	Teseq	INA 6502-CIB	Step up Transformer	124	N/A	2020-March-05

Note: All 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
2	VI Automation	Via EMC Immunity Executive	1.0.308	Radiated and Conducted Immunity Test Program
3	TESEQ	WIN 3000	1.2.0	Surge, EFT & Voltage Dips Immunity Test Program
4	Thurlby Thandar Instruments	HA-PC Link Version	2.02	Harmonics and Flicker Test Program

Section III: Unintentional Radiated Emissions Test Result

3.1 AC Mains Conducted Emissions

Date Performed:

- April 5, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.207

Test Method:

- ANSI C63.4-2014

Test Requirement:

FCC/ISED/CE for above standards-Class B

Frequency (MHz)	Conducted Limit (dBµV)		Result
	Quasi-Peak	Average	
0.15 – 0.50	66 to 56	56 to 46	Complies
0.50 – 5	56	46	
5 – 30	60	50	
Note 1: The lower limit shall apply at the transition frequencies. **Note 2:** The limit decreases linearly with the logarithm of the frequency in the 0.15 to 0.50 MHz			

- ### Method of Measurement:

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

- ### Modifications:

  No modification was required to comply for this test.

- ### Result:

  The EUT complies with the applicable standard.

Measurement Data and Plot:

Test Mains Voltage Used:

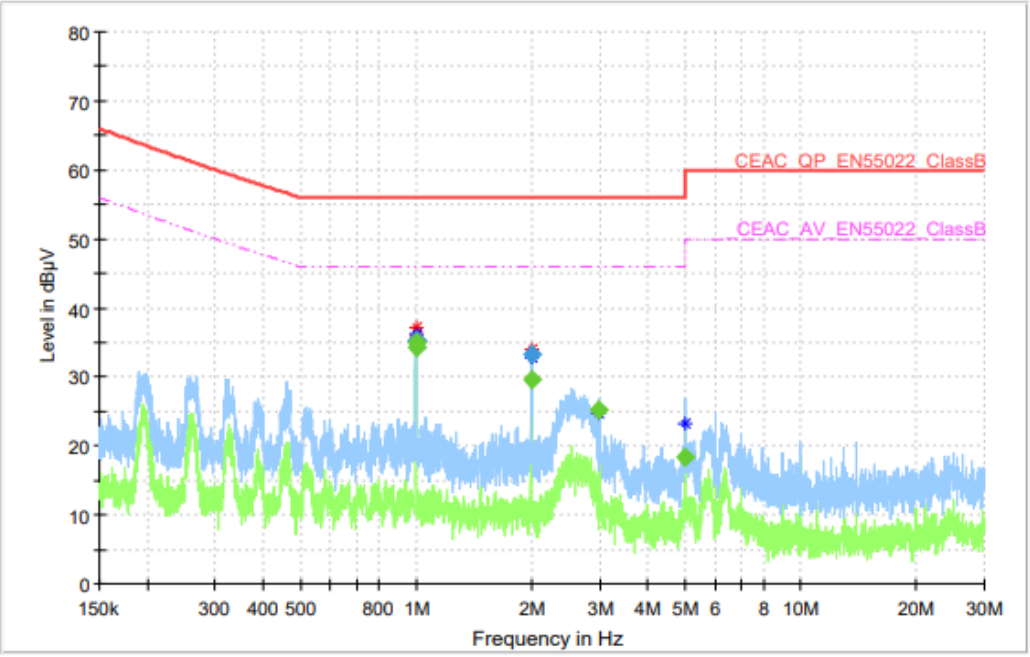
- 120Vac/60Hz, Line 1

Frequency Range:

- 150 kHz to 30 MHz

Table 1: Conducted Emissions – Line 1, 120Vac/60Hz

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.999932	35.34	---	56.00	20.66	1000.0	9.000	L1	GND	10.2
0.999932	---	34.13	46.00	11.87	1000.0	9.000	L1	GND	10.2
1.000000	---	35.05	46.00	10.95	1000.0	9.000	L1	GND	10.3
1.000000	35.31	---	56.00	20.69	1000.0	9.000	L1	GND	10.3
1.995022	---	29.64	46.00	16.36	1000.0	9.000	L1	GND	10.3
1.995022	33.30	---	56.00	22.70	1000.0	9.000	L1	GND	10.3
2.993526	---	25.14	46.00	20.86	1000.0	9.000	L1	GND	10.3
4.988806	---	18.28	46.00	27.72	1000.0	9.000	L1	GND	10.4



Plot 1: Conducted Emissions – Line 1, 120Vac/60Hz

Test Mains Voltage Used:

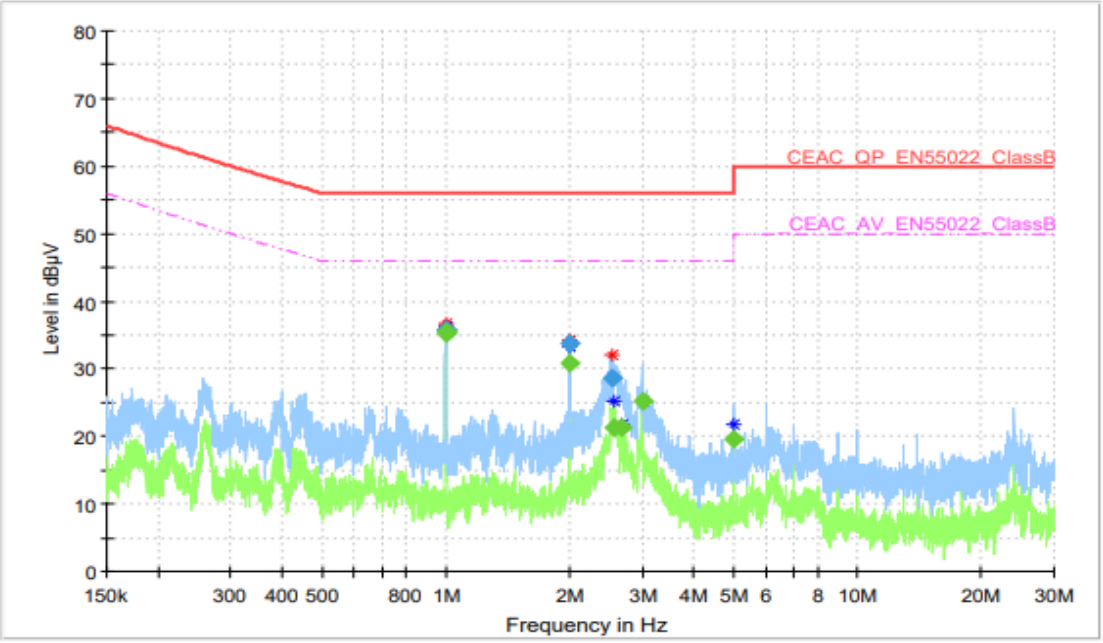
- 120Vac/60Hz, Line 2

Frequency Range:

- 150 kHz to 30 MHz

Table 2: Conducted Emissions – Line 2, 120Vac/60Hz

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.999932	35.72	---	56.00	20.28	1000.0	9.000	L1	GND	10.2
0.999932	---	35.13	46.00	10.87	1000.0	9.000	L1	GND	10.2
1.000000	---	35.40	46.00	10.60	1000.0	9.000	L1	GND	10.3
1.000000	35.67	---	56.00	20.33	1000.0	9.000	L1	GND	10.3
1.997017	---	30.73	46.00	15.27	1000.0	9.000	L1	GND	10.3
1.997017	33.79	---	56.00	22.21	1000.0	9.000	L1	GND	10.3
2.530801	28.53	---	56.00	27.47	1000.0	9.000	L1	GND	10.3
2.558780	---	21.40	46.00	24.60	1000.0	9.000	L1	GND	10.3
2.665815	---	21.37	46.00	24.63	1000.0	9.000	L1	GND	10.3
2.996520	---	25.25	46.00	20.75	1000.0	9.000	L1	GND	10.3
4.993795	---	19.61	46.00	26.39	1000.0	9.000	L1	GND	10.4



Plot 2: Conducted Emissions – Line 2, 120Vac/60Hz

Test Mains Voltage Used:

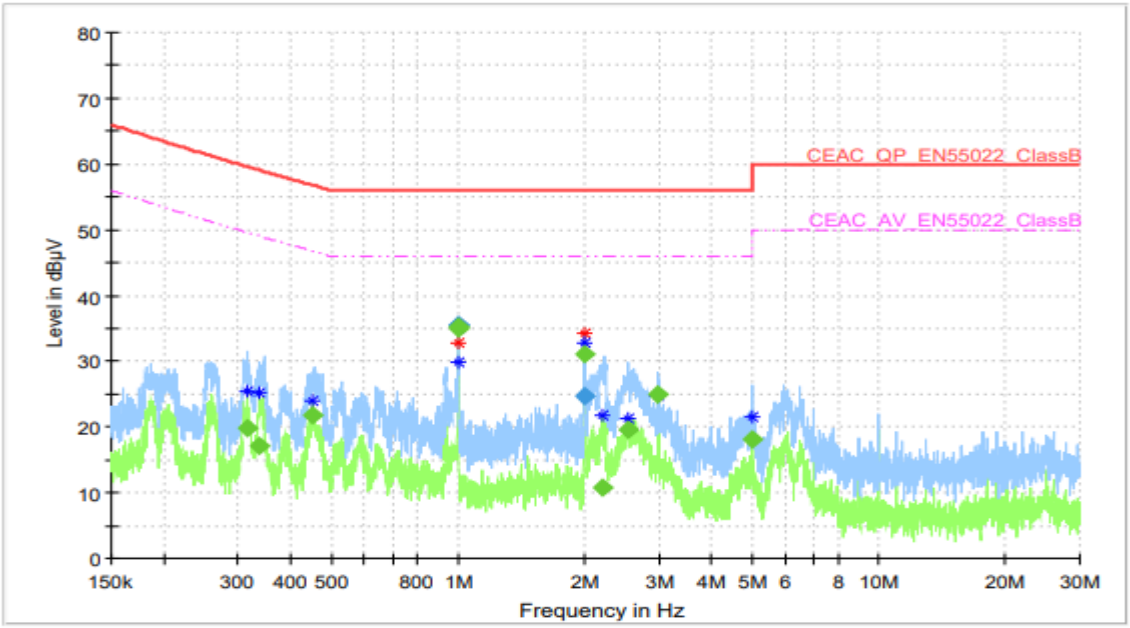
- 240Vac/60Hz, Line 1

Frequency Range:

- 150 kHz to 30 MHz

Table 3: Conducted Emissions – Line 1, 240Vac/60Hz

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.314903	---	19.89	49.61	29.72	1000.0	9.000	L1	GND	10.2
0.338738	---	17.20	49.02	31.82	1000.0	9.000	L1	GND	10.1
0.453086	---	21.81	46.75	24.94	1000.0	9.000	L1	GND	10.1
1.000000	---	34.92	46.00	11.08	1000.0	9.000	L1	GND	10.3
1.000000	35.37	---	56.00	20.63	1000.0	9.000	L1	GND	10.3
1.000000	---	35.12	46.00	10.88	1000.0	9.000	L1	GND	10.3
1.000000	35.41	---	56.00	20.59	1000.0	9.000	L1	GND	10.3
1.997017	---	31.02	46.00	14.98	1000.0	9.000	L1	GND	10.3
2.003014	24.63	---	56.00	31.37	1000.0	9.000	L1	GND	10.3
2.200327	---	10.74	46.00	35.26	1000.0	9.000	L1	GND	10.3
2.540940	---	19.65	46.00	26.35	1000.0	9.000	L1	GND	10.3
2.993526	---	24.87	46.00	21.13	1000.0	9.000	L1	GND	10.3
4.988806	---	18.01	46.00	27.99	1000.0	9.000	L1	GND	10.4



Plot 3: Conducted Emissions – Line 1, 240Vac/60Hz

Test Mains Voltage Used:

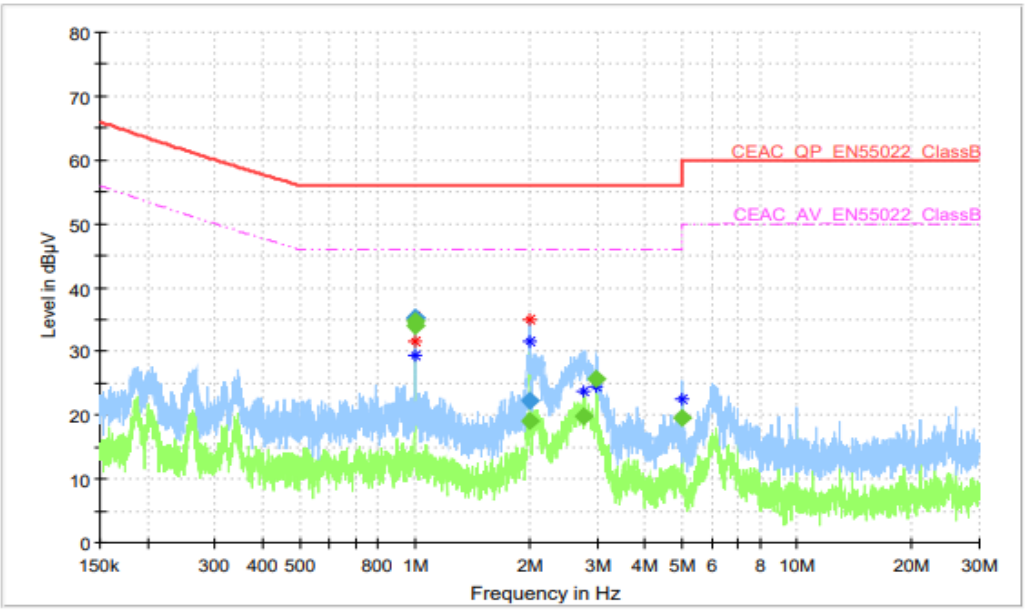
- 240Vac/60Hz, Line 1

Frequency Range:

- 150 kHz to 30 MHz

Table 4: Conducted Emissions – Line 2, 240Vac/60Hz

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
1.000000	35.23	---	56.00	20.77	1000.0	9.000	L1	GND	10.3
1.000000	---	34.76	46.00	11.24	1000.0	9.000	L1	GND	10.3
1.000000	---	34.10	46.00	11.90	1000.0	9.000	L1	GND	10.3
1.000000	35.25	---	56.00	20.75	1000.0	9.000	L1	GND	10.3
2.003014	---	19.15	46.00	26.85	1000.0	9.000	L1	GND	10.3
2.003014	22.34	---	56.00	33.66	1000.0	9.000	L1	GND	10.3
2.752457	---	19.82	46.00	26.18	1000.0	9.000	L1	GND	10.3
2.993526	---	25.64	46.00	20.36	1000.0	9.000	L1	GND	10.3
4.988806	---	19.49	46.00	26.51	1000.0	9.000	L1	GND	10.4



Plot 4: Conducted Emissions – Line 2, 240Vac/60Hz

3.2 Unintentional Radiated Emissions

Date Performed:

- April 5, 2019

Test Standard:

- FCC Title 47 CFR Part 15: Subpart B §15.109
- ICES-003 Issue 6: Clause 6.2
- RSS-Gen Issue 5: Clause 7.1

Test Method:

- ANSI C63.4-2014

Test Requirement:

FCC/IC Limit:

Frequency (MHz)	Field Strength Quasi Peak dBµV/m @ 3m
30 – 88	49.5
88 – 216	54.0
216 – 960	56.9
Above 960	60.0

Method of Measurement:

The EUT was positioned in the center of the turntable in the SAC. The EUT was then measured for all the radiated emissions in the frequency range of 30MHz – 1GHz. Measurements were made using the spectrum analyzer and receiver using the appropriate antennas, amplifiers, attenuators, and filters.

