

ELECTROMAGNETIC COMPATIBILITY TEST REPORT

PREPARED FOR BLACKLINE SAFETY CORP.
BY QAI LABORATORIES



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Laboratory Accreditations (per ISO/IEC 17025:2005):



American Association for Laboratory Accreditation Certificate Number: 3657.02

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Applicable Test Standards: FCC Title 47 CFR Part 15: Subpart B
FCC Title 47 CFR Part 15: Subpart C - § 15.247
RSS-247 Issue 2, RSS-Gen Issue 5, ICES-003 Issue 6

Equipment Tested: G7C Device
Model Number: G7C
FCC ID: Host Product: W77G7C, Contains: XPY1CGM5NNN
IC Certification Number: Host Product: 8255A-G7C, Contains: 8595A-1CGM5NNN
Manufacturer: Blackline Safety Corp.



blacklinesafety

REVISION HISTORY

Date	Report Number	Rev #	Details	Author
September 20, 2018	E10995-1801_Blackline_G7C_FCC_IC_Rev0.0	0.0	Initial Release	JQ
September 25, 2018	E10995-1801_Blackline_G7C_FCC_IC_Rev1.0	1.0	Finalized	JQ
October 24, 2018	E10995-1801_Blackline_G7C_FCC_IC_Rev2.0	2.0	Updated as per Timco	JQ
November 1, 2018	E10995-1801_Blackline_G7C_FCC_IC_Rev2.1	2.1	Updated Test equipment list	JQ
November 6, 2018	E10995-1801_Blackline_G7C_FCC_IC_Rev2.1	3.0	Add data of RE 18-25 GHz	JQ

All previous versions of this report have been superseded by the latest dated revision as listed in the above table.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 Blackline Safety Corp. Tests were conducted on the sample equipment as requested by Blackline Safety Corp. for the purpose of demonstrating compliance with FCC Title 47 CFR Part 15: Subpart B, FCC Title 47 CFR Part 15: Subpart C - § 15.247, RSS-247 Issue 2, RSS-Gen Issue 5 & ICES-003 Issue 6 as agreed upon by Blackline Safety Corp. as per Quote 18SH06222.

Blackline Safety 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 & 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.

X 

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Approved by Parminder Singh
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QAI FACILITIES

Founded in 1994 by a group of experienced certification and testing experts, QAI is an independent third-party testing, inspection and certification organization which serves the building industry, government and individuals with cost effective solutions through our in-house capabilities / services, and an established world-wide network of qualified affiliates. To help get your product to market, trust the provider that many leading global manufacturers do: QAI.

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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
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**Headquarters & EMC Laboratory in
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Section I: EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of G7C Device 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 18SH:

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 Licence-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, and FCC KDB 558074 D01 DTS Meas Guidance v05.

1.3 Summary of 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	RF Peak Power Output	FCC Title 47 CFR Part 15: Subpart C - §15.247 (b)(1) RSS-247 Issue 2	Complies
3	Radiated Spurious Emissions	RSS-247-Issue 2, RSS-Gen Issue 5 FCC Subpart C §15.205, §15.209 & §15.247	Complies
4	20 dB Bandwidth	RSS-247-Issue 2, RSS-Gen Issue 5 FCC Subpart C §15.247	Complies
5	99% Bandwidth	RSS-247 Issue 2, RSS-Gen Issue 5	Complies
6	Out-of-Band Emissions (Band Edge)	FCC Title 47 CFR Part 15: Subpart C - §15.247 (d) RSS-247-Issue 2	Complies
7	Channel Separation	FCC Title 47 CFR Part 15: Subpart C - §15.247 (a)(1) RSS-247-Issue 2	Complies
8	Number of Hopping Channels	FCC Title 47 CFR Part 15: Subpart C - §15.247 RSS-247-Issue 2	Complies
9	Dwell Time and Time Occupancy Per Frequency	FCC Title 47 CFR Part 15: Subpart C - §15.247 (a)(1)(iii) RSS-247-Issue 2	Complies
10	Unintentional Radiated Emissions	FCC Title 47 CFR Part 15: Subpart B - §15.109 ICES-003 Issue 6	Complies
11	AC Mains Conducted Emissions	FCC Title 47 CFR Part 15: Subpart B - §15.109 ICES-003 Issue 6	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.

Equipment Under Test (EUT) Information

EUT	G7C Device
Functional Description	G7C is a wireless gas monitor
Operating Frequency	2400MHz to 2483.5MHz
FCC ID	Host Product: W77G7C, Contains: XPY1CGM5NNN
IC Certification Number	Host Product: 8255A-G7C, Contains: 8595A-1CGM5NNN
Manufacturer	Blackline Safety Corp.



Equipment Under Test (EUT)

Auxiliary Equipment	Power Supply
Model Number	8AW08D-050-1000UB
Input	100 -240V, 50/60Hz, 0.3A
Output	5Vdc, 1A

2.2 Environmental Conditions

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

Parameter	Conditions
Location	Indoors
Temperature	22-28°C
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	±1°C
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)	QPeak (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)	QPeak (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)	QPeak (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:

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

2.6 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 1.3.

Emissions Test Equipment

Manufacturer	Model	Description	Serial No.	Last Calibration Date	Calibration Due Date
ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
Sunol Sciences	SM46C	Turntable	051204-2	N/A	N/A
Sunol Sciences	TWR95	Mast	TREML0001	N/A	N/A
Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A120106	2017-Sep-24	2020-Sep-24
Sunol Sciences	DRH-118	Horn Antenna 1GHz-18GHz	A050905	2016-Mar-10	2019-Mar-10
Rohde & Schwarz	ESU40	EMI Receiver	100011	2017-Nov-20	2020-Nov-20
Fischer	FCC-LISN-50-25-2-08	LISN (150kHz-30MHz)	2041	2015-Nov-19	2018-Nov-19
EMCO	6502	Loop Antenna	6502	11/13/2017	11/13/2020
EMCO	3160-09	Horn Antenna 18-26.5GHz	9701-1071	13-Sep-17	13-Sep-20

The following components and equipment are calibrated as a complete signal path.

Manufacturer	Model	Description	Serial No.	Last Calibration Date	Calibration Due Date
AH Systems	PAM118	Amplifier 10KHz-18GHz	189	January 1, 2018	January 1, 2019
Insulated Wire Inc.	SPS-1753-1140-SPS	Yellow cable, 3m	102395		
Insulated Wire Inc.	SPS-1753-2400-SPS	Yellow cable, 6m	091096		
WEINSCHL ENGINEERING	44	6db attenuator	665	January 1, 2018	January 1, 2019
A.H.Systems	PAM-1840VH	Preamplifier 18-40GHz	152		
A.H.Systems	2649-03	Green short input cable	395		
A.H.Systems	2649-225	Green short output cable	396		

Measurement Software List

Manufacturer	Model	Version	Description
Rhode & Schwarz	EMC 32	6.20.0	Emissions Test Software

Section III: TEST RESULTS

4.1 Antenna Requirements

Date Performed:

September 17, 2018

Test Standard:

FCC 47 CFR Part 15.203 and IC RSS-Gen Issue 5 Section 7.1.2

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: August 21, 2018

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

Test Method: FCC KDB 558074 D01 DTS Meas Guidance v04

Test Requirement: For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt.

Result: The EUT complies with the applicable standard.

Measurement Data:

Mode	Carrier Frequency	Raw Peak @ 3m	Ant. Pol.	Ant. Factor	System Loss	Corr. Peak @ 3m	EIRP	Ant. Gain	Peak Conducted Output Power	Limit	Margin
	MHz	dBµV	V or H	dB/m	dB	dBµV/m	dBm	dB	dBm	dBm	dB
Bluetooth, GFSK	2402	62.9	V	32.5	5.28	100.68	5.42	2.2	3.22	30	26.78
		70.1	H	32.5	5.28	107.88	12.62	2.2	10.42	30	19.58
	2441	62.6	V	32.5	6	101.1	5.84	2.2	3.64	30	26.36
		71.1	H	32.5	6	109.6	14.34	2.2	12.14	30	17.86
	2480	61.1	V	32.5	6.4	100	4.74	2.2	2.54	30	27.46
		71.5	H	32.5	6.4	110.4	15.14	2.2	12.94	30	17.06
Bluetooth, QPSK	2402	59.3	V	32.5	5.28	97.08	1.82	2.2	-0.38	30	30.38
		69.6	H	32.5	5.28	107.38	12.12	2.2	9.92	30	20.08
	2441	60.3	V	32.5	6	98.8	3.54	2.2	1.34	30	28.66
		70.1	H	32.5	6	108.6	13.34	2.2	11.14	30	18.86
	2480	61	V	32.5	6.4	99.9	4.64	2.2	2.44	30	27.56
		69.8	H	32.5	6.4	108.7	13.44	2.2	11.24	30	18.76
Bluetooth, 8-PSK	2402	59.8	V	32.5	5.28	97.58	2.32	2.2	0.12	30	29.88
		70	H	32.5	5.28	107.78	12.52	2.2	10.32	30	19.68
	2441	61.6	V	32.5	6	100.1	4.84	2.2	2.64	30	27.36
		70.1	H	32.5	6	108.6	13.34	2.2	11.14	30	18.86
	2480	60.8	V	32.5	6.4	99.7	4.44	2.2	2.24	30	27.76
		70.5	H	32.5	6.4	109.4	14.14	2.2	11.94	30	18.06

Note: Corr. Peak@3m = Raw Peak@3m + Ant. Factor + System Loss

EIRP = Corr. Peak@3m - 95.26

Peak Conducted Output Power = EIRP - Ant. Gain

4.3 Radiated Spurious Emissions

Date Performed: August 24, 2018
Test Standard: RSS-247-Issue 2, RSS-Gen Issue 5
 FCC Subpart C §15.205, 15.209 & 15.247

Required Limits:

1) Radiated emission limits; general requirements.

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

Frequency, <i>f</i> (MHz)	Field strength (dBµV/m)
0.009 – 0.490	$(20*\log(2400/f(\text{kHz}))) + 40 \text{ dB}$
0.490 – 1.705	$(20*\log(24000/f(\text{kHz}))) + 20 \text{ dB}$
1.705 – 30.0	49.5
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
above 960	54.0

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.

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.

IC Restricted Bands:

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.

FCC Restricted Bands:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	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			

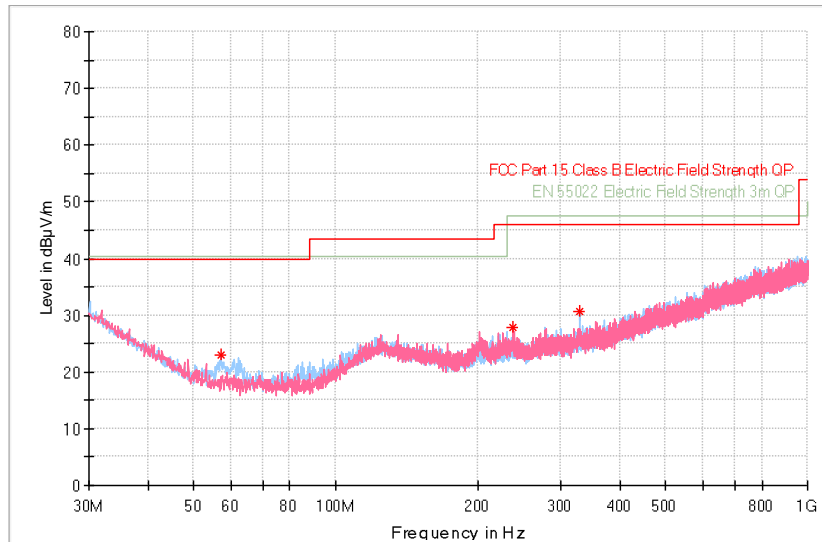
3) §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band 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. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Method of Measurement:

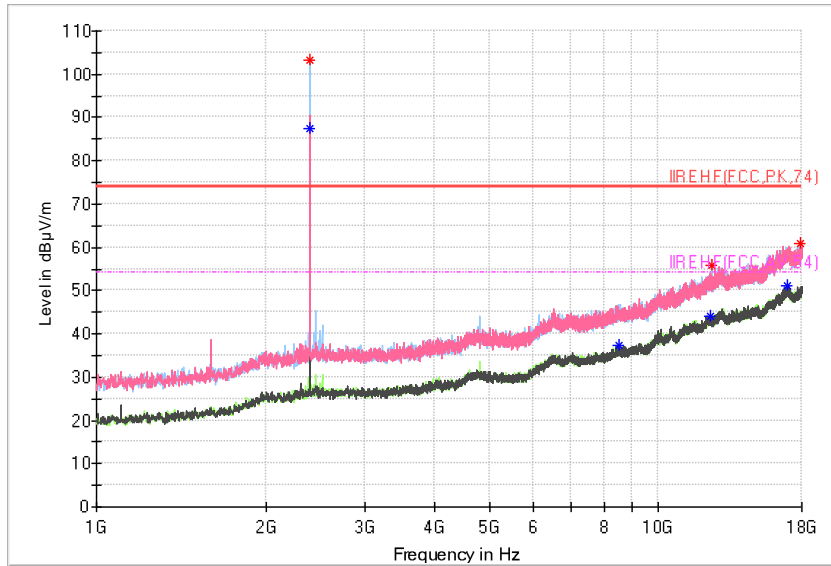
The EUT was tested in our 3 m SAC and was positioned on the center of the turntable. The transmitter was set for continuous transmission. The operating frequency of the device was measured for all radiated emissions 10 kHz to 4 GHz up to the 10th harmonic of the highest fundamental frequency. The EUT 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.

Result: The EUT complies with the applicable standard.

