Test Report Prepared By:
Electronics Test Centre
27 East Lake Hill
Airdrie, Alberta
Canada
T4A 2K3
sales@etc-mpbtech.com
http://www.etc-mpb.com

Telephone: 1-403-912-0037

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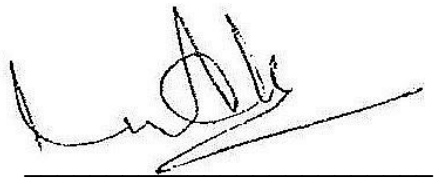
EMC testing of SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 65" QX Series IFP display, Model: IDQX65-1 in accordance with:

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

Test Personnel: Janet Mijares

Prepared for: SMART Technologies ULC
3636 Research Rd NW
Calgary, AB, Canada
T2L 1Y1
Telephone: (403) 245-0333



Imran Akram
iakram@etc-mpbtech.com
Quality Assurance Representative
Electronics Test Centre (Airdrie)

REVISION RECORD

ISSUE	DATE YYYY/MM/DD	AUTHOR	REVISIONS
DRAFT 1	2023/05/24	I. Akram	Initial draft submitted for review.
Release 1	2023/05/31	I. Akram	Sign Off
Release 2	2023/06/05	I. Akram	Added Radio Information in section 1.3 Sign Off

TABLE OF CONTENTS

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 65" QX Series 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)
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 0 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

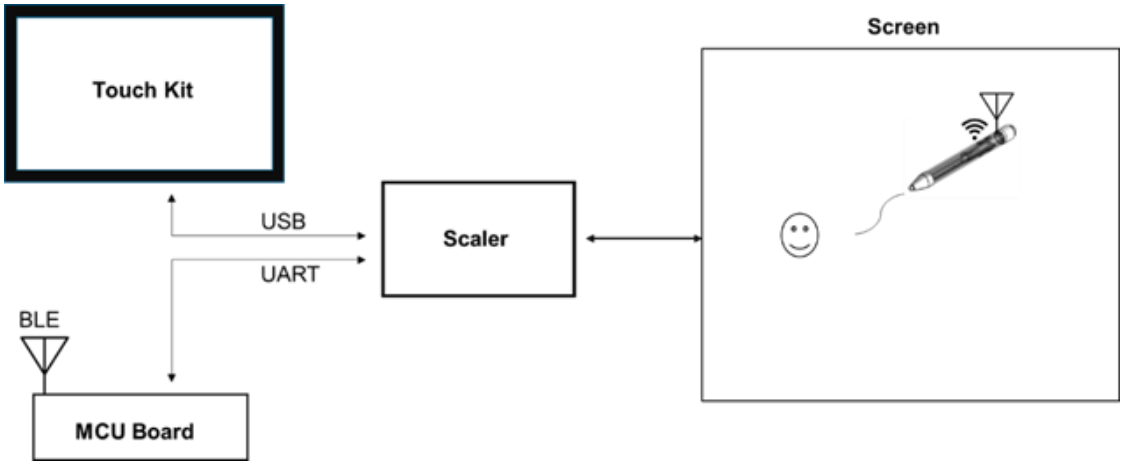
Standards	Description
RSS-GEN, Issue 5	General Requirements for Compliance of Radio Apparatus
FCC, title 47 CFR § 15.207	Intentional radiator, conducted emission limits
FCC, title 47 CFR § 15.209	Intentional radiator, radiated emission limits
ANSI C63.10 (2013)	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

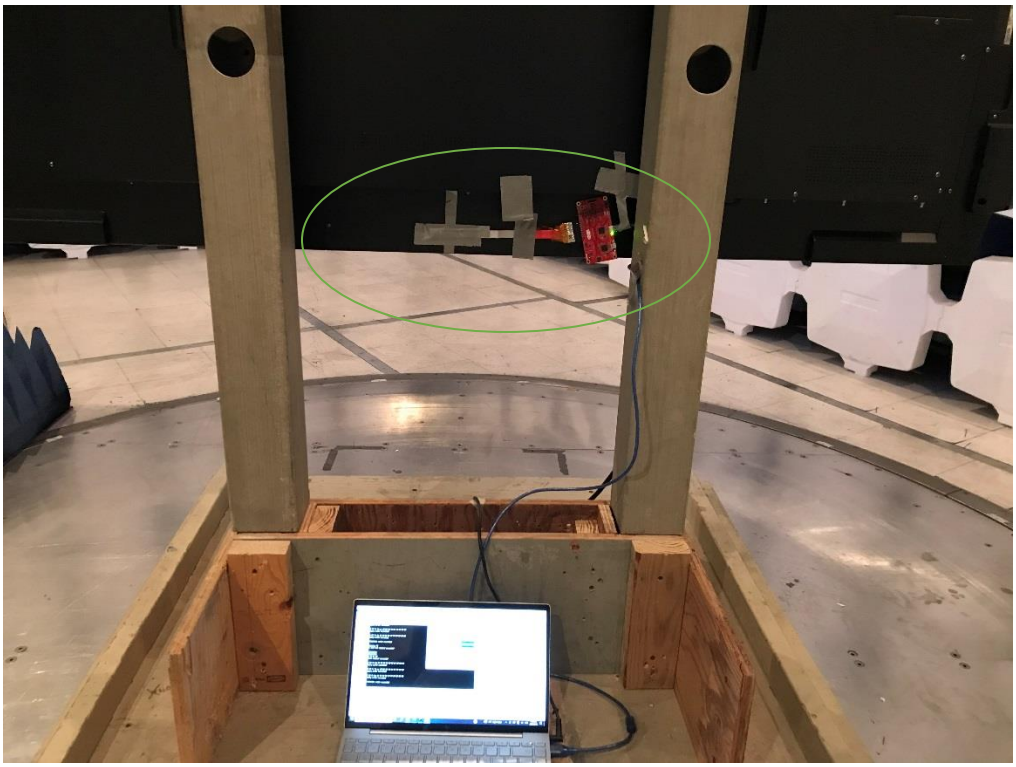
1.6 Acronyms and Abbreviations

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 Low, Mid or High channel using the provided SMART Tech laptop with the ATM RF Test Tool.

The radio module is located within the SMART QX Series 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 QX Series 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
Radiated Emissions Level (26.5 GHz – 40 GHz)	±5.2 dB
Conducted Emissions Level (9 kHz – 150 kHz)	±3.4 dB
Conducted Emissions Level (150 kHz – 30 MHz)	±3.0 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 2, Clause 5.4(d), (a)	Low /MID/ High	QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within host product, Model: IDQX65-1	**Compliant**
§ 2.2	Radiated Spurious Emissions	FCC Part 15.209 RSS-GEN	30k – 26.5GHz		**Compliant**
§ 2.3	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 65" QX Series IFP display**
Test Personnel: Janet Mijares	**Standard: FCC15.247/RSS-247 Issue 2**
Date: 2023/05/08 (21.5°C, 26.5% 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 2, Clause 5.4(d), (a): 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:

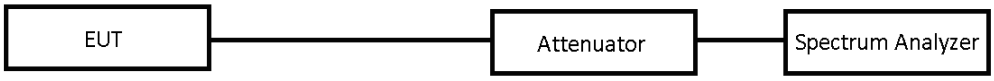
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Cal. Due
EMI receiver	Agilent	N9038A (FW A.25.05)	6130	2022-07-12	2023-07-12
Temp/Humidity	Extech	42270	5871	2022-05-09	2023-05-09
Antenna 1- 18GHz	EMCO	3115	19357	2022-10-05	2024-10-05
RE Cable	A.H. Systems Inc.	SAC-26G-5.23	6187	*2023-03-24	2024-03-24
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 is done.

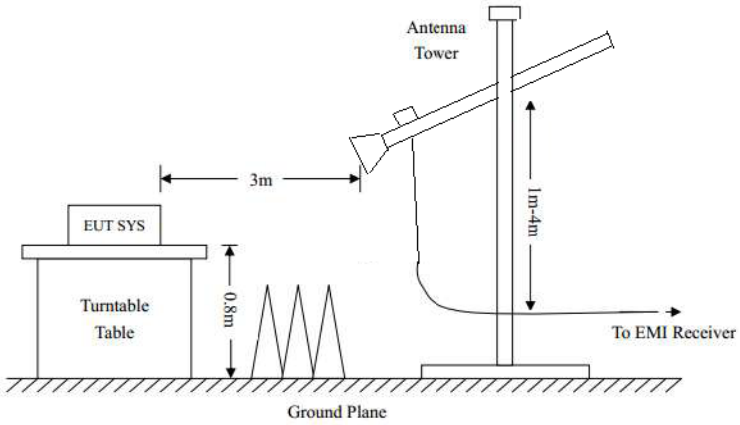
2.1.4 Test Sample Verification, Configuration & Modifications

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:



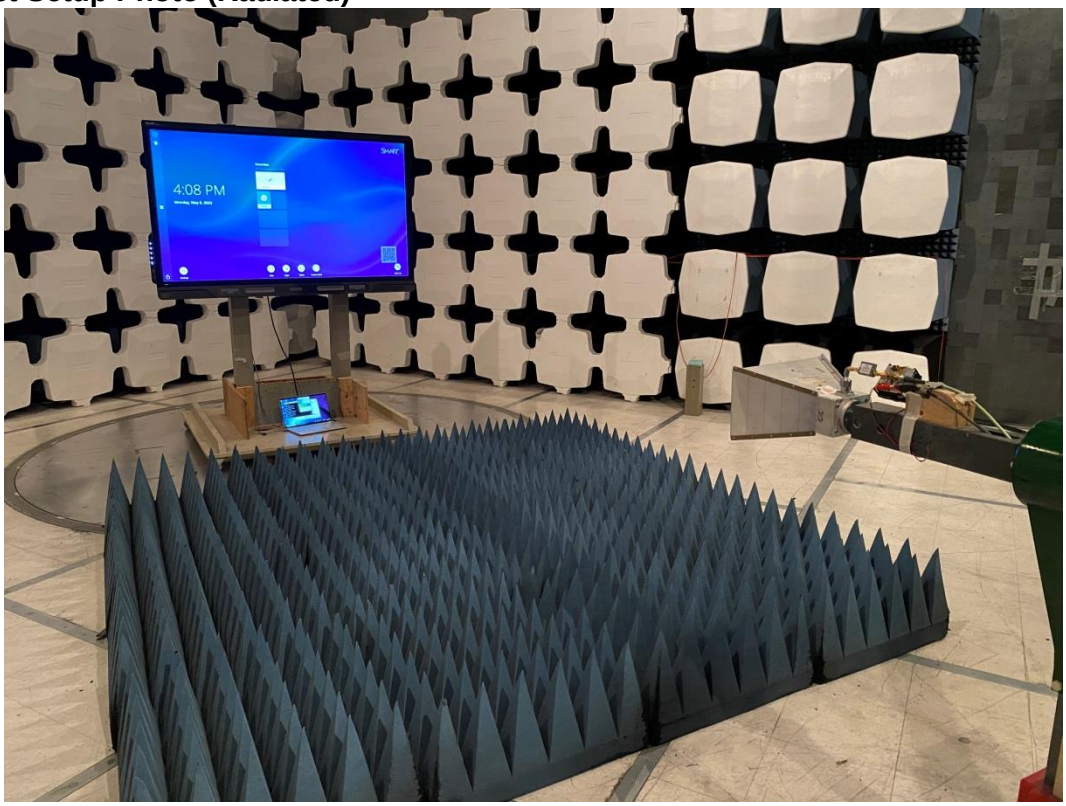
2.1.5 EIRP Data

Frequency (MHz)	Conducted Reading (dBm)	Max Antenna Gain dBi	EIRP dBm	EIRP (Watts)	EIRP Limit (Watts)	Margin (Output - limit)
Conducted Output Power Measurement						
2402	-2.087	4	1.913	0.0015535	≤ 4 (36dBm)	-3.99845
2440	-2.034	4	1.966	0.0015725		-3.99843
2480	-2.051	4	1.949	0.0015664		-3.99843

Polarity	Frequency (MHz)	Corrected Field Strength Reading (dBµ/m)	Converting Field Strength to dBm (dBµ/m -95.2) (EIRP dBm)	EIRP (Watts)	EIRP Limit (Watts)	Margin (Output - limit)
Maximized Radiated Output power Measurement						
Horizontal	2402	90.56	-4.64	0.0003436	≤ 4 (36dBm)	-3.99966
	2440	92.96	-2.24	0.0005970		-3.99940
	2480	97.77	2.57	0.001810		-3.99819
Vertical	2402	97.28	2.08	0.0016144		-3.99839
	2440	97.55	2.35	0.001718		-3.99828
	2480	98.83	3.63	0.0023067		-3.99769

Test Setup Photo (Conducted)

Test Setup Photo (Radiated)



2.2 Radiated Spurious Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 65" QX Series IFP display**
Test Personnel: Janet Mijares	**Standard: FCC Part 15.209, RSS-GEN**
Date: 2023/05/08 (21.5°C, 26.5% RH)	**Basic Standard: ANSI C63.10**
2023/05/08 (21.0°C, 30.3% RH)	

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 device, measured at a distance of 3 meters, shall not exceed the limits as specified.

2.2.1 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.

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	2022/07/12	2023/07/12
Loop Antenna	EMCO	6502	10868	2021/05/11	2023/05/11
Biconilog Antenna	SunAR	JB1	6905	2021/10/29	2023/10/29
DRG Horn	EMCO	3115	19357	2022/10/05	2024/10/05
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	
Pre-Amplifier (0.1-1.3 MHz)	HP	8447D	9291	*Monitored	

In house loss / gain verification performed.

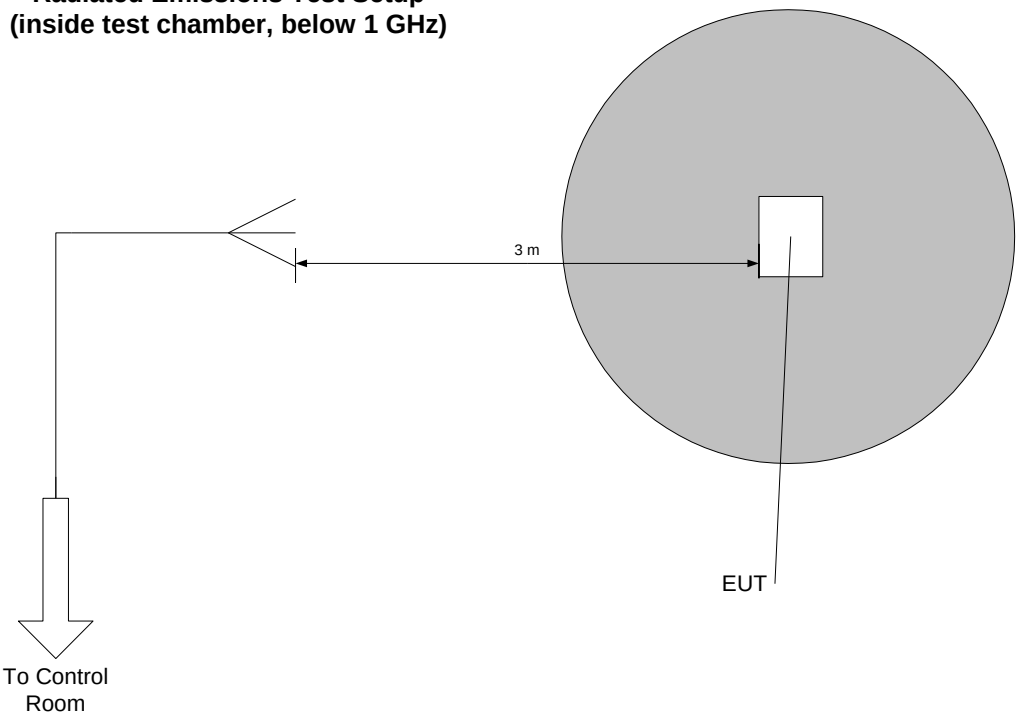
2.2.4 Test Sample Verification, Configuration & Modifications

See diagram in section 1.7

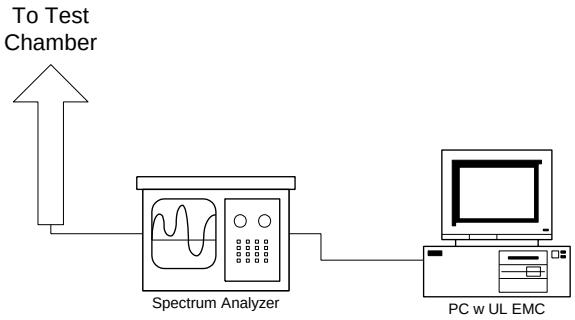
The EUT met the requirements without modification.

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. For LOW and MID channels above 1 GHz radiated spurious emission spot check was performed. Data is provided in section 2.2.6 and 2.2.7.

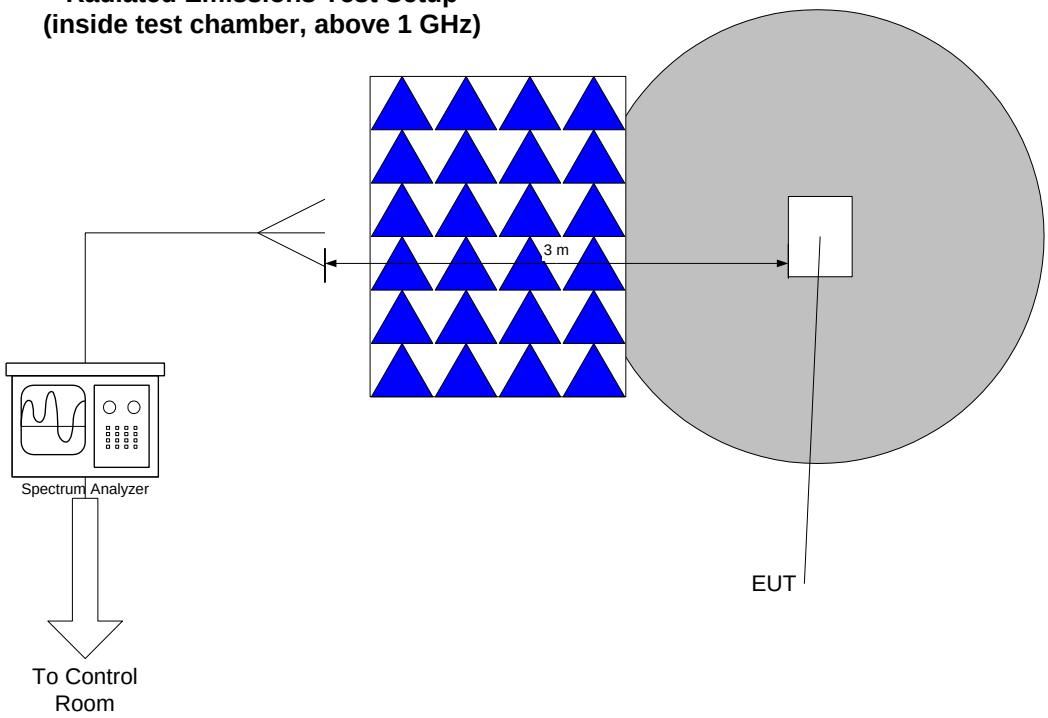
Radiated Emissions Test Setup (inside test chamber, below 1 GHz)



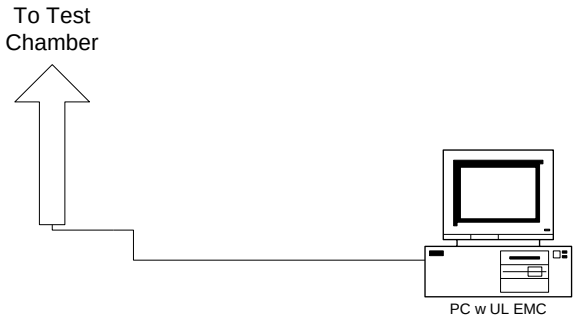
Radiated Emissions Test Setup (inside control room, below 1 GHz)



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



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



2.2.5 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.