The required Quasi-Peak CISPR bandwidth shall be 120 kHz for the range 30 – 1000 MHz. A 1 MHz Resolution Bandwidth (RBW, CISPR Band E) shall be used and a 10 Hz Video Bandwidth (VBW). The ANSI C63.4:2014 requirement for the placement of RF Absorber on the turntable Ground Plane shall be satisfied.

Emissions in both horizontal and vertical polarizations were measured while rotating the Equipment Under Test (EUT) on the turntable to maximize signal strength. In the case of high ambient noises, the measurements are performed at a closer distance and the limit is adjusted per the equation below. The result is added or subtracted to the required emission level to ensure compliance at the new distance.

$$20 \log\left(\frac{D1}{D2}\right);$$ Where D1 = Current Distance, D2 = Required Distance

- **Modifications:**

  No modification was required to comply for this test.

- **Result:**

  The EUT complies with the applicable standard.

Measurement Data and Plot:

- EUT Test Mode:

  Run Mode, No TX

- Test Mains Voltage Used:

  120Vac/60Hz

- Frequency Range:

  30MHz to 1GHz

Note 1: Data was 20 dB below the limit

Note 2: The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part. - *§15.31 (o)*

Section IV: RF Devices Intentional Radiators Test Result

4.1 Antenna Requirements

- **Date Performed:**

  April 7 to 25, 2019

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.203
  RSS-Gen Issue 5: Clause 8.3

- **Applicable Regulation:**

  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."

- **Modifications:**

  No modification was required to comply for this test.

- **Result:**

  An integrated antenna is used on this product and it is not field replaceable.

4.2 RF Peak Power Output

- **Date Performed:**

  April 11, 2019

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.247 (b) (2)
  RSS-247 Issue 2: Clause 5.4 (1)

- **Test Method:**

  FCC KDB 558074 D01 DTS Meas. Guidance v04

- **Test Requirement:**

  For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

- **Test Setup:**

  The antenna port of EUT was directly connected to a spectrum analyzer.

- **Measurement Method:**

  Power meter was used for this radio therefore there was no plots generated.

- **Modifications:**

  No modification was required to comply for this test.

- **Result:**

  The EUT complies with the applicable standard.

Table 5: Conducted output power measurements (Low Data)

Channel	Freq. (MHz)	Correction Factor (dB)	Corrected Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	902.2	27.6	27.82	30	2.18
Middle	914.9	27.6	28.01	30	1.99
High	927.7	27.6	28.30	30	1.99

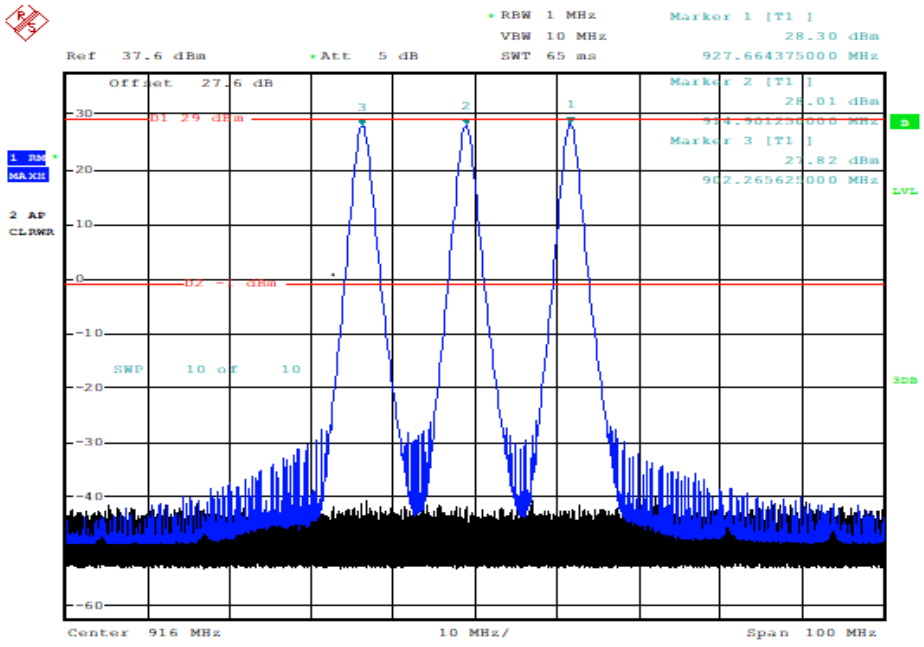
Table 6: Conducted output power measurements (High Data)

Channel	Freq. (MHz)	Correction Factor (dB)	Corrected Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	902.2	27.6	28.35	30	1.65
Middle	915.1	27.6	28.55	30	1.45
High	927.7	27.6	28.89	30	1.11

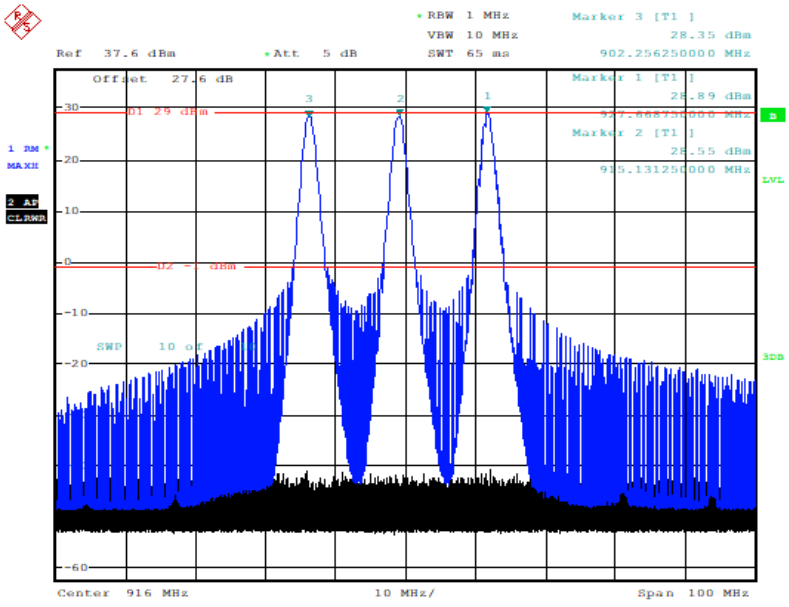
Table 7: EIRP measurements

Channel	Pol	Freq. (MHz)	Correction Factor (dB)	Corrected EIRP (dBuV/m)	Corrected EIRP (dBm)	Limit (dBm)	Margin (dB)
Low	VERT	902.2	32.6	127.5	25.2	36.0	10.8
Middle	VERT	915.1	32.5	122.7	26.3	36.0	9.7
High	VERT	927.7	32.5	123.8	26.3	36.0	9.7
Low	HORZ	902.2	32.6	123.8	24.7	36.0	11.3
Middle	HORZ	915.1	32.5	122.2	25.5	36.0	10.5
High	HORZ	927.7	32.5	123.0	25.1	36.0	10.9

Measurement Data and Plot: RF Peak Conducted Power Output (Low Data Rate) at Low Channel ~902.2MHz, Mid Channel ~914.9MHz & High Channel ~927.7MHz



Plot 5: RF Peak Conducted Power Output (Low Data Rate)
at Low Channel ~902.2MHz, Mid Channel ~914.9MHz & High Channel ~927.7MHz



4.3 20dB Occupied Bandwidth

- **Date Performed:**

  April 11 - 12, 2019

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.247 (a)(1)(i)
  RSS-247 Issue 2: Clause 5.1 (3)

- **Test Method:**

  ANSI C63.10:2013

- **Test Requirement:**

  For FHSs in the band 902-928 MHz: if the 20dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

- **Test Setup:**

  The antenna port of EUT was directly connected to a spectrum analyzer.

- **Measurement Method:**

  As called in ANSI C63.10-2013.

- **Modifications:**

  No modification was required to comply for this test.

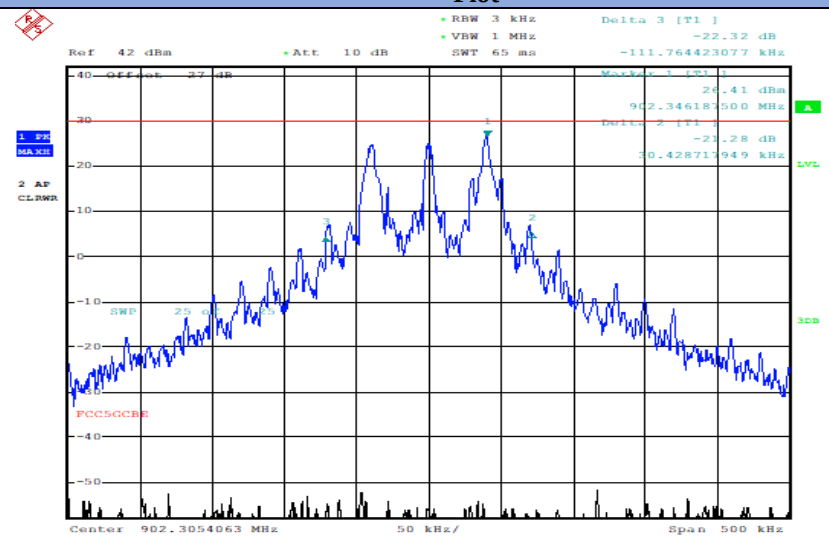
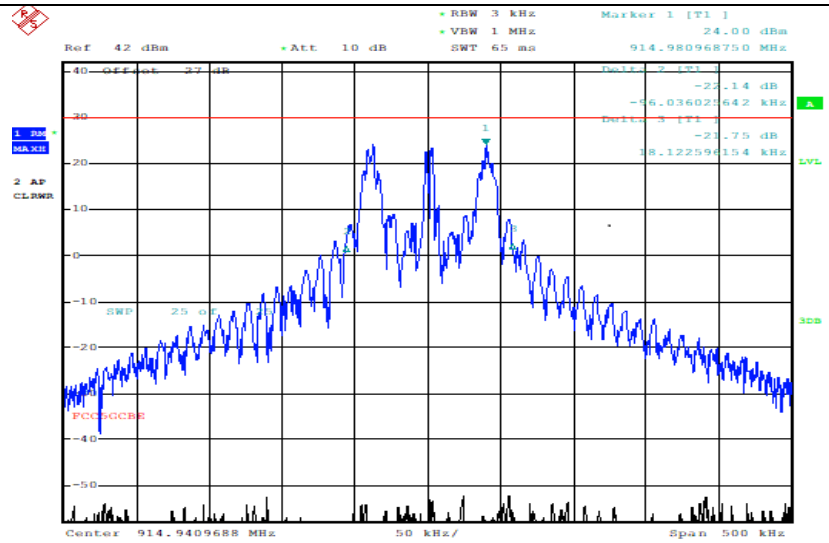
- **Result:**

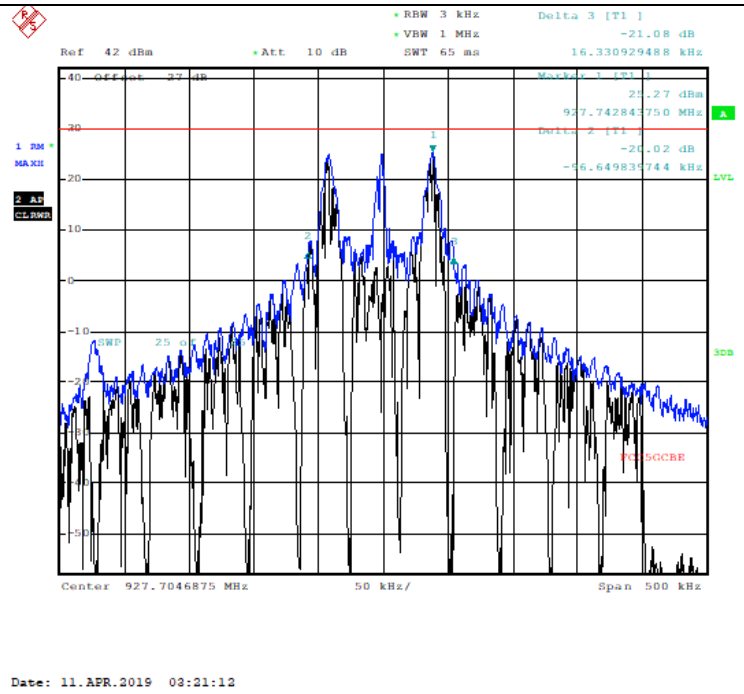
  The EUT complies with the applicable standard.

