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ELECTROMAGNETIC COMPATIBILITY TEST REPORT

PREPARED FOR Biolux Technology
by QAI LABORATORIES

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

American Association for Laboratory Accreditation Certificate Number: 3657.02

EMC Test Laboratory:	**QAI Laboratories Ltd.**
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Applicable Test Standards:	FCC Title 47 CFR Part 15: Subpart B , 47 CFR18 (305 & 309) FCC Title 47 CFR Part 15: Subpart C - § 15.247 RSS-247 Issue 2, RSS-Gen Issue 5, ICES-003 Issue 6,CFR Title 47 FCC Part 18 Part 18.305 and 18.309, AC mains conducted emissions Part 18.307(b). RF Exposure KDB 447498, RS 102 Issue 5

Equipment Tested	OrthoPulse® Gen 2 with wireless charger
Model Number:	OPi2S-100 / OPi2E-100
FCC ID:	**2A6CA-OPI**
IC Certification Number:	**28421- OPI**
Manufacturer:	Biolux Technology

REVISION HISTORY

Date	Report Number	Rev #	Details	Author
June 15, 2012	E11284-2201_Biolux_FCC_IC_1.1	1.	Added intentional radiator time, fixed ID typo	AN
June 09, 2012	E11284-2201_Biolux_FCC_IC_1.0	1.0	Updated Logo, removed typo	AN
June 09, 2012	E11284-2201_Biolux_FCC_IC-0.0	0.0	Initial Release	AN
All previous versions of this report have been superseded by the latest dated revision as listed in the above table.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 Biolux. Tests were conducted on the sample equipment as requested by Biolux 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 Biolux as per Quote 21RH11022R4 Biolux 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.

Testing Performed by
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EMC Test Engineer

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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
Burnaby, BC, Canada	CA9543	21146-1	3657.02

Headquarters & EMC Laboratory in Burnaby, BC

TABLE OF CONTENTS

Section I: EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of OrthoPulse® Gen 2 with wireless charger as per Sections 1.2 & 1.3.
The radio module activates only the first minute of when the product puts in the charger. Therefore, the product is categorized as Mobile. It does not transmit when it in the mouth!

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 21RH11022R1

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

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
12	RF Exposure Evaluation	KDB 447498 D01, RSS 102 Issue 5 (the KDB 447498 is used)	Provided in seperated document Complies

Section II: GENERAL INFORMATION

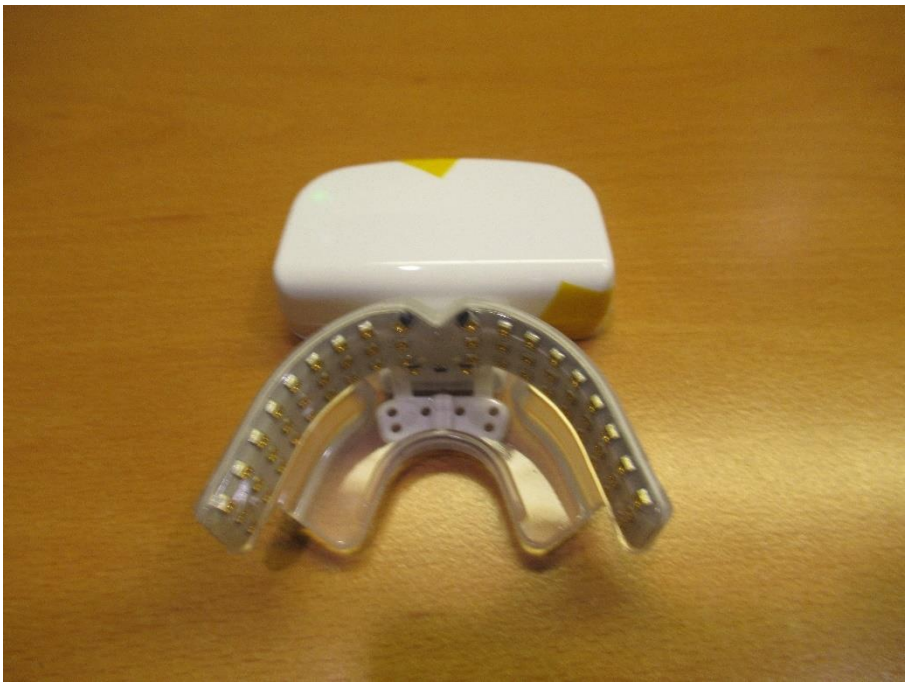
2.1 Product Description

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	OrthoPulse Gen 2 with Charger
Functional Description	The device is intended for use during orthodontic treatment. It is used in conjunction with brackets and wires or aligners and helps facilitate minor anterior tooth movement. The intended environment is a home healthcare environment.
Operating Frequency	2400MHz to 2483.5MHz
FCC ID	**2A6CA-OPI**
IC Certification Number	**28421-OPI**
Manufacturer	Biolux Technology
HVIN	OPI

EUT in the Charger



Equipment Under Test (EUT)

2.2 Environmental Conditions

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

Parameter	Conditions
Location	Indoors
Temperature	23-24ºC
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)	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:

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)	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:

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 I.

Emissions Test Equipment

Sl. NO.	Manufacturer	Model	Description	Serial No.	S/W Version	Calibration Due Date
1	AH Systems	PAM118	Amplifier (10KHz-18GHz)	189	N/A	Conditional Use
2	EMCO	3825/2	LISN (150kHz-30MHz)	9002-1601	N/A	2026-Oct-01
3	ETS Lindgren	2165	Turntable	00043677	N/A	N/A
4	ETS Lindgren	2125	Mast	00077487	N/A	N/A
5	ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
6	Hewlett Packard	8449B	Preamplifier (1-26 GHz)	2933A00198	N/A	2025-Feb-15
7	Rohde & Schwarz	ESU40	EMI Receiver	100011	EMC32 v10.35.10/ FV 4.73 SP4	2023-Jul-05
8	Sunol Sciences	DRH-118	Horn Antenna, 1.0-18 GHz	A050905	N/A	2023-07-28
9	Sunol Sciences	SM46C	Turntable	051204-2	N/A	N/A
10	Sunol Sciences	TWR95	Mast	TREML0001	N/A	N/A
12	Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A042004	N/A	2023-Jul-30
13	TTi	HA1600A	Power Analyzer; Harm/Flicker	318801	N/A	2022-Oct-01
14	TTi	AC1000A	Power Supply, Low Distortion	317113	N/A	2022-Oct-01
15	Keysight	N9322C	Spectrum Analyser	39775	N/A	4/11/2023

Note: Equipment listed above have 3 years calibration interval.

Measurement Software List

Sl. No.	Manufacturer	Model	Version	Description
1	Rhode & Schwarz	EMC 32	10.35.10	Emissions Test Software
2	TESEQ	WIN 3000	1.2.0	Surge, EFT & Voltage Dips Immunity Test Program
3	Thurlby Thandar Instruments	HA-PC Link Version	2.02	Harmonics and Flicker Test Program
4	VI Automation	Via EMC Immunity Executive	1.0.308	Radiated and Conducted Immunity Test Program

Immunity Testing Equipment

Sl. No.	Manufacturer	Model	Description	Serial No.	S/W Version	Calibration Due Date
1	Chase	emCELL	RF Immunity Chamber	1016	N/A	N/A
2	EMC Partner	CN-EFT1000	Capacitive Clamp	#408	N/A	N/A
3	ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A	N/A
5	FCC	F-120-9A	Bulk Injection Clamp	399	N/A	N/A
6	Haefely Trench	PESD 1600	ESD Generator	H601-018	N/A	2022-Aug-28
7	HP	8648C	Signal Generator	3623A03622	N/A	N/A
8	Ophir	5048FE	RF Amplifier 0.15-230 MHz	1035	N/A	N/A
9	Ophir	5125FE	RF Amplifier 20-1000 MHz	1030	N/A	N/A
10	Ophir	5163FE	RF Amplifier 0.8-4.2 GHz	1044	N/A	N/A
11	Rohde & Schwarz	SMP04 (Opt.B1,B2,B5,B12,B13&B14)	Signal Generator	847908/003	N/A	N/A
12	Teseq	NSG 3060	EMC multifunction Generator 6kV with CDN and INA	184	WIN3000 v1.3.2 / FV V2.20	2023-Oct-08
13	Teseq	CDN 3061	Surge CDN	184	N/A	2023-Oct-08
14	Teseq	INA 6502-CIB	Step up Transformer	124	N/A	2023-Oct-08

Section III: TEST RESULTS

3.1 Antenna Requirements

Date Performed:

March 22, 2022

Test Standard:

Per section 1.3

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 standard

Modifications:

No modification was required to comply for this test.

Result:

The antenna is a trace antenna that was replicated from another design with a **(-1dBi) peak gain**.

3.2 RF Peak Conducted Output Power

Date Performed: May 30, 2022

Test Standard: **Per section 1.3**

Test Method: ANSI C63.10:2013

Test Requirement:

The transmitter output power shall be measured in terms of average power.

Measurement Method:

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

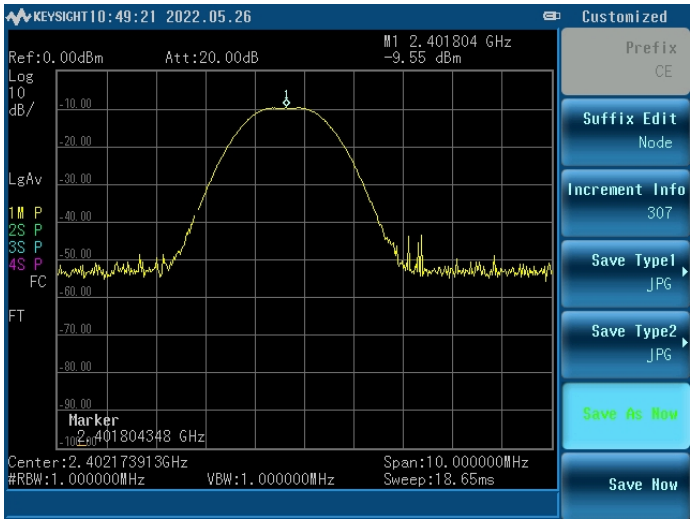
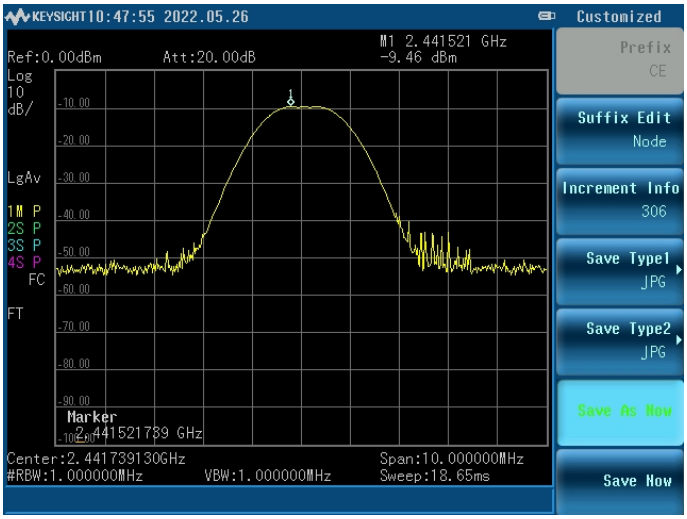
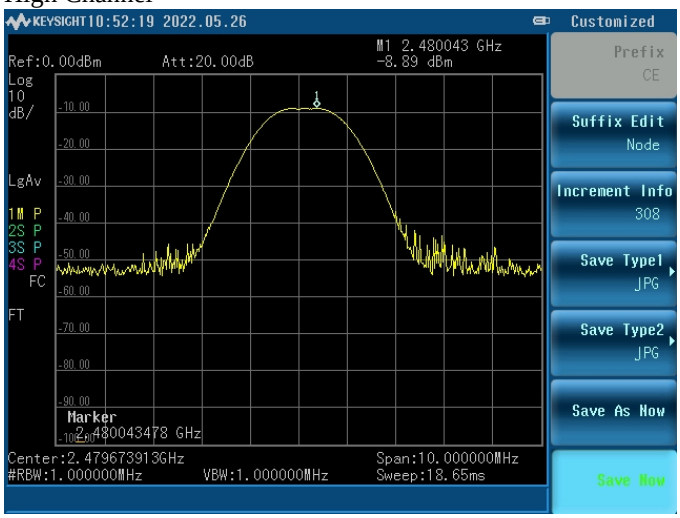
Modifications: No modification was required to comply for this test.

