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Elster Solutions, LLC

2109-108C-4



Certificate #3293.03

FCC Accreditation Designation Number:
US1308

Innovation, Science and Economic Development Canada
Accreditation Site Number:
US0232

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FCC Test Report 2109-108C-4 Rev. N/C

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

For

Elster Solutions, LLC

208 S Rogers Lane
Raleigh, NC 27610

On

A4MGK4


FCC ID: QZC-A4MGK4 ; IC: 4557A-A4MGK4

Model Number: A4MGK4 ; Part Number: N/A ; Serial Number: N/A

Performed By: **Keystone Compliance, LLC.**

2320 Presidential Drive, Suite 101
Durham, NC 27703

Keystone Compliance, LLC. does hereby certify that all inspections and tests have been performed in accordance with the documents referenced herein with exceptions as noted in this report. The results in this report pertain to the specified equipment tested. This report shall not be reproduced, except in full, without the written authorization of Keystone Compliance, LLC.

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Testing Services

www.keystonecompliance.com



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Document History				
Revision	Issue Date	Initial Release	Revised By	Approved By
N/C	11/16/21	Initial Release	N/A	A.S.



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Client Information	
Purchase Order	A000966904
Quote Number	2109-108C-4
EUT Arrival Date	9/20/2021 -- Recieved in good condition
Company Name	Elster Solutions, LLC
Address	208 S Rogers Lane
City, State Zip	Raleigh, NC 27610
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Test Facility Information	
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Introduction

This report documents the results of the EMC tests performed on the A4MGK4, Model Number: A4MGK4; Part Number: N/A; Serial Number: N/A, submitted by Elster Solutions, LLC

The EMC test programs described herein were performed in accordance with the applicable requirements of FCC Rule Part: 15.247 & ISED Canada Radio Standards Specification: RSS-247.

All test data is included in this document.

All tests performed at Keystone Compliance Durham, NC EMC test facility. All tests were performed using the test set-ups of the relevant standard for tests performed in laboratory conditions.

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Acronyms and Abbreviations

EMC – Electromagnetic Compatibility	EMI – Electromagnetic Interference
EUT – Equipment Under Test	M/N – Model Number
P/N – Part Number	S/N – Serial Number
Vac – Voltage Alternating Current	DC – Direct Current
AM – Amplitude Modulation	dB – Decibel
deg – Degree	H/V – Horizontal or Vertical Polarity
m – Meters	cm – Centimeter
V/m – Volts per meter	dBuV/m – Decibel microvolts per meter
kV – Kilovolt	Hz – Hertz
kHz – Kilohertz	MHz – Megahertz
GHz – Gigahertz	pF – Picofarad
Ω – Ohm	QP – Quasi-Peak
N/A – Not Applicable	

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Configuration

Testing performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations, and settings used to complete the evaluation. The actual test parameters specified in the test data; this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation indicated in the test data.