Measurement Data and Plot:

Table 8: 20dB Occupied Bandwidth Data on Low Data Rate

Channel	Frequency (MHz)	20dB Bandwidth (kHz)
Low	902.23	142.31
Middle	914.98	114.30
High	927.75	113.10

Channel	Plot
Low Data Rate	
Low Data Rate	

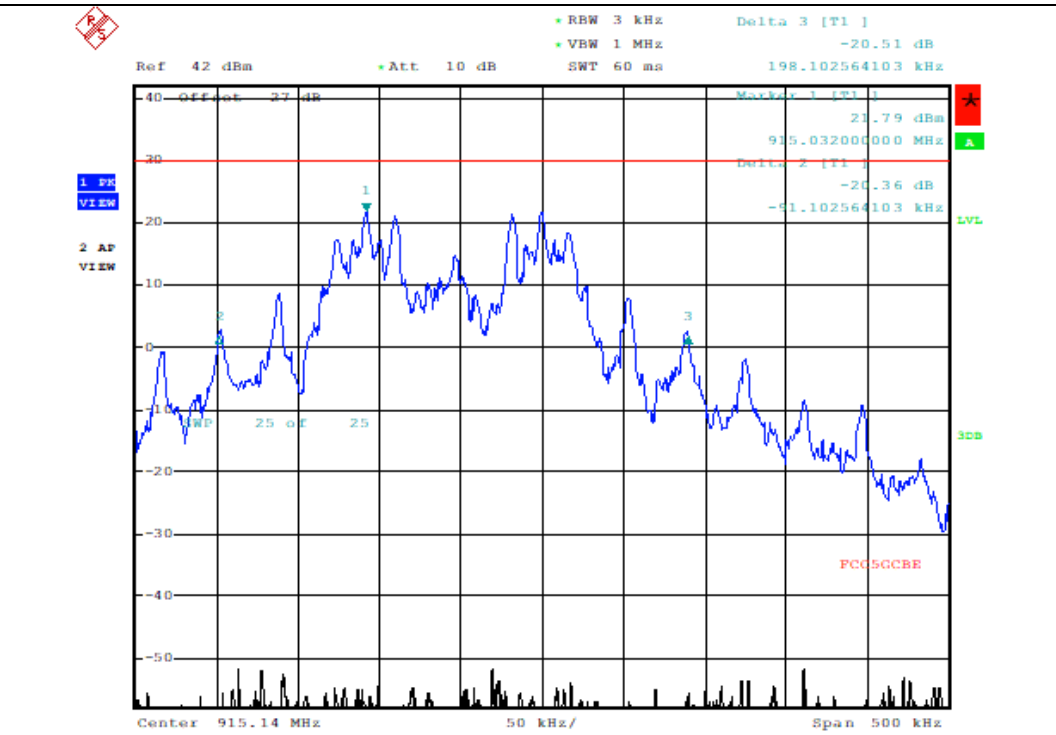
Low Data Rate	

Plot 6: 20dB Occupied Bandwidth Plot (Low Data Rate)

High Data Rate

Table 9: 20dB Occupied Bandwidth Data on High Data Rate

Channel	Frequency (MHz)	20dB Bandwidth (kHz)
Low	902.25	221.40
Middle	915.03	289.40
High	927.67	220.10

Channel	Plot
Mid Data Rate	
Mid Data Rate	

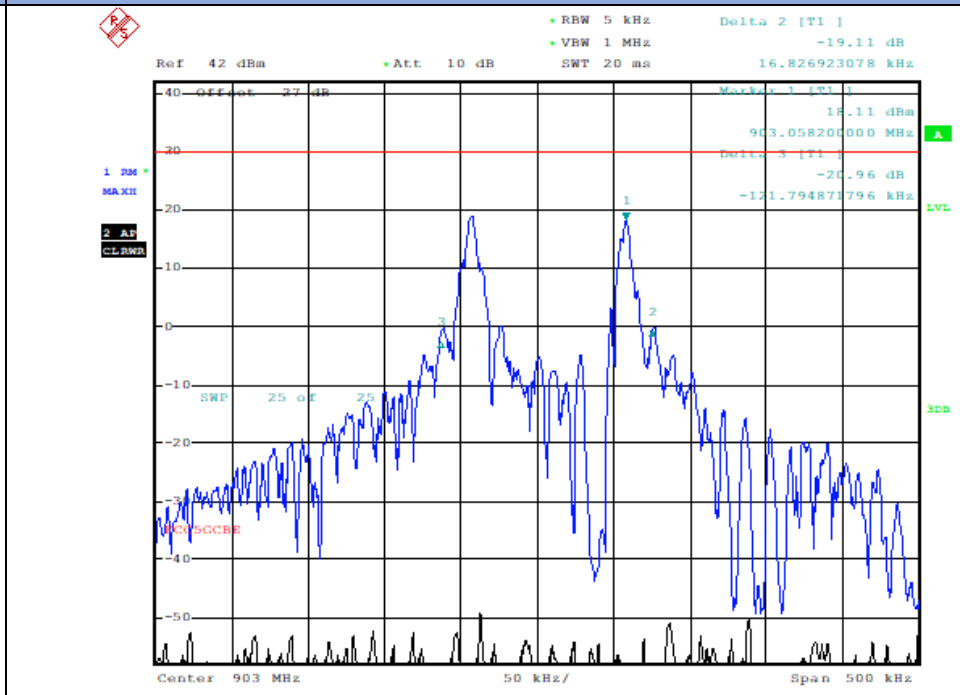
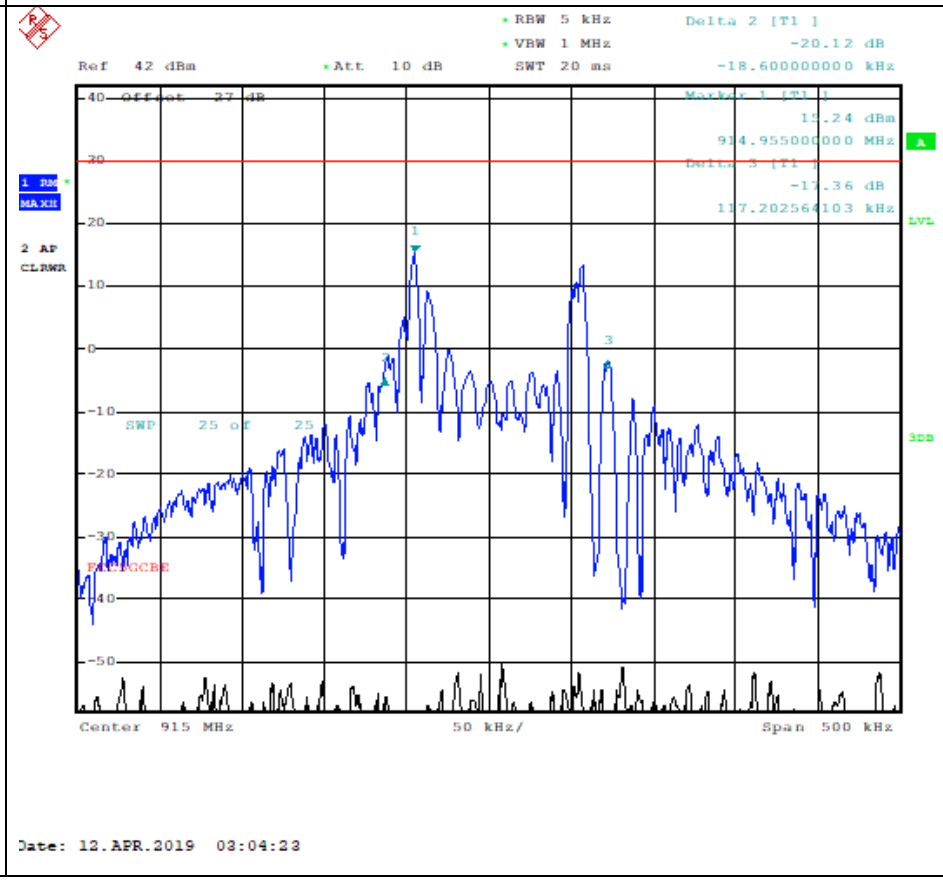
Mid Data Rate	

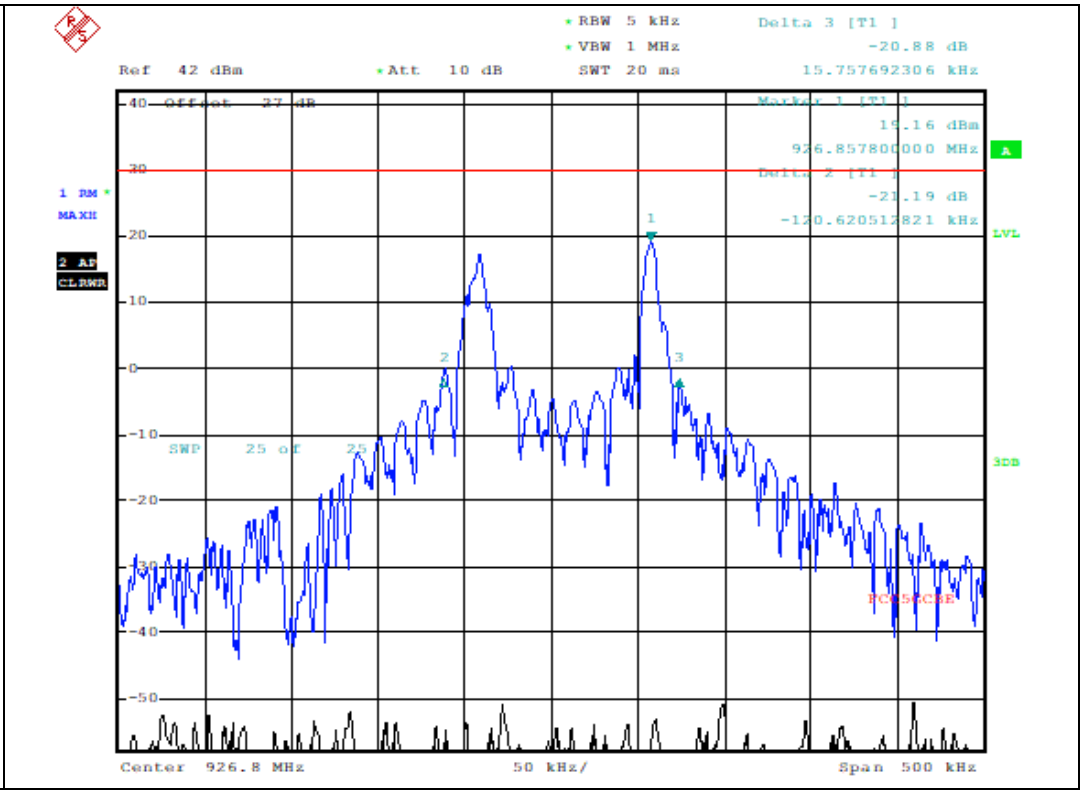
Plot 7: 20dB Occupied Bandwidth Plot (High Data Rate)

Data rate for communication to approved Part 15 device

Table 10: 20dB Occupied Bandwidth "Data rate for communication to approved Part 15 device"

Channel	Frequency (MHz)	20dB Bandwidth (kHz)
Low	902.24	138.7
Middle	914.96	135.9
High	927.78	136.4

Channel	Plot
High Data Rate	
High Data Rate	

High Data Rate	

Plot 8: 20dB Occupied Bandwidth Plot (Data rate for communication to approved Part 15 device)

4.4 Out of Band Emissions (Band Edge)

- **Date Performed:**

  April 7-10, 2017

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.247 (d)
  RSS-247 Issue 2: Clause 5.5

- **Test Method:**

  ANSI C63.10:2013

- **Test Requirement:**

  In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20dB. Attenuation below the general field strength limits specified in RSS-Gen Issue 5 is not required.

- **Test Setup:**

  The antenna port of EUT was directly connected to a spectrum analyzer.

- **Measurement Method:**

  The measurement method used for both radios was Section 6.10.6.2 Marker-delta Method of ANSI C63.10-2013 standard.

- **Modifications:**

  No modification was required to comply for this test.

- **Result:**

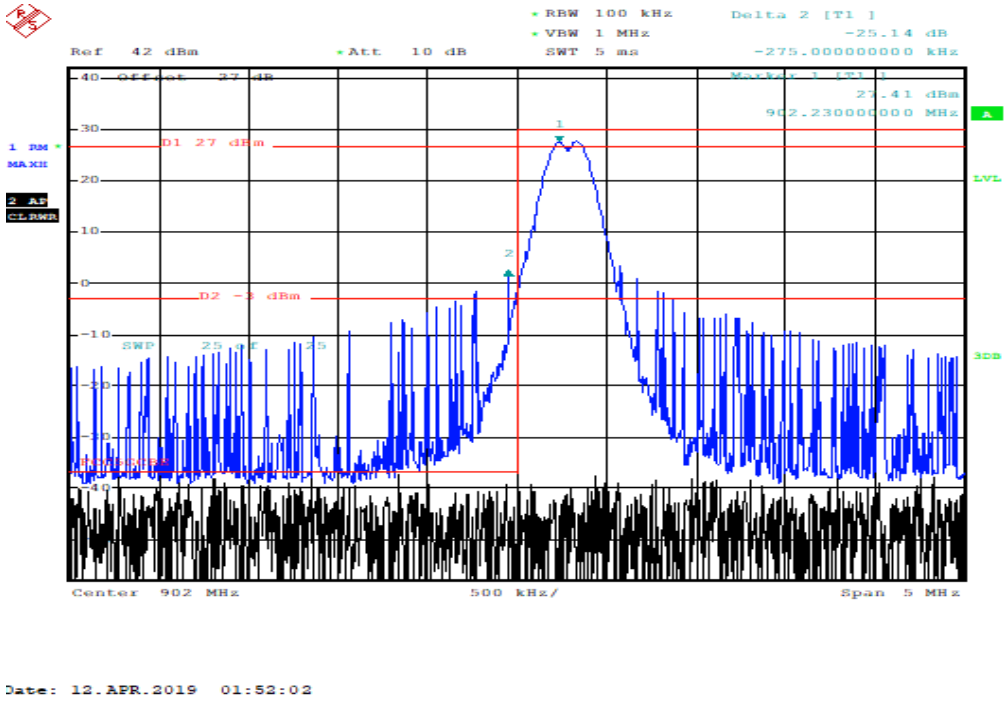
  The EUT complies with the applicable standard.