Final Result: The EUT **complies** with the applicable standard.

Table 1: Max. Conducted RF Output Power

Mode	Carrier Frequency	Measured Peak Conducted Output Power	Corrected Peak Conducted Output Power (1)	Limit	Margin
	MHz	dBm	dBm	dBm	dB
BLE GFSK	2401	-9.55	-9.15	30	39.15
	2441	-9.46	-9.06	30	39.06
	2480	-8.89	-8.49	30	38.49

Note(1): 0.4 dB cable and connector loss

Low channel 	Mid Channel 
High Channel 	

Plot 1: Max. Peak Conducted RF Power Output

3.3 Radiated Spurious Emissions Unintentional

Date Performed: May 31, 2022
Test Standard: **Per section 1.3**

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, *f* (MHz)	Field strength (dBµV/m)
0.009 – 0.490	(20*log(2400/*f* (kHz))) + 40 dB
0.490 – 1.705	(20*log(24000/*f* (kHz))) + 20 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	--	

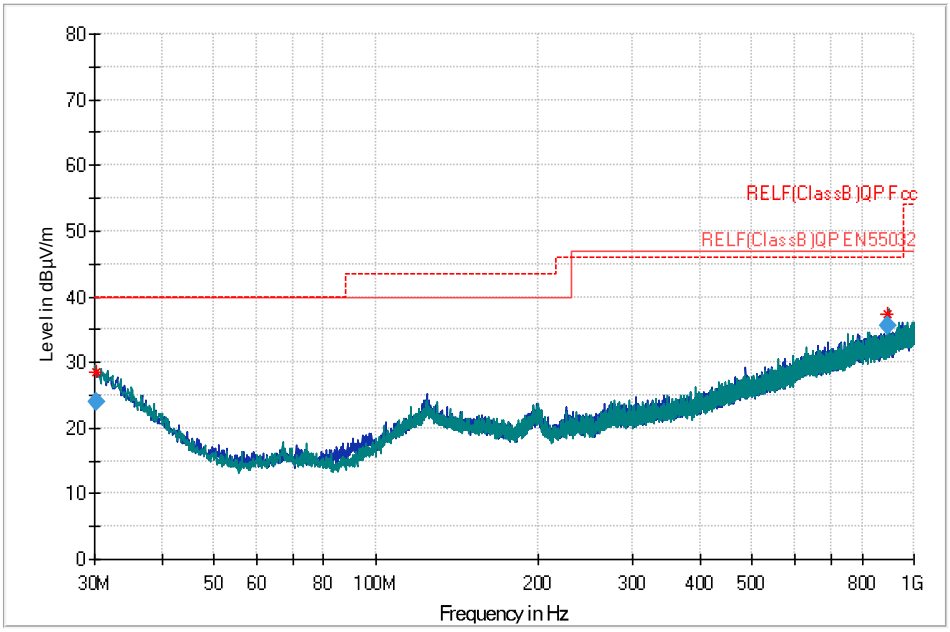
* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

FCC Restricted Bands:

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

Result: The EUT complies with the applicable standard.

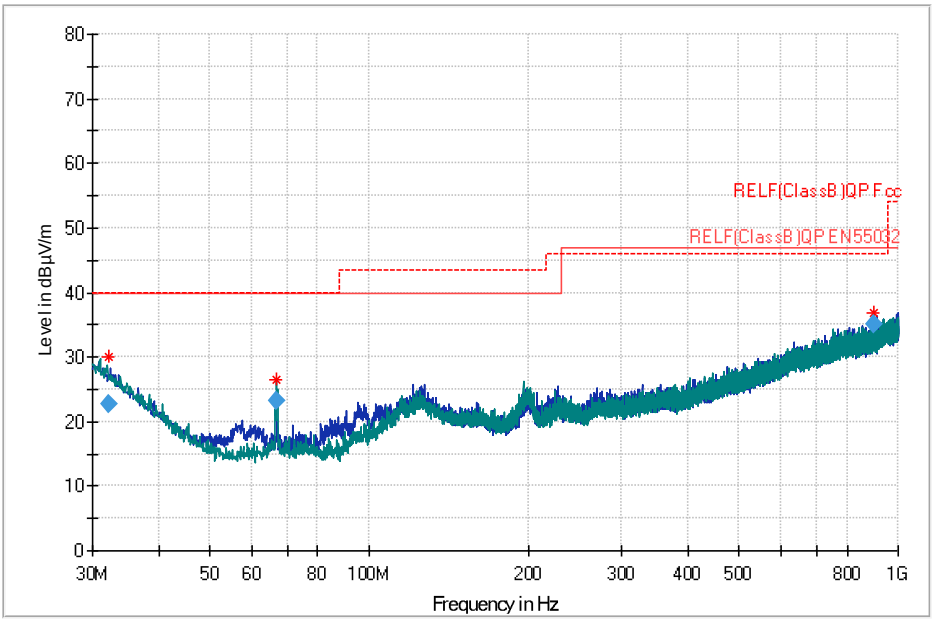
Measurement Data and Plot:



Plot 2: Radiated Emissions at 3m SAC- Battery Mode–Class B Limit

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.2073	23.97	40.00	16.03	1000.0	120.0	227.0	V	178	26.4
895.9992	35.63	47.00	11.37	1000.0	120.0	289.0	V	236	29.0

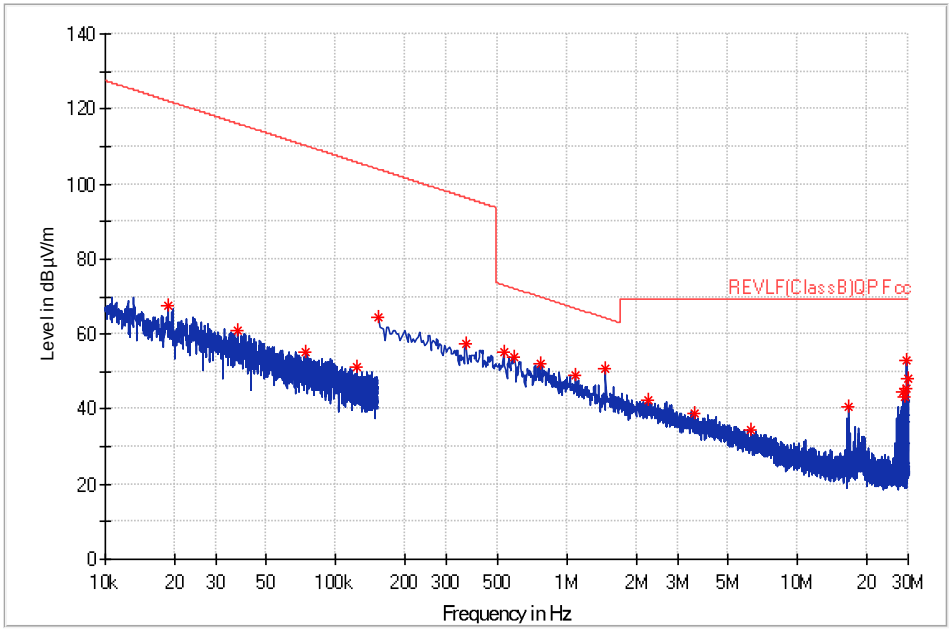
Table 2: Data of Radiated Emissions at 3m SAC Battery Mode–Class B Limit



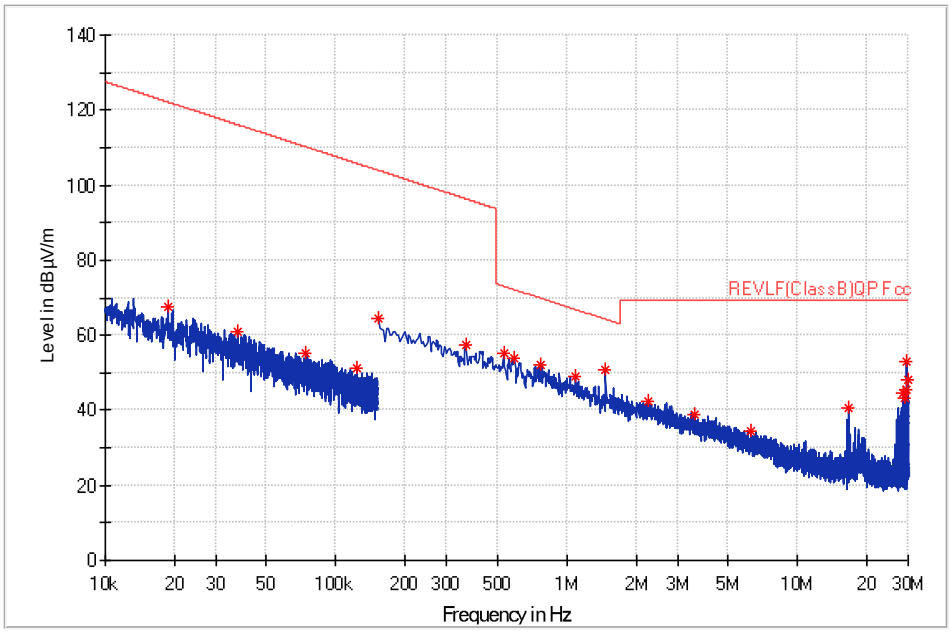
Plot 3: Radiated Emissions at 3m SAC- Charging Mode–Class B Limit

