Certification Test Report

FCC ID: SK9G5R1
IC: 864G-G5R1

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

Report Number: AT72160720-1C1

Manufacturer: Itron, Inc.
Model: G5R1

Test Begin Date: May 27, 2020
Test End Date: August 25, 2020

Report Issue Date: September 3, 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 31 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

Itron, Inc.
313 N Hwy 11
West Union, SC 29696

1.3 Product Description

The Itron G5R1 is an electricity metering module which includes a 902.4 MHz to 927.6 MHz transmitter as well as 2.4GHz WLAN. The module operates on AC as well as DC voltage which is supplied by a host device.

This test report documents the compliance of the WiFi transceiver mode of operation.

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	24Vdc
Antenna Type / Gain	PCB Embedded Antenna / 2.9dBi

Test Sample Serial Number: Radiated Emissions: 113200003145
Power Line Conducted Emissions: 113200003145
RF Conducted Emissions: 113200003139

Test Sample Condition: The test samples were provided in good working order with no visible defects.

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 5.5Mbps. The worst-case data rate for 802.11g mode was 12Mbps. The worst-case data rate for 802.11n (HT 20) mode was MCS0. The worst-case data rate for 802.11n (HT 40) mode was MCS5.

For radiated emissions, the EUT was evaluated in three orthogonal orientations. The worst-case orientation was X-orientation. See test setup photos for more information.

For AC power line conducted emissions the EUT was evaluated with a commercially available wall wart power supply.

For RF Conducted Emissions, the EUT was modified with an u.fl antenna connector to facilitate connection to the test equipment.

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

Power setting during test – 802.11b:	20
Power setting during test – 802.11g:	20
Power setting during test – 802.11n (HT 20):	20
Power setting during test – 802.11n (HT 40):	15

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
FCC Test Site Registration Number:	967699
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

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.

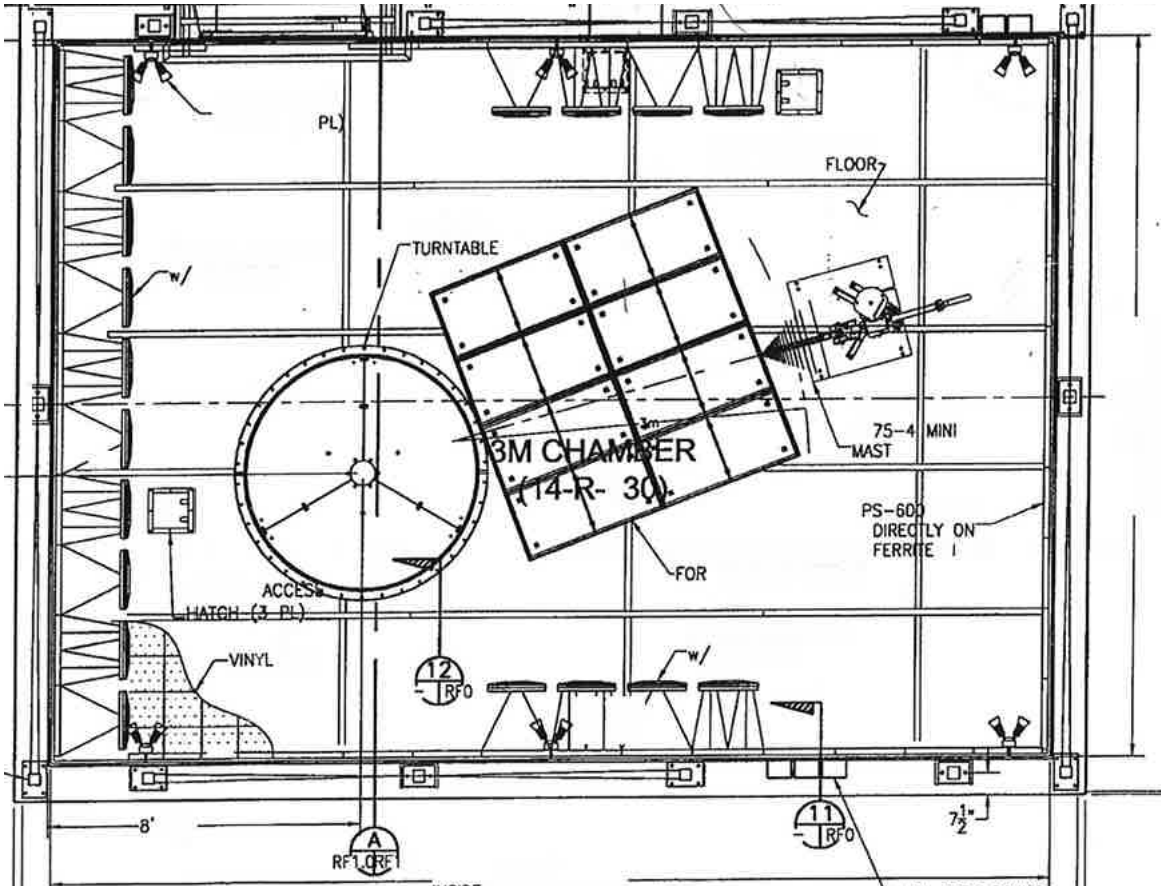

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

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.

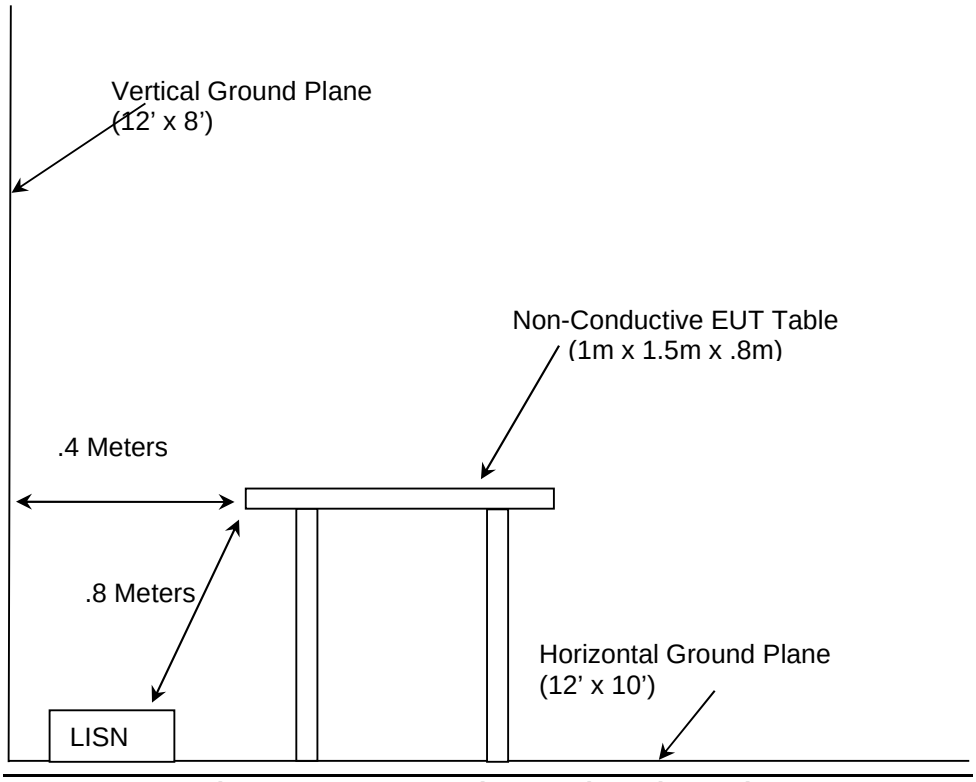

Figure 2.4.1-1: AC Mains Conducted EMI Site

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 Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules, 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, 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
324	ACS	Belden	Conducted EMI Cable	8214	4/3/2020	4/3/2021
334	Rohde & Schwarz	3160-09	HF 18 - 26.5GHz	49404	NCR	NCR
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
628	EMCO	6502	Active Loop Antenna 10kHz-30MHz	9407-2877	02/11/2019	11/02/2021
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
813	PMM	9010	EMI Receiver; RF Input 50ohm; 10Hz-50MHz; 10Hz-30MHz	697WW30606	3/3/2020	3/3/2021
819	Rohde & Schwarz	ESR26	EMI Test Receiver	101345	4/2/2020	4/2/2021
836	ETS Lindgren	SAC Cable Set	SAC Cable Set includes 620, 837, 838	N/A	5/11/2020	5/11/2021
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
3010	Rohde & Schwarz	ENV216	Two-Line V-Network	3010	07/10/2019	07/10/2020
RE880	Rhode & Schwarz USA	ESW44	Test Receiver	1206247	11/06/2019	11/6/2020