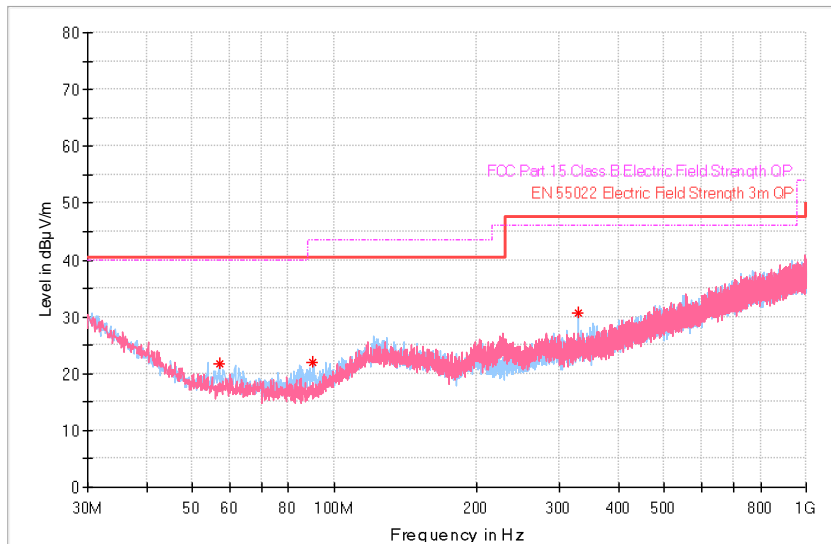
Measurement Data and Plot:



Radiated Spurious Emissions, 30M – 1G Hz, Bluetooth GFSK

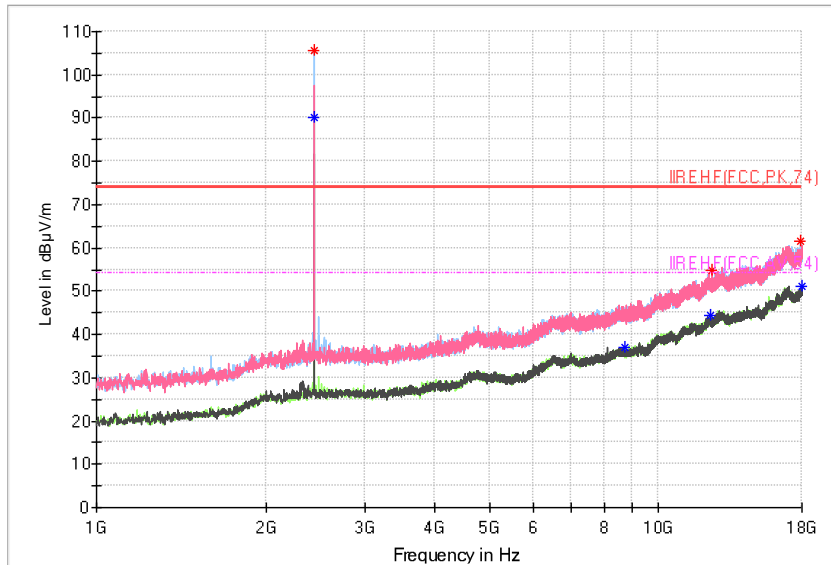


Radiated Spurious Emissions, 1G – 18G Hz, Bluetooth GFSK

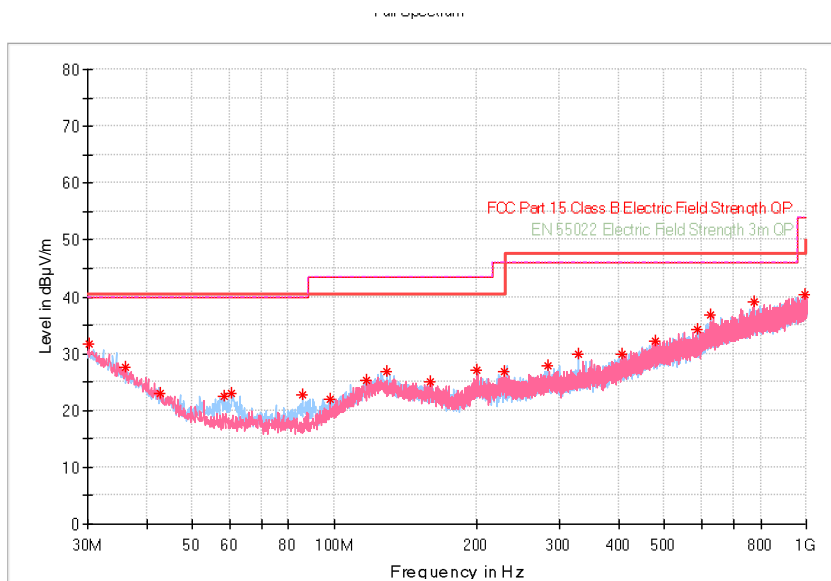


Radiated Spurious Emissions, 30M – 1G Hz, Bluetooth QPSK

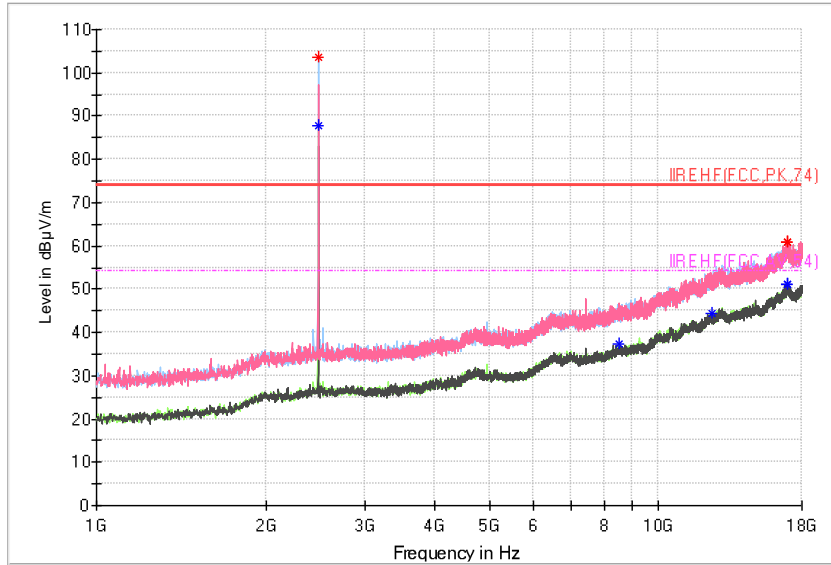
Note: Measurements were also performed from 9 kHz to 30 MHz with an active loop antenna, but no emissions were found in that range.



Radiated Spurious Emissions, 1G – 18G Hz, Bluetooth QPSK



Radiated Spurious Emissions, 30M – 1G Hz, Bluetooth 8PSK



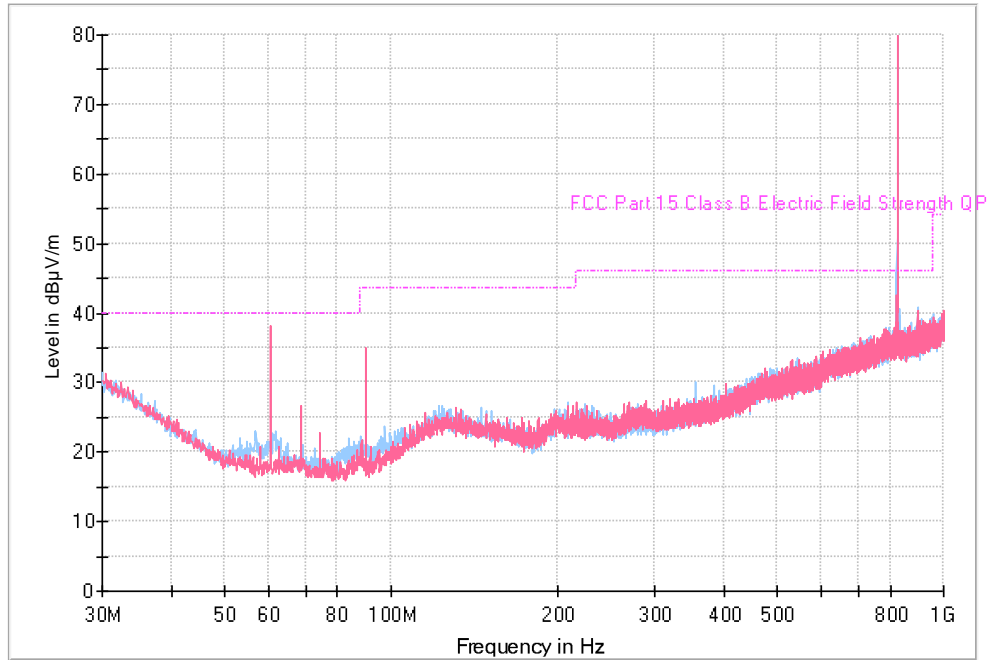
Radiated Spurious Emissions, 1G – 18G Hz, Bluetooth 8PSK

Data, Spurious Emissions of Harmonics

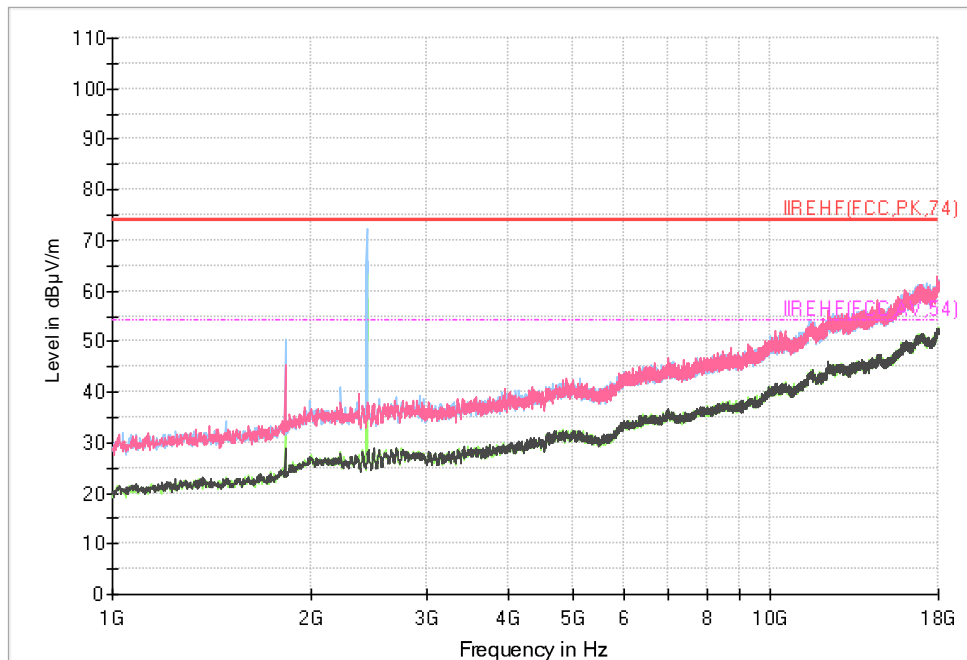
Modulation	Freq.	Peak Raw	Avg. Raw	Pol.	Gain/Loss	Anten. factor	Peak Corr	Avg. Corr.	Peak Limit	Avg. Limit
	MHz	dBuV/m	dBuV/m	V/H	dB	dBm	dBuV/m	dBuV/m	dBuV/m	dBuV/m
Bluetooth GFSK, Low channel	4804	50.7	43	H	-26.14	34.1	58.66	50.96	74	54
	7206	46.5	33.5	V	-22.97	35.6	59.13	46.13	<20dBC	<20dBC
Bluetooth GFSK, Mid channel	4882	46.6	37.3	H	-26.15	34.1	54.55	45.25	74	54
	7323	46.3	35.7	V	-22.53	35.6	59.37	48.77	74	54
Bluetooth GFSK, High channel	4960	47.5	38.5	H	-26.93	34.1	54.67	45.67	74	54
	7440	47.4	36.9	V	-21.43	35.6	61.57	51.07	74	54
Bluetooth QPSK, Low channel	4804	48	37	H	-26.14	34.1	55.96	44.96	74	54
	7206	43	30	V	-22.97	35.6	55.63	42.63	<20dBC	<20dBC
Bluetooth QPSK, Mid channel	4882	44	32	H	-26.15	34.1	51.95	39.95	74	54
	7323	43	30	V	-22.53	35.6	56.07	43.07	74	54
Bluetooth QPSK, High channel	4960	47	34	H	-26.93	34.1	54.17	41.17	74	54
	7440	45	32	V	-21.43	35.6	59.17	46.17	74	54
Bluetooth 8-PSK, Low channel	4804	48	37	H	-26.14	34.1	55.96	44.96	74	54
	7206	44	31	V	-22.97	35.6	56.63	43.63	<20dBC	<20dBC
Bluetooth 8-PSK, Mid channel	4882	43	31	H	-26.15	34.1	50.95	38.95	74	54
	7323	44	31	V	-22.53	35.6	57.07	44.07	74	54
Bluetooth 8-PSK, High channel	4960	48	35	H	-26.93	34.1	55.17	42.17	74	54
	7440	46	33	V	-21.43	35.6	60.17	47.17	74	54

Spurious Emissions of Radio Collocation Data:

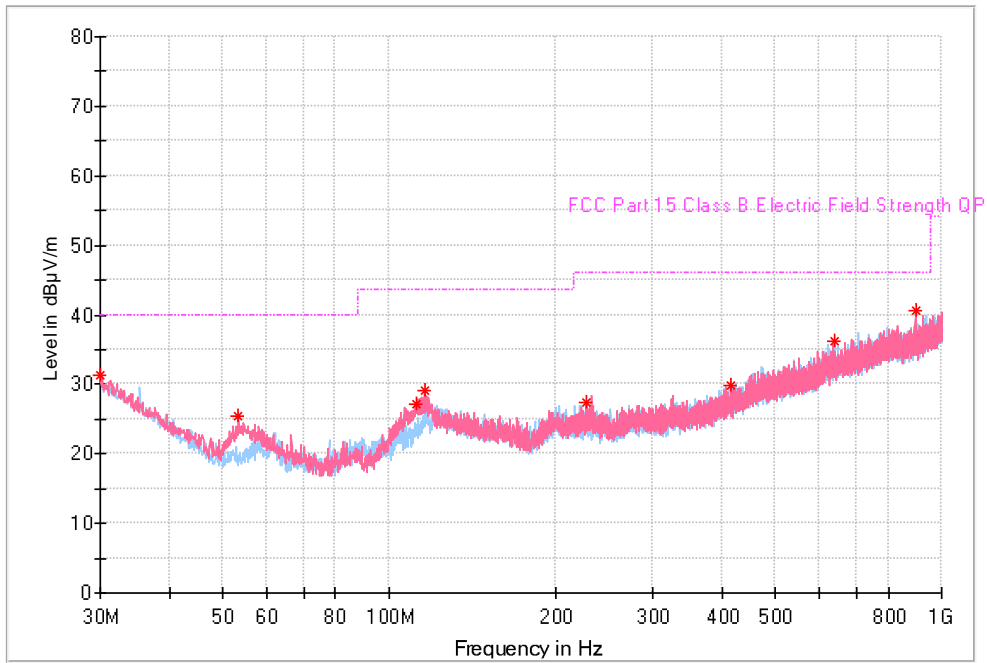
There were no intermodulation frequencies detected during the simultaneous transmission of the two radio modules. Peaks showing in the plots are harmonics of the fundamental frequencies, which are at least 20 dB below the limits.



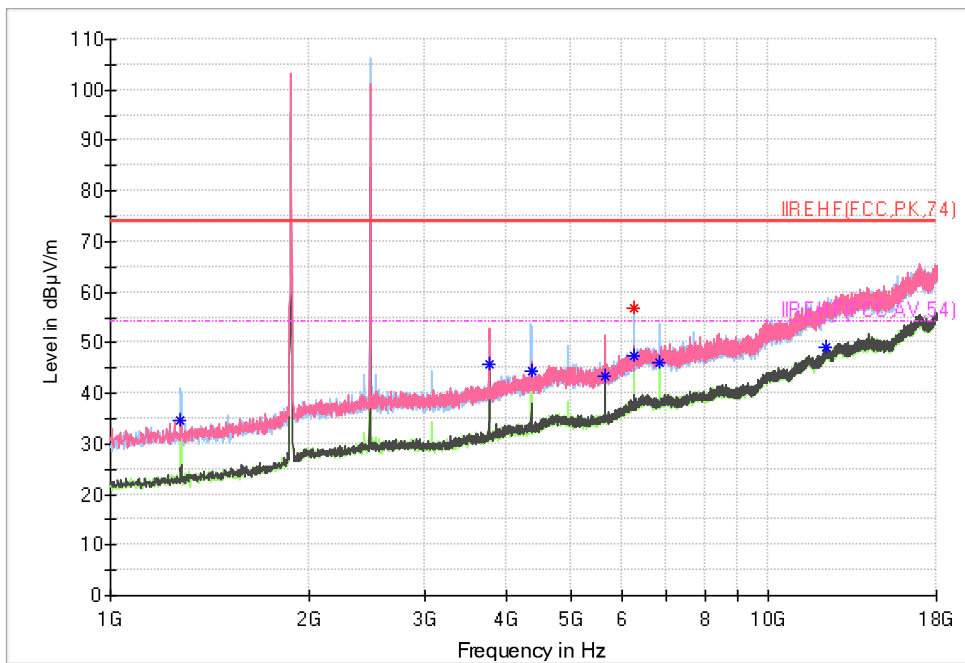
Spurious Emissions of Radio Collocation, 30M – 1G Hz, Bluetooth & 2G Tx on



