Test Report

FCC ID: 2AVE9-TRKR01
IC: 25817-TRKR01

FCC Rule Part: 15.247
ISED Canada Radio Standards Specification: RSS-247

Report Number: AT72154363-3C2

Manufacturer: Swarm Technologies
Product: Tracker
Model: TRKR01

Test Begin Date: December 19, 2019
Test End Date: March 12, 2020

Report Issue Date: April 9, 2020

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: 2955.09

This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

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This report contains 30 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Innovation, Science, and Economic Development Canada's Radio Standards Specification RSS-247 Certification for modular approval.

1.2 Applicant Information

Swarm Technologies
435 N Whisman Road
Suite 100
Mountain View, California 94043

1.3 Product Description

The Tracker is a Remote 2-way data transfer device from anywhere on Earth via the Swarm satellite constellation. The Tracker connects to a third-party sensor and transmits the data to Swarm's space network. The Tracker contains a VHF satellite radio, GNSS Receiver, 802.11 WLAN radio, Bluetooth Classic, and Bluetooth Low Energy radio.

This report covers the compliance of the 802.11 WLAN radio only. All other radios are covered in separate reports accompanying this certification filing.

Technical Information:

Detail	Description
Frequency Range	2412 – 2462 MHz
Number of Channels	802.11b/g/n (HT 20): 11 802.11n (HT 40): 7
Modulation Format	802.11b: DSSS (DBPSK / DQPSK / CCK) 802.11g/n (HT 20/40): OFDM (BPSK / QPSK / 16QAM / 64QAM)
Data Rates	802.11b: 1 – 11 Mbps 802.11g: 6 – 54 Mbps 802.11n (HT 20): 6.5 – 72 Mbps 802.11n (HT 40): 13.5 – 150 Mbps
Number of Inputs/Outputs	1T1R
Operating Voltage	5 VDC
Antenna Type / Gain	Ceramic Chip Antenna / 1 dBi

Test Sample Serial Number(s): C3 (Radiated measurements)
C7 (Antenna Port Conducted measurements)

Test Sample Condition: The equipment was provided in good condition without any physical damage.

1.4 Test Methodology and Considerations

All modes of operation, including all data rates, were evaluated and the data presented in this report represents the worst case where applicable. The worst-case data rate for 802.11b mode was 1Mbps. The worst-case data rate for 802.11g mode was 18Mbps. The worst-case data rate for 802.11n (HT 20) mode was MCS2. The worst-case data rate for 802.11n (HT 40) mode was MCS2.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was Y-position. A 50-ohm non-radiating termination was placed on the VHF antenna port.

For antenna port conducted emissions, the EUT was coupled to the measuring equipment through a temporary SMA Pigtail in place of the ceramic chip antenna with suitable attenuation. A 50-ohm non-radiating termination was placed on the VHF antenna port and GNSS Antenna port.

For power line conducted emissions, the EUT was programmed for continuous modulated transmission on the BLE radio and the VHF radio. All combinations of VHF radio antennas were evaluated, and the worst case was with the quarter-wave antenna.

Radiated inter-modulation testing was performed for all combinations of simultaneous transmission and found to be compliant.

Power attenuation setting during test: 16 (x 0.25dB steps)

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following addresses:

TÜV SÜD America, Inc.
5945 Cabot Pkwy, Suite 100
Alpharetta, GA 30005
Phone: (678) 341-5900

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America, Inc. is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation/A2LA accreditation program and has been issued certificate number 2955.09 in recognition of this accreditation.

Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scopes of accreditation.

The Semi-Anechoic Chamber Test Sites and Conducted Emissions Sites have been fully described, submitted to, and accepted by the FCC, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Designation Accreditation Number:	US1233
ISED Canada Lab Code:	23932
VCCI Member Number:	1831
• VCCI Registration Number	A-0295

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site – Chamber A

The Semi-Anechoic Chamber Test Site consists of a 20’ x 30’ x 18’ shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 5' in diameter and is located 5’6” from the back wall of the chamber. The chamber is grounded via 1 - 8’ copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted EMCO Model 1060 installed in an all steel frame. The table is remotely operated from inside the control room located 25’ from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3’ x 6’ x 4’ deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4” PVC chase from the turntable to the pit that allows for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

The chamber rear wall is covered with a mixture of Siepel pyramidal absorber. The side walls of the chamber are partially covered with Siepel pyramidal absorber.

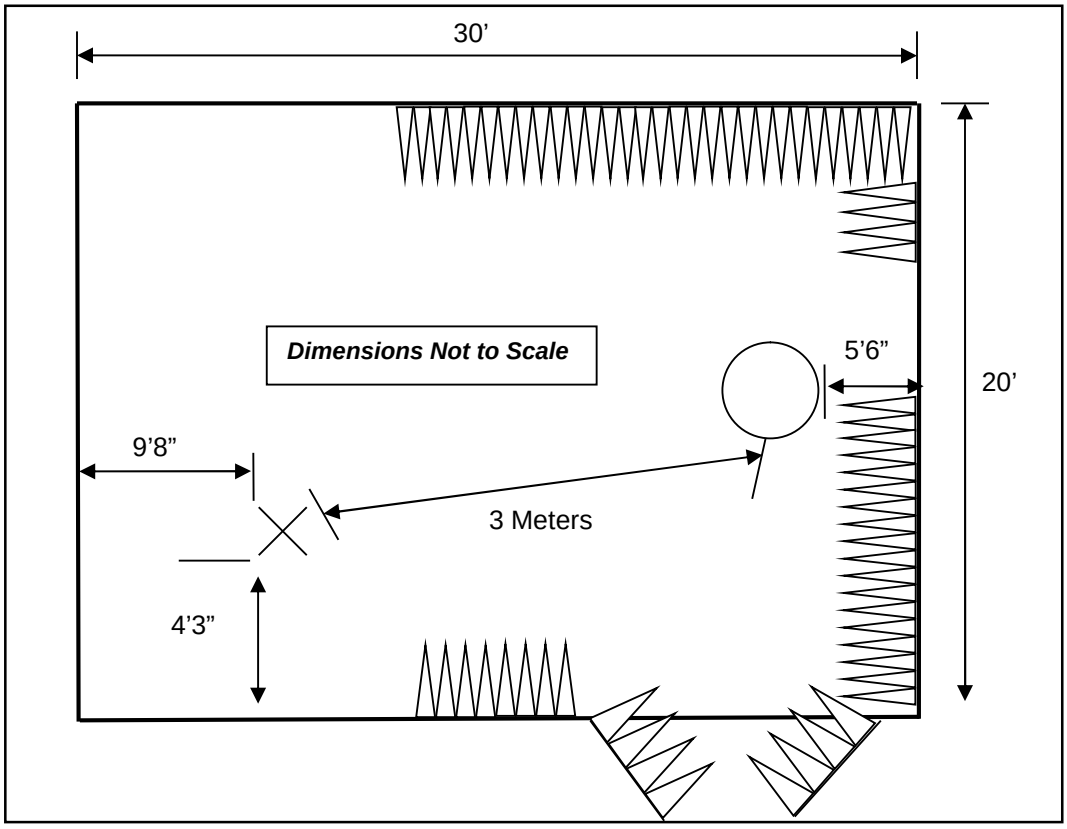

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site – Chamber A

2.3.2 Semi-Anechoic Chamber Test Site – Chamber B

The Semi-Anechoic Chamber Test Site consists of a 20'W x 30'L x 20'H shielded enclosure. The chamber is lined with ETS-Lindgren Ferrite Absorber, model number FT-1500. The ferrite tile 600 mm x 600 mm (2.62 in x 23.62 in) panels and are mounted directly on the inner walls of the chamber shield.

The specular regions of the chamber are lined with additional ETS-Lindgren PS-600 hybrid absorber to extend its frequency range up to 18GHz and beyond.

The turntable is a 2m ETS-Lindgren Model 2170 and installed off the center axis is located 5'6" from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the shield using #8 solid copper wire.

The antenna mast is an EMCO 1060 and is remotely controlled from the control room for both antenna height and polarization.

