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EMC testing of SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 86" IFP display, Model: IDQR86-A in accordance with:

- **RSS-GEN, Issue 5**
- **FCC, title 47 CFR § 15.207 and 15.209**

Test Personnel: Brendan Van Hee, Janet Mijares

Test Dates: December 7 and 8, 2023

Prepared for: **SMART Technologies ULC**
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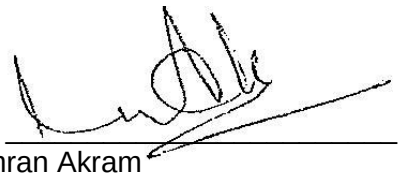

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REVISION RECORD

ISSUE	DATE YYYY/MM/DD	AUTHOR	REVISIONS
DRAFT 1	2023/12/12	I. Akram	Initial draft submitted for review.
DRAFT 2	2024/01/02	B. Van Hee	Corrected EUT PN throughout Added EUT description
Release 1	2024/01/10	I. Akram	Sign Off
Release 2	2024/04/09	I. Akram	See changes below. Sign off.

Release 2 Updates

- Updated customer address on page 1 and in appendix A form.
- Added RSS-247 and FCC part 15.247 reference standards in section 1.5.
- Added conducted output power test uncertainty in section 1.8.
- Added Standard horn antenna/LNA (18-26GHz) in section 2.3.3 test equipment table.
- Added RSS-247 and FCC Part 15.247 out of band emission requirement in section 2.3.1.
- Added conversion note from dBµv/m to dBµA/m below section 2.3.5 table.
- Corrected RSS-247 Issue from 2 to 3.
- Added duty cycle correction factors (DCCF) for Radiated Band edge measurement in section 2.2.
- Explanation note is added in section 1.7 why the unit is tested in floor standing test setup only.
- Emission results which are unrelated to BLE transmitter extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements) in table-1 of section 2.3.5.

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1 INTRODUCTION

1.1 Scope

The purpose of this report is to present the results of compliance testing performed in accordance with RSS-GEN Issue 5, and FCC 47 CFR 15.207, 15.209 as specified by SMART Technologies. All test procedures, limits, criteria, and results described in this report apply only to the SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 86” IFP display test sample, referred to herein as the EUT (Equipment Under Test).

The sample has been provided by the customer.

This report does not imply product endorsement by the Electronics Test Centre, A2LA, nor any Canadian Government agency.

1.2 Applicant

This test report has been prepared for SMART Technologies, located in Calgary, Alberta, Canada.

1.3 Test Sample Description

As provided to ETC (Airdrie) by SMART Technologies:

Product Description	SMART QX Series BLE Module (Tool Sense Controller)
Panel Serial #	C080PW39C0014
Model number	IDQXMOD1
Frequency Range	2402 – 2480 MHz
Antenna Type/Gain	Flexible Printed Circuit / 4 dBi
Type Modulation	BLE / GFSK
Rated output power	0 dBm
Rated power (EIRP)	4 dBm
Data rate	1 Mbps
Software/Firmware	Atmosic RF Tool, Version 1.6.4 / Atmosic SDK, Version 5.1.0
Power	5 VDC

More detailed information is provided by SMART Technologies in Appendix A.

1.4 General Test Conditions

The EUT was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. All inputs and outputs to and from other equipment associated with the EUT were simulated as per the customer setup (refer to section 1.7 for details).

Where relevant, the EUT was only tested using the monitoring methods and test criteria defined in this report.

The environmental conditions are recorded during each test, and are reported in the relevant sections of this document.

1.5 Reference standards

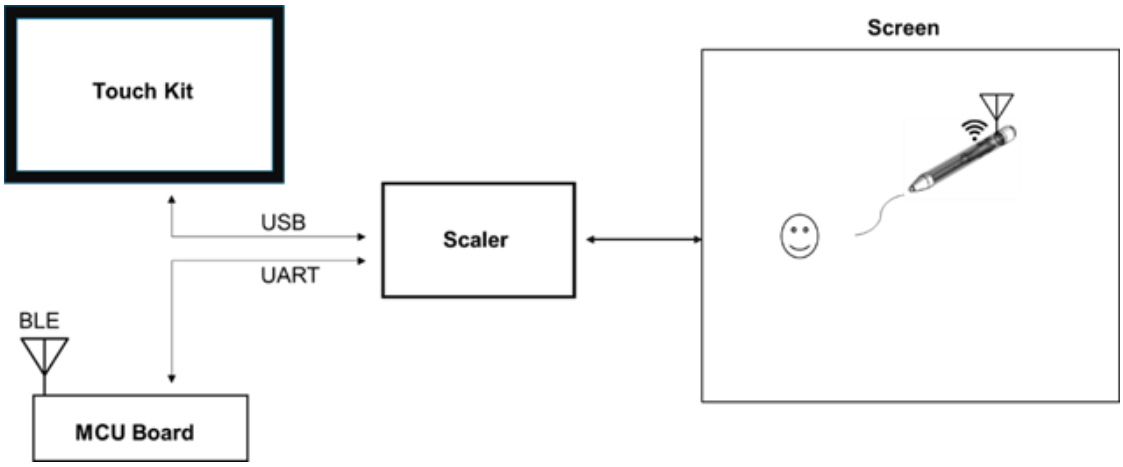
Standards	Description
RSS-GEN, Issue 5	General Requirements for Compliance of Radio Apparatus
FCC, title 47 CFR § 15.207	Intentional radiator, conducted emission limits
FCC, title 47 CFR § 15.209	Intentional radiator, radiated emission limits
FCC, title 47 CFR § 15.247	Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.
RSS-247 Issue 3 (08-2023)	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.10 (2013)	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.6 Acronyms and Abbreviations

Acronyms/Abbreviations	Description
AV	Average
BW	Bandwidth
dB	Decibel, ratio base 10
dBm	Decibel referenced to 1 mW
dBµV	Decibel reference to 1 µV
EUT	Equipment Under Test
ETC	Electronics Test Centre
GHz	Giga-Hertz
kHz	Kilo-Hertz
m	meter
mW	Milli-Watt
MHz	Mega-Hertz
PK	Peak
QP	Quasi-Peak
QC	Quality Check
SE/AE	Support/Auxiliary Equipment
µV	Micro-Volt

1.7 Test Sample Verification, Configuration & Modifications

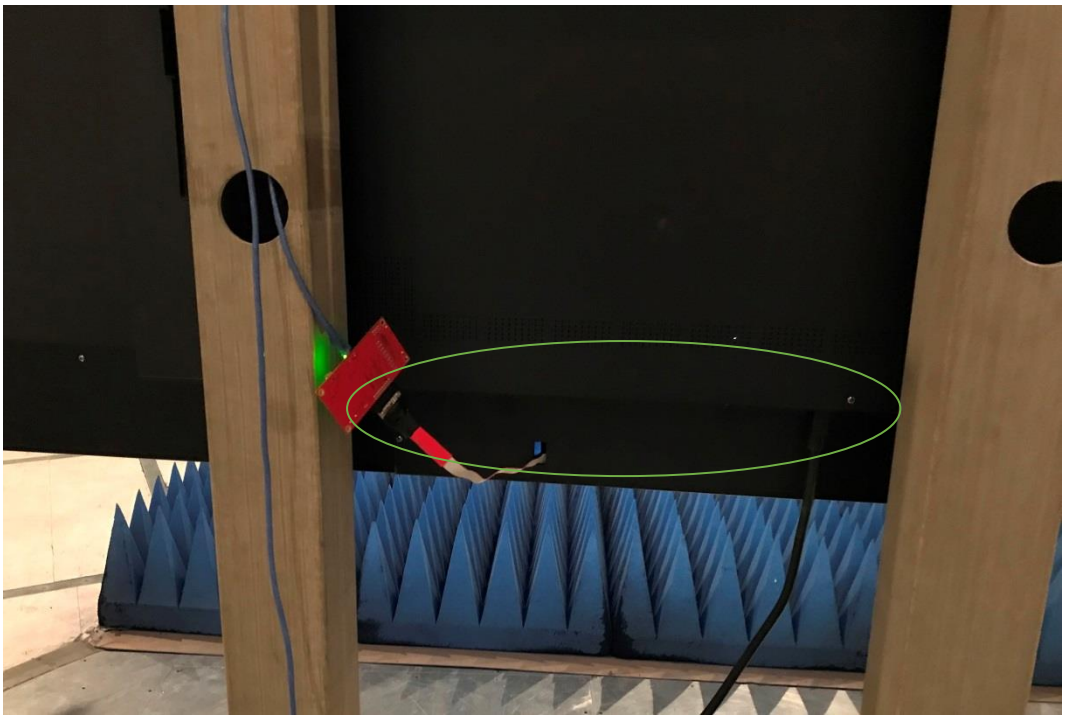
EUT setup, configuration, protocols for operation and monitoring functions are detailed here. Any modifications performed in order to meet the requirements, are detailed in each Test Case of Section 2 of this report.



During Radiated Emissions testing, the BLE module is configured to constantly transmit on the worse selected channel (High channel) using the provided SMART Tech laptop with the ATM RF Test Tool.

Note: The device is designed to be either wall mounted or floor standing (using mobile stand accessory) during operation. For the purposes of testing this large equipment it was impractical to test wall-mounted therefore the system was tested according to ANSI C63.10 as floor-standing equipment with the device mounted to a floor-standing mount. For radiated emissions testing as per ANSI C63.10: Where possible, the antenna(s) of the EUT shall be located at a height of 1.5 m above the floor, and the intentional radiator circuitry shall be located within the system at a height of at least 0.8 m above the floor. For this device the radiator circuitry and antennas are located at the bottom of the device which was 0.8m above the floor of the chamber for 86” panel. It was not practical to safely raise the system to have the antennas at the 1.5m height.

The radio module is located within the SMART IFP display (area contained within the green circle) with connection to the laptop through the ATM Interface Board mounted externally on the display. Any references to the ‘EUT’ in this report refer to the BLE module only. The SMART IFP display is considered support equipment and has already gone through the required testing.



1.8 Uncertainty of Measurement

The factors contributing to measurement uncertainty are identified and calculated in accordance with CISPR 16-4-2: 2011.

This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of k = 2.

Test Method	Uncertainty
Radiated Emissions Level (30 MHz – 1 GHz)	±5.8 dB
Radiated Emissions Level (1 GHz – 18 GHz)	±4.9 dB
Radiated Emissions Level (18 GHz – 26.5 GHz)	±5.0 dB
Conducted Emissions Level (150 kHz – 30 MHz)	±3.0 dB
Uncertainty Conducted Power level	±0.5 dB

2 TEST CONCLUSION

STATEMENT OF COMPLIANCE

The customer equipment referred to in this report was found to COMPLY with the requirements, as summarized below.

The measurement uncertainty is not accounted for determination of the statement of compliance. The statement of compliance is based only on the measurement value recorded.

The EUT was subjected to the following tests. Compliance status is reported as **Compliant** or **Non-compliant**. If testing was not performed at this time, the appropriate field is marked **n/t**. **N/A** indicates the test was Not Applicable to the EUT.

Note: *Maintenance of compliance is the responsibility of the Manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the EUT with respect to the standards detailed in this test report.*

The following table summarizes the tests performed in terms of the specification, class or performance criterion applied, and the EUT modification state.

Test Case	Test Type	Specification	Range	Test Sample	Result
§ 2.1	Conducted/Radiated Output power	FCC Part 15.247(b, 3), RSS-247 Issue 3, Clause 5.4(d), (a)	Low /MID/ High	QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within host product, Model: IDQR86-A	**Compliant**
§ 2.2	Radiated Band edge (Restricted Band)	FCC Part 15.209 RSS-GEN	Low / High		**Compliant**
§ 2.3	Radiated Spurious Emissions (Restricted Band)	FCC Part 15.209 RSS-GEN	9.0kHz – 26.5GHz		**Compliant**
§ 2.4	AC Main Conducted Emissions	FCC Part 15.207 RSS-GEN	150k – 30MHz		**Compliant**

Refer to the test data for applicable test conditions.

2.1 EIRP Output Power

Test Lab: Electronics Test Centre, Airdrie	**EUT: SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 86” IFP display**
Test Personnel: Brendan Van Hee Janet Mijares	**Standard: FCC15.247/RSS-247 Issue 3**
Date: 2023/12/07 (19.6°C, 21.8% RH) 2023/12/11 (20.0°C, 17.3% RH)	**Basic Standard: ANSI C63.10-2013**

EUT status: Compliant

Specification:

FCC Part 15.247(b, 3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

RSS-247 Issue 3, Clause 5.4(d): For DTSs employing digital modulation techniques operating in the bands 902 – 928 MHz and 2400 – 2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4W, except as provided in Section 5.4(e).

2.1.1 Test Guidance: ANSI C63.10-2013, Clause 9.5

Calculate the EIRP from the antenna port conducted emission by adding the transmit antenna dBi gain.

2.1.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.1.3 Test Equipment

Testing was performed with the following equipment:

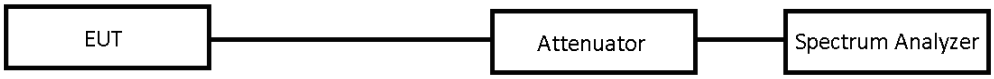
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2023-08-11	2024-08-11
Temp/Humidity	Extech	42270	5871	2023-04-14	2024-04-14
Antenna 1- 18GHz	EMCO	3115	19357	2022-10-05	2024-10-05
RE Cable	A.H. Systems Inc.	SAC-26G-5.23	6187	*2023-03-24	2024-03-24
Attenuator	Fairview Microwave	SA18N5WA-10	6886	Cal. before each use	
Coaxial Cables (RF)	W.L. Gore	Pgr10R01036.0	-	Cal. before each use	

* In house cable loss verification performed.

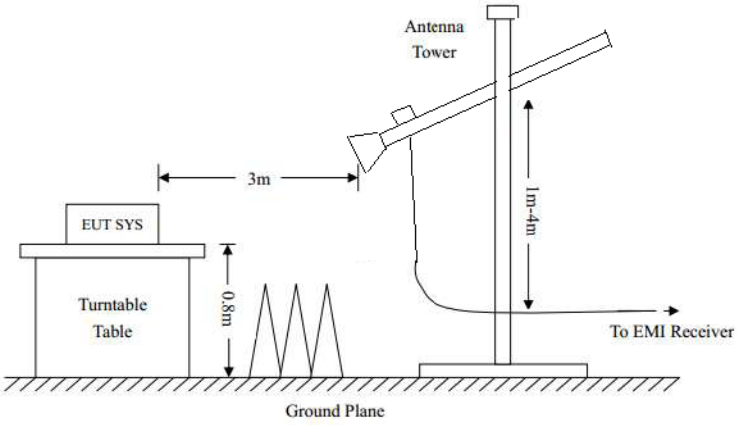
2.1.4 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation

Test setup diagrams for Conducted EIRP testing:



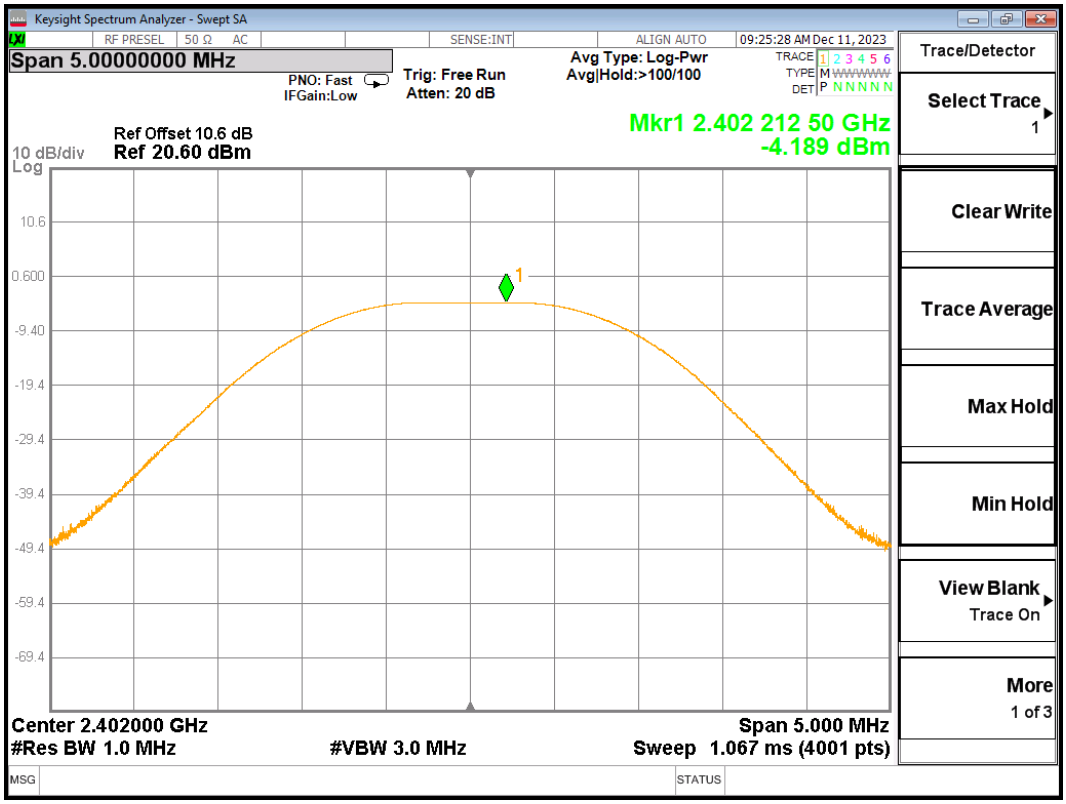
Test setup diagrams for Radiated EIRP testing:



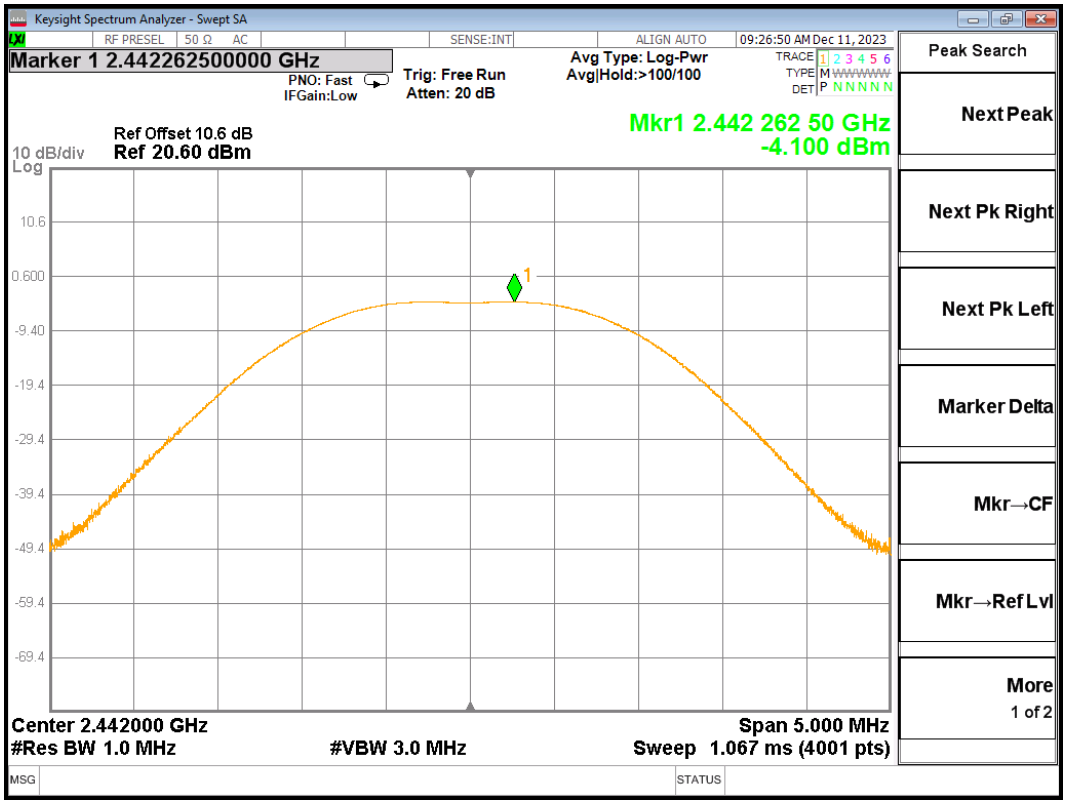
2.1.5 EIRP Data (Conducted)

Frequency (MHz)	Conducted Reading (dBm)	Max Antenna Gain dBi	EIRP dBm	EIRP (Watts)	EIRP Limit (Watts)
Conducted Output Power Measurement					
2402	-4.189	4	-0.189	0.0009574	≤ 4 (36dBm)
2442	-4.100	4	-0.1	0.0009772	
2480	-3.958	4	0.042	0.00101	

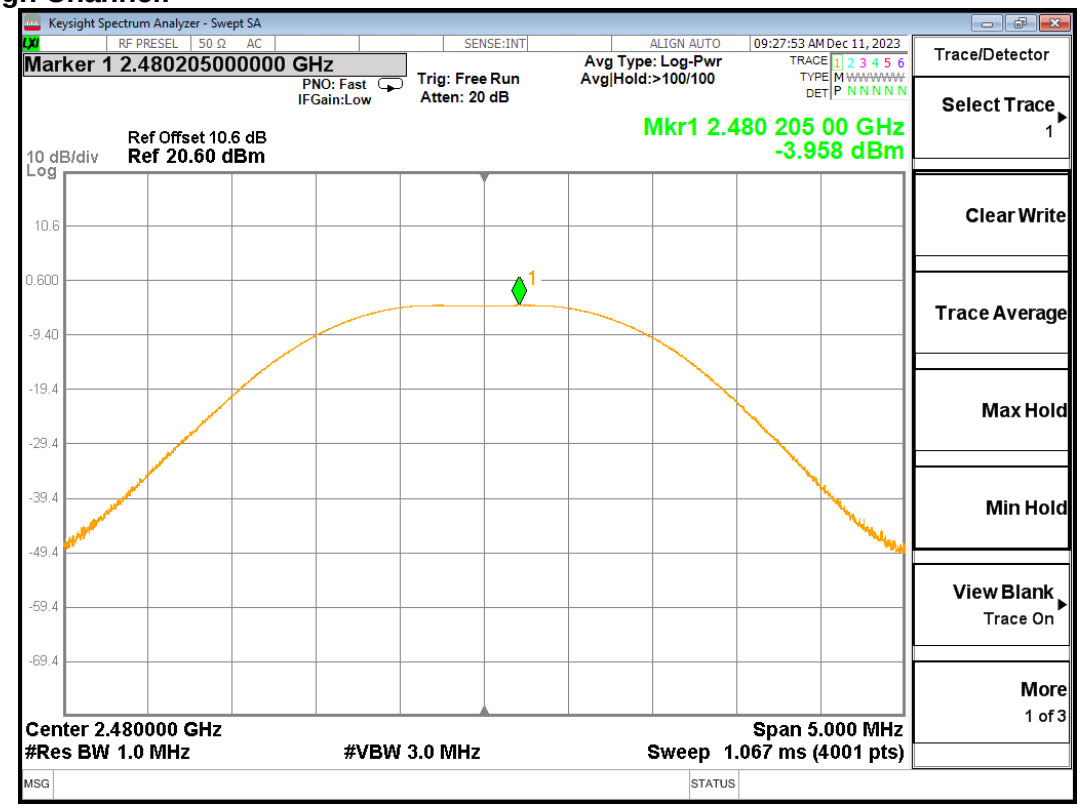
Low Channel:



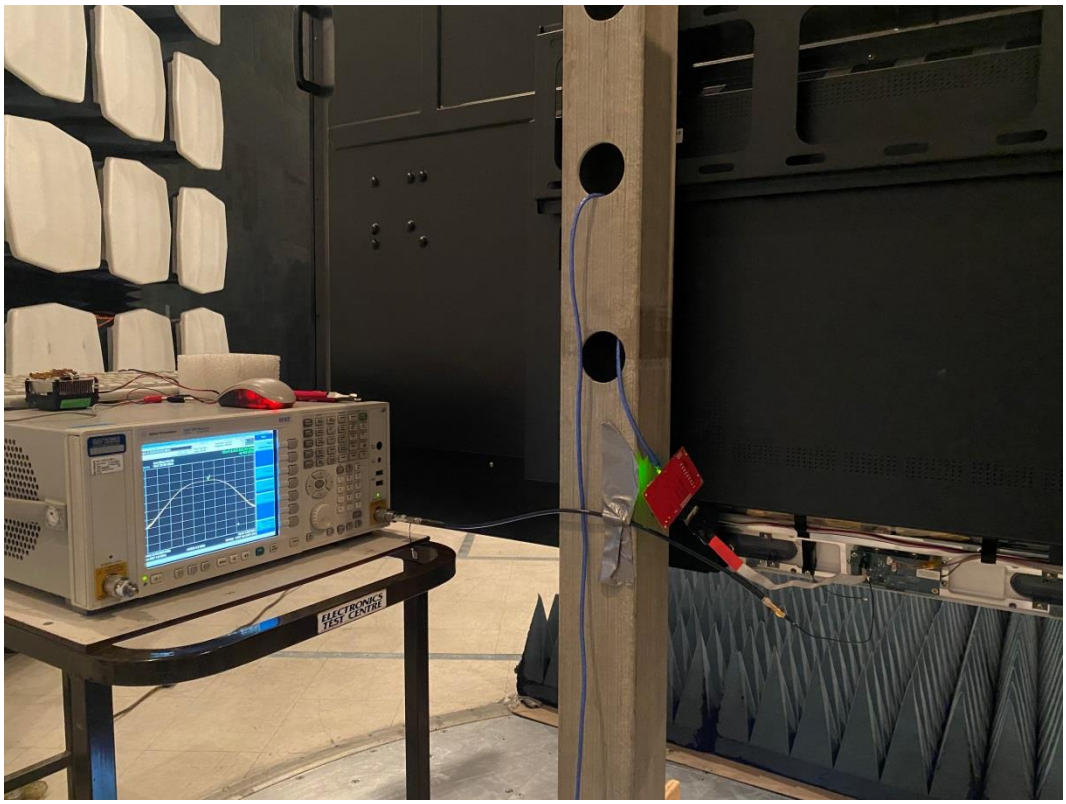
MID Channel:



High Channel:



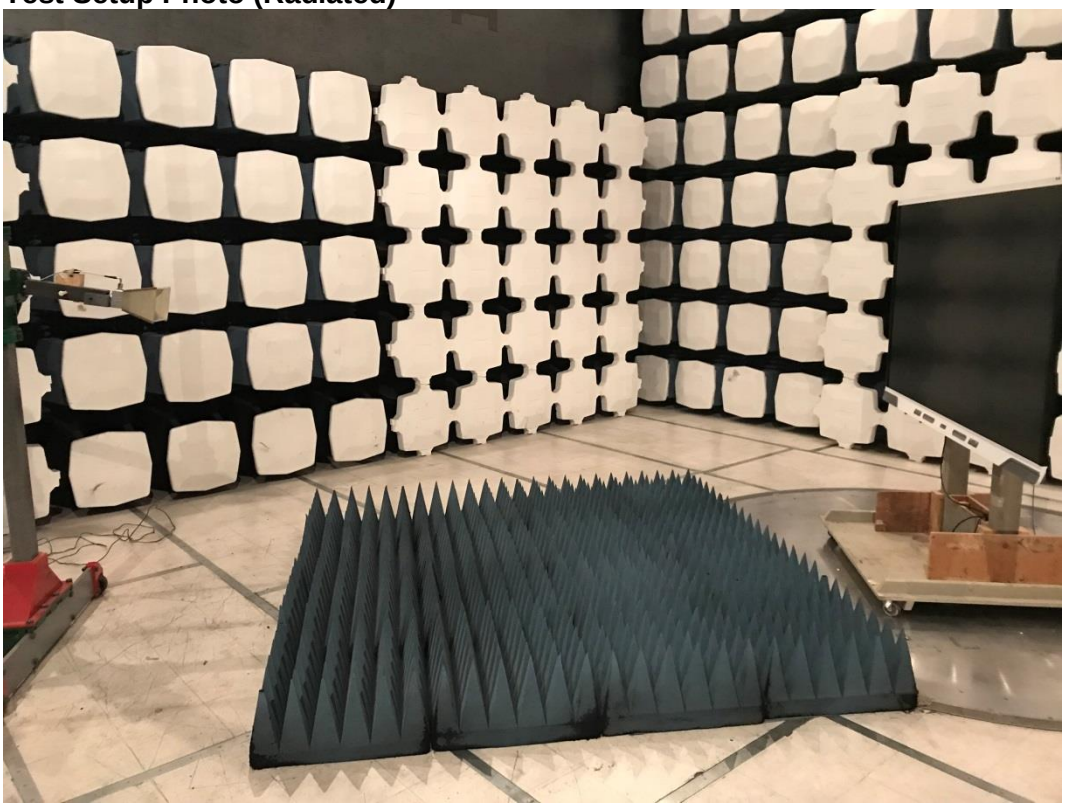
Setup Photo Conducted:



2.1.6 EIRP Data (Radiated)

Maximized Radiated Output power Measurement					
Polarity	**Frequency (MHz)**	**Corrected Field Strength Reading (dBµ/m)**	**Converting Field Strength to dBm (dBµ/m -95.3) (EIRP dBm)**	**EIRP (Watts)**	**EIRP Limit (Watts)**
Horizontal	2402	89.05	-6.25	0.0002371	≤ 4 (36dBm)
	2442	86.26	-9.04	0.0001247	
	2480	89.39	-5.91	0.0002564	
Vertical	2402	91.7	-3.6	0.0004365	
	2442	92.65	-2.65	0.00054325	
	2480	94.47	-0.83	0.00082604	

Test Setup Photo (Radiated)



2.2 Radiated Band Edge (Restricted-band band-edge)

Test Lab: Electronics Test Centre, Airdrie	**EUT: SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 86” IFP display**
Test Personnel: B. Van Hee	**Standard: FCC Part 15.209, RSS-GEN**
Date: 2023/12/08 (20.1°C,20.0% RH)	**Basic Standard: ANSI C63.10**

EUT status: Compliant

2.2.1 Test Guidance

Above 1000 MHz, measurements are performed with a DRG Horn antenna and a resolution bandwidth of 1 MHz.

Low and high channels are optimized. The EUT is rotated in azimuth over 360 degrees and the azimuth of maximum value is noted and antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum value. Then the maximum level is measured with the appropriate peak and average detector and recorded.

2.2.2 Deviations From The Standard

There were no deviations from the EUT setup or methodology specified in the standard.

2.2.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date YYYY/MM/DD	Cal. Due YYYY/MM/DD
EMC Software	UL	Ver. 9.5	SWE021	N/A	
EMI receiver	Agilent	N9038A (FW v. A.25.05)	6130	2023-08-11	2024-08-11
DRG Horn	EMCO	3115	19357	2022-10-05	2024-10-05
T/H Logger	Extech	42270	5892	2023-04-14	2024-04-14
RE Cable	A.H. Systems Inc.	SAC-26G-5.23	6187	*2023-03-24	2024-03-24

* In house cable loss verification performed.

2.2.4 Band Edge Data

Test Channel	Frequency (MHz)	Detector	Correction Factor (Antenna + Cable Loss) (dB)	DCCF (dB)	Corrected Level (dBµv/m)	Limit@3m (dBµv/m)	Margin (dB)
LOW	2390	Peak	32.2	-	51.57	74	-22.43
	2390	Average		-8.53	33.381	54	-20.619
High	2483.60	Peak	32.5	-	54.255	74	-19.745
	2483.60	Average		-8.53	33.924	54	-20.076

Receiver Reading in dBµV + Correction factor offset (dB/m + dB) + DCCF (dB) = Corrected Field Strength in dBµV/m.

Notes:

- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum emission value. The reported measurement is obtained with the appropriate peak and Average detector after the height and azimuth have been adjusted for maximum emission.
- Antenna factor (dB/m) and cable loss (dB) together used as offset in the receiver setting.
- Test mode Duty Cycle (D) = 53.4% (.534)

  DCCF = 10log (1/D) = 10log (1/.534) = 2.72 dB

  Maximum operating duty cycle (D) = 7.5% (0.075)

  DCCF = 10log (1/D) = 10log (1/.075) = 11.25 dB

  DCCF applied to Band edge Avg measurements = (Test mode duty cycle) – (Max operating duty cycle)

  DCCF = 2.72 - 11.25

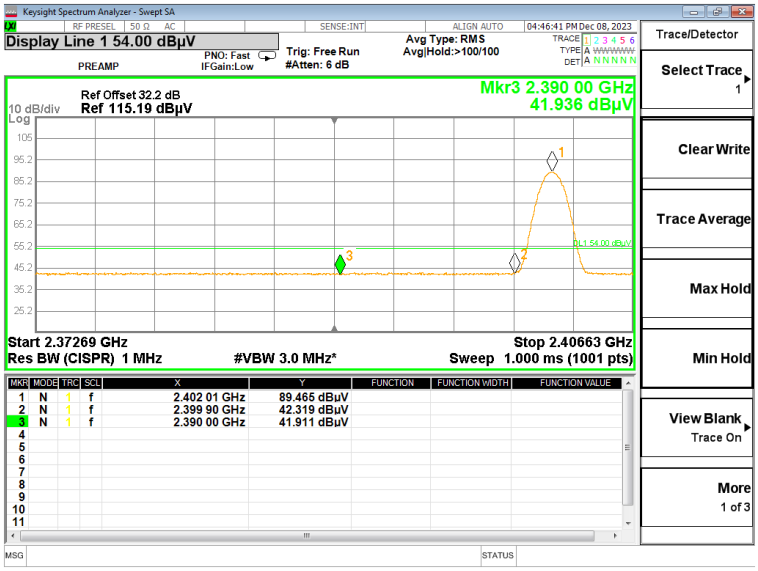
  DCCF = -8.53 dB

Negative values for Delta indicate compliance.

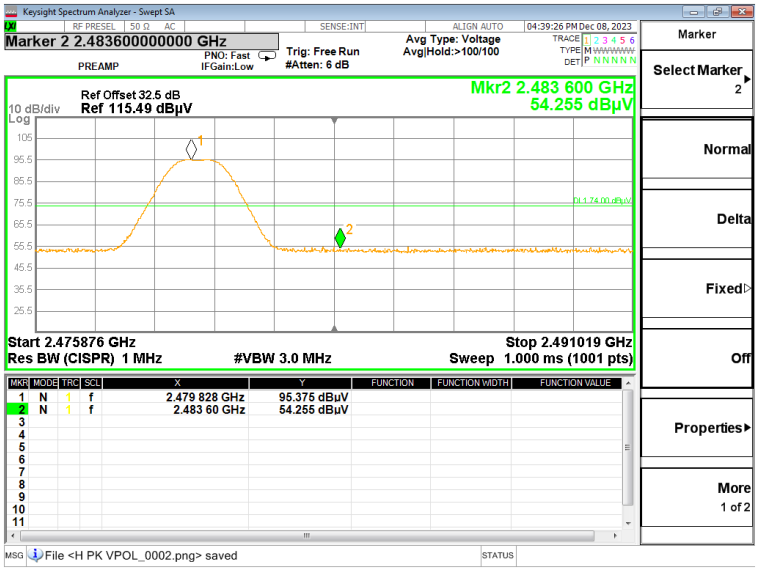
Test Plots:

Low Channel Peak

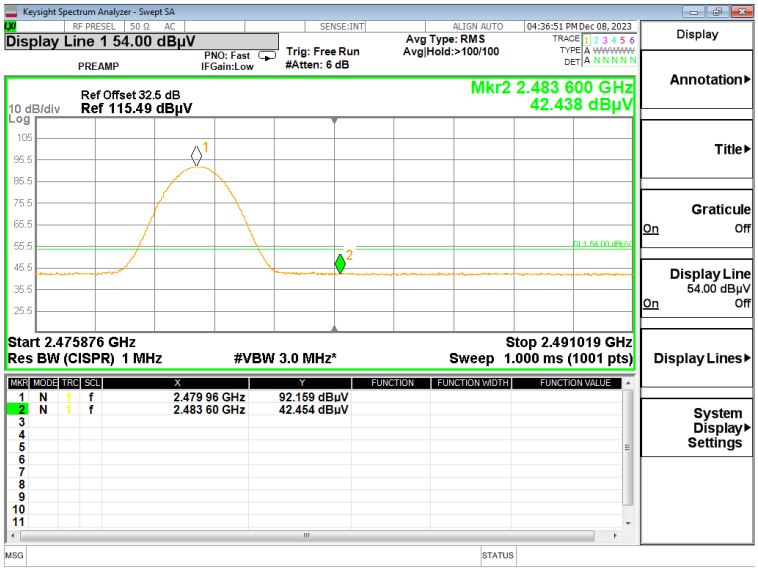
Low Channel Average



High Channel Peak

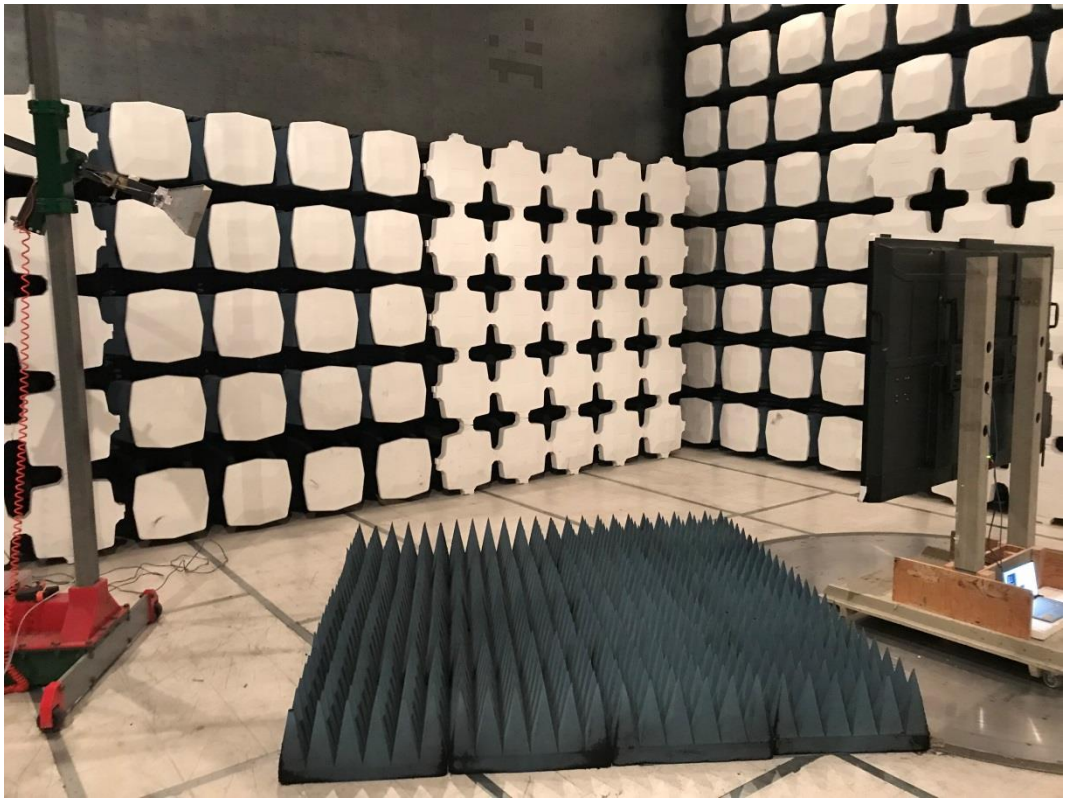


High Channel Average

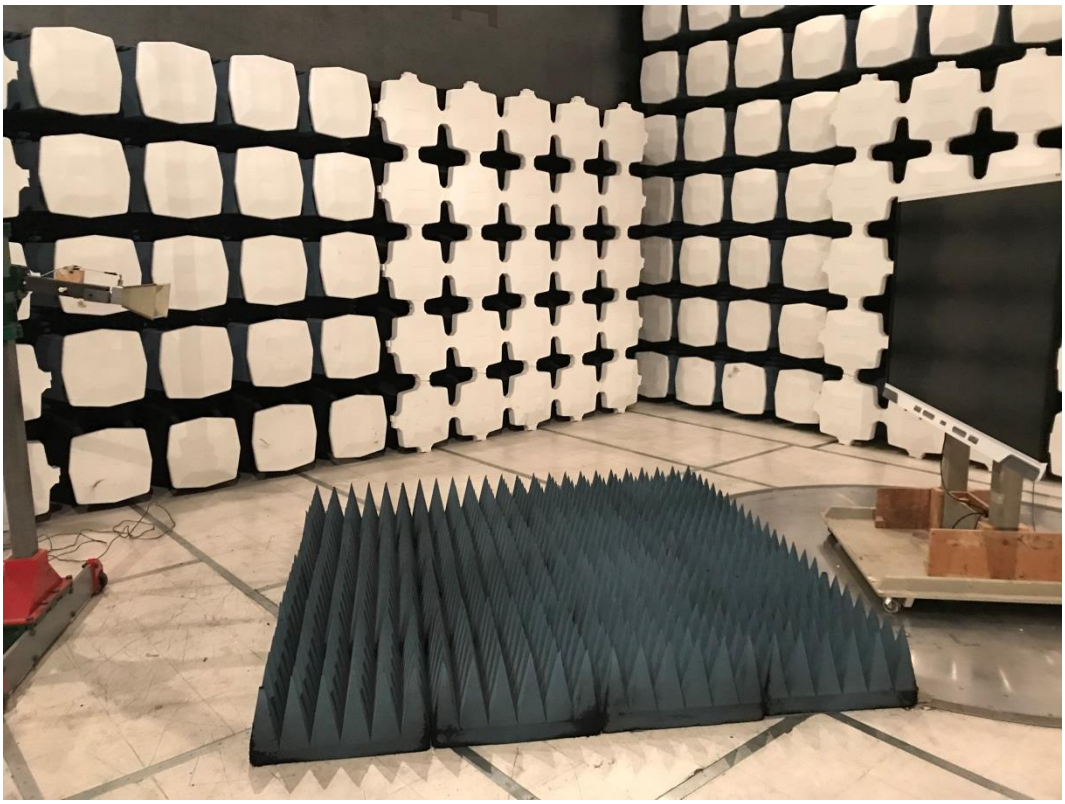


Setup Photo:

Horizontal:



Vertical:



2.3 Radiated Spurious Emissions

Test Lab: Electronics Test Centre, Airdrie **Test Personnel: B. Van Hee** **Date: 2023/12/07 (19.6°C, 21.8% RH)** **2023/12/08 (20.1°C,20.0% RH)**	**EUT: SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 86” IFP display** **Standard: FCC Part 15.209, RSS-GEN** **Basic Standard: ANSI C63.10**
EUT status: Compliant	

Specification: FCC Part 15.209 / RSS-GEN

Frequency (MHz)	Limit 3m (dBµV/m)
0.009 – 0.490	128.5 – 93.8
0.490 – 1.705	73.8 – 62.97
1.705 – 30	69.54 – 69.54
30 – 88	40
88 – 216	43.52
216 – 960	46.02
Above 960	53.98

Criteria: The radiated emissions produced by a radio device falling in restricted band, measured at a distance of 3 meters, shall not exceed the 15.209/RSS-GEN limits.

Frequency (MHz)	Class A FCC Part 15 10 m Limit (dBµV/m)	Class A FCC Part 15 3 m Limit (dBµV/m)
30 – 88	39.08	49.54
88 – 216	43.50	53.98
216 – 960	46.44	56.90
Above 960	49.54	60.00

Criteria: The radiated emissions produced by a digital device, measured at a distance of 3 meters, shall not exceed the Class A limit

FCC Part 15.205 Restricted Band List			
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	
13.36–13.41			

2.3.1 Test Guidance

From 30 MHz to 1000 MHz, measurements are performed with a broadband biconilog antenna and a resolution bandwidth of 120 kHz.

Above 1000 MHz, measurements are performed with a DRG Horn antenna or a Standard Gain horn, and a resolution bandwidth of 1 MHz.

The scan is performed at discreet increments of turntable azimuth and stepped antenna height, with peak detector and Max Hold function which are selected in accordance with the applicable standard in order to assure capture of frequencies of interest. Optimization is performed based on the scan data.

After the scan is completed, the frequencies of interest are optimized. The EUT is rotated in azimuth over 360 degrees and the direction of maximum emission is noted.

Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the appropriate detector and recorded. This may produce a different reading than the pre-scan trace. Up to 1 GHz, measurements are performed with a Quasi-Peak detector. Above 1 GHz, measurements are recorded with Peak and/or Average detectors, as applicable.

RSS-247 Issue 3 Clause 5.5 (unwanted Emission)

In any 100 kHz 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 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 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 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. **Attenuation below the general field strength limits specified in RSS-Gen is not required.**

FCC Part 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)).**

2.3.2 Deviations From The Standard

There were no deviations from the EUT setup or methodology specified in the standard.

2.3.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date YYYY/MM/DD	Cal. Due YYYY/MM/DD
EMC Software	UL	Ver. 9.5	SWE021	N/A	
EMI receiver	Agilent	N9038A (FW v. A.25.05)	6130	2023/08/11	2024/08/11
Active Loop Antenna	EMCO	6502	10868	2023/06/21	2025/06/21
Biconilog Antenna	SunAR	JB1	6905	2023/11/29	2025/11/29
DRG Horn (1 – 18 GHz)	EMCO	3115	19357	2022/10/05	2024/10/05
STD Horn (18-26 GHz)	Quinstar	QWH-KRPS00	6163	2022-10-10	2025-10-10
T/H Logger	Extech	42270	5892	2023/04/14	2024/04/14
Notch filter (2.4-2.5 GHz)	Micro-Tronics	BRM50702	6953	*Monitored	
Low Noise Amplifier (1-18 GHz)	MITEQ	JS43-01001800-21-5P	4354	*Monitored	
Low Noise Amplifier (18-26 GHz)	MITEQ	JS44-01002650-33-3P	6163	*Monitored	
Pre-Amplifier (0.1-1.3 MHz)	HP	8447D	9291	*Monitored	

* In house loss / gain verification performed.