Freq. Marker	Freq. [MHz]	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	0.13503	46.0	QP	10.4	.1	56.5	104.99	-48.49	63	200	Parallel
2	1.081	34.19	QP	10.8	.2	45.19	66.92	-21.73	77	200	Parallel
3	13.56	28.56	QP	10.9	.9	40.36	69.56	-29.9	271	200	Parallel
1	0.135	43.28	QP	10.4	.1	53.78	104.99	-51.21	0	200	Perpendicular
2	13.56	29.19	QP	10.9	.9	40.99	69.56	-28.57	325	200	Perpendicular
1	159.74	47.32	QP	16.1	-22.9	40.52	43.53	-3.01	170	117	Horizontal
2	463.89	19.84	QP	21	-20.8	20.04	46.03	-25.99	289	349	Horizontal
3	32.24	33.32	QP	23.4	-24.8	31.92	40.01	-8.09	112	108	Vertical
4	153.60	42.41	QP	16.3	-22.9	35.81	43.53	-7.72	194	237	Vertical
5	959.96	29.5	QP	26.6	-18.4	37.7	46.03	-8.33	227	105	Vertical

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.
- QP = Quasi-Peak detector; AV = Average detector; PK = Peak detector

Negative values for Delta indicate compliance.

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	1.44	46.63	AV	25.6	-34.8	37.43	54	-16.57	162	102	Horizontal
		53.6	PK			44.4	74	-29.60			
2	1.8755	26.96	AV	27.3	-32.9	21.36	54	-32.64	244	210	Horizontal
		39.78	PK			34.18	74	-39.82			
3	2.9699	43.58	AV	29.9	-32.4	41.08	54	-12.92	315	171	Horizontal
		47.99	PK			45.49	74	-28.51			
4	5.823	23.07	AV	33.7	-28.9	27.87	54	-26.13	209	375	Horizontal
		35.31	PK			40.11	74	-33.89			
5	5.94	40.43	AV	33.9	-29.4	44.93	54	-9.07	228	172	Horizontal
		44.91	PK			49.41	74	-24.59			
6	7.4404	38.3	AV	36.6	-26.3	48.6	54	-5.40	189	141	Horizontal
		45.36	PK			55.66	74	-18.34			
7	17.8751	5.88	AV	46.7	-16.2	36.38	54	-17.62	62	127	Horizontal
		10.45	PK			40.95	74	-33.05			
8	1.4066	37.86	AV	25.5	-34.9	28.46	54	-25.54	174	215	Vertical
		54.81	PK			45.41	74	-28.59			
9	1.5637	36.37	AV	26.1	-34.5	27.97	54	-26.03	9	157	Vertical
		49.89	PK			41.49	74	-32.51			
10	2.9702	50.05	AV	29.9	-32.4	47.55	54	-6.45	312	118	Vertical
		52.66	PK			50.16	74	-23.84			
11	5.3288	20.24	AV	33.7	-28.4	25.54	54	-28.46	40	251	Vertical
		44.02	PK			49.32	74	-24.68			
12	5.9401	41.53	AV	33.9	-29.4	46.03	54	-7.97	231	104	Vertical
		45.8	PK			50.3	74	-23.70			
13	7.4393	40.29	AV	36.6	-26.3	50.59	54	-3.41	149	109	Vertical
		47.93	PK			58.23	74	-15.77			
14	9.9208	28.33	AV	38	-25.1	41.23	54	-12.77	185	334	Vertical
		37.56	PK			50.46	74	-23.54			
15	17.8722	15.3	AV	46.7	-16.3	45.7	54	-8.30	0	161	Vertical
		29.82	PK			60.22	74	-13.78			
1	19.8421	29.37	AV	34.9	-21.4	42.87	54	-11.13	218	143	Horizontal
		39.74	PK			53.24	74	-20.76			
2	19.8381	21.45	AV	34.9	-21.5	34.85	54	-19.15	193	133	Vertical
		34.27	PK			47.67	74	-26.33			

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.
- QP = Quasi-Peak detector; 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)

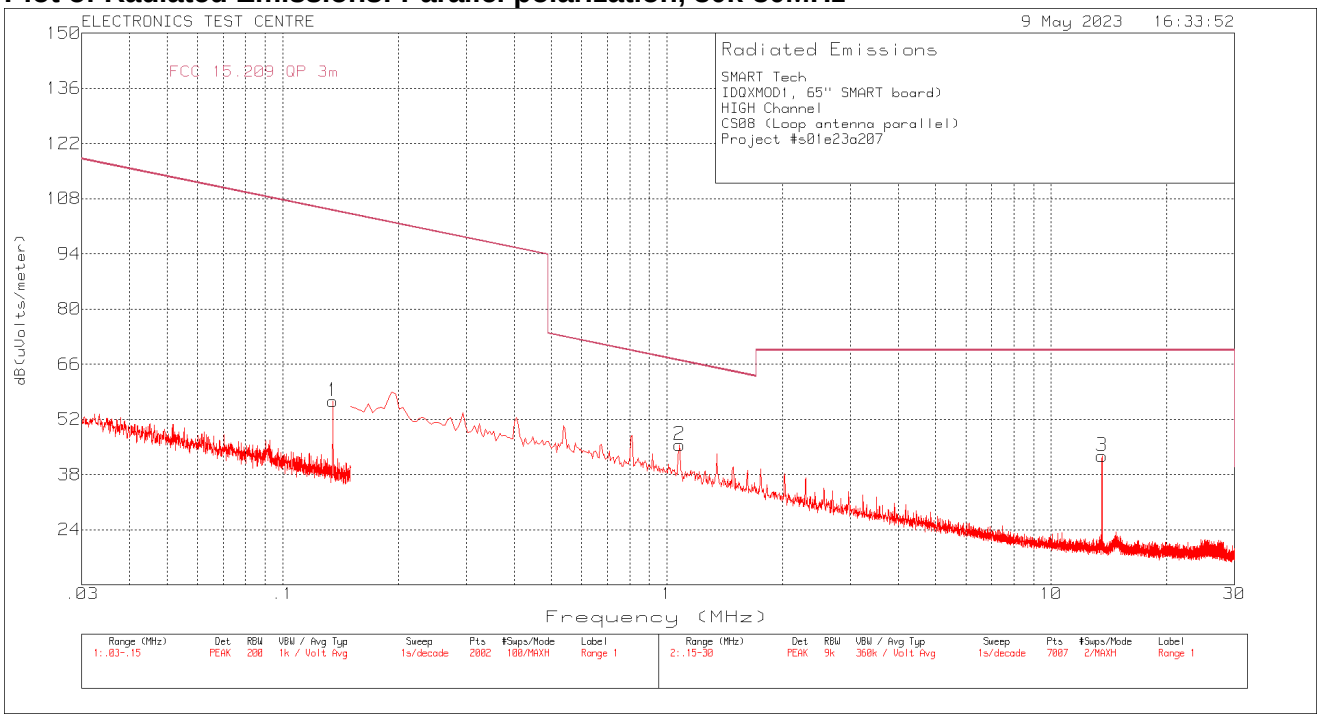
DCCF = 2.72 - 11.25

DCCF = -8.53 dB

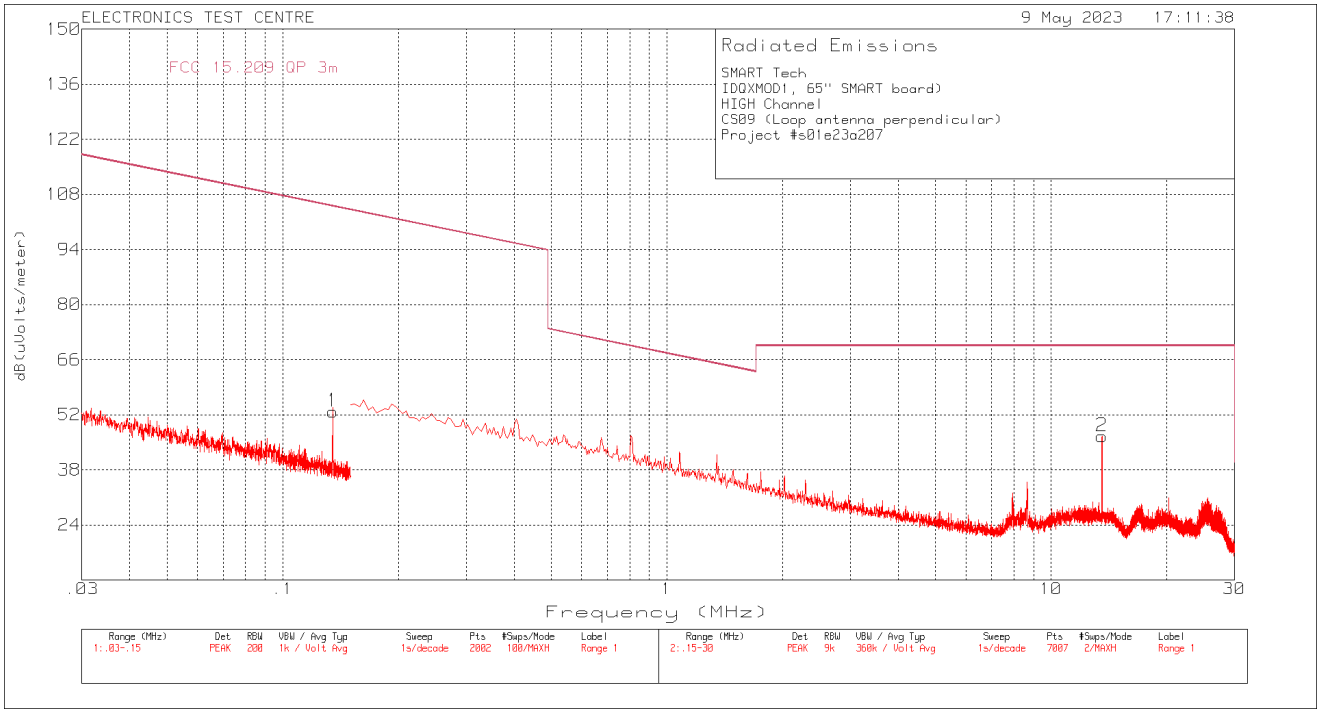
Freq. Marker	Freq. [GHz]	Measured Average Reading [dBµV/m]	D.C Correction Factor (dB)	Corrected Average Value [dBµV/m]	RSS-GEN FCC 15.209 Limit [dBµV/m]	Delta [dB]	Polarization
6	7.4404	48.6	-8.53	40.07	54	-13.93	Horizontal
13	7.4393	50.59	-8.53	42.06	54	-11.94	Vertical
14	9.9208	41.23	-8.53	32.70	54	-21.3	Vertical
1	19.8421	42.87	-8.53	34.34	54	-19.66	Horizontal
2	19.8381	34.85	-8.53	26.32	54	-27.68	Vertical

Negative values for Delta indicate compliance.

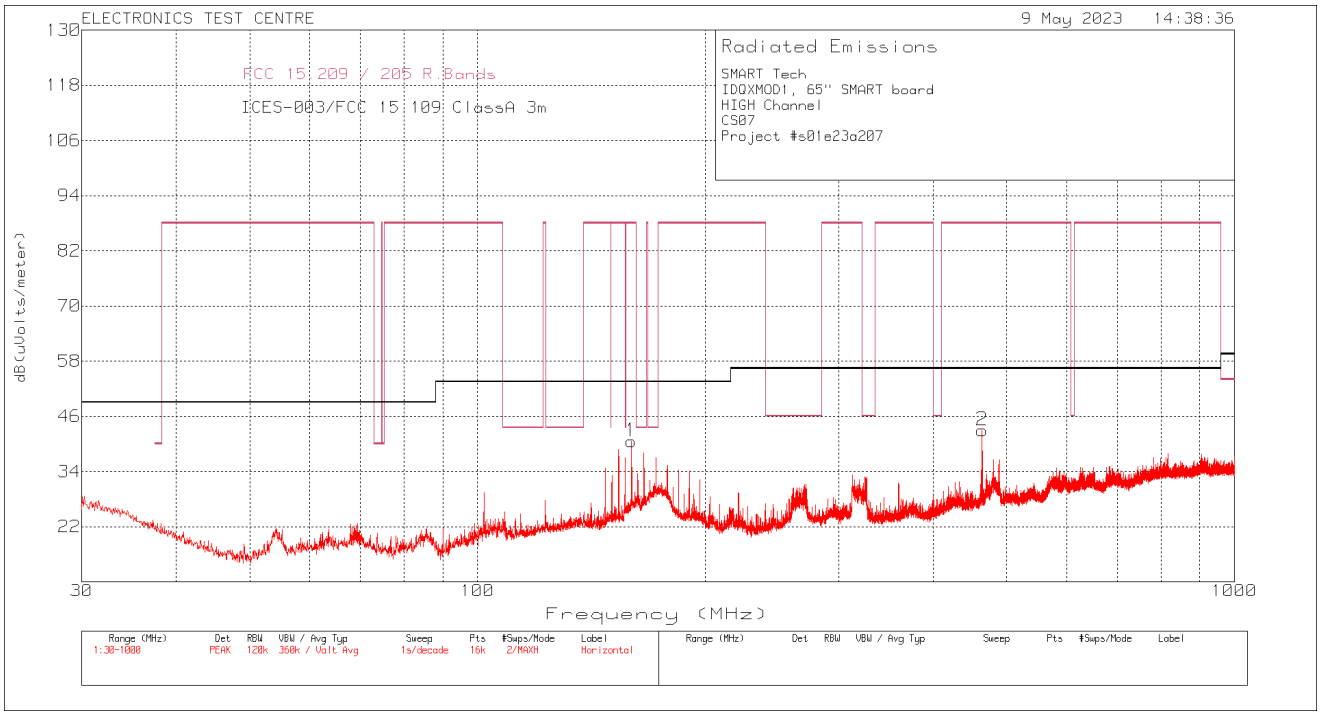
Plot of Radiated Emissions: Parallel polarization, 30k-30MHz



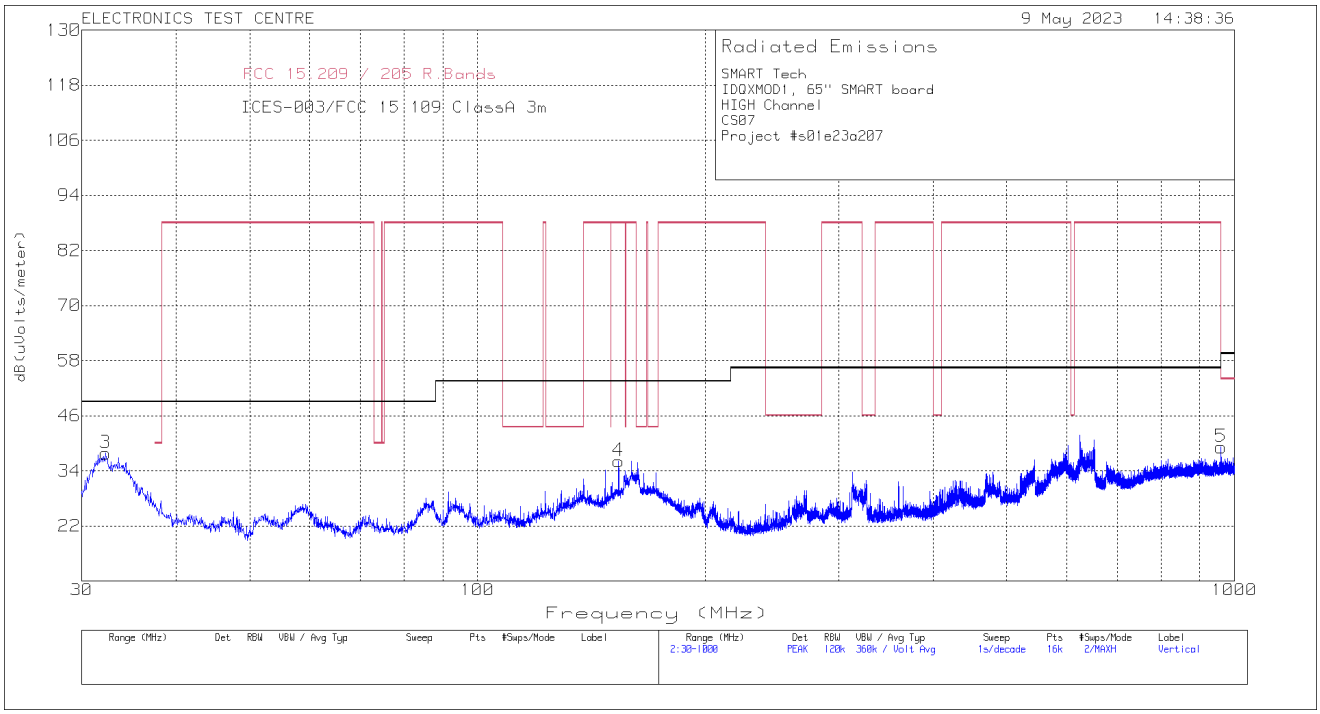
Plot of Radiated Emissions: Perpendicular polarization, 30k-30MHz



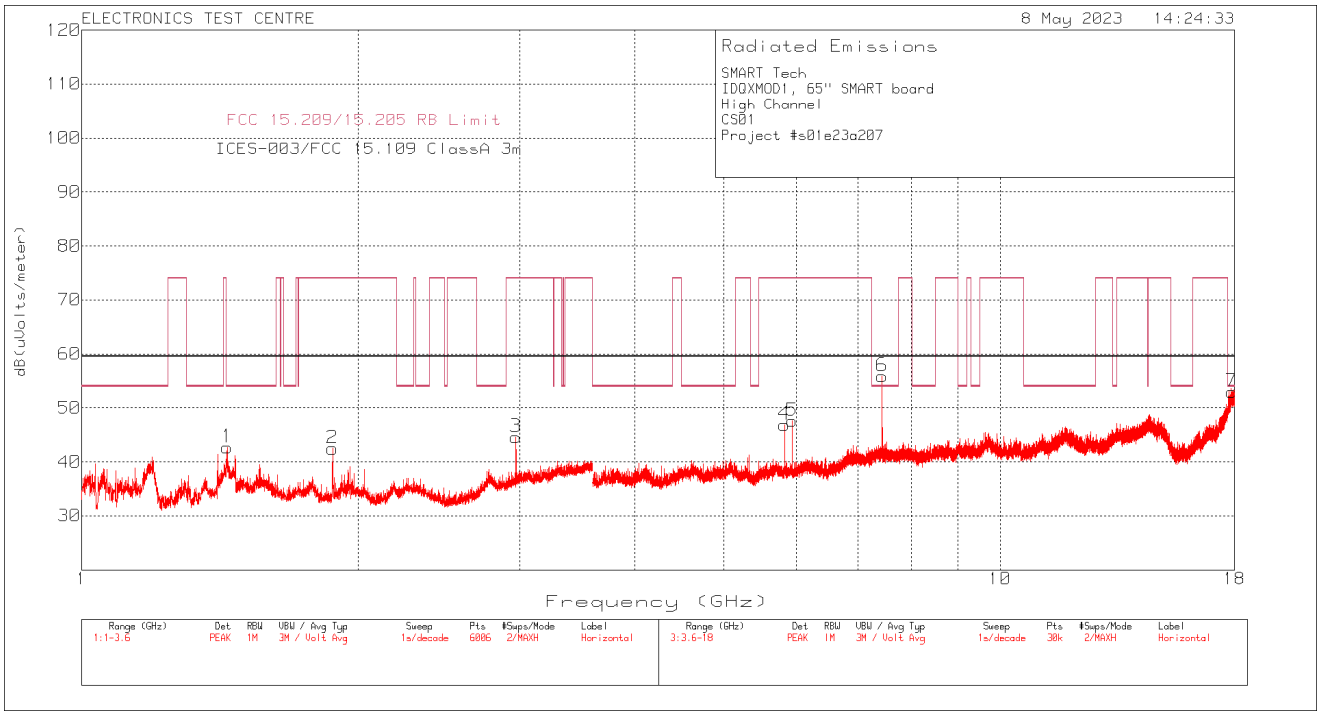
Plot of Radiated Emissions: Horizontal polarization, 30M-1GHz