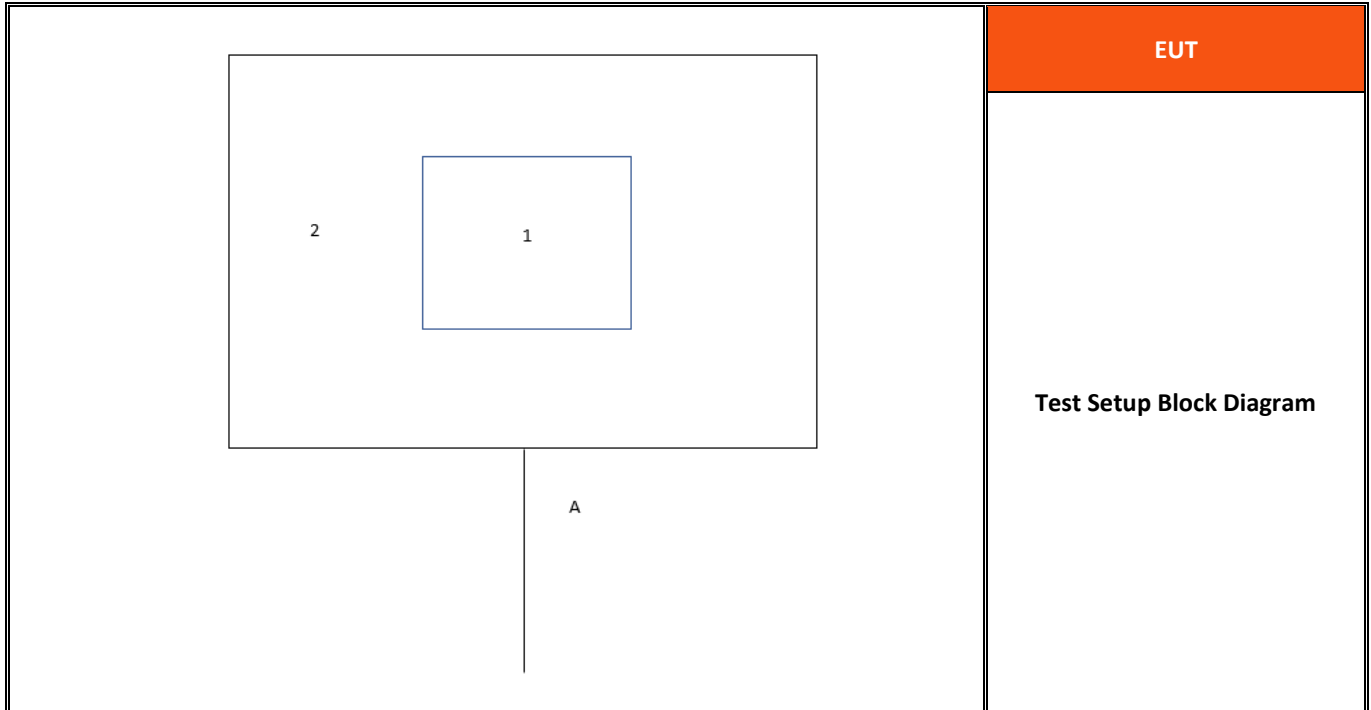
EUT		
Description		Manufacturer
A4MGK4		Elster Solutions, LLC
FCC ID		IC
QZC-A4MGK4		4557A-A4MGK4
Model Number	Part Number	Serial Number
A4MGK4	N/A	N/A

Technical Details	
Detail	Description
Frequency Range (MHz)	902.4 – 927.6
Number of Channels	25
Channel Spacing	400 kHz
Modulation Format	Energy Axis (EA)
Data Rates	35 kbps, 1472 kbps
Operating Voltage	4 VDC
Antenna Type(s) / Gain(s)	On-board dipole, +2.1 dBi

Support Equipment				
Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	EUT	Elster Solutions, LLC	A4MGK4	N/A
2	Host Device	Elster Solutions, LLC	2S	N/A

Cable Description				
Item	Cable Type	Length	Shield	Termination
A	AC Power	1 M	No	1 - AC

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Section 1 – Test Conditions and Equipment**1.1 Instrumentation and Equipment**

Keystone Compliance, LLC attests that the commercial sources providing calibration services on the above referenced equipment, other than the NIST Standards are in fact capable of performing the required services to the satisfaction of Keystone Compliance, LLC Quality Assurance. Certifications of all calibrations performed are retained on file in the Keystone Compliance, LLC Quality Assurance Department, and are available for inspection upon request by customer representatives.

The test equipment utilized during this test program is listed on individual Test Equipment Log located in Section 3 of this document.

1.2 Tolerances

All test conditions were maintained within all applicable specified tolerances.

1.3 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.

For radiated emissions, the EUT was evaluated inside a 2S Watt-Hour meter in an orientation representative of normal operation.

For antenna port conducted emissions, an SMA to U.FL connector was mounted directly onto the board to facilitate testing.

For power line conducted emissions, the EUT was evaluated inside a 2S Watt-Hour meter.