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

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model/Part Number	Serial Number
1	AC/DC Adapter	CUI, Inc.	SW125-24-N	N/A

Table 5-2: Cable Description

Cable	Cable Type	Length	Shield	Termination
A	DC Power Cable	1.75 m	No	EUT to Power Supply

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

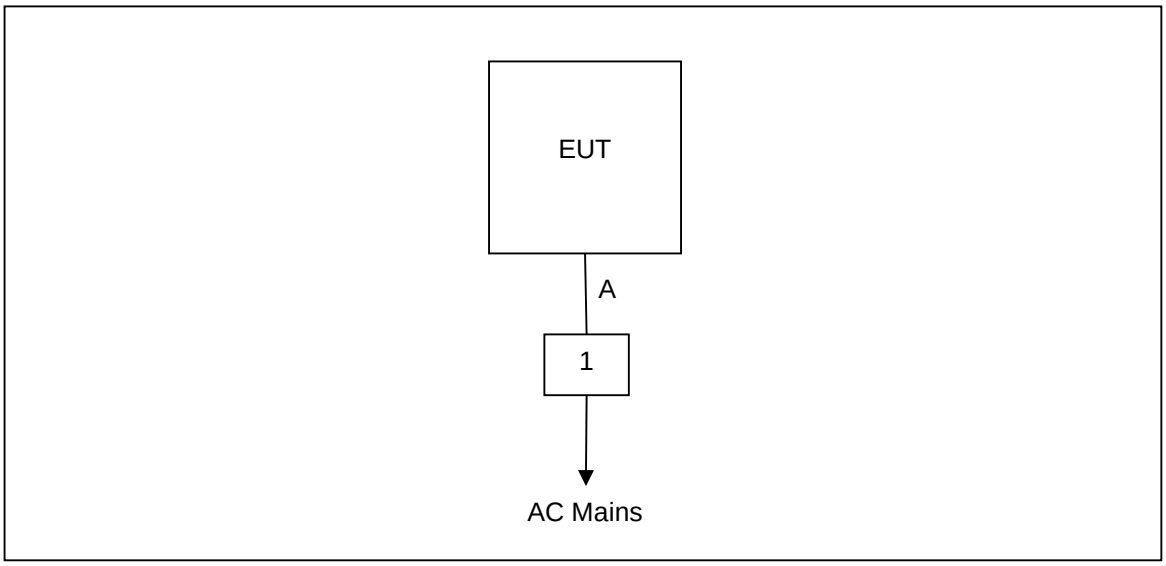

Figure 6-1: Test Setup Block Diagram

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 15.203

The EUT utilizes a PCB embedded antenna. The antenna is integral to the device and cannot be removed or replaced by the end user. The gain of the antenna is 2.9dBi.

7.2 Power Line Conducted Emissions – FCC 15.207, ISED Canada: RSS-Gen 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: Sean Vick

Table 7.2.2-1: Conducted EMI Results (Line)

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	50.18	33.55	79	66	-28.82	-32.45	9.43
0.154	49.42	34.8	79	66	-29.58	-31.2	9.43
0.166	48.98	29.63	79	66	-30.02	-36.37	9.44
0.182	46.98	25.12	79	66	-32.02	-40.88	9.44
0.202	43.14	22.54	79	66	-35.86	-43.46	9.45
0.21	41.36	24.21	79	66	-37.64	-41.79	9.45
0.238	41.68	32.93	79	66	-37.32	-33.07	9.46
0.302	42.6	36.3	79	66	-36.4	-29.7	9.48
0.31	45.65	38.68	79	66	-33.35	-27.32	9.48
0.318	46.1	39.14	79	66	-32.9	-26.86	9.48

Table 7.2.2-2: Conducted EMI Results (Neutral)

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	49.71	31.23	79	66	-29.29	-34.77	9.41
0.158	48.95	31.84	79	66	-30.05	-34.16	9.41
0.166	48.69	27.41	79	66	-30.31	-38.59	9.41
0.19	46.45	23.4	79	66	-32.55	-42.6	9.42
0.206	41.96	22.48	79	66	-37.04	-43.52	9.42
0.222	41.06	24.35	79	66	-37.94	-41.65	9.42
0.234	41.58	30.69	79	66	-37.42	-35.31	9.42
0.25	41.56	31.31	79	66	-37.44	-34.69	9.42
0.314	45.24	37.94	79	66	-33.76	-28.06	9.43
0.33	45.02	36.09	79	66	-33.98	-29.91	9.43

7.3 6dB / 99% Bandwidth – FCC 15.247(a)(2), ISED Canada: RSS-247 5.2(1)

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance. 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: Jeremy Pickens

Table 7.3.2-1: 6dB / 99% Bandwidth

Modulation	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)
802.11b	2412	10.30	14.70
	2437	10.25	14.70
	2462	10.50	14.70
802.11g	2412	15.15	16.40
	2437	15.15	19.00
	2462	15.15	16.30
802.11n(HT20)	2412	15.15	17.60
	2437	15.20	18.60
	2462	15.15	17.60
802.11n(HT40)	2422	35.15	36.00
	2437	35.15	36.25
	2452	35.15	36.00

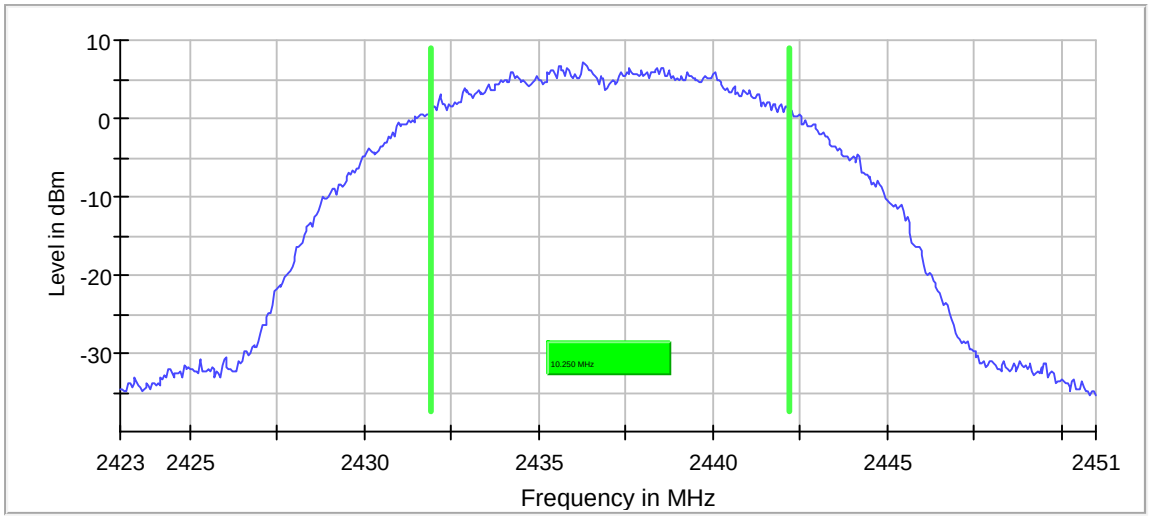

Figure 7.3.2-1: Sample Plot - 6dB BW

Table 7.3.2-2: Sample Measurement Settings (OBW)