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
32.1641	22.70	40.00	17.30	1000.0	120.0	293.0	V	181	25.0
66.8499	23.13	40.00	16.87	1000.0	120.0	134.0	V	338	13.1
896.0270	34.97	47.00	12.03	1000.0	120.0	402.0	V	168	29.0

Table 3: Data of Radiated Emissions at 3m SAC Charging Mode–Class B Limit

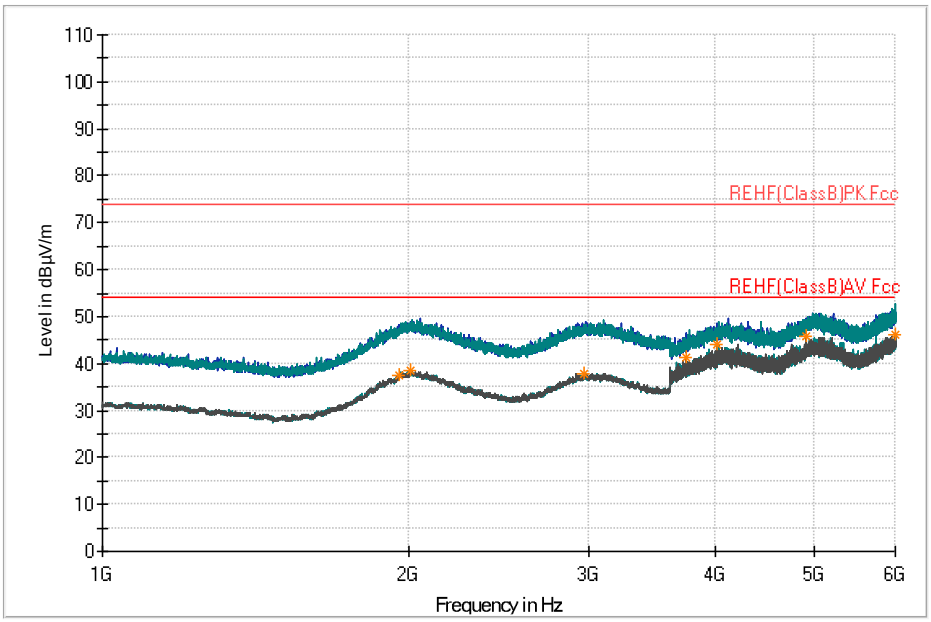


Horizontal

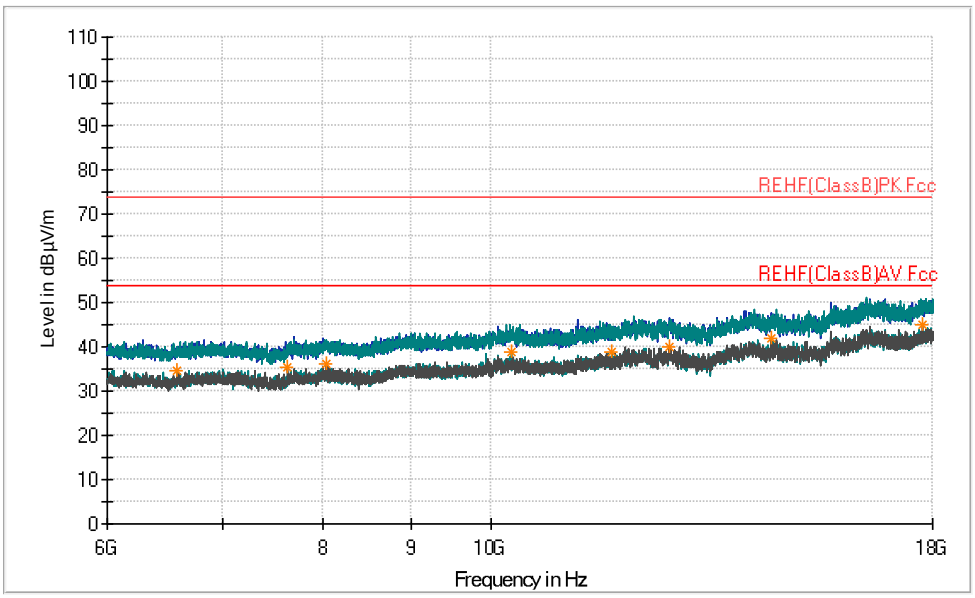


Vertical

Plot 4: Radiated Emissions at 3m SAC Below 30MHz- Charging Mode–Class B Limit



Full Spectrum

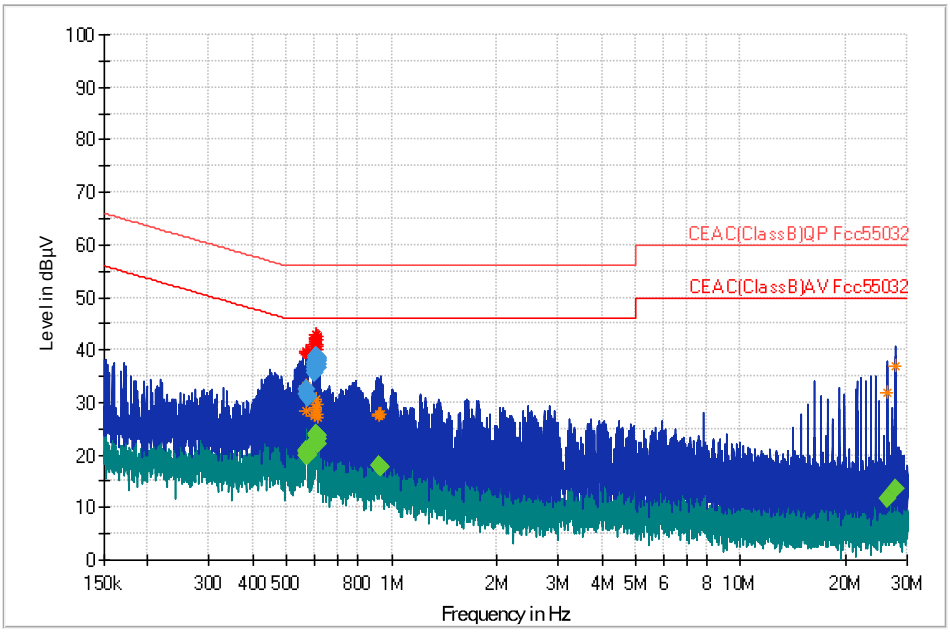


Plot 5: Radiated Emissions Above 1G Hz, Charging Mode Class B

Frequency (MHz)	MaxPeak (dBµV/	Average (dBµV/ m)	Limit (dBµV/ m)	Margin (dB)	Azimuth (deg)	Corr. (dB)	Height (cm)	Pol
1956.0000	---	37.48	54.00	16.52	0	-0.3	100.0	H
2009.5000	---	38.58	54.00	15.42	98	0.3	100.0	V
2970.0000	---	37.85	54.00	16.15	286	0.0	400.0	H
3737.0000	---	41.33	54.00	12.67	332	1.7	250.0	V
4016.5000	---	44.16	54.00	9.84	0	2.4	400.0	H
4909.0000	---	45.78	54.00	8.22	154	4.2	350.0	V
5996.0000	---	46.25	54.00	7.75	250	5.6	250.0	V

Frequency (MHz)	MaxPeak (dBµV/	Average (dBµV/ m)	Limit (dBµV/ m)	Margin (dB)	Azimuth (deg)	Corr. (dB)	Height (cm)	Pol
6583.2000	---	34.73	54.00	19.27	38	-7.5	150.0	H
7632.0000	---	35.28	54.00	18.72	163	-5.3	250.0	V
8024.4000	---	36.27	54.00	17.73	15	-4.5	250.0	V
10276.8000	---	38.92	54.00	15.08	351	1.5	200.0	H
11754.0000	---	38.84	54.00	15.16	215	3.9	250.0	H
12678.0000	---	40.07	54.00	13.93	137	4.7	250.0	V
14524.8000	---	41.90	54.00	12.10	168	6.7	150.0	V
17754.0000	---	44.81	54.00	9.19	**Azim**	**Corr.**	100.0	V

Table 4: Data of Radiated Emissions at 3m SAC Above 1 GHz Charging Mode–Class B Limit