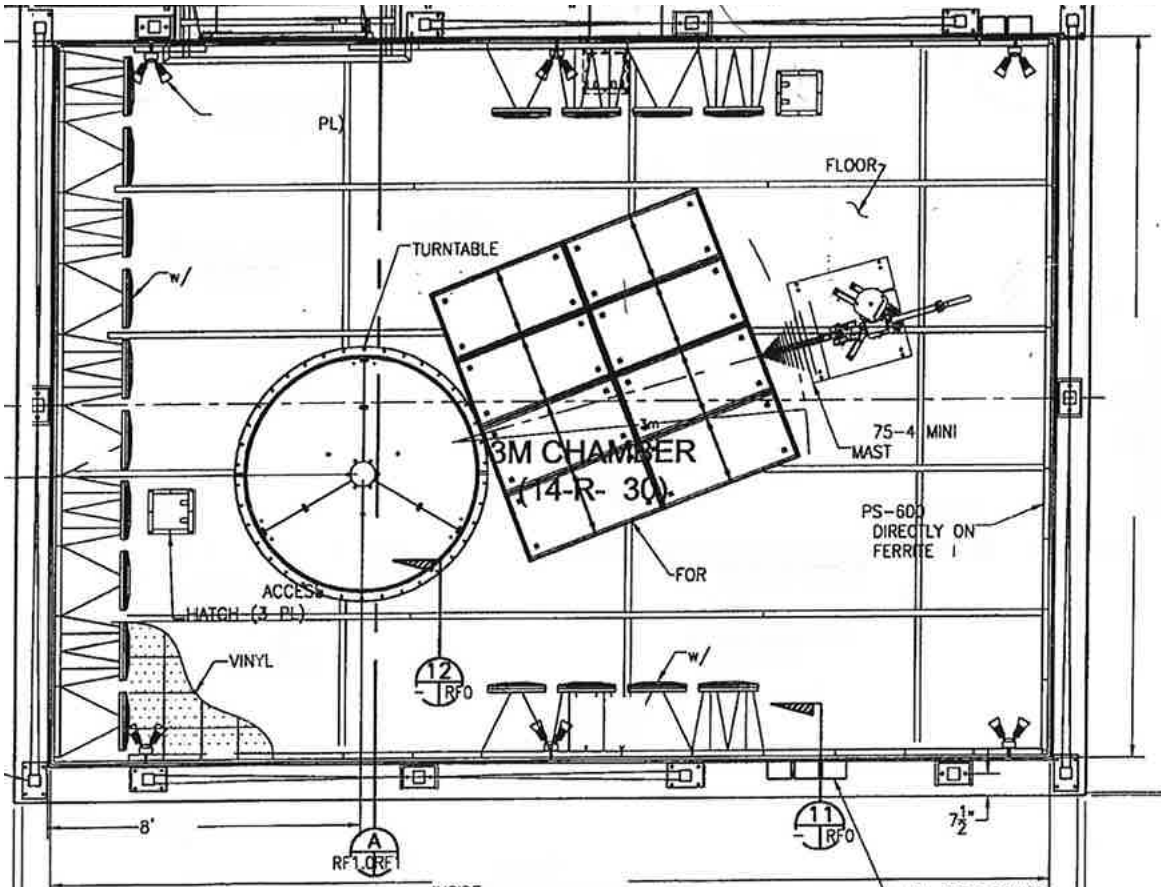

Figure 2.3.2-1: Semi-Anechoic Chamber Test Site – Chamber B

2.4 Conducted Emissions Test Site Description

2.4.1 Conducted Emissions Test Site

The AC mains conducted EMI site is located in the main EMC lab. It consists of a 12' x 10' horizontal coupling plane (HCP) as well as a 12'x8' vertical coupling plane (VCP). The HGP is constructed of 4' x 10' sheets of particle board sandwiched by galvanized steel sheets. These panels are bonded using 11AWG 1/8" x 2" by 10' galvanized sheet steel secured to the panels via by screws. The VCP is constructed of three 4'x8' sheets of 11AWG solid aluminum.

The HCP and VCP are electrically bonded together using 1"x1" angled aluminum secured with screws.

The site is of sufficient size to test tabletop and floor standing equipment in accordance with section 6.1.4 of ANSI C63.10.

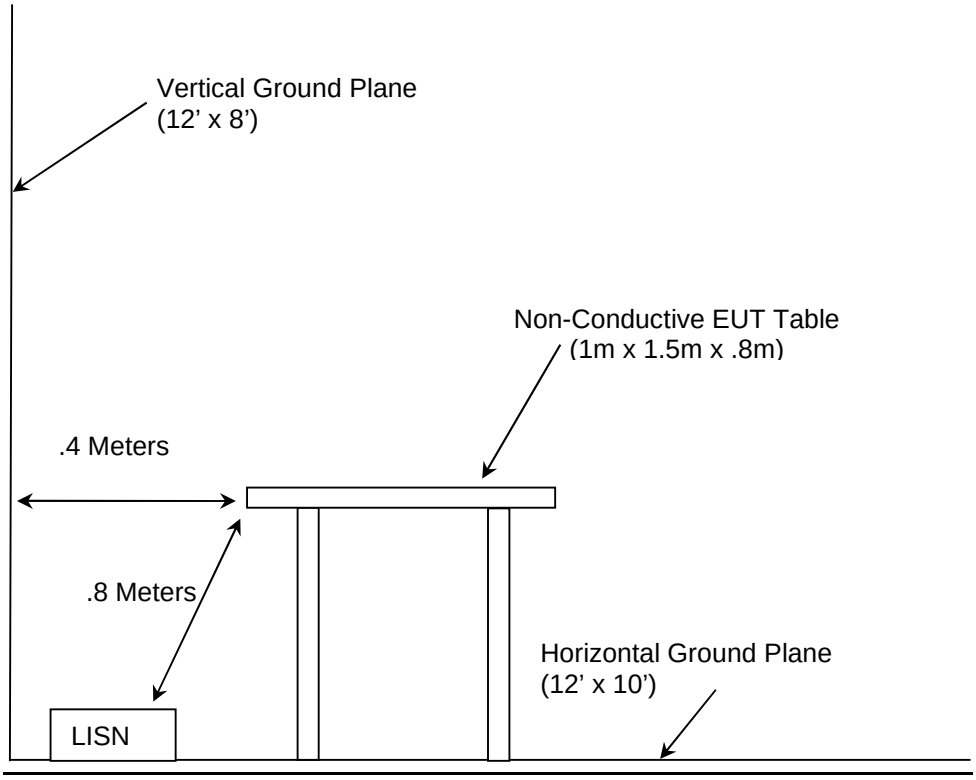

Figure 2.4.1-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2020
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2020
- FCC KDB 558074 D01 DTS Meas Guidance v05r02 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 2, 2019
- ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 2, February 2017.
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 5, April 2018 + Amendment 1, March 2019

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

Asset ID	Manufacturer	Model	Equipment Type	Serial Number	Last Calibration Date	Calibration Due Date
213	TEC	PA 102	Amplifier	44927	07/22/2019	07/22/2020
335	Suhner	SF-102A	Cable (40GHZ)	882/2A	07/08/2019	07/08/2020
338	Hewlett Packard	8449B	High Frequency Pre-Amp	3008A01111	07/15/2019	07/15/2021
432	Microwave Circuits	H3G020G4	Highpass Filter	264066	05/31/2019	05/31/2020
622	Rohde & Schwarz	FSV40 (v3.40)	FSV Signal Analyzer 10Hz to 40GHz	101338	07/30/2018	07/30/2020
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	02/11/2019	11/02/2021
638	Rohde & Schwarz	OSP 120	Open Switch and Control Unit	101229	06/11/2019	06/11/2021
651	Rohde & Schwarz	TS-PR26	18GHz to 26.5GHz Pre-Amplifier	100023	07/10/2019	07/10/2020
652	Rohde & Schwarz	3160-09	High Frequency Antenna 18GHz to 26.5GHz	060922-21894	NCR	NCR
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	11/01/2019	05/01/2020
827	(-)	TS8997 Rack Cable Set	TS8997 Rack Cable Set	N/A	05/01/2019	05/01/2020
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	05/01/2019	05/01/2020
853	Teseq	CBL 6112D; 6804.17.A	Bilog Antenna; Attenuator	51616; 20181110A	10/15/2018	10/15/2020
857	ETS Lindgren	3117	Horn Antenna 1-18GHz	00153608	11/12/2019	11/12/2021
RE880	Rhode & Schwarz USA	Test Recever	R&S ESW44	1206247	11/06/2019	11/06/2020