Setting	Instrument Value	Target Value
Start Frequency	2.42300 GHz	2.42300 GHz
Stop Frequency	2.45100 GHz	2.45100 GHz
Span	28.000 MHz	28.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	560	~ 560
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	72 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.33 dB	0.50 dB

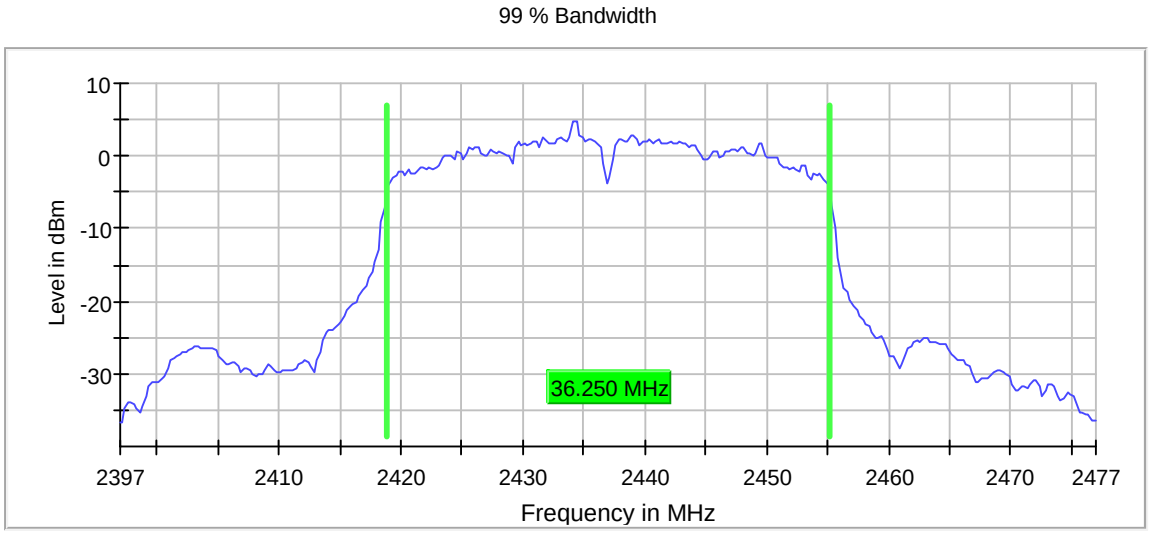

Figure 7.3.2-2: Sample Plot - 99% OBW

Table 7.3.2-3: Sample Measurement Settings (OBW)

Setting	Instrument Value	Target Value
Start Frequency	2.39700 GHz	2.39700 GHz
Stop Frequency	2.47700 GHz	2.47700 GHz
Span	80.000 MHz	80.000 MHz
RBW	500.000 kHz	>= 400.000 kHz
VBW	2.000 MHz	>= 1.500 MHz
SweepPoints	320	~ 320
Sweeptime	18.906 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 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	58 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.15 dB	0.30 dB

7.4 Fundamental Emission Output Power – FCC 15.247(b)(3), ISED Canada: RSS-247 5.4(4)

7.4.1 Measurement Procedure

The maximum conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Meas Guidance utilizing the PKPM1 method for 20MHz channel bandwidths and the AVGPM-G method for 40MHz channels. The RF output of the equipment under test was directly connected to the input of the power meter applying suitable attenuation. Worst-case power across all data rates is reported.

7.4.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.4.2-1: Conducted Output Power

Modulation	Frequency (MHz)	Power (dBm)
802.11b	2412	18.3
	2437	18.2
	2462	17.9
802.11g	2412	21.1
	2437	21.8
	2462	21.1
802.11n(HT20)	2412	21.4
	2437	21.8
	2462	21.3
802.11n(HT40)	2422	10.9
	2437	11.5
	2452	10.8

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 DTS Meas Guidance. 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 20 dBc limit for 20MHz channel bandwidths and 30 dBc for 40MHz channel bandwidths 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, 5.5Mbps.