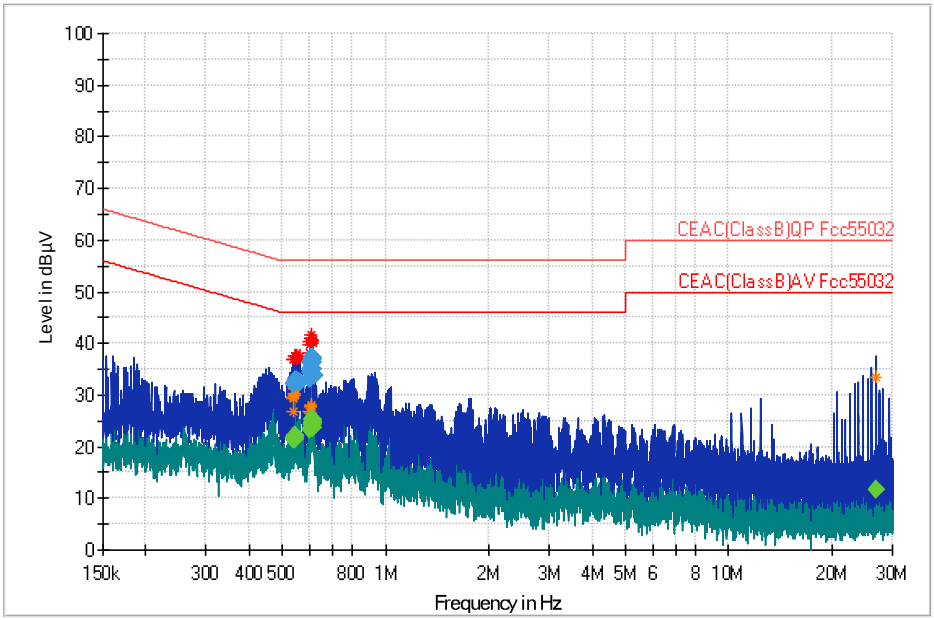


Plot 6:Conducted Emissions at 15kHz to 30MHz, Class B Line 1

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.5658	---	20.75	46.00	25.25	1000.0	9.0	10.4
0.5666	---	20.84	46.00	25.16	1000.0	9.0	10.4
0.5666	32.40	---	56.00	23.60	1000.0	9.0	10.4
0.5676	---	20.69	46.00	25.31	1000.0	9.0	10.4
0.5686	---	19.97	46.00	26.03	1000.0	9.0	10.4
0.5698	---	20.52	46.00	25.48	1000.0	9.0	10.4
0.5708	31.42	---	56.00	24.58	1000.0	9.0	10.4
0.5708	---	19.90	46.00	26.10	1000.0	9.0	10.4
0.5720	31.30	---	56.00	24.70	1000.0	9.0	10.4
0.5720	---	20.20	46.00	25.80	1000.0	9.0	10.4
0.5730	---	19.97	46.00	26.03	1000.0	9.0	10.4
0.5730	31.02	---	56.00	24.98	1000.0	9.0	10.4
0.5996	35.64	---	56.00	20.36	1000.0	9.0	10.4
0.6008	36.41	---	56.00	19.59	1000.0	9.0	10.4
0.6018	---	22.54	46.00	23.46	1000.0	9.0	10.4
0.6018	36.93	---	56.00	19.07	1000.0	9.0	10.4
0.6028	37.42	---	56.00	18.58	1000.0	9.0	10.4
0.6040	37.84	---	56.00	18.16	1000.0	9.0	10.4
0.6050	38.22	---	56.00	17.78	1000.0	9.0	10.4
0.6062	---	23.84	46.00	22.16	1000.0	9.0	10.4
0.6062	38.47	---	56.00	17.53	1000.0	9.0	10.4
0.6070	38.64	---	56.00	17.36	1000.0	9.0	10.4
0.6072	---	23.60	46.00	22.40	1000.0	9.0	10.4
0.6082	38.73	---	56.00	17.27	1000.0	9.0	10.4
0.6082	---	24.10	46.00	21.90	1000.0	9.0	10.4
0.6094	38.74	---	56.00	17.26	1000.0	9.0	10.4
0.6104	38.62	---	56.00	17.38	1000.0	9.0	10.4
0.6114	38.46	---	56.00	17.54	1000.0	9.0	10.4
0.6114	---	23.58	46.00	22.42	1000.0	9.0	10.4
0.6124	38.11	---	56.00	17.89	1000.0	9.0	10.4
0.6136	37.70	---	56.00	18.30	1000.0	9.0	10.4
0.6146	37.27	---	56.00	18.73	1000.0	9.0	10.4

0.6158	---	23.01	46.00	22.99	1000.0	9.0	10.4
0.6158	36.60	---	56.00	19.40	1000.0	9.0	10.4
0.6168	---	22.01	46.00	23.99	1000.0	9.0	10.4
0.9214	---	17.95	46.00	28.05	1000.0	9.0	10.4
0.9246	---	17.85	46.00	28.15	1000.0	9.0	10.4
0.9268	---	17.77	46.00	28.23	1000.0	9.0	10.4
26.4260	---	11.68	50.00	38.32	1000.0	9.0	10.7
27.8340	---	13.45	50.00	36.55	1000.0	9.0	10.8

Table 5: Data of Conducted Emissions at 3m SAC–Class B Limit Line 1



Plot 7: Conducted Emissions at 15kHz to 30MHz, Class B Line 2

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.5392	---	21.61	46.00	24.39	1000.0	9.0	10.4
0.5402	---	21.55	46.00	24.45	1000.0	9.0	10.4
0.5402	32.13	---	56.00	23.87	1000.0	9.0	10.4
0.5414	---	21.84	46.00	24.16	1000.0	9.0	10.4
0.5414	32.29	---	56.00	23.71	1000.0	9.0	10.4
0.5424	---	21.33	46.00	24.67	1000.0	9.0	10.4
0.5434	---	21.93	46.00	24.07	1000.0	9.0	10.4
0.5444	32.54	---	56.00	23.46	1000.0	9.0	10.4
0.5444	---	21.72	46.00	24.28	1000.0	9.0	10.4
0.5454	32.67	---	56.00	23.33	1000.0	9.0	10.4
0.5456	---	22.11	46.00	23.89	1000.0	9.0	10.4
0.5466	---	22.16	46.00	23.84	1000.0	9.0	10.4
0.5508	32.89	---	56.00	23.11	1000.0	9.0	10.4
0.5530	32.92	---	56.00	23.08	1000.0	9.0	10.4
0.5594	32.64	---	56.00	23.36	1000.0	9.0	10.4
0.5606	32.53	---	56.00	23.47	1000.0	9.0	10.4
0.5980	33.18	---	56.00	22.82	1000.0	9.0	10.4
0.5992	34.26	---	56.00	21.74	1000.0	9.0	10.4
0.6012	35.08	---	56.00	20.92	1000.0	9.0	10.4
0.6012	---	23.23	46.00	22.77	1000.0	9.0	10.4
0.6034	36.24	---	56.00	19.76	1000.0	9.0	10.4
0.6046	---	24.42	46.00	21.58	1000.0	9.0	10.4
0.6054	36.92	---	56.00	19.08	1000.0	9.0	10.4
0.6056	---	24.38	46.00	21.62	1000.0	9.0	10.4
0.6076	37.38	---	56.00	18.62	1000.0	9.0	10.4
0.6088	---	25.23	46.00	20.77	1000.0	9.0	10.4
0.6098	37.35	---	56.00	18.65	1000.0	9.0	10.4
0.6098	---	24.67	46.00	21.33	1000.0	9.0	10.4
0.6108	---	25.22	46.00	20.78	1000.0	9.0	10.4
0.6108	37.28	---	56.00	18.72	1000.0	9.0	10.4
0.6120	37.01	---	56.00	18.99	1000.0	9.0	10.4

0.6120	---	25.05	46.00	20.95	1000.0	9.0	10.4
0.6130	---	24.45	46.00	21.55	1000.0	9.0	10.4
0.6140	36.34	---	56.00	19.66	1000.0	9.0	10.4
0.6140	---	24.54	46.00	21.46	1000.0	9.0	10.4
0.6152	---	24.17	46.00	21.83	1000.0	9.0	10.4
0.6162	35.14	---	56.00	20.86	1000.0	9.0	10.4
0.6162	---	23.81	46.00	22.19	1000.0	9.0	10.4
0.6184	33.74	---	56.00	22.26	1000.0	9.0	10.4
26.7860	---	11.76	50.00	38.24	1000.0	9.0	10.9

Table 6: Conducted Emissions Data, 150 kHz to 30 MHz, Class B - Line 2

3.4 20dB Occupied Bandwidth

Date Performed: May 26, 2022
Test Standard: **Per section 1.3**

RSS-Gen Issue 5

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.

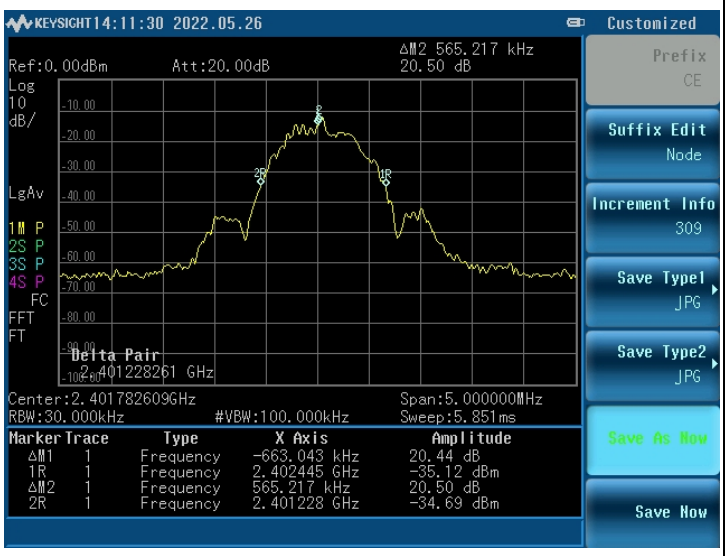
Measurement Data and Plot:

20 dB Occupied Bandwidth, Bluetooth_GFSK

Data

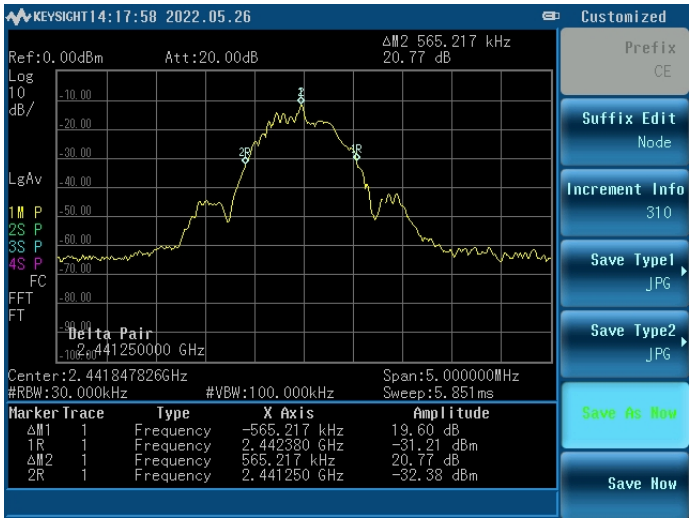
Channel	Frequency	Bandwidth	Result
	MHz	kHz	
Low	2401	1228	Complies
Mid	2441	1130	Complies
High	2480	1140	Complies