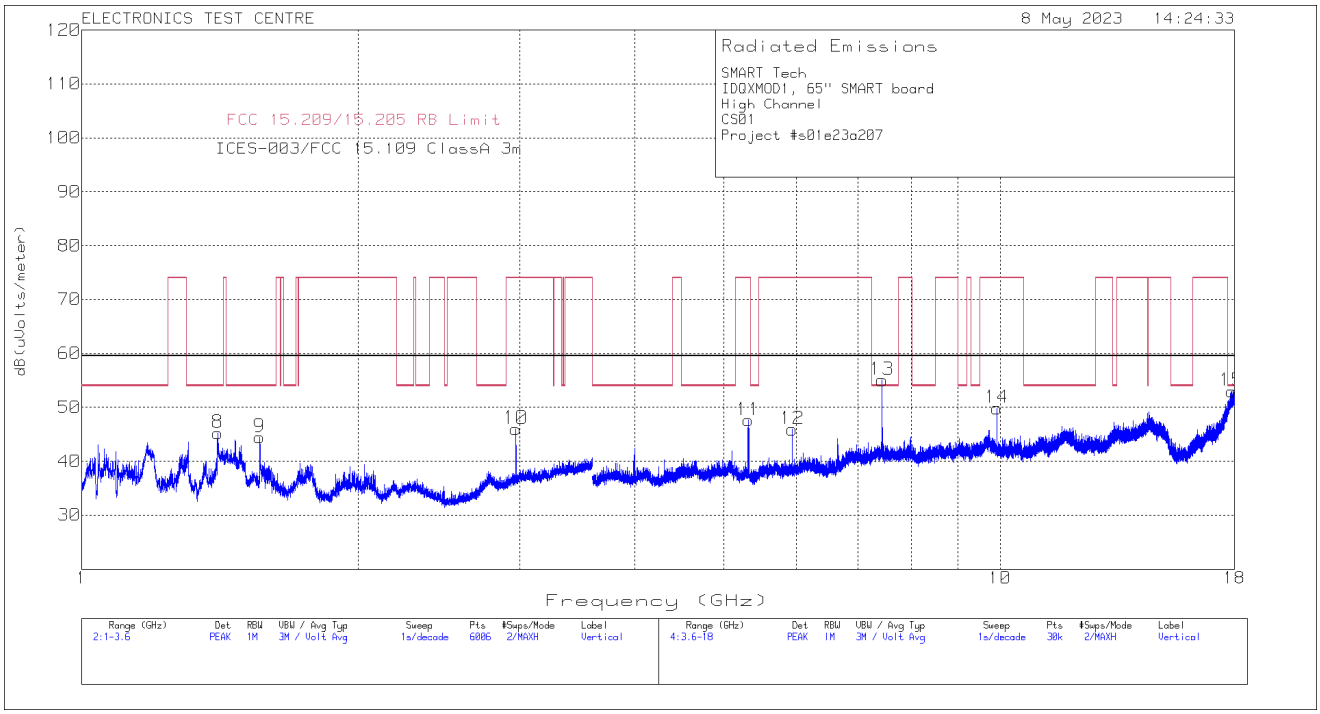
Plot of Radiated Emissions: Vertical polarization, 30M-1GHz



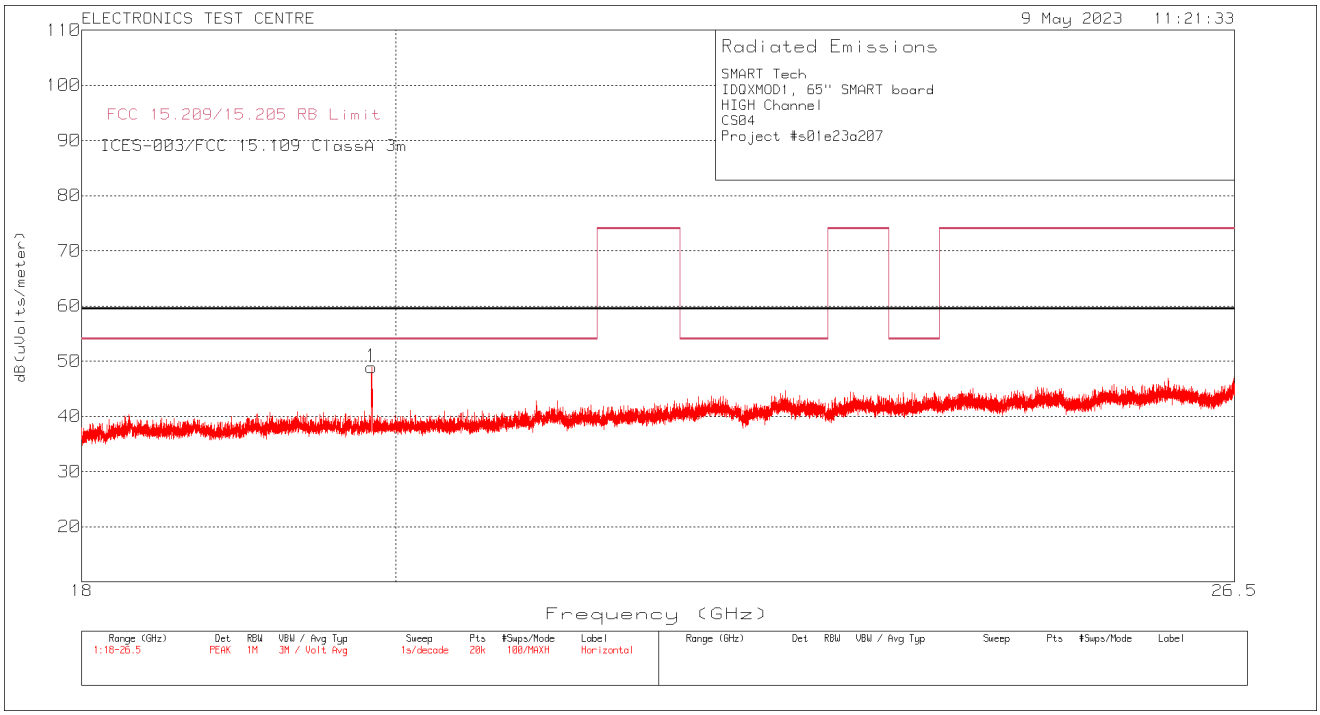
Plot of Radiated Emissions: Horizontal polarization, 1-18GHz



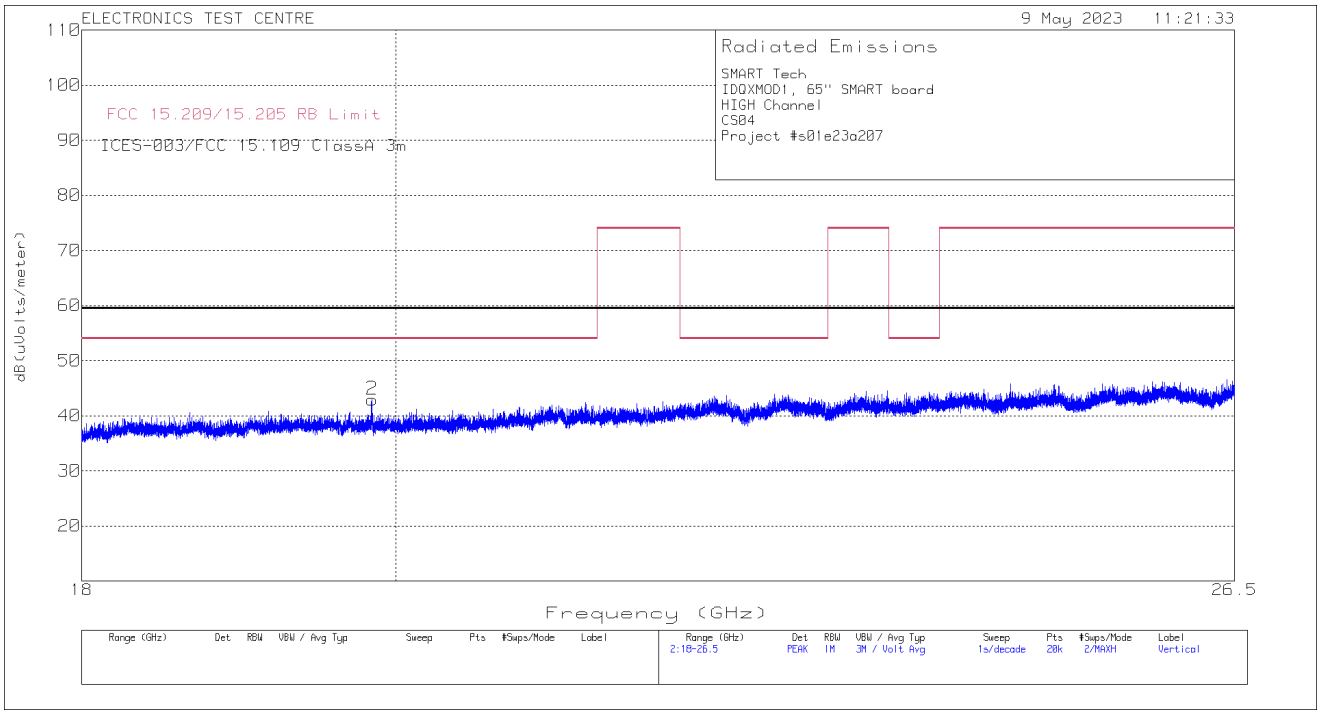
Plot of Radiated Emissions: Vertical polarization, 1-18GHz



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



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



2.2.6 Radiated Emissions Maximized Data (LOW 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.

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	7.206	36.49	AV	36	-26.6	45.89	54	-8.11	125	105	Horizontal
		44.32	PK			53.72	74	-20.28			
2	9.068	25.22	AV	37.6	-24.7	38.12	54	-15.88	218	106	Horizontal
		36.1	PK			49.0	74	-25.0			
3	17.87	15.29	AV	46.7	-17.8	44.19	54	-9.81	273	185	Horizontal
		37.95	PK			56.85	74	-17.15			
4	7.206	36.02	AV	36	-26.6	45.42	54	-8.58	183	186	Vertical
		44.04	PK			53.44	74	-20.56			
5	9.068	29.64	AV	37.6	-24.7	42.54	54	-11.46	182	309	Vertical
		38.72	PK			51.62	74	-22.38			
6	17.87	15.13	AV	46.7	-17.8	43.93	54	-10.07	101	100	Vertical
		26.21	PK			55.01	74	-18.99			
1	19.214	32.46	AV	34.6	-22.1	44.96	54	-9.04	186	109	Horizontal
		42.33	PK			54.83	74	-19.18			
2	19.214	28.11	AV	34.6	-22.1	40.61	54	-13.39	224	205	Vertical
		38.7	PK			51.2	74	-22.80			

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 the Average measurements = (Test mode duty cycle) – (Max operating duty cycle)

DCCF = 2.72 - 11.25
DCCF = -8.53 dB

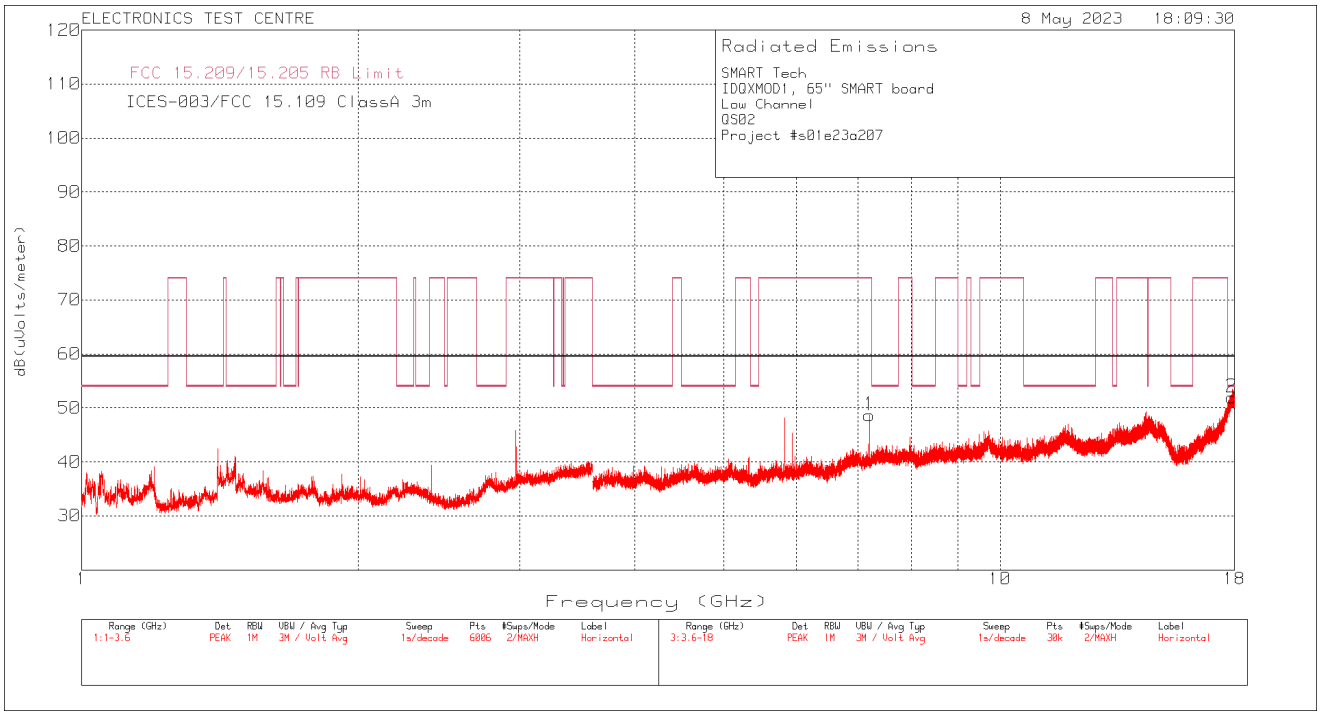
Freq. Marker	Freq. [GHz]	Measured AVG Value [dBµV/m]	D.C Correction Factor (dB)	Corrected Average Value [dBµV/m]	RSS-GEN FCC 15.209 Limit [dBµV/m]	Delta [dB]	Polarization
1	7.206	45.89	-8.53	37.36	54	-16.64	Horizontal
2	9.068	38.12	-8.53	29.59	54	-24.41	Horizontal
4	7.206	45.42	-8.53	36.89	54	-17.11	Vertical
5	9.068	42.54	-8.53	34.01	54	-19.99	Vertical
1	19.214	44.96	-8.53	36.43	54	-17.57	Horizontal
2	19.214	40.61	-8.53	32.08	54	-21.92	Vertical

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

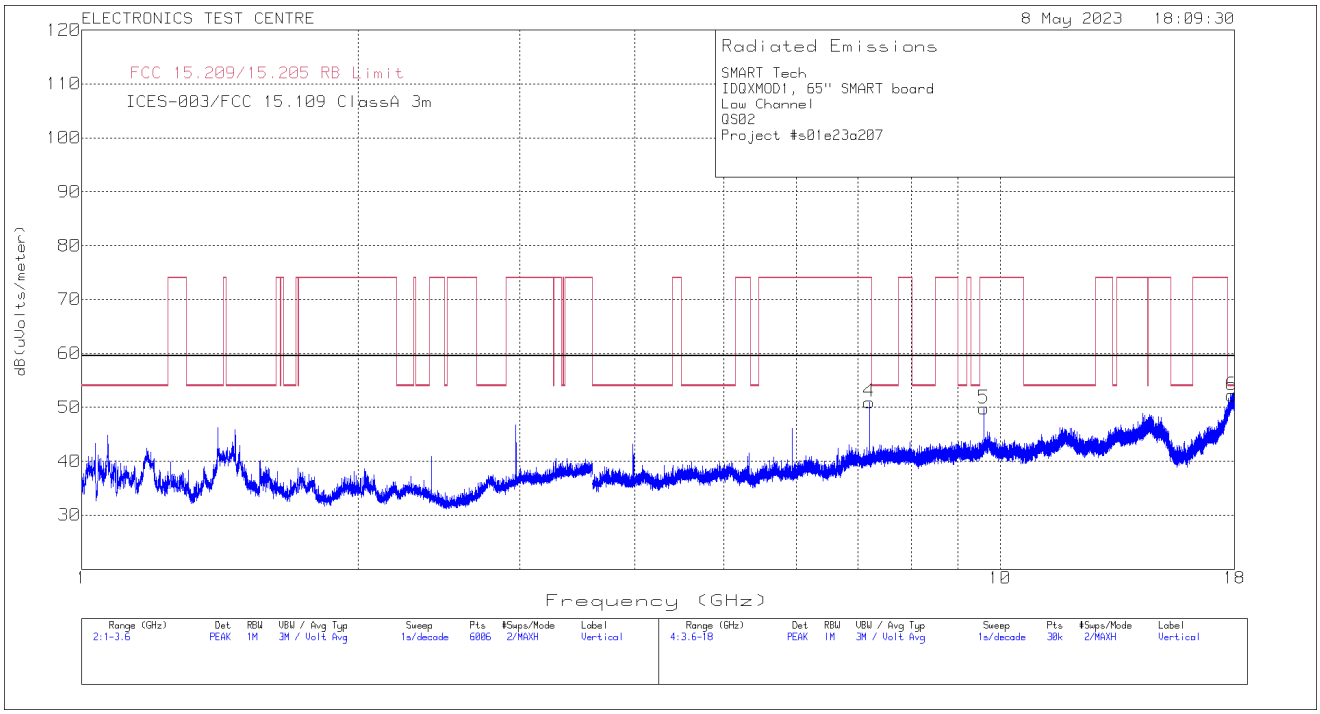
- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum emission. This may produce a different reading than the plot trace. The plot is 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.