7.5.1.2 Measurement Results

Performed by: Jeremy Pickens

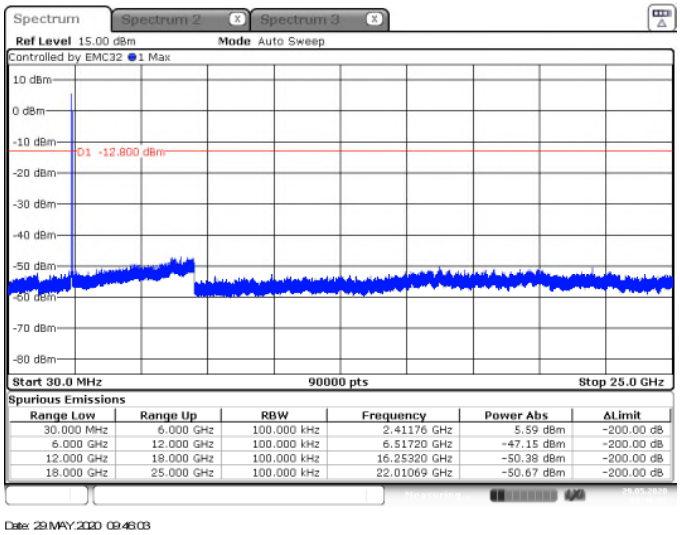

Figure 7.5.1.2-1: 802.11b – LCH – 30MHz–25GHz

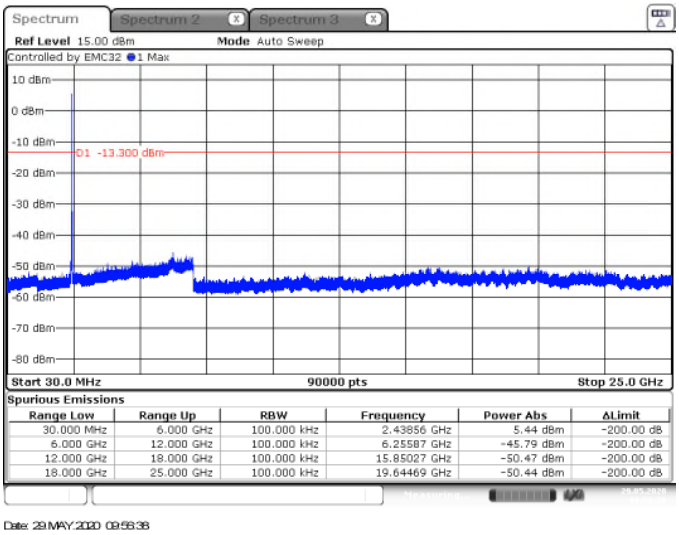

Figure 7.5.1.2-2: 802.11b – MCH – 30MHz–25GHz

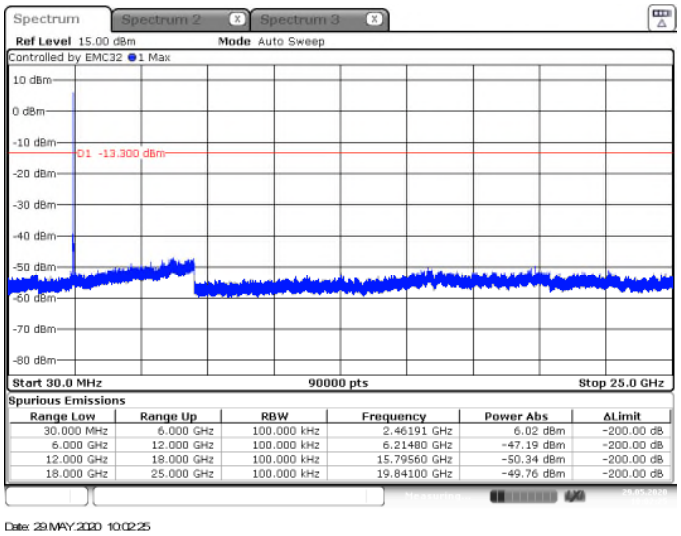

Figure 7.5.1.2-3: 802.11b – HCH – 30MHz–25GHz

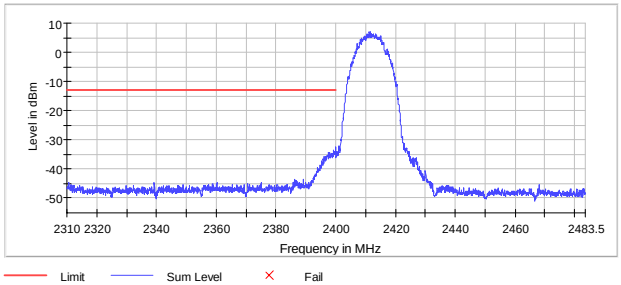

Figure 7.5.1.2-4: 802.11b – Lower Band-edge

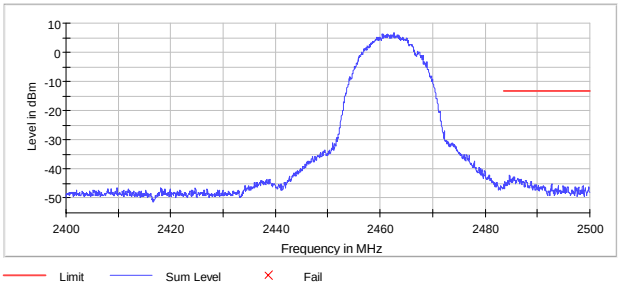

Figure 7.5.1.2-5: 802.11b – Upper Band-edge

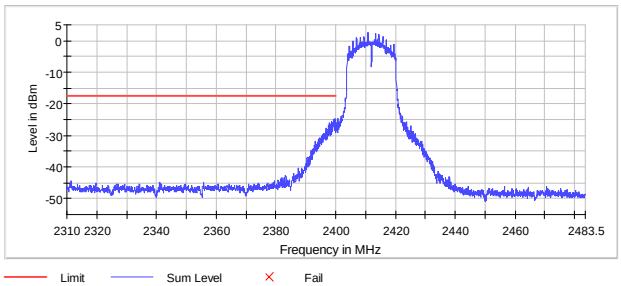

Figure 7.5.1.2-6: 802.11g – Lower Band-edge

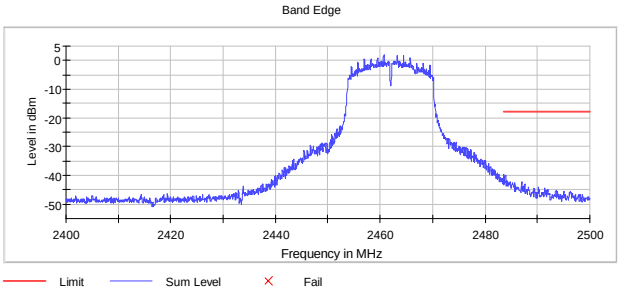

Figure 7.5.1.2-7: 802.11g – Upper Band-edge

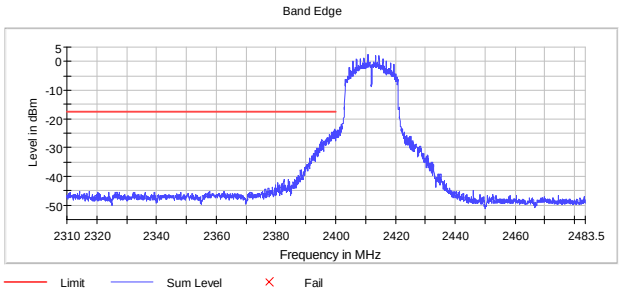

Figure 7.5.1.2-8: 802.11n20 – Lower Band-edge

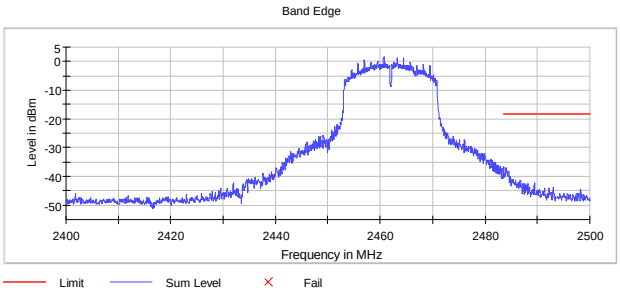

Figure 7.5.1.2-9: 802.11n20 – Upper Band-edge

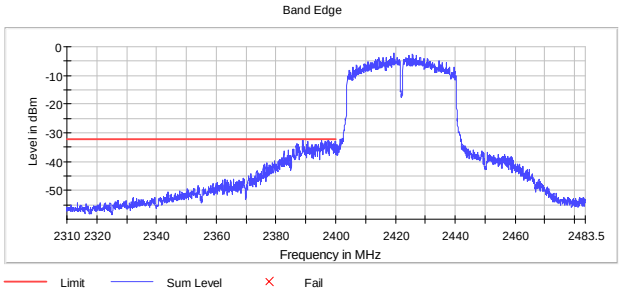

Figure 7.5.1.2-10: 802.11n40 – Lower Band-edge

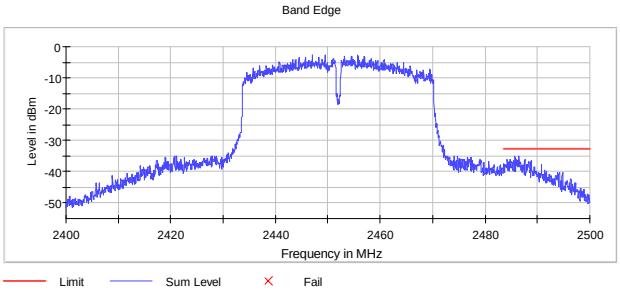

Figure 7.5.1.2-11: 802.11n40 – Upper Band-edge

Table 7.5.1.2-1: 802.11b – Lower Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.925000	-32.6	19.8	-12.8	PASS
2399.975000	-33.1	20.3	-12.8	PASS
2399.875000	-33.4	20.6	-12.8	PASS
2399.375000	-33.5	20.7	-12.8	PASS
2399.825000	-33.6	20.8	-12.8	PASS
2399.425000	-33.9	21.1	-12.8	PASS
2399.675000	-34.0	21.2	-12.8	PASS
2399.575000	-34.1	21.3	-12.8	PASS
2397.575000	-34.3	21.5	-12.8	PASS
2399.625000	-34.3	21.5	-12.8	PASS
2399.525000	-34.4	21.6	-12.8	PASS
2397.975000	-34.5	21.7	-12.8	PASS
2397.625000	-34.5	21.7	-12.8	PASS
2399.325000	-34.5	21.7	-12.8	PASS
2399.725000	-34.5	21.7	-12.8	PASS

Table 7.5.1.2-2: 802.11b – Upper Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2484.675000	-42.0	28.7	-13.3	PASS
2484.725000	-42.4	29.1	-13.3	PASS
2484.625000	-42.7	29.3	-13.3	PASS
2485.625000	-42.8	29.4	-13.3	PASS
2485.425000	-42.8	29.5	-13.3	PASS
2485.375000	-42.8	29.5	-13.3	PASS
2485.175000	-43.0	29.7	-13.3	PASS
2485.225000	-43.1	29.8	-13.3	PASS
2486.325000	-43.2	29.8	-13.3	PASS
2485.475000	-43.3	30.0	-13.3	PASS
2486.275000	-43.3	30.0	-13.3	PASS
2485.575000	-43.4	30.0	-13.3	PASS
2485.675000	-43.5	30.1	-13.3	PASS
2486.875000	-43.5	30.1	-13.3	PASS
2486.825000	-43.5	30.2	-13.3	PASS