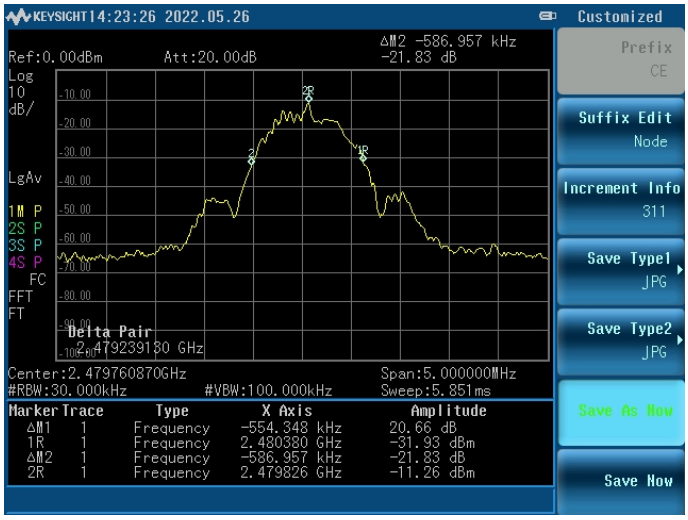
Low Channel



Mid Channel

High Channel





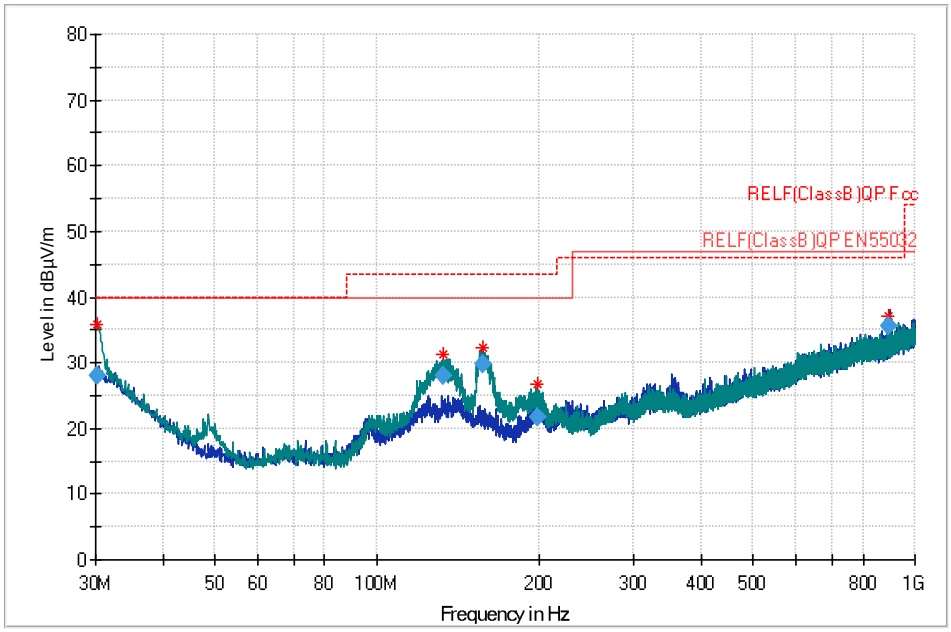
Plot 8: 20 dB Band Width

3.5 Transmitter radiated spurious Emissions

Date Performed: May 30, 2022

Test standard: **Per section 1.3**

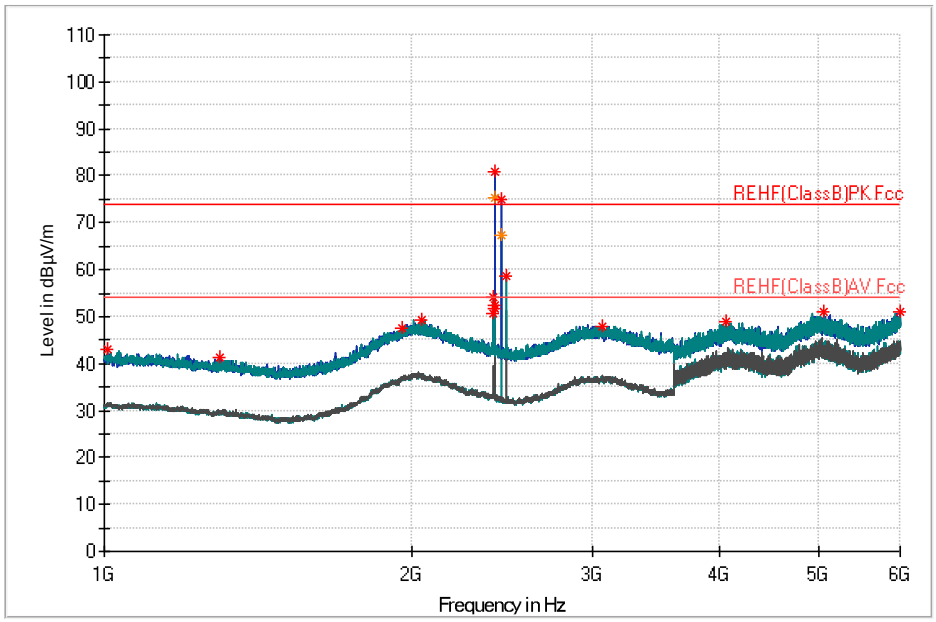
- **Requirement**



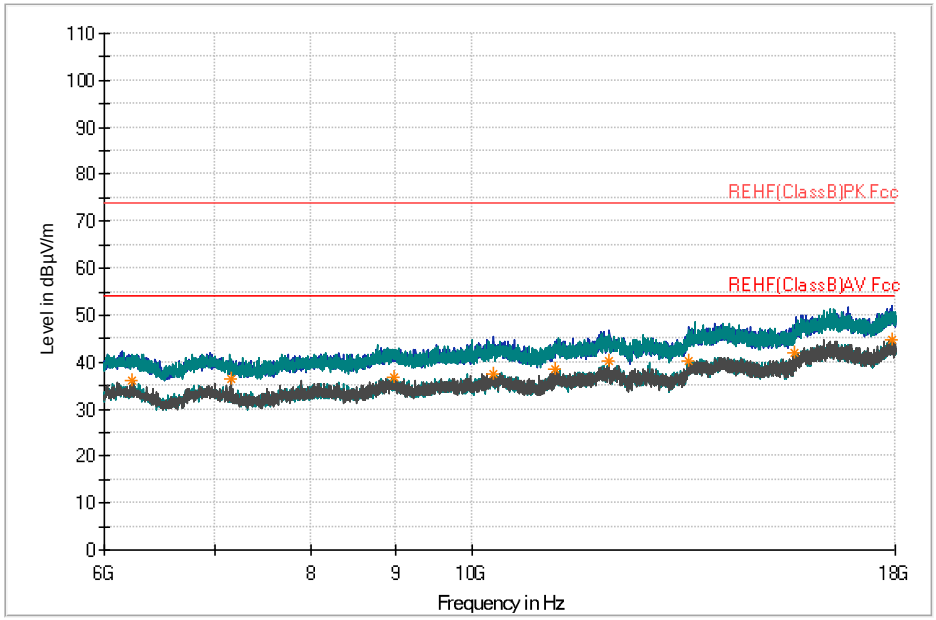
Plot 9: Radiated Emissions Transmitter Mode, Below 1 GHz, Class B

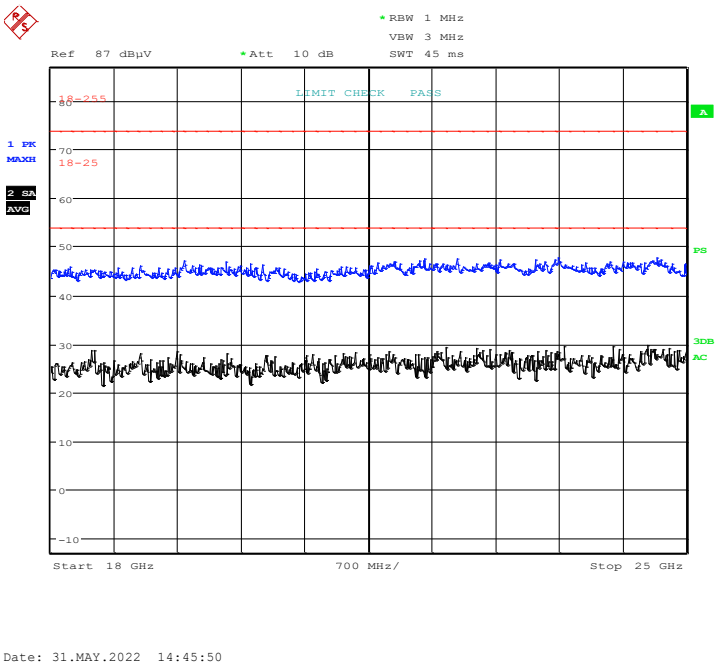
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.1370	27.91	40.00	12.09	1000.0	120.0	171.0	V	196	26.5
132.8364	27.98	40.00	12.02	1000.0	120.0	100.0	V	146	19.2
157.5571	29.74	40.00	10.26	1000.0	120.0	111.0	V	144	18.0
199.4489	21.67	40.00	18.33	1000.0	120.0	100.0	V	173	18.9
895.9997	35.59	47.00	11.41	1000.0	120.0	217.0	H	266	29.0

Table 7: Data Radiated Emissions Transmitter Mode, below 1 GHz, Class B



Note: 2.4 GHz Spikes are known intentional radiation





Plot 10: Radiated Emissions Transmitter Mode, above 1 GHz, Class B

Frequency (MHz)	MaxPeak (dBµV/	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2412.0000	81.00	---	54.00	-27.00	150.0	H	268	-0.7
2444.5000	74.91	---	54.00	-20.91	250.0	H	68	-0.6
2471.5000	58.61	---	54.00	-4.61	150.0	V	0	-0.5
2412.0000	---	75.34	74.00	-1.34	150.0	H	268	-0.7
2404.5000	54.18	---	54.00	-0.18	200.0	V	0	-0.7
2410.0000	52.24	---	54.00	1.76	100.0	H	1	-0.7
2405.5000	51.78	---	54.00	2.22	200.0	V	0	-0.7
5994.0000	51.08	---	54.00	2.92	150.0	H	284	5.6
5047.5000	50.87	---	54.00	3.13	250.0	V	214	4.4
2401.5000	50.53	---	54.00	3.47	200.0	H	212	-0.7
2040.0000	49.44	---	54.00	4.56	250.0	V	37	0.1
4054.5000	48.78	---	54.00	5.22	100.0	V	215	2.5
3071.5000	47.91	---	54.00	6.09	200.0	H	294	0.1
1953.0000	47.60	---	54.00	6.40	200.0	H	33	-0.4
2444.5000	---	67.33	74.00	6.67	250.0	H	68	-0.6
1008.0000	43.15	---	54.00	10.85	150.0	V	48	-8.5
1297.5000	41.16	---	54.00	12.84	200.0	H	81	-6.7

	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
15654.0000	---	42.05	54.00	11.95	250.0	H	150	8.3
12082.8000	---	40.11	54.00	13.89	250.0	H	168	5.2
11210.4000	---	38.52	54.00	15.48	200.0	H	276	1.8
10294.8000	---	37.61	54.00	16.39	150.0	H	294	1.5
8974.8000	---	36.89	54.00	17.11	250.0	H	323	-2.3
13514.4000	---	40.25	54.00	13.75	100.0	H	328	4.4
7161.6000	---	36.38	54.00	17.62	200.0	V	316	-6.4
6231.6000	---	36.03	54.00	17.97	200.0	V	330	-8.2
17924.4000	---	44.80	54.00	9.20	150.0	V	337	12.9

Table 8: Data Radiated Emissions-Transmitter Mode, Above 1 GHz, Class B

3.6 Channel Separation

- **Date Performed:** May 26, 2022

  Test standard: **Per section 1.3**

- **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.

- **Test Set-up:**

  Conducted measurement at antenna port using spectrum analyzer.

  Span = 2 MHz.

  RBW = 10kHz, VBW = 30 kHz

  Sweep time: 20 ms.

- **Modifications:**

  EUT configured to transmit in frequency hopping mode. Integrated antenna removed.