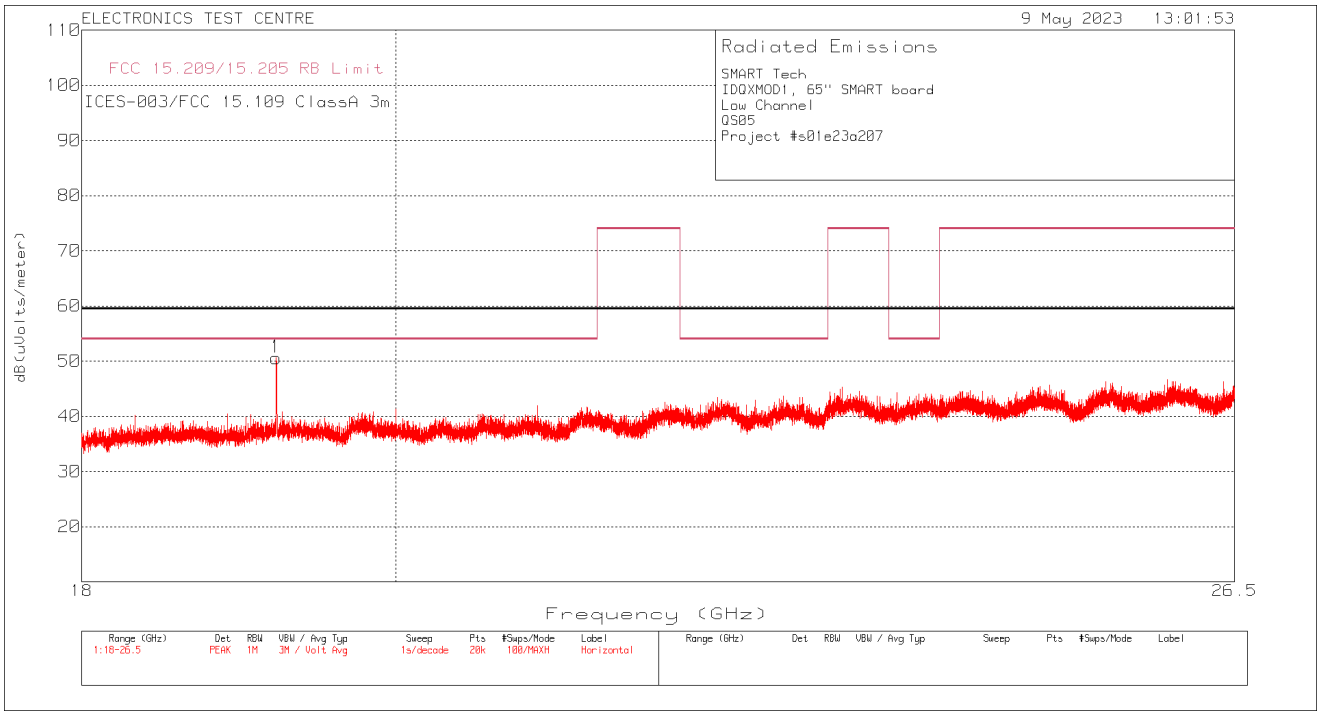
Plot of Radiated Emissions: Horizontal polarization, 1-18GHz



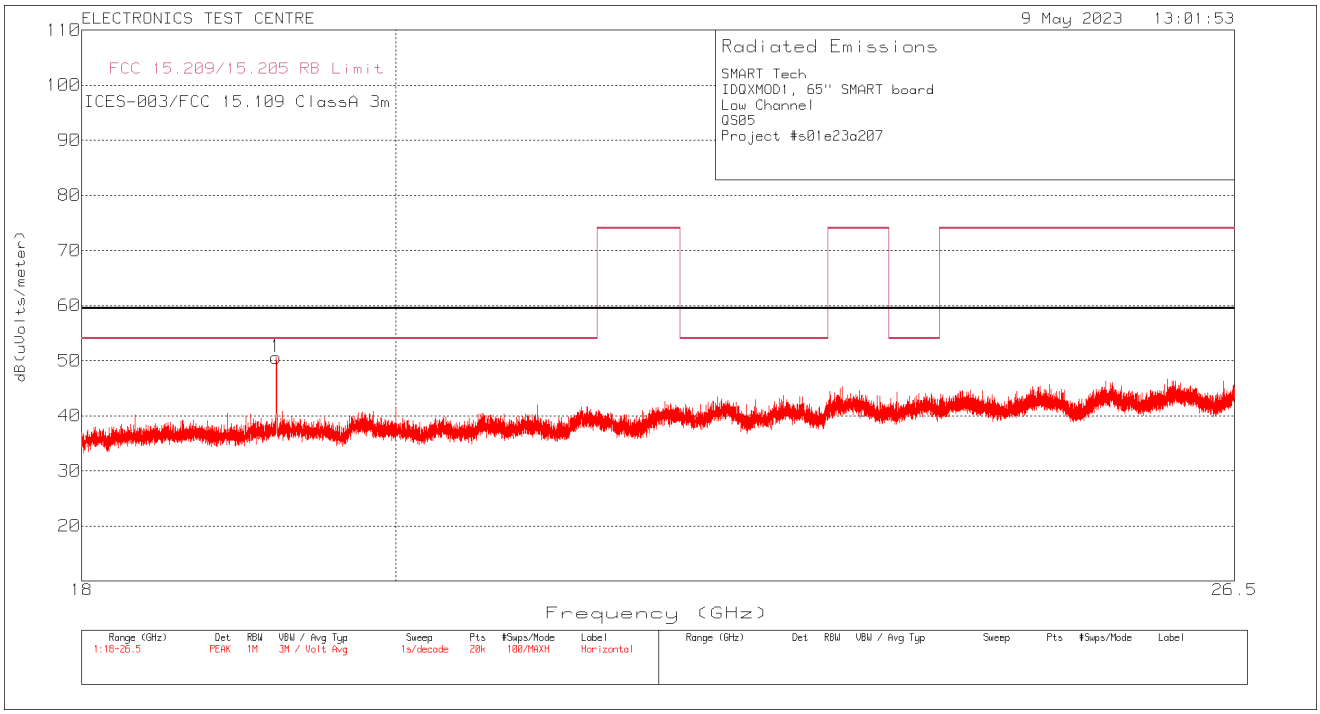
Plot of Radiated Emissions: Vertical polarization, 1-18GHz



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



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



2.2.7 Radiated Emissions Maximized Data (MID 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.

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	7.3265	33.43	AV	36.5	-26.8	43.13	54	-10.87	88	380	Horizontal
		41.5	PK			51.2	74	-22.80			
2	9.7677	21.14	AV	37.8	-24.4	34.34	54	-19.66	192	286	Horizontal
		33.35	PK			46.55	74	-27.45			
3	17.93	15.49	AV	46.8	-17.7	44.59	54	-9.41	51	112	Horizontal
		29.12	PK			58.22	74	-15.78			
4	7.3254	37.46	AV	36.5	-26.8	47.16	54	-6.84	150	113	Vertical
		44.96	PK			54.66	74	-19.34			
5	9.76	30.03	AV	37.8	24.6	43.23	54	-10.77	185	106	Vertical
		40.26	PK			53.46	74	-20.54			
6	17.86	15.07	AV	46.5	-17.9	43.67	54	-10.33	3	217	Vertical
		27.68	PK			56.28	74	-17.72			
1	19.53	31.89	AV	34.7	-22.1	44.49	54	-9.51	172	131	Horizontal
		41.92	PK			54.52	74	-19.48			
2	19.53	27.38	AV	34.7	-22.1	39.98	54	-14.02	166	106	Vertical
		37.74	PK			50.34	74	-23.66			

Measured 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 the Average measurements = (Test mode duty cycle) – (Max operating duty cycle)

DCCF = 2.72 - 11.25
DCCF = -8.53 dB

Freq. Marker	Freq. [GHz]	Measured AVG Value [dBµV/m]	D.C Correction Factor (dB)	Corrected Average Value [dBµV/m]	RSS-GEN FCC 15.209 Limit [dBµV/m]	Delta [dB]	Polarization
1	7.3265	43.13	-8.53	34.6	54	-19.4	Horizontal
2	9.7677	34.34	-8.53	25.81	54	-28.19	Horizontal
4	7.3254	47.16	-8.53	38.63	54	-15.37	Vertical
5	9.76	43.23	-8.53	34.7	54	-19.3	Vertical
1	19.53	44.49	-8.53	35.96	54	-18.04	Horizontal
2	19.53	39.98	-8.53	31.45	54	-22.55	Vertical

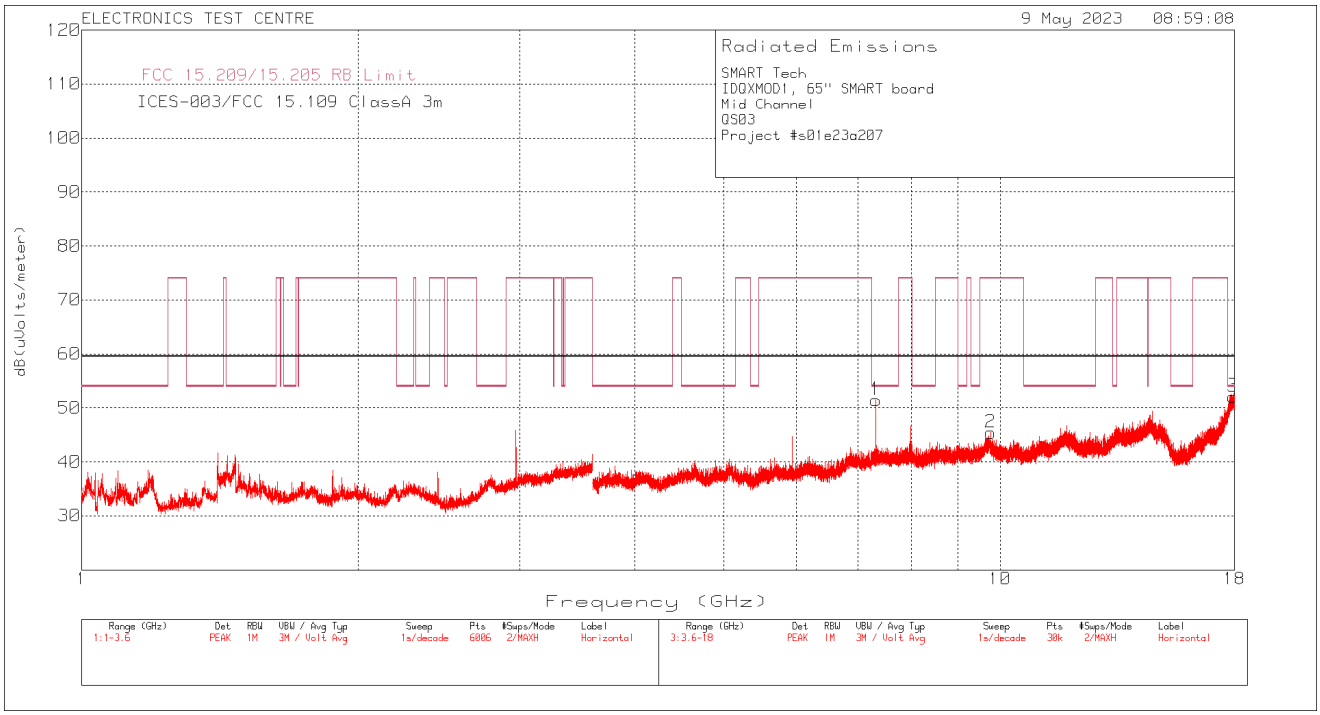
Meter Reading in dBµV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dBµV/m.

Notes:

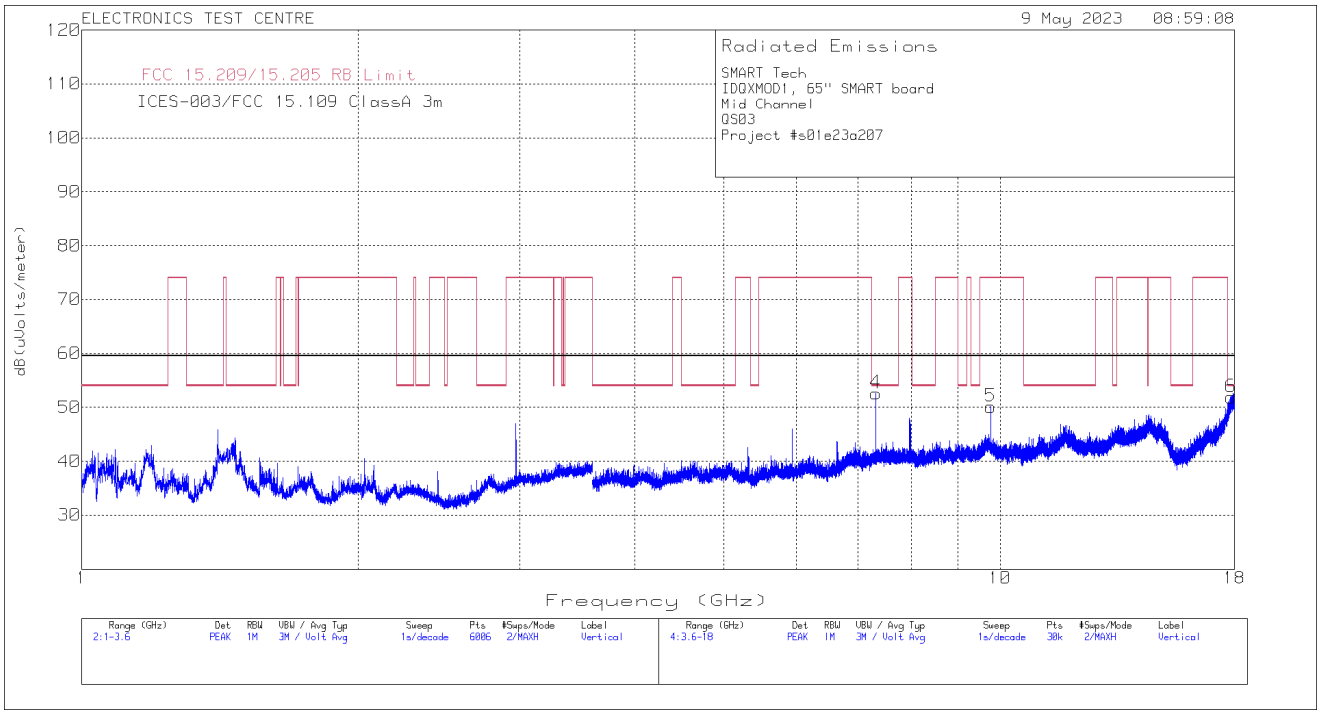
- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum emission. This may produce a different reading than the plot trace. The plot is 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.

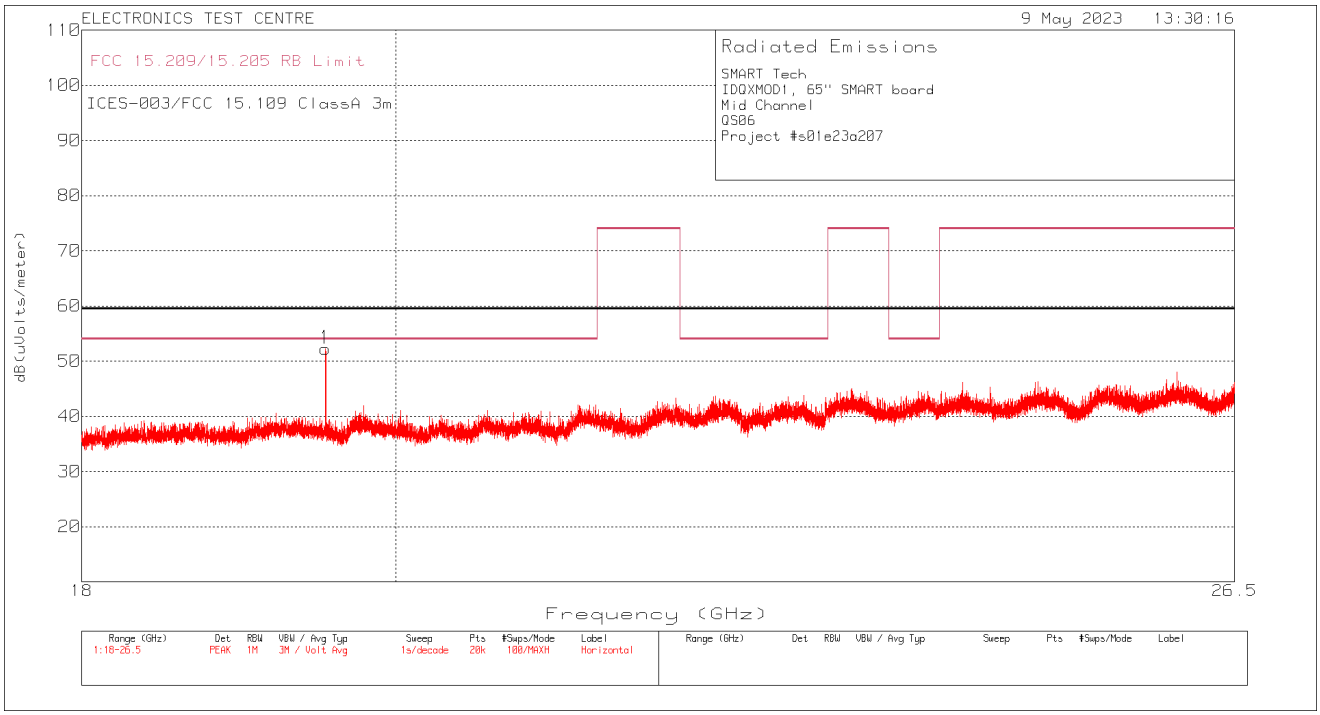
Plot of Radiated Emissions: Horizontal polarization, 1-18GHz



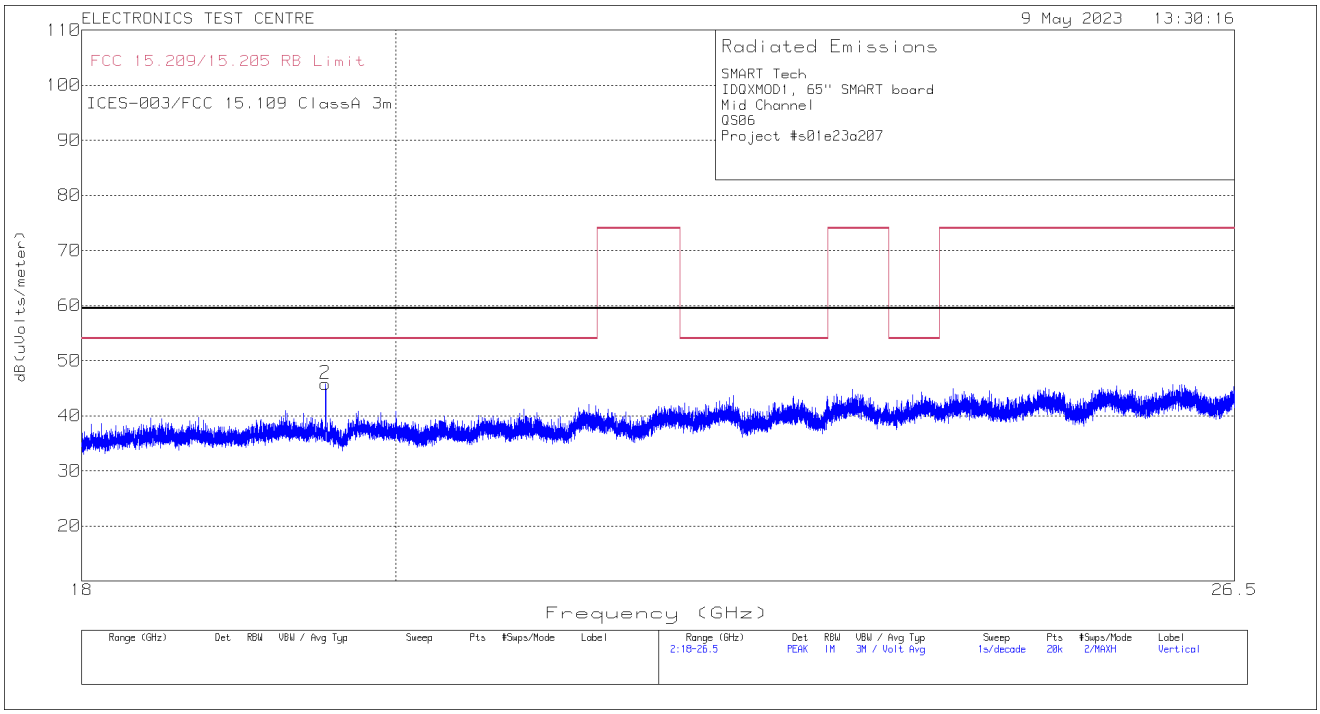
Plot of Radiated Emissions: Vertical polarization, 1-18GHz