NCR = No Calibration Required
NOTE: All test equipment was used only during active calibration cycles as reported above.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	EUT	Swarm Technologies	TRKR01	C3 (Radiated) C7 (RF Conducted)
2	Wall Wart Power Supply	Anker Innovations Limited	A2627	AFYQAJ0926171083
3	50-ohm Termination	Mini Circuits	ANNE-50+	N/A

Table 5-2: Cable Description

Item	Cable Type	Length	Shield	Termination
A	USB-C Cable	2 m	Yes	1 – 2

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

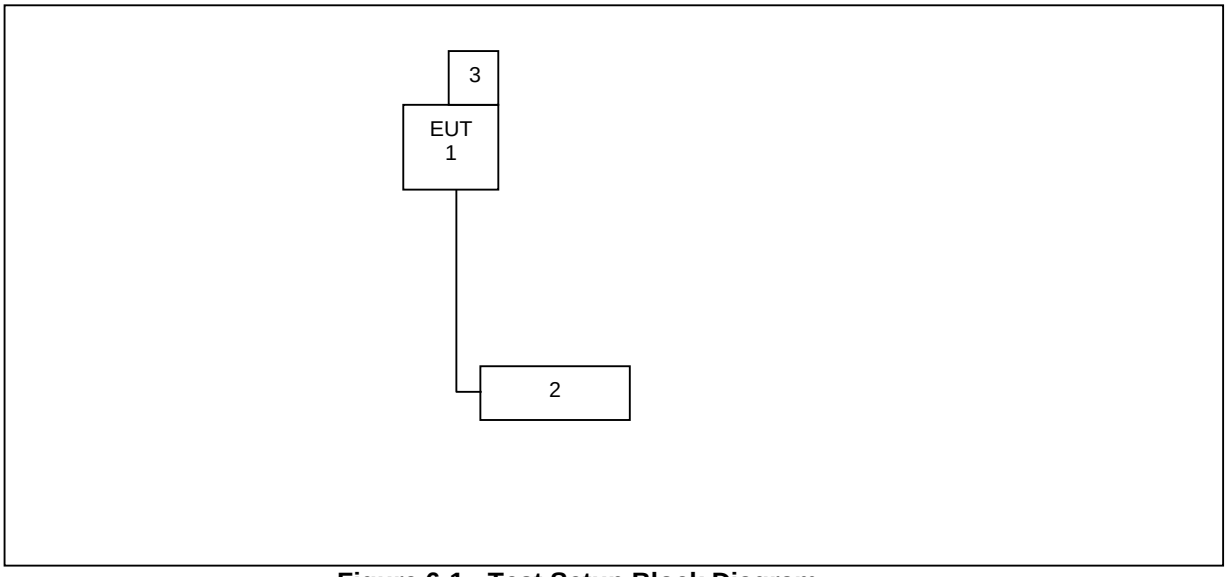

Figure 6-1: Test Setup Block Diagram

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC: Section 15.203

The EUT utilizes a Ceramic Chip Antenna. The antenna is integral to the device and cannot be removed or replaced by the end user. The gain of the antenna is 1 dBi.

7.2 Power Line Conducted Emissions – FCC: Section 15.207; ISED Canada: RSS-Gen Section 8.8

7.2.1 Measurement Procedure

Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Measurement Results

Performed by: Eugene Sello

Table 7.2.2-1: Conducted EMI Results

Frequency (MHz)	Corrected Reading		Limit		Margin		Correction (dB)
	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	
	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dB)	
0.158	44.85	27.05	65.57	55.57	20.72	28.52	9.45
0.178	42.59	22.61	64.58	54.58	21.99	31.97	9.46
0.194	42.13	22.52	63.86	53.86	21.73	31.34	9.47
0.214	41.19	22.4	63.05	53.05	21.86	30.65	9.47
0.226	40.84	22.35	62.6	52.6	21.76	30.25	9.48
0.482	42.21	38.93	56.3	46.3	14.09	7.37	9.53
0.678	35.29	22.38	56	46	20.71	23.62	9.57
0.69	36.05	22.37	56	46	19.95	23.63	9.57
0.714	36.85	22.36	56	46	19.15	23.64	9.57
0.77	36.16	22.35	56	46	19.84	23.65	9.59

Table 7.2.2-2: Conducted EMI Results

Frequency (MHz)	Corrected Reading		Limit		Margin		Correction (dB)
	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	
	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dB)	
0.15	46.86	26.75	66	56	19.14	29.25	9.43
0.154	46.54	24.9	65.78	55.78	19.24	30.88	9.43
0.17	46	22.6	64.96	54.96	18.96	32.36	9.43
0.182	43.57	22.55	64.39	54.39	20.82	31.84	9.44
0.202	41.92	22.46	63.53	53.53	21.61	31.07	9.44
0.222	41.82	25.26	62.74	52.74	20.92	27.48	9.44
0.234	41.35	22.29	62.31	52.31	20.96	30.02	9.44
0.254	38.19	22.2	61.63	51.63	23.44	29.43	9.45
0.478	43.02	39.37	56.37	46.37	13.35	7	9.48
0.722	34.61	22.3	56	46	21.39	23.7	9.52

7.3 6dB / 99% Bandwidth – FCC: Section 15.247(a)(2); ISED Canada: RSS-247 Section 5.2(a) / RSS-GEN Section 6.7

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 Section 8.2 which references Subclause 11.8 of ANSI C63.10. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 3 times the RBW. The trace was set to max hold with a peak detector active. The marker-delta function of the spectrum analyzer was utilized to determine the 6 dB bandwidth of the emission.

The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set from 1% to 5% of the occupied bandwidth and the video bandwidth set to at least 3 times the resolution bandwidth. A peak detector was used.

7.3.2 Measurement Results

Performed by: Ryan McGann

Table 7.3.2-1: 6dB / 99% Bandwidth

Modulation	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)
802.11b	2412	9.200000	13.100000
	2437	10.100000	13.000000
	2462	9.200000	13.100000
802.11g	2412	16.600000	16.600000
	2437	16.550000	16.600000
	2462	16.550000	16.600000
802.11n(HT20)	2412	17.700000	17.600000
	2437	17.650000	17.600000
	2462	17.700000	17.600000
802.11n(HT40)	2422	36.550000	36.500000
	2437	36.550000	36.500000
	2452	36.550000	36.500000

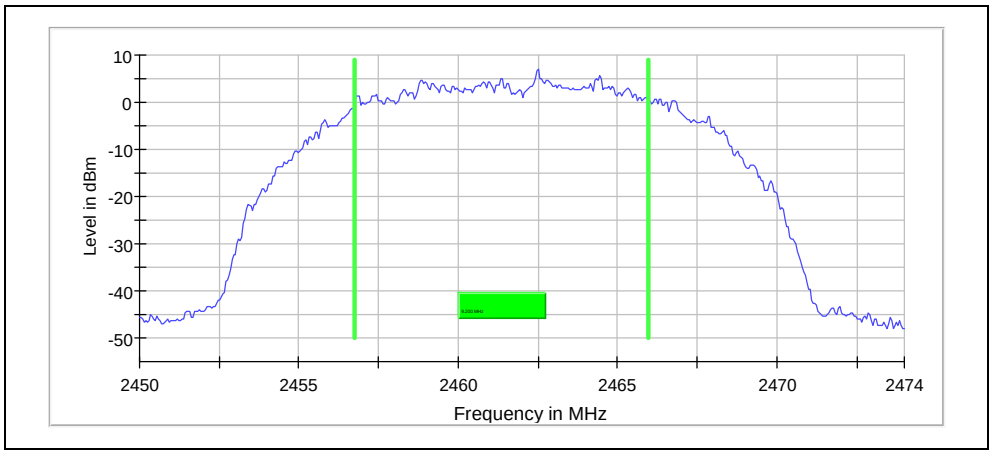

Figure 7.3.2-1: Sample Plot - 6dB BW

Table 7.3.2-2: Sample Measurement Settings (6dB BW)

Setting	Instrument Value	Target Value
Start Frequency	2.45000 GHz	2.45000 GHz
Stop Frequency	2.47400 GHz	2.47400 GHz
Span	24.000 MHz	24.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	480	~ 480
Sweeptime	37.891 µs	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	28 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.28 dB	0.50 dB