- **Result:**

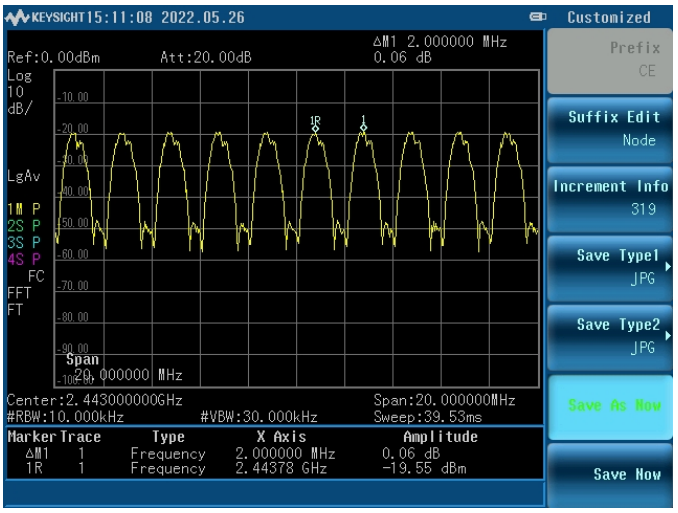
  Channel separation is 2000 kHz > max. (25 kHz or 20dB BW). EUT complies.

- **Status: Complies**

Measurement Data and Plot:

Channel Separation	GFSK

Channel	Channel Separation	20 dB Bandwidth	Complies
	kHz	kHz	
GFSK	2000	1228	



Plot 11: Channel Separation

3.7 99% Occupied Bandwidth

Date Performed: May 26, 2022

Test Standard: **Per section 1.3**

Test Method: ANSI C63.10:2013

Modifications: No modification was required to comply for this test

Final Result: The EUT **Comply** with the applicable standard.

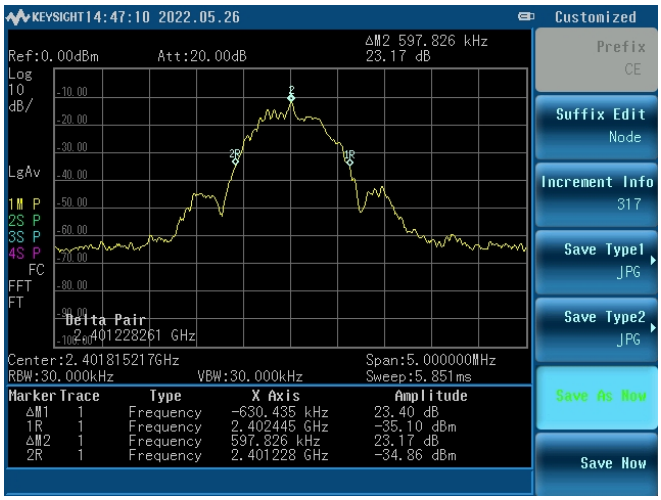
Test Requirement:

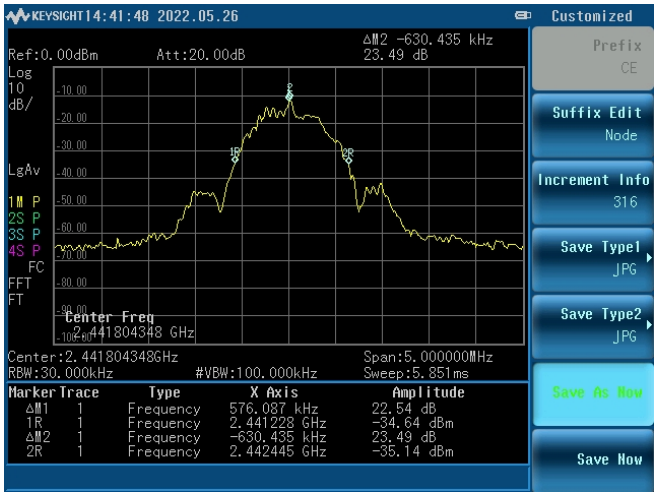
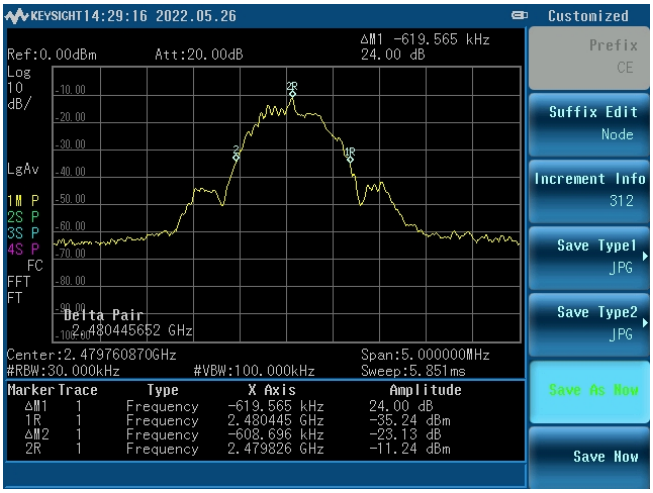
The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal.
The bandwidth shall fall completely within the frequency range specified by the standard.

Measurement Data and Plot:

99% Occupied Bandwidth, Bluetooth GFSK	
Data	Low Channel

Channel	Frequency	Bandwidth	Result
	MHz	kHz	
Low	2401	1227	Complies
Mid	2441	1206	Complies
High	2480	1227	Complies



	
Mid Channel	High Channel

Plot 12: 99% Occupied bandwidth

3.8 Time of occupancy and dwelling time

- **Date Performed:** May 26, 2022

  Test standard: **Per section 1.3**

- **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.

- **Test Set-up:**

  Conducted measurement at antenna port using spectrum analyzer.

  Span = 0 Hz.

  RBW = 10kHz, VBW = 30 kHz

  Sweep time: 20 s.

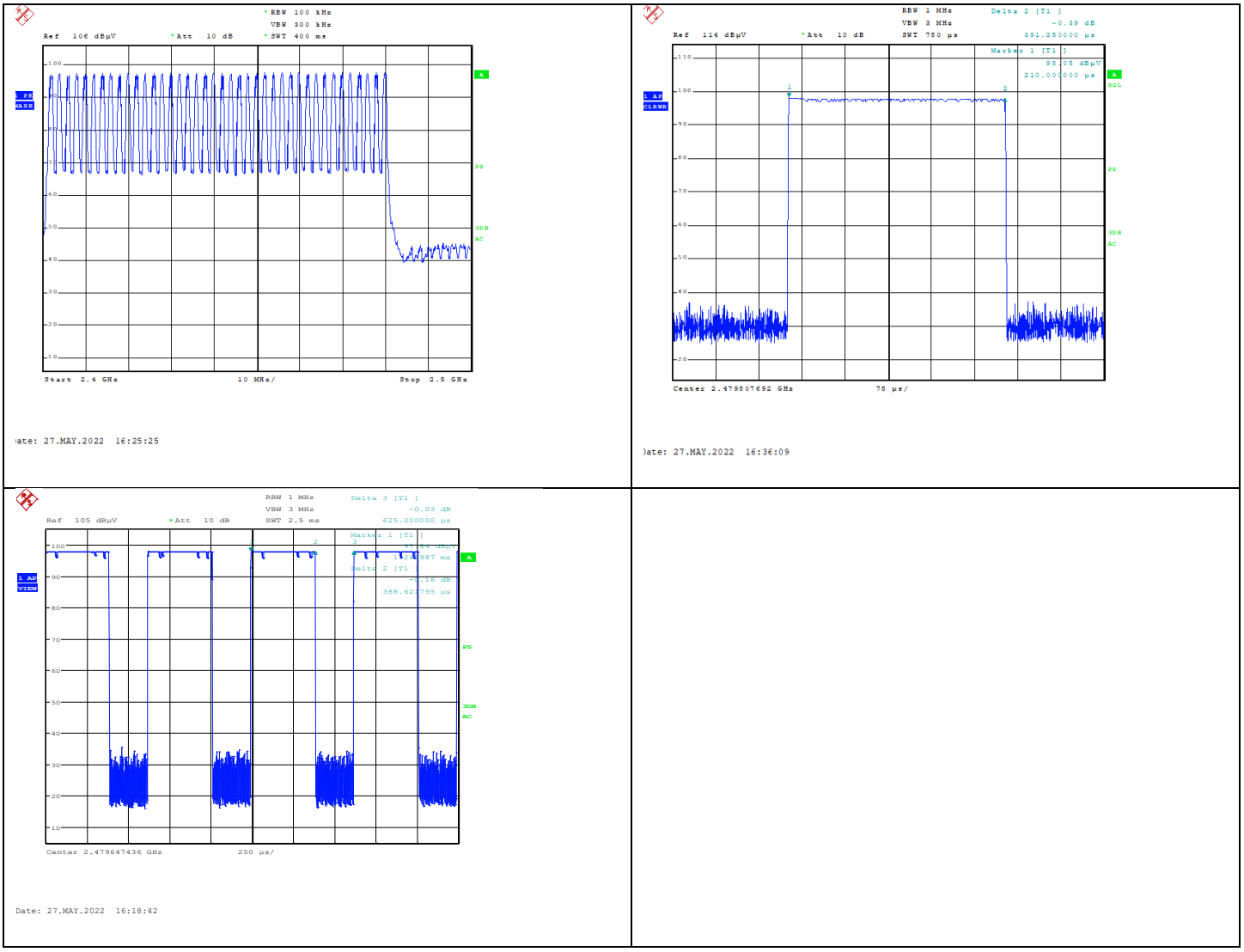
- **Modifications:**

  EUT configured to transmit at 100% duty cycle in frequency hopping mode. Integrated antenna removed.

- **Result:**

  Time of occupancy is less than 400 ms. EUT complies.

- **Plots and table:**



Modulation	Pulse number	Burst Pulse Width	Time of Occupancy	Max Limit	Burst Duty Cycle	Results
		ms	ms	ms	%	
GFSK	40	0.391	15.64	400	62	Complies

Plot 13: Time of Occupancy and duty cycle

3.9 Number of Hopping Channels

Date Performed: May 27, 2022

Test Standard: **Per section 1.3**

Test Method:

- ANSI C63.10:2013

Test Requirement:

The number of Hopping Channels is measured and reported.