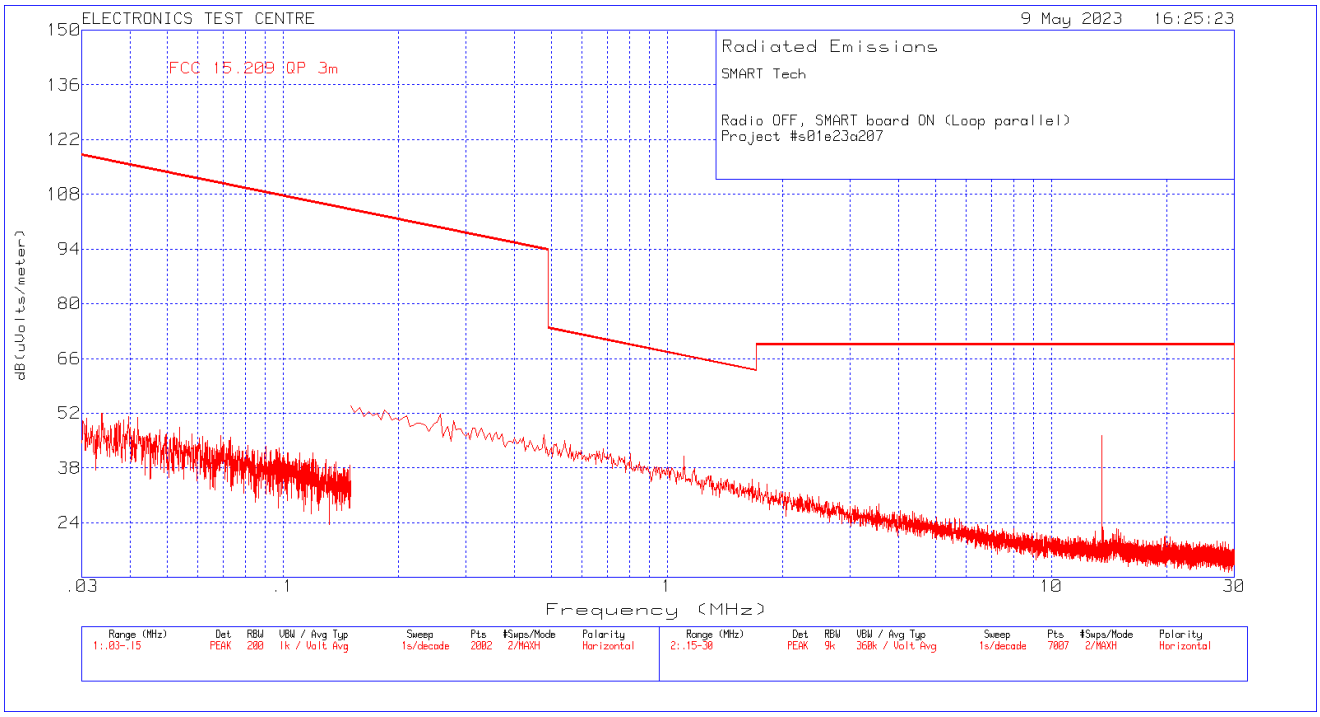
Plot of Radiated Emissions: Horizontal polarization, 18-26.5GHz



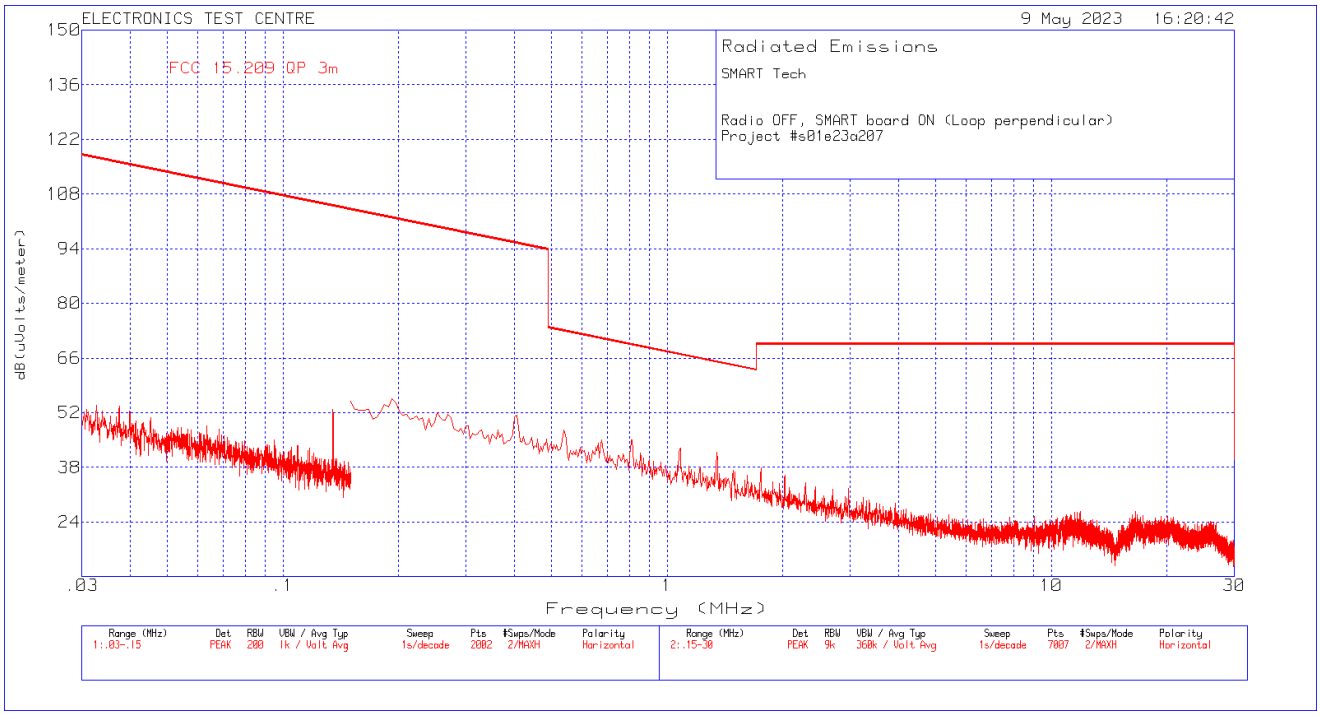
Plot of Radiated Emissions: Vertical polarization, 18-26.5GHz



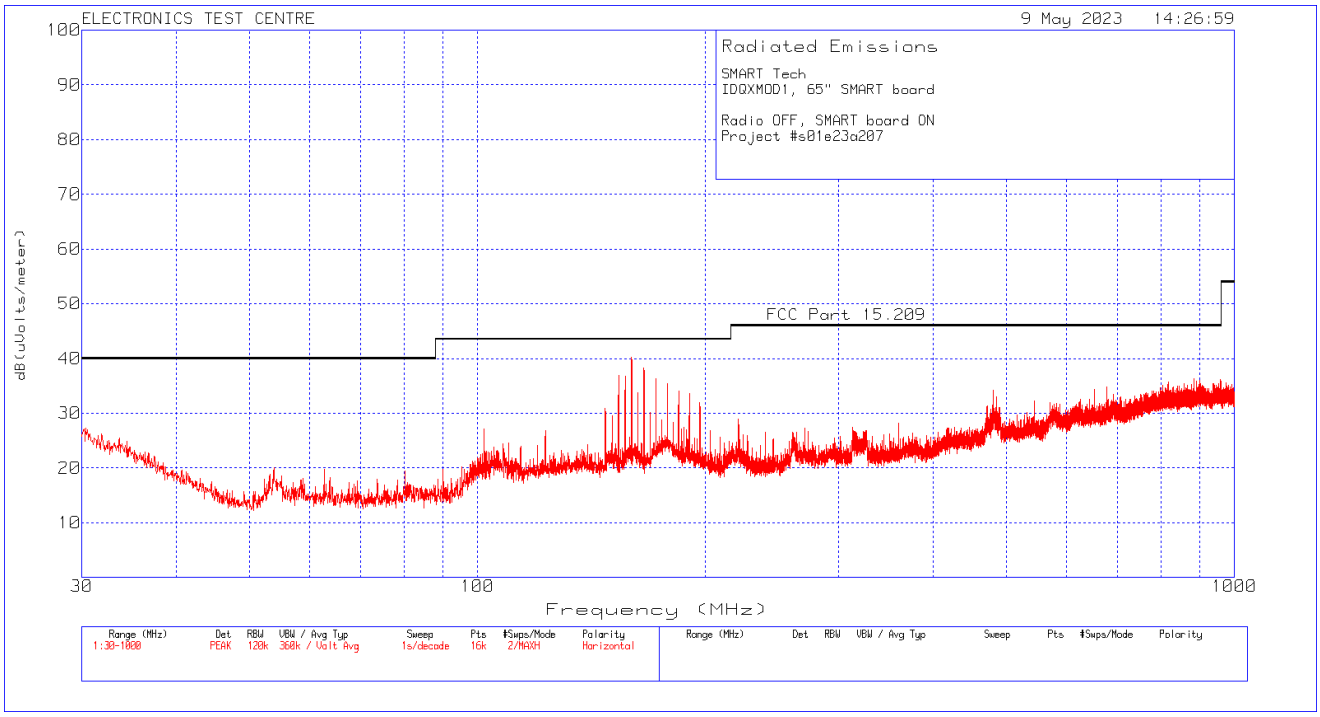
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Parallel polarization, 30k-30MHz



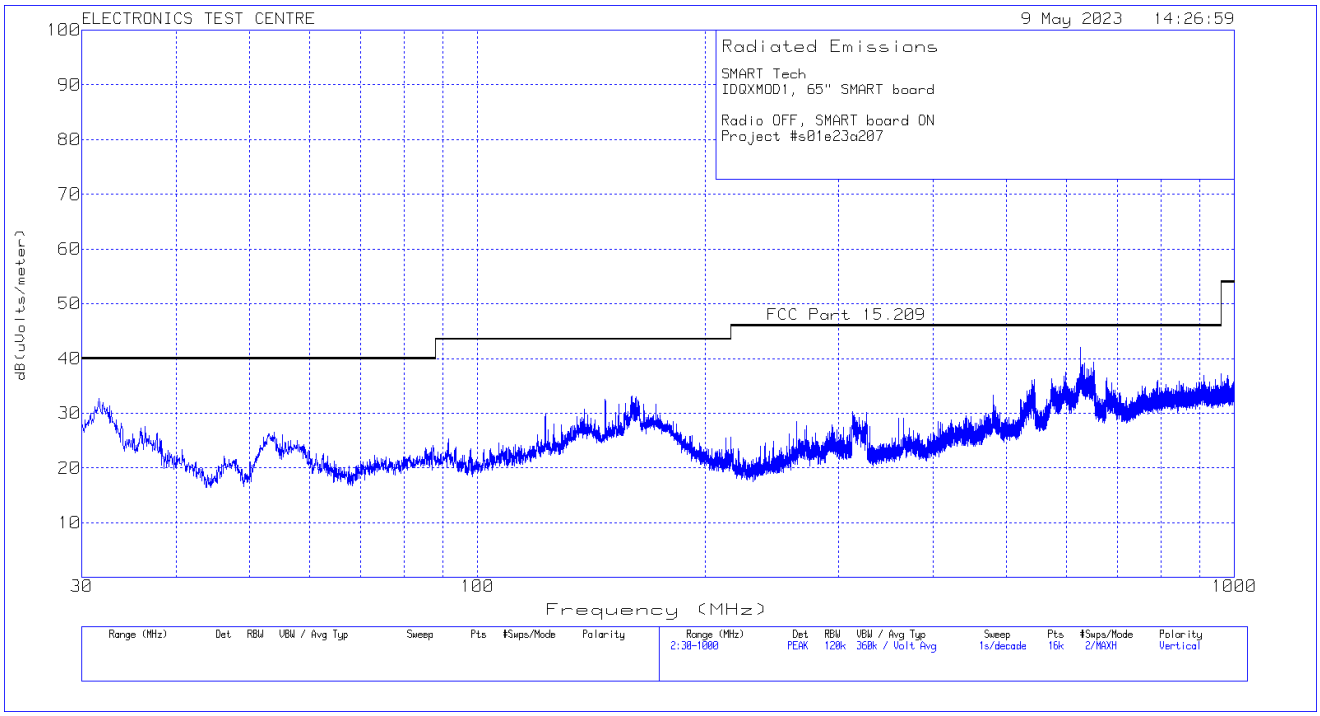
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Perpendicular polarization, 30k-30MHz



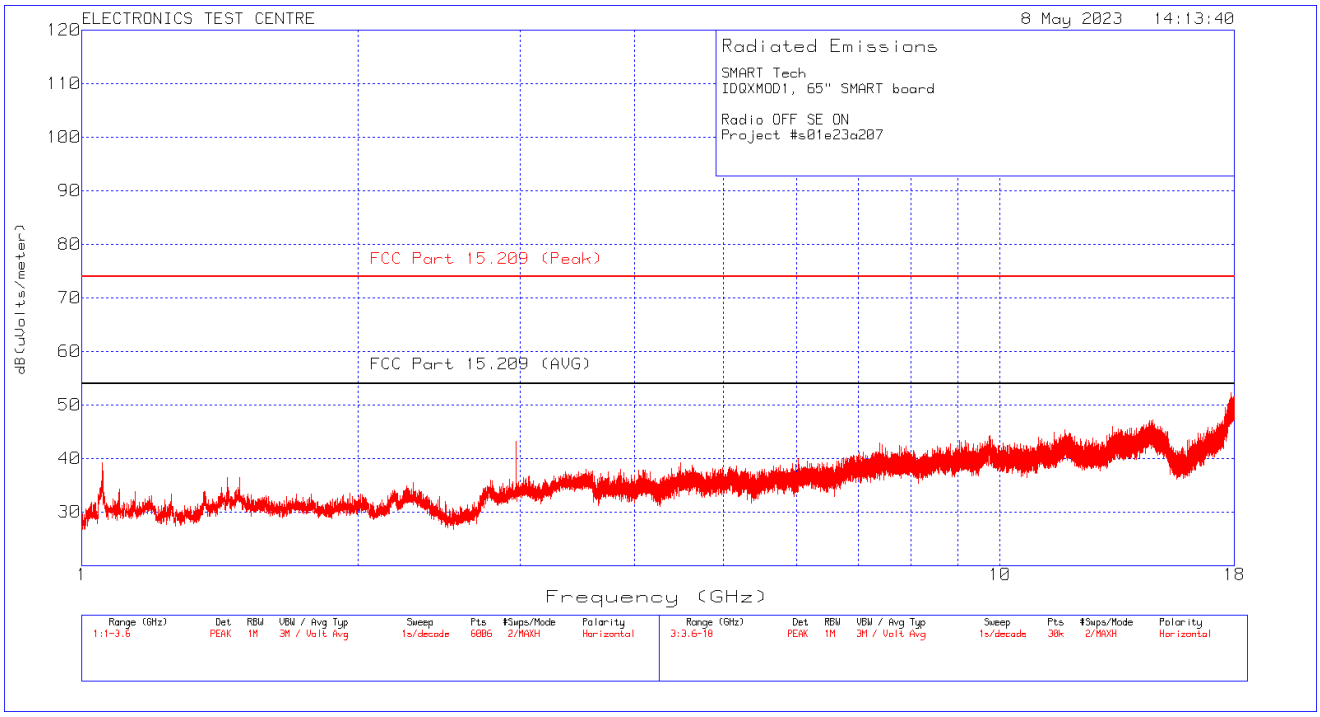
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Horizontal polarization, 30M-1GHz



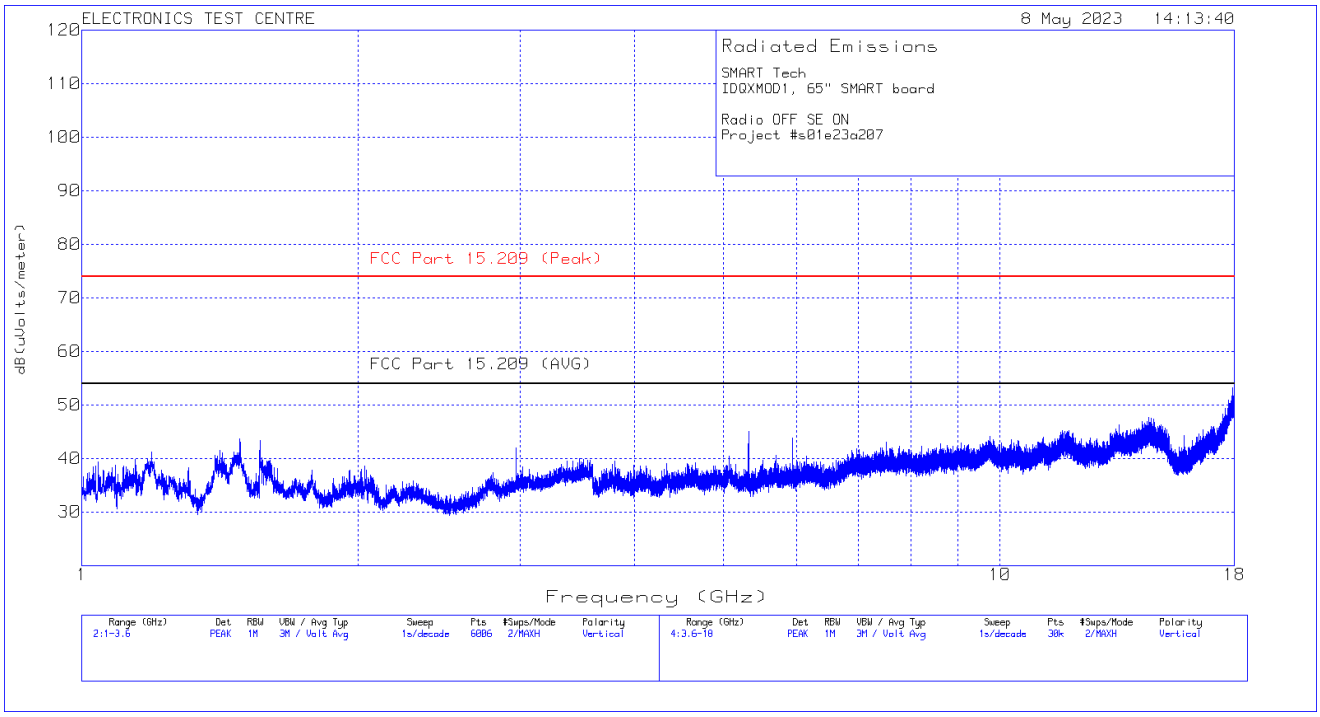
Plot of Radiated Emissions: BLE Radio OFF, SE ON, Vertical polarization, 30M-1GHz



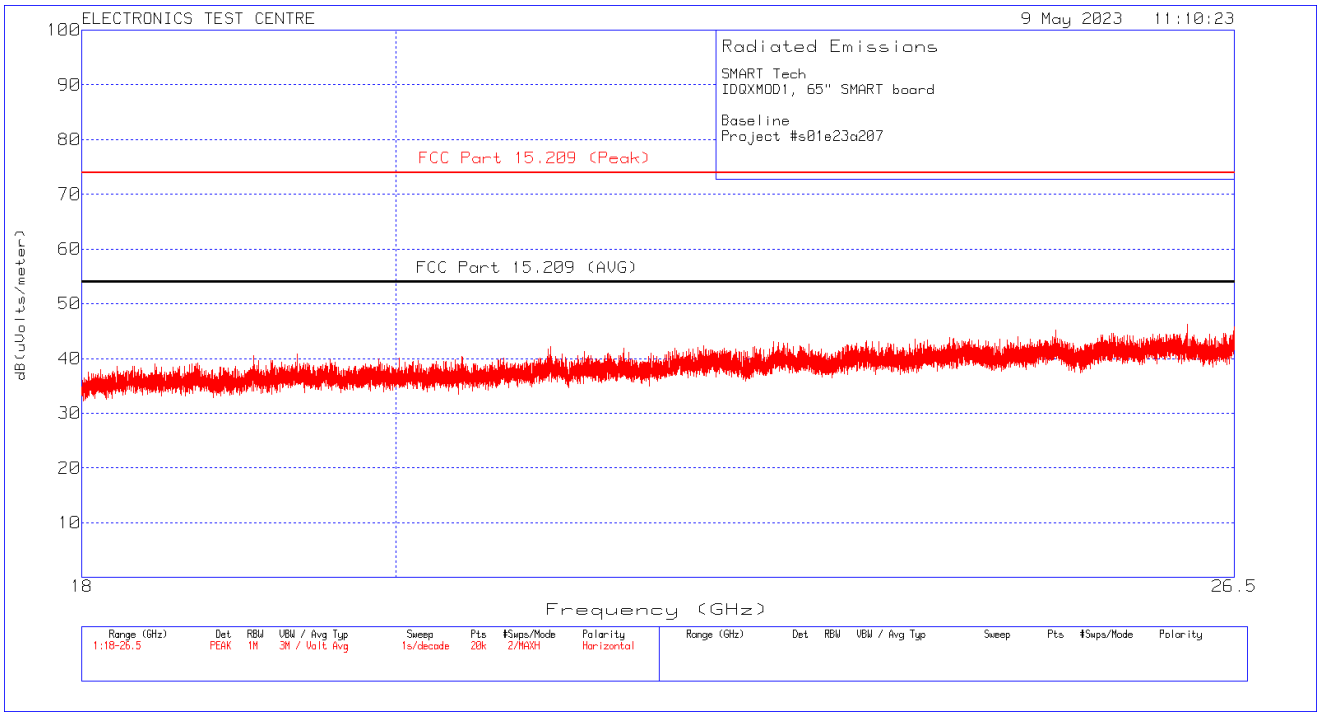
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Horizontal polarization, 1-18GHz