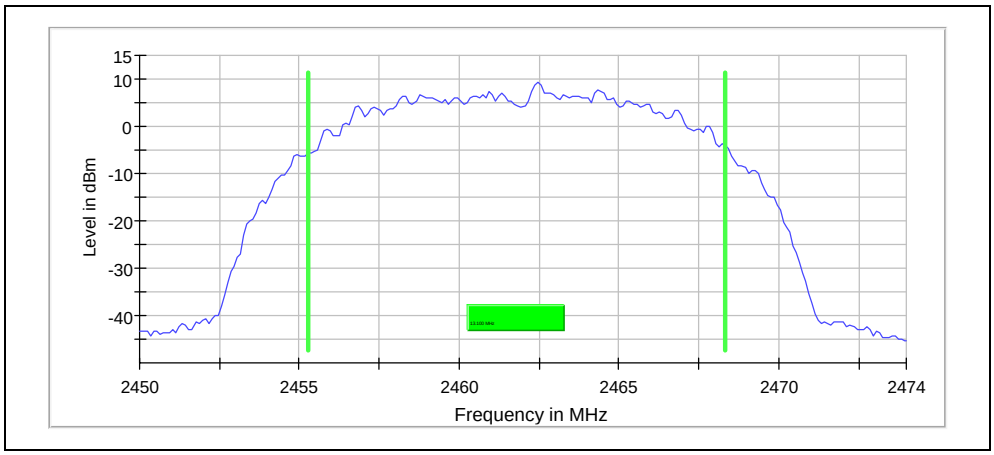

Figure 7.3.2-2: Sample Plot - 99% OBW

Table 7.3.2-3: Sample Measurement Settings (OBW)

Setting	Instrument Value	Target Value
Start Frequency	2.45000 GHz	2.45000 GHz
Stop Frequency	2.47400 GHz	2.47400 GHz
Span	24.000 MHz	24.000 MHz
RBW	200.000 kHz	>= 120.000 kHz
VBW	1.000 MHz	>= 600.000 kHz
SweepPoints	240	~ 240
Sweeptime	18.984 µs	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	22 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.24 dB	0.30 dB

7.4 Fundamental Emission Output Power – FCC: Section 15.247(b)(3); ISED Canada: RSS-247 Section 5.4(d)

7.4.1 Measurement Procedure

The maximum conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Meas Guidance utilizing the AVGPM-G method. The RF output of the equipment under test was directly connected to the input of the power sensor applying suitable attenuation. Worst-case power across all data rates is reported.

7.4.2 Measurement Results

Performed by: Ryan McGann

Table 7.4.2-1: Conducted Output Power

Modulation	Frequency (MHz)	RMS Power (dBm)
802.11b	2412	14.601
	2437	14.702
	2462	14.354
802.11g	2412	14.012
	2437	14.135
	2462	13.840
802.11n(HT20)	2412	13.829
	2437	14.057
	2462	13.720
802.11n(HT40)	2422	13.985
	2437	13.798
	2452	13.821

7.5 Emission Levels

7.5.1 Emissions into Non-restricted Frequency Bands – FCC 15.247(d); ISED Canada: RSS-247 5.5

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 Section 8.5. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to ≥ 300 kHz. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 30 dBc limit at the band edges. The spectrum span was then adjusted for the measurement of spurious emissions from 30MHz to 25GHz, 10 times the highest fundamental frequency. The worst-case for each modulation was investigated at the lower and upper band edges. For the 30MHz to 25GHz measurements, only the worst-case with respect to power was investigated: 802.11b, 1Mbps.