Spurious Emissions of Radio Collocation, 1G– 18G Hz, Bluetooth & 2G Tx on



Spurious Emissions of Radio Collocation, 30M – 1G Hz, Bluetooth & 3G Tx on



Spurious Emissions of Radio Collocation, 1G– 18G Hz, Bluetooth & 3G Tx on

4.4 20dB Bandwidth

Date Performed: August 24, 2018

Test Standard: RSS-247-Issue 2, RSS-Gen Issue 5; FCC Subpart C §15.247

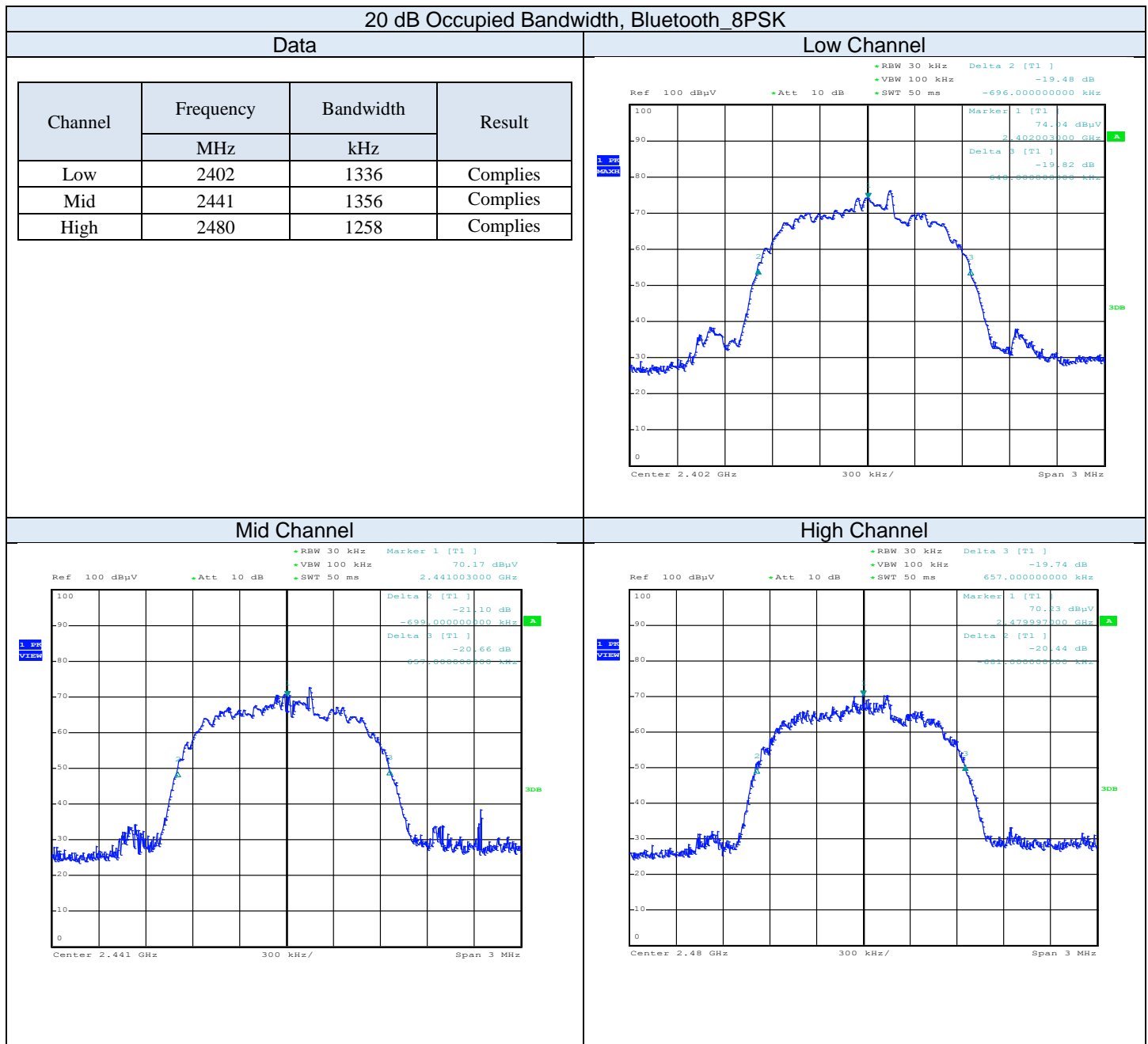
Test Method: ANSI C63.10:2013

Test Requirement: The value of 20 dB bandwidth is not specified in the above standards. The bandwidth is measured and reported.

Measurement Method: As called in ANSI C63.10-2013.

Result: The EUT performed as expected.

Measurement Data and Plot:

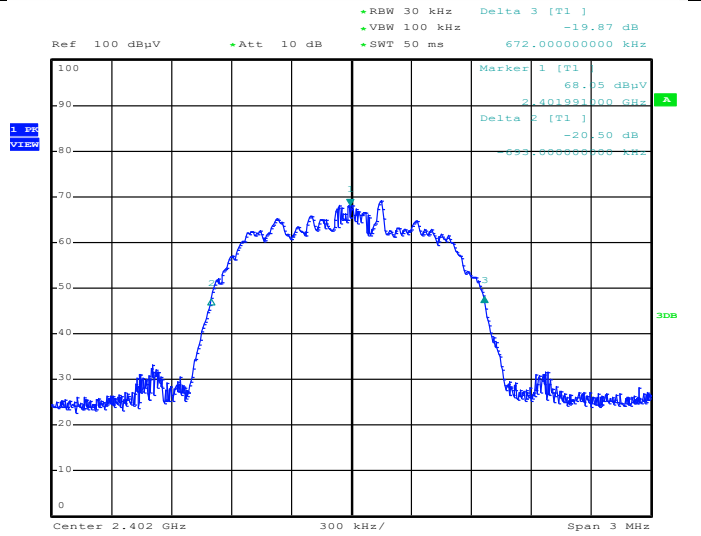


20 dB Occupied Bandwidth, Bluetooth_QPSK

Data

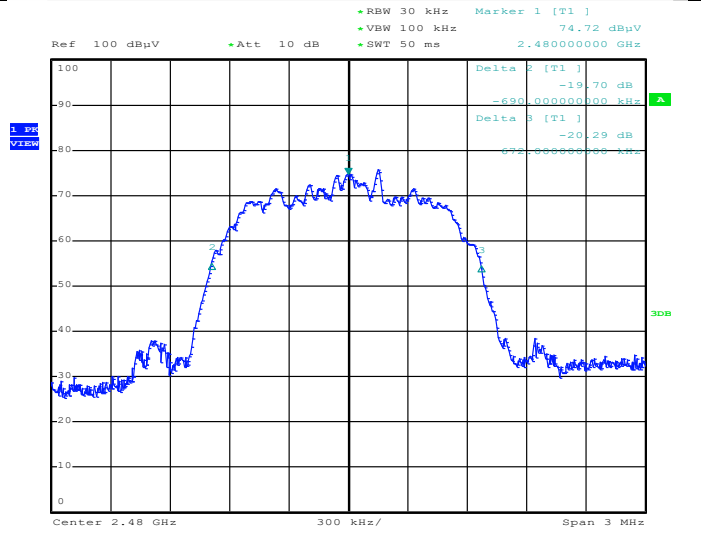
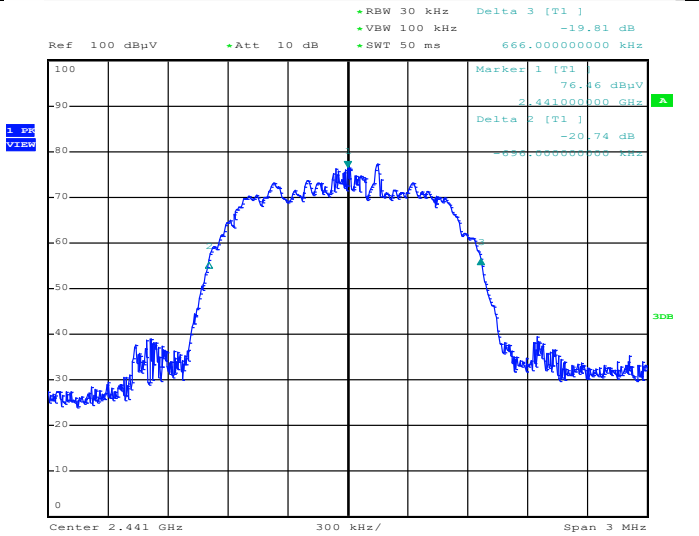
Low Channel

Channel	Frequency	Bandwidth	Result
	MHz	kHz	
Low	2402	1365	Complies
Mid	2441	1362	Complies
High	2480	1362	Complies



Mid Channel

High Channel

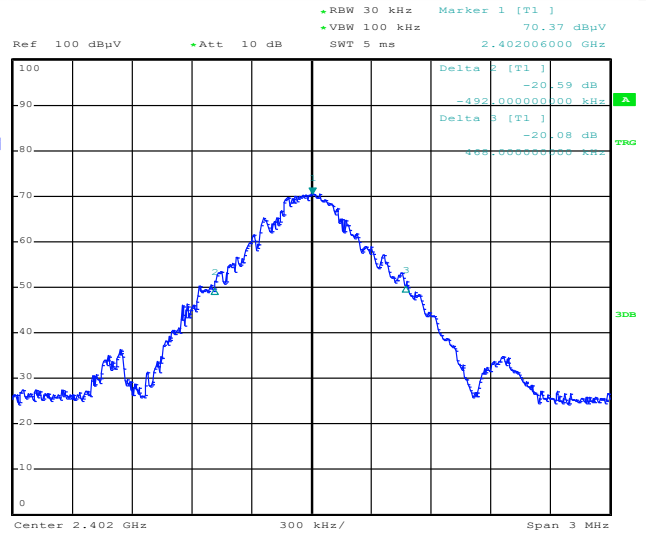


20 dB Occupied Bandwidth, Bluetooth GFSK

Data

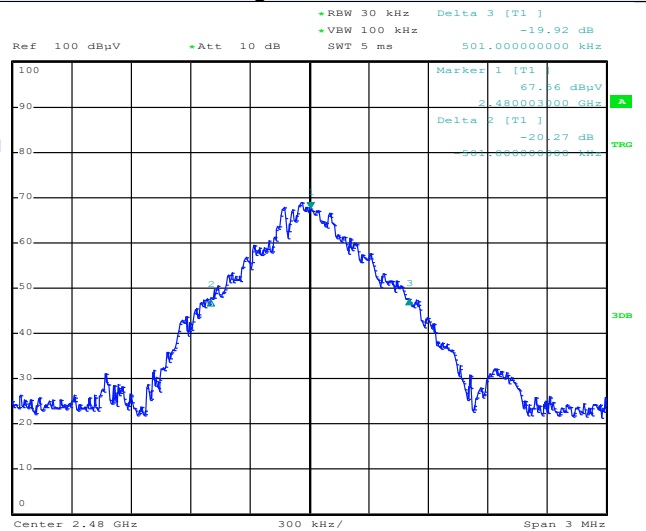
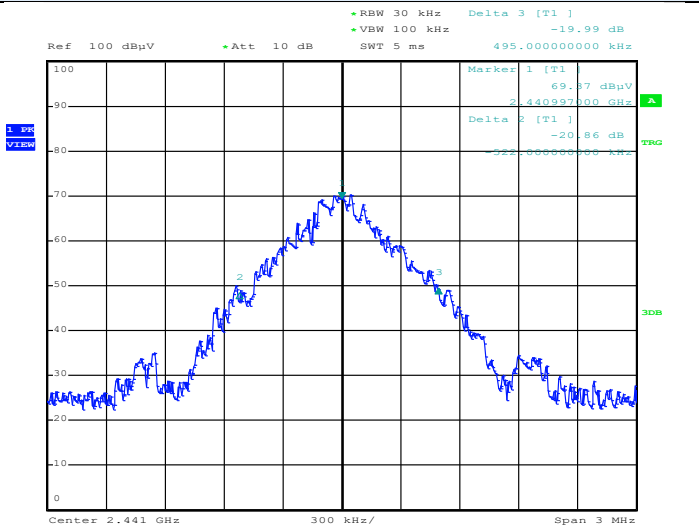
Low Channel

Channel	Frequency	Bandwidth	Result
	MHz	kHz	
Low	2402	952	Complies
Mid	2441	1017	Complies
High	2480	1002	Complies



Mid Channel

High Channel



4.5 99% Bandwidth

Date Performed: August 24, 2018

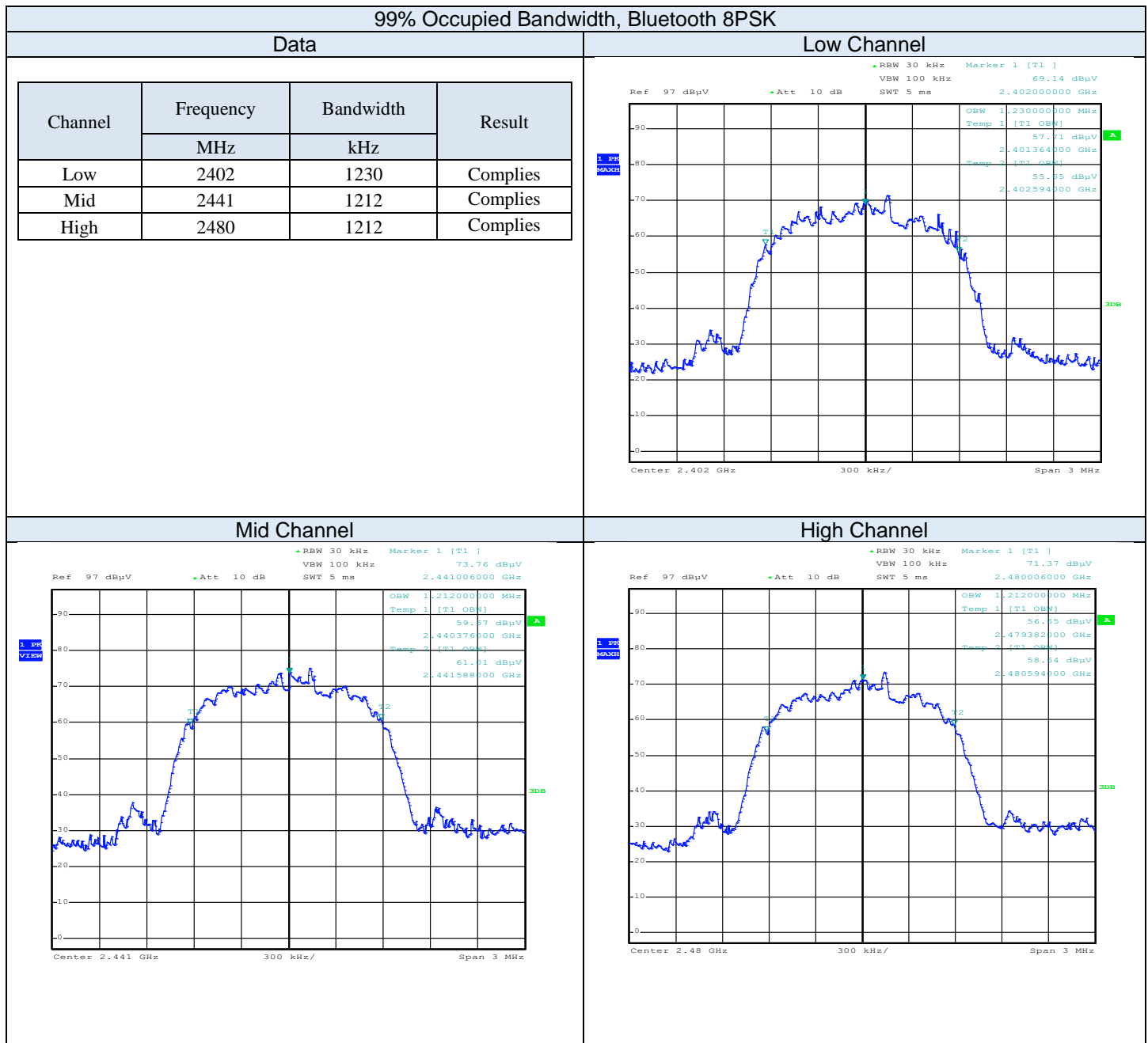
Test Standard: RSS-247 Issue 2, RSS-Gen Issue 5

Minimum Requirement: The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal. The bandwidth shall fall completely within the frequency range specified by the standard.

Measurement Method: As called in ANSI C63.10-2013.

Result: The EUT complies with the applicable standard.