Table 11: Band-edge Requirement Data

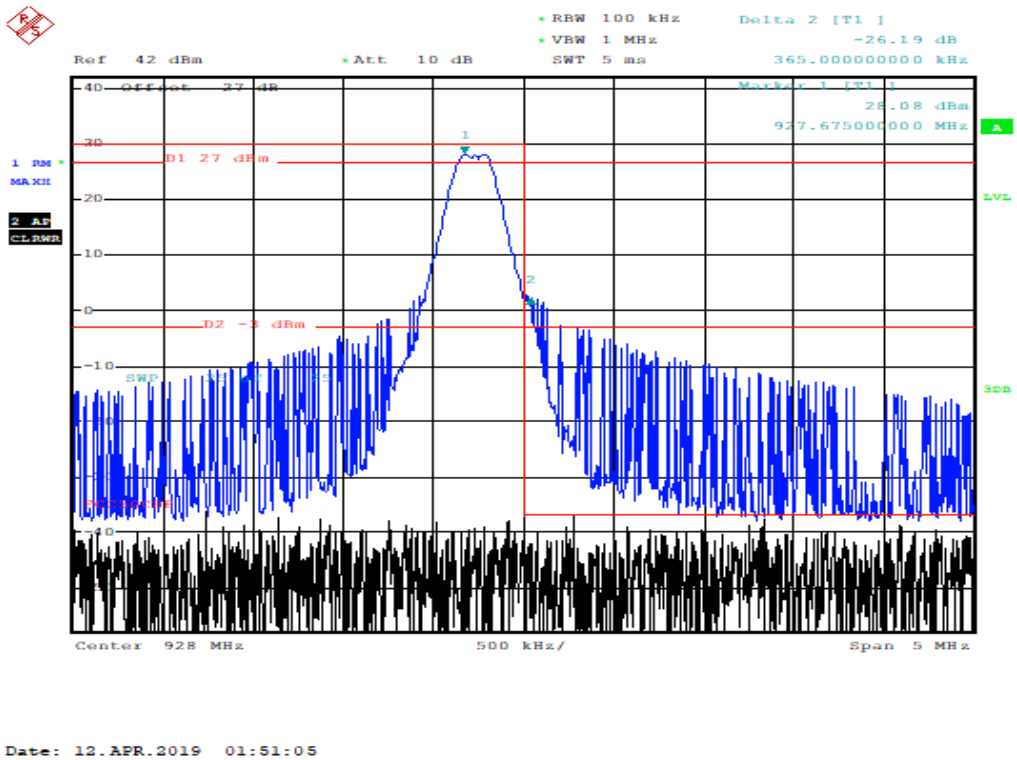
Rate	Band-edge MHz	Reading dBc	Margin dB (Limit > 20 dBc)	
Low	902	25.14	5.14	PASS
Low	928	26.19	6.19	PASS
Middle	902	52.56	32.56	PASS
Middle	928	43.08	23.08	PASS
High	902	23.75	3.75	PASS
High	928	23.96	3.96	PASS

Measurement Data and Plot:

Low Data Rate

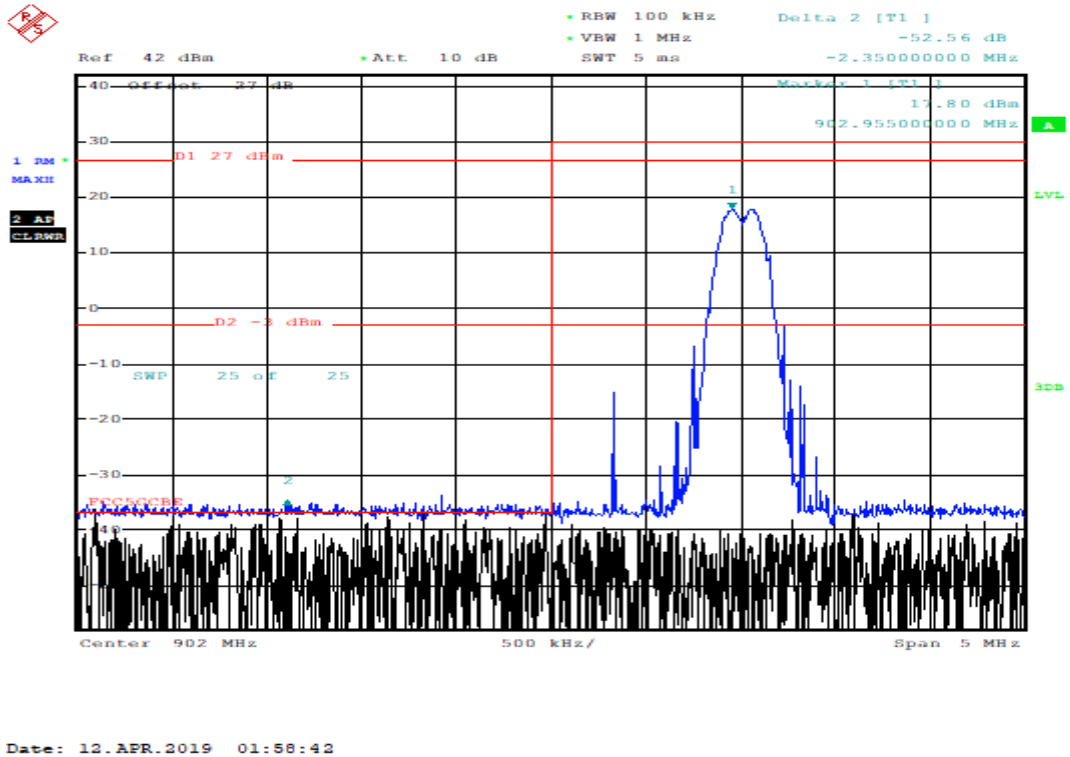


Plot 9: Band Edge Plot (Low Channel ~902.3MHz_Low Data Rate)

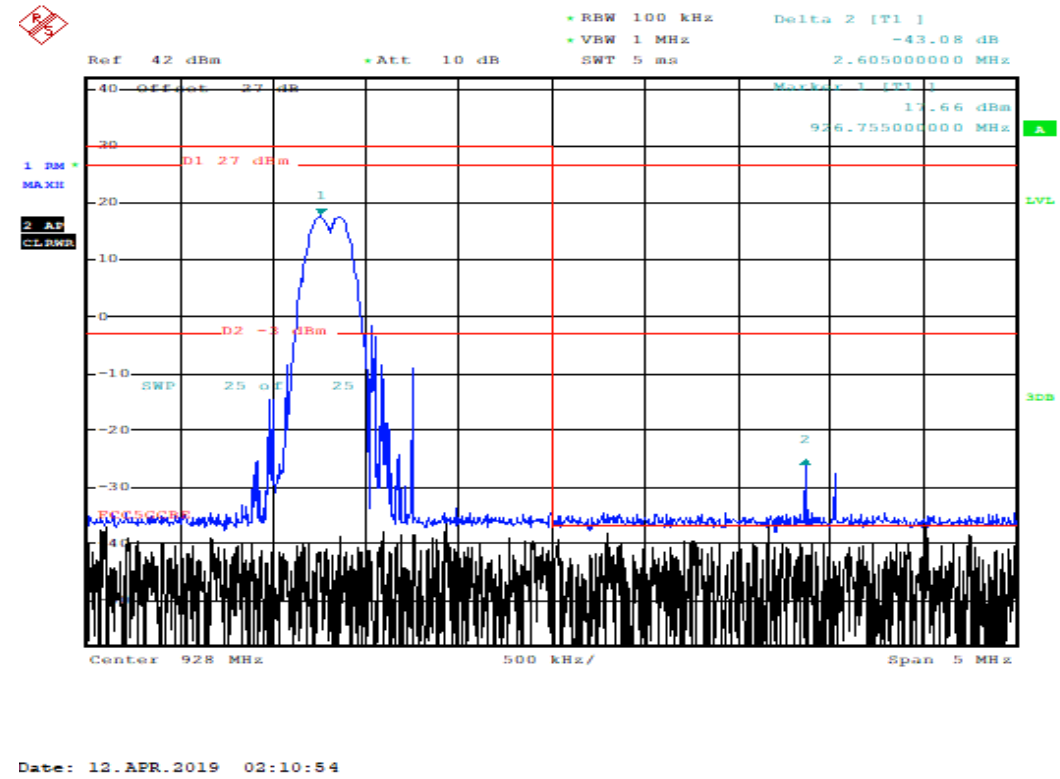


Plot 10: Band Edge Plot (High Channel ~927.8MHz_Low Data Rate)

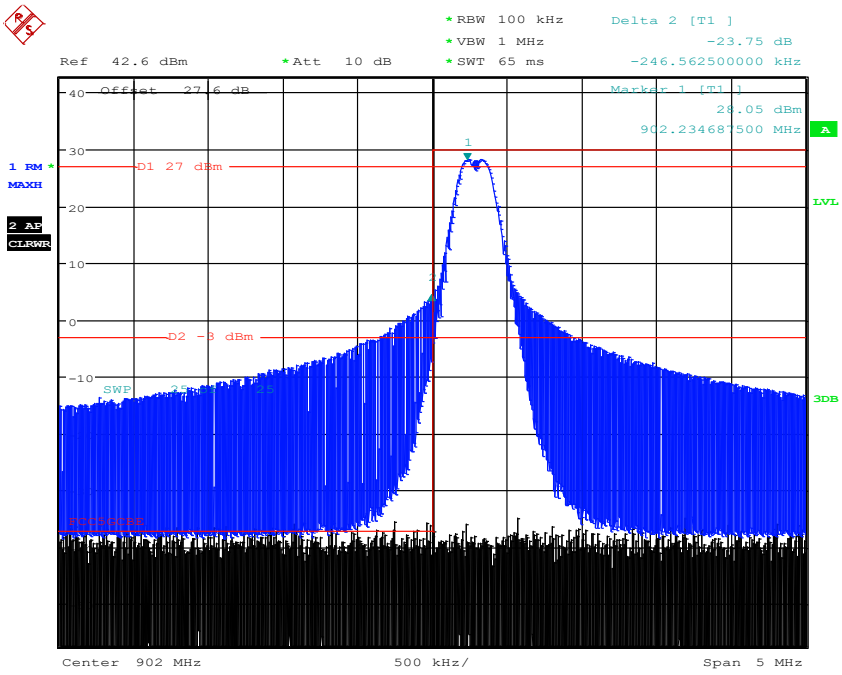
High Data Rate



Plot 11: Band Edge Plot (Low Channel ~902.2MHz_High Data rate)

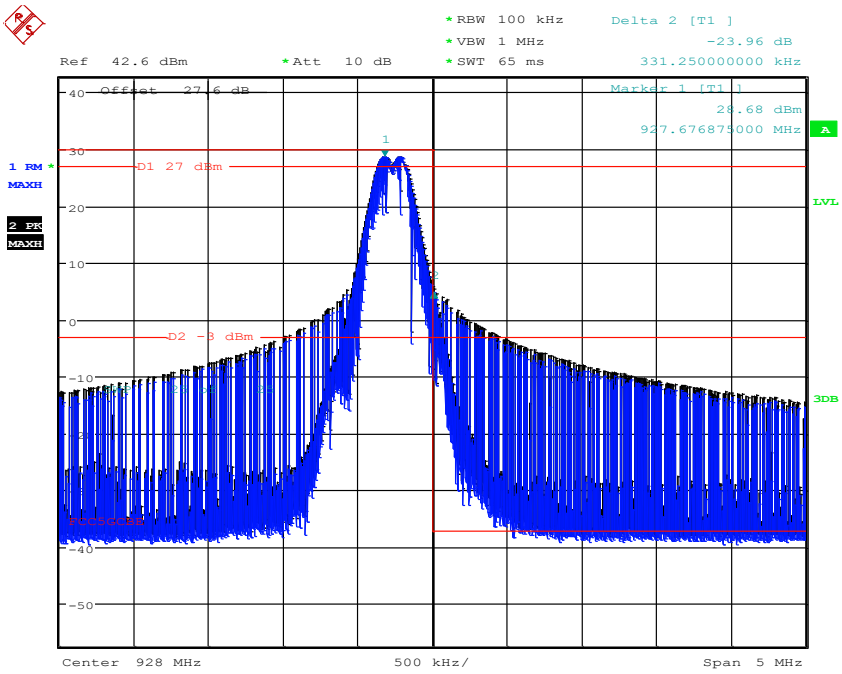


Plot 12: Band Edge Plot (High Channel ~927.7MHz_)



Date: 11.APR.2019 23:13:24

Plot 13: Band Edge Plot (High Channel ~927.7MHz_)



Date: 11.APR.2019 23:15:38

Plot 14: Band Edge Plot (High Channel ~927.7MHz_)

4.5 Channel Separation

- **Date Performed:**

  April 12, 2019

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.247 (a)(1)
  RSS-247 Issue 2: Clause 5.1 (2)

- **Test Method:**

  ANSI C63.10:2013

- **Test Requirement:**

  Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

- **Test Setup:**

  The antenna port of EUT was directly connected to a spectrum analyzer.

- **Measurement Method:**

  As called in ANSI C63.10-2013.

- **Modifications:**

  No modification was required to comply for this test.

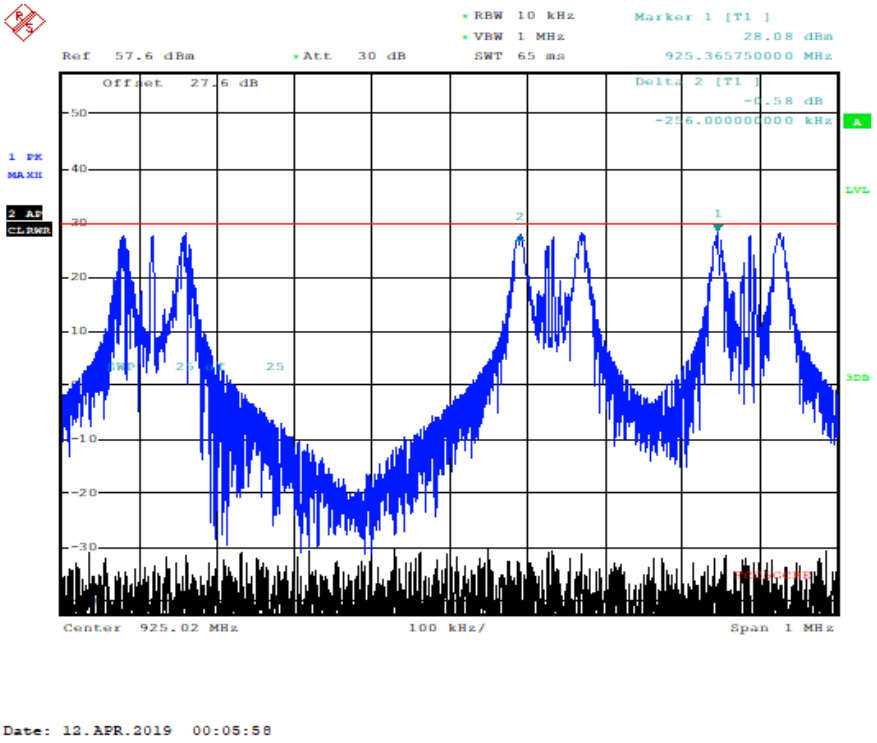
- **Result:**

  The EUT complies with the applicable standard.