7.5.1.2 Measurement Results

Performed by: Ryan McGann

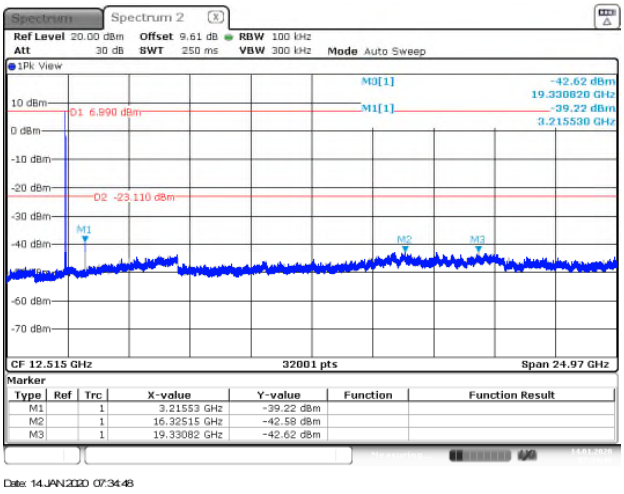

Figure 7.5.1.2-1: 802.11b – LCH – 30MHz–25GHz

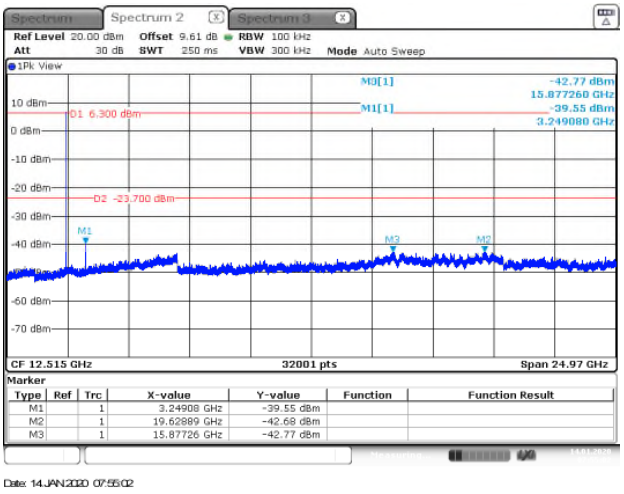

Figure 7.5.1.2-2: 802.11b – MCH – 30MHz–25GHz

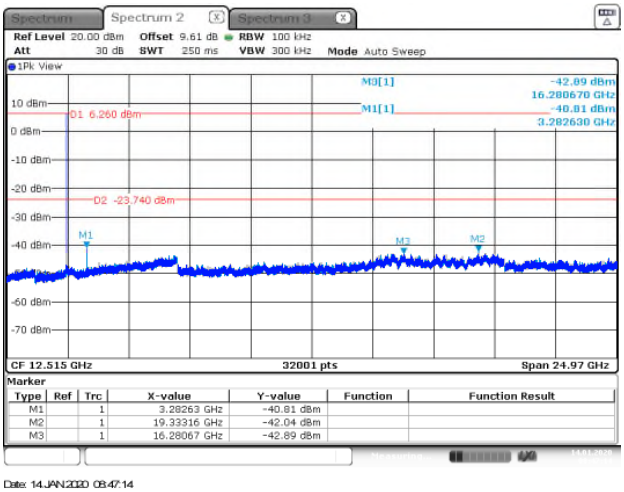

Figure 7.5.1.2-3: 802.11b – HCH – 30MHz–25GHz

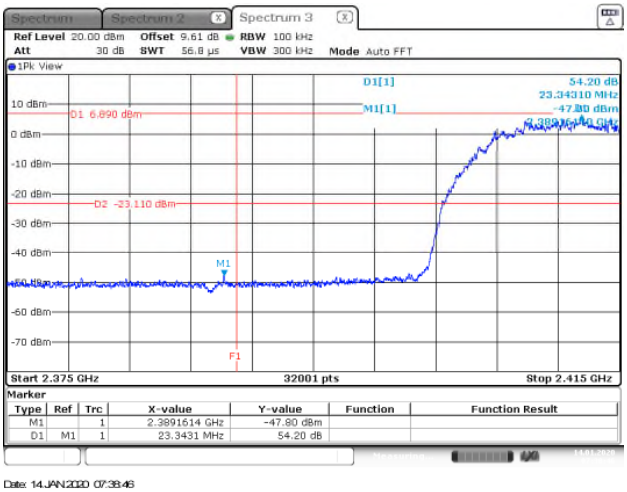

Figure 7.5.1.2-4: Lower Band-edge – 802.11b

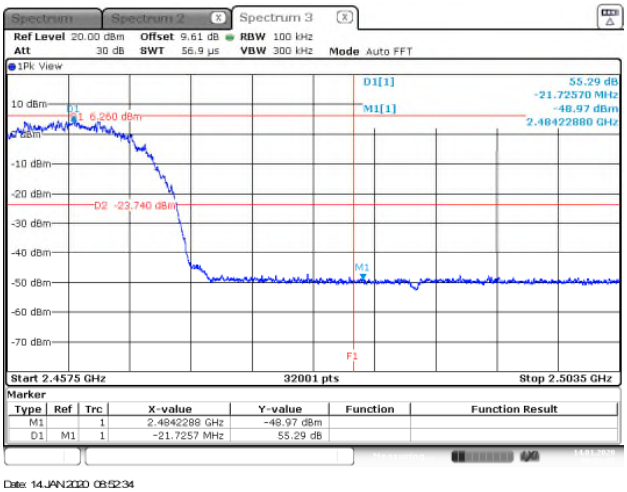

Figure 7.5.1.2-5: Upper Band-edge – 802.11b

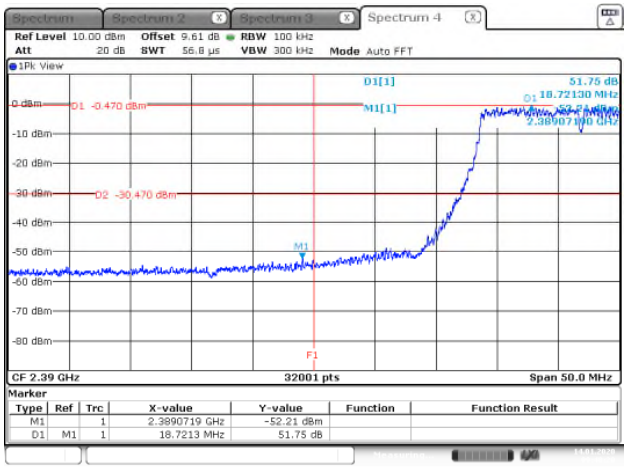

Figure 7.5.1.2-6: Lower Band-edge – 802.11g

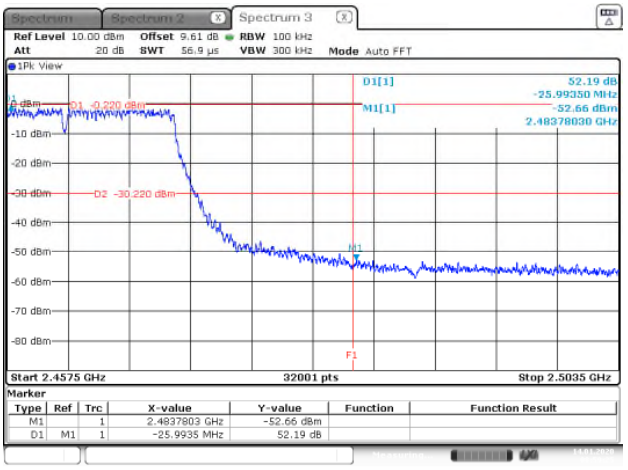

Figure 7.5.1.2-7: Upper Band-edge – 802.11g

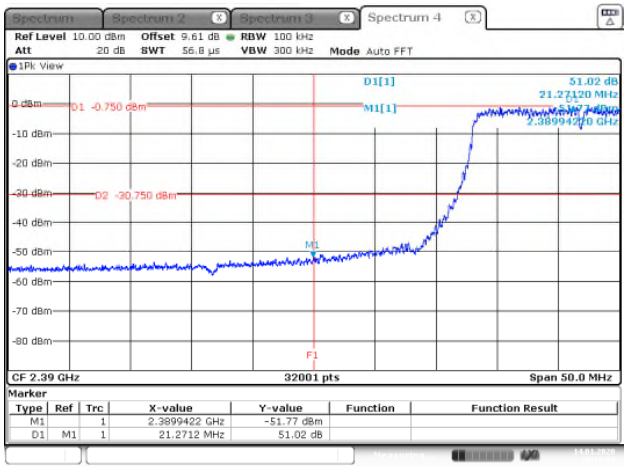

Figure 7.5.1.2-8: Lower Band-edge – 802.11n20

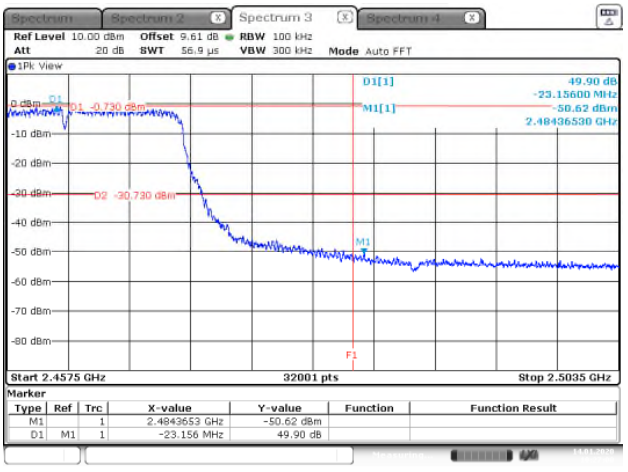

Figure 7.5.1.2-9: Upper Band-edge – 802.11n20

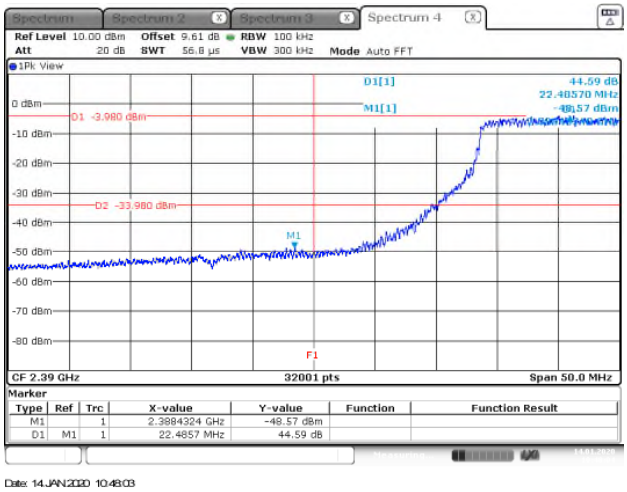

Figure 7.5.1.2-10: Lower Band-edge – 802.11n40

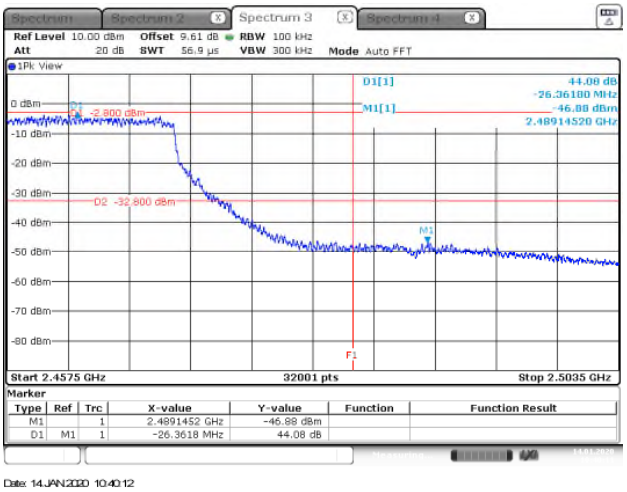

Figure 7.5.1.2-11: Upper Band-edge – 802.11n40

7.5.2 Emissions into Restricted Frequency Bands – FCC: Section 15.205, 15.209; ISED Canada: RSS-Gen Section 8.9 / 8.10

7.5.2.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 9kHz to 25GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1 meter to 4 meters so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

7.5.2.2 Measurement Results

Performed by: Ryan McGann and Jeremy Pickens

Table 7.5.2.2-1: Radiated Spurious Emissions Tabulated Data – 802.11b

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2412 MHz										
2390	47.1	34	H	3.77	50.87	37.77	74.0	54.0	23.1	16.2
2390	44.7	31.8	V	3.77	48.47	35.57	74.0	54.0	25.5	18.4
4824	42	28.5	H	8.94	50.94	37.44	74.0	54.0	23.1	16.6
4824	44.7	32	V	8.94	53.64	40.94	74.0	54.0	20.4	13.1
2437 MHz										
4874	43.2	30.1	H	8.97	52.17	39.07	74.0	54.0	21.8	14.9
4874	45.3	32.5	V	8.97	54.27	41.47	74.0	54.0	19.7	12.5
2462 MHz										
2483.5	51.30	37.10	H	4.01	55.31	41.11	74.0	54.0	18.7	12.9
2483.5	47.20	33.80	V	4.01	51.21	37.81	74.0	54.0	22.8	16.2
4824	42	28.5	H	8.94	50.94	37.44	74.0	54.0	23.1	16.6
4824	44.7	32	V	8.94	53.64	40.94	74.0	54.0	20.4	13.1