Power setting during test: Set By Manufacturer

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1.4.1 Semi-Anechoic Chamber Test Site

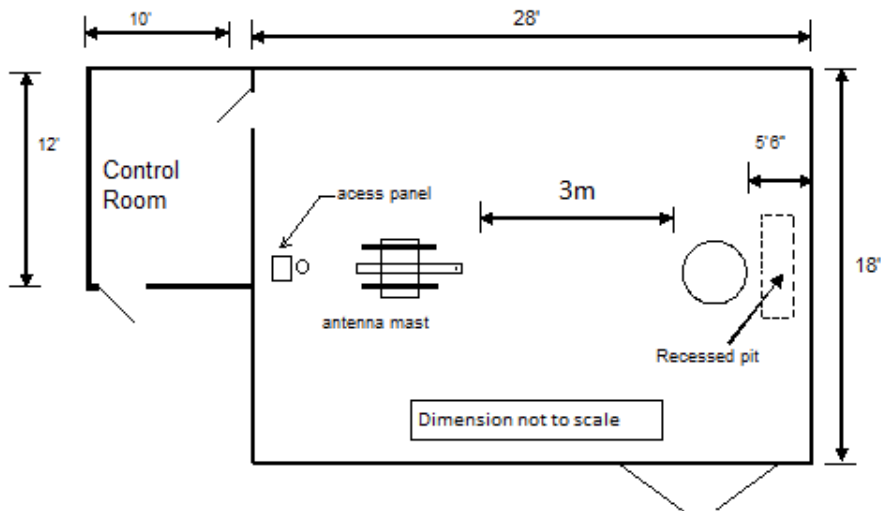
The Semi-Anechoic Chamber Test Site consists of an 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm 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 short #6 copper wire. The turntable is all steel, flush mounted table installed in an all-steel frame. The table is remotely operated from inside the control room located 25' from the turntable. 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.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase from the turntable to the pit that allow 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.

To comply with the requirements of the test methods given on page 4, RF absorbing foam was placed inside the chamber in a configuration that provided the best results. First, a 12ft X 12ft. patch of 10" tall absorber was placed on the floor between the turntable and the receiving antenna. This absorber meets the absorption requirements specified in ANSI C63.4:2009.

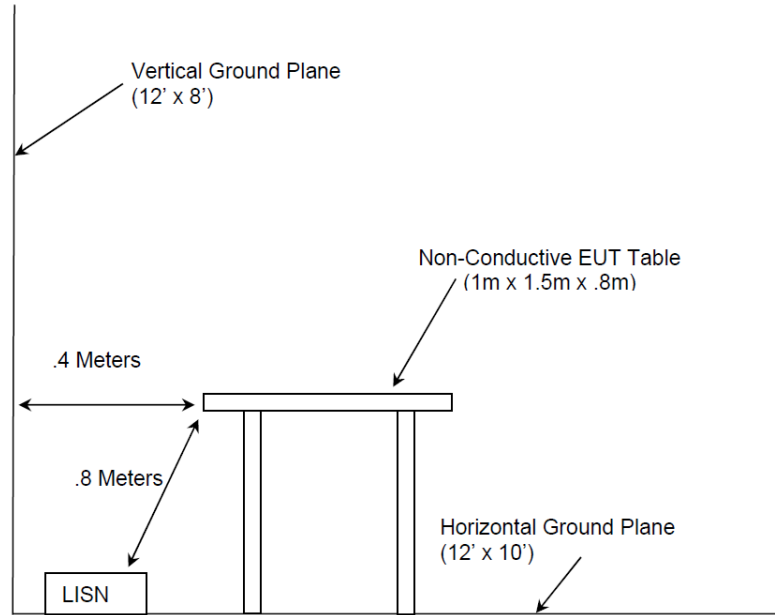
A diagram of the Semi-Anechoic Chamber Test Site is shown below:



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1.5.1 Semi-Anechoic Chamber Test Site

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



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Section 2 – References

2.1 Applicable Specifications

Reference Specification Title	ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference Specification Title	US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J Equipment Authorization Procedures, 2020
Reference Specification Title	US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C Radio Frequency Devices, Intentional Radiators, 2020
Reference Specification Title	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
Reference Specification Title	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.
Reference Specification Title	ISED Canada Radio Standards Specification: RSS-GEN General Requirements for Compliance of Radio Apparatus, Issue 5, April 2018 + Amendment 1, March 2019