Table 7.5.1.2-3: 802.11g – Lower Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.775000	-24.7	7.2	-17.5	PASS
2399.825000	-24.9	7.3	-17.5	PASS
2399.225000	-25.1	7.5	-17.5	PASS
2399.175000	-25.1	7.6	-17.5	PASS
2399.475000	-25.2	7.7	-17.5	PASS
2399.425000	-25.3	7.8	-17.5	PASS
2399.725000	-25.5	8.0	-17.5	PASS
2398.525000	-25.6	8.1	-17.5	PASS
2399.125000	-25.8	8.2	-17.5	PASS
2398.575000	-25.9	8.3	-17.5	PASS
2397.925000	-26.1	8.6	-17.5	PASS
2398.875000	-26.1	8.6	-17.5	PASS
2397.975000	-26.1	8.6	-17.5	PASS
2398.925000	-26.3	8.7	-17.5	PASS
2399.525000	-26.4	8.8	-17.5	PASS

Table 7.5.1.2-4: 802.11g – Upper Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.525000	-39.7	21.7	-18.0	PASS
2483.575000	-39.9	21.9	-18.0	PASS
2483.925000	-39.9	21.9	-18.0	PASS
2483.975000	-40.2	22.2	-18.0	PASS
2483.875000	-40.4	22.4	-18.0	PASS
2484.175000	-41.7	23.7	-18.0	PASS
2484.225000	-41.7	23.7	-18.0	PASS
2484.275000	-42.1	24.1	-18.0	PASS
2484.025000	-42.1	24.1	-18.0	PASS
2483.625000	-42.2	24.2	-18.0	PASS
2487.025000	-42.2	24.2	-18.0	PASS
2483.775000	-42.3	24.3	-18.0	PASS
2486.975000	-42.3	24.3	-18.0	PASS
2484.875000	-42.4	24.4	-18.0	PASS
2484.325000	-42.4	24.4	-18.0	PASS

Table 7.5.1.2-5: 802.11n20 – Lower Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.475000	-23.4	5.8	-17.5	PASS
2399.875000	-23.8	6.3	-17.5	PASS
2399.525000	-23.9	6.3	-17.5	PASS
2399.825000	-23.9	6.3	-17.5	PASS
2398.875000	-24.4	6.9	-17.5	PASS
2399.425000	-24.5	7.0	-17.5	PASS
2398.925000	-24.6	7.1	-17.5	PASS
2399.225000	-24.7	7.1	-17.5	PASS
2398.575000	-24.7	7.2	-17.5	PASS
2398.525000	-24.8	7.3	-17.5	PASS
2398.825000	-25.0	7.4	-17.5	PASS
2399.275000	-25.1	7.5	-17.5	PASS
2399.175000	-25.2	7.7	-17.5	PASS
2398.625000	-25.3	7.7	-17.5	PASS
2397.975000	-25.4	7.8	-17.5	PASS

Table 7.5.1.2-6: 802.11n20 – Upper Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.525000	-36.5	18.3	-18.2	PASS
2483.975000	-37.0	18.8	-18.2	PASS
2484.025000	-37.4	19.2	-18.2	PASS
2483.575000	-37.7	19.4	-18.2	PASS
2484.475000	-38.2	19.9	-18.2	PASS
2484.125000	-38.3	20.1	-18.2	PASS
2484.525000	-38.4	20.1	-18.2	PASS
2483.925000	-38.4	20.2	-18.2	PASS
2484.175000	-38.5	20.3	-18.2	PASS
2484.075000	-38.5	20.3	-18.2	PASS
2484.225000	-38.7	20.5	-18.2	PASS
2484.275000	-38.8	20.6	-18.2	PASS
2483.625000	-39.2	21.0	-18.2	PASS
2483.825000	-39.4	21.2	-18.2	PASS
2483.775000	-39.5	21.3	-18.2	PASS

Table 7.5.1.2-7: 802.11n40 – Lower Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2388.975000	-32.7	0.3	-32.4	PASS
2397.325000	-32.8	0.3	-32.4	PASS
2389.025000	-32.8	0.3	-32.4	PASS
2395.425000	-32.8	0.4	-32.4	PASS
2397.625000	-32.8	0.4	-32.4	PASS
2395.475000	-32.8	0.4	-32.4	PASS
2390.675000	-33.0	0.5	-32.4	PASS
2396.375000	-33.0	0.5	-32.4	PASS
2397.575000	-33.0	0.6	-32.4	PASS
2399.825000	-33.0	0.6	-32.4	PASS
2397.275000	-33.0	0.6	-32.4	PASS
2397.675000	-33.0	0.6	-32.4	PASS
2396.425000	-33.1	0.7	-32.4	PASS
2398.575000	-33.1	0.7	-32.4	PASS
2399.775000	-33.1	0.7	-32.4	PASS

Table 7.5.1.2-8: 802.11n40 – Upper Band-edge

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2486.475000	-35.2	2.5	-32.6	PASS
2485.725000	-35.2	2.6	-32.6	PASS
2486.425000	-35.5	2.9	-32.6	PASS
2486.525000	-35.7	3.1	-32.6	PASS
2485.775000	-35.7	3.1	-32.6	PASS
2485.675000	-36.0	3.4	-32.6	PASS
2487.625000	-36.1	3.5	-32.6	PASS
2484.275000	-36.2	3.5	-32.6	PASS
2486.075000	-36.3	3.6	-32.6	PASS
2484.825000	-36.3	3.6	-32.6	PASS
2484.225000	-36.4	3.7	-32.6	PASS
2488.825000	-36.4	3.7	-32.6	PASS
2486.025000	-36.4	3.8	-32.6	PASS
2484.775000	-36.4	3.8	-32.6	PASS
2486.225000	-36.4	3.8	-32.6	PASS

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

7.5.2.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz 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: Jeremy Pickens

Radiated spurious emissions found in the band of 9kHz to 25GHz are reported in the Tables 7.5.2.2-1 to 7.5.2.2-4 below.

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

Frequency (MHz)	Level (dBµV)		Antenna Polarity	Correction Factors	Corrected Level (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
2390	54.50	42.70	H	-0.11	54.39	42.59	74.0	54.0	19.6	11.4
2390	55.00	43.60	V	-0.11	54.89	43.49	74.0	54.0	19.1	10.5
4824	48.40	33.80	H	4.69	53.09	38.49	74.0	54.0	20.9	15.5
4824	46.90	33.50	V	4.69	51.59	38.19	74.0	54.0	22.4	15.8
Middle Channel										
4874	46.9	33.6	H	4.77	51.67	38.37	74.0	54.0	22.3	15.6
4874	46.1	33.5	V	4.77	50.87	38.27	74.0	54.0	23.1	15.7
High Channel										
2483.5	54.00	43.20	H	-0.02	53.98	43.18	74.0	54.0	20.0	10.8
2483.5	57.4	47.1	V	-0.02	57.38	47.08	74.0	54.0	16.6	6.9
4924	47.7	34	H	4.85	52.55	38.85	74.0	54.0	21.4	15.1
4924	46.4	33.8	V	4.85	51.25	38.65	74.0	54.0	22.7	15.3