Table 7.5.2.2-2: Radiated Spurious Emissions Tabulated Data – 802.11g

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2412 MHz										
2390	59.5	44.7	H	3.77	63.27	48.47	74.0	54.0	10.7	5.5
2390	56.4	41.3	V	3.77	60.17	45.07	74.0	54.0	13.8	8.9
4824	42.6	29.3	H	8.94	51.54	38.24	74.0	54.0	22.5	15.8
4824	42.8	29.4	V	8.94	51.74	38.34	74.0	54.0	22.3	15.7
2437 MHz										
4874	42.4	28.8	H	8.97	51.37	37.77	74.0	54.0	22.6	16.2
4874	44.5	31.3	V	8.97	53.47	40.27	74.0	54.0	20.5	13.7
2462 MHz										
2483.5	61.70	46.10	H	4.01	65.71	50.11	74.0	54.0	8.3	3.9
2483.5	58.50	42.80	V	4.01	62.51	46.81	74.0	54.0	11.5	7.2
4924	41.40	28.20	H	9.00	50.40	37.20	74.0	54.0	23.6	16.8
4924	41.70	28.20	V	9.00	50.70	37.20	74.0	54.0	23.3	16.8

Table 7.5.2.2-3: Radiated Spurious Emissions Tabulated Data – 802.11n (HT 20)

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2412 MHz										
2390	65.20	49.60	H	-1.17	64.03	48.43	74.0	54.0	10.0	5.6
2390	61.50	45.80	V	-1.17	60.33	44.63	74.0	54.0	13.7	9.4
4824	52.30	40.80	H	3.31	55.61	44.11	74.0	54.0	18.4	9.9
4824	51.30	38.60	V	3.31	54.61	41.91	74.0	54.0	19.4	12.1
2437 MHz										
4874	52.8	40.8	H	3.33	56.13	44.13	74.0	54.0	17.9	9.9
4874	51.5	37.5	V	3.33	54.83	40.83	74.0	54.0	19.2	13.2
2462 MHz										
2483.5	62.3	48.4	H	-0.96	61.34	47.44	74.0	54.0	12.7	6.6
2483.5	60.6	46.7	V	-0.96	59.64	45.74	74.0	54.0	14.4	8.3
4924	52.5	40	H	3.36	55.86	43.36	74.0	54.0	18.1	10.6
4924	50	37.2	V	3.36	53.36	40.56	74.0	54.0	20.6	13.4

Table 7.5.2.2-4: Radiated Spurious Emissions Tabulated Data – 802.11n (HT 40)

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2422 MHz										
2390	66.50	54.10	H	-1.17	65.33	52.93	74.0	54.0	8.7	1.1
2390	60.70	48.20	V	-1.17	59.53	47.03	74.0	54.0	14.5	7.0
4844	54.90	37.00	H	3.32	58.22	40.32	74.0	54.0	15.8	13.7
4844	49.30	35.60	V	3.32	52.62	38.92	74.0	54.0	21.4	15.1
2437 MHz										
4874	50.1	36.9	H	3.33	53.43	40.23	74.0	54.0	20.6	13.8
4874	49	36.1	V	3.33	52.33	39.43	74.0	54.0	21.7	14.6
2452 MHz										
2483.5	66.8	54.1	H	-0.96	65.84	53.14	74.0	54.0	8.2	0.9
2483.5	63.2	49.4	V	-0.96	62.24	48.44	74.0	54.0	11.8	5.6
4904	49.7	36.6	H	3.35	53.05	39.95	74.0	54.0	21.0	14.1
4904	48.6	35.3	V	3.35	51.95	38.65	74.0	54.0	22.1	15.4

7.5.2.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation: Peak – 802.11n(HT40)

Corrected Level: 66.8 + -0.96 = 65.84dBuV/m
Margin: 74dBuV/m – 65.84dBuV/m = 8.2dB

Example Calculation: Average – 802.11 n(HT40)

Corrected Level: 54.1 + -0.96 - 0 = 53.14dBuV
Margin: 54dBuV – 53.14dBuV = 0.9dB

7.6 Maximum Power Spectral Density in the Fundamental Emission – FCC: Section 15.247(e); ISED Canada: RSS-247 Section 5.2(b)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 utilizing Section 8.4. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer applying suitable attenuation. The Resolution Bandwidth (RBW) of the spectrum analyzer was set to 100 kHz. The Video Bandwidth (VBW) was set to 300 kHz. Span was set to 1.5 times the channel bandwidth. The trace was set to max hold with the peak detector active.

7.6.2 Measurement Results

Performed by: Ryan McGann

Table 7.6.2-1: Power Spectral Density

Modulation	Frequency (MHz)	PSD (dBm)
802.11b	2412	7.132
	2437	7.122
	2462	6.926
802.11g	2412	0.293
	2437	0.526
	2462	0.243
802.11n(HT20)	2412	-0.258
	2437	0.165
	2462	-0.310
802.11n(HT40)	2422	-4.981
	2437	-5.673
	2452	-5.800

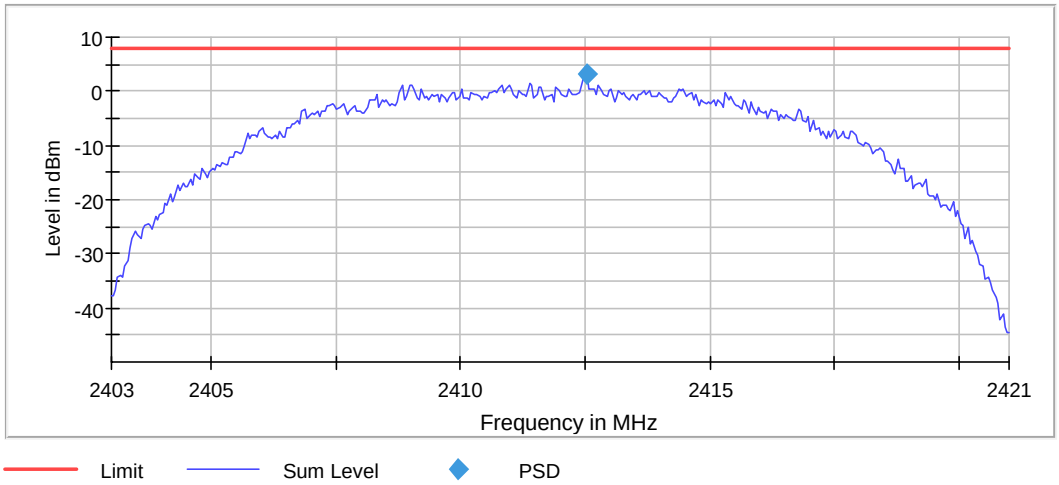

Figure 7.6.2-1: Sample PSD Plot

Table 7.6.2-2: Sample Measurement Settings (PSD)

Setting	Instrument Value	Target Value
Start Frequency	2.40300 GHz	2.40300 GHz
Stop Frequency	2.42100 GHz	2.42100 GHz
Span	18.000 MHz	18.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	360	~ 360
Sweeptime	7.200 ms	7.200 ms
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	RMS	RMS
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	80 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.30 dB	0.50 dB

8 ESTIMATION OF MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

Table 8-1: Estimation of Measurement Uncertainty

Parameter	U_{lab}
Occupied Channel Bandwidth	± 0.009 %
RF Conducted Output Power	± 0.349 dB
Power Spectral Density	± 0.372 dB
Antenna Port Conducted Emissions	± 1.264 dB
Radiated Emissions ≤ 1 GHz	± 5.814 dB
Radiated Emissions > 1 GHz	± 4.318 dB
Temperature	± 0.860 °C
Radio Frequency	± 2.832×10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TUV SUD the Tracker, manufactured by Swarm Technologies meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247 for the tests documented herein.