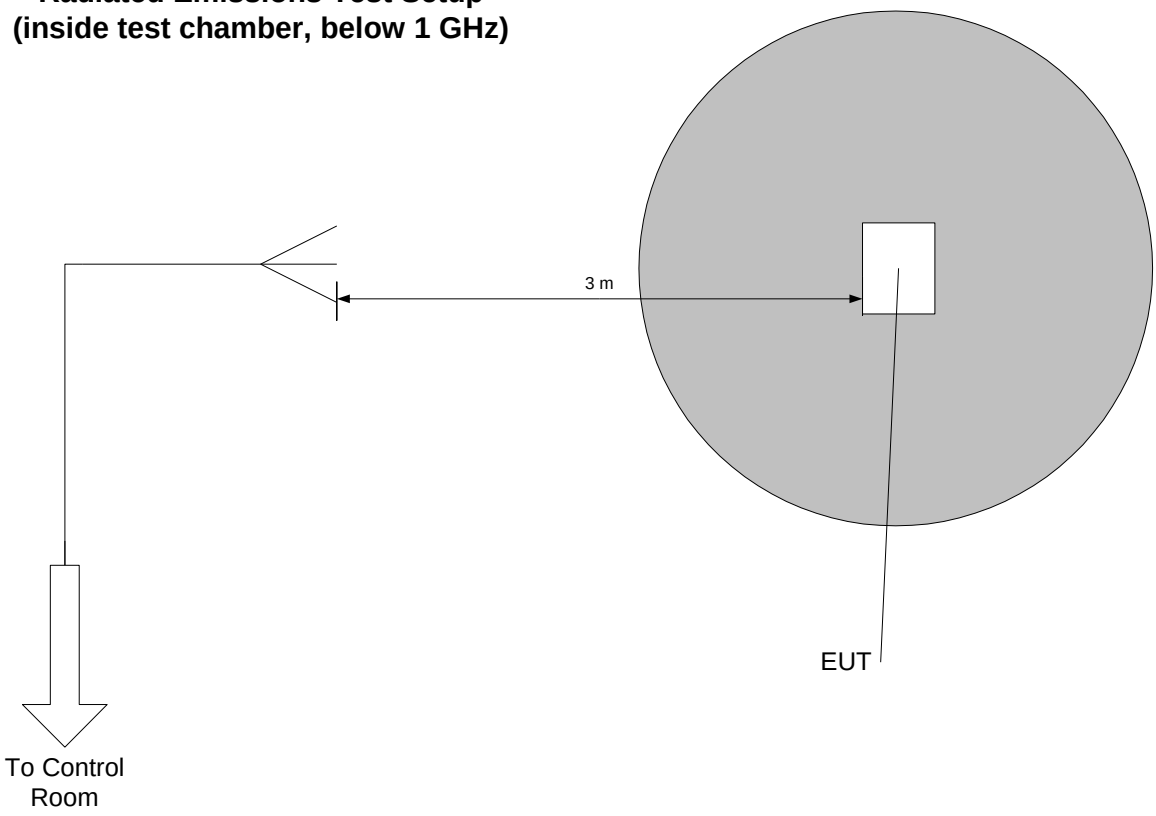
2.3.4 Test Sample Verification, Configuration & Modifications

See diagram in section 1.7

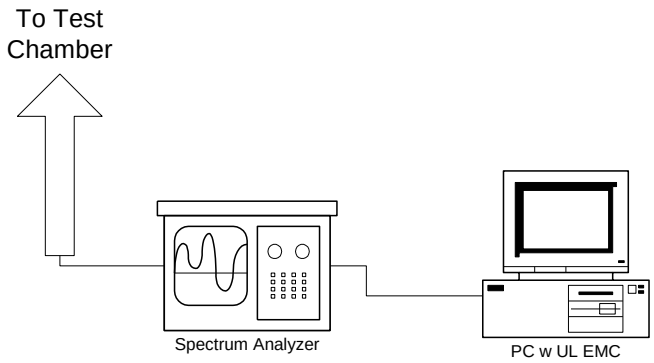
The EUT met the requirements without modification.

Prior to the test, each channel’s radiated power was measured to determine the worse channel which would be used for the detailed compliance measurement. High channel 2480 MHz was found in both conducted and radiated output measurement as worse channel and used for full radiated spurious emission analysis.

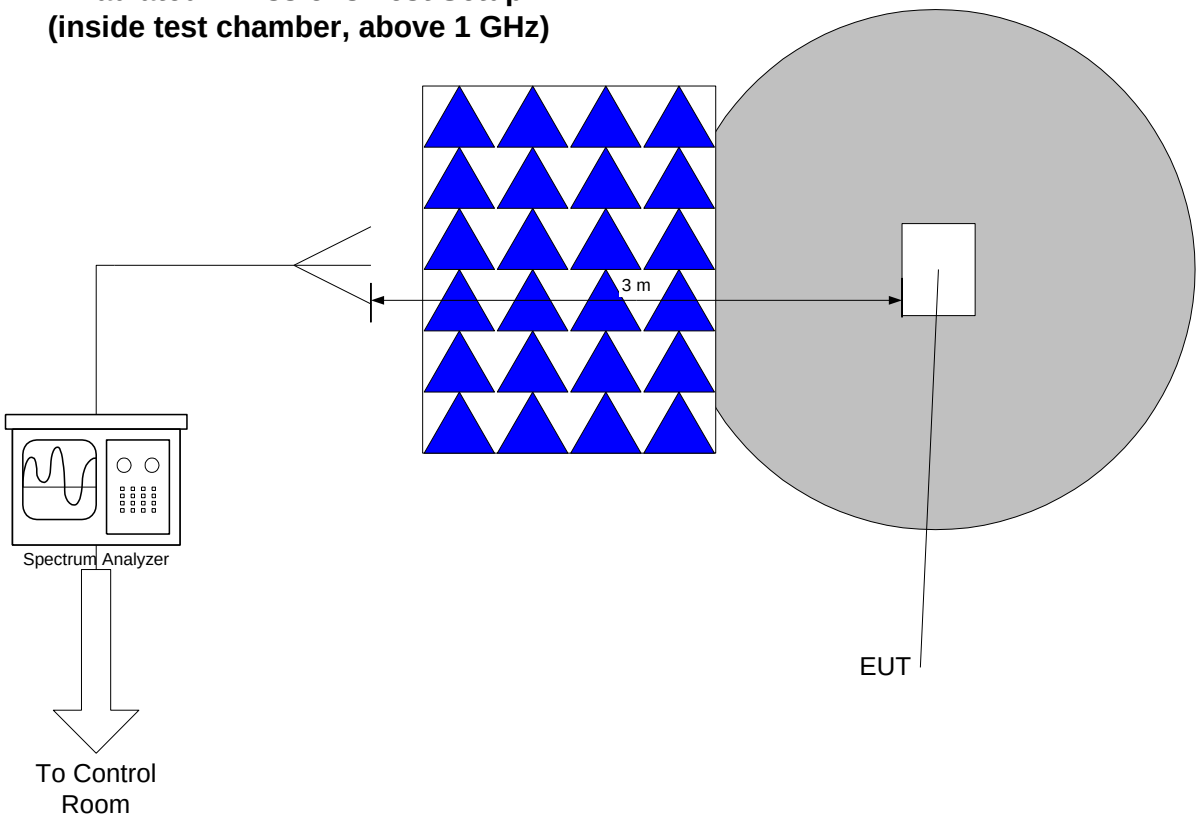
Radiated Emissions Test Setup (inside test chamber, below 1 GHz)



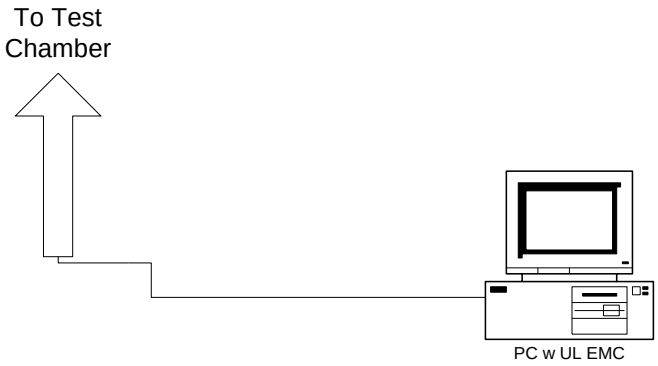
Radiated Emissions Test Setup (inside control room, below 1 GHz)



Radiated Emissions Test Setup (inside test chamber, above 1 GHz)



Radiated Emissions Test Setup (inside control room, above 1 GHz)



2.3.5 Radiated Emissions Maximized Data (High Channel)

The emissions data are presented in tabular form, showing turntable azimuth, antenna height and polarization, the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value of the limit at the frequency investigated, and the Delta between the result and the limit.

Table-1 below 1GHz

Freq. Marker	Freq. [MHz]	Raw reading[dBµV]	Det	Antenna Factor [dB/m]	Cable Loss [dB]	Corrected Reading [dBµV/m]	Class A 10 m Limit [dBµV/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	*13.5648	28.8	QP	10.7	0.9	40.4	[1]69.56	-29.16	231	150	Parallel
1	*13.5625	36.3	QP	10.7	0.9	47.9	[1]69.56	-21.66	297	150	Perpendicular
1	*34.8594	32.67	QP	21.7	-24.7	19.21	39.08	-19.87	9	394	Horizontal
2	*46.7953	43.87	QP	13	-24.5	21.91	39.08	-17.17	194	395	Horizontal
3	*63.9875	53.42	QP	11.9	-24.2	30.66	39.08	-8.42	353	286	Horizontal
4	*76.3924	44.44	QP	12	-23.9	22.08	39.08	-17.0	358	261	Horizontal
5	*483.8993	30.03	QP	21.7	-20.8	20.47	46.44	-25.97	53	229	Horizontal
6	*34.8188	41.1	QP	21.7	-24.7	27.64	39.08	-11.44	295	107	Vertical
7	*46.374	48.91	QP	13.2	-24.5	27.15	39.08	-11.93	282	105	Vertical
8	*50.812	54.95	QP	11.5	-24.4	31.6	39.08	-7.49	343	107	Vertical
9	*60.3745	55.52	QP	11.5	-24.2	32.36	39.08	-6.72	334	105	Vertical
10	*63.9359	52.71	QP	11.9	-24.2	29.95	39.08	-9.13	48	105	Vertical
11	*80.7562	44.99	QP	11.7	-23.9	22.33	39.08	-16.75	195	105	Vertical

Note FCC15.31: When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements). Test results are extrapolated from measured at 3m to 10m.

*** Not falling in restricted band meet Class A limit**

[1]15.209 Limit

Meter Reading in dBµV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dBµV/m.

Notes:

- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discreet increments of height and azimuth, while the reported measurement is obtained with the appropriate Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency 13.56 MHz resulted in a level of 40.4 dBuV/m, which is equivalent to 40.4-51.5 = -11.1 dBuA/m, which has the same margin, 29.16 dB, to the corresponding RSS-GEN Table 6 limit as it has to be 15.209(a) limit.
- QP = Quasi-Peak detector

Negative values for Delta indicate compliance.

Table-2 above 1GHz

Freq. Marker	Freq. [GHz]	Raw reading [dBµV]	Det	Antenna Factor [dB/m]	Cable Loss [dB]	Corrected Reading [dBµV/m]	RSS-GEN FCC 15.209 Limit [dBµV/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	2.9726	40.54	AV	29.9	-32.4	38.04	54	-15.96	243	383	Horizontal
		56.77	PK			54.27	74	-19.73			
2	*2.0933	35.56	AV	27.9	-29.7	33.76	54	-20.24	165	234	Vertical
		49.24	PK			47.44	74	-26.56			
3	2.9679	39.4	AV	29.9	-32.4	36.9	54	-17.10	44	238	Vertical
		55.06	PK			52.56	74	-21.44			
4	5.9425	25.23	AV	33.9	-29.4	29.73	54	-24.27	278	396	Horizontal
		41.35	PK			45.85	74	-28.15			
5	*7.4408	36.41	AV	36.6	-26.3	46.71	54	-7.29	144	168	Horizontal
		45.85	PK			56.15	74	-17.85			
6	8.8998	21.23	AV	37.3	-24.0	34.53	54	-19.47	180	168	Horizontal
		36.99	PK			50.29	74	-23.71			
7	*17.9362	12.54	AV	46.7	-15.9	43.34	54	-10.66	315	149	Horizontal
		25.31	PK			56.11	74	-17.89			
8	4.3098	39.57	AV	32.1	-31.2	40.47	54	-13.53	166	286	Vertical
		44.7	PK			45.6	74	-28.40			
9	5.9396	27.74	AV	33.9	-29.4	32.24	54	-21.76	159	265	Vertical
		44.77	PK			49.27	74	-24.73			
10	*7.4394	38.99	AV	36.6	-26.3	49.29	54	-4.71	154	264	Vertical
		46.79	PK			57.09	74	-16.91			
11	8.9204	22.69	AV	37.3	-24.3	35.69	54	-18.31	143	260	Vertical
		40.31	PK			53.31	74	-20.69			
12	14.8498	21.33	AV	41.5	-20.6	42.23	54	-11.77	231	257	Vertical
		34.72	PK			55.62	74	-18.38			
13	*17.8815	11.97	AV	46.7	-16.2	42.47	54	-11.53	23	393	Vertical
		25.73	PK			56.23	74	-17.77			
1	*19.8424	28.22	AV	34.9	-21.4	41.72	54	-12.27	174	197	Horizontal
		41.99	PK			55.49	74	-18.53			
2	*19.842	26.84	AV	34.9	-21.4	40.34	54	-13.64	119	190	Vertical
		39.66	PK			53.16	74	-20.86			

**** Emissions fell into the restricted band and met 15.209 limits. Rest emissions are out of the restricted band, and 15.209 limits are not applicable, but they still meet the 209 limit, considering it the worst case senior.***

Meter Reading in dBµV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dBµV/m.

Notes:

- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discreet increments of height and azimuth, while the reported measurement is obtained with the appropriate Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- AV = Average detector; PK = Peak detector

Negative values for Delta indicate compliance.

Test mode Duty Cycle (D) = 53.4% (.534)

DCCF = 10log (1/D) = 10log (1/.534) = 2.72 dB

Maximum operating duty cycle (D) = 7.5% (0.075)

DCCF = 10log (1/D) = 10log (1/.075) = 11.25 dB

DCCF applied to harmonic Avg measurements = (Test mode duty cycle) – (Max operating duty cycle)

DCCF = 2.72 - 11.25

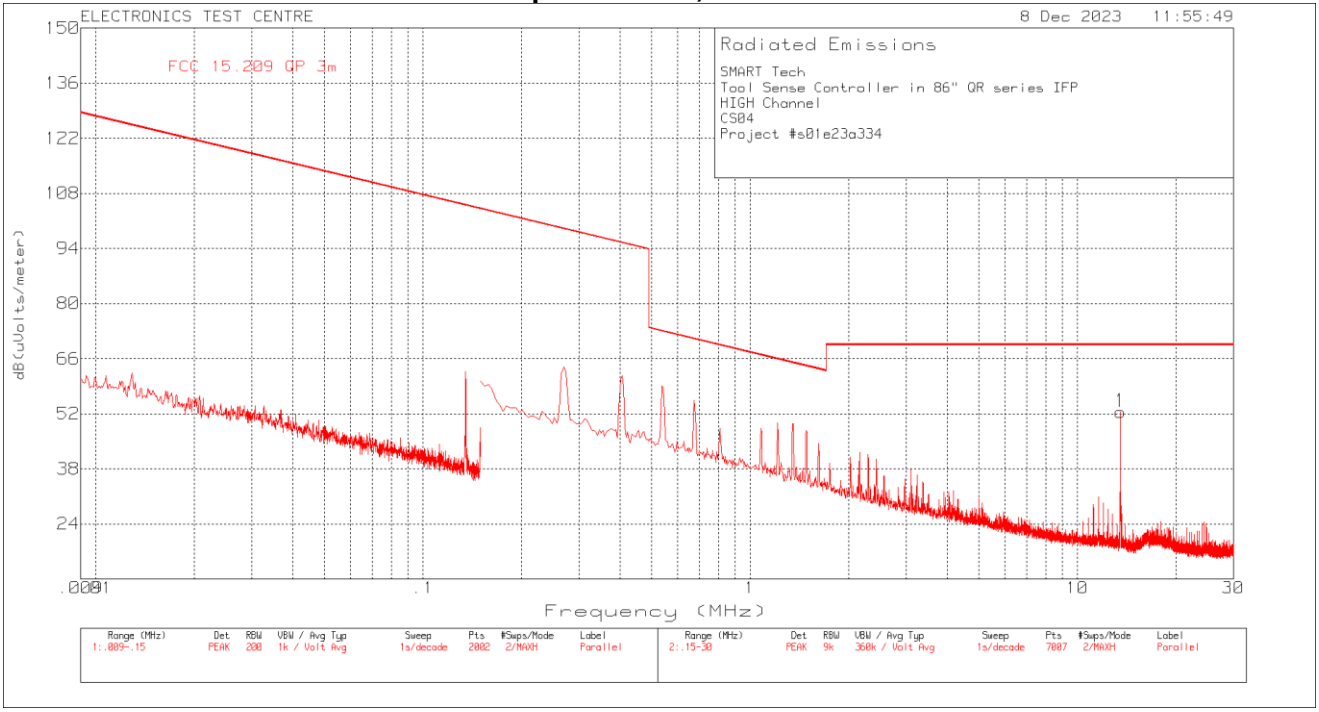
DCCF = -8.53 dB

Freq. Marker	Freq. [GHz]	Measured AV Reading [dBµV/m]	D.C Correction Factor (dB)	Corrected Average Value [dBµV/m]	RSS-GEN FCC 15.209 Limit [dBµV/m]	Delta [dB]	Polarization
2	2.0933	33.76	-8.53	25.23	54	-28.77	Vertical
5	7.4408	46.71	-8.53	38.18	54	-15.82	Horizontal
7	17.9362	43.34	-8.53	34.81	54	-19.19	Horizontal
10	7.4393	49.29	-8.53	40.76	54	-13.24	Vertical
13	17.8815	42.47	-8.53	33.94	54	-20.06	Vertical
1	19.8420	41.72	-8.53	33.19	54	-20.81	Horizontal
2	19.842	40.34	-8.53	31.81	54	-23.28	Vertical

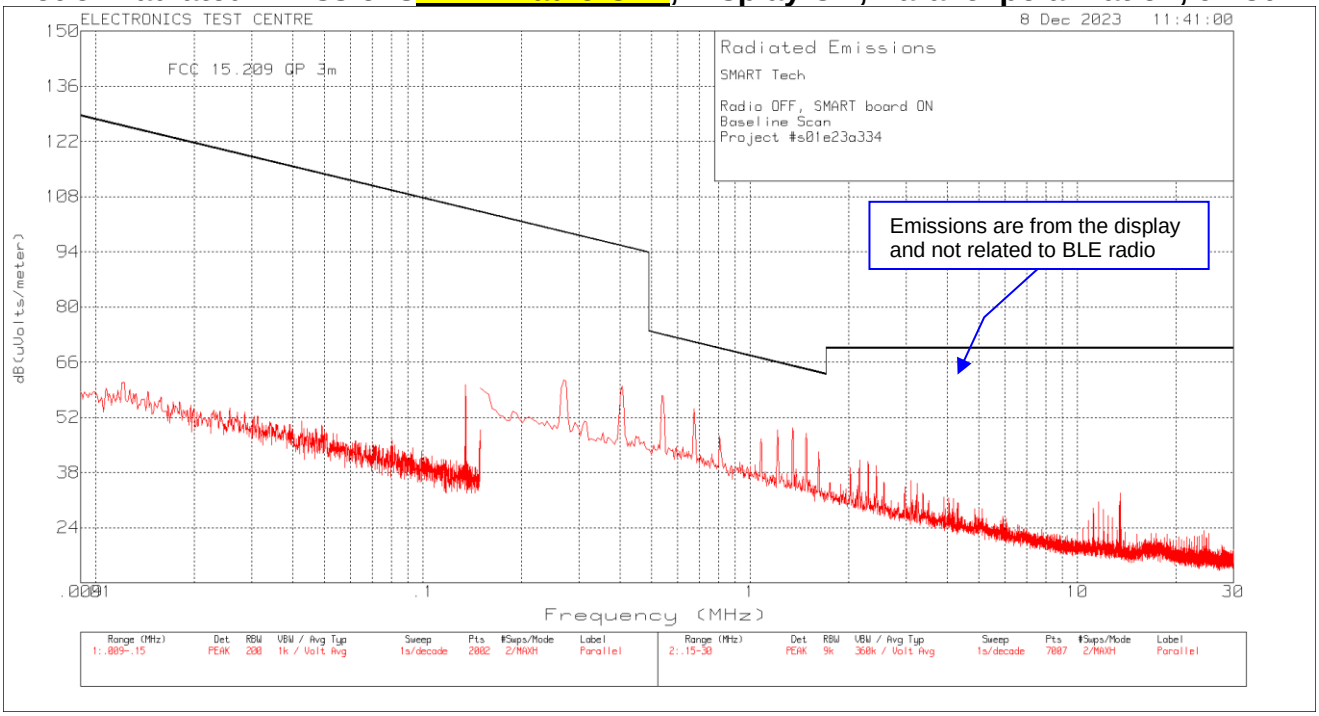
- Measured average reading using linear average detector during radiated emission is corrected with operating duty cycle correction factors.

Negative values for Delta indicate compliance.