Measurement Data and Plot:

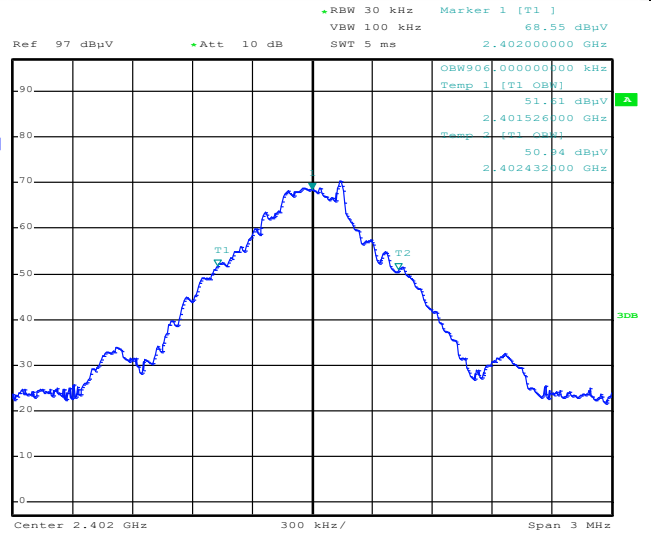


99% Occupied Bandwidth, Bluetooth GFSK

Data

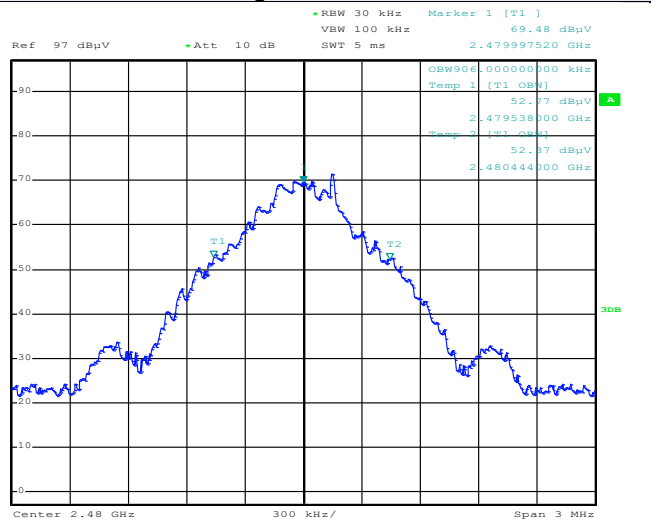
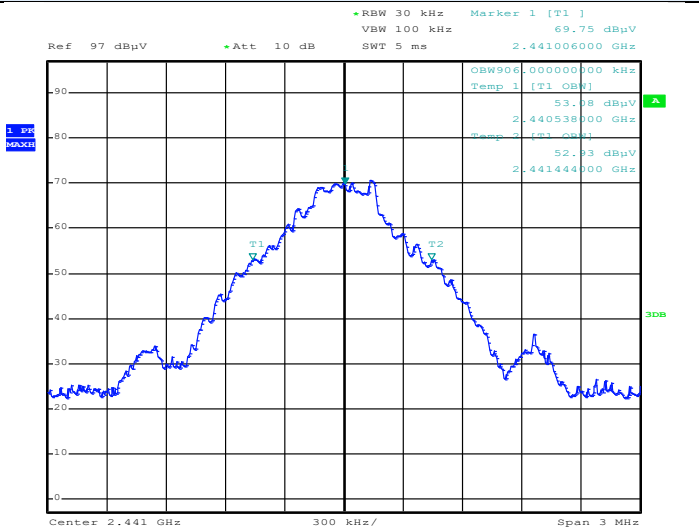
Low Channel

Channel	Frequency	Bandwidth	Result
	MHz	kHz	
Low	2402	906	Complies
Mid	2441	906	Complies
High	2480	906	Complies



Mid Channel

High Channel

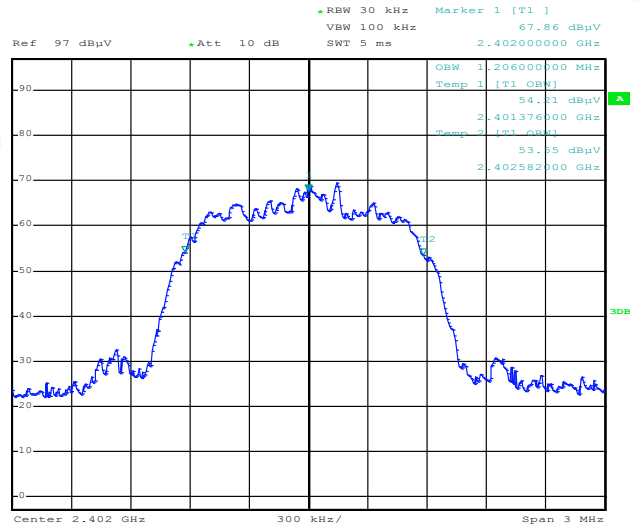


99% Occupied Bandwidth, Bluetooth QPSK

Data

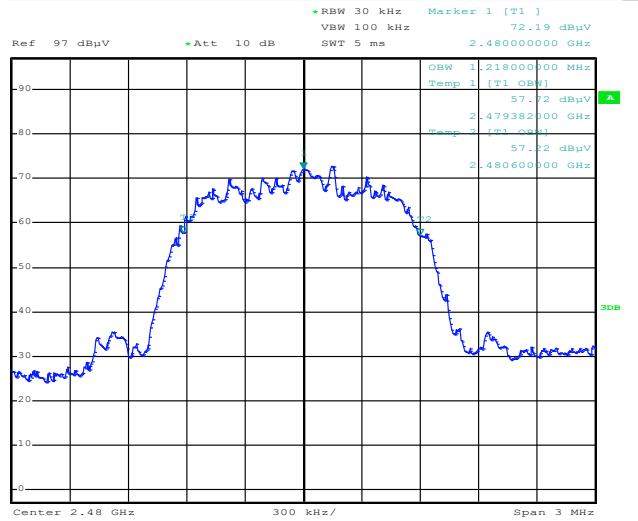
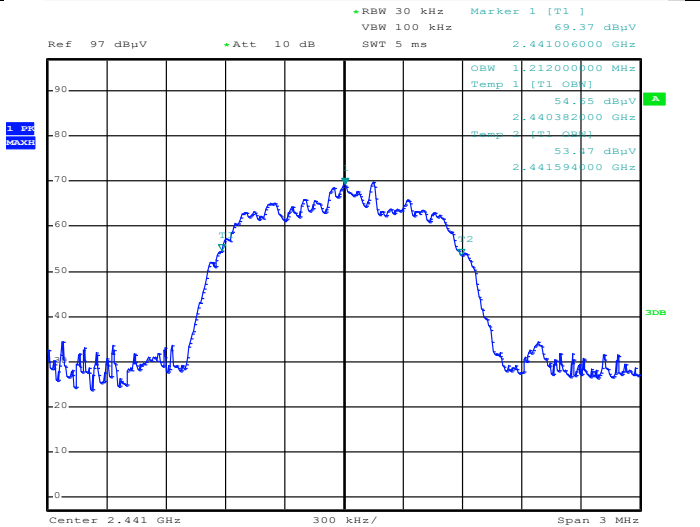
Low Channel

Channel	Frequency	Bandwidth	Result
	MHz	kHz	
Low	2402	1206	Complies
Mid	2441	1212	Complies
High	2480	1218	Complies



Mid Channel

High Channel



4.6 Out of Band Emissions (Band Edge)

Date Performed:

August 24, 2018

Test Standard:

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

Test Method:

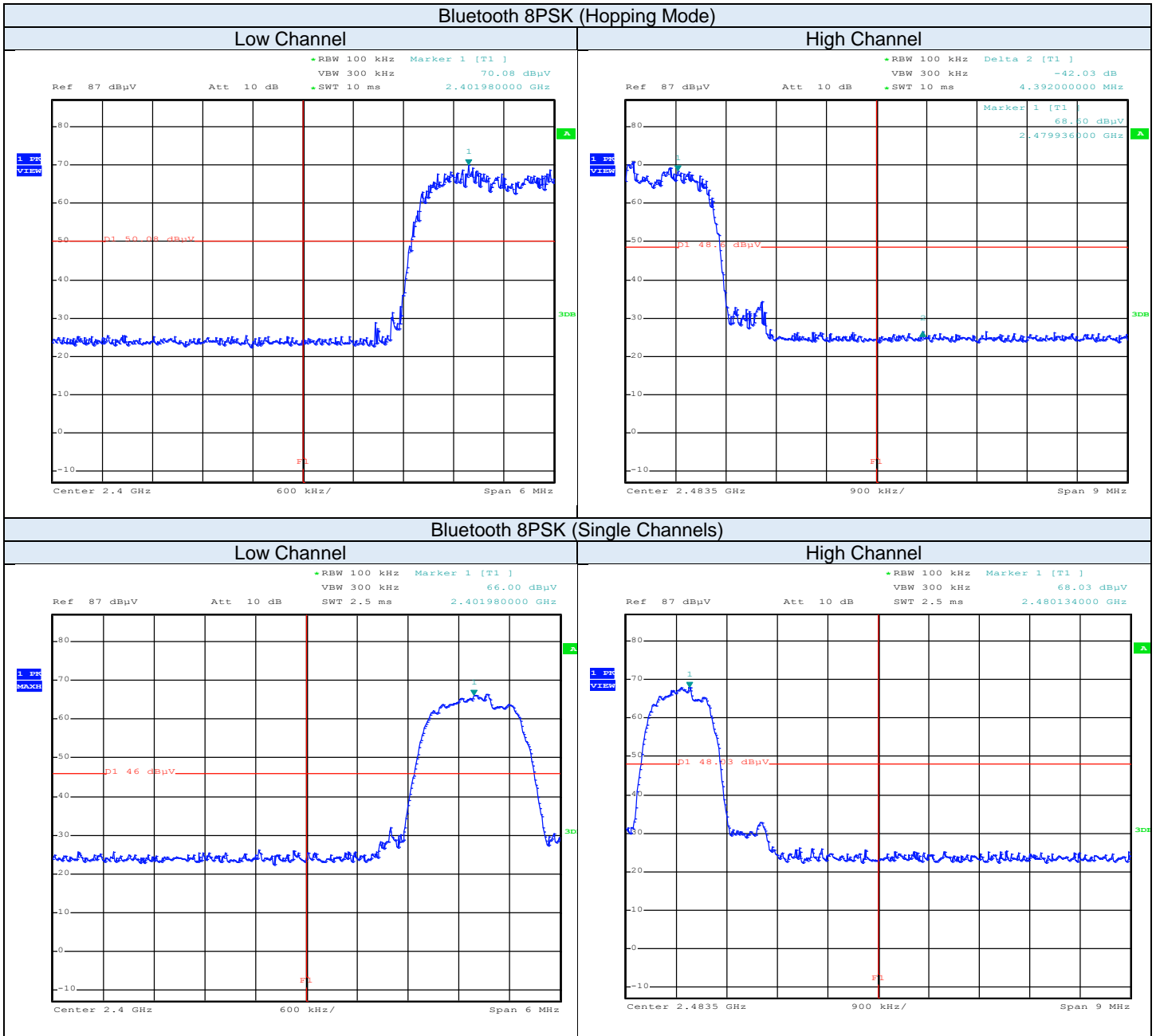
- ANSI C63.10:2013

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.

Result:

The EUT complies with the applicable standard.

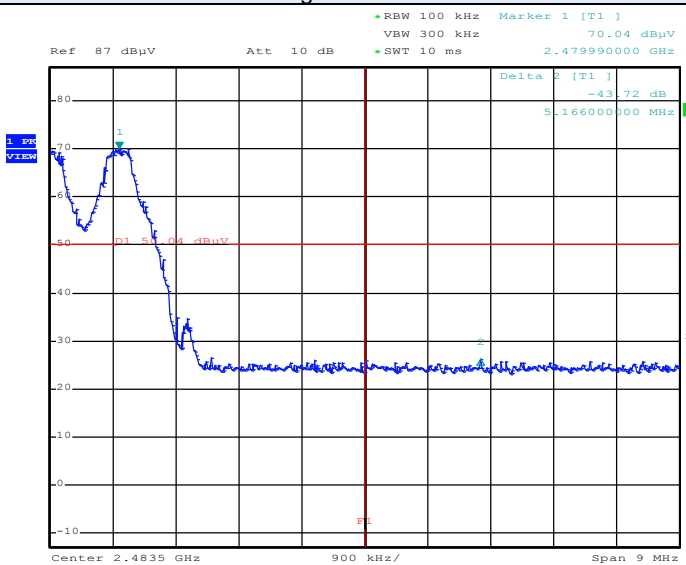
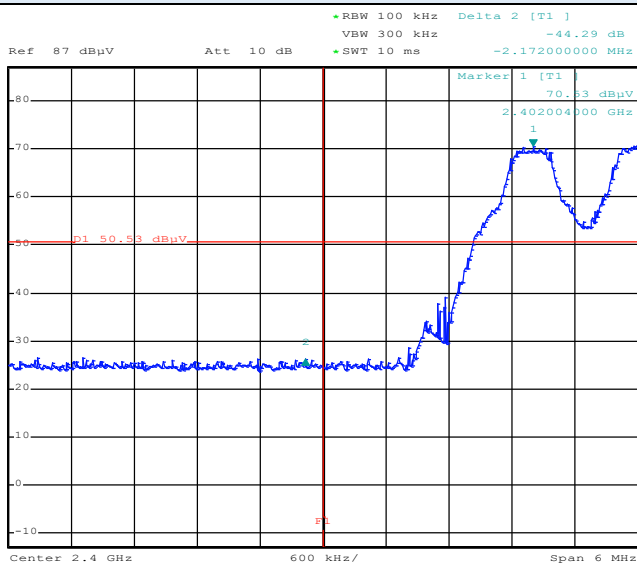
Measurement Data and Plot:



Bluetooth GFSK (Hopping Mode)

Low Channel

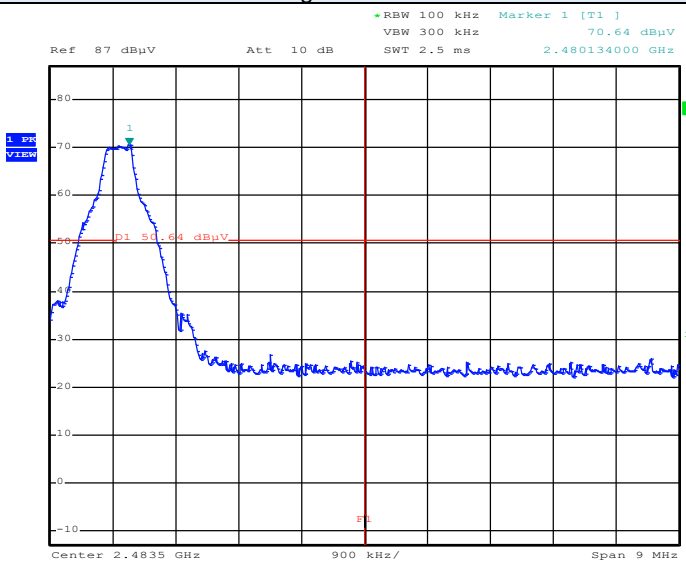
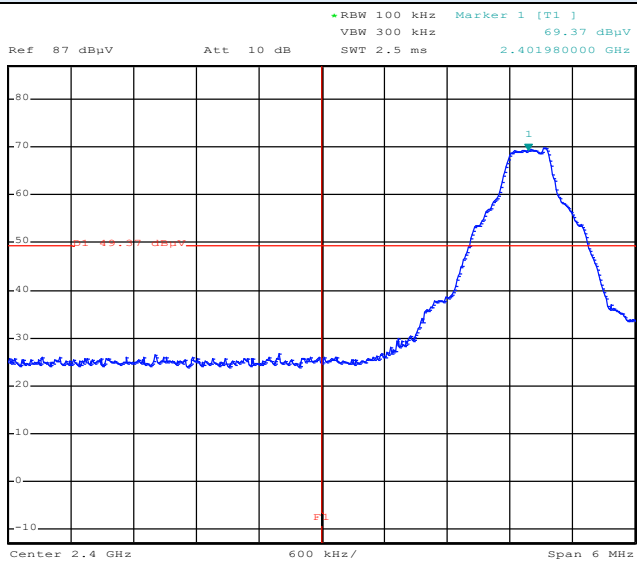
High Channel