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Section 3 – Test Equipment
3.1 Test Equipment

Equipment Log	
Customer:	Elster Solutions, LLC
Date:	9/20/21 – 9/21/21
Test Engineer:	T. Leeson

Test Equipment						
Asset No.	Description	Manufacturer	Model	Serial No.	Last Cal.	Cal. Due
CA000	3 Meter Chamber	ETS Lindgren	N/A	P32431/J.G.	N/A	N/A
CB001	Spectrum Analyzer	Hewlett Packard	E440A	MY44303432 FW: A.11.21	1/20/2021	1/20/2022
CB006	EMI Receiver, 1Hz - 40GHz	Rohde & Schwartz	ESW-44	102020	1/18/2021	1/18/2022
CC009	Pressure, Humidity and Temperature Meter	Extech	SD700	A.103649	1/29/2021	1/29/2022
CE001	Dual Ridged Horn Antenna	Astro Antenna	AHA-118S	3014	2/2/2021	2/2/2022
CE013	Active Loop Antenna 1 kHz – 30 MHz	EMCO	6507	0003-1430	1/28/2021	1/28/2022
CE017	Biconilog Antenna	Hewlett Packard	CBL6110B	1875	4/20/2021	4/20/2022
CG000	100kHz – 3000MHz RF Pre-Amplifier	Hewlett Packard	8347A	3307A02193	1/20/2021	1/20/2022
CG012	1-26.5GHz Preamplifier	Hewlett Packard	8449B	3008A01153	1/26/2021	1/26/2022
CK003	LISN (2 pieces)	Com-Power	LI1258C	20020018, 20020019	1/25/2021	1/25/2022
CN046	Transient Limiter	Com-Power	LIT-153A	22010080	8/31/2021	8/31/2022
CT009	RF Cable	Megaphase	EMC1-K1K1-192	N/A	2/22/2021	2/22/2022
CT012	N-Type (300 kHz – 18 GHz)	Suhner	Sucoflex 165500	165500	3/29/2021	3/29/2022
CT013	2 meer SMA to N type Cable	Suhner	Succoflex100	N/A	3/18/2021	3/18/2022
CT015	Cable, BNC to BNC	N/A	N/A	NEK-M17028	4/1/2021	4/1/2022

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Test Equipment						
Asset No.	Description	Manufacturer	Model	Serial No.	Last Cal.	Cal. Due
CT016	Cable, BNC to BNC	Pomona Electronics	N/A	2249-C-480	4/1/2021	4/1/2022
CT017	Cable N-Type to N-Type	Suhner	Sucoflex 165500	N/A	4/6/2021	4/6/2022

UWCE: Used With Calibrated Equipment

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Section 4 – Summary of Tests

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

4.1 Antenna Requirement - FCC: 15.203

The EUT utilizes several different antenna options: the SMT Chip Antenna and PCB Trace Antenna are permanently affixed to the module; the external antenna options attach to the module via a U.fl cable permanently attached to the antenna.

4.2 Power Line Conducted Emissions - FCC: 15.207, ISED Canada: RSS-Gen 8.8
4.2.1 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:

$$\text{Corrected Reading} = \text{Analyzer Reading} + \text{LISN Loss} + \text{Cable Loss Margin} = \text{Corrected Reading} - \text{Applicable Limit}$$

4.2.2 Measurement Results

Performed by: Tyler Leeson

Conducted EMI Results - 120VAC/60Hz - Line 1

Frequency (MHz)	Corrected Reading		Limit		Margin	
	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
	(dBμV)	(dBμV)	(dBμV)	(dBμV)	(dB)	(dB)
0.177	17.31	-----	64.63	-----	47.32	-----
2.2695	14.36	-----	56	-----	41.64	-----
2.64075	16.78	-----	56	-----	39.22	-----
6.999	25.34	-----	60	-----	34.66	-----
13.41825	27.88	-----	60	-----	32.12	-----
23.127	26.14	-----	60	-----	33.86	-----