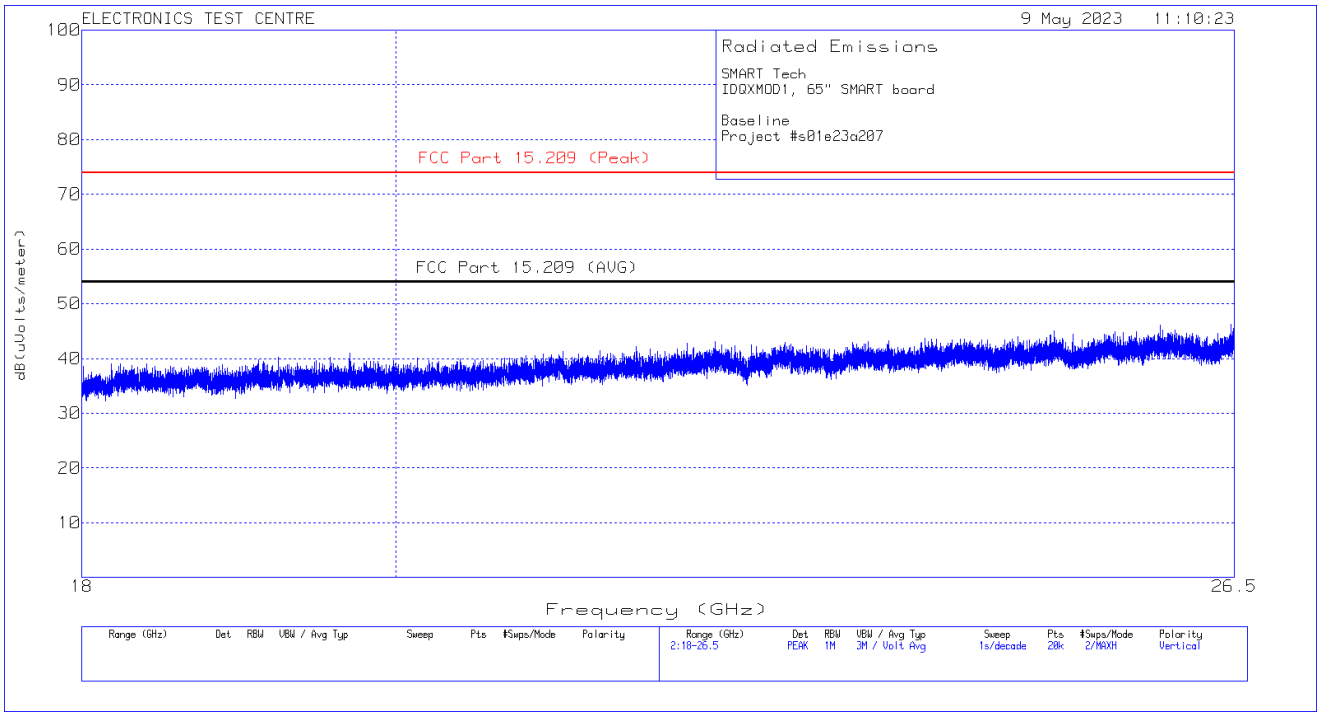
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Vertical polarization, 1-18GHz



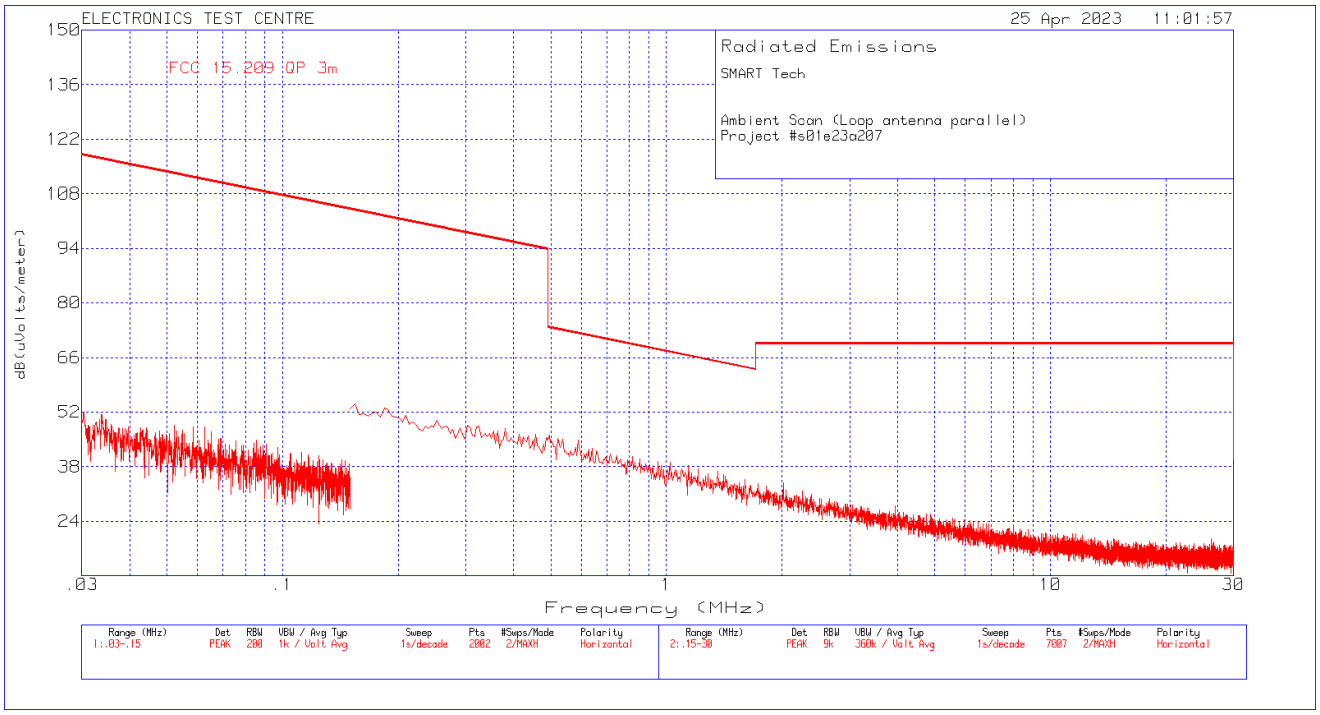
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Horizontal polarization, 18-26.5GHz



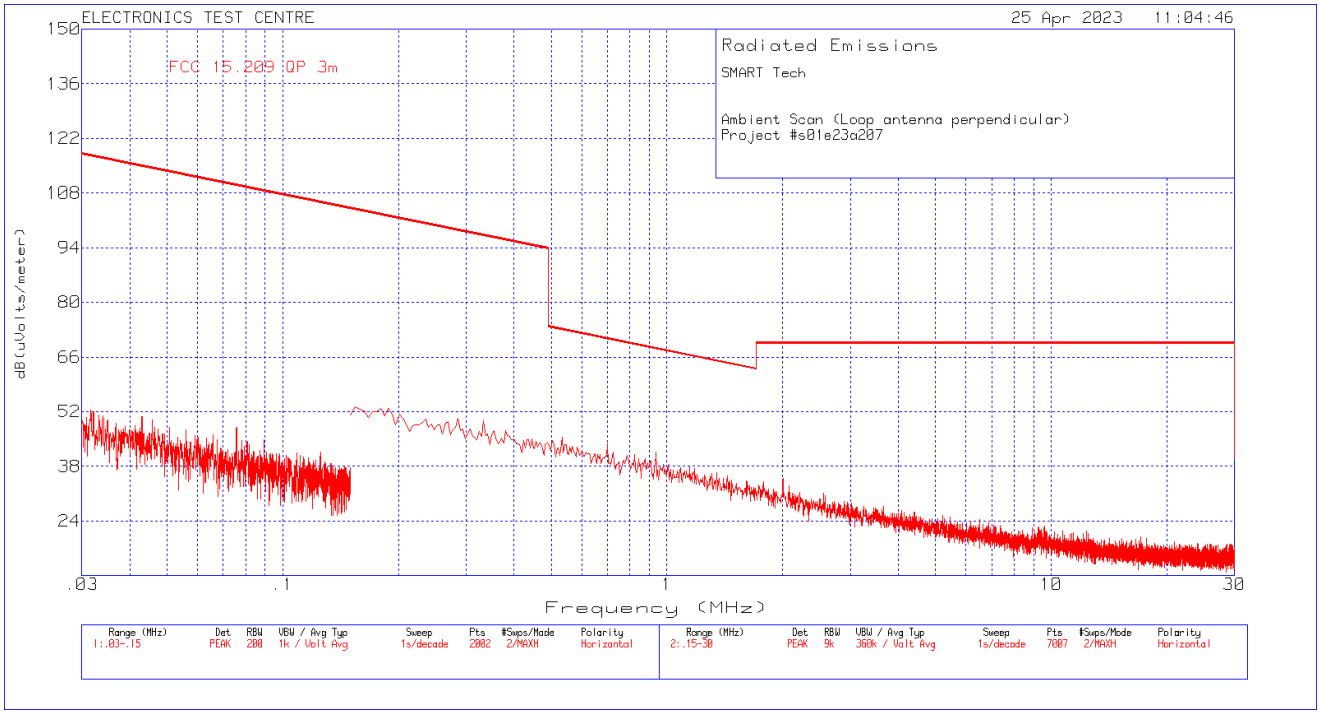
Plot of Radiated Emissions: BLE Radio OFF, Display ON, Vertical polarization, 18-26.5GHz



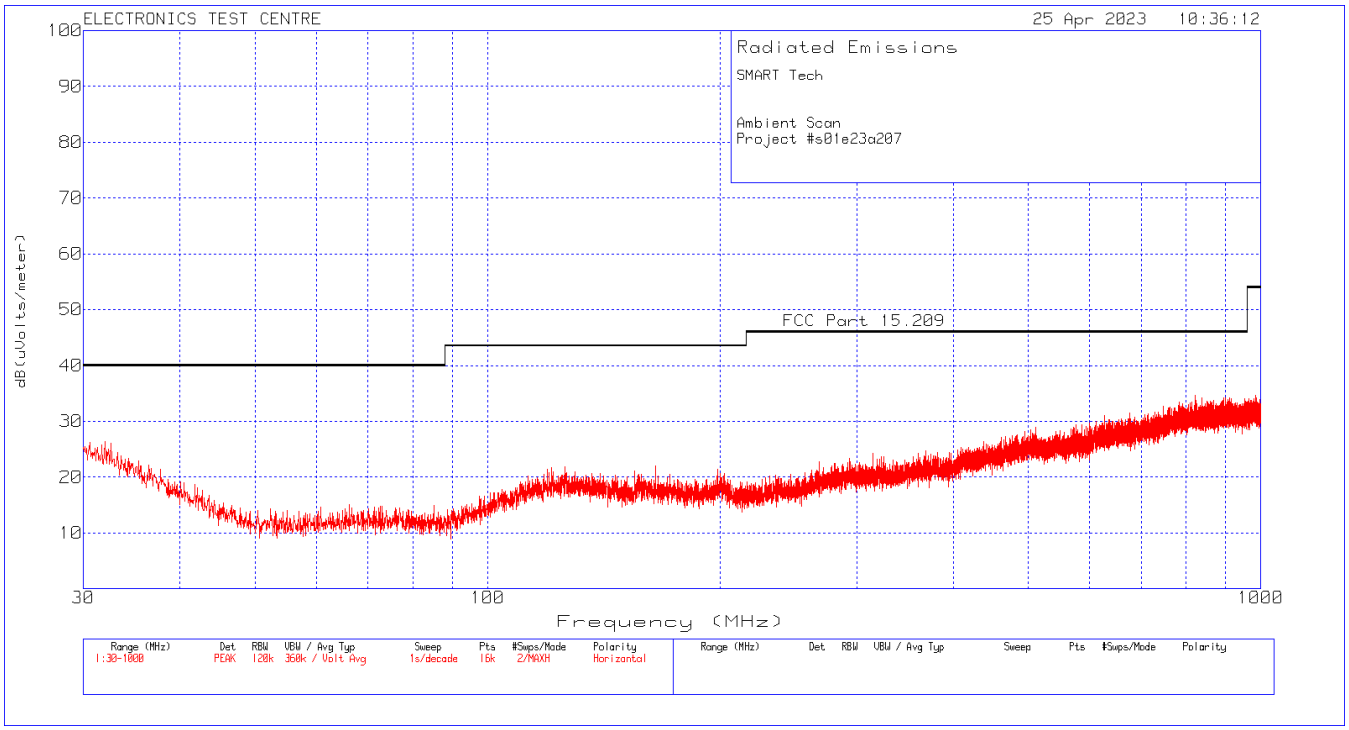
Plot of Test Chamber Ambient: Parallel



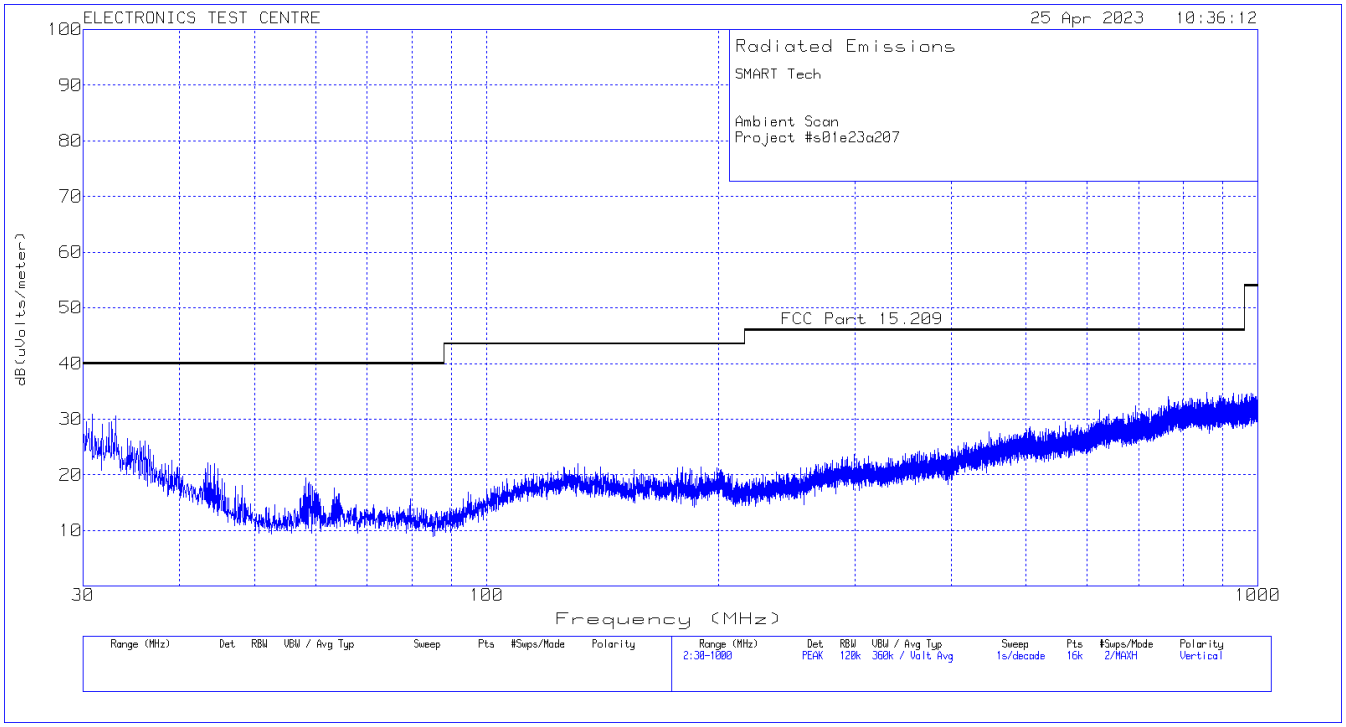
Plot of Test Chamber Ambient: Perpendicular



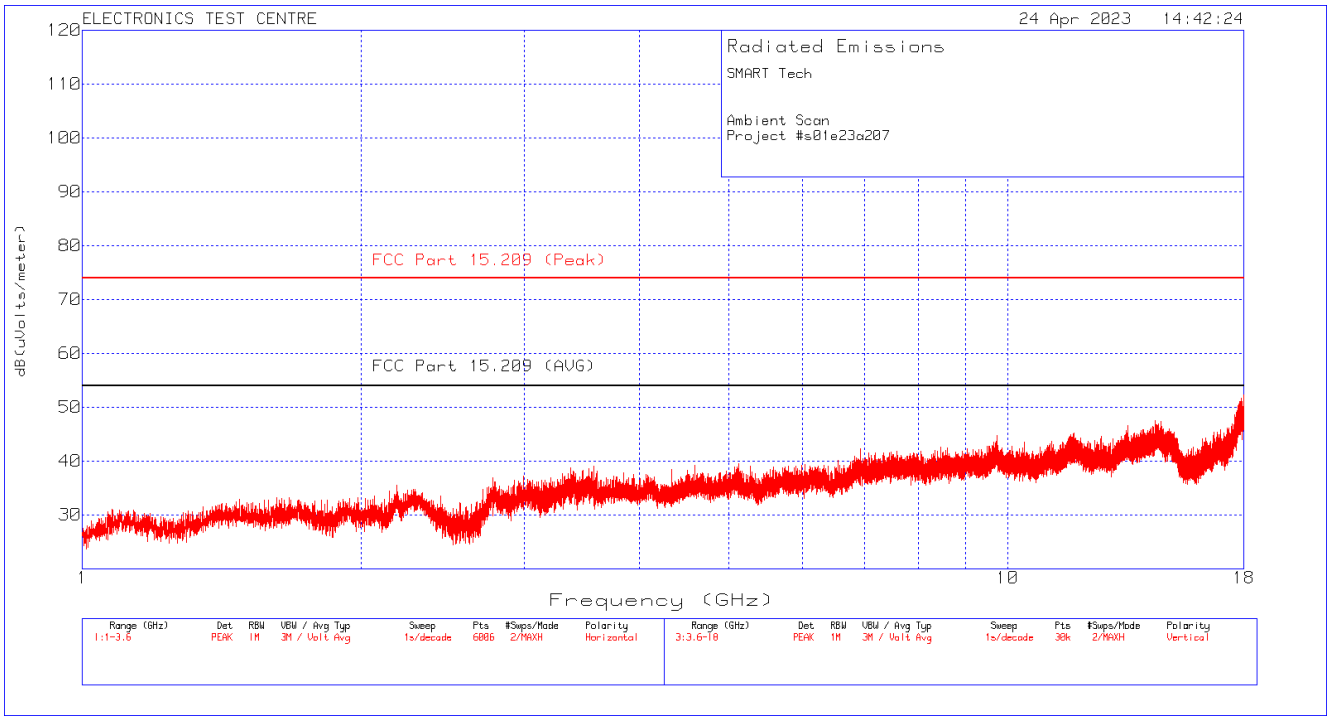
Plot of Test Chamber Ambient: Horizontal polarization