Rate	Measured OBW kHz	Frequency Separation kHz	Frequency Separation > OBW
Low	142.3	200.0	PASS
Middle	289.4	319.2	PASS
High	220.9	256.0	PASS

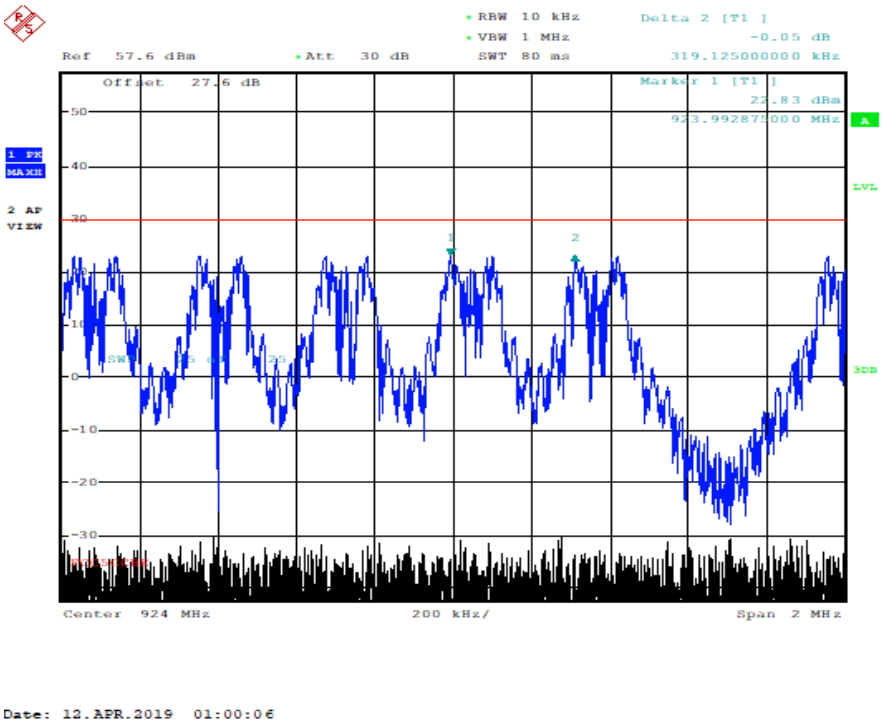
Measurement Data and Plot:

Low Data Rate

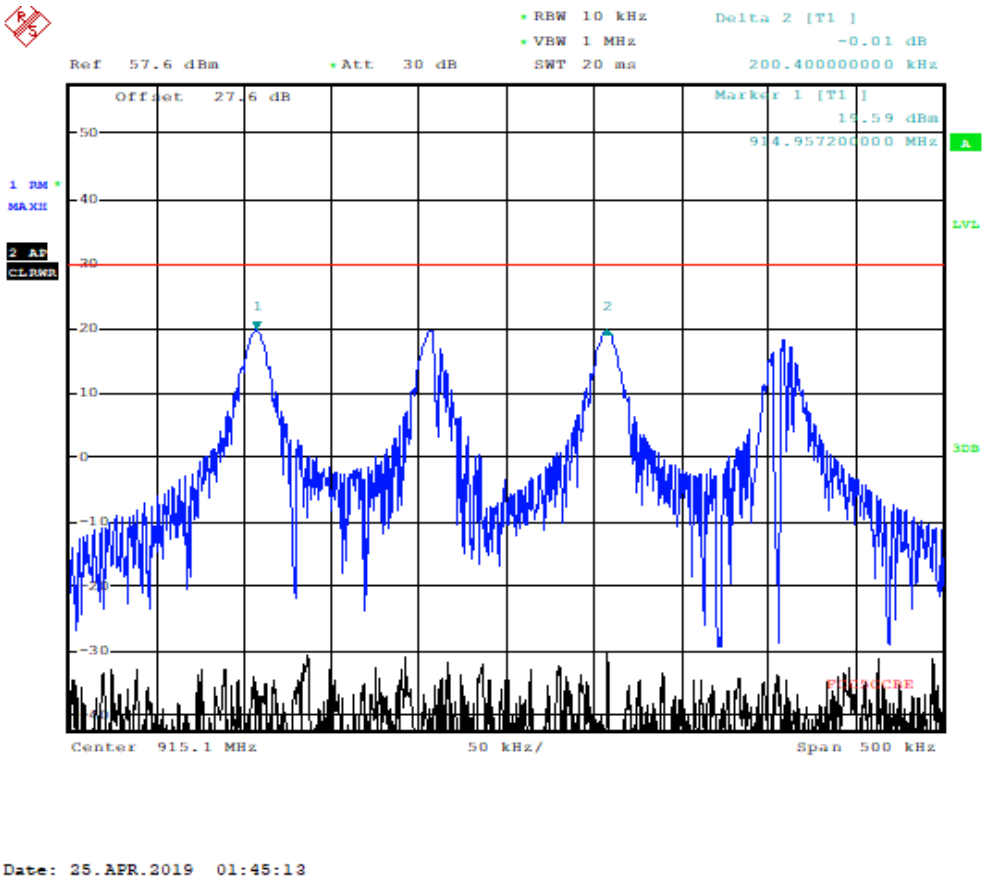


Plot 15: Channel Separation → 256 kHz

High Data Rate



Plot 16: Channel Separation → 319.2 kHz



Plot 17: Channel Separation → 200.0 kHz

4.6 Number of Hopping Channels

- **Date Performed:**

  April 11, 2019

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.247 (a)(1)(i)
  RSS-247 Issue 2: Clause 5.1 (3)

- **Test Method:**

  ANSI C63.10:2013

- **Test Requirement:**

  For FHSs in the band 902-928 MHz: if the 20dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

- **Test Setup:**

  The antenna port of EUT was directly connected to a spectrum analyzer.

- **Measurement Method:**

  As called in ANSI C63.10-2013.

- **Modifications:**

  No modification was required to comply for this test.

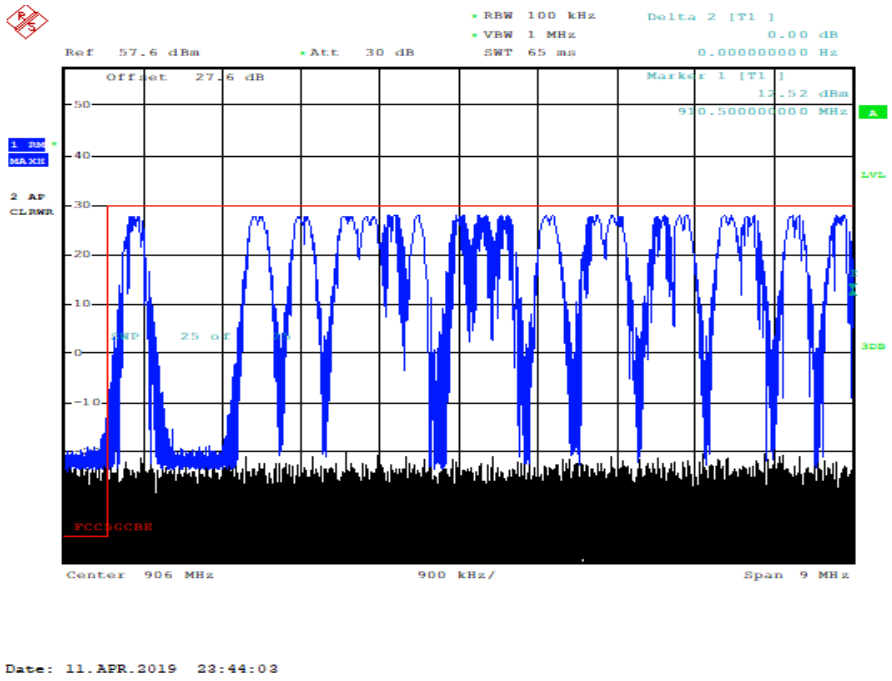
- **Result:**

  The EUT complies with the applicable standard.

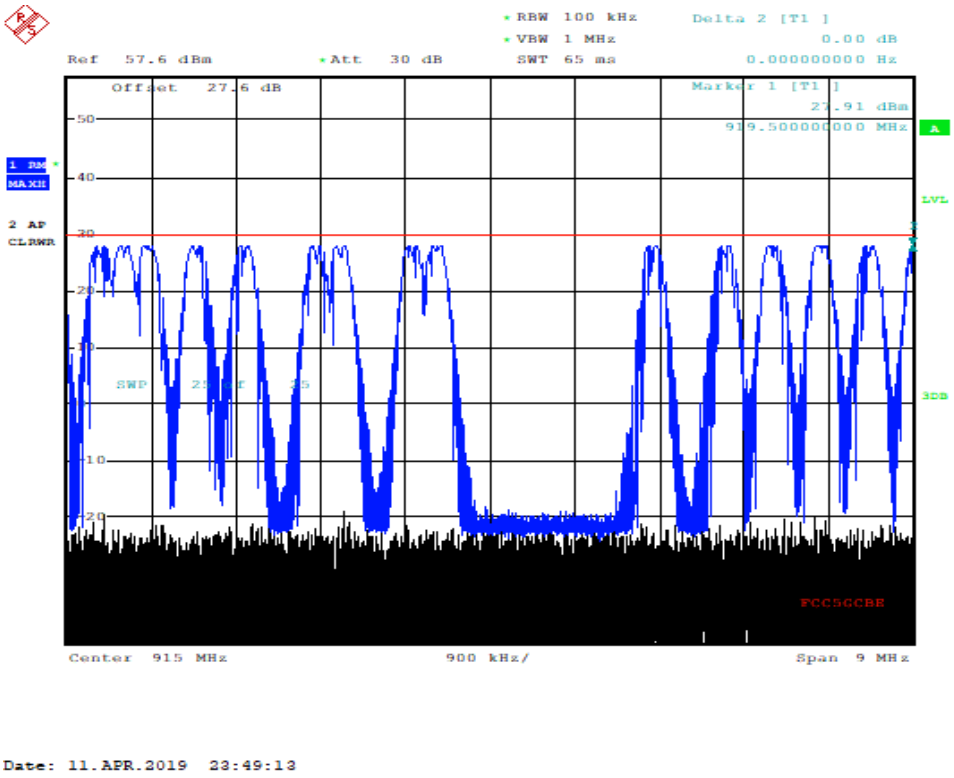
Data Rate	Frequency Range	Number of Hopping Frequencies
Low Data Rate	906MHz	19
	915MHz	15
	924MHz	16
	Total	50
Mid Data Rate	906MHz	18
	915MHz	18
	924MHz	14
	Total	50
High Data Rate	906 -915MHz	25
	922.5MHz	25
	Total	50

Measurement Data and Plot:

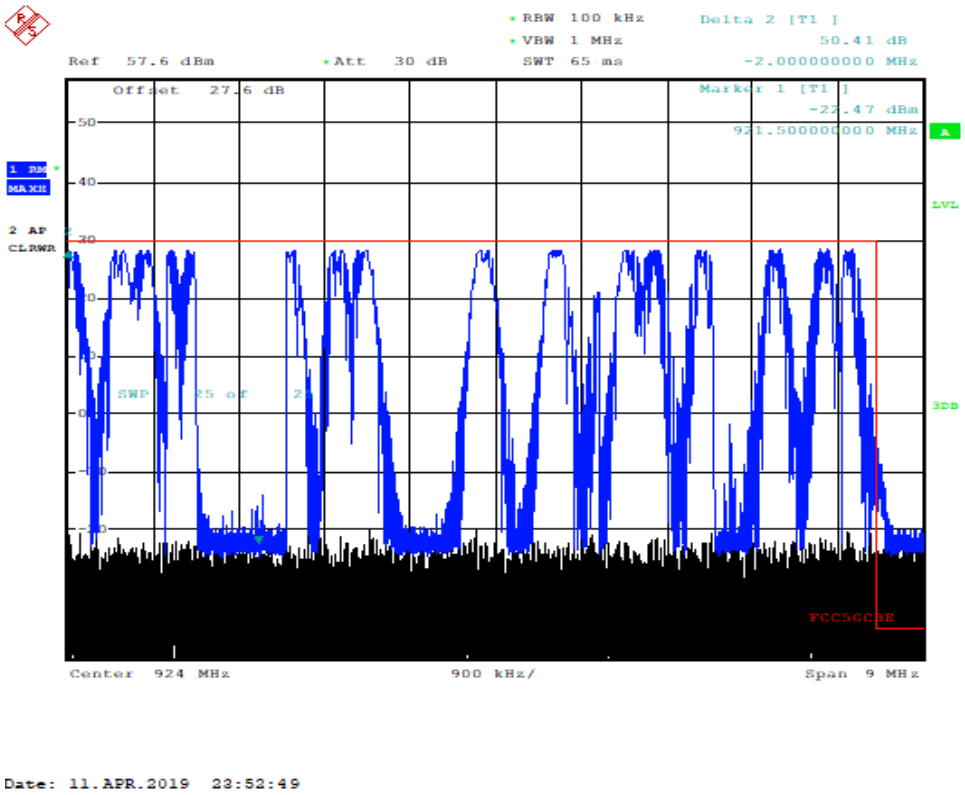
Low Data Rate



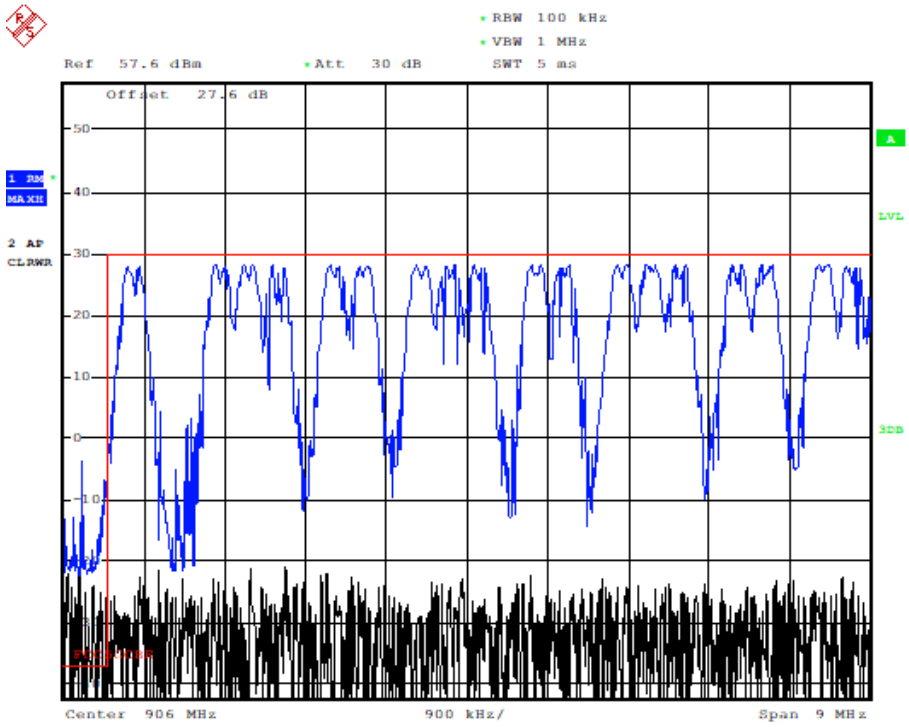
Plot 18: Number of Hopping Channels → 906MHz (Low Data Rate) ~ 19 frequencies