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

Frequency (MHz)	Level (dBµV)		Antenna Polarity	Correction Factors	Corrected Level (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
2390	64.70	47.30	H	-0.11	64.59	47.19	74.0	54.0	9.4	6.8
2390	65.50	48.70	V	-0.11	65.39	48.59	74.0	54.0	8.6	5.4
4824	46.20	34.30	H	4.69	50.89	38.99	74.0	54.0	23.1	15.0
4824	46.10	34.10	V	4.69	50.79	38.79	74.0	54.0	23.2	15.2
Middle Channel										
4874	46.7	34.5	H	4.77	51.47	39.27	74.0	54.0	22.5	14.7
4874	46	34.2	V	4.77	50.77	38.97	74.0	54.0	23.2	15.0
High Channel										
2483.5	64.20	46.00	H	-0.02	64.18	45.98	74.0	54.0	9.8	8.0
2483.5	66.7	48.6	V	-0.02	66.68	48.58	74.0	54.0	7.3	5.4
4924	46.2	34.6	H	4.85	51.05	39.45	74.0	54.0	22.9	14.5
4924	46.1	34.5	V	4.85	50.95	39.35	74.0	54.0	23.0	14.6

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

Frequency (MHz)	Level (dBµV)		Antenna Polarity	Correction Factors	Corrected Level (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
2390	69.10	49.40	H	-0.11	68.99	49.29	74.0	54.0	5.0	4.7
2390	68.30	48.70	V	-0.11	68.19	48.59	74.0	54.0	5.8	5.4
4824	46.20	34.30	H	4.69	50.89	38.99	74.0	54.0	23.1	15.0
4824	46.10	34.10	V	4.69	50.79	38.79	74.0	54.0	23.2	15.2
Middle Channel										
4824	46.10	34.00	H	4.69	50.79	38.69	74.0	54.0	23.2	15.3
4824	45.80	33.80	V	4.69	50.49	38.49	74.0	54.0	23.5	15.5
High Channel										
2483.5	71.30	49.80	H	-0.02	71.28	49.78	74.0	54.0	2.7	4.2
2483.5	71.1	49.5	V	-0.02	71.08	49.48	74.0	54.0	2.9	4.5
4924	46.8	34.3	H	4.85	51.65	39.15	74.0	54.0	22.3	14.8
4924	46.5	34.2	V	4.85	51.35	39.05	74.0	54.0	22.6	14.9

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

Frequency (MHz)	Level (dBµV)		Antenna Polarity	Correction Factors	Corrected Level (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
2390	69.00	51.70	H	-0.11	68.89	51.59	74.0	54.0	5.1	2.4
2390	70.60	52.90	V	-0.11	70.49	52.79	74.0	54.0	3.5	1.2
Middle Channel										
No emissions detected										
High Channel										
2483.5	70.4	51.3	H	-0.02	70.38	51.28	74.0	54.0	3.6	2.7
2483.5	70.1	51	V	-0.02	70.08	50.98	74.0	54.0	3.9	3.0

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: 70.6 + -0.11 = 70.49dBµV/m
Margin: 74dBµV/m – 70.49dBµV/m = 3.5dB

Example Calculation: Average – 802.11n (HT40)

Corrected Level: 52.90 + -0.11 - 0 = 52.79dBµV
Margin: 54dBµV – 52.79dBµV = 1.2dB

7.6 Maximum Power Spectral Density in the Fundamental Emission – FCC 15.247(e) ISED Canada: RSS-247 5.2(2)

7.6.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance peak PSD methods for 20MHz channel bandwidths and the AVGPSD-2 method for 40MHz channels. 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.

7.6.2 Measurement Results

Performed by: Jeremy Pickens

Table 7.6.2-1: Power Spectral Density

Modulation	Frequency (MHz)	PSD (dBm)
802.11b	2412	7.674
	2437	7.192
	2462	6.177
802.11g	2412	2.492
	2437	5.340
	2462	2.037
802.11n(HT20)	2412	2.696
	2437	4.441
	2462	2.282
802.11n(HT40)	2422	-10.784
	2437	-9.848
	2452	-11.145

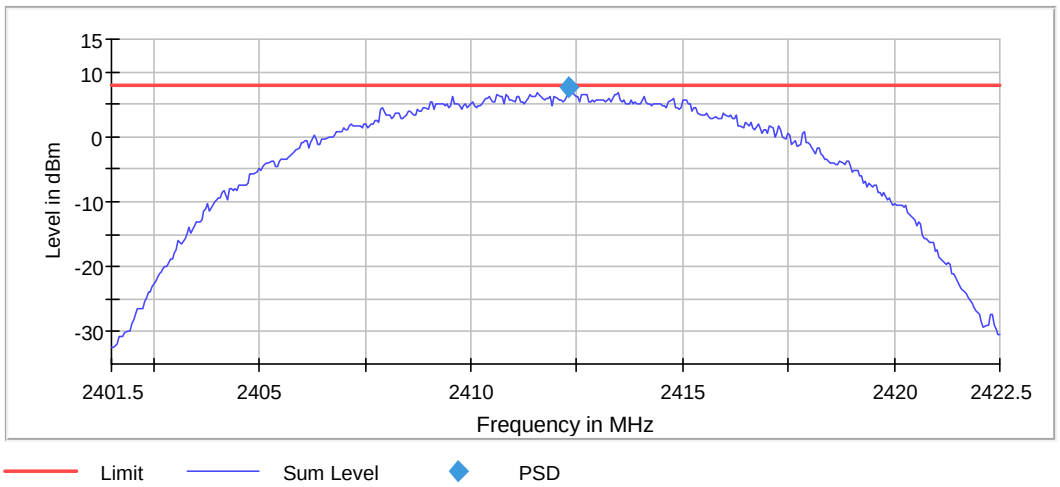

Figure 7.6.2-1: Sample PSD Plot

Table 7.6.2-2: Sample Measurement Settings (PSD)

Setting	Instrument Value	Target Value
Start Frequency	2.40150 GHz	2.40150 GHz
Stop Frequency	2.42250 GHz	2.42250 GHz
Span	21.000 MHz	21.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	420	~ 420
Sweeptime	1.070 ms	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	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	43 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.50 dB	0.50 dB

7.7 Duty Cycle

7.7.1 Measurement Procedure

The duty cycle was using a fast power sensor and meter in conjunction with the WMS32 software. The software recorded the on and off times over a sample period and reported the duty cycle.

7.7.2 Measurement Results

Performed by: Jeremy Pickens

The results for all the modes of operation are provided below.

Table 7.7.2-1 Duty Cycle Correction Factor

Mode	Data Rate	Duty Cycle (%)	Correction Factor (dB)
802.11b	5.5	99	0.0
802.11g	12	92.5	0.7
802.11n	MCS0	95.8	0.4
802.11n (HT 40)	MCS5	60.6	4.4

Note: The correction factor was calculated as 10*log (1/DC)

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 x 10^{-8}
AC Power Line Conducted Emissions	± 3.360 dB

9 CONCLUSION

In the opinion of TUV SUD the G5R1, manufactured by Itron, Inc. 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