Measurement Method:

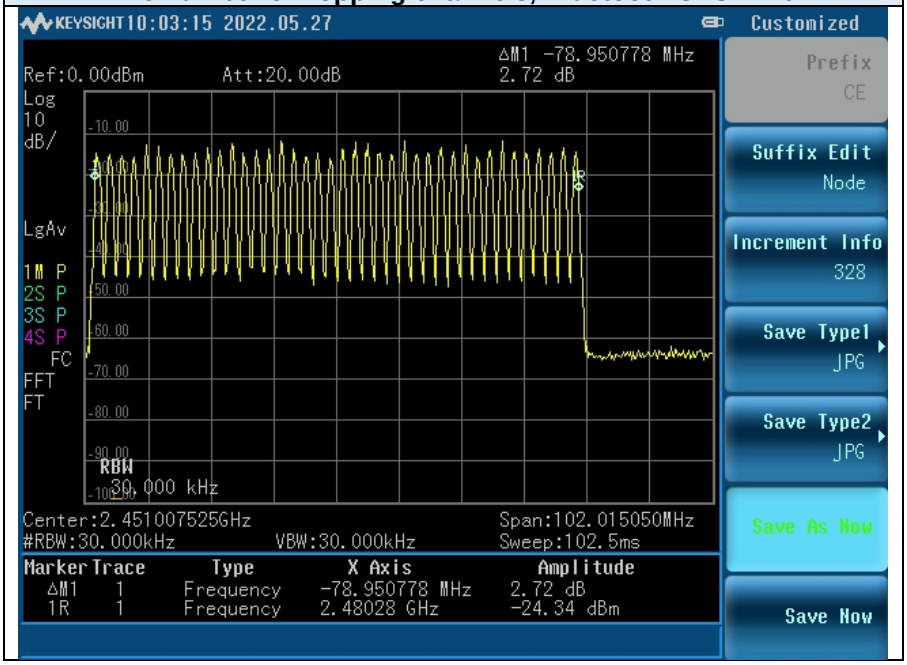
As called in ANSI C63.10-2013.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

The number of hopping channels, Bluetooth GFSK: 40



Plot 14: Number of Hopping Channels

3.10 Out of Band Emissions (Band Edge)

Date Performed: May 27, 2022

Test Standard: Per section 1.3

Test Method:

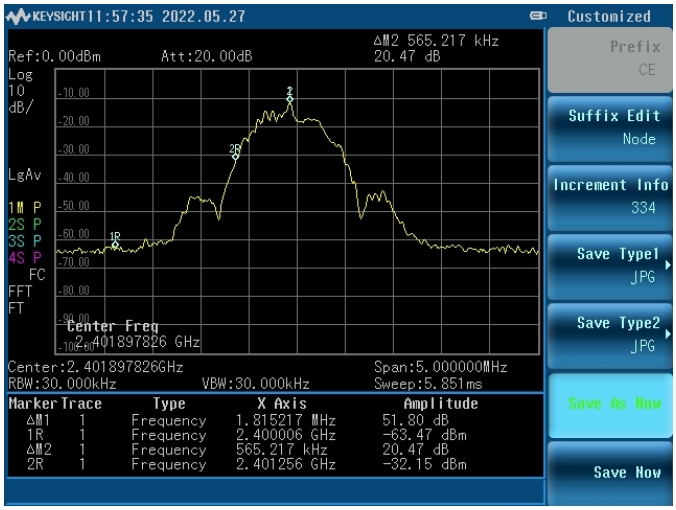
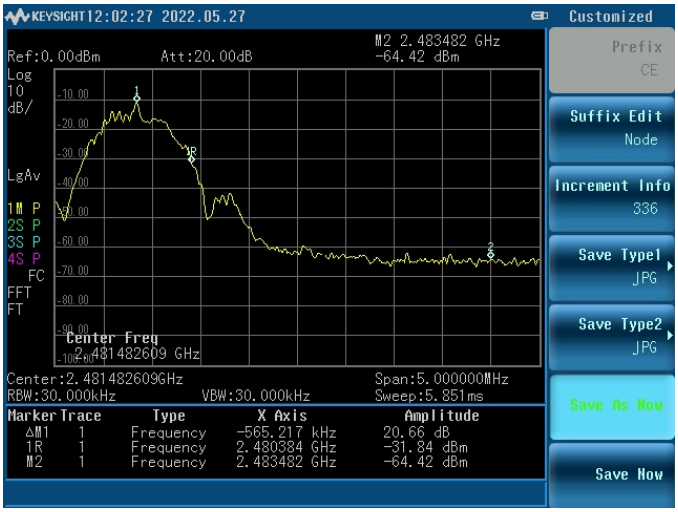
- ANSI C63.10:2013