Plot 19: Number of Hopping Channels → 915MHz (Low Data Rate) ~15 frequencies

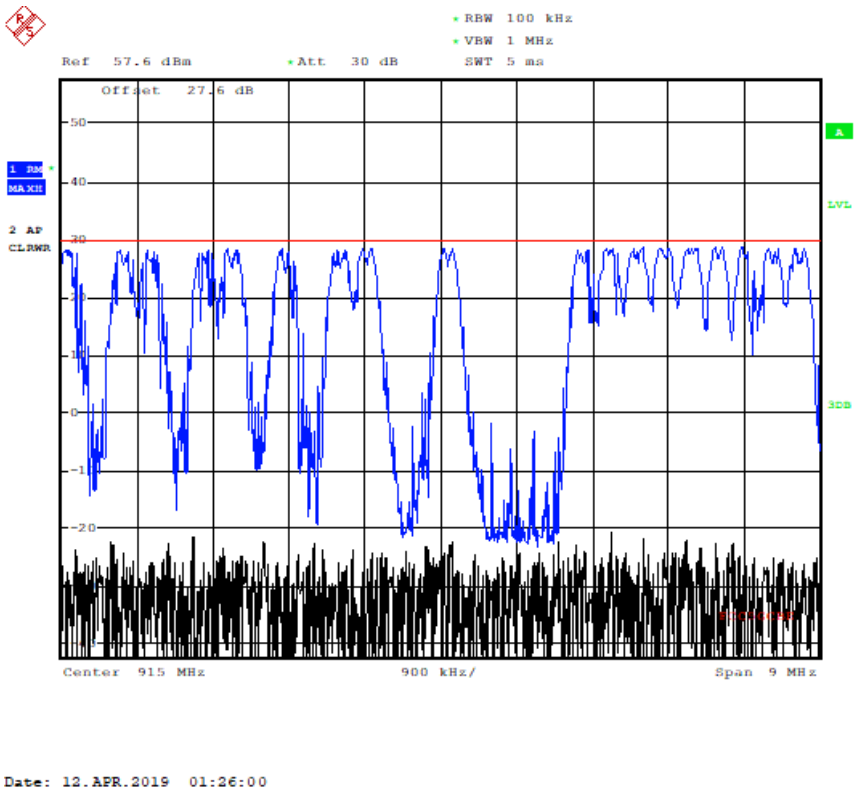


Plot 20: Number of Hopping Channels → 924MHz (Low Data Rate) ~16 frequencies

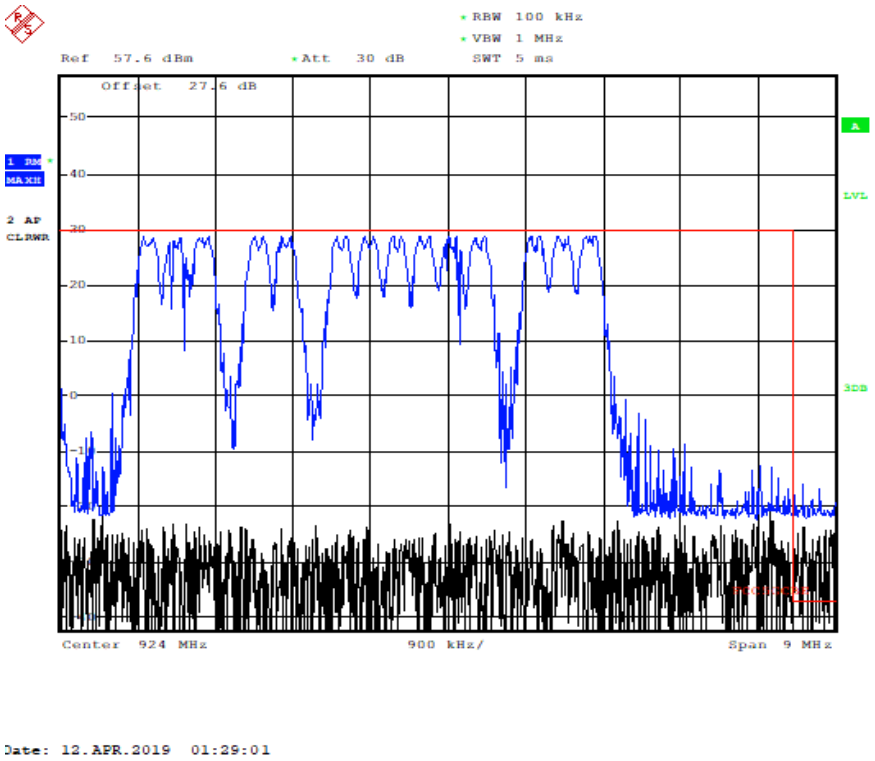


Plot 21: Number of Hopping Channels → 906MHz (Mid Data Rate) ~18 frequencies

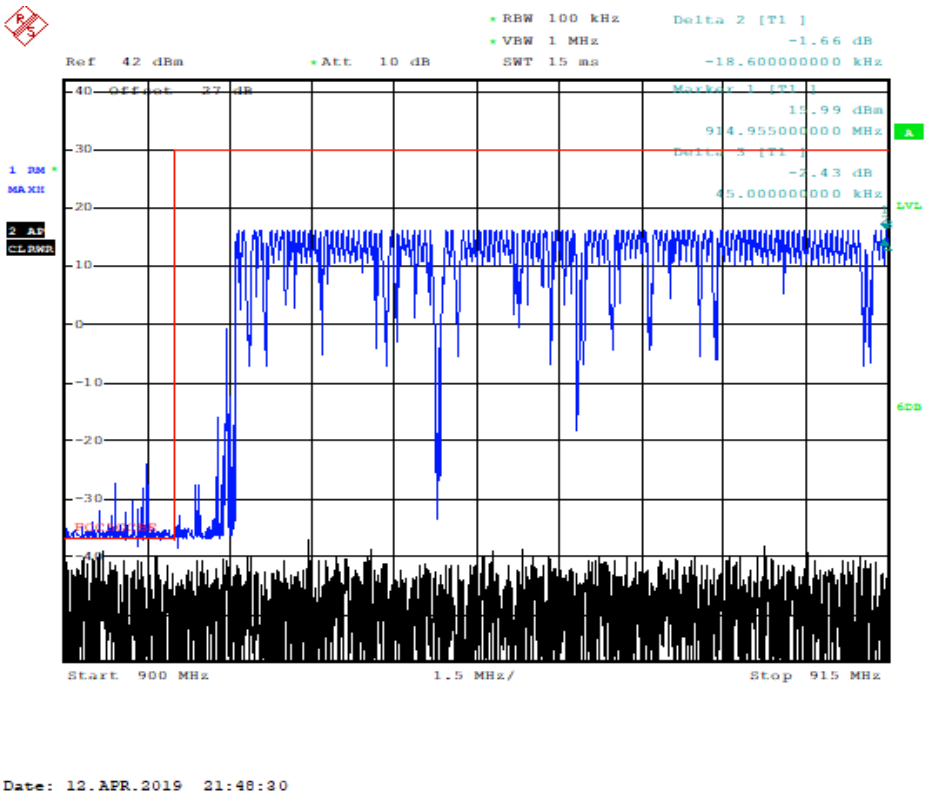
High Data Rate



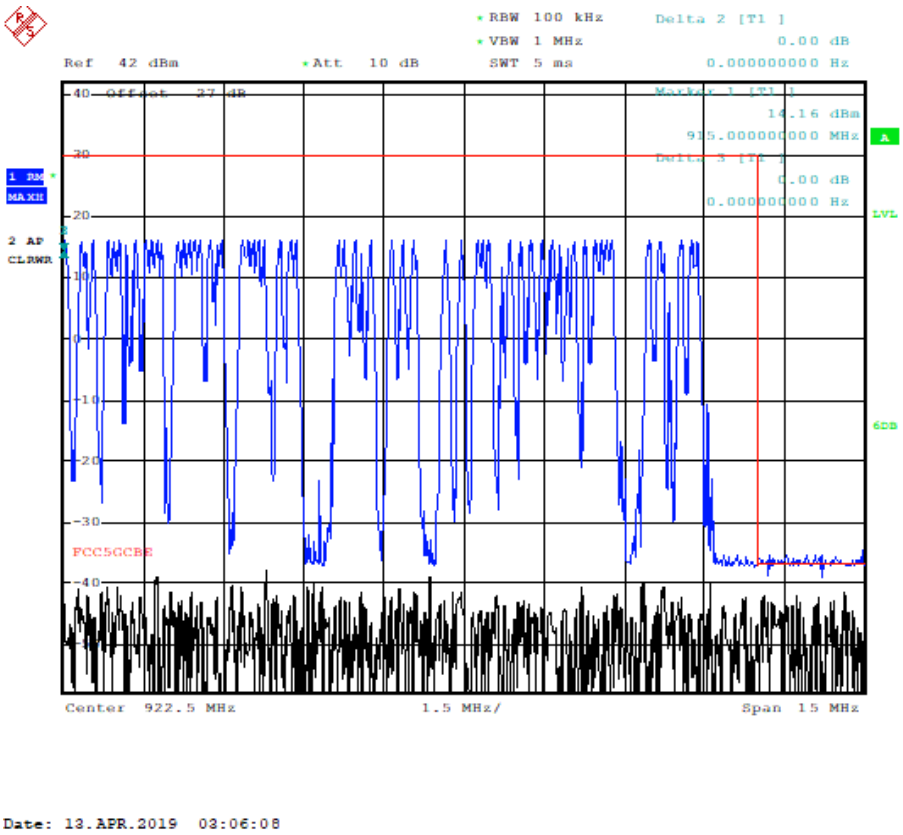
Plot 22: Number of Hopping Channels → 915MHz (Mid Data Rate) ~18 frequencies



Plot 23: Number of Hopping Channels → 924MHz (Mid Data Rate) ~14 frequencies



Plot 24: Number of Hopping Channels → 900MHz to 915 MHz (High Data Rate) ~25 frequencies



Plot 25: Number of Hopping Channels → 922.5MHz ~25 frequencies

4.7 Dwell Time and Time Occupancy Per Frequency

- **Date Performed:**

  April 12, 2019

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.247 (a)(1)(i)
  RSS-247 Issue 2: Clause 5.1 (3)

- **Test Method:**

  ANSI C63.10:2013

- **Test Requirement:**

  For FHSs in the band 902-928 MHz: if the 20dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be500 kHz.

- **Test Setup:**

  The antenna port of EUT was directly connected to a spectrum analyzer.

- **Measurement Method:**

  As called in ANSI C63.10-2013.

- **Modifications:**

  No modification was required to comply for this test.

- **Result:**

  The EUT complies with the applicable standard.

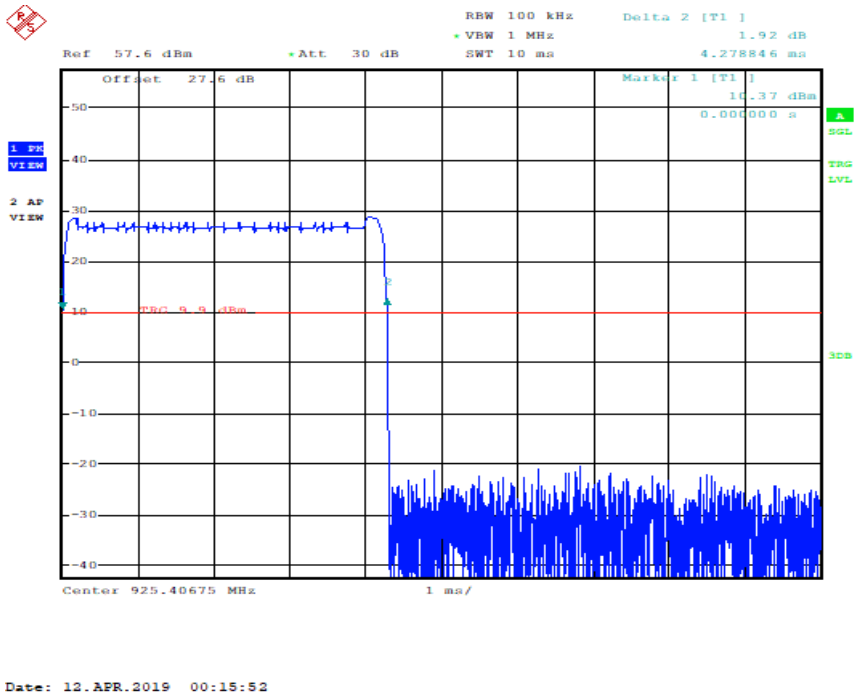
Occupancy is calculated from the dwell (pulse width) and interval between pulses.