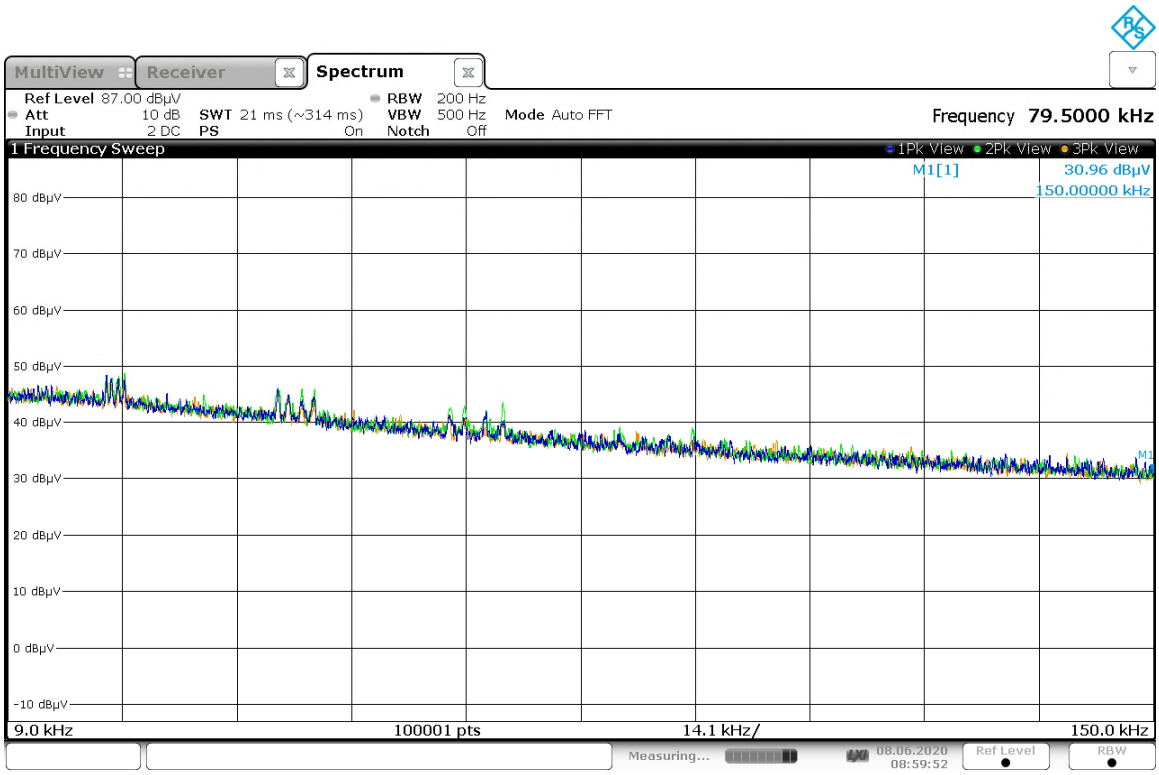

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Figure A-1: Radiated Spurious Emissions – 9 kHz – 150 kHz

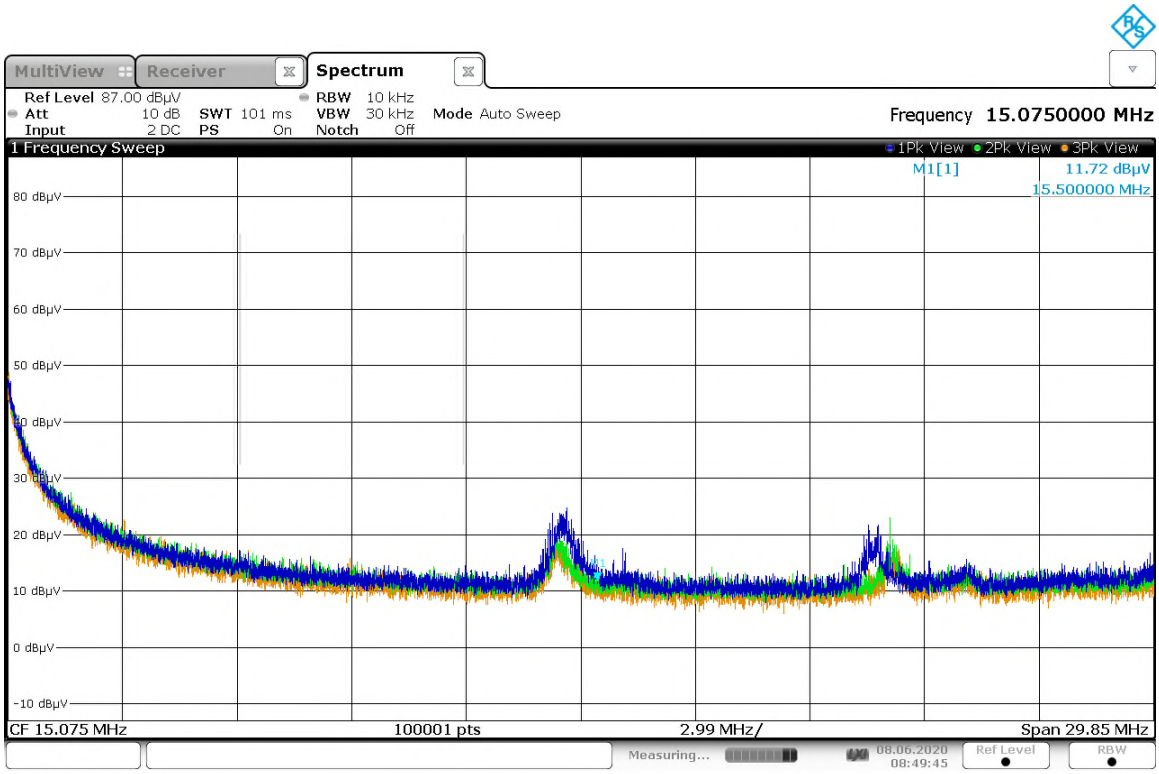

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Figure A-2: Radiated Spurious Emissions – 150 kHz to 30 MHz