Plot of Radiated Emissions: Parallel polarization, 9k-30MHz

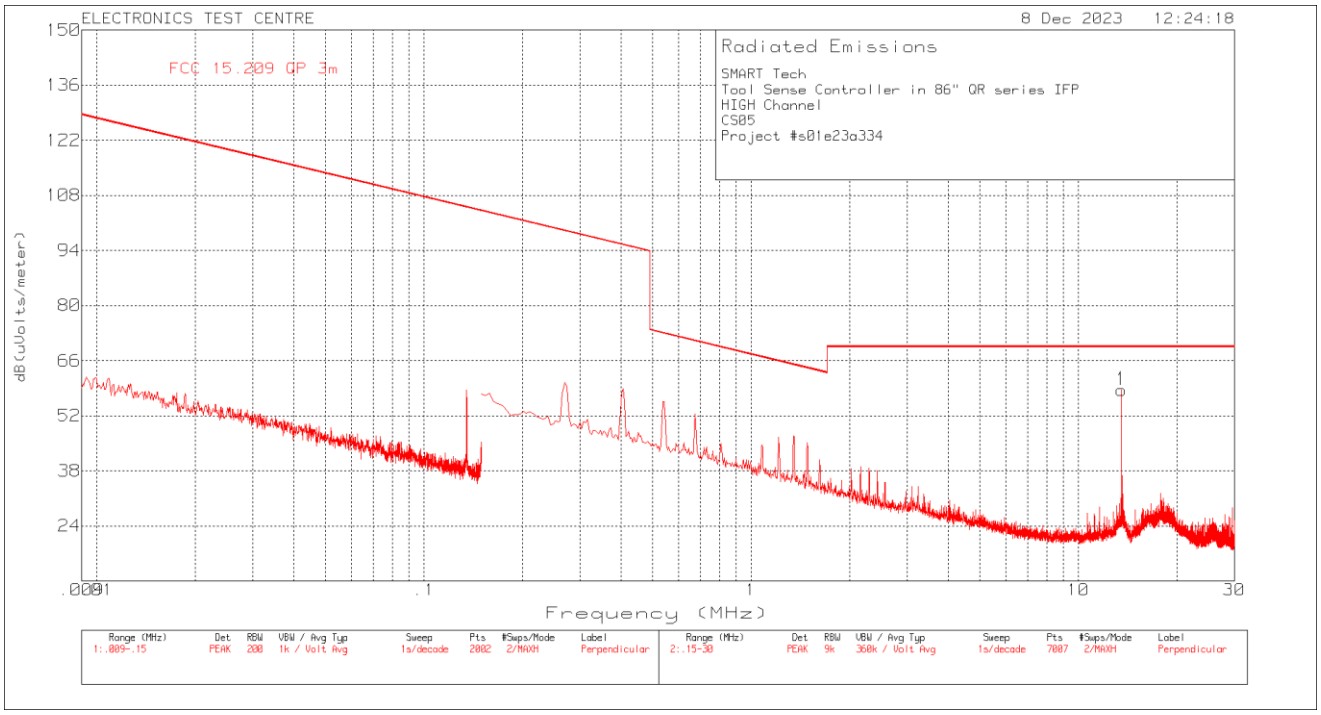


Plot of Radiated Emissions: BLE Radio OFF, Display ON, Parallel polarization, 9k-30MHz

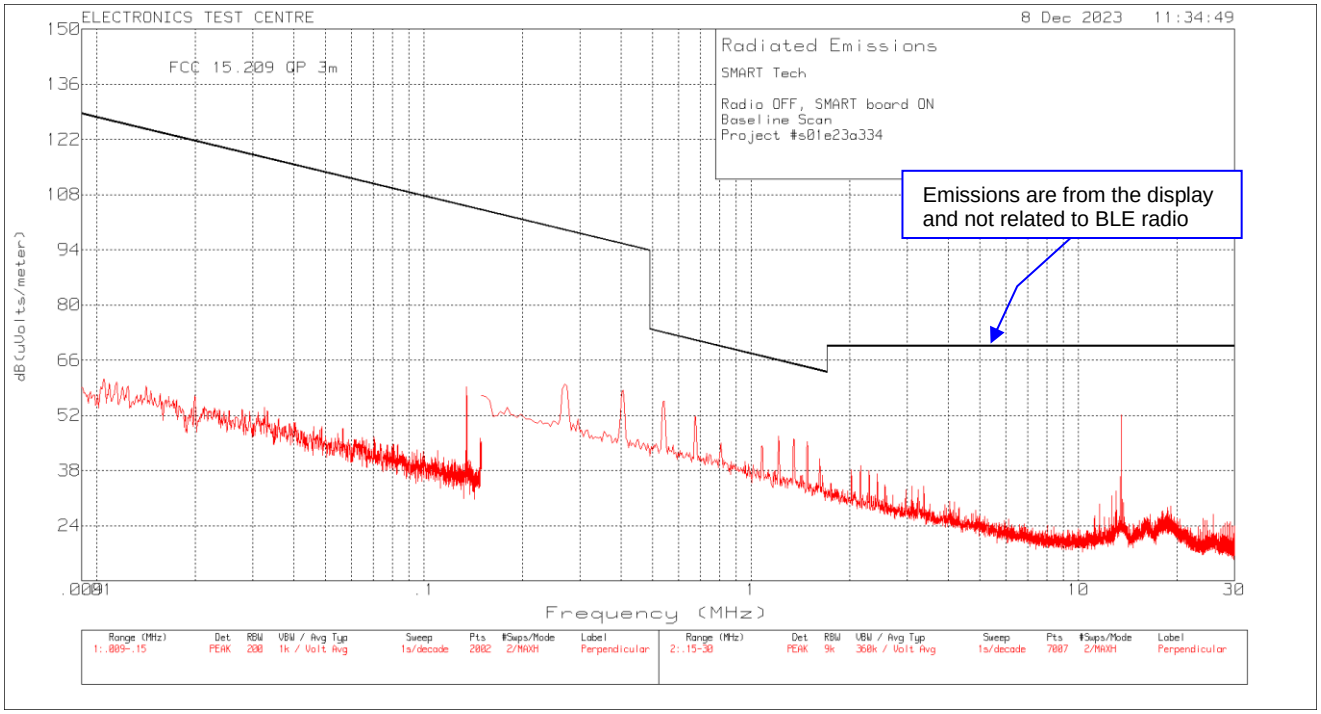


Note: Magnetic Field Strength dBµA/m = dBµV/m – 51.5
Electric Field Strength (dBµV/m) = dBµA/m + 51.5

Plot of Radiated Emissions: Perpendicular polarization, 9k-30MHz

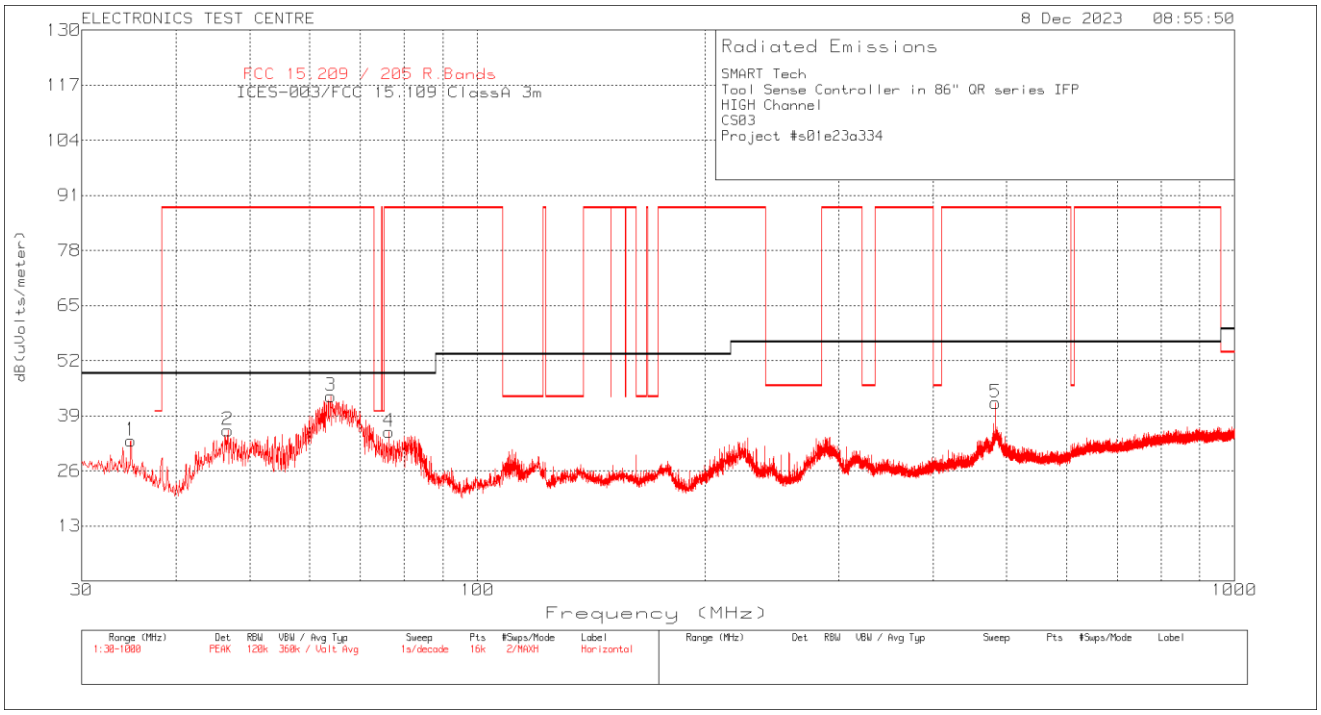


Plot of Radiated Emissions: BLE Radio OFF, Display ON, Perpendicular polarization, 9k-30MHz

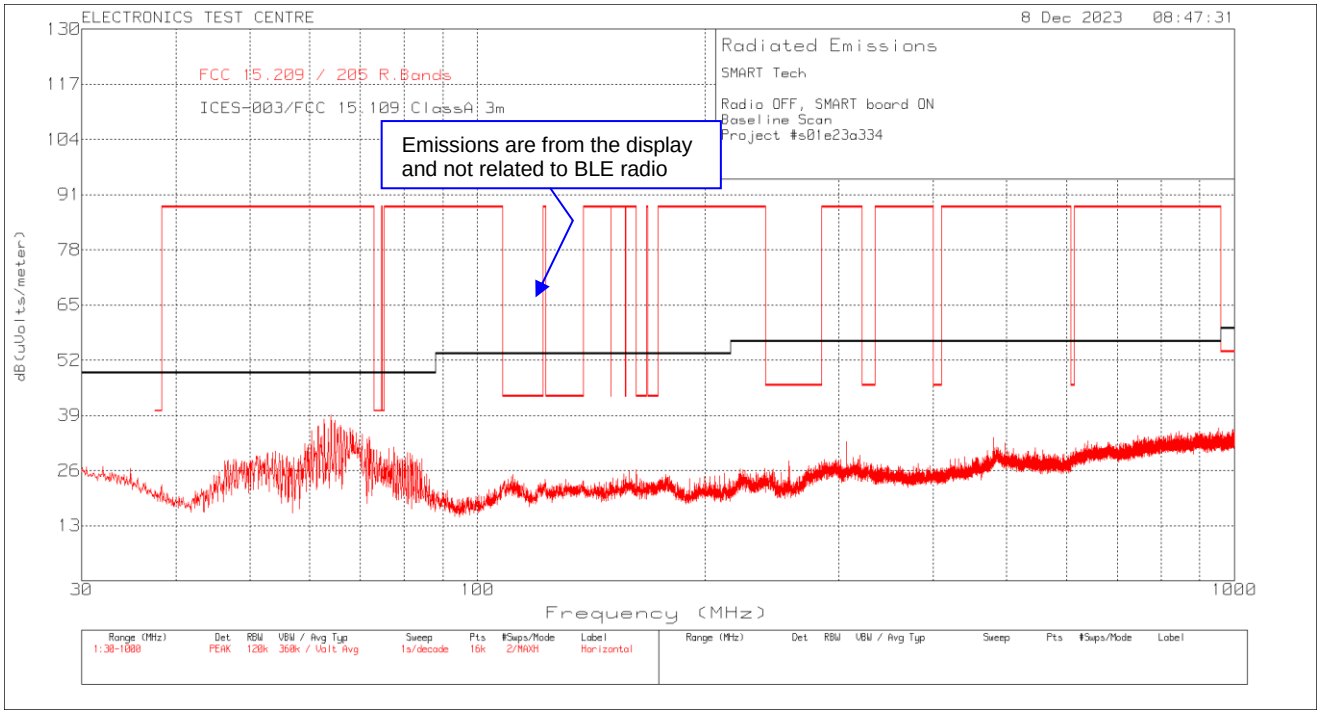


Note: Magnetic Field Strength dBµA/m = dBµV/m – 51.5
Electric Field Strength (dBµV/m) = dBµA/m + 51.5

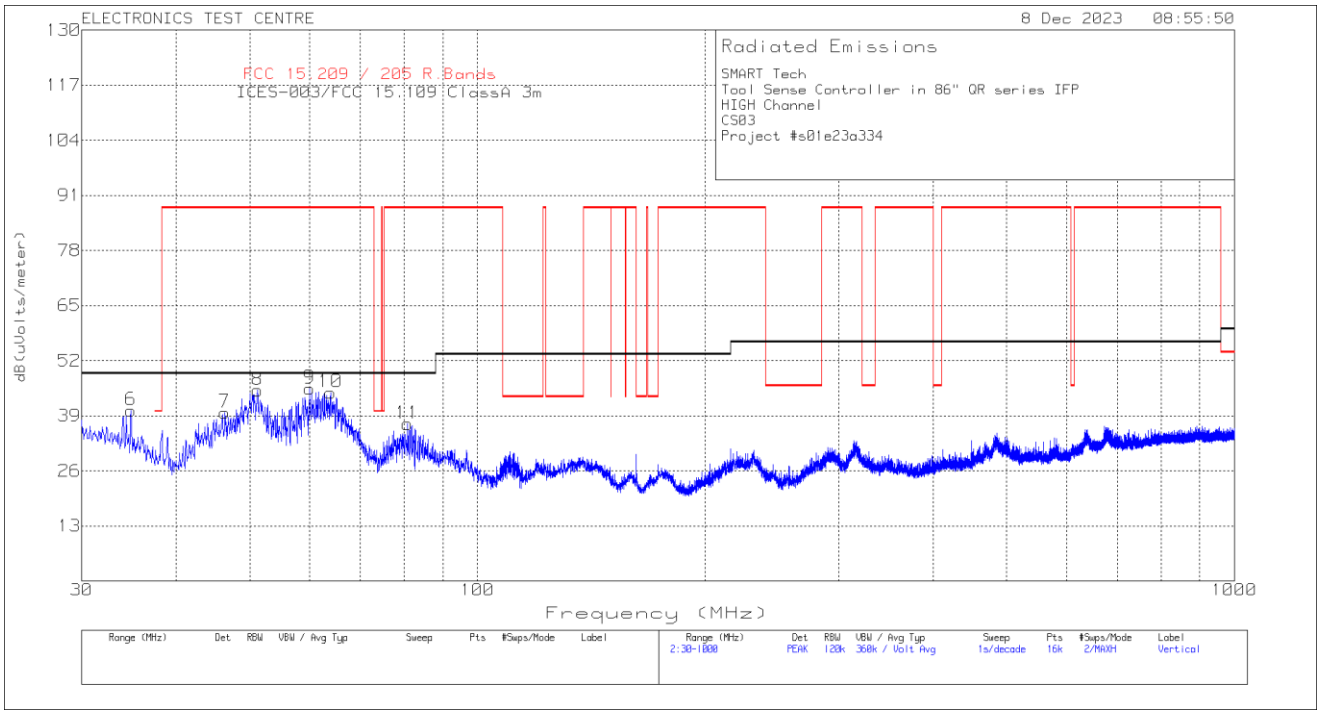
Plot of Radiated Emissions: Horizontal polarization, 30M-1GHz



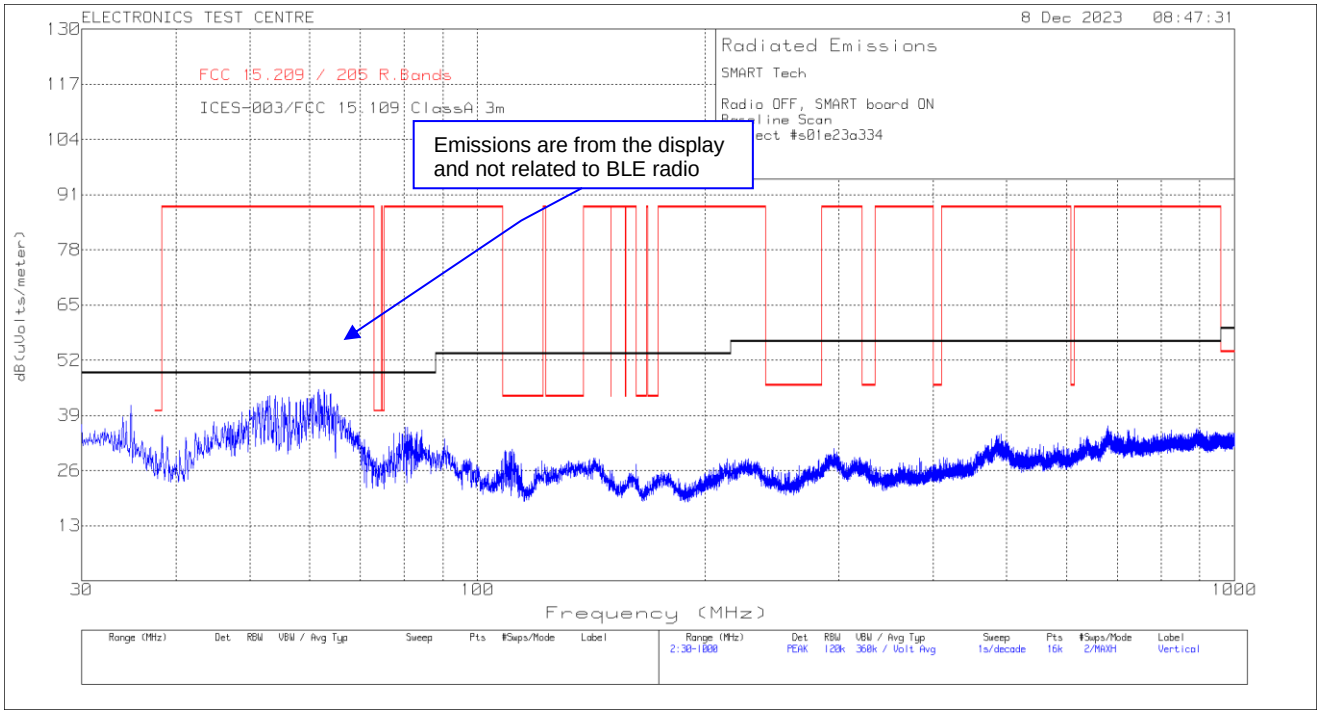
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Horizontal polarization, 30M-1GHz



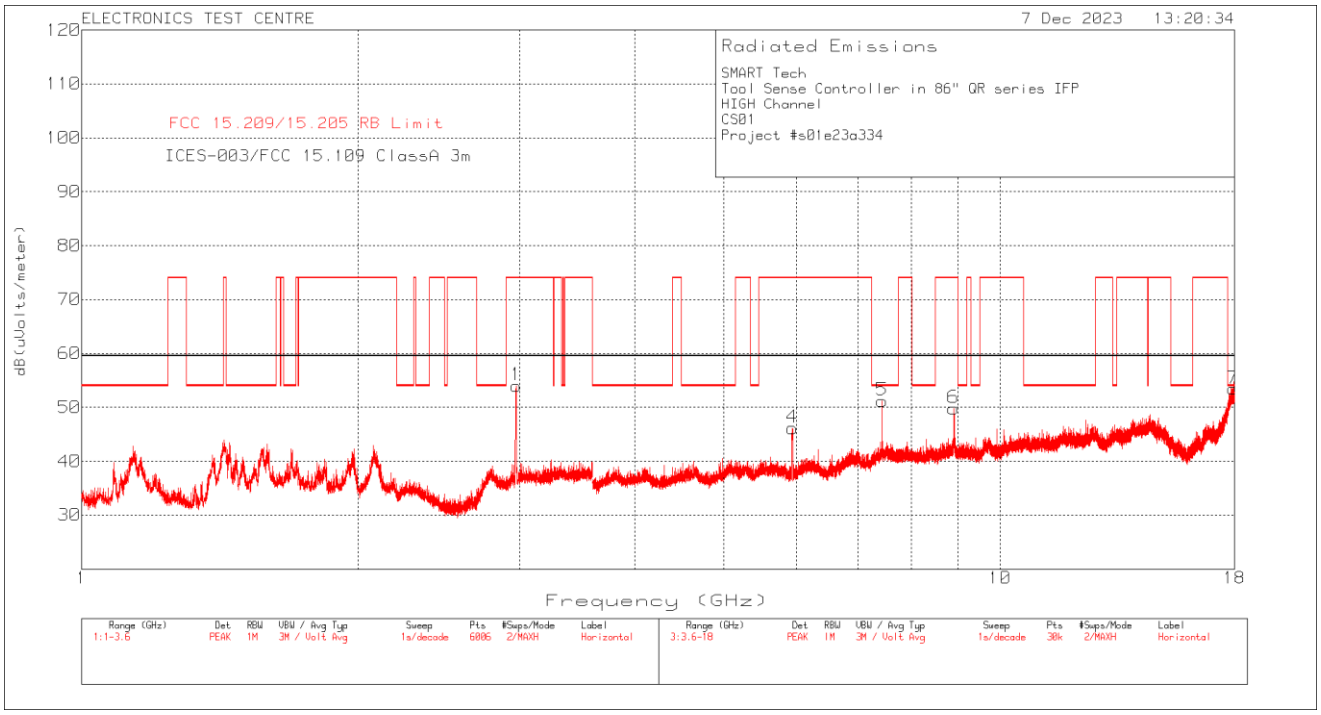
Plot of Radiated Emissions: Vertical polarization, 30M-1GHz



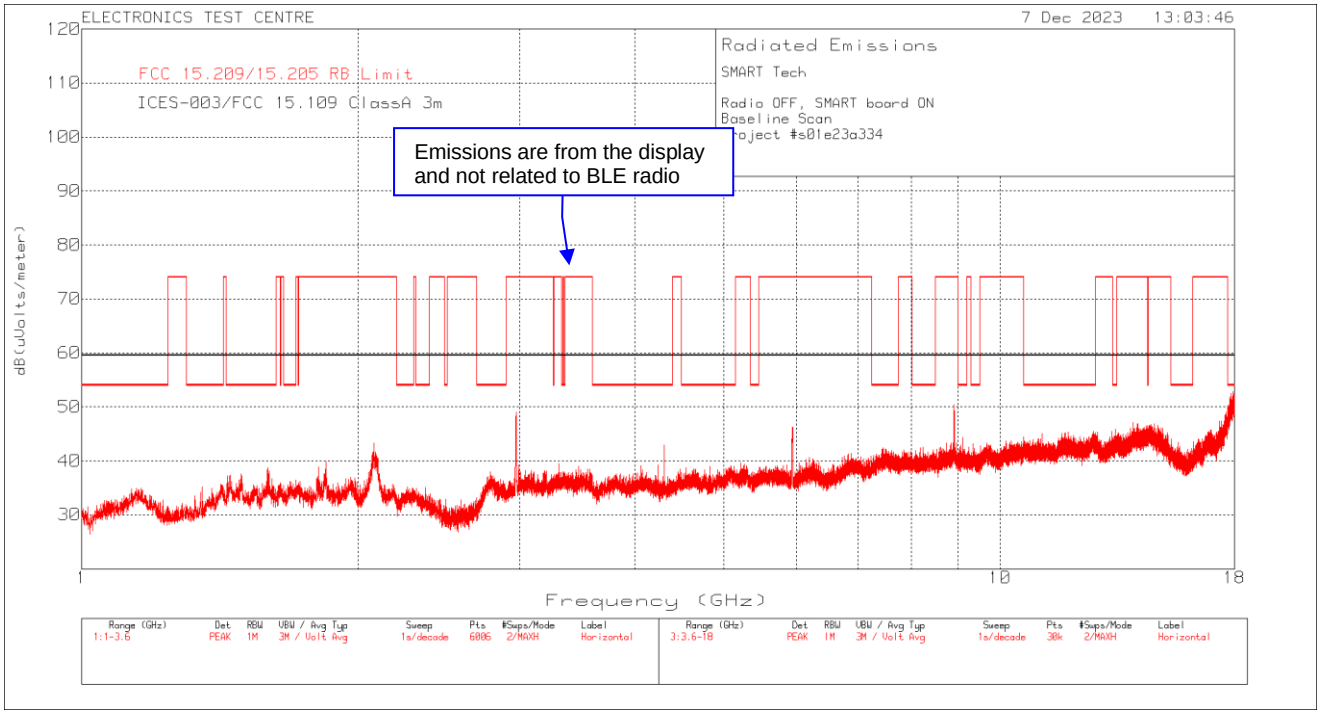
Plot of Radiated Emissions: BLE Radio OFF, SE ON, Vertical polarization, 30M-1GHz