Occupancy time within 20 seconds' period is $\frac{Dwell\ (s) \times 20\ (s)}{Interval\ (s)} = Occupancy$

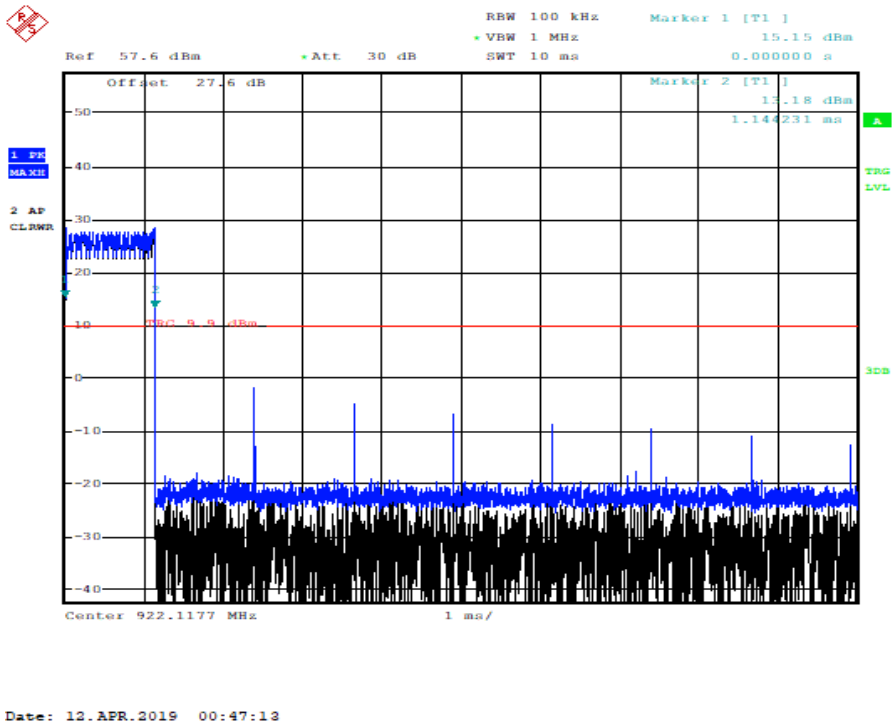
Rate	Pulse width (msec)	Interval (sec)	20 sec Occupancy Limit < 0.4 sec	
Low	4.28	2.3	0.038	PASS
Middle	1.14	0.7	0.035	PASS
High	6.30	15.2	0.008	PASS

Dwell Time Measurement Data and Plot:

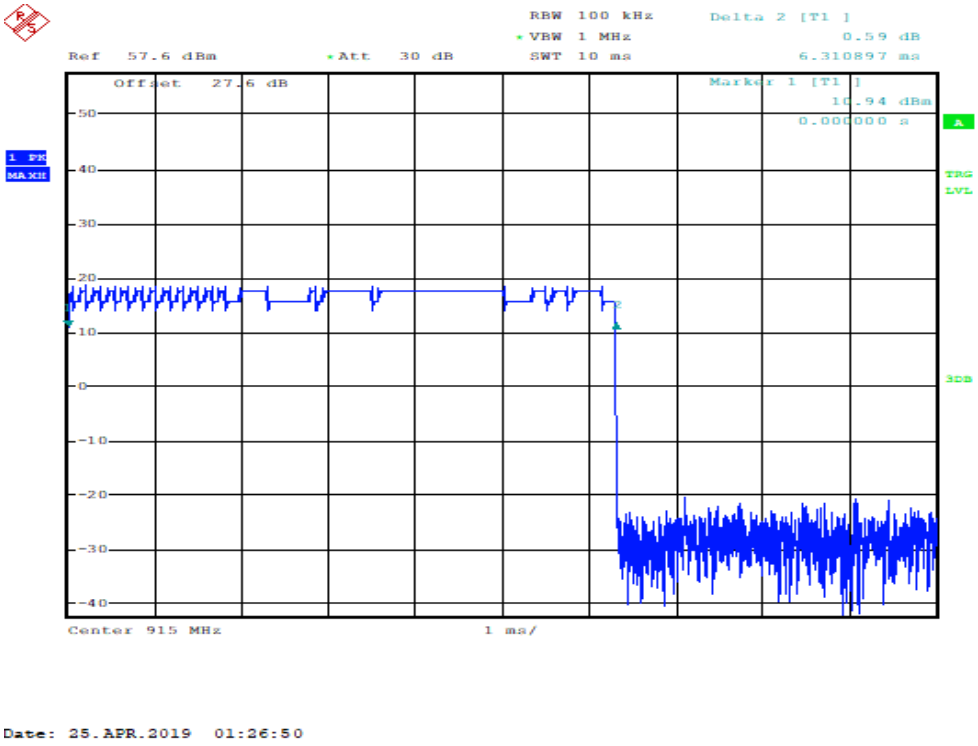
Low Data Rate



Plot 26: Dwell Time → 4.28ms

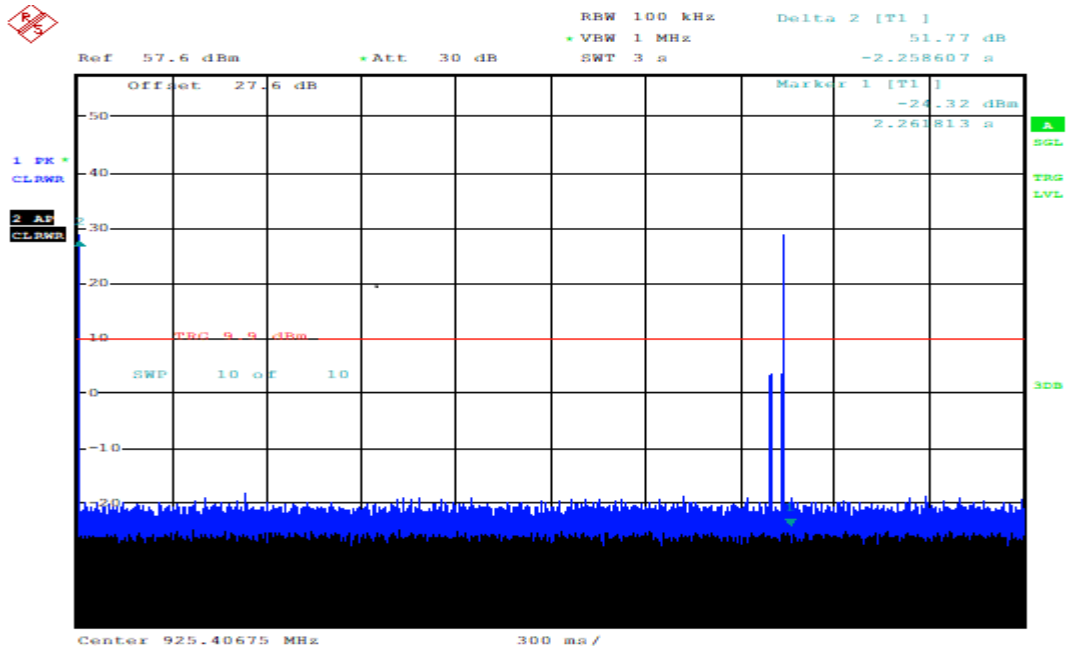


Plot 27: Dwell Time → 1.14ms

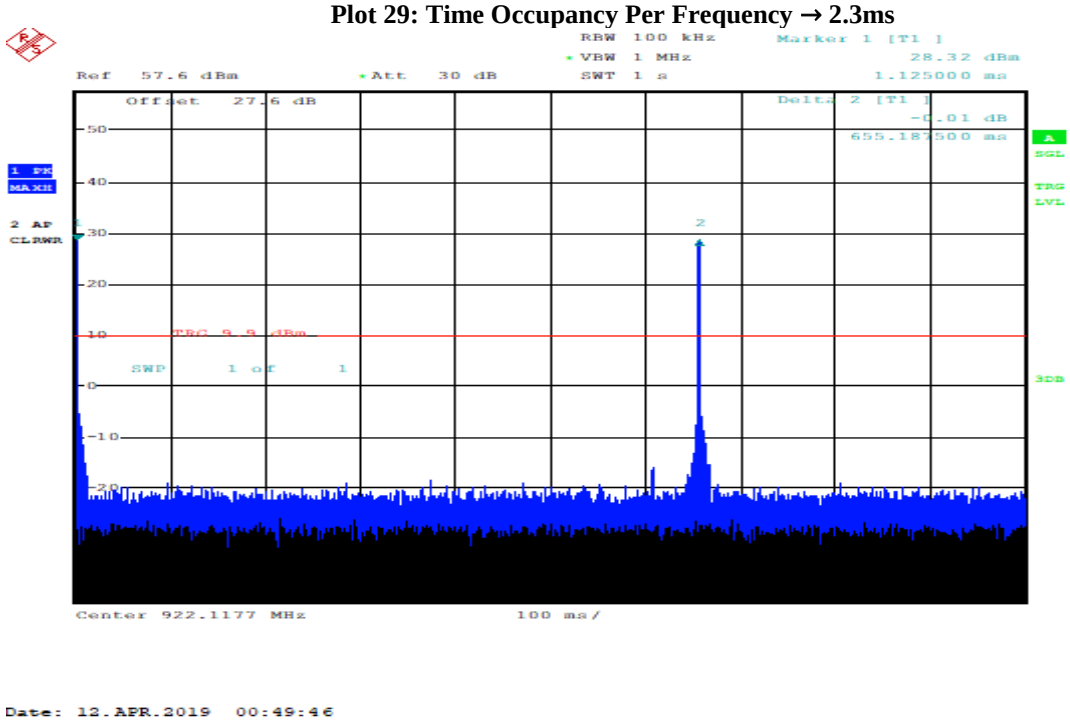


Plot 28: Dwell Time → 6.3ms

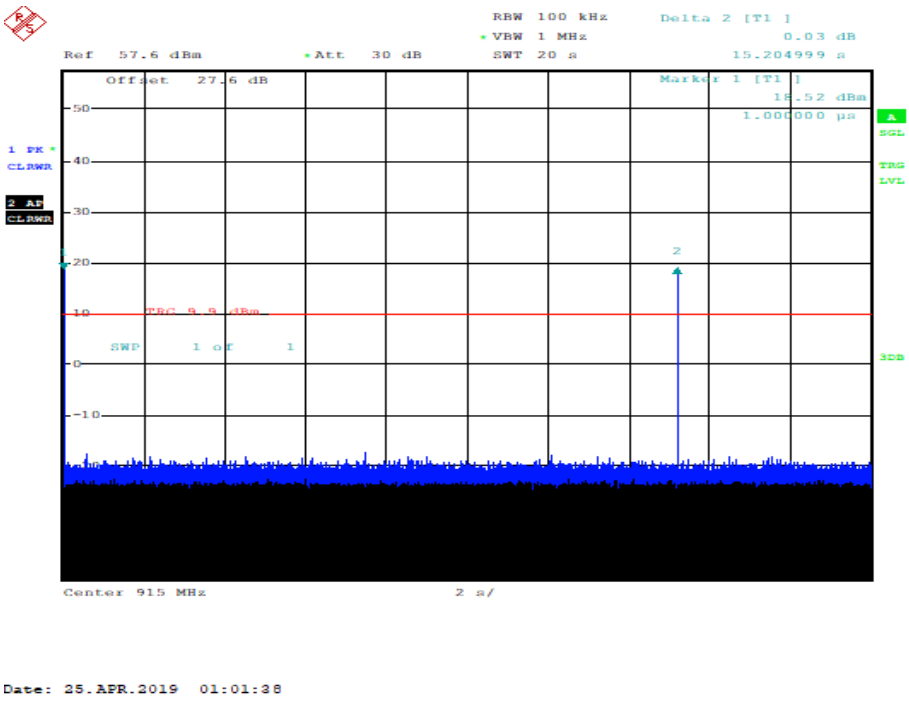
Occupancy Time Data and Plot:



Plot 29: Time Occupancy Per Frequency → 2.3ms



Plot 30: Time Occupancy Per Frequency → 656ms



Plot 31: Time Occupancy Per Frequency → 15.2ms

4.8 Radiated Spurious Emissions Transmit Mode

- **Date Performed:**

  April 7-10, 2017

- **Test Standard:**

  FCC Title 47 CFR Part 15: Subpart C §15.209
  FCC Title 47 CFR Part 15: Subpart C §15.205
  RSS-Gen Issue 5: Clause 8.9
  RSS-Gen Issue 5: Clause 8.10

- **Test Method:**

  ANSI C63.10:2013

- **Test Requirement:**

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or to the general field strength limits listed in RSS-Gen Issue 5, whichever is less stringent.

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency if the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Unwanted emissions falling into restricted bands of shall comply with the limits specified below

Frequency (MHz)	Field Strength (dBµV/m) at 3m
0.009 – 0.490	128.5 – 93.8
0.490 – 1.705	73.8 – 63.0
1.705 – 30.0	69.5

Frequency (MHz)	Field Strength Quasi Peak dBµV/m @ 3m
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
Above 960	54.0

Table 12: FCC PART 15.205-RESTRICTED BANDS OF OPERATION

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1] 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			

*** - note FCC-specific .**

Canada-specific frequency ranges in MHz – 3.020-3.026, 5.677–5.683, 121.94-123.0. 149.9-150.05, 162.0125-167.17, 167.72-173.2, 1300-1427, 2483.5-2500, 3500-3600,

(2) Above 38,6 GHz

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

Table 13: RESTRICTED FREQUENCY BANDS (RSS-GEN ISSUE 5)

MHz
0.090-0.110
2.1735-2.1905
3.020-3.026
4.125-4.128
4.17725-4.17775
4.20725-4.20775
5.677-5.683
6.215-6.218
6.26775-6.26825
6.31175-6.31225
8.291-8.294
8.362-8.366
8.37625-8.38675
8.41425-8.41475
12.29-12.293
12.51975-12.52025
12.57675-12.57725
13.36-13.41
16.42-16.423
16.69475-16.69525
16.80425-16.80475
25.5-25.67
37.5-38.25
73-74.6
74.8-75.2
108-138
156.52475-156.52525
156.7-156.9

MHz
240-285
322-335.4
399.9-410
608-614
960-1427
1435-1626.5
1645.5-1646.5
1660-1710
1718.8-1722.2
2200-2300
2310-2390
2655-2900
3260-3267
3332-3339
3345.8-3358
3500-4400
4500-5150
5350-5460
7250-7750
8025-8500

GHz
9.0-9.2
9.3-9.5
10.6-12.7
13.25-13.4
14.47-14.5
15.35-16.2
17.7-21.4
22.01-23.12
23.6-24.0
31.2-31.8
36.43-36.5
Above 38.6

Note: Certain frequency bands listed in Table 3 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in the 200– and 300– series RSSs, such as RSS-210 and RSS-310, which contain the requirements that apply to licence-exempt radio apparatus.

Test Setup:

The EUT was tested in our 3 m SAC and was positioned on the center of the turntable. The transmitter was set for continuous transmission. The lowest, middle and highest channels in the 902-928 MHz bands were measured for all radiated emissions 10kHz to 18 GHz. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed flat on the table top as indicated in the test photos.

- ## Measurement Method:

  ANSI C63.10:2013 radiated emissions procedure was followed to demonstrate the compliance of EUT.

- ## Modifications:

  No modification was required to comply for this test.

- ## Result:

  The EUT complies with the applicable standard.