Bluetooth GFSK (Single Channels)

Low Channel

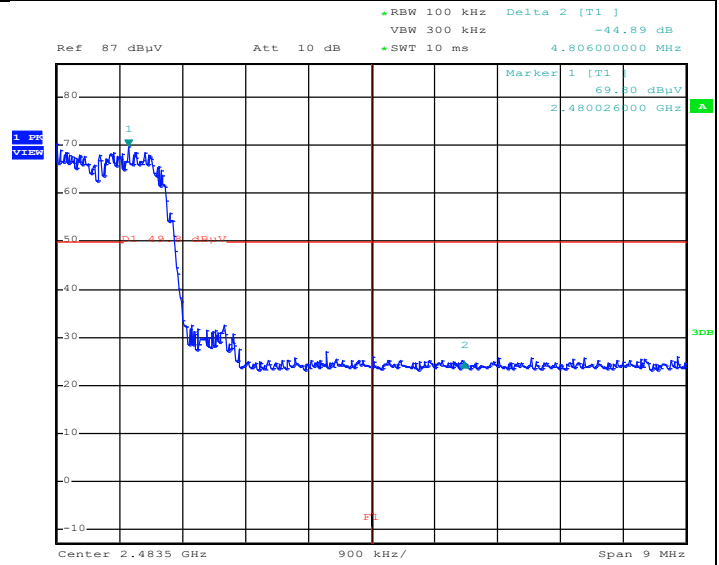
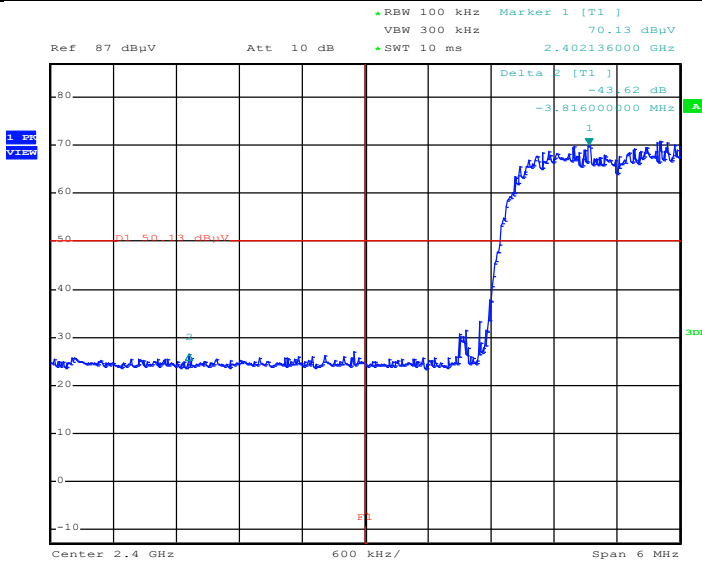
High Channel



Bluetooth QPSK (Hopping Mode)

Low Channel

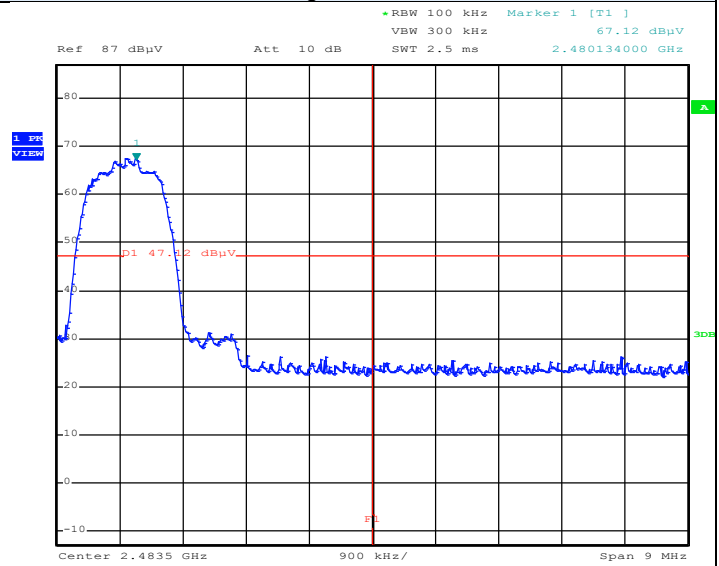
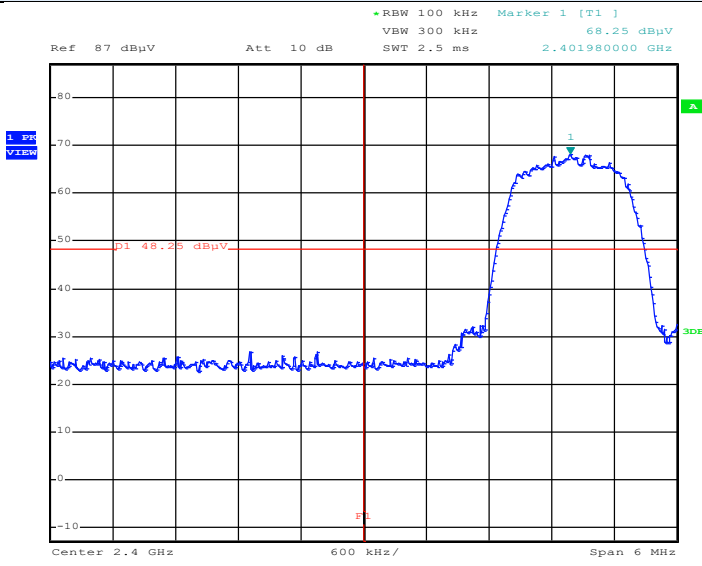
High Channel



Bluetooth QPSK (Single Channels)

Low Channel

High Channel



4.7 Channel Separation

Date Performed: August 24, 2018

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

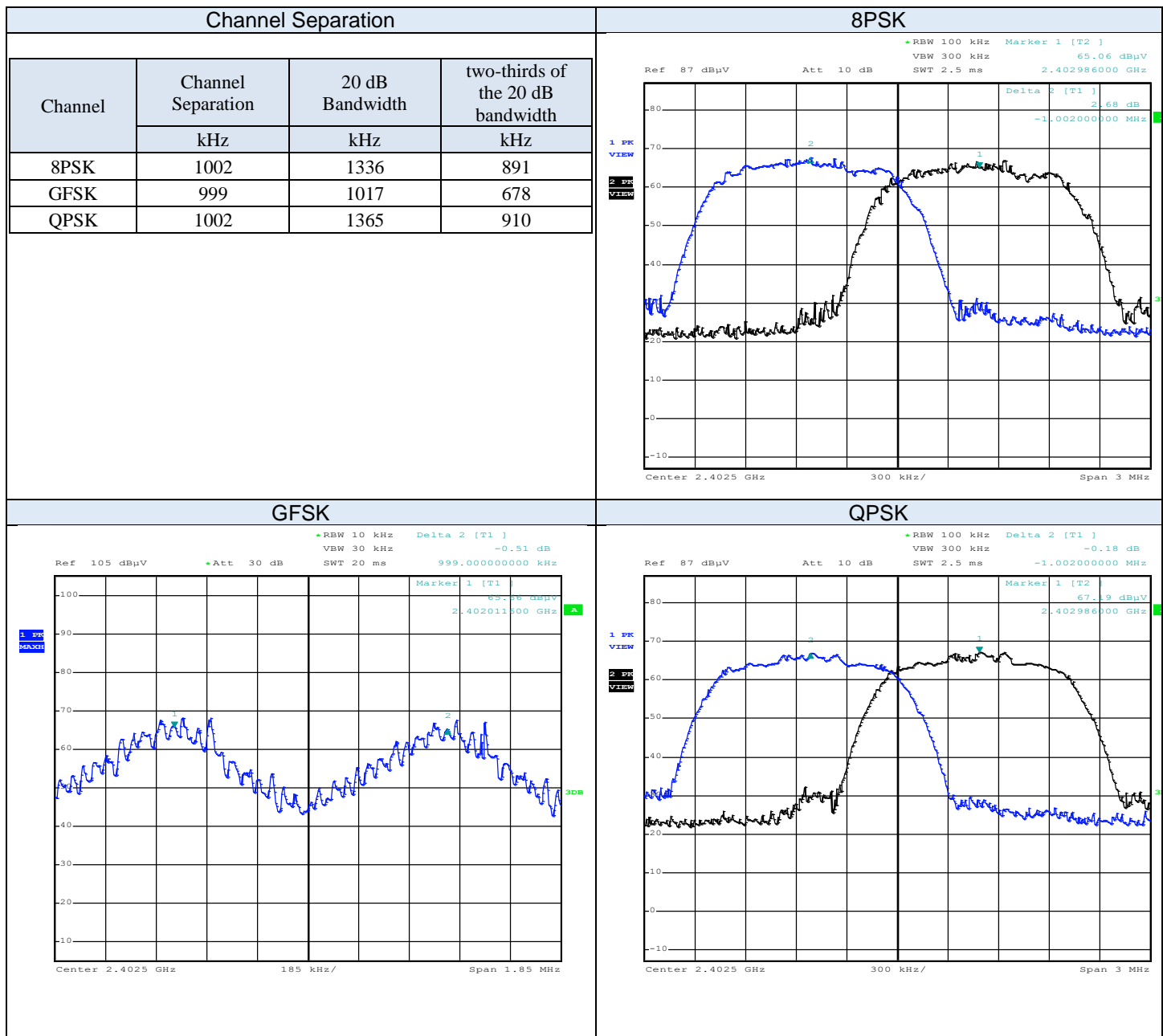
Test Method: ANSI C63.10:2013

Test Requirement: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Measurement Method: As called in ANSI C63.10-2013.

Result: The EUT complies with the applicable standard.

Measurement Data and Plot:



4.8 Number of Hopping Channels

Date Performed:

August 24, 2018

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C - §15.247, RSS-247-Issue 2

Test Method:

- ANSI C63.10:2013

Test Requirement:

The number of Hopping Channels is measured and reported.

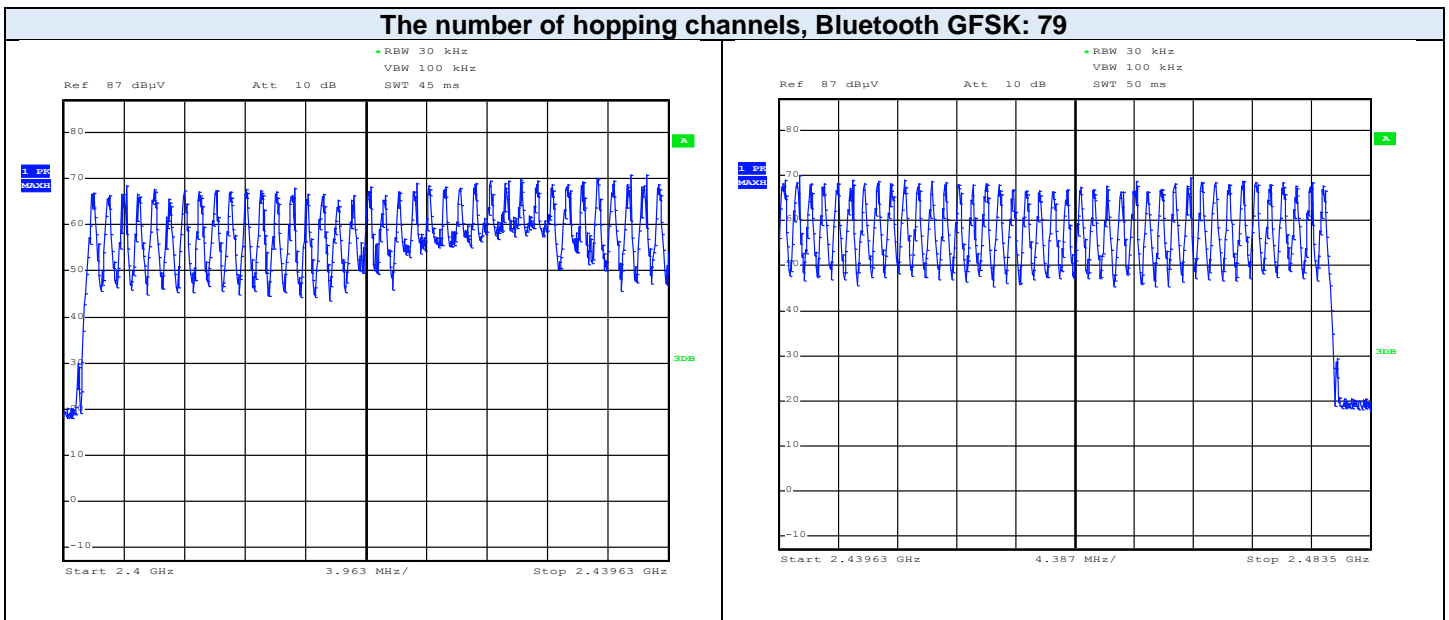
Measurement Method:

As called in ANSI C63.10-2013.

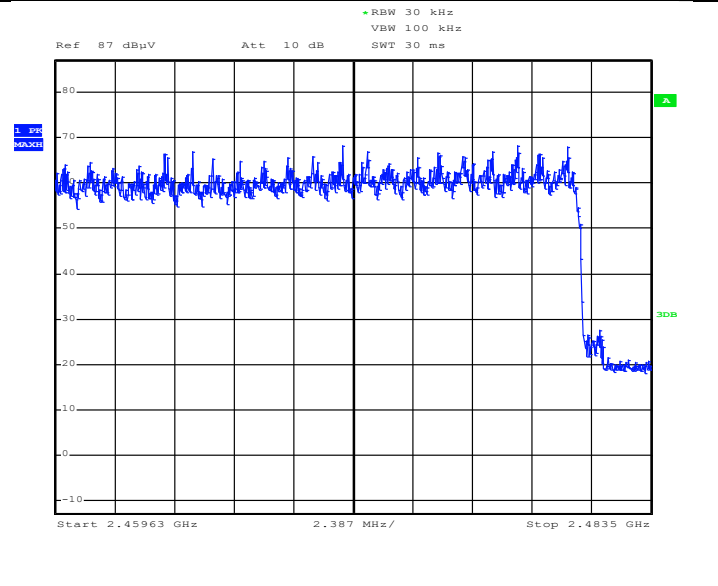
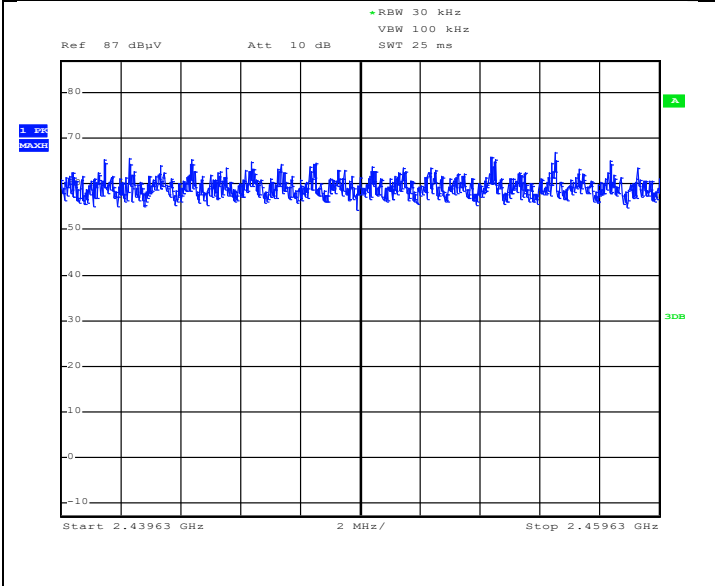
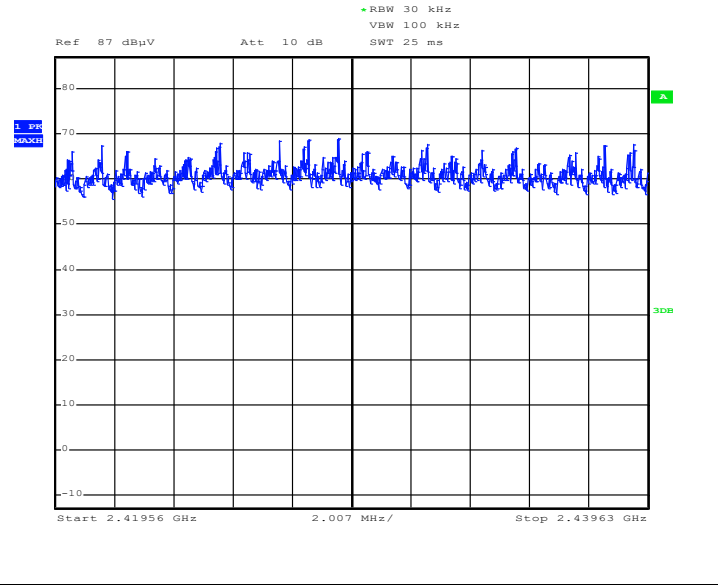
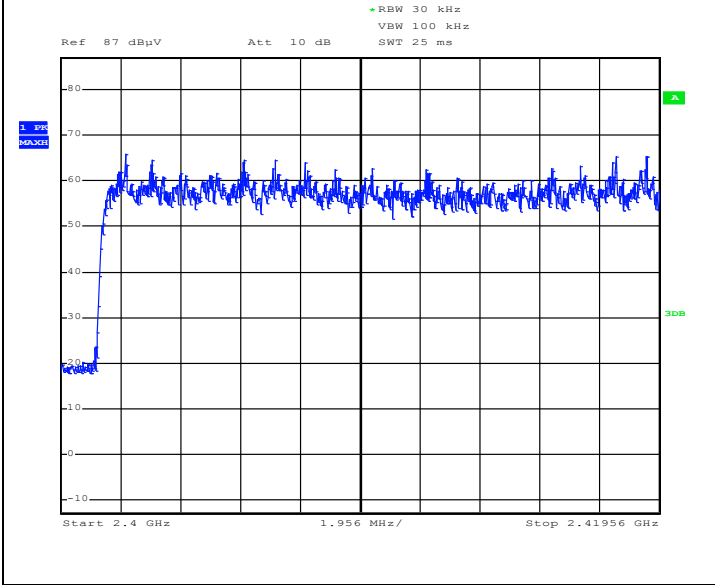
Result:

The EUT complies with the applicable standard.

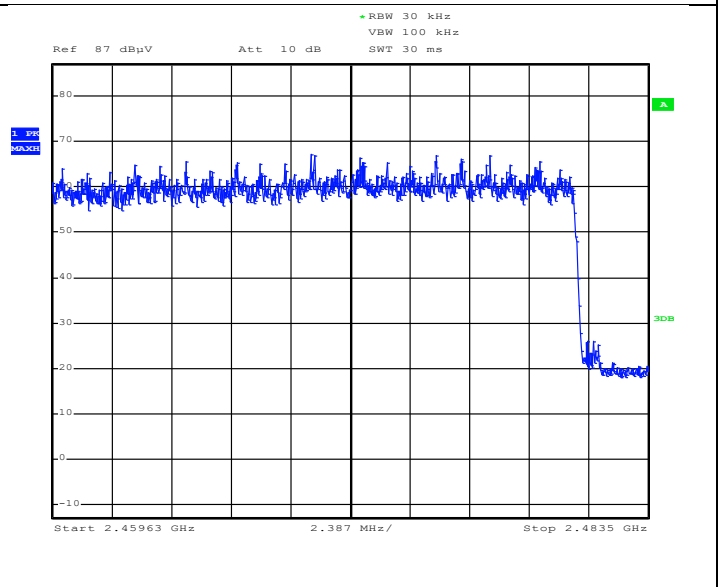
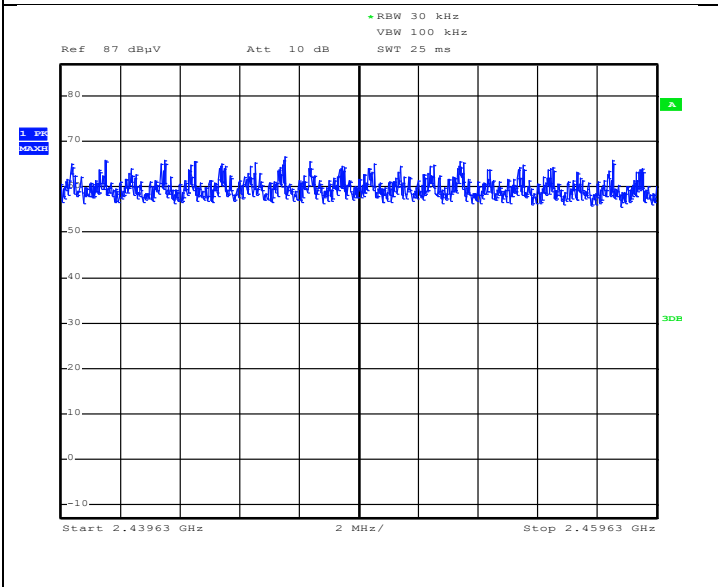
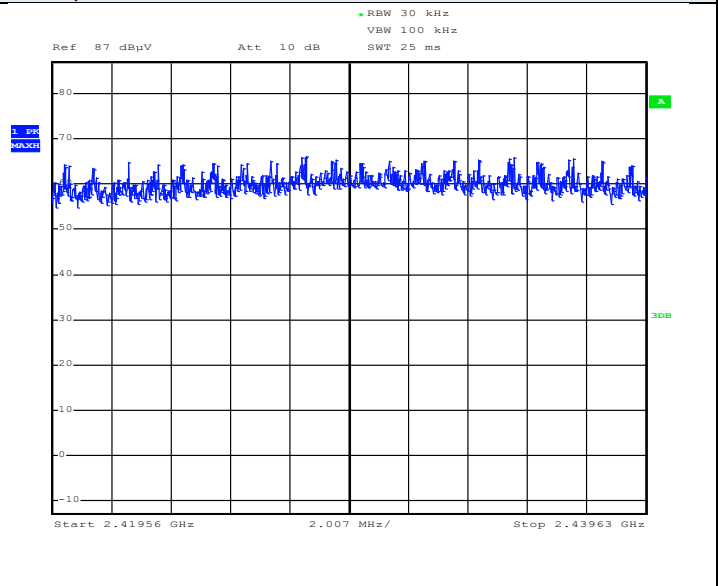
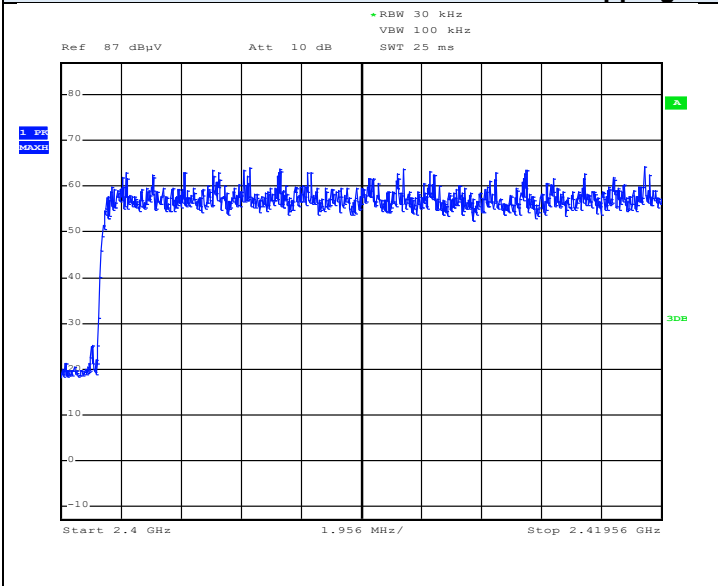
Measurement Data and Plot:



The number of hopping channels, Bluetooth 8PSK: 79



The number of hopping channels, Bluetooth GFSK: 79



4.9 Dwell Time and Time Occupancy Per Frequency

Date Performed: August 24, 2018

Test Standard: FCC Title 47 CFR Part 15: Subpart C - §15.247 (a)(1)(iii), RSS-247-Issue 2

Test Method: ANSI C63.10:2013

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

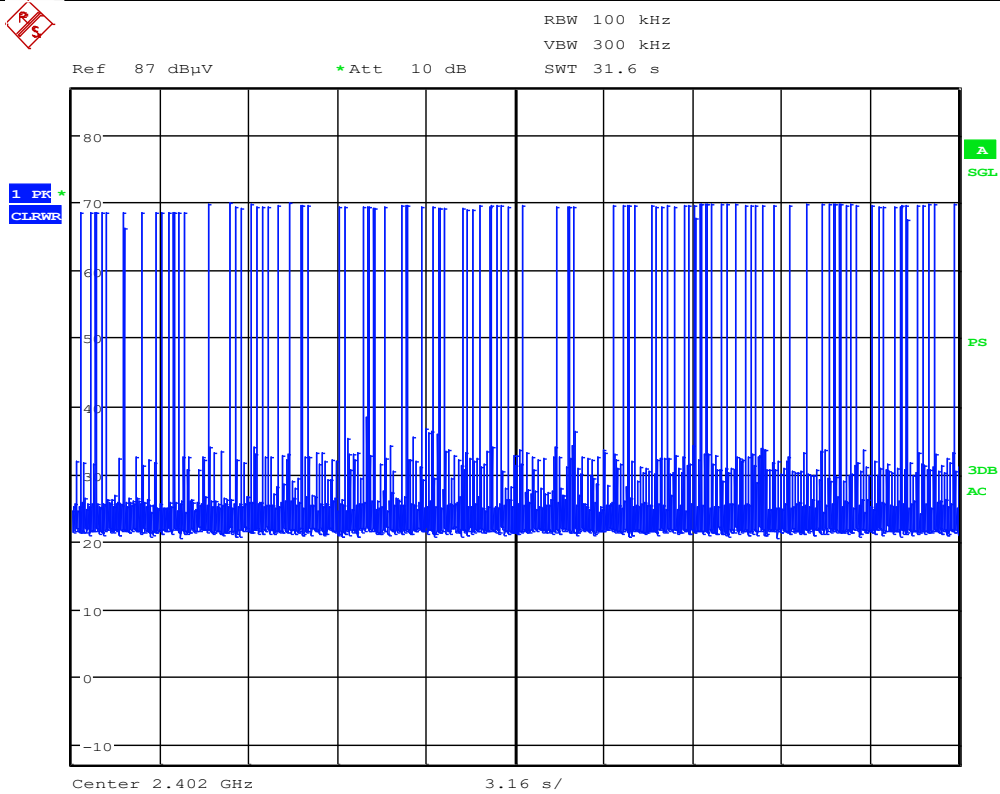
Measurement Method: As called in ANSI C63.10-2013.

Result: The EUT complies with the applicable standard.

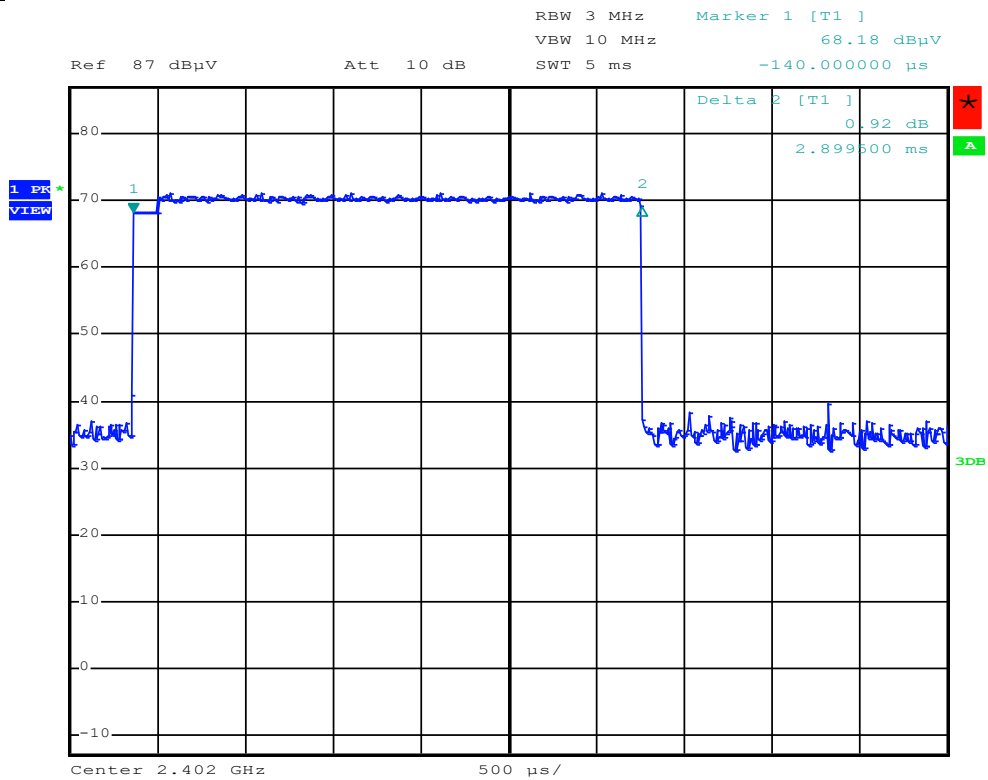
Measurement Data and Plot:

Dwell Time and Time Occupancy Per Frequency, 8PSK: 307 ms

Pulse numbers in 31.6 seconds: 106

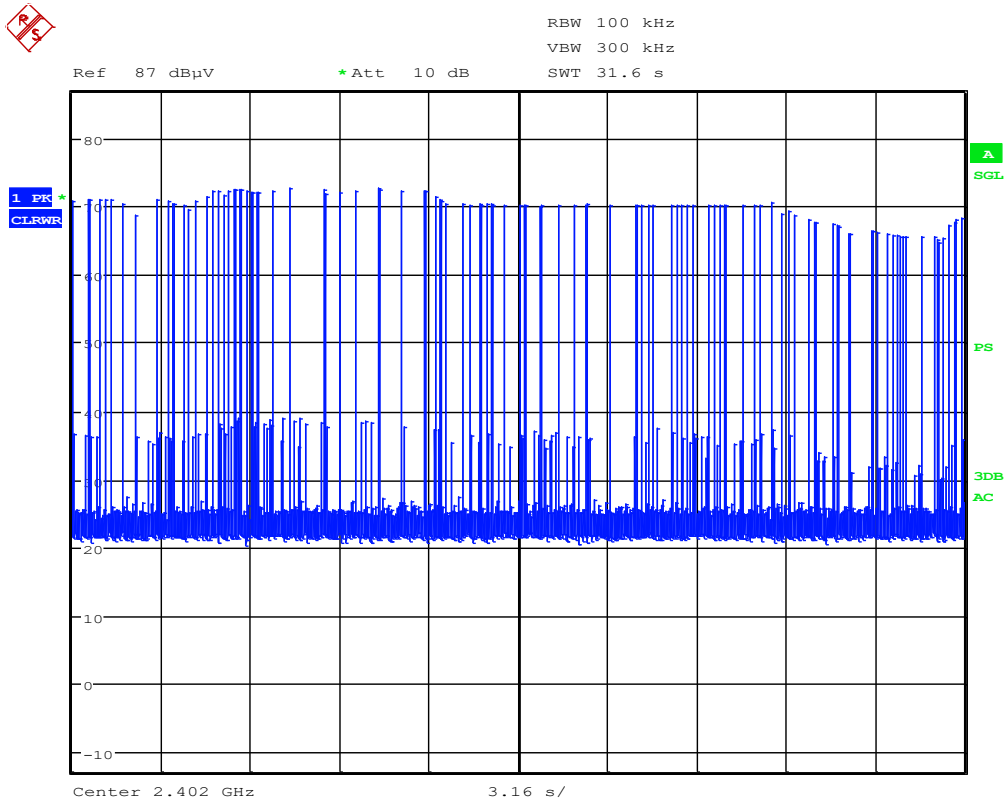


Dwell time per pulse: 2.8995 ms

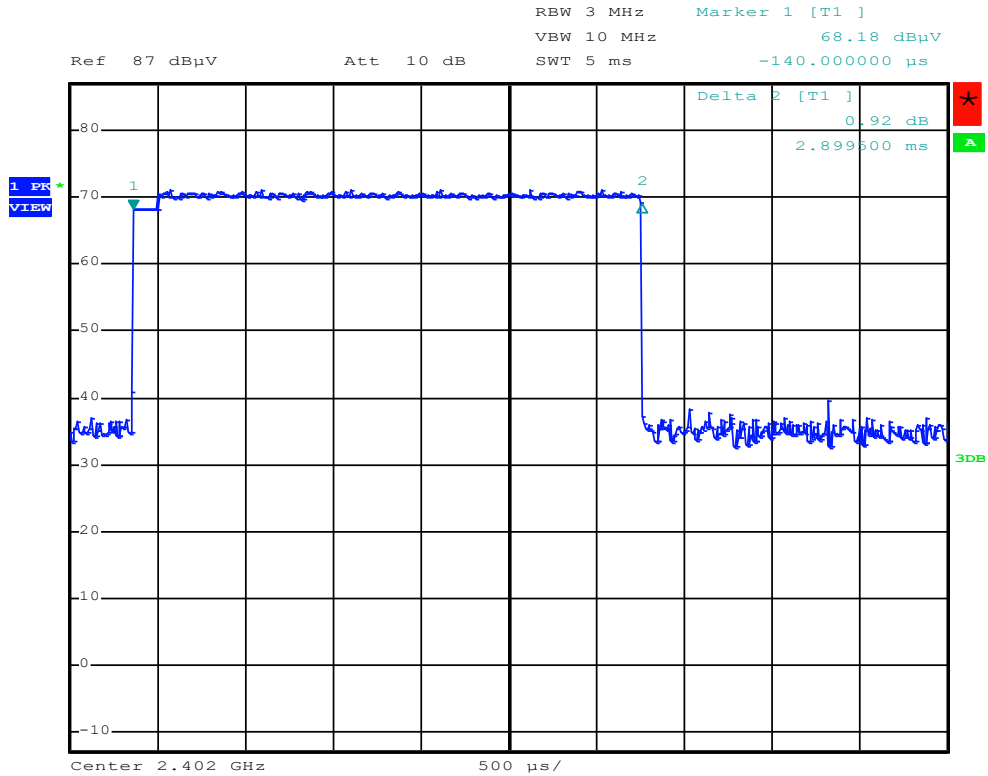


Dwell Time and Time Occupancy Per Frequency, GFSK: 305ms

Pulse numbers in 31.6 seconds: 105

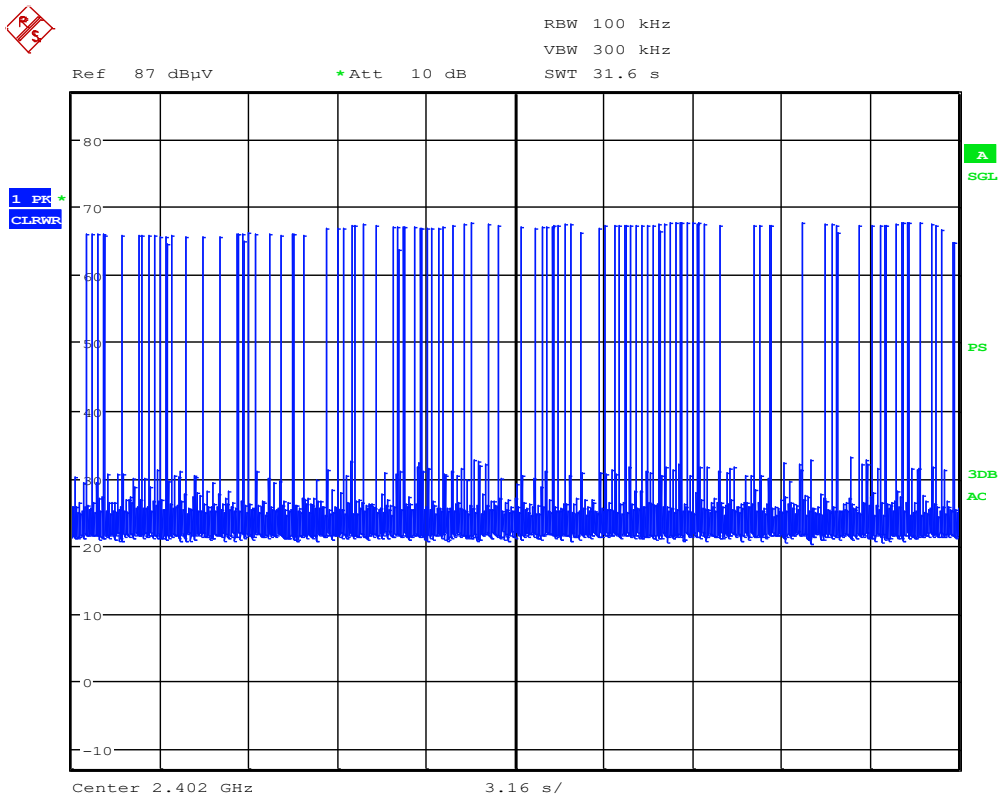


Dwell time per pulse: 2.8995 ms

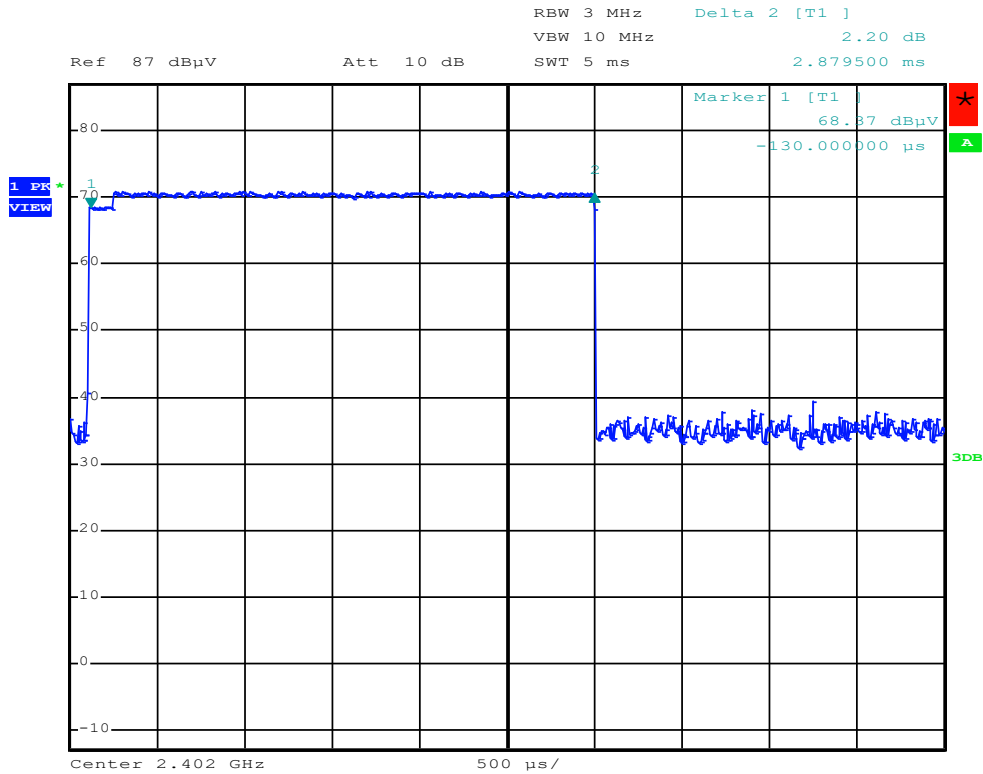


Dwell Time and Time Occupancy Per Frequency, QPSK: 308 ms

Pulse numbers in 31.6 seconds: 107



Dwell time per pulse: 2.8795ms



4.10 Unintentional Radiated Emissions

Date Performed:

August 17, 2018

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 (dB μ V/m)
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
above 960	54.0

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.

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.

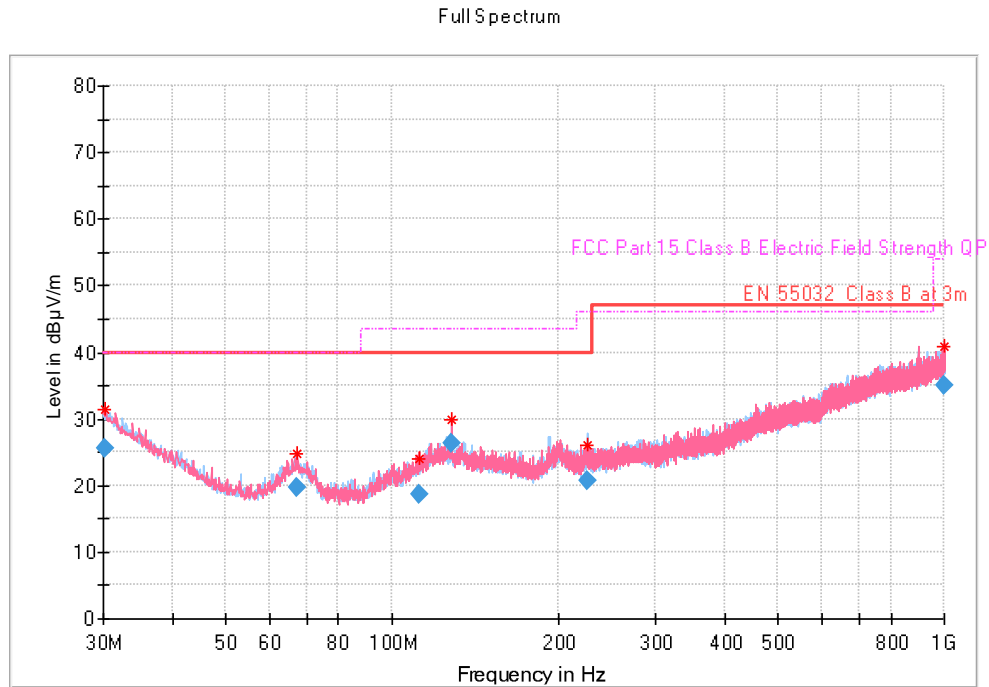
Emissions in both horizontal and vertical polarizations were measured while rotating the Equipment Under Test (EUT) on the turntable to maximize signal strength. In the case of high ambient noises, the measurements are performed at a closer distance and the limit is adjusted per the equation below. The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

$$20 \log \left(\frac{D1}{D2} \right); \quad \text{Where } \begin{array}{l} D1 = \text{Current Distance} \\ D2 = \text{Required Distance} \end{array}$$

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:



30MHz – 1GHz Unintentional Radiated Emissions scanned at 3m SAC, Class B limit

Unintentional radiated spurious emissions measurement dataMA

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.117768	25.64	1000.000	120.000	167	V	39	28.4	14.36	40
67.05944	19.77	1000.000	120.000	110	V	9	16	20.23	40
111.93528	18.65	1000.000	120.000	233	V	94	21	24.85	43.5
127.98608	26.41	1000.000	120.000	195	V	230	22.3	17.09	43.5
225.27212	20.72	1000.000	120.000	236	H	247	20	25.28	46
999.66942	35.11	1000.000	120.000	316	V	318	34.6	20.89	56
30.117768	25.64	1000.000	120.000	167	V	39	28.4	14.36	40

4.12 AC Mains Conducted Emissions

Date Performed:

August 17, 2018

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 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	66 to 56	56 to 46
0.50 – 5	56	46
5.0 – 30.0	60	50

Note 1: The lower limit shall apply at the transition frequencies.

Method of Measurement:

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

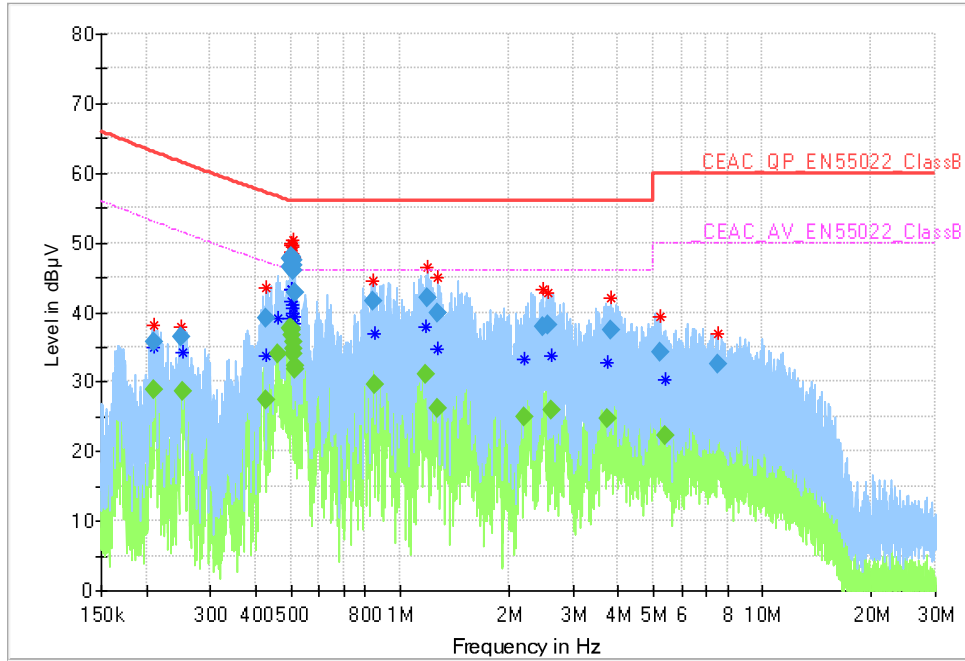
Modifications:

No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

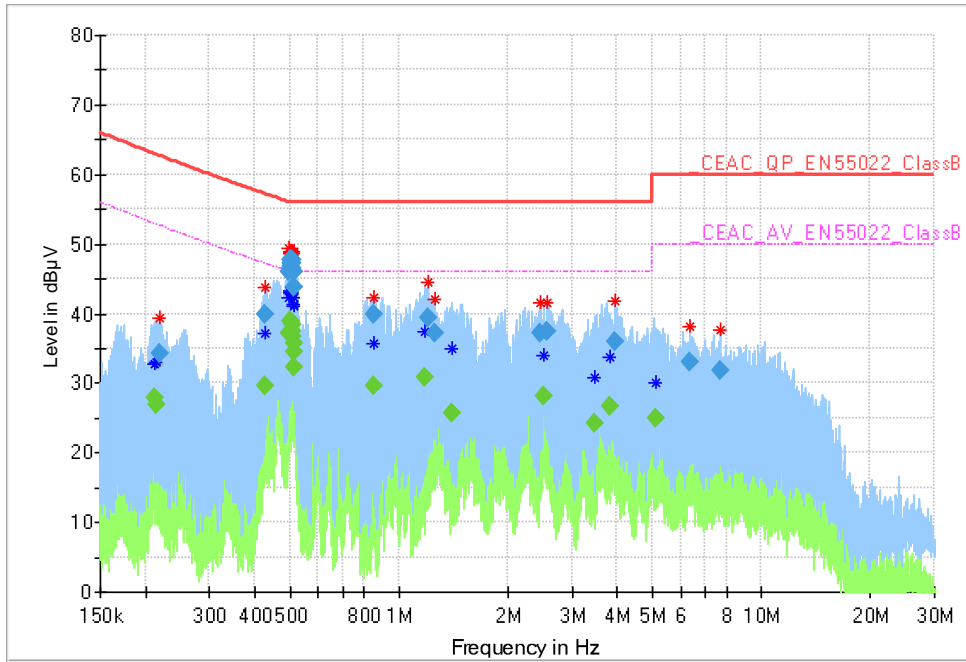
Measurement Data and Plot:



Conducted Emissions – Line 1, 120Vac/60Hz

Conducted Emissions Data – Line 1, 120Vac/60Hz

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Corr. (dB)
0.209028	---	28.77	53.05	24.28	1000.0	9.000	GND	11.0
0.210286	35.81	---	63.03	27.21	1000.0	9.000	GND	11.0
0.250230	36.56	---	61.55	24.99	1000.0	9.000	GND	10.9
0.251735	---	28.65	51.46	22.81	1000.0	9.000	GND	10.9
0.425011	39.04	---	57.26	18.21	1000.0	9.000	GND	10.9
0.428851	---	27.52	47.17	19.65	1000.0	9.000	GND	10.9
0.458553	---	34.00	46.66	12.66	1000.0	9.000	GND	10.9
0.496229	46.44	---	56.06	9.62	1000.0	9.000	GND	10.9
0.499214	47.81	---	56.01	8.20	1000.0	9.000	GND	10.9
0.499214	---	37.76	46.01	8.25	1000.0	9.000	GND	10.9
0.500713	---	37.78	46.00	8.22	1000.0	9.000	GND	10.9
0.500713	47.99	---	56.00	8.01	1000.0	9.000	GND	10.9
0.502216	---	37.35	46.00	8.65	1000.0	9.000	GND	10.9
0.502216	48.03	---	56.00	7.97	1000.0	9.000	GND	10.9
0.503725	---	36.62	46.00	9.38	1000.0	9.000	GND	10.9
0.503725	47.79	---	56.00	8.21	1000.0	9.000	GND	10.9
0.505237	47.51	---	56.00	8.49	1000.0	9.000	GND	10.9
0.505237	---	35.82	46.00	10.18	1000.0	9.000	GND	10.9
0.506755	46.75	---	56.00	9.25	1000.0	9.000	GND	10.9
0.506755	---	34.75	46.00	11.25	1000.0	9.000	GND	10.9
0.508276	45.97	---	56.00	10.03	1000.0	9.000	GND	10.9
0.508276	---	33.94	46.00	12.06	1000.0	9.000	GND	10.9
0.511334	---	32.40	46.00	13.60	1000.0	9.000	GND	10.9
0.512869	42.72	---	56.00	13.28	1000.0	9.000	GND	10.9
0.512869	---	31.81	46.00	14.19	1000.0	9.000	GND	10.9
0.844523	41.60	---	56.00	14.40	1000.0	9.000	GND	11.0
0.849602	---	29.60	46.00	16.40	1000.0	9.000	GND	11.0
1.175685	---	30.99	46.00	15.01	1000.0	9.000	GND	11.0
1.188682	42.13	---	56.00	13.87	1000.0	9.000	GND	11.0
1.273553	39.76	---	56.00	16.24	1000.0	9.000	GND	11.0
1.277378	---	26.26	46.00	19.74	1000.0	9.000	GND	11.1
2.201413	---	24.91	46.00	21.09	1000.0	9.000	GND	11.2
2.469565	37.88	---	56.00	18.12	1000.0	9.000	GND	11.2
2.562602	38.20	---	56.00	17.80	1000.0	9.000	GND	11.2
2.624817	---	25.81	46.00	20.19	1000.0	9.000	GND	11.2
3.727866	---	24.78	46.00	21.22	1000.0	9.000	GND	11.3
3.803136	37.32	---	56.00	18.68	1000.0	9.000	GND	11.3
5.247045	34.20	---	60.00	25.80	1000.0	9.000	GND	11.3
5.369064	---	22.36	50.00	27.64	1000.0	9.000	GND	11.3
7.519391	32.64	---	60.00	27.36	1000.0	9.000	GND	11.5

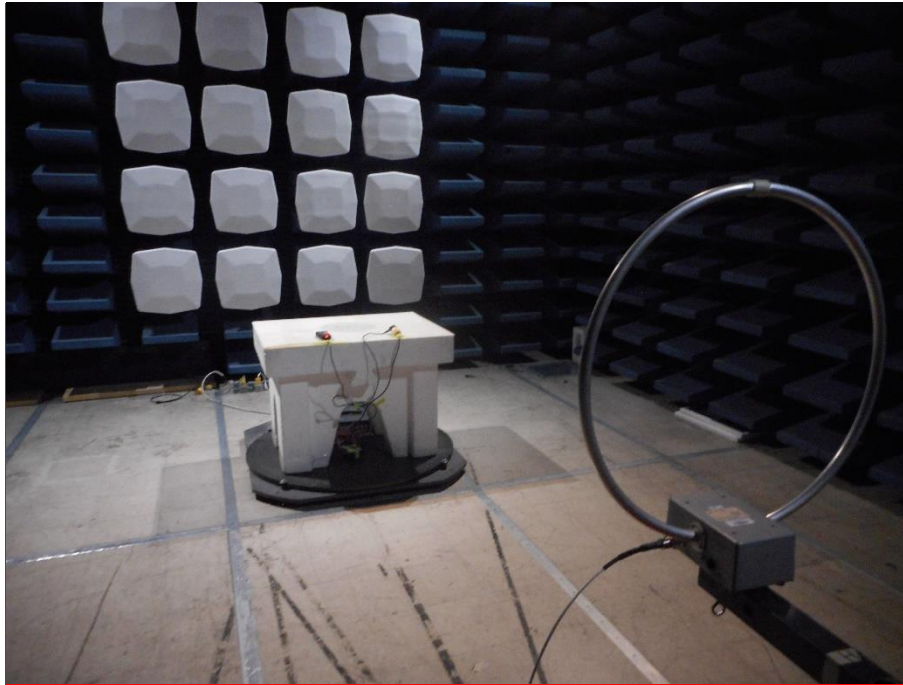


Conducted Emissions – Line 2, 120Vac/60Hz

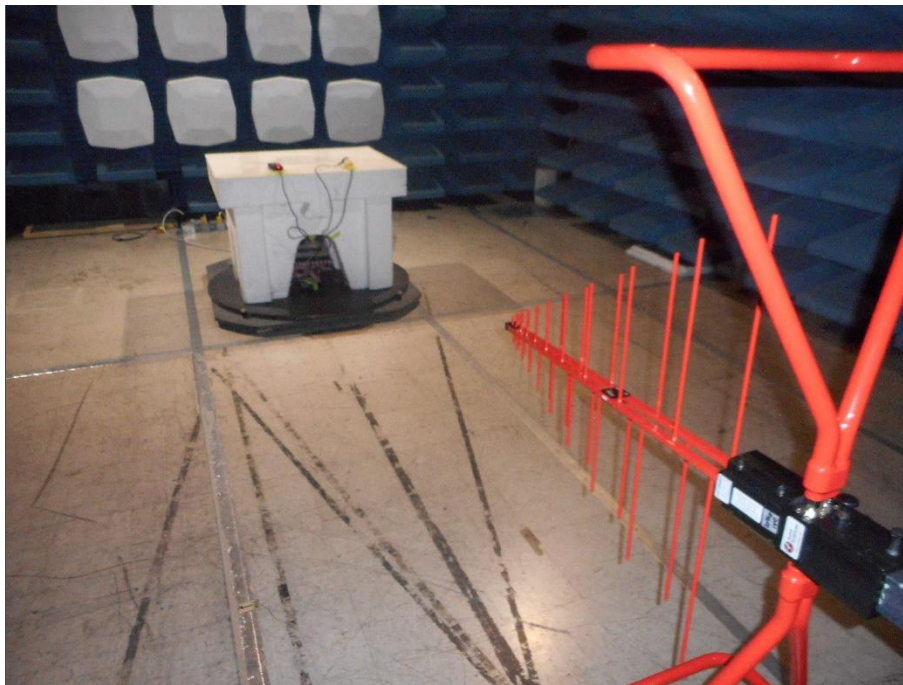
Conducted Emissions Data – Line 2, 120Vac/60Hz

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Corr. (dB)
0.212823	---	27.95	52.89	24.94	1000.0	9.000	GND	11.0
0.214317	---	26.91	52.83	25.92	1000.0	9.000	GND	11.0
0.218426	34.29	---	62.70	28.41	1000.0	9.000	GND	11.0
0.427140	---	29.72	47.20	17.48	1000.0	9.000	GND	10.9
0.428423	39.95	---	57.19	17.24	1000.0	9.000	GND	10.9
0.498715	46.11	---	56.02	9.91	1000.0	9.000	GND	10.9
0.498715	---	37.17	46.02	8.85	1000.0	9.000	GND	10.9
0.500213	46.78	---	56.00	9.22	1000.0	9.000	GND	10.9
0.501715	---	38.85	46.00	7.15	1000.0	9.000	GND	10.9
0.501715	47.15	---	56.00	8.85	1000.0	9.000	GND	10.9
0.503221	47.75	---	56.00	8.25	1000.0	9.000	GND	10.9
0.503221	---	38.95	46.00	7.05	1000.0	9.000	GND	10.9
0.504733	47.75	---	56.00	8.25	1000.0	9.000	GND	10.9
0.504733	---	39.00	46.00	7.00	1000.0	9.000	GND	10.9
0.506248	---	38.34	46.00	7.66	1000.0	9.000	GND	10.9
0.506248	47.61	---	56.00	8.39	1000.0	9.000	GND	10.9
0.507769	47.12	---	56.00	8.88	1000.0	9.000	GND	10.9
0.507769	---	37.44	46.00	8.56	1000.0	9.000	GND	10.9
0.509293	46.58	---	56.00	9.42	1000.0	9.000	GND	10.9
0.509293	---	36.65	46.00	9.35	1000.0	9.000	GND	10.9
0.510823	45.90	---	56.00	10.10	1000.0	9.000	GND	10.9
0.510823	---	35.64	46.00	10.36	1000.0	9.000	GND	10.9
0.512357	---	34.53	46.00	11.47	1000.0	9.000	GND	10.9
0.515439	---	32.35	46.00	13.65	1000.0	9.000	GND	10.9
0.515439	43.70	---	56.00	12.30	1000.0	9.000	GND	10.9
0.848754	---	29.54	46.00	16.46	1000.0	9.000	GND	11.0
0.853859	39.80	---	56.00	16.20	1000.0	9.000	GND	11.0
1.180395	---	30.90	46.00	15.10	1000.0	9.000	GND	11.0
1.200623	39.30	---	56.00	16.70	1000.0	9.000	GND	11.0
1.262148	37.12	---	56.00	18.88	1000.0	9.000	GND	11.0
1.399009	---	25.79	46.00	20.21	1000.0	9.000	GND	11.1
2.467097	37.30	---	56.00	18.70	1000.0	9.000	GND	11.2
2.496866	---	28.02	46.00	17.98	1000.0	9.000	GND	11.2
2.567730	37.47	---	56.00	18.53	1000.0	9.000	GND	11.2
3.458633	---	24.10	46.00	21.90	1000.0	9.000	GND	11.3
3.799337	---	26.62	46.00	19.38	1000.0	9.000	GND	11.3
3.946415	36.06	---	56.00	19.94	1000.0	9.000	GND	11.3
5.138060	---	25.03	50.00	24.97	1000.0	9.000	GND	11.3
6.363437	33.00	---	60.00	27.00	1000.0	9.000	GND	11.4
7.663553	31.91	---	60.00	28.09	1000.0	9.000	GND	11.5

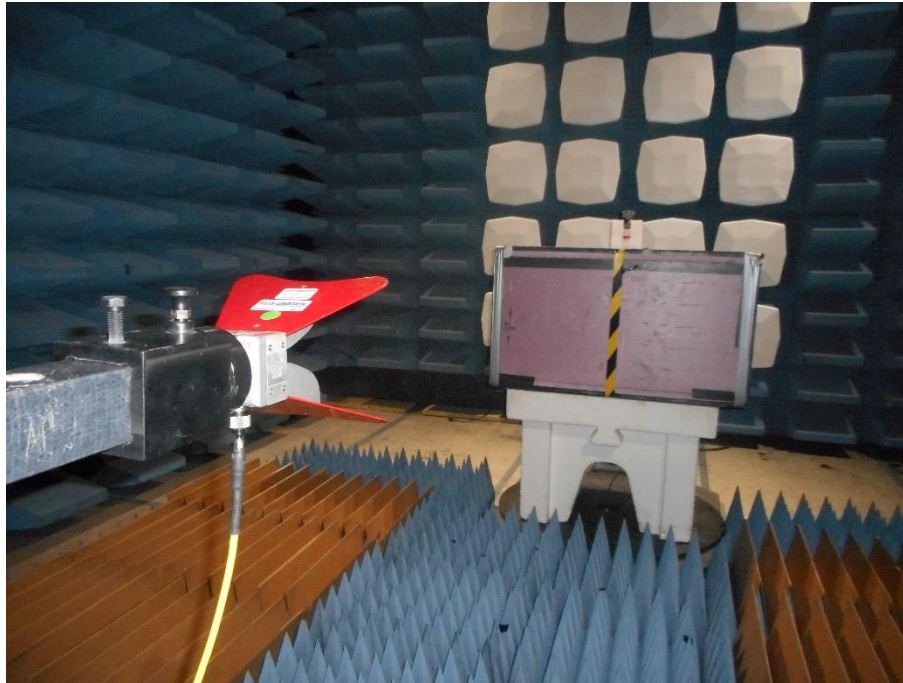
Appendix A: TEST SETUP PHOTOS



Radiated Emissions performed at the 3m SAC, 150kHz – 30MHz



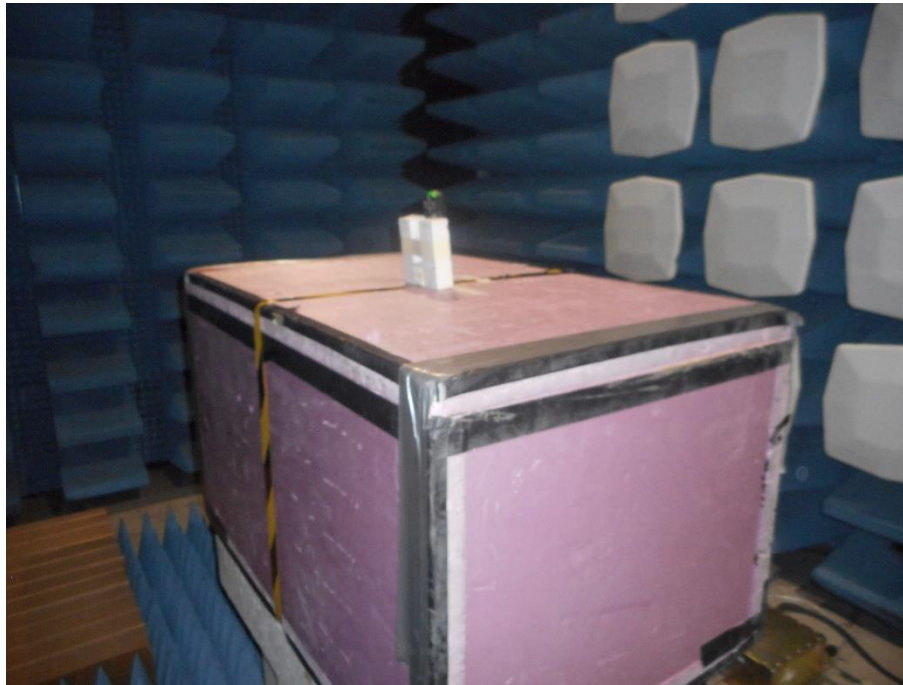
Radiated Emissions performed at the 3m SAC, 30MHz – 1GHz



Radiated Emissions performed at the 3m, 1 -18 GHz



Radiated Emissions performed at the 1m, above 18 -25 GHz



The setup of the EUT at the 3m SAC, above 1 GHz



Conducted Emissions performed at the 3m SAC

Appendix B: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
AM	Amplitude Modulation
CISPR	Comité International Spécial des Perturbations Radioélectriques
DC	Direct Current
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
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