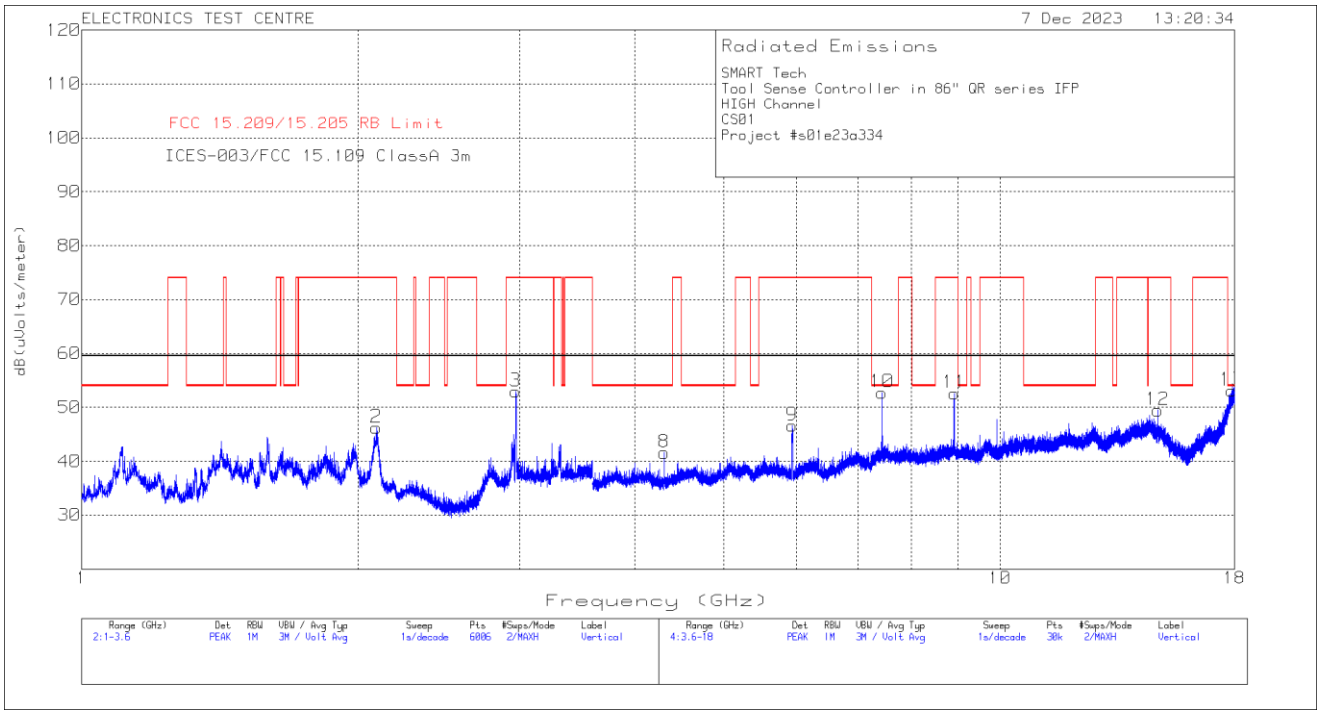
Plot of Radiated Emissions: Horizontal polarization, 1-18GHz



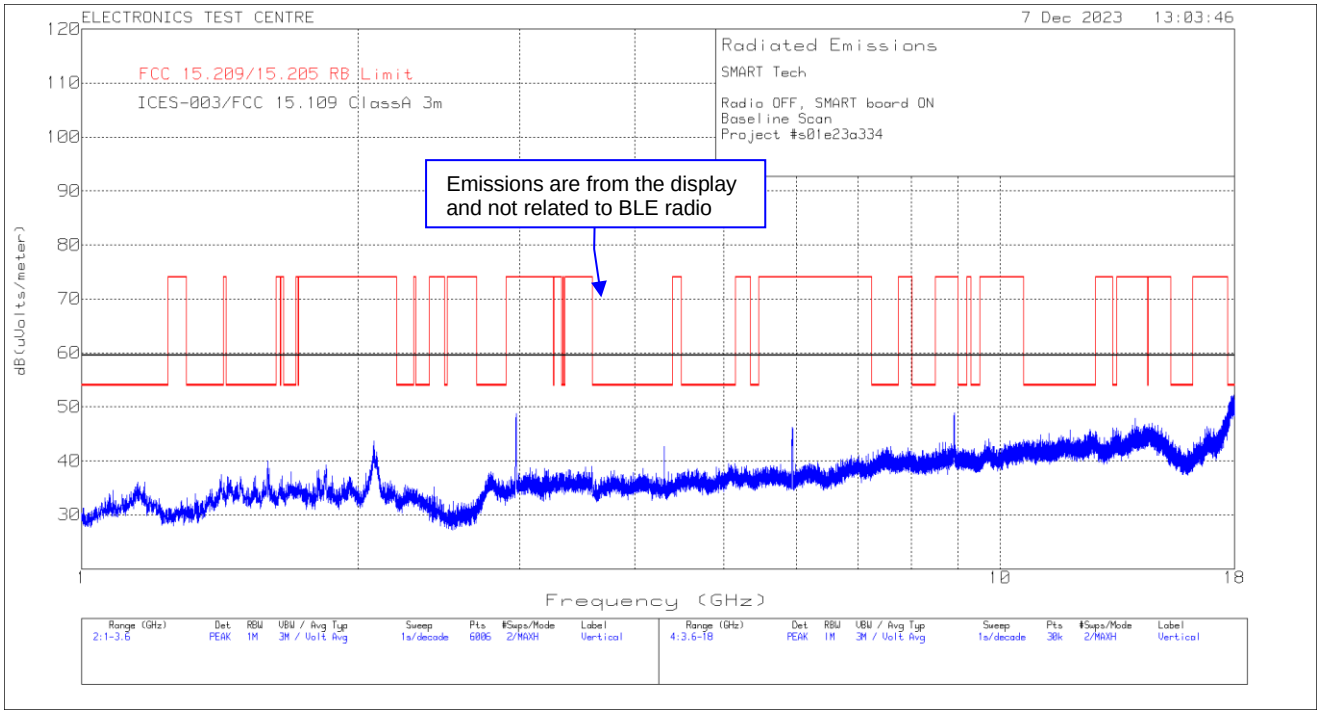
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Horizontal polarization, 1-18GHz



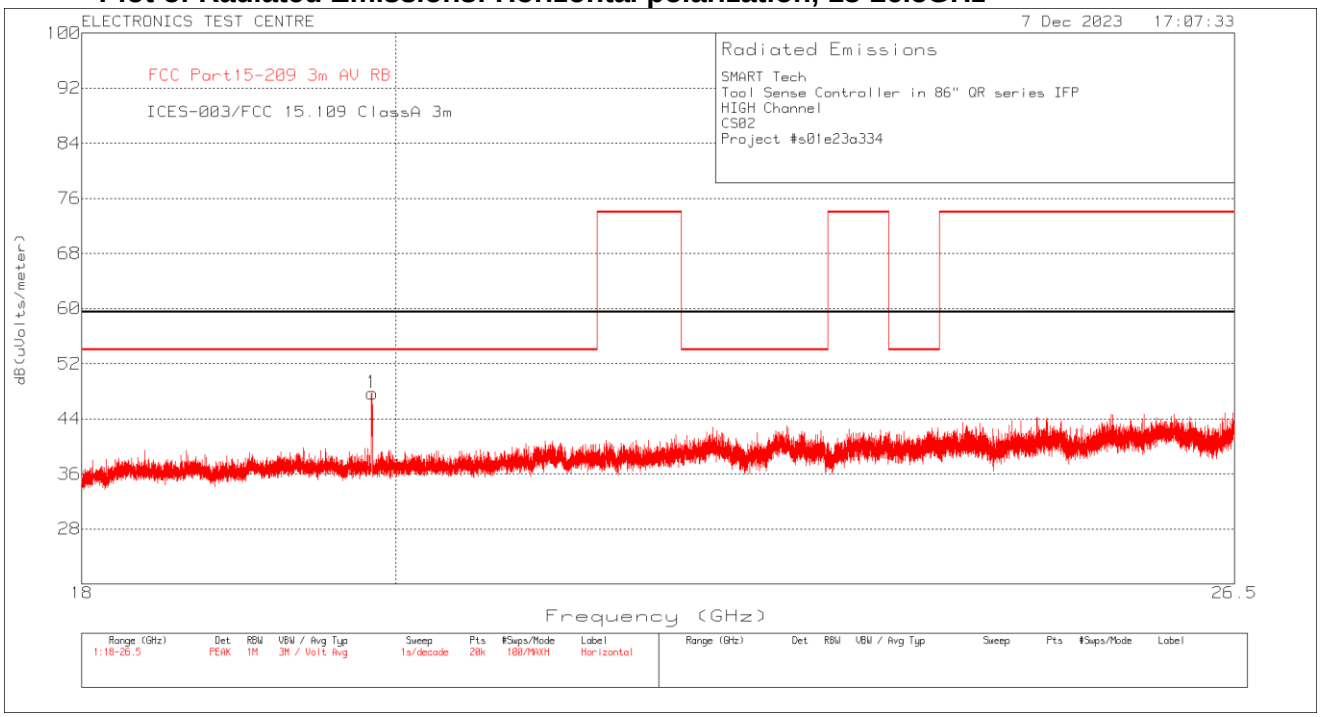
Plot of Radiated Emissions: Vertical polarization, 1-18GHz



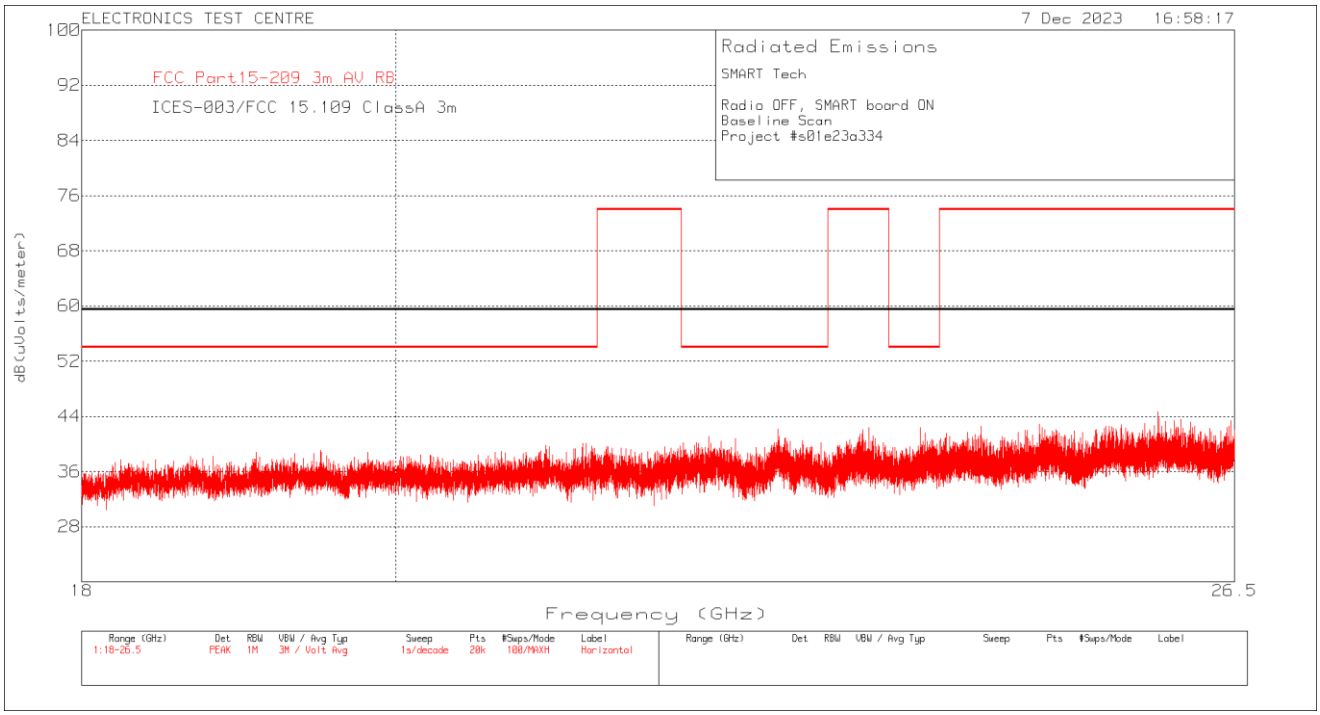
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Vertical polarization, 1-18GHz



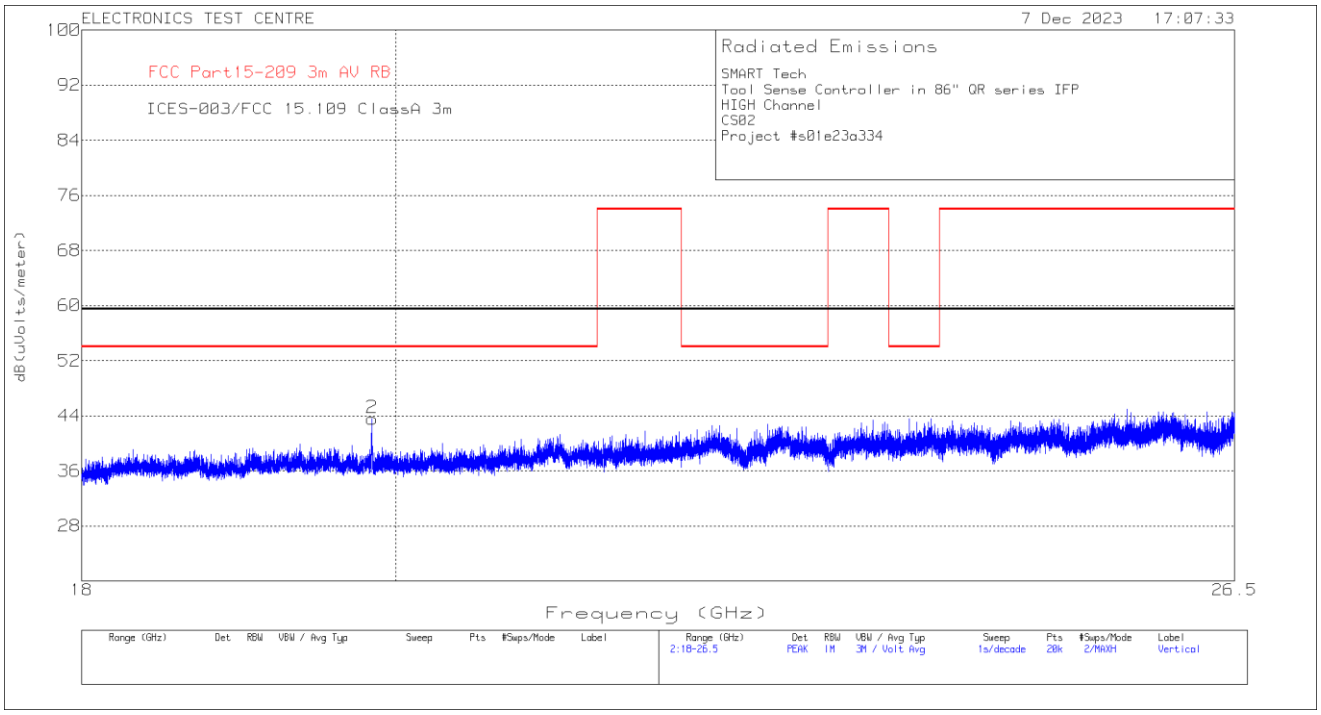
Plot of Radiated Emissions: Horizontal polarization, 18-26.5GHz



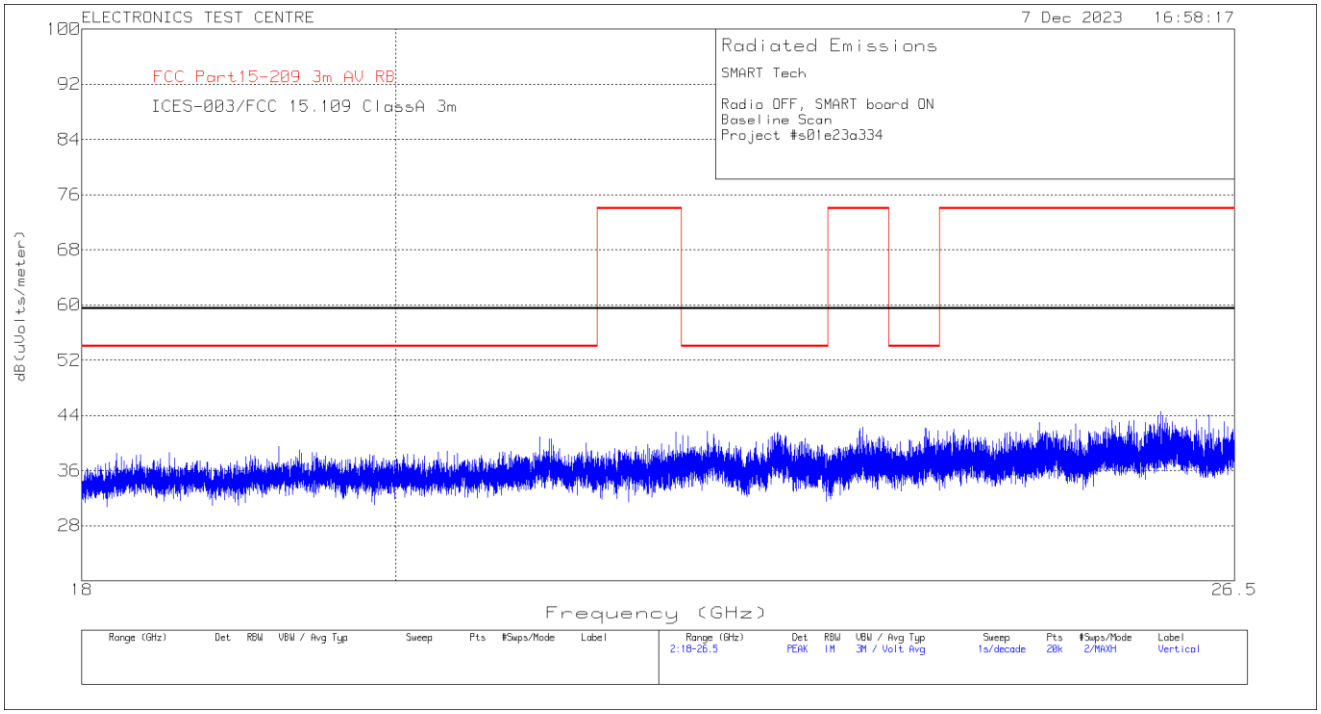
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Horizontal polarization, 18-26.5GHz



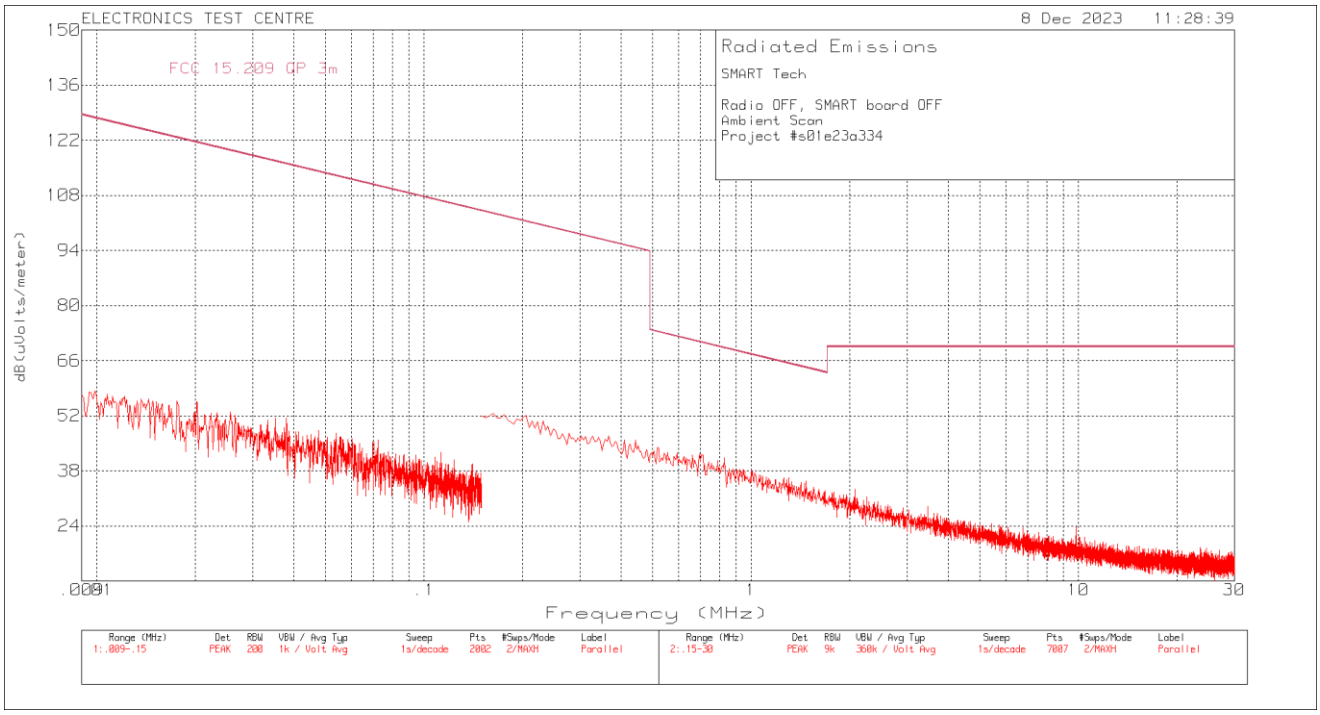
Plot of Radiated Emissions: Vertical polarization, 18-26.5GHz