Appendix A: Plots

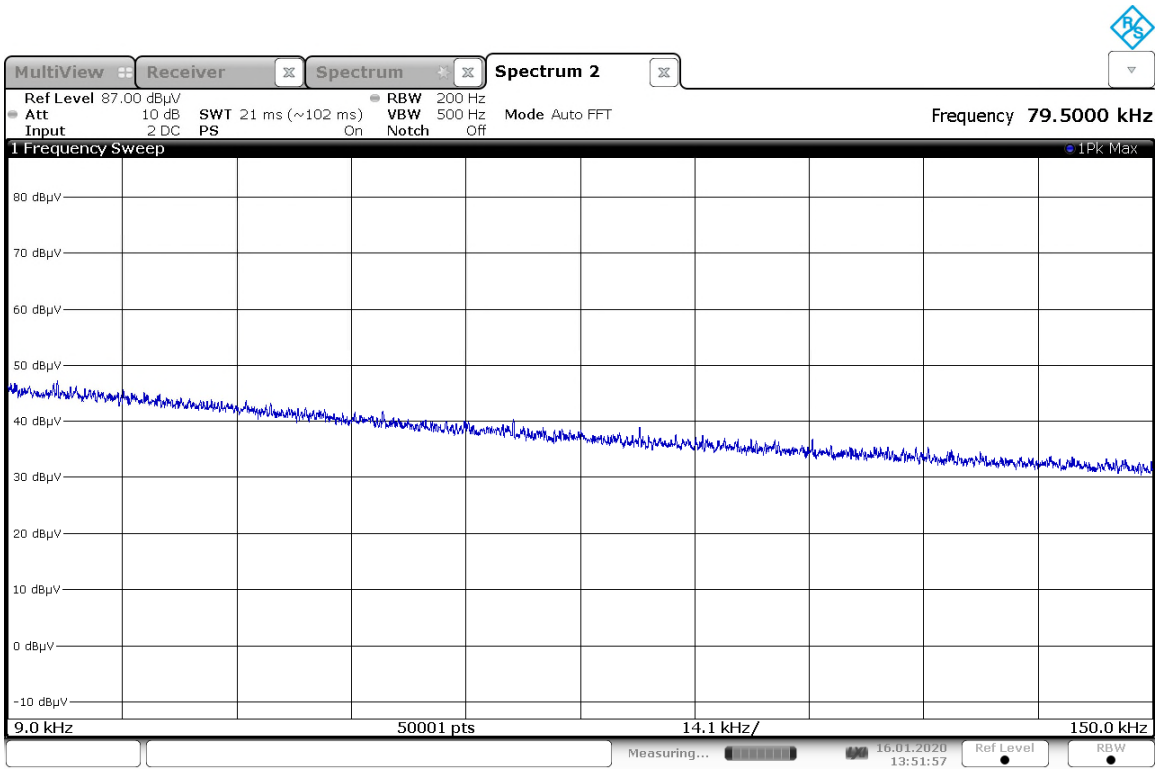

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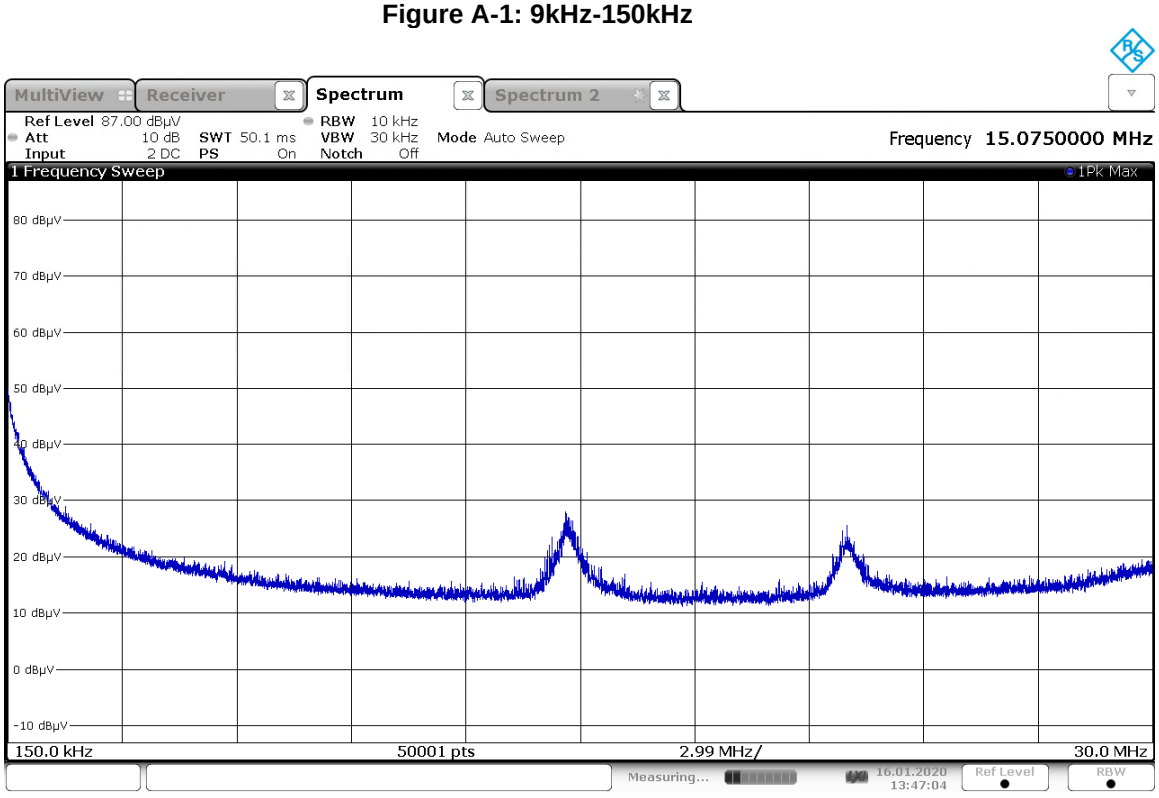
Figure A-1: 9kHz-150kHz



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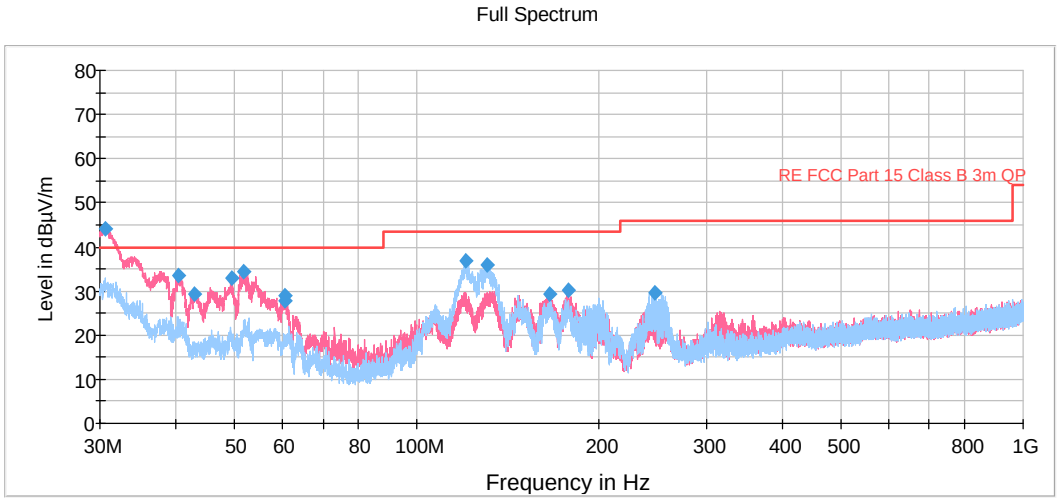
Note: Emissions above the noise floor are ambient not associated with the DUT.

Figure A-2: 150kHz-30MHz



Note: Emissions above the noise floor are from the digital sections of the DUT and not associated with the radio.