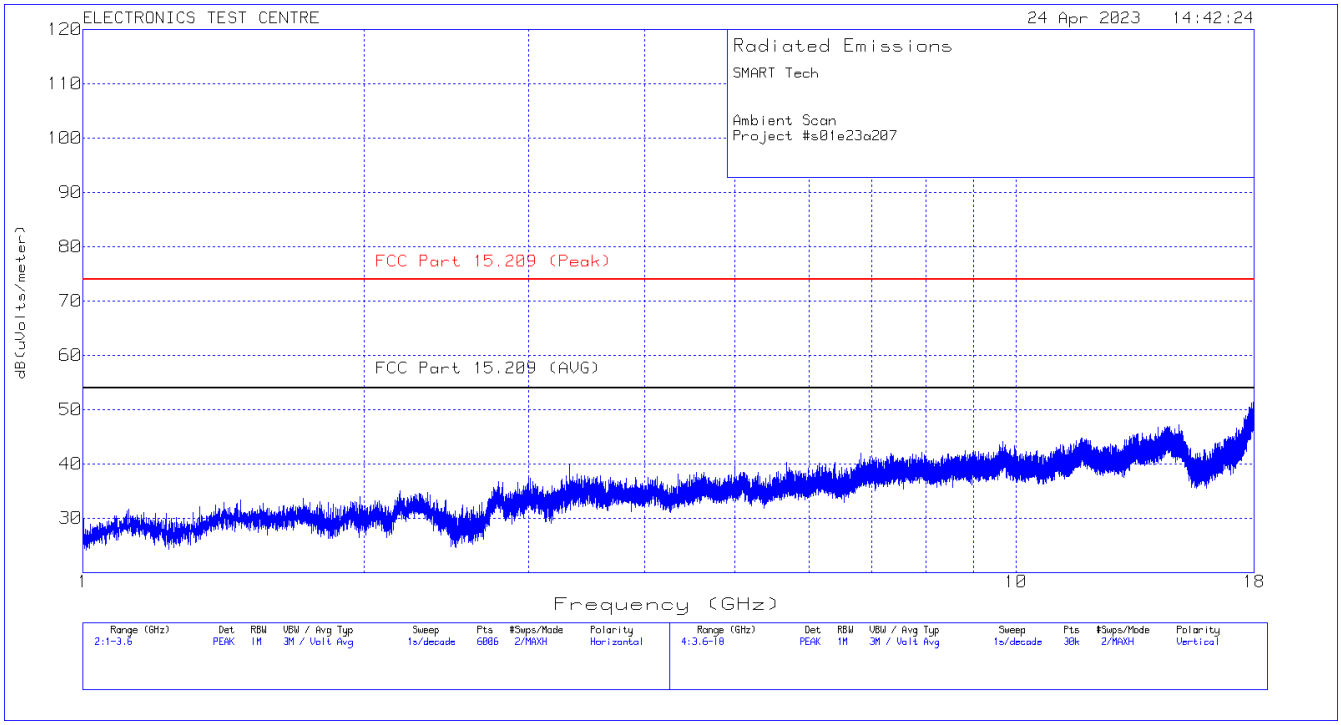
Plot of Test Chamber Ambient: Vertical polarization



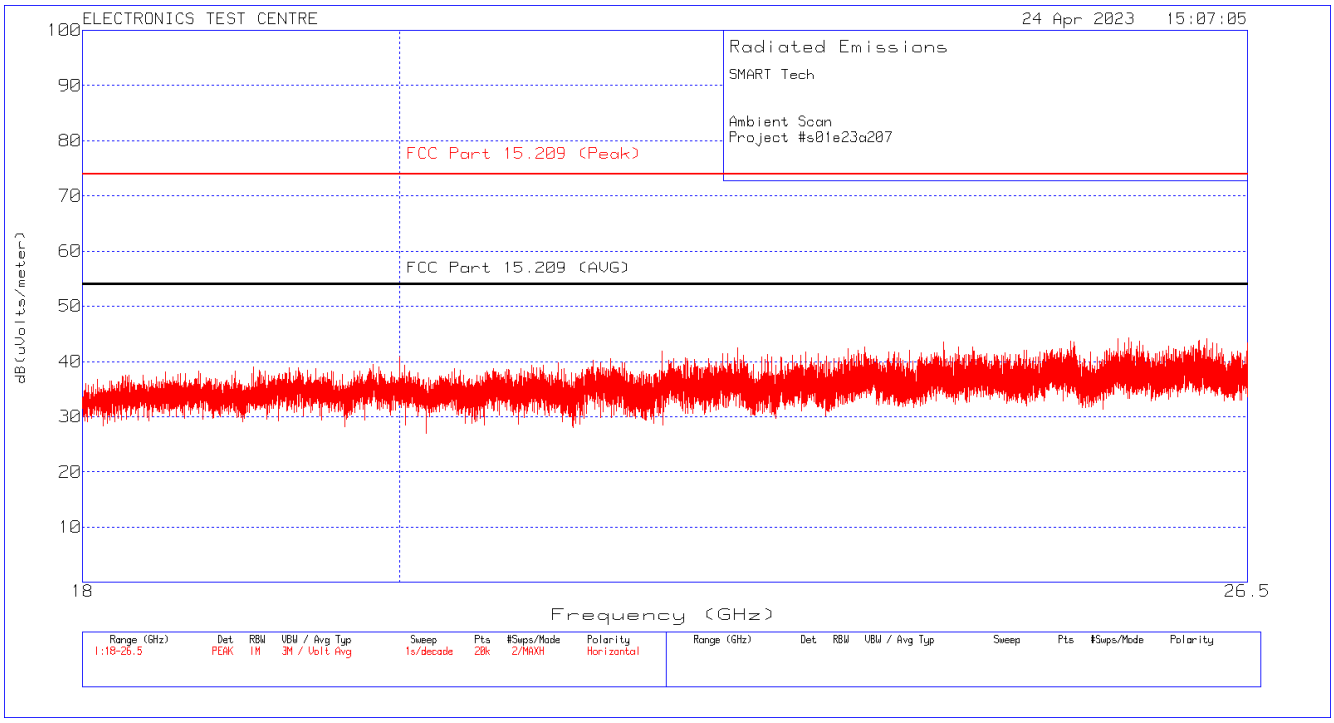
Plot of Test Chamber Ambient: Horizontal polarization



Plot of Test Chamber Ambient: Vertical polarization



Plot of Test Chamber Ambient: Horizontal polarization



Plot of Test Chamber Ambient: Vertical polarization

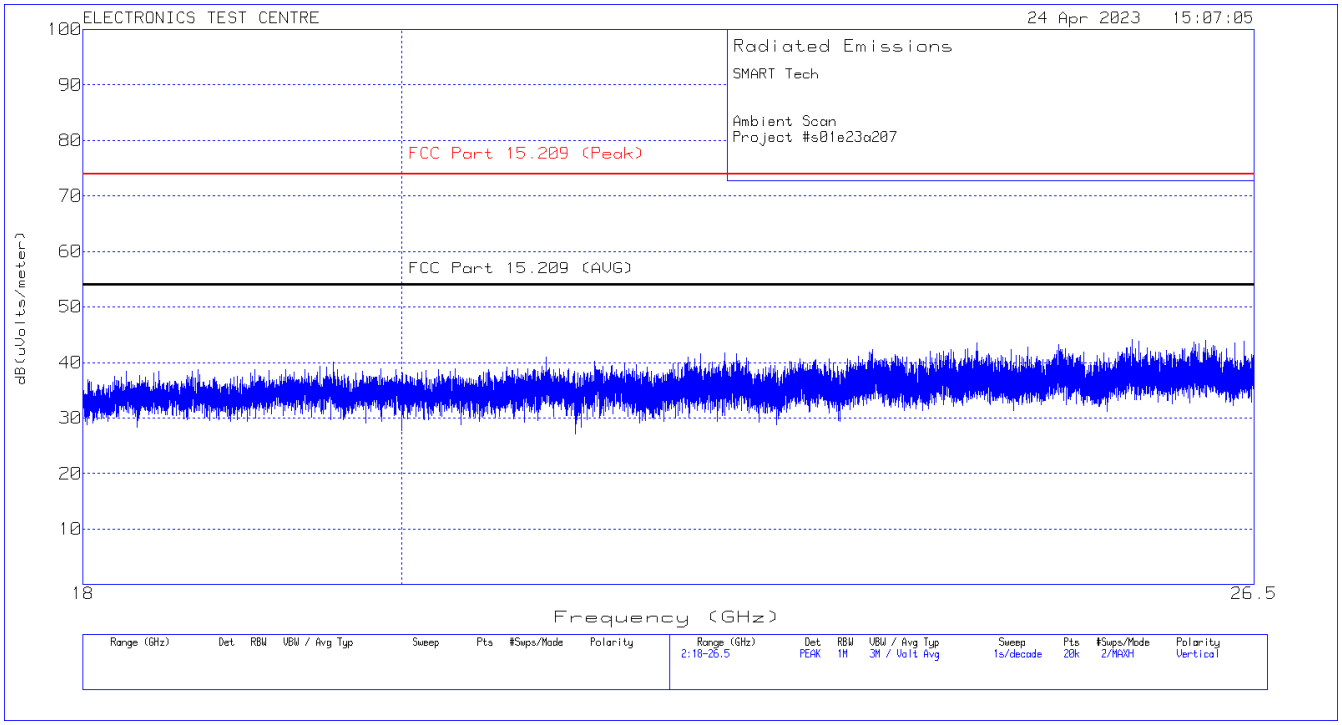


Photo of Radiated Emissions test setup: 30k-30MHz

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

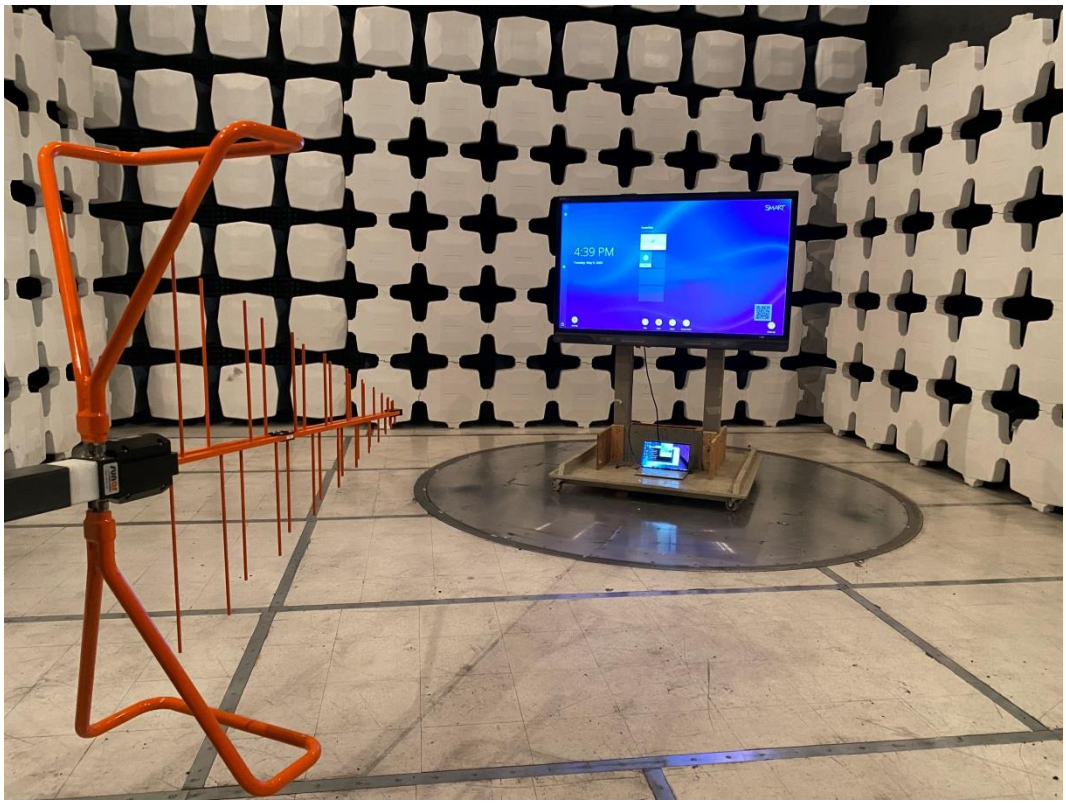


Photo of Radiated Emissions test setup: 1-18GHz

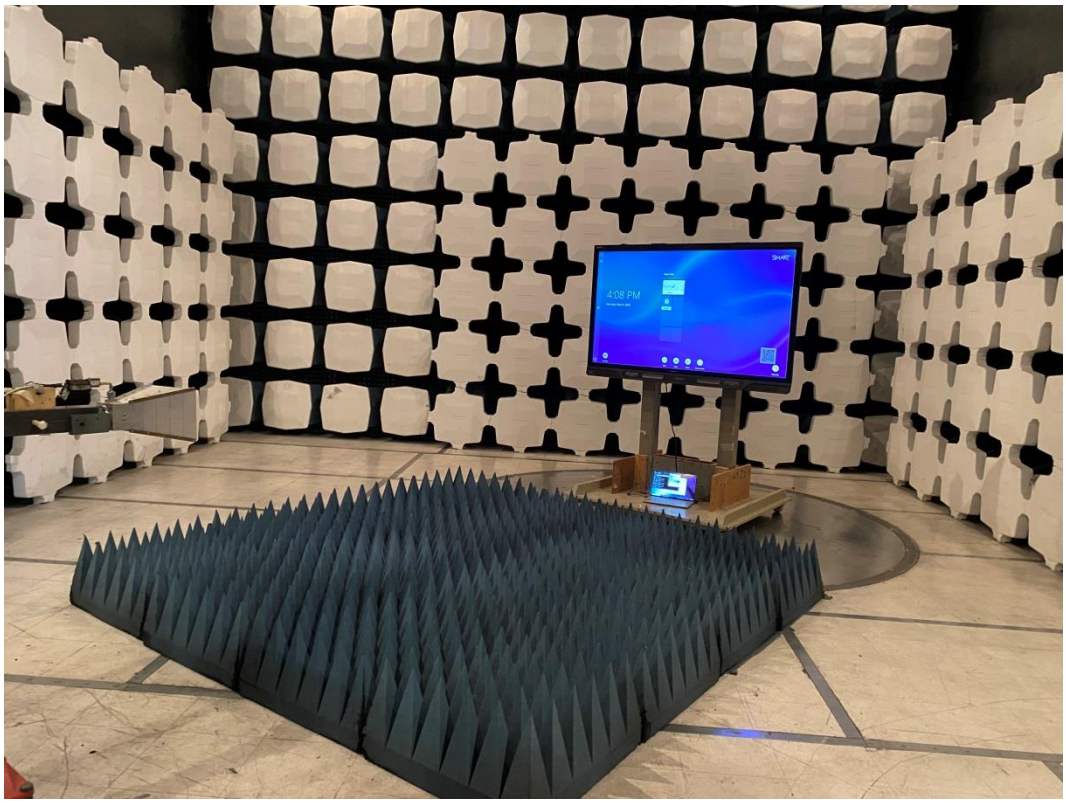
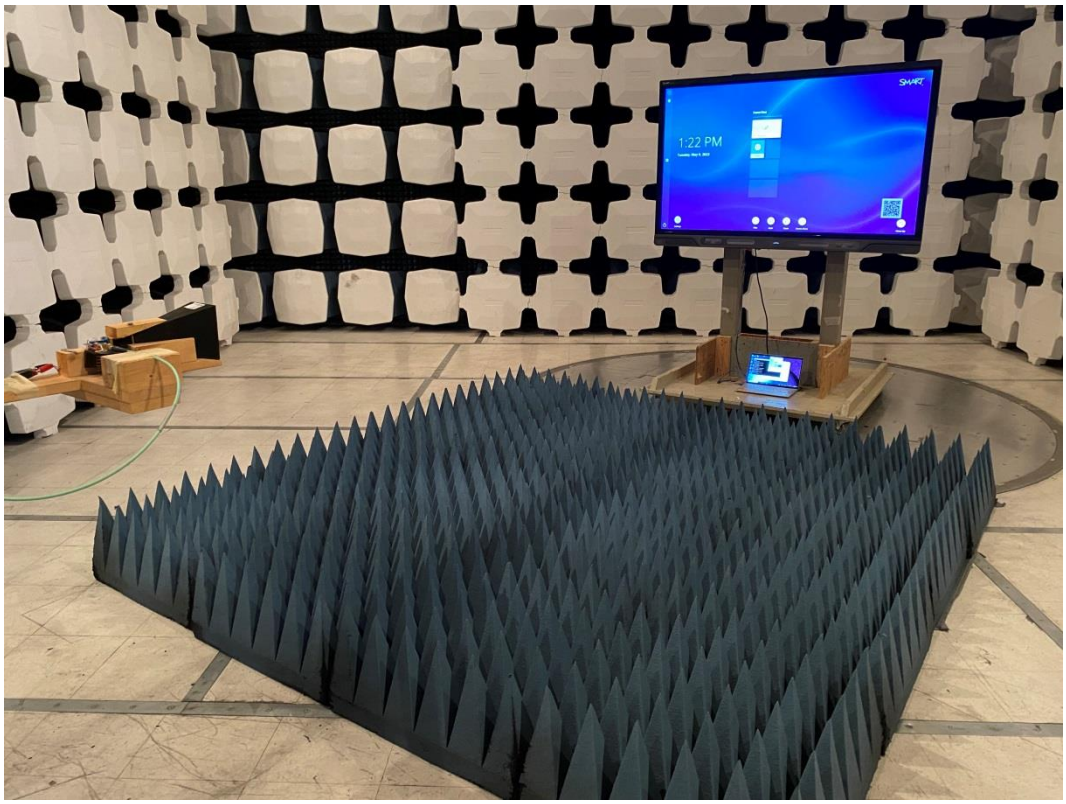


Photo of Radiated Emissions test setup: 18-26.5GHz



2.3 AC Main Conducted Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 65" QX Series IFP display**
Test Personnel: Janet Mijares	**Standard: FCC Part 15.207, RSS-GEN**
Date:2023/05/10 (21.0°C, 30.3% RH)	**Basic Standard: ANSI C63.10-2013**

EUT status:

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

2.3.1 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.