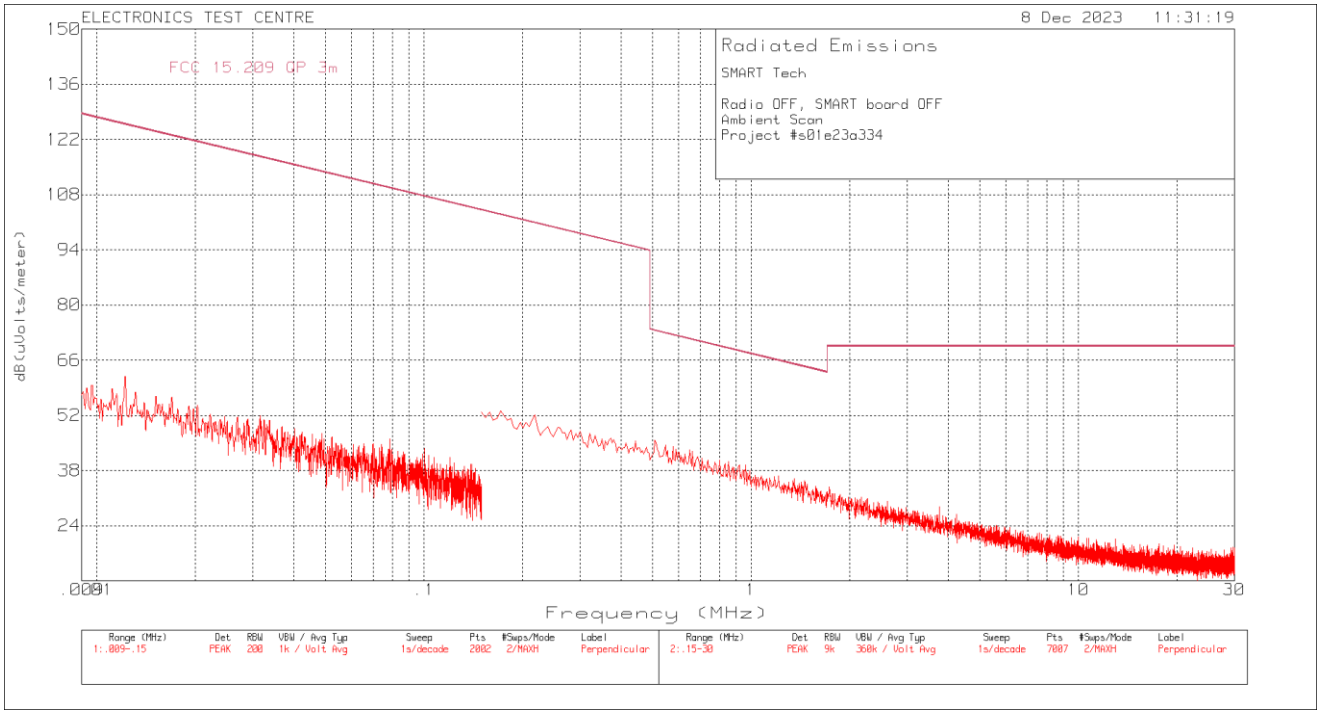
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Vertical polarization, 18-26.5GHz



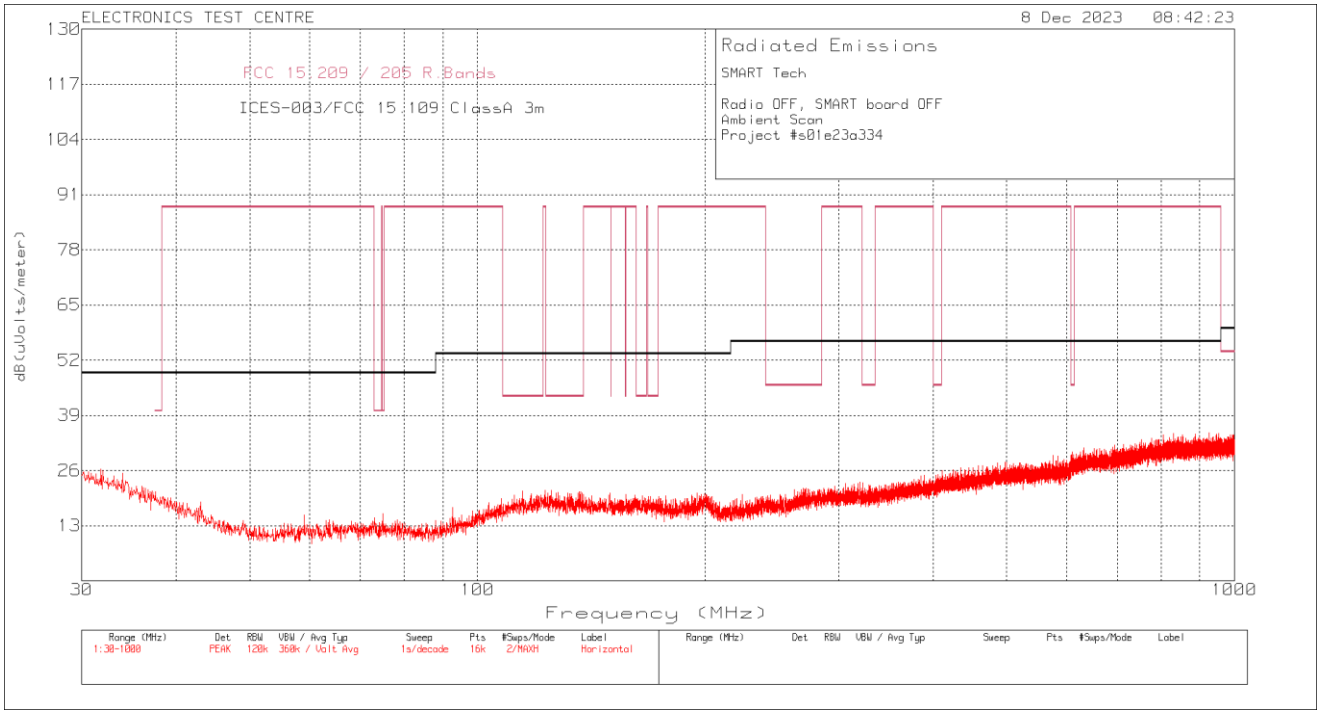
Plot of Test Chamber Ambient: Parallel



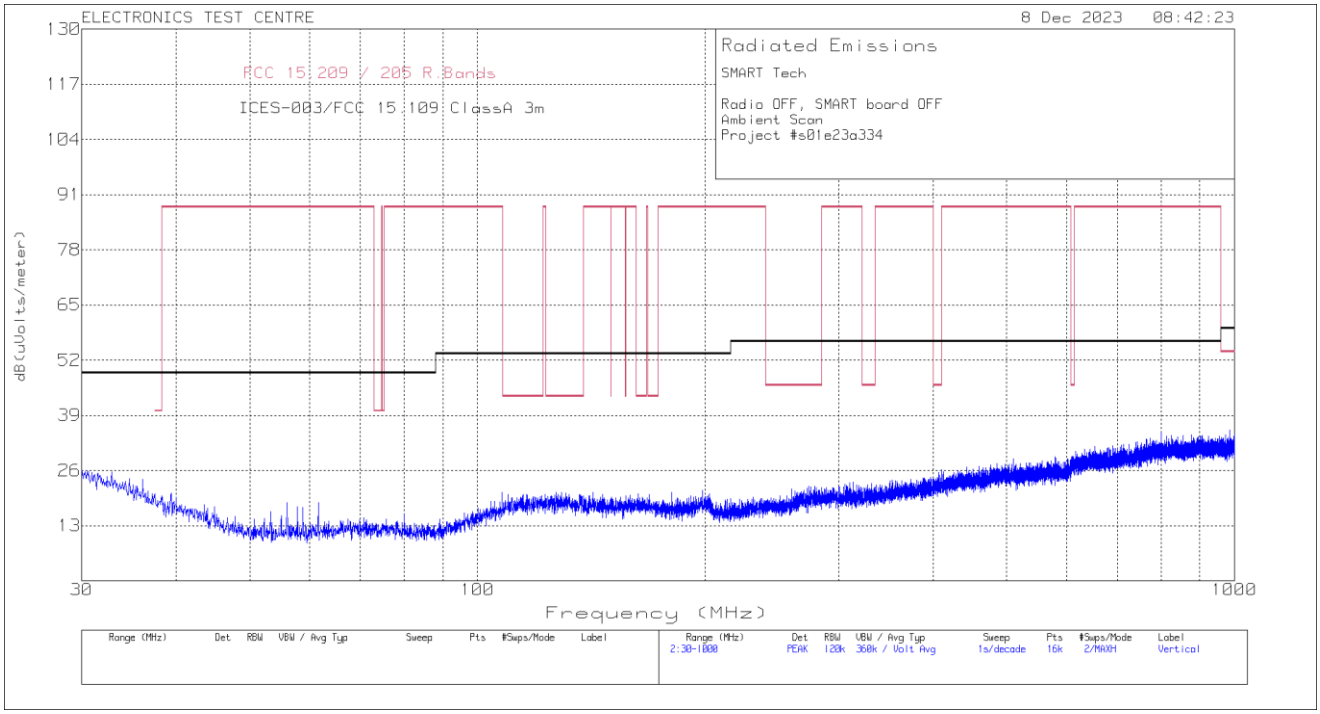
Plot of Test Chamber Ambient: Perpendicular



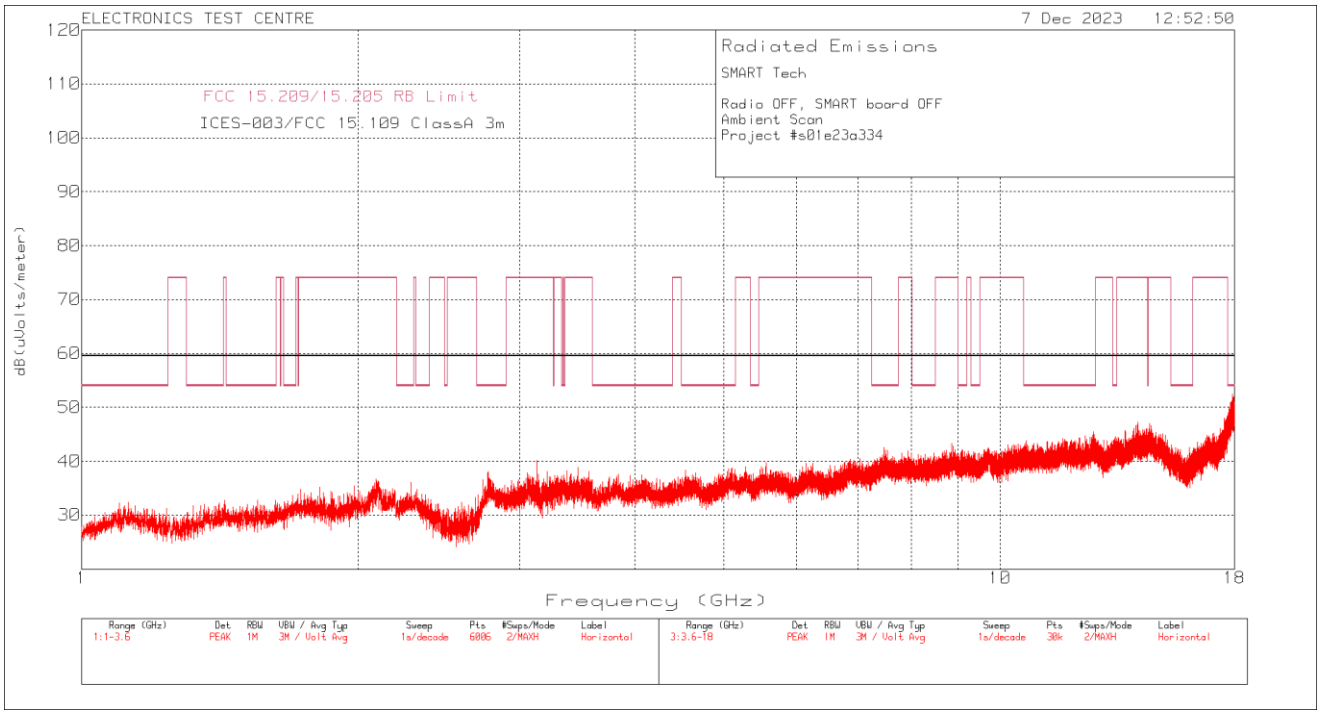
Plot of Test Chamber Ambient: Horizontal polarization



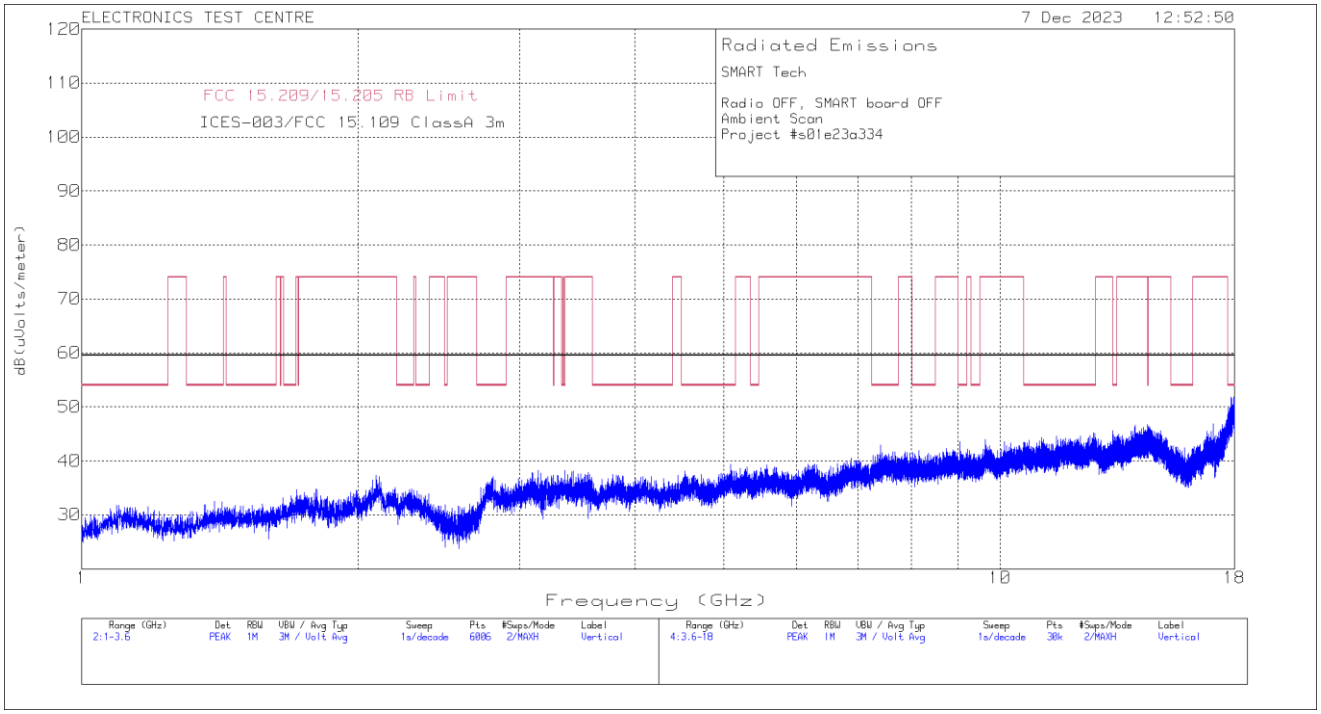
Plot of Test Chamber Ambient: Vertical polarization



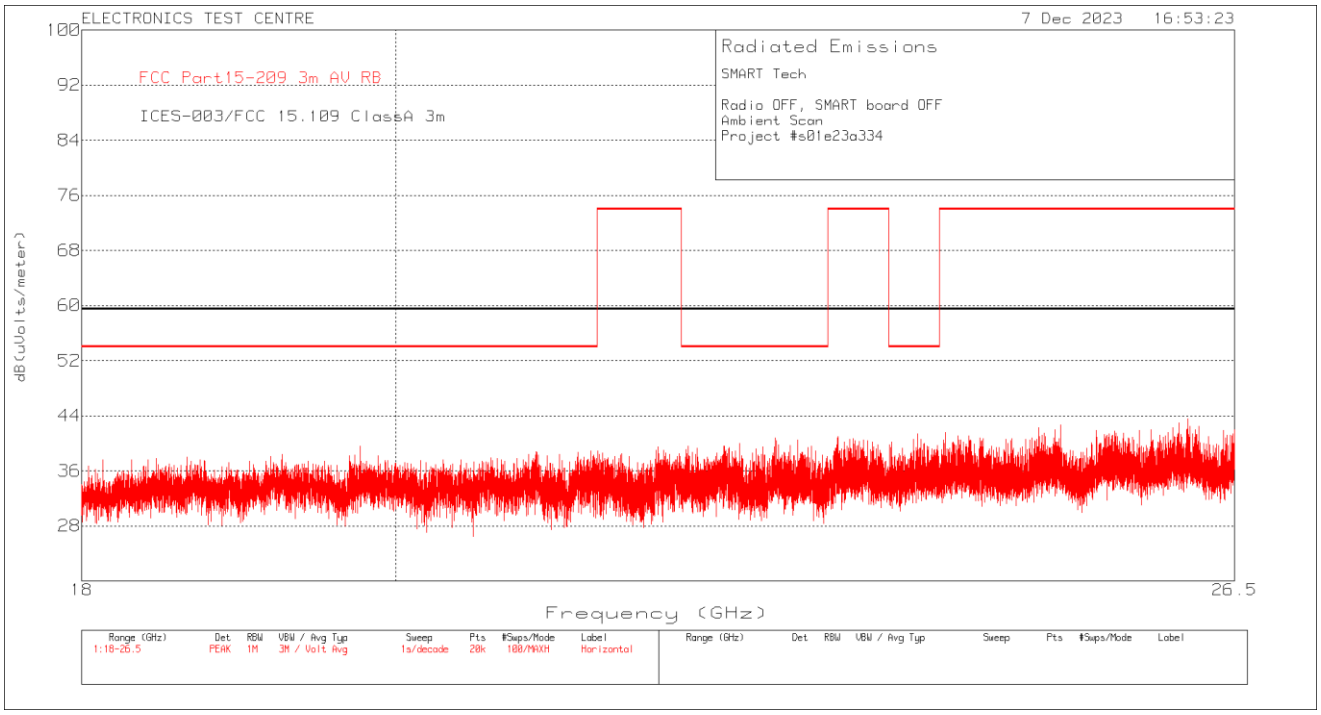
Plot of Test Chamber Ambient: Horizontal polarization



Plot of Test Chamber Ambient: Vertical polarization



Plot of Test Chamber Ambient: Horizontal polarization



Plot of Test Chamber Ambient: Vertical polarization

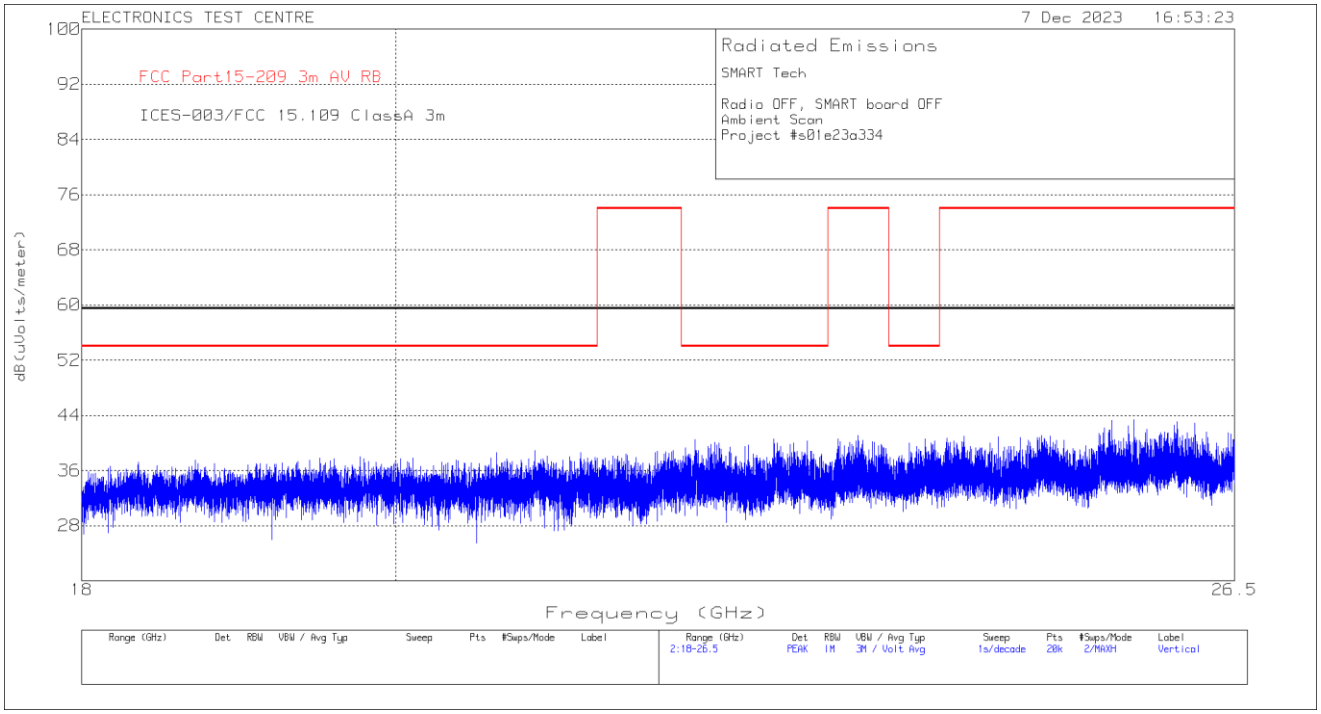
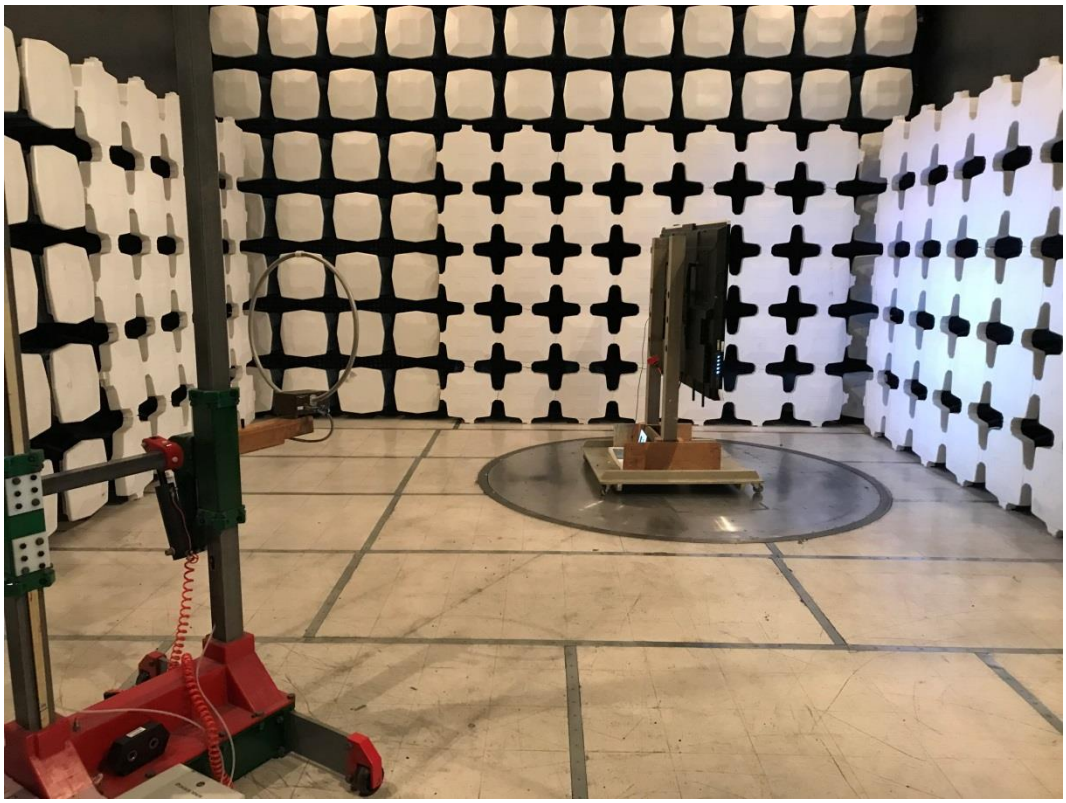