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	
Low Channel	High Channel
	

Plot 15: Bandesge

Appendix A: TEST SETUP PHOTOS

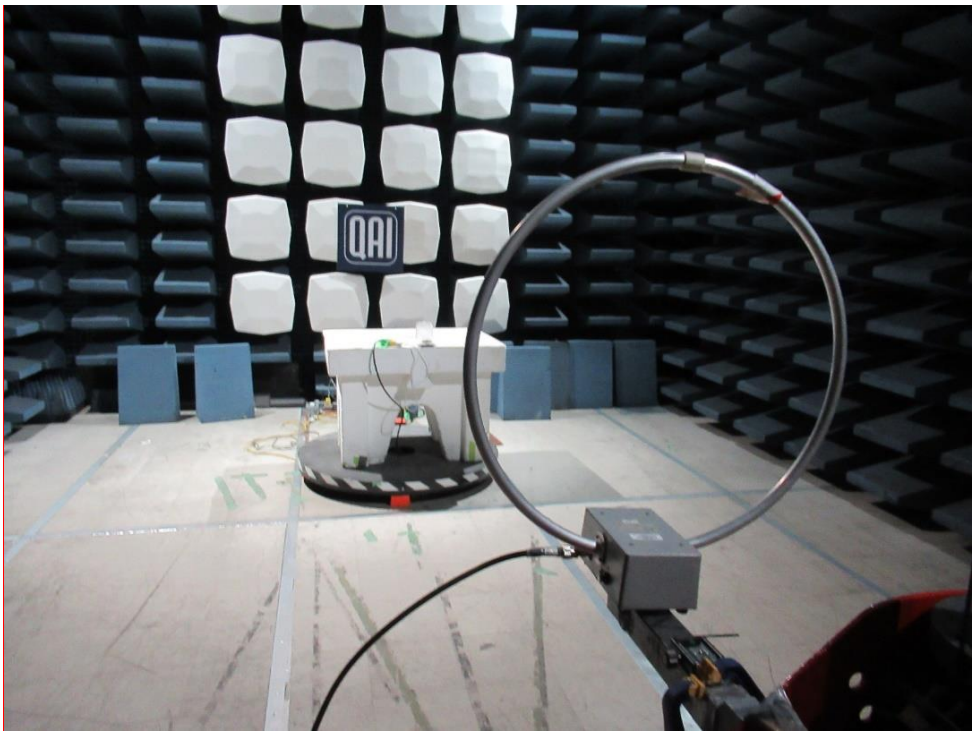


Figure 1: Radiated Emissions performed at the 3m SAC, 150kHz – 30MHz

Figure 2: Radiated Emissions performed at the 3m SAC, 30MHz – 1GHz Battery Mode

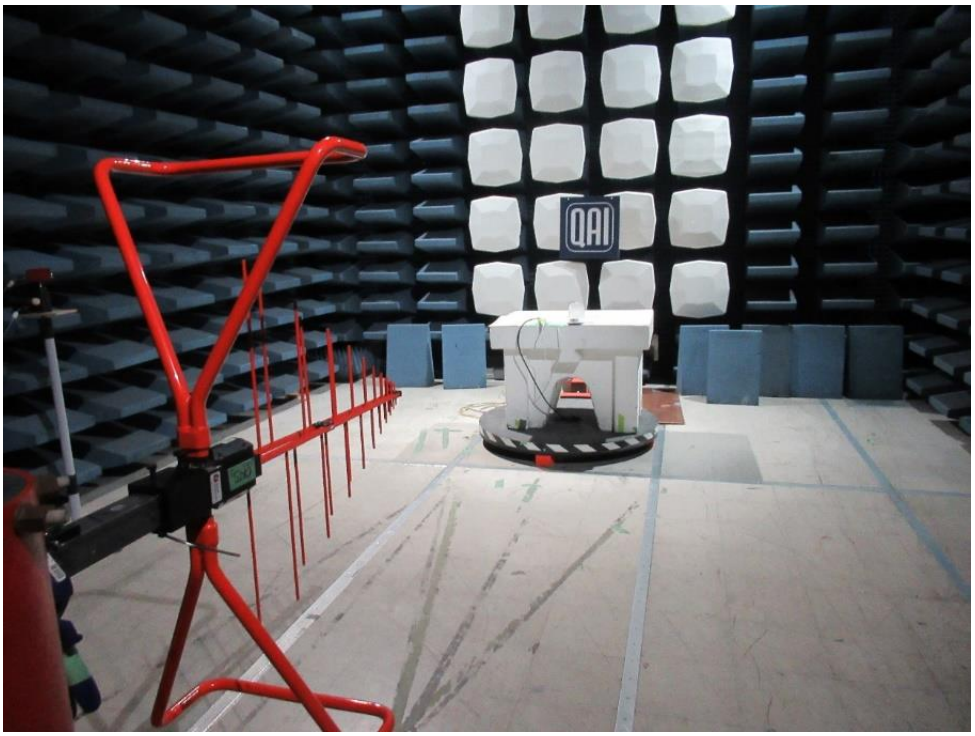


Figure 3: Radiated Emissions performed at the 3m SAC, 30MHz – 1GHz Charging Mode

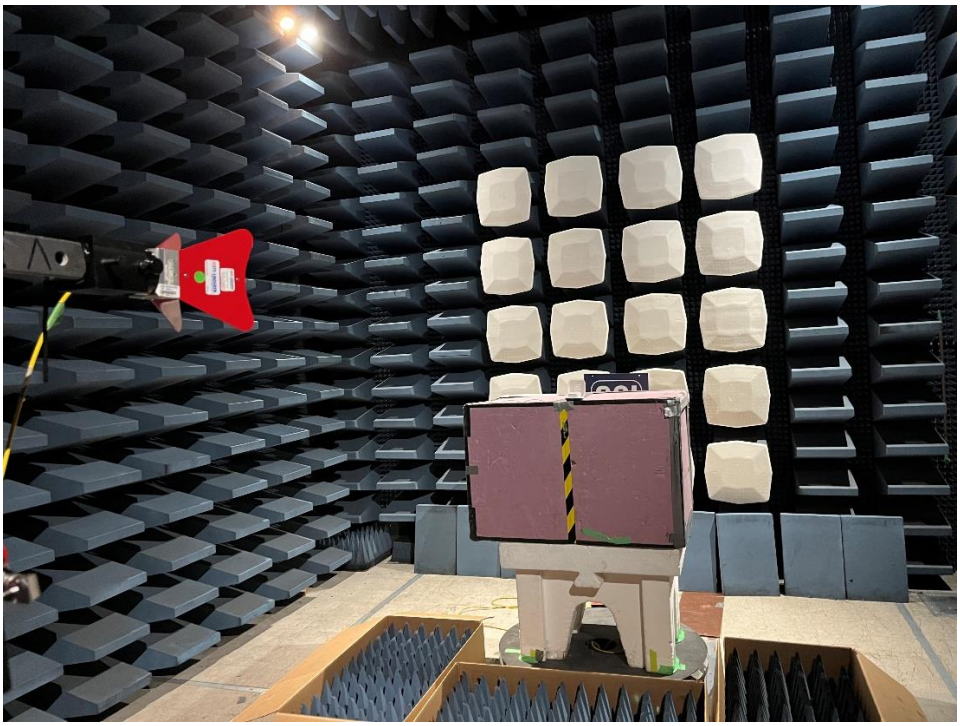


Figure 4: Radiated Emissions above 1GHz performed at the 3m SAC

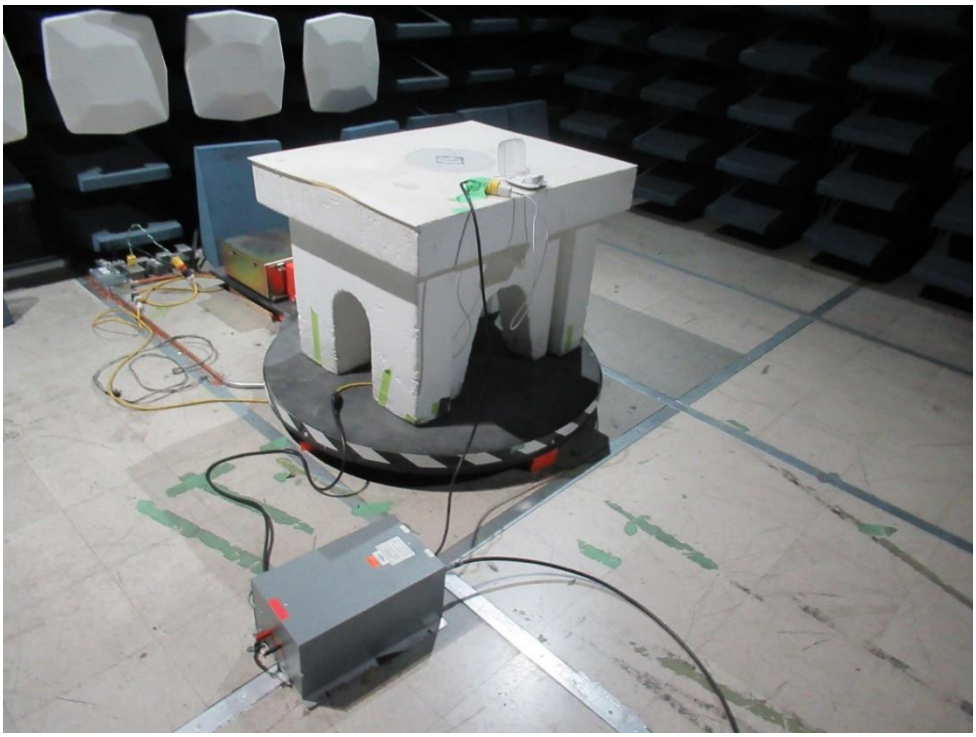


Figure 5: Conducted Emissions performed at the 3m SAC

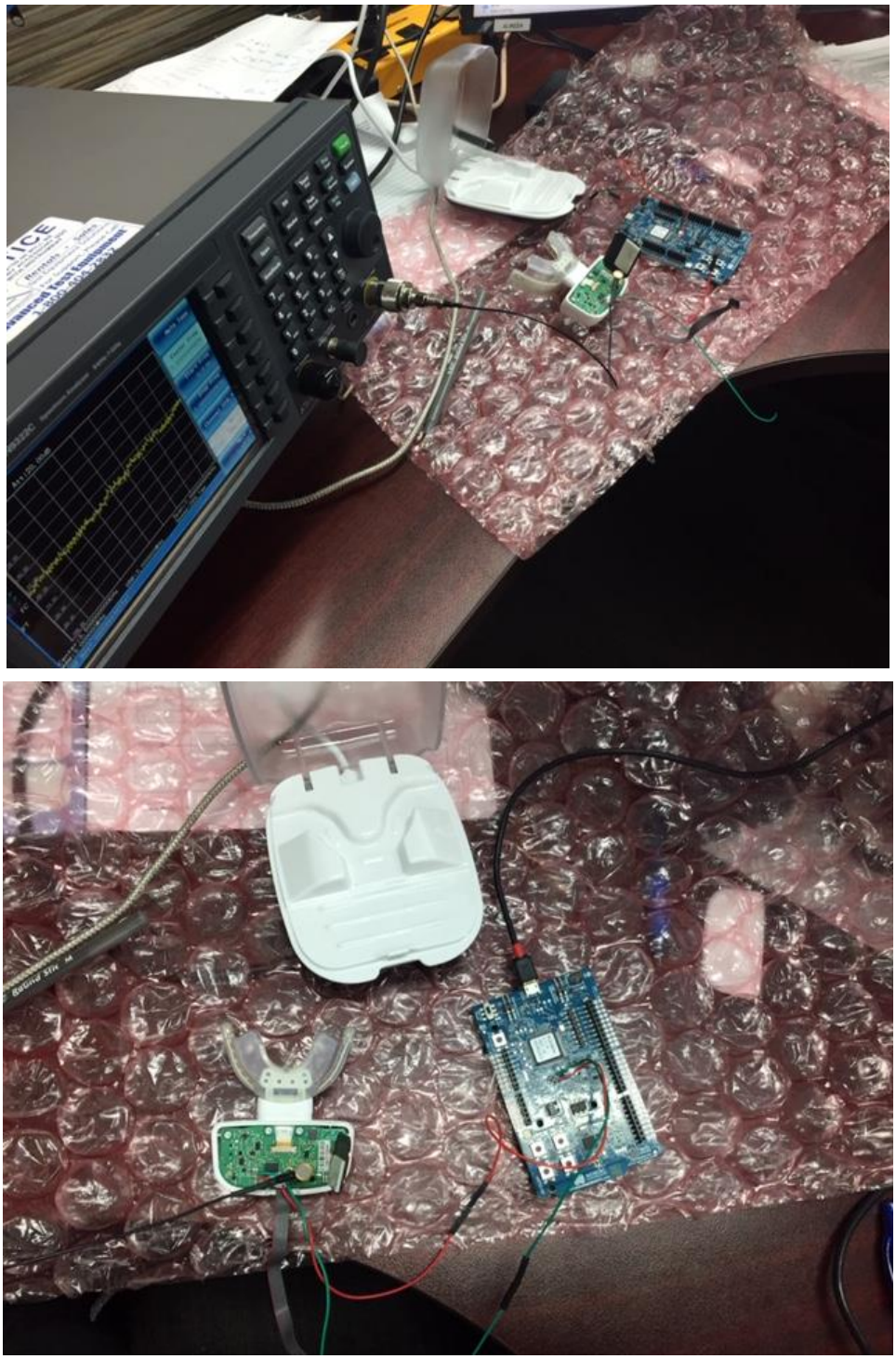


Figure 6: Radio Testing Station

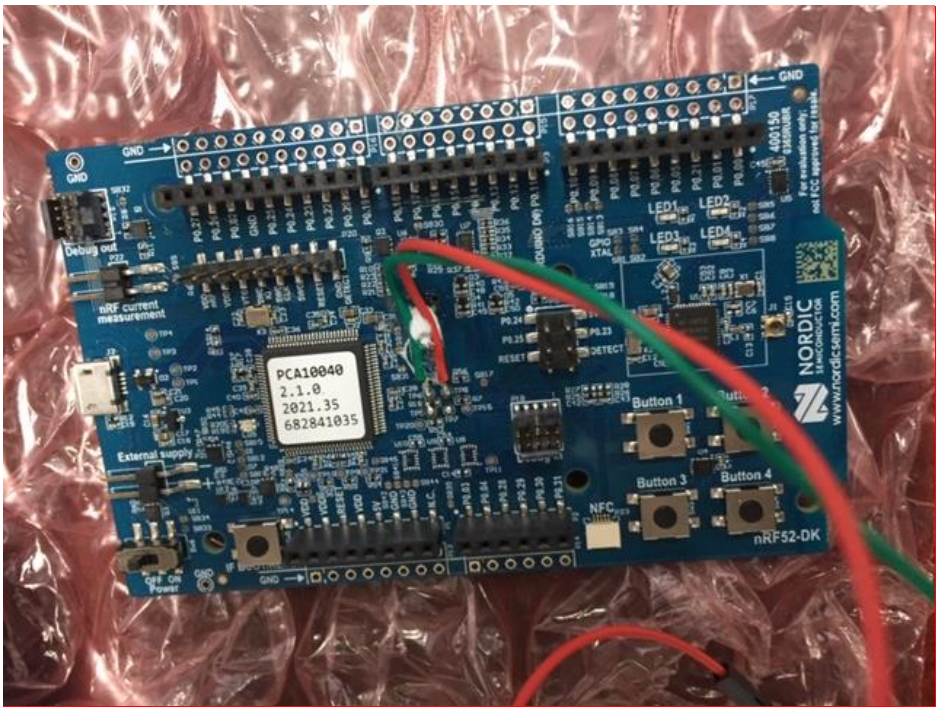


Figure 7: Companion board

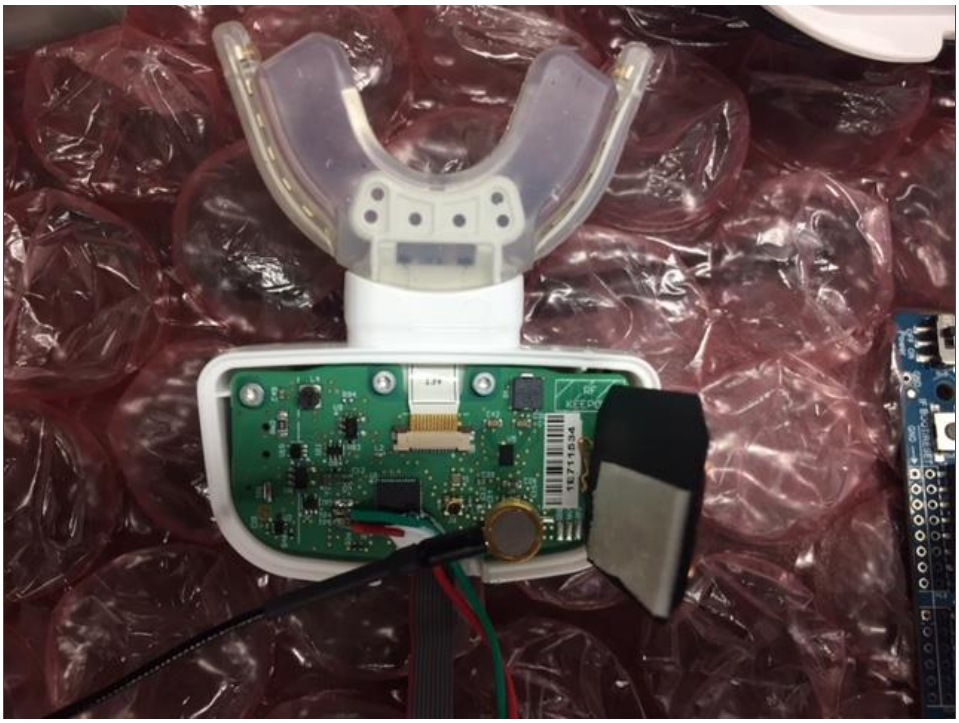


Figure 8: Open EUT

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