Figure A-3: 30MHz-1GHz

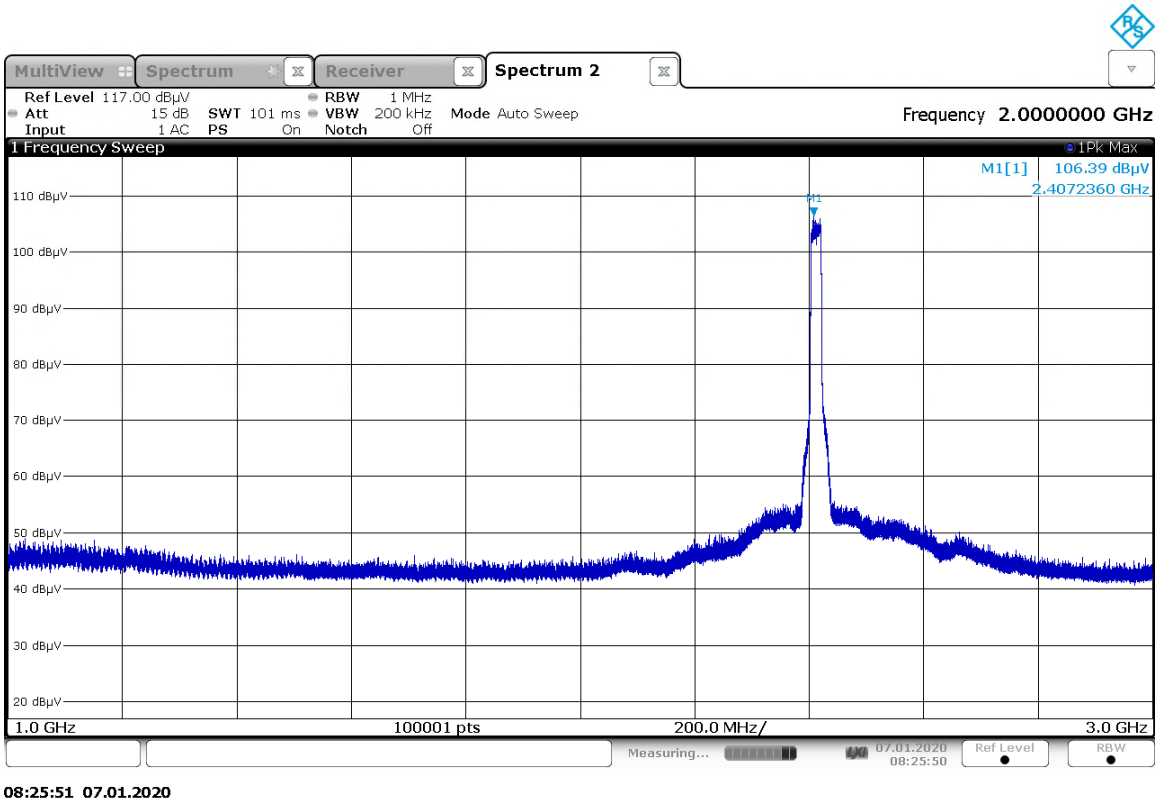


Figure A-4: 1GHz-3GHz

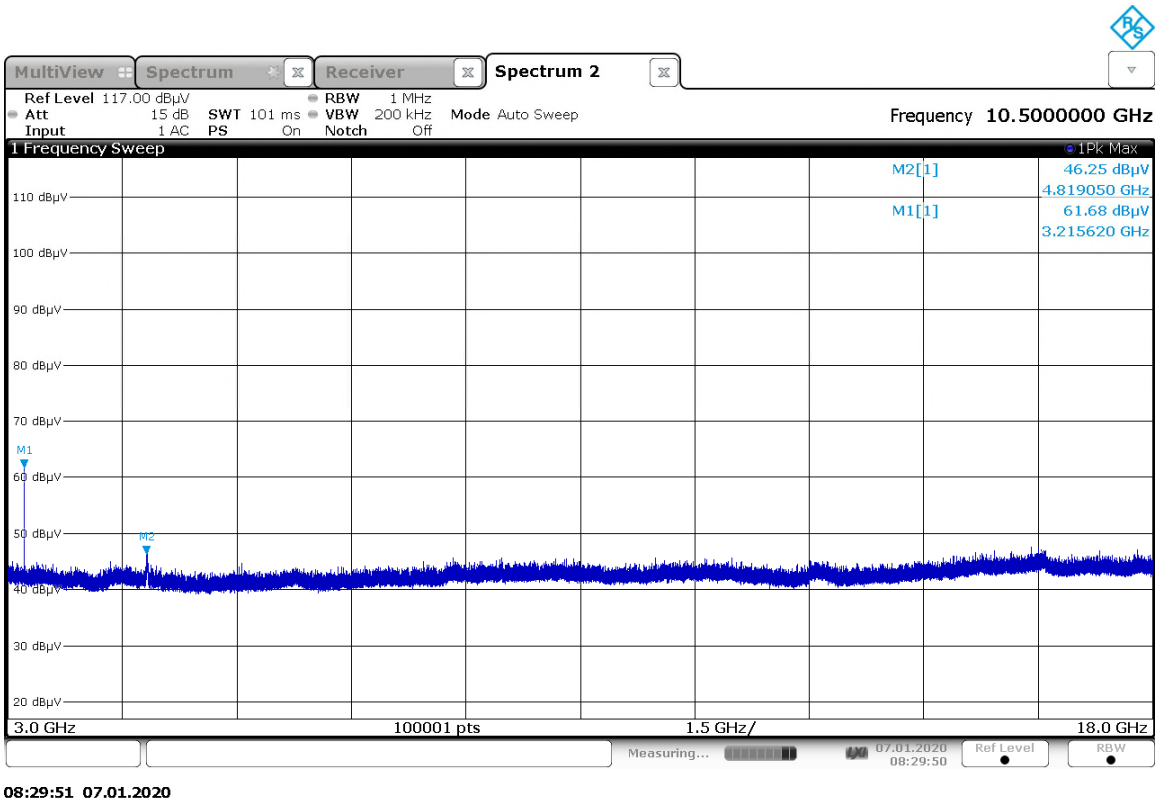


Figure A-5: 3GHz-18GHz

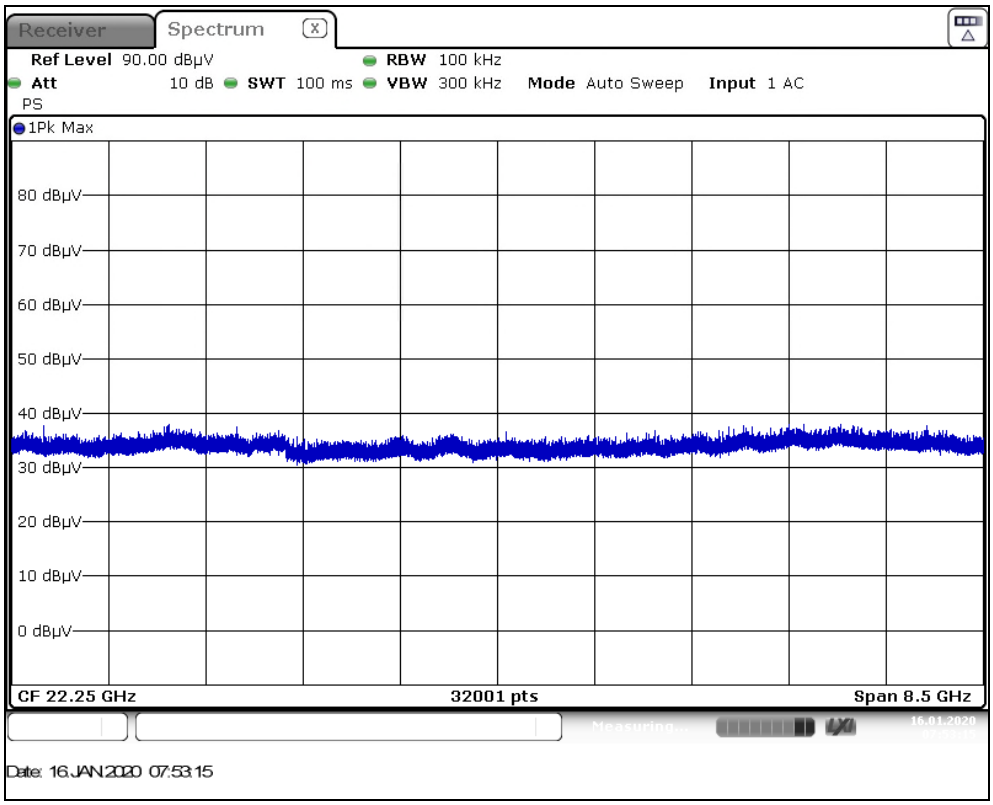


Figure A-6: 18GHz-25GHz

END REPORT