2.3.2 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	ETC-SW-EMC 2.1	N/A	
EMI receiver	Agilent	N9038A (FW v. A.25.05)	6130	2022/07/12	2023/07/12
LISN	Com-Power	LI-215A	6180	2022/08/09	2023/08/09
Milli-Ohm meter	HP	4328A	9060	2022/01/28	2024/01/28
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
T/H Logger	Extech	42270	5892	2023/04/14	2024/04/14

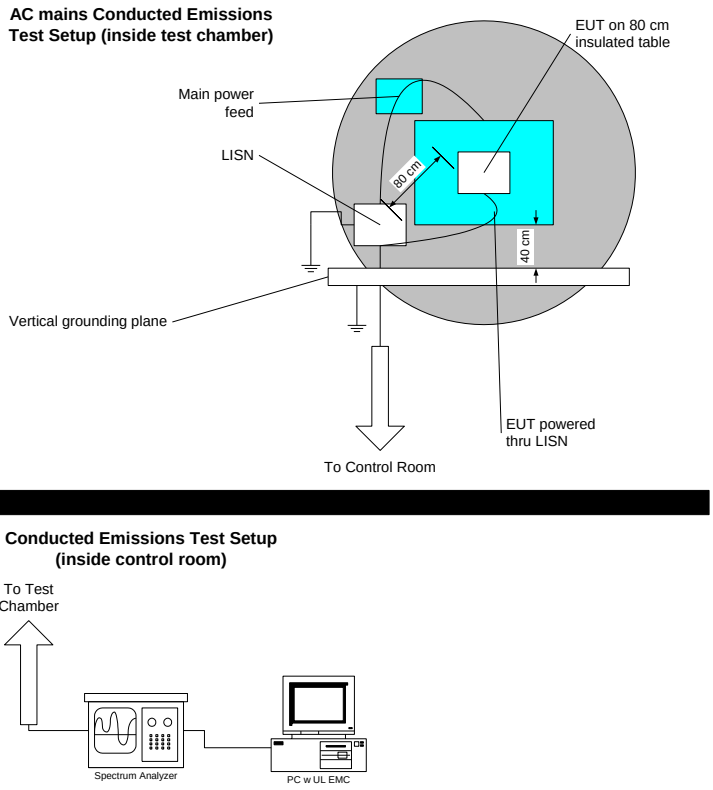
2.3.4 Test Sample Verification, Configuration & Modifications

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:



2.3.5 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)	ICES-003 & FCC 15.107 Class A Limit (dBµV)	Delta (dB)	L / N
1	0.194	49.42	AV	.1	9.8	59.32	66	-6.68	Line
2	0.995	26.33	AV	0	9.8	36.13	60	-23.87	Line
3	1.39	30.08	AV	0	9.8	39.88	60	-20.12	Line
4	1.72	25.91	AV	0	9.8	35.71	60	-24.29	Line
5	8.43	25.99	AV	0	10.2	36.19	60	-23.81	Line
6	19.14	24.13	AV	.1	10.7	34.93	60	-25.07	Line
1	0.1943	49.67	AV	.1	9.8	59.57	66	-6.43	Neutral
2	0.9952	25.63	AV	0	9.8	35.43	60	-24.57	Neutral
3	1.39	29.12	AV	0	9.8	38.92	60	-21.08	Neutral
4	1.72	25.17	AV	0	9.8	34.97	60	-25.03	Neutral
5	18.79	9.85	AV	0	9.9	20.45	60	-39.55	Neutral
6	19.14	24.13	AV	0	10.5	34.83	60	-25.17	Neutral

Note: Emission is from digital circuitry and compliant to Class A limit

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

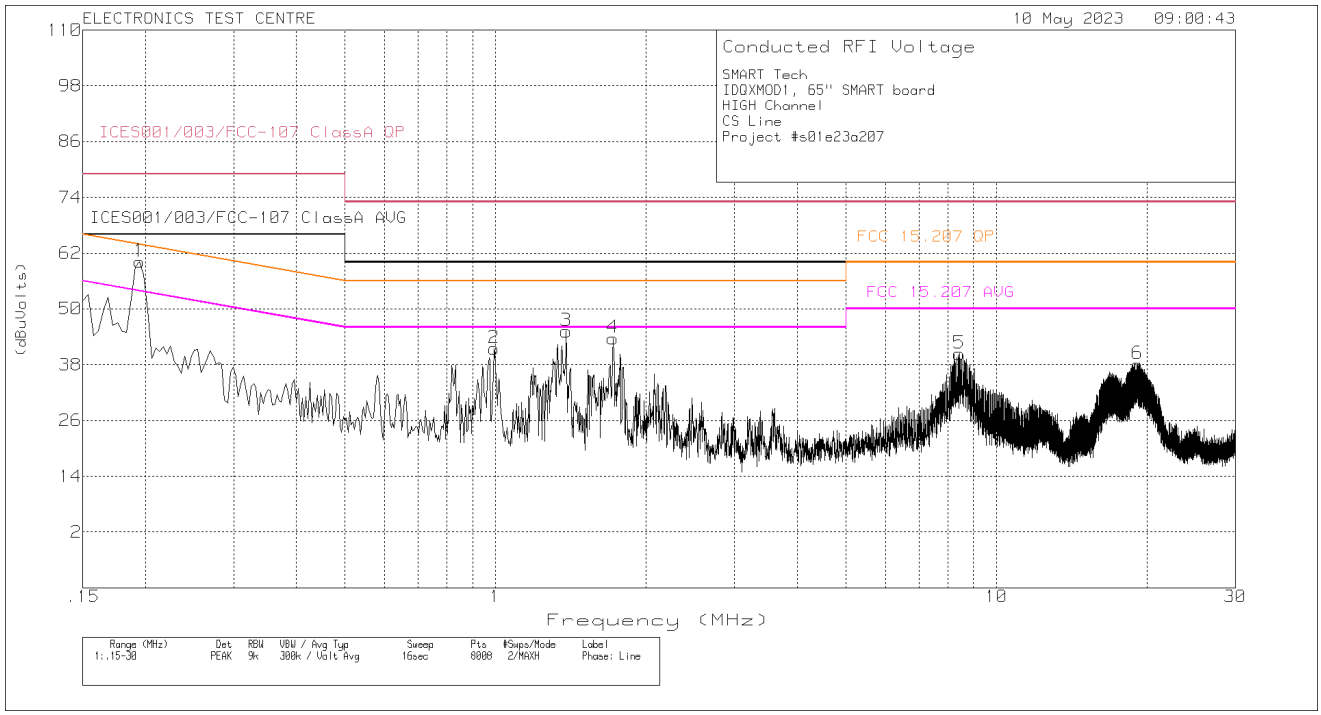
Notes:

- 10 dB transient limiter is used
- AV = Average detector

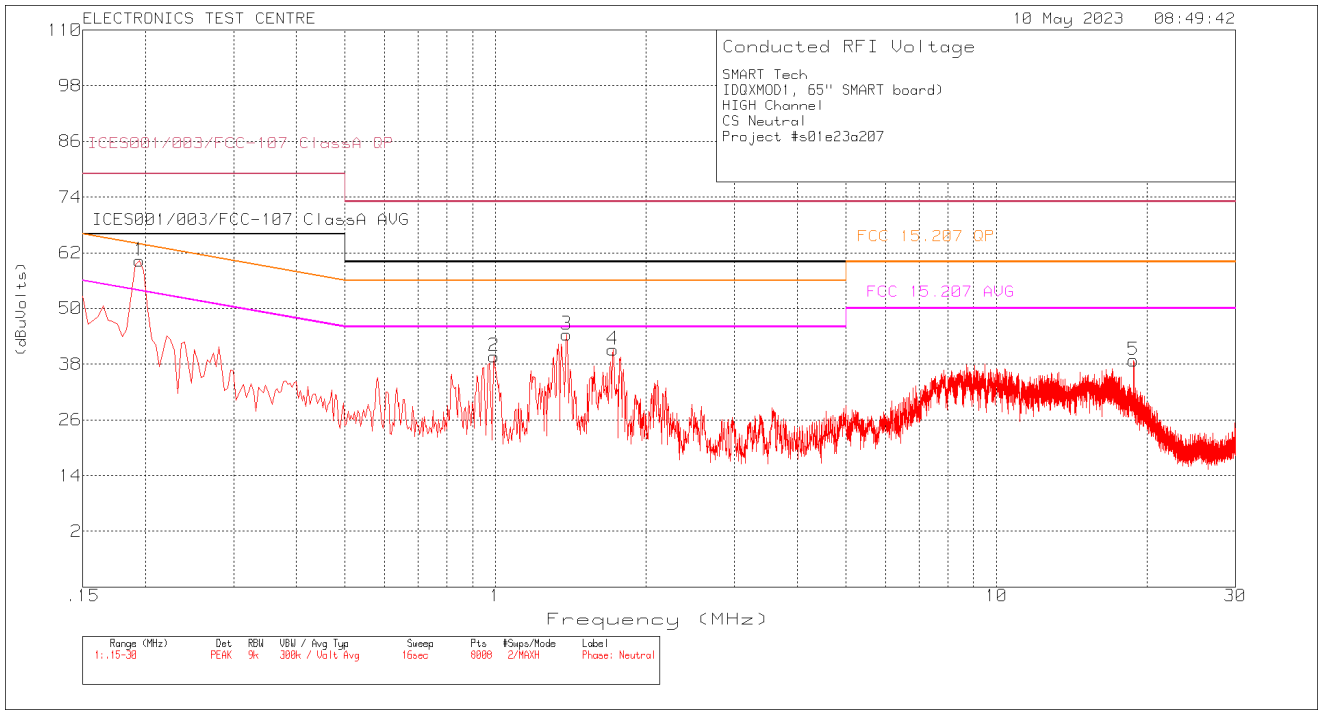
Negative values for Delta indicate compliance.

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

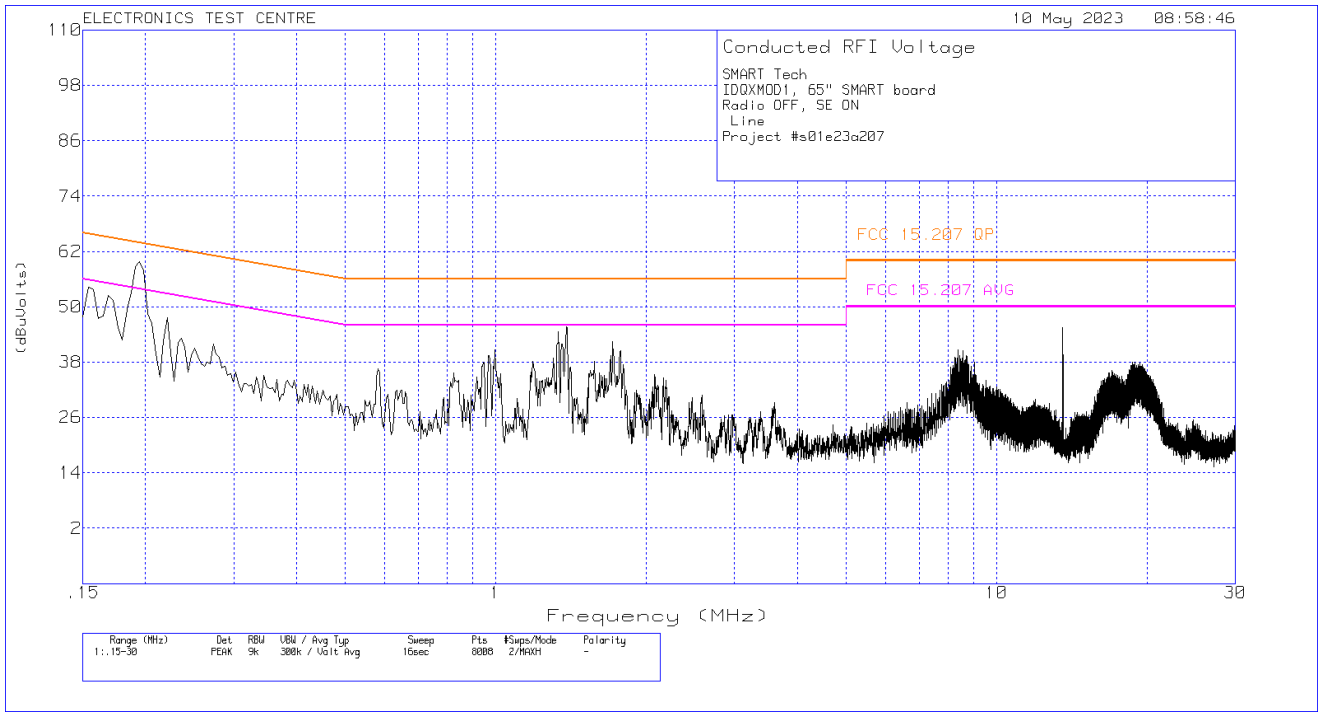
Plot of Conducted Emissions: Line



Plot of Conducted Emissions: Neutral



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



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

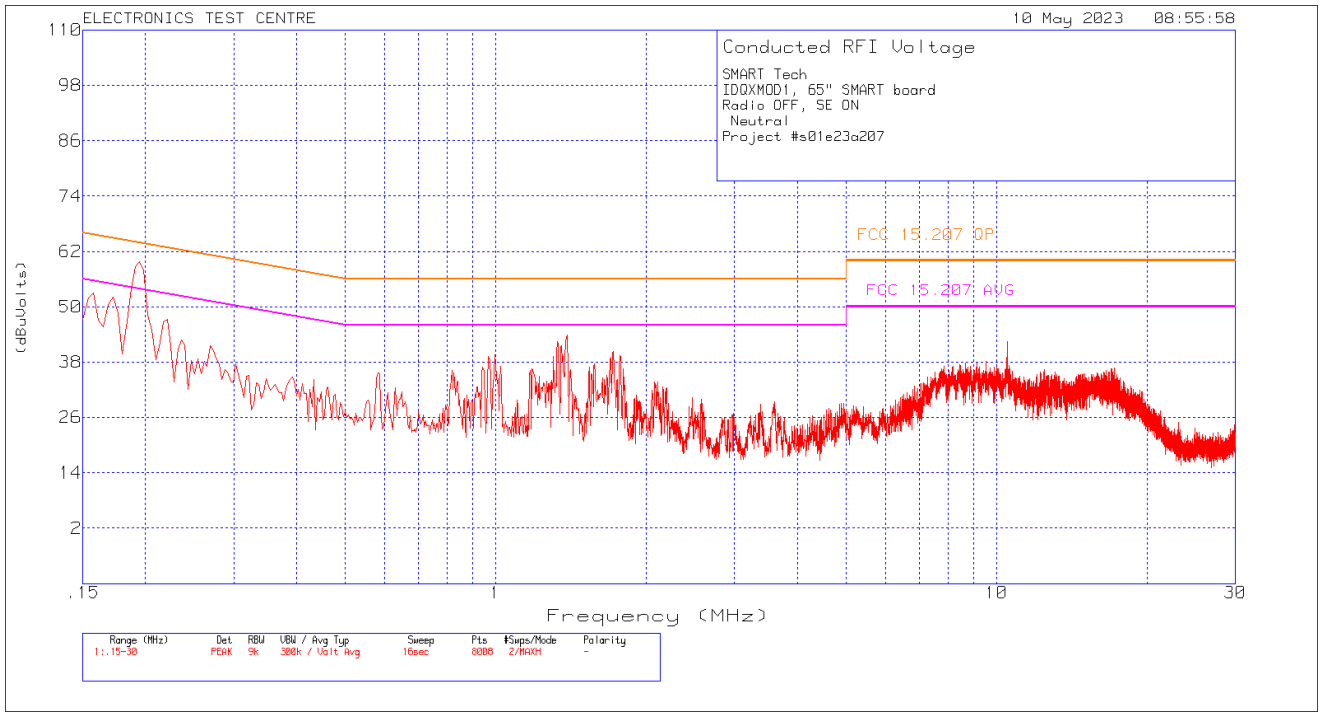
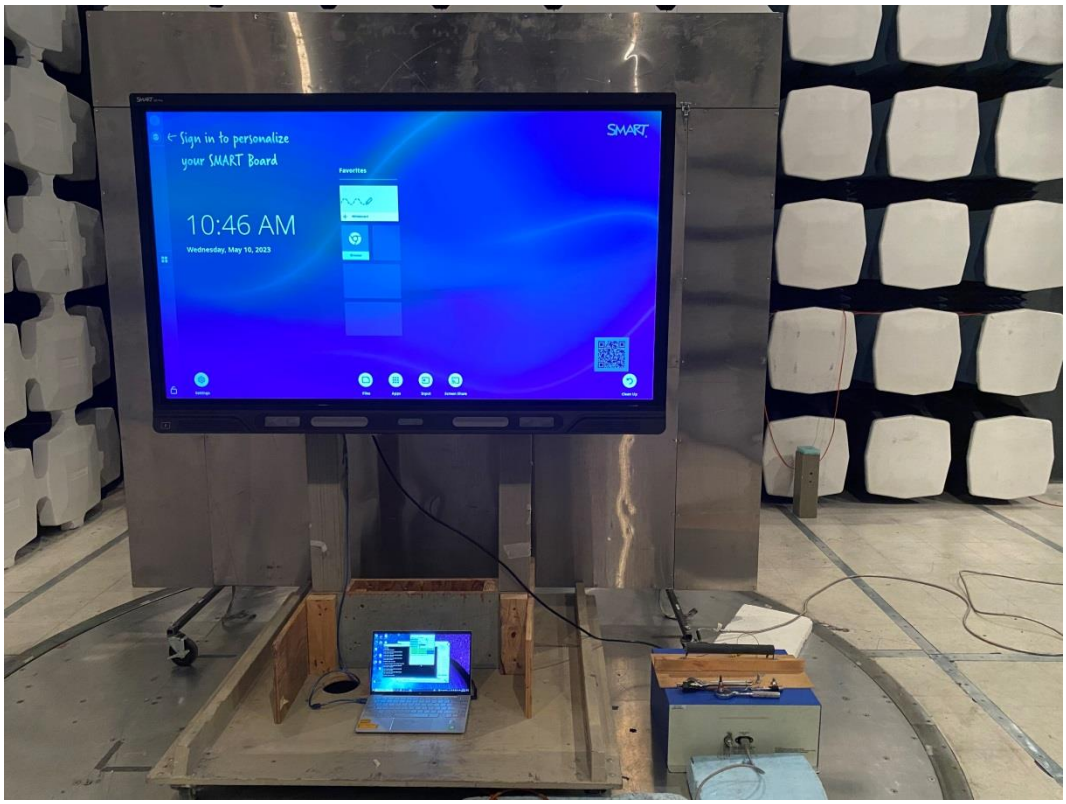
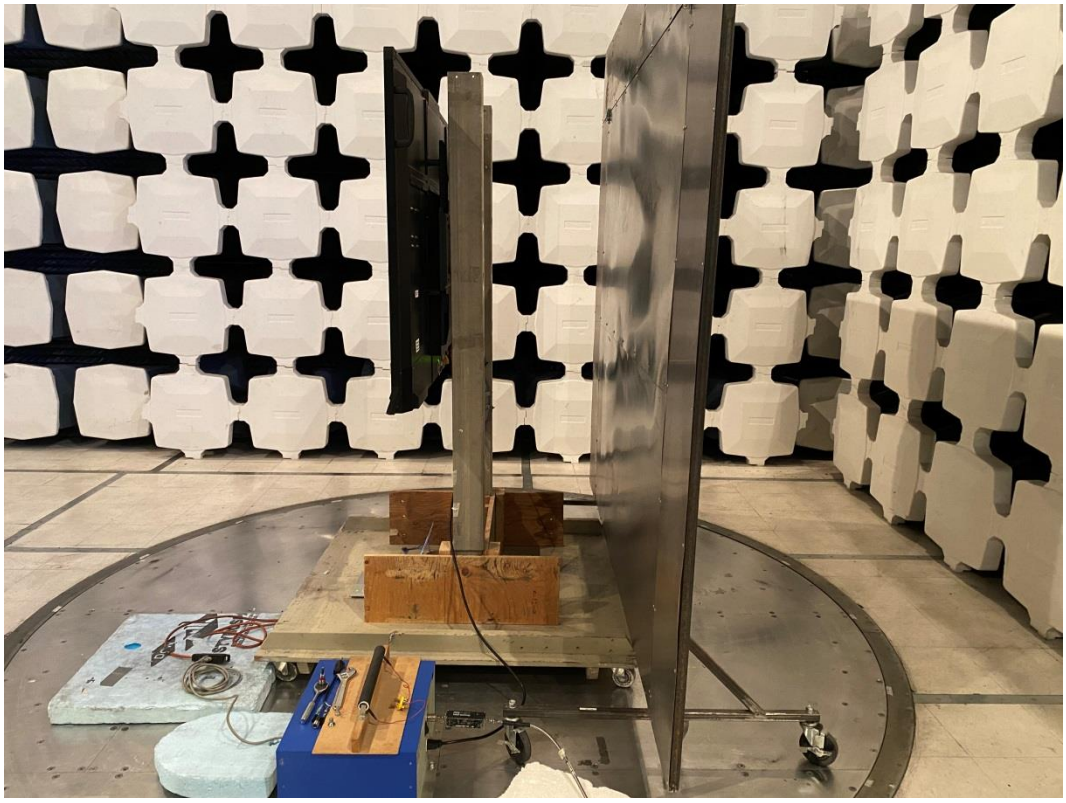


Photo of Conducted Emissions test setup:





3 TEST FACILITY

3.1 Location

The SMART QX Series BLE Module, Model: IDQXMOD1 (Tool Sense Controller) within 65" QX Series IFP display 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

(Information provided by <customer>)

Quotation Number:	s01q23a223	Project Number:	s01e23a207
Company Name :	SMART Technologies	Contact Name :	Sean MacKellar
Address :	3636 Research Rd NW	Phone :	+1 (360) 201-8932
	Calgary, Alberta T2L 1Y1	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 QX 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 QX Series IFPs, Models: IDQX65-1, IDQX75-1, IDQX86-1. 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