Photo of Radiated Emissions test setup: 9k-30MHz



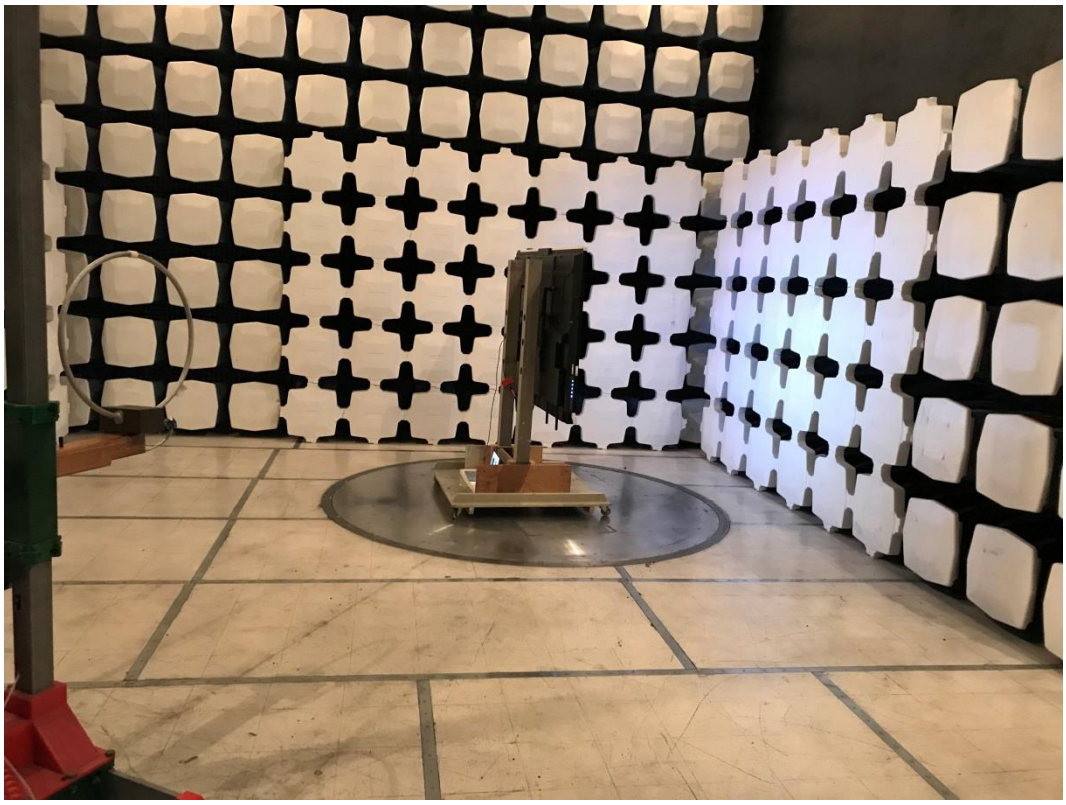


Photo of Radiated Emissions test setup: 30M-1GHz

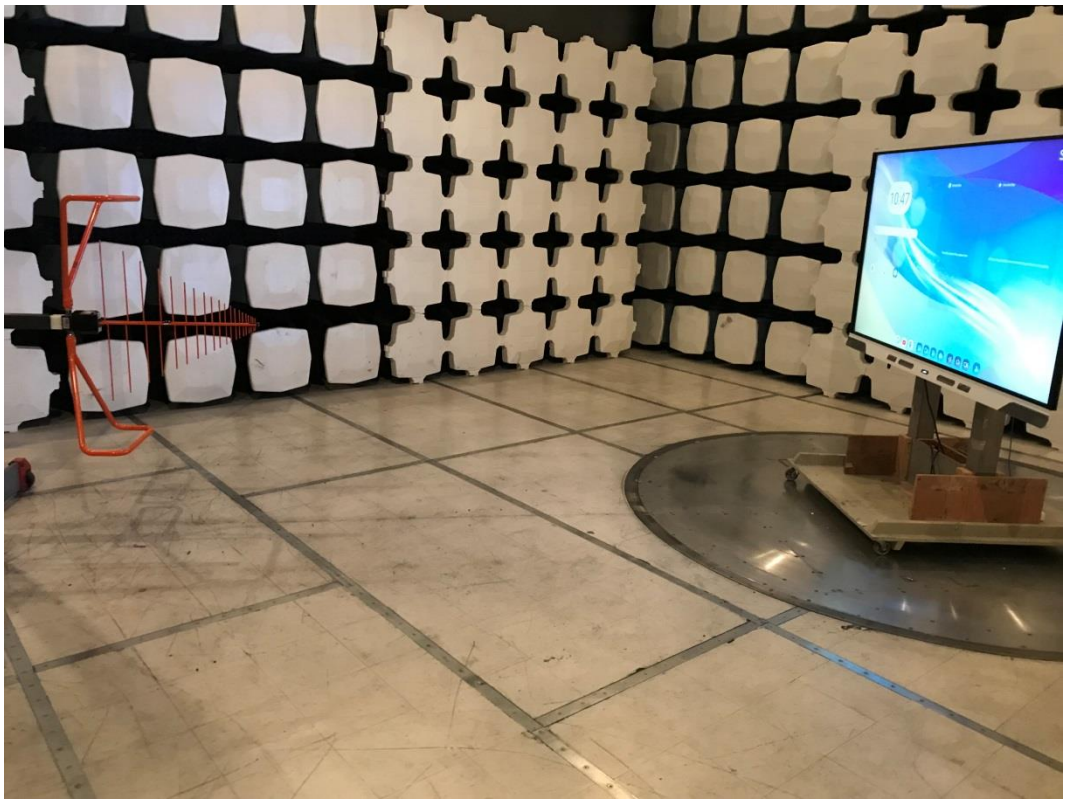


Photo of Radiated Emissions test setup: 1-18GHz

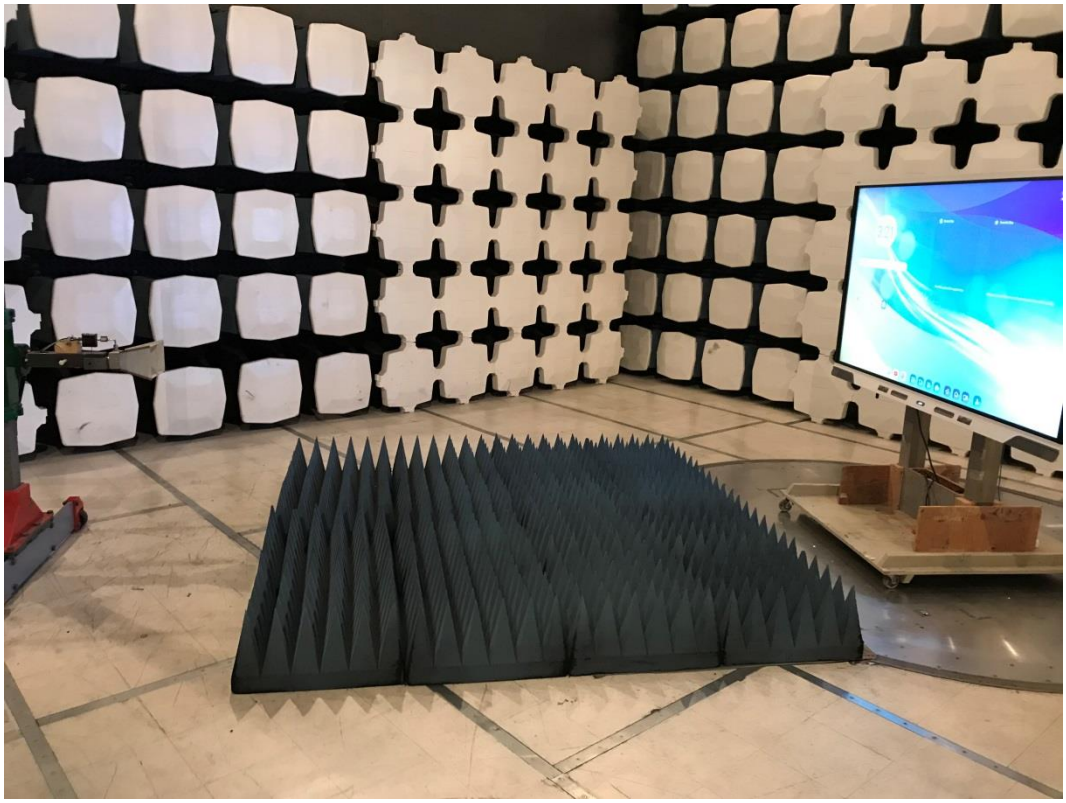
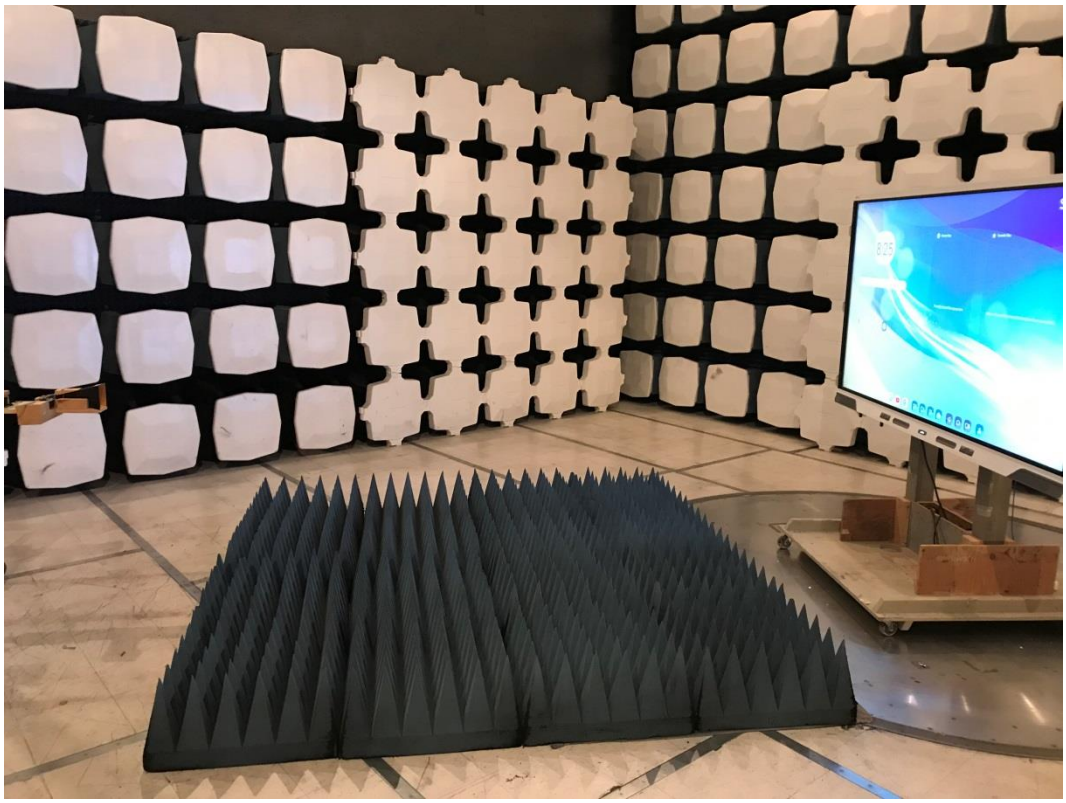


Photo of Radiated Emissions test setup: 18-26.5GHz



2.4 AC Main Conducted Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 86” IFP display**
Test Personnel: B. Van Hee	**Standard: FCC Part 15.207, RSS-GEN**
Date:2023/12/08 (20.1°C,20.0% RH)	**Basic Standard: ANSI C63.10-2013**

EUT status: Compliant

Specification: FCC Part 15.207 / RSS-GEN

Frequency (MHz)	Limit (dBµV)	
	QP	AV
0.15 – 0.5	66 to 56 *	56 to 46 *
0.5 – 5	56	46
5 – 30	60	50

Criteria: The conducted emissions produced by a device shall not exceed the limits as specified.

Decreases linearly with the logarithm of the frequency

2.4.1 Test Guidance

Before any testing is performed, the Ambient (measurement noise floor) is recorded, and a QC check is performed to show that the system is functioning correctly.

The EUT is powered through a 50µH Line Impedance Stabilizing Network (LISN) which is placed 80cm away from the EUT. For tabletop equipment, a vertical ground plane is placed 40cm from the edge of the table. Lastly, the spectrum analyzer is connected to the LISN via armored cable run from the control room to the test chamber. Both the LISN and vertical ground plane are grounded to the reference ground plane on the chamber floor.

Testing starts with a scan, performed under software control. After this is complete, the list of frequencies of interest is generated. These frequencies are then investigated for quasi-peak and average amplitude, as applicable. Emissions measured with a QP detector that fall below the Average limit are deemed to meet both requirements.

2.4.2 Deviations From The Standard

There were no deviations from the EUT setup or methodology specified in the standard.

2.4.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date YYYY/MM/DD	Cal. Due YYYY/MM/DD
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A (FW v. A.25.05)	6130	2023/08/11	2024/08/11
LISN	Com-Power	LI-215A	6180	2022/08/04	2024/08/04
Milli-Ohm meter	HP	4328A	9060	2022/01/28	2024/01/28
T/H Logger	Extech	42270	5892	2023/04/14	2024/04/14
Cable (9 kHz-30 MHz)	Insulated Wire	KPS-1501A-3600	4436	*2023/03/24	2024/03/24
Transient Limiter	Electro-metrics	EM-7600	4454	*2023/03/24	2024/03/24

* In house loss verification performed.

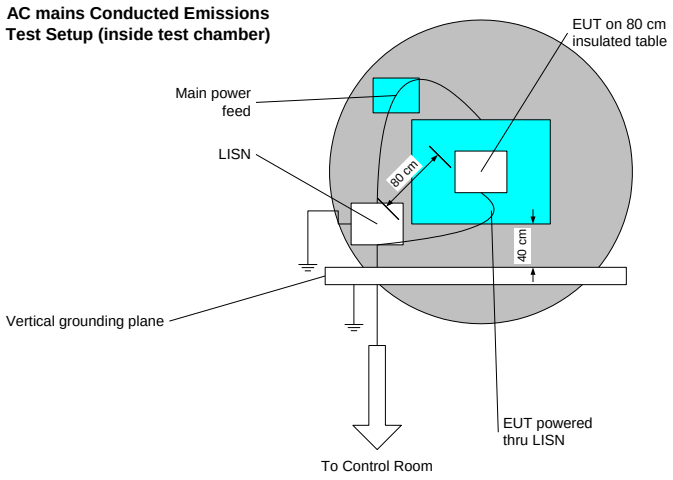
2.4.4 Test Sample Verification, Configuration & Modifications

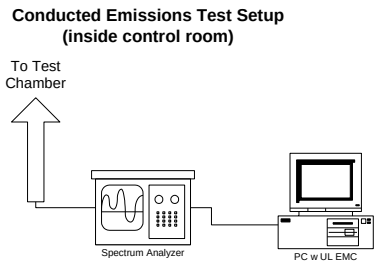
See diagram in section 0

Prior to the test, each channel’s radiated power was measured to determine which would be used for the compliance measurement.

The EUT met the requirements without modification.

Diagram of setup for Conducted Emissions testing:





2.4.5 Conducted Emissions Data

The emissions data is presented in tabular form, showing the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value(s) of limit at the frequency measured, and the Delta between the result and the limit.

Freq. Marker	Freq. (MHz)	Raw reading (dBµV)	Det.	LISN Factor (dB/m)	Cable Loss (dB)	Corrected Reading (dBµV)	RSS-GEN FCC 15.207 Limit (dBµV)	Delta (dB)	L / N
1	13.5338	6.54	AV	0	10.5	17.04	50	-32.96	Line
2	15.3599	18.28	AV	0.1	10.5	28.88	50	-21.12	Line
1	13.5592	23.25	AV	0	10.5	33.75	50	-16.25	Neutral

Meter Reading in dBµV + LISN Factor in dB + Gain/Loss Factor in dB = Corrected Emission Strength in dBµV.

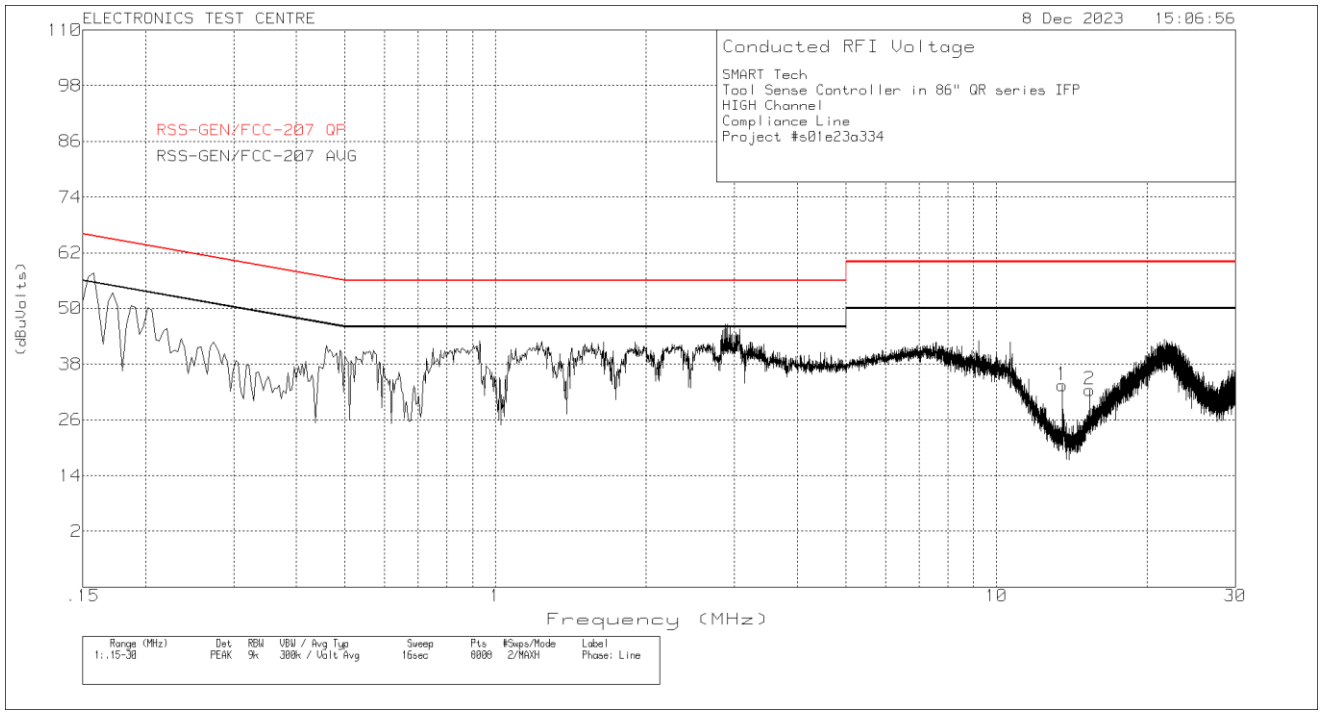
Notes:

- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- AV = Average detector

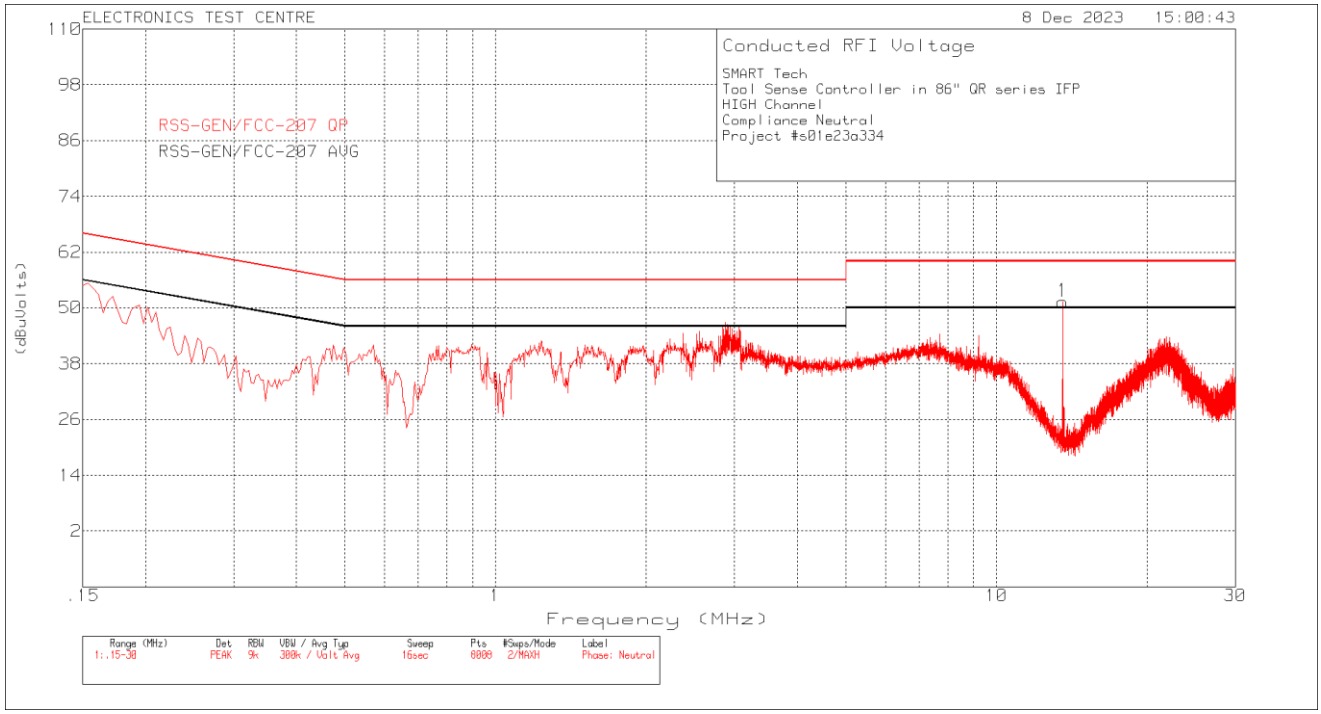
Negative values for Delta indicate compliance.