Measurement Data and Plot:

- EUT Test Mode:

  Transmit Mode

- Test Mains Voltage Used:

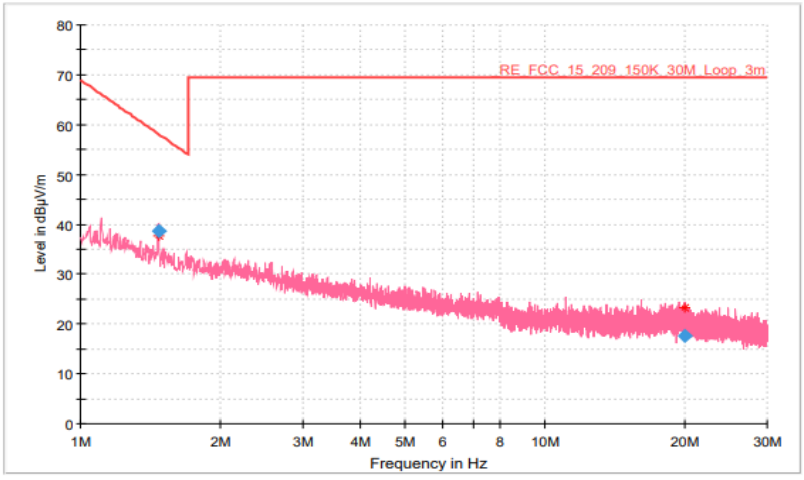
  120Vac/60Hz

- Frequency Range:

  1 MHz to 30MHz

Table 14: Radiated Emissions from 1MHz to 30MHz

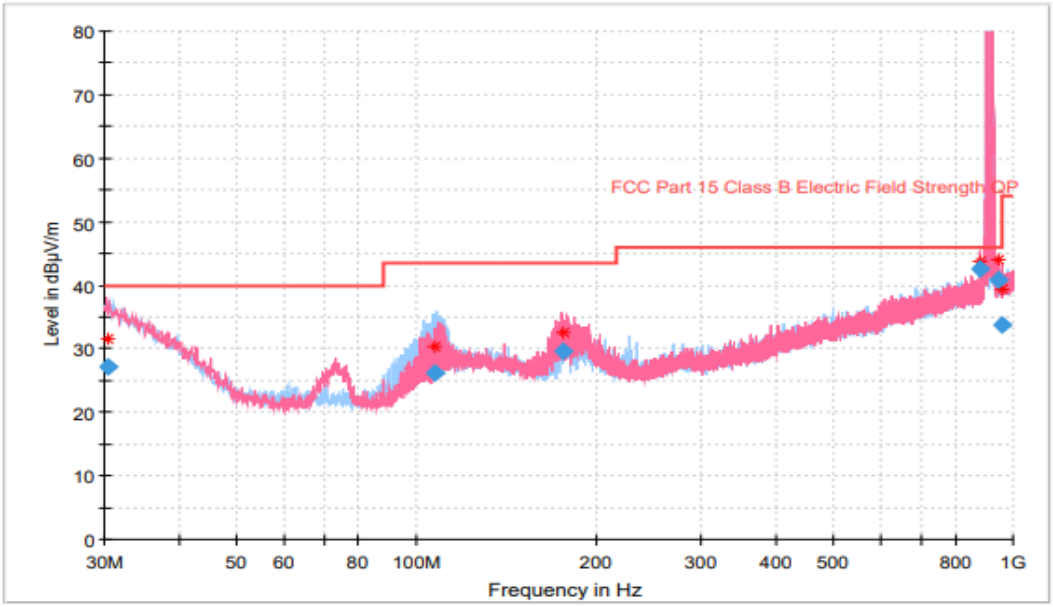
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1.472086	38.75	58.12	19.38	1000.0	9.000	250.0	V	11.0	20.9
19.939690	17.58	69.50	51.92	1000.0	9.000	300.0	V	0.0	21.0



Plot 32: Radiated Emissions scanned at 3m SAC

Table 15: Radiated Emissions from 30 MHz to 1GHz

Frequency (MHz)	Quasi Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.478909	27.17	40.00	12.83	1000.0	120.000	315.0	V	167.0	29.4
107.014840	26.16	43.50	17.34	1000.0	120.000	164.0	H	6.0	19.2
176.347480	29.66	43.50	13.84	1000.0	120.000	100.0	V	132.0	18.9
882.885000	42.56	46.00	3.44	1000.0	120.000	114.0	V	33.0	32.1
946.963360	40.96	46.00	5.04	1000.0	120.000	325.0	H	44.0	33.0
959.811280	33.79	46.00	12.21	1000.0	120.000	183.0	V	289.0	33.1

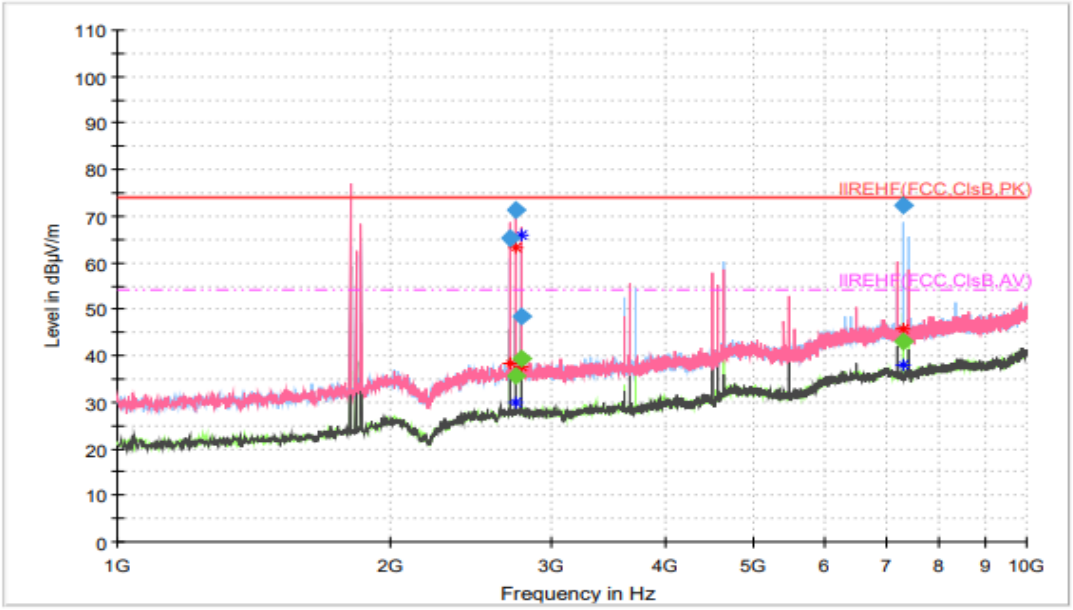


Plot 33: Radiated Emissions scanned at 3m SAC

Note 1: The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part. - *§15.31 (o)*

Table 16: Radiated Emissions from 1GHz to 10GHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2707.589200	65.34	---	74.00	8.66	1000.0	1000	112.0	V	12.0	1.4
2743.360800	---	35.53	54.00	18.47	1000.0	1000	139.0	H	22.0	1.5
2744.994800	71.30	---	74.00	2.70	1000.0	1000	124.0	V	0.0	1.5
2781.662400	48.46	---	74.00	25.54	1000.0	1000	163.0	V	283.0	1.4
2782.984000	---	39.25	54.00	14.75	1000.0	1000	139.0	H	22.0	1.4
7317.096000	---	43.22	54.00	10.78	1000.0	1000	139.0	H	22.0	10.3
7318.957600	72.39	---	74.00	1.61	1000.0	1000	139.0	H	22.0	10.3



Appendix A: TEST SETUP PICTURES

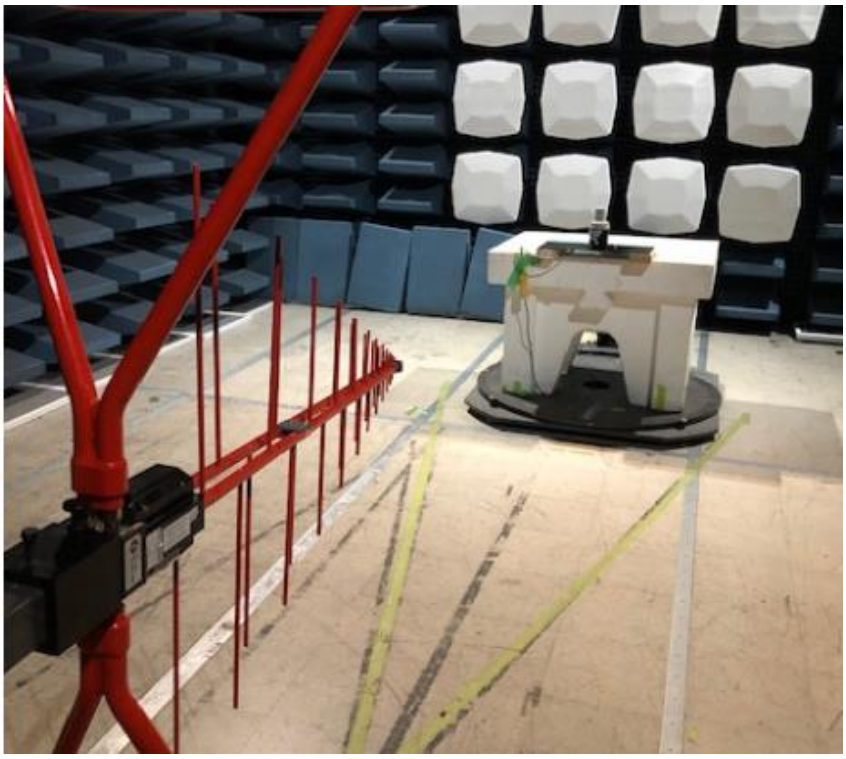


Figure 1: Radiated Emissions (below 1GHz) Test Setup

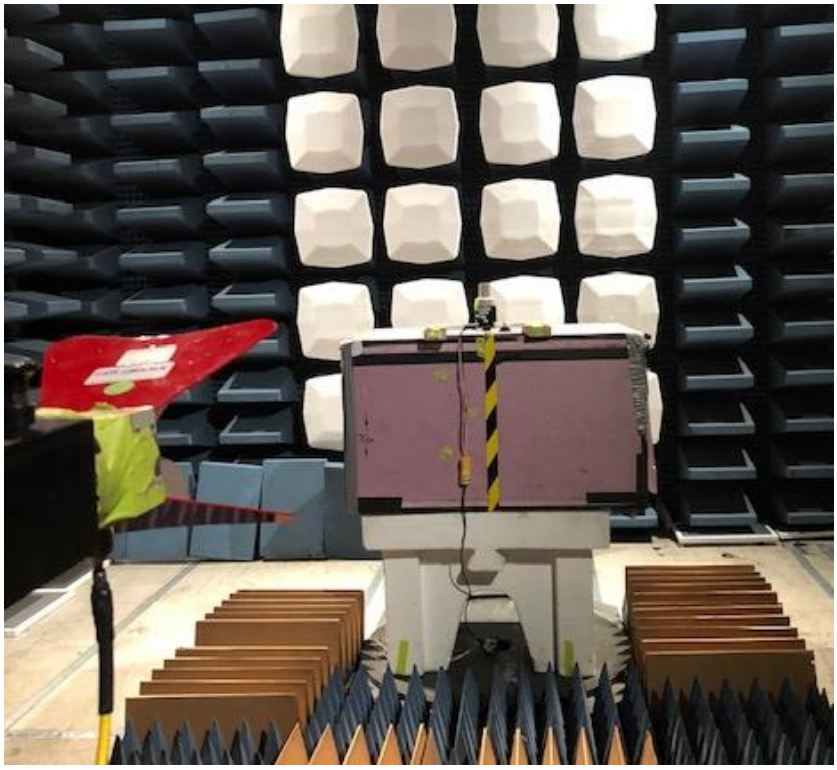


Figure 2: Radiated Emissions (above 1 GHz) Test Setup

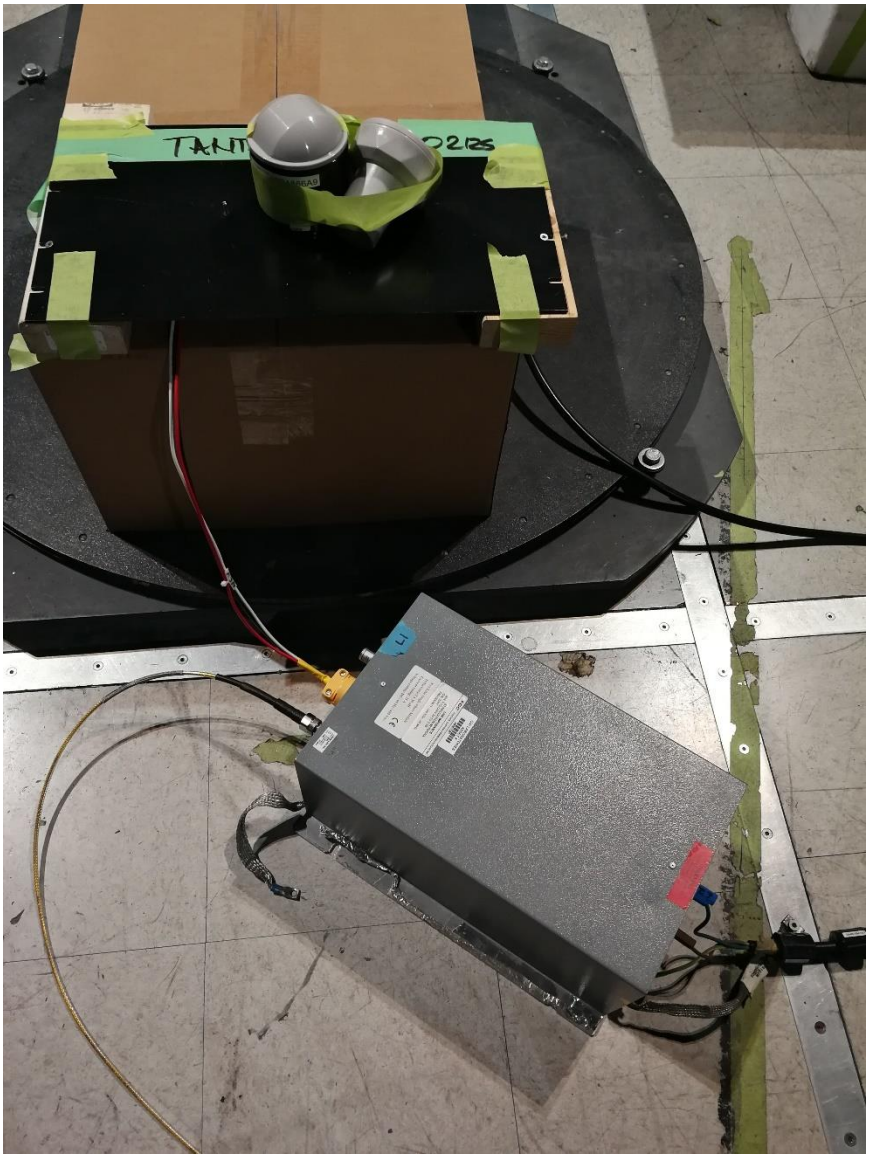


Figure 3: Conducted Emissions AC Test Setup

Appendix B: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
AM	Amplitude Modulation
CE	European Conformity
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
DC	Direct Current
EFT	Electrical Fast Transient
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electro Static Discharge
EUT	Equipment Under Test
FCC	Federal Communications Commission
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

END OF REPORT