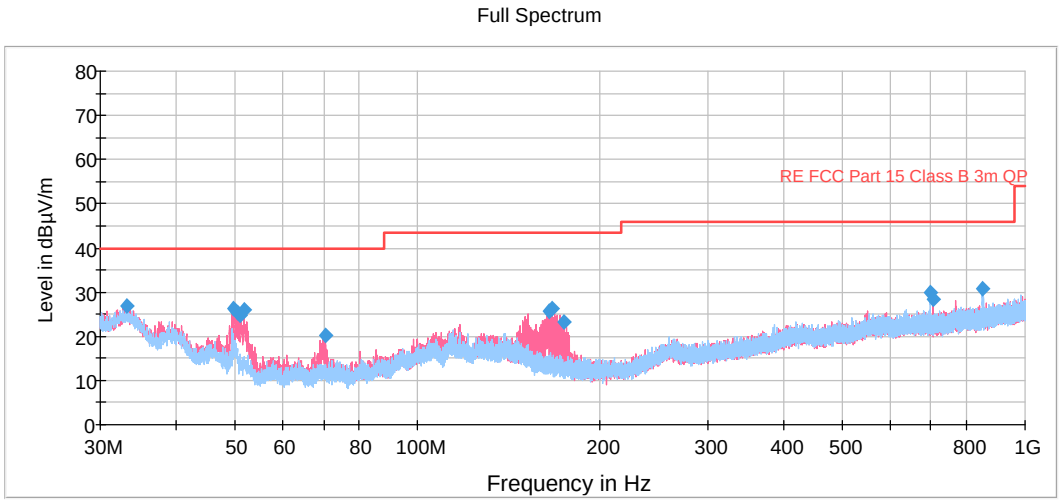
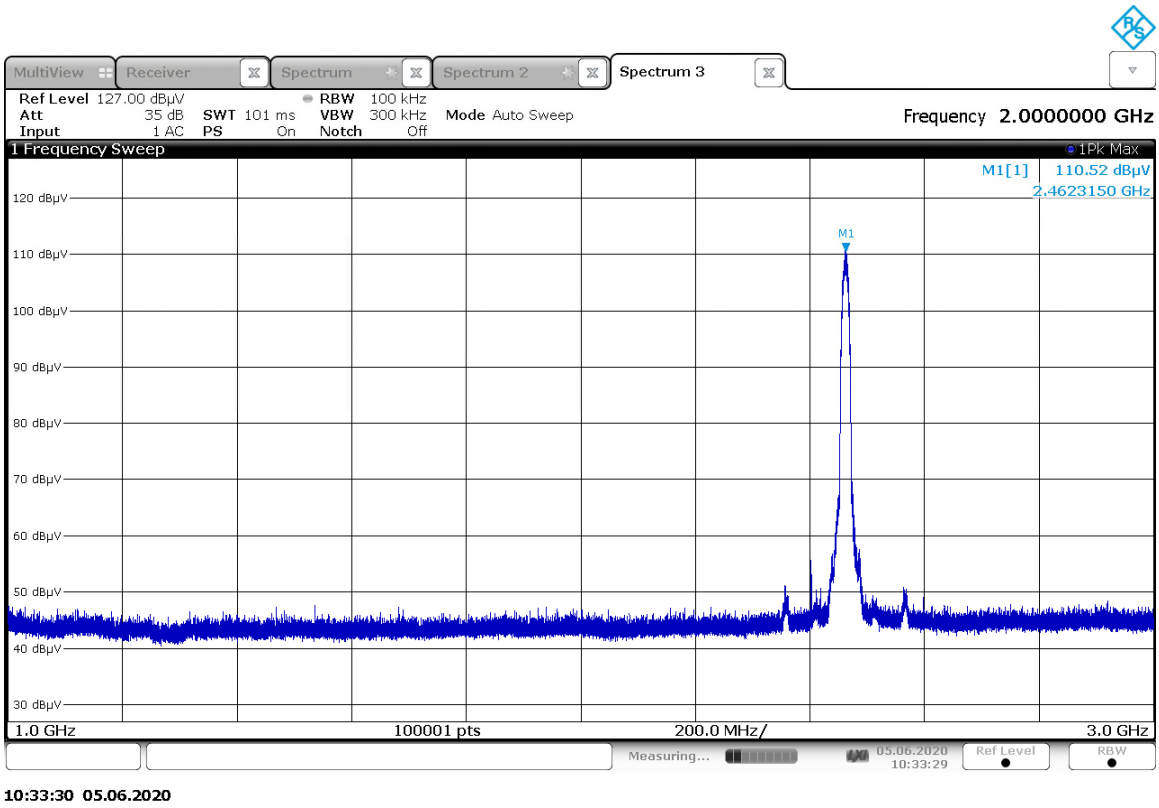
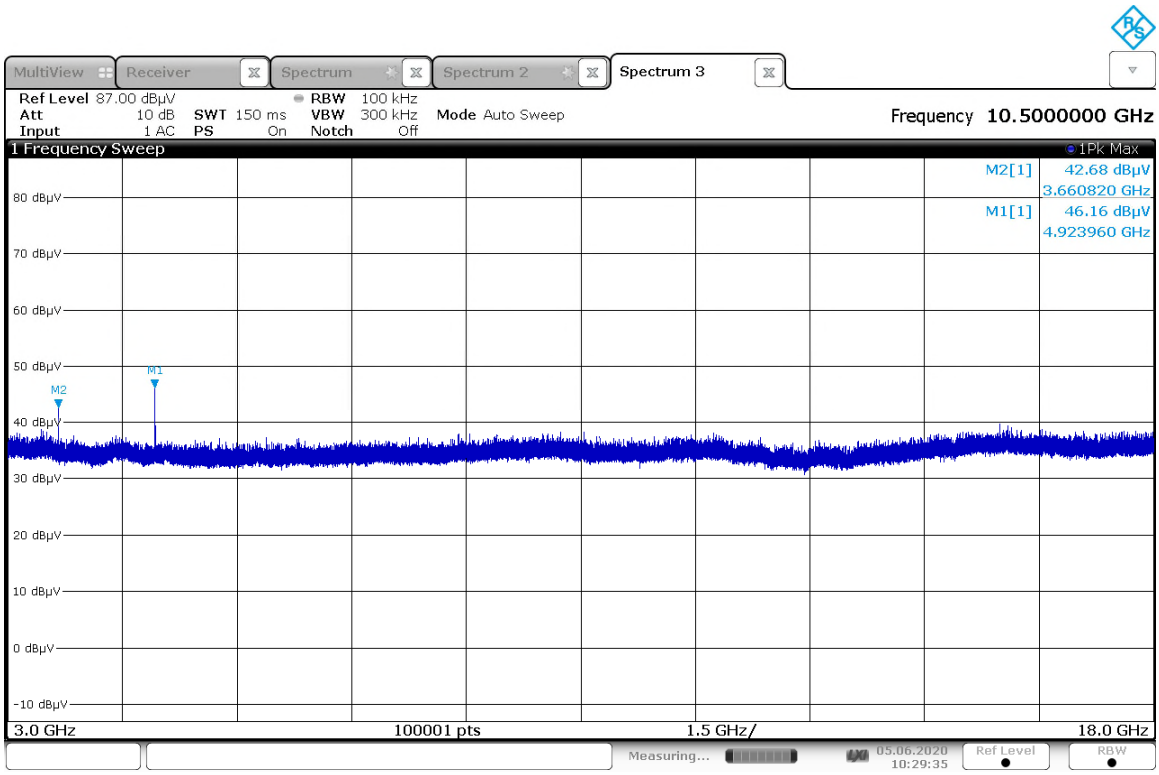


Figure A-3: Radiated Spurious Emissions – 30 MHz – 1GHz



10:33:30 05.06.2020

Figure A-4: Radiated Spurious Emissions – 1 GHz – 3 GHz



10:29:36 05.06.2020

Figure A-5: Radiated Spurious Emissions – 3 GHz – 18 GHz

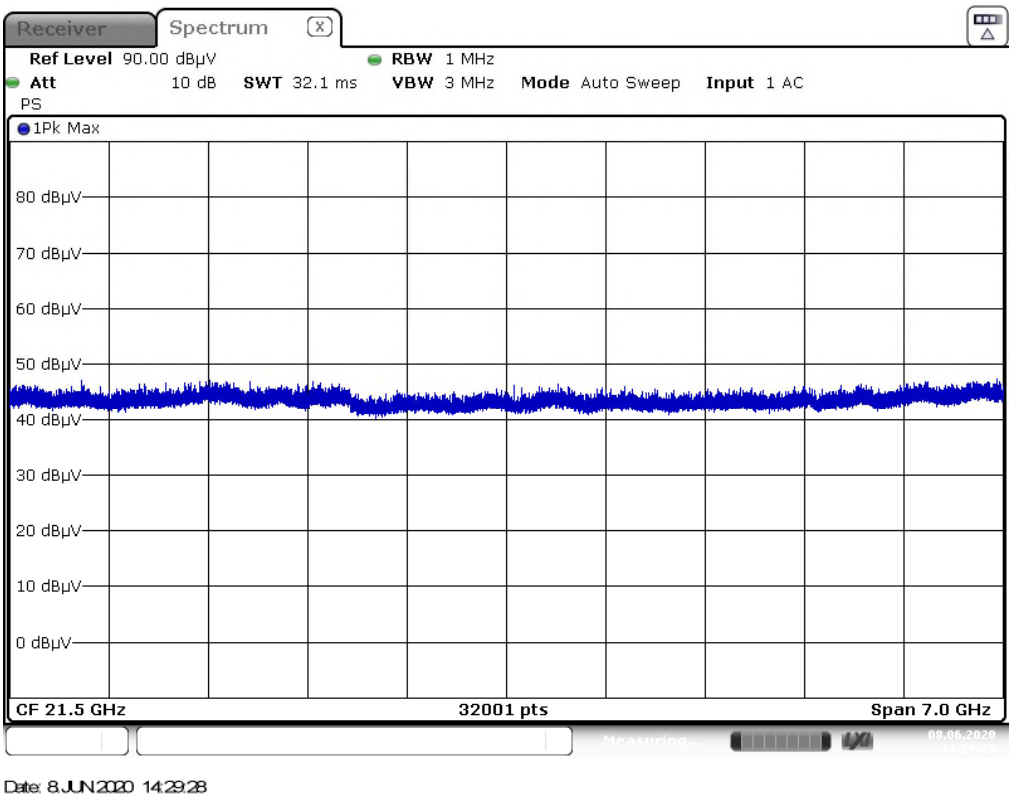


Figure A-6: Radiated Spurious Emissions – 18 GHz – 26 GHz

END REPORT