The Ground Bond was measured and found to be 1.2 mΩ.

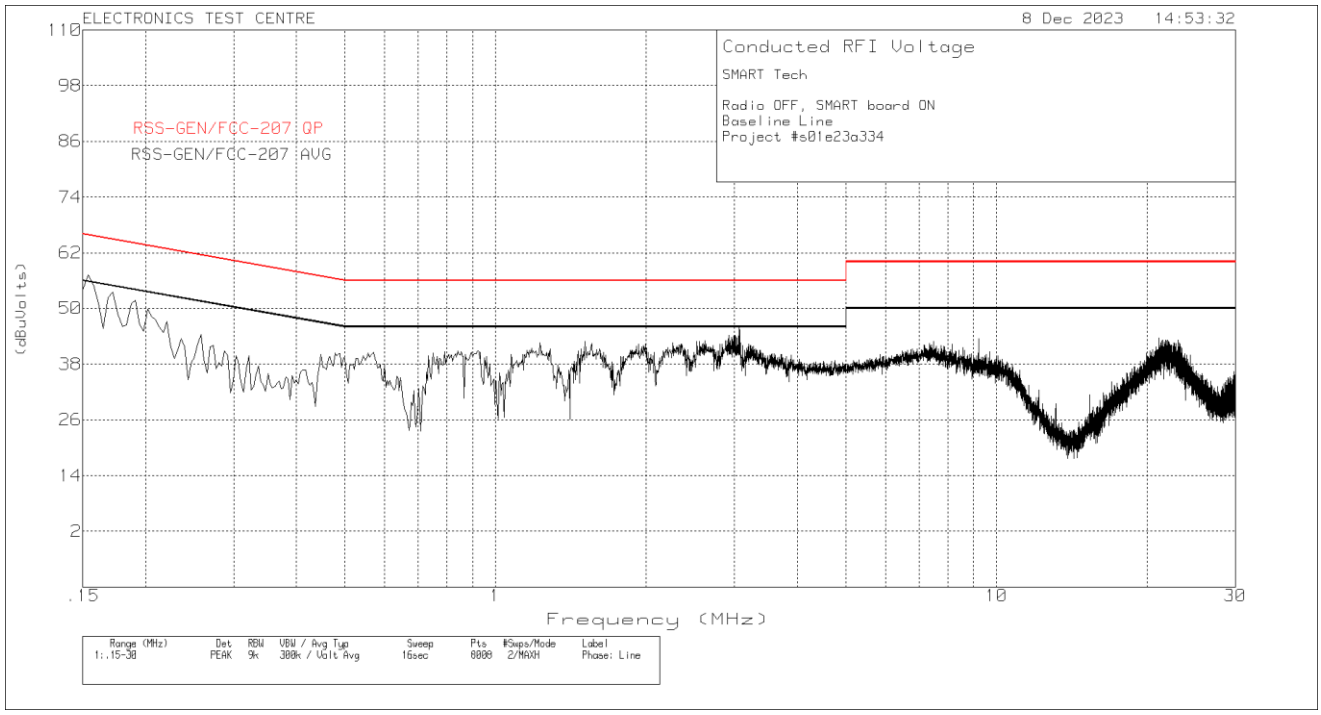
Plot of Conducted Emissions: Line



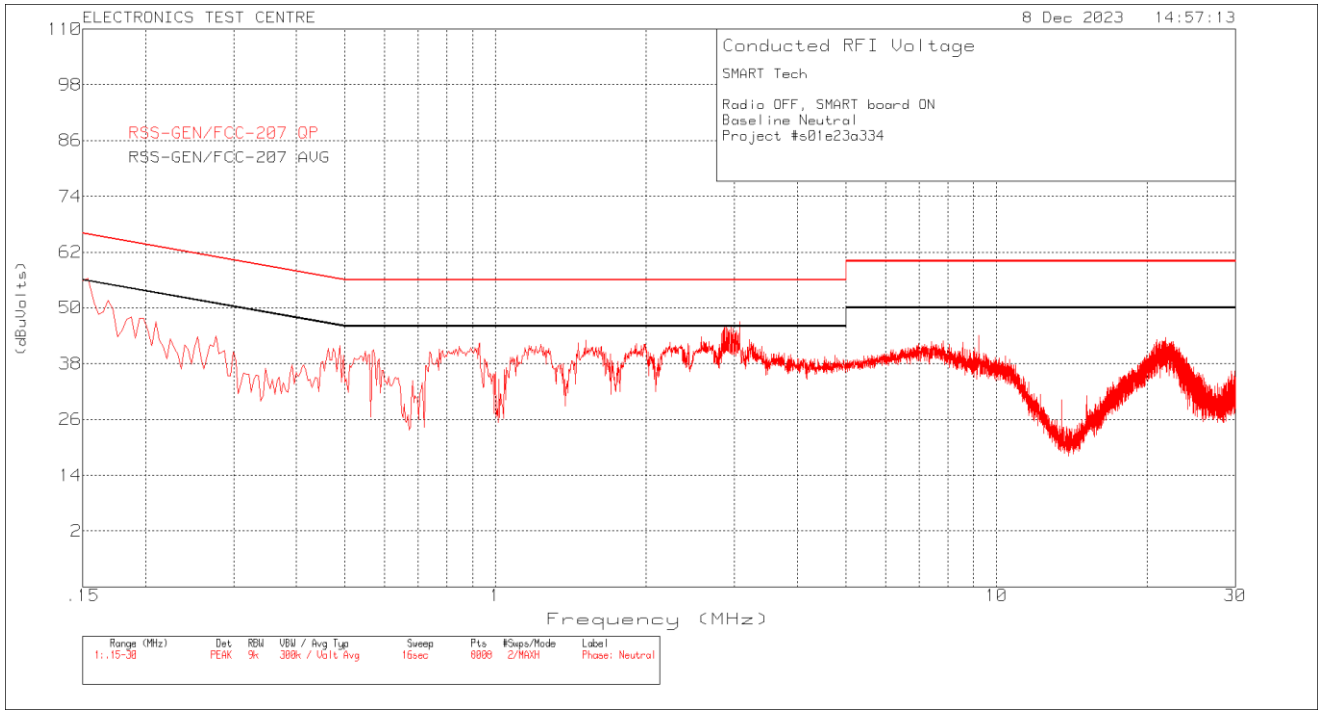
Plot of Conducted Emissions: Neutral



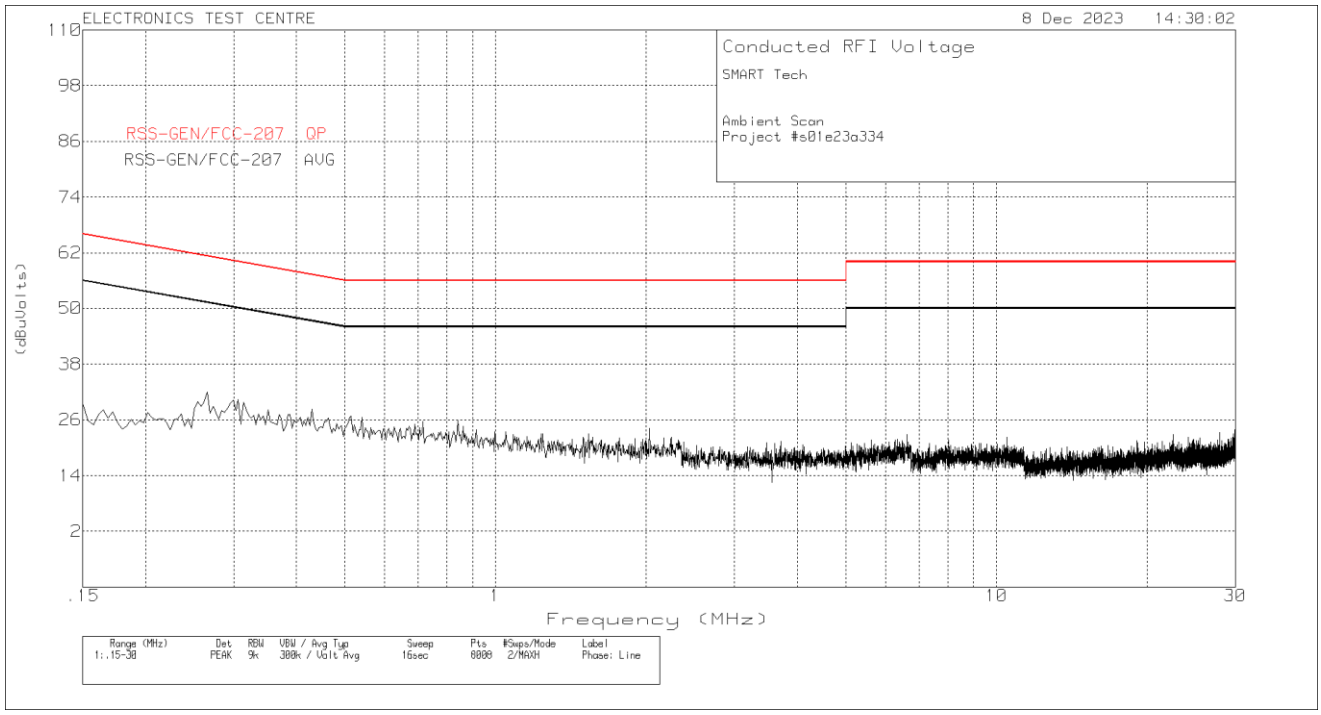
Plot of Test Ambient: BLE OFF (A.E Display ON) Line



Plot of Test Ambient: BLE OFF (A.E Display ON) Neutral



Plot of Test Ambient: BLE OFF (A.E Display OFF) Line



Plot of Test Ambient: BLE OFF (A.E Display OFF) Neutral

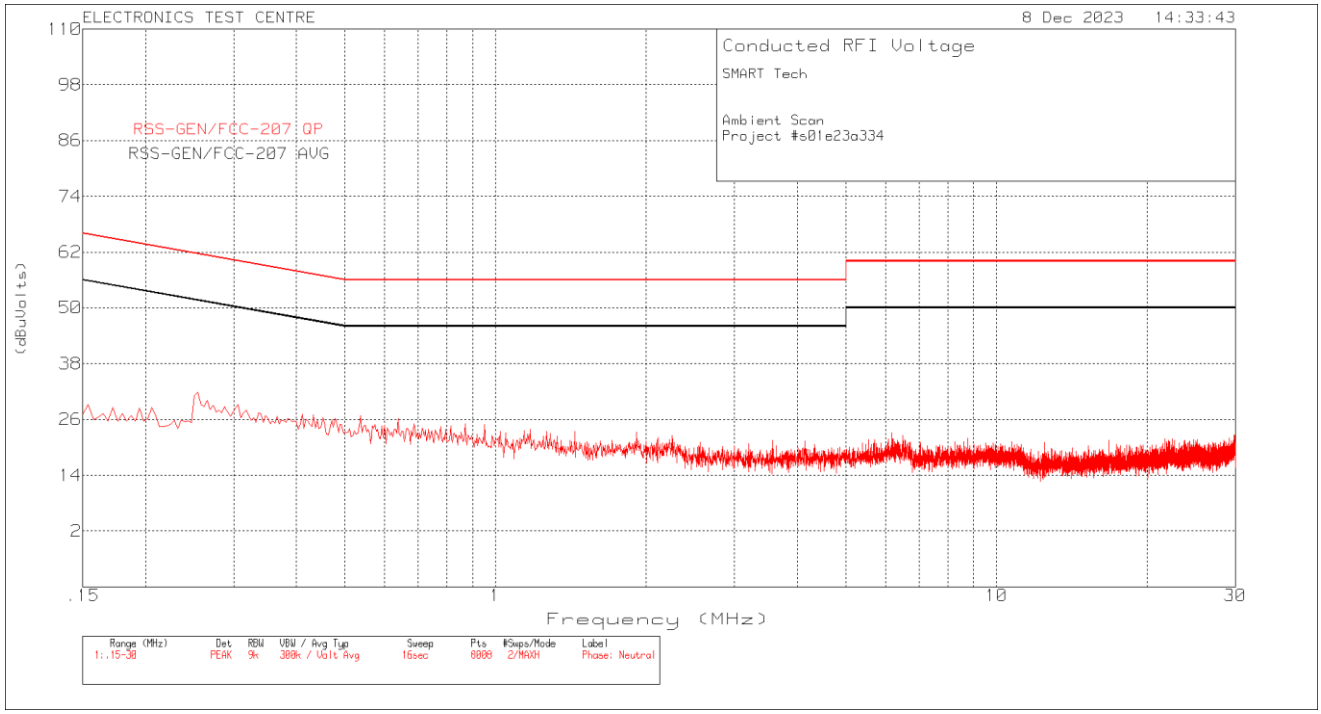
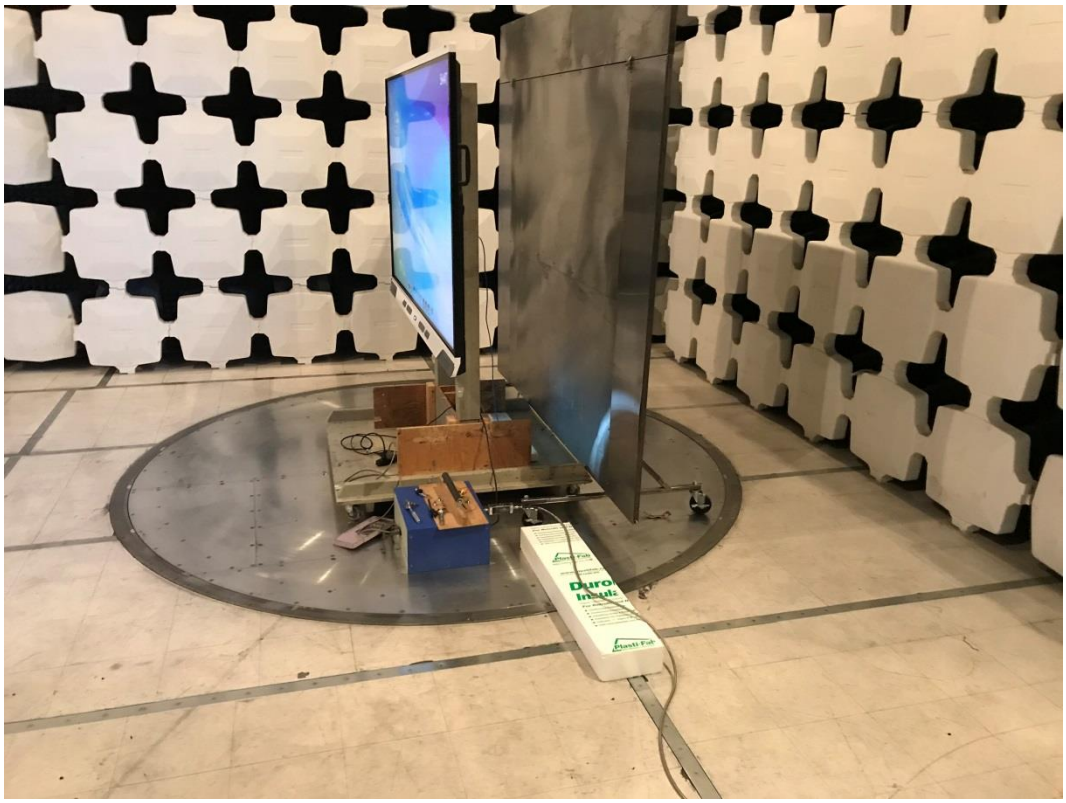


Photo of Conducted Emissions test setup:



3 TEST FACILITY

3.1 Location

The SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 86” IFP display (Model IDQR86-A) was tested at the Electronics Test Centre laboratory located in Airdrie, Alberta, Canada. The Radio Frequency Anechoic Chamber (RFAC), identified as Chamber 1, has a usable working space measuring 10.6 m long x 7.3 m wide x 6.5 m high.

Measurements taken at this site are accepted by Industry Canada as evidence of conformity per registration file # 2046A. This site is also listed with the FCC under Registration Number CA2046.

The floor, walls and ceiling consist of annealed steel panels. The walls and ceiling are covered with ferrite tile, augmented by RF absorbant foam material on the end wall nearest the turntable, and on the adjacent walls and the ceiling. The chamber floor supports a 15 cm high internal floor, constructed of annealed steel panels, that forms the ground plane, and is bonded to the chamber walls.

The 3-m diameter turntable is flush-mounted with the floor. A sub-floor cable-way is provided to route cables between the turntable pit and EUT support equipment located in the Control Room. Cables reach the EUT through an opening in the centre of the turntable.

Test instrumentation and EUT support equipment is located in the Control Room, consisting of two shielded vestibules joined together at the side of the main room. Cables are routed through bulkhead panels between the rooms and the test chamber as required. Power feeds are routed into the main room and vestibules through line filters providing at least 100 dB of attenuation between 10 kHz and 10 GHz.

Either floor mounted or table-top equipment can be tested at this facility.

3.2 Grounding Plan

The EUT was placed at the center of the test chamber turntable. The EUT was grounded according to SMART Technologies ULC specifications.

3.3 Power Supply

All EUT power was supplied by filtered AC Main.

3.4 Emissions Profile

Ambient emission profiles were generated throughout the tests and are included in the test data.

Appendix A: Test Sample Description

Quotation Number:	s01q23a401	Project Number:	s01e23a334
Company Name :	SMART Technologies	Contact Name :	Sean MacKellar
Address :	Suite 600, 214 11 Ave SW	Phone :	+1 (360) 201-8932
	Calgary, Alberta T2R 0K1	Fax :	403-228-2500
	Canada	E-mail :	SeanMacKellar@smarttech.com
Product Name: SMART QX Series BLE Module (Tool Sense Controller)			# of units to be tested : 1 each
Part/Model # : IDQXMOD1			Serial # ***(Critical)*** : Host Sample #1

Product Application	**Designated Marketplaces**	**Is your product or system considered to be Controlled Good?**
Residential ☐ Industrial ☑ Military ☐	Canada ☑ Other United States of America ☑ _____ European Union ☐ _____	Yes ☐ No ☑

GENERAL INFORMATION REQUIRED FOR ALL PRODUCTS

Dimensions (L x W x H) **4.5cm x 10cm x 0.5cm**	Weight: _10_ (lbs. kgs.)	Engineering Evaluation? **YES** ☐ **NO (compliance test only)** ☑
If compliance testing, to what standards?		

Regulatory Compliance testing: Yes: ☑ No: ☐	For: FCC ☑ Industry Canada ☑ Other ☐ Specify: _____	ETC to do the submission? YES ☐ NO ☑

Power Requirements: (A DC powered device that is sold with an AC/DC adaptor is considered to be AC powered for emissions testing purposes.)	**AC (incl wall wart) ☐** Voltage: _____VAC # of AC phases: ___ Current: ____ Amps Frequency: ____ Hz	**DC ☑** External ☑ Internal Battery ☐ Voltage: __5__ VDC Current: ____ Amps

Duration of self-test : _____	Fault Recovery Time: ____	Reaction Time (delay between fault & alarm): ____
Product Intended Application	BLE radio – Tool Sense Controller installed in RX/QX-V2 Series IFPs	
Product Deployment Environments	School classrooms, Business	
Operating Modes in the Field	Communication with IFP accessories (i.e.: Model: PQX-1 pen)	
Peripheral and/or Support Equipment to Monitor and Operate the Product (to be supplied by client):		

Description of interconnecting leads & cables (Attach separate sheet, if required		Cable 1	Cable 2	Cable 3	Cable 4
	Type:	**Interface**	**USB**		
	Connectors:	**Flex**	**USB**		
	Terminations :	**Tool Sense Controller > Interface Board**	**Interface Board > Laptop**		
	Shielding:	**No**	**Yes**		
	Length:	**10 cm**	**0.5 m**		

List of internally generated frequencies: Crystal / Oscillator / Switcher / LO	2.402 – 2.480 GHz
Typical installation and operating instructions/configuration to expedite EUT set-up (Attach a Separate sheet, if required)	BLE radio installed in RX Series IFPs, Models: RX/QX-V2 Series IFPs, Models: IDQR65-A, IDQR75-A, IDQR86-A. Test application provided to support TX/RX mode spurious emissions testing. Test application provided to monitor communication with pen (IFP accessory).
Brief Functional description of Product including System Block Diagram (Attach a Separate sheet, if required)	BLE radio – data communication with IFP accessories (i.e.: Model: PQX-1 pen)
Any additional information?	- Test mode duty cycle: 53.4%, correlates to an upward duty cycle correction factor (DCCF) of +2.72 dB, which is applied to the Average measurement to account for the radio transmitted <98%. - Maximum operating duty cycle: 7.5%, which correlates to a downward DCCF of -11.25, which is applied to account for the maximum operating duty cycle during typical operation. The overall DCCF: (+2.72 – 11.25) = -8.53 dB should be applied to the Average measurements of all transmitter harmonics.

WIRELESS PRODUCT INFORMATION

Type of Radio Device (check all applicable Equipment Configurations)							
Intentional transmitter	☑	Receiver	☑	Transceiver	☐		
Type of Radio Operating License							
Unlicensed Personal Communication	☑	Unlicensed National Information Infrastructure	☐	Ultra-Wideband Operation	☐	Licensed	☐
Type of Modulation of Radio Device							
CDMA	☐	TDMA	☐	Other	☐		
Spread Spectrum Technology	☐	Direct sequencer	☐	Frequency hopper	☑		

Transmitter Power Output **: 4 dBm EIRP**	Emission Designator **:**
Information on Radio Frequencies	
Transmitter Operating Frequency(s) & Bandwidth	**2 MHz**
Transmitter Channel Frequencies & separations (If required, attach a separate sheet)	**2402 – 2480 MHz**
Receiver Operating Frequency(s) & Bandwidth	**2 MHz**
Receiver Channel Frequencies & separations (If required, attach a separate sheet)	**2402 – 2480 MHz**
Information on Antenna(s)	

Is the antenna removable?	**YES** ☐ **NO** ☑	Antenna Connector Type **: u.fl**	Number of Antennas **: 1**	
Gain of Each Antenna (and tolerance)		4 dBi		
Activity and State of Digital Circuitry during ON Time		TX mode: BLE_1M		
Radio Transmission Type				
Continuous	☑	Intermittent	☐	ON Time/ OFF Time **:** 7.5% (Typical)
Activity and State of Digital Circuitry during OFF Time		Receive mode. Transmission only occurs during pen firmware updates (OTA).		

Pre-Approved Radio Systems & Sub-Assemblies		
FCC ID:	Grantee Code:	Approval Agency /TCB:
Software changes to the Pre-Approved Equipment?		
Software additions to the Pre-Approved Equipment		
Hardware changes to the Pre-Approved Equipment?		
Hardware additions to the Pre-Approved Equipment?		

Prepared By: Sean MacKellar	Title: Sr. Regulatory Specialist	Date: 5/22/2023

End of Document