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Conducted EMI Results - 120VAC/60Hz - Line 2

Frequency (MHz)	Corrected Reading		Limit		Margin	
	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
	(dB μ V)	(dB μ V)	(dB μ V)	(dB μ V)	(dB)	(dB)
1.698	21.16	-----	56	-----	34.84	-----
2.0355	20.80	-----	56	-----	35.20	-----
5.45325	15.53	-----	60	-----	44.47	-----
6.6435	21.46	-----	60	-----	38.54	-----
12.74775	28.42	-----	60	-----	31.58	-----
20.37525	19.42	-----	60	-----	40.58	-----

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4.3 20dB Bandwidth - FCC: 15.247(a)(2), ISSED Canada: RSS-247 5.2(a), RSS-GEN 6.7
4.3.1 Measurement Procedure

The 20dB 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 6dB bandwidth of the emission.

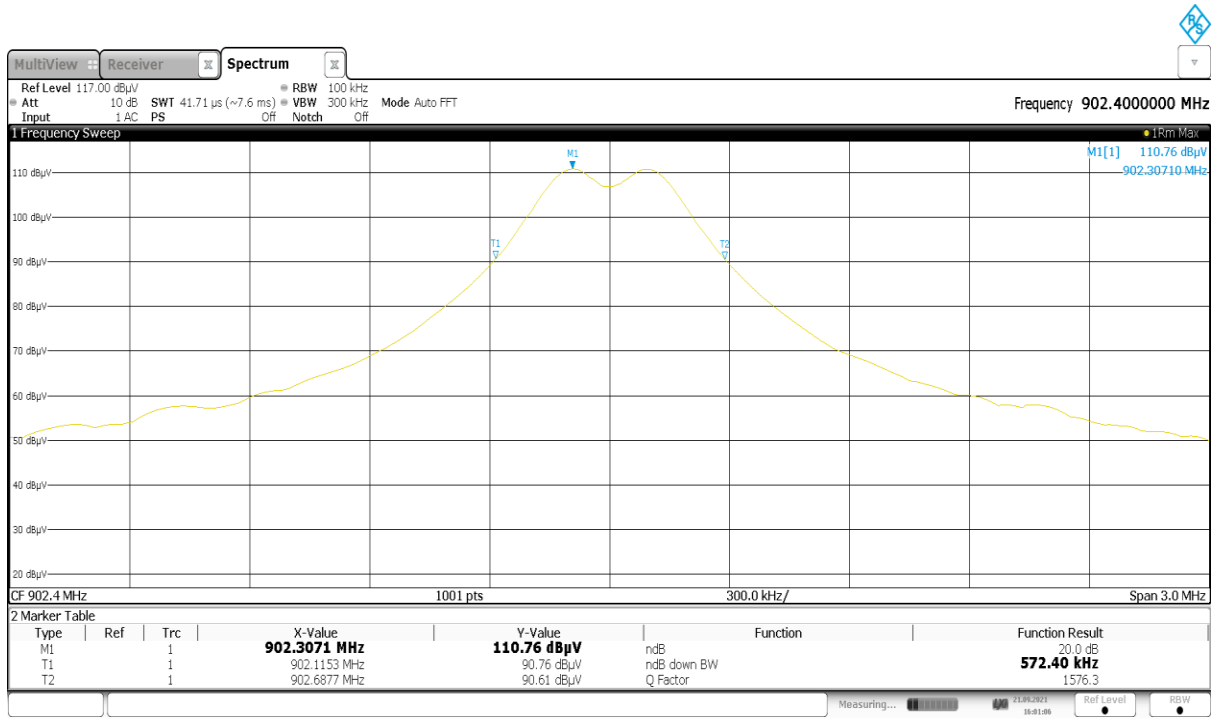
The occupied bandwidth measurement function of the spectrum analyzer was used to measure the 99% bandwidth. The span of the analyzer was set to capture all products of the modulation process, including the emission sidebands. The resolution bandwidth was set from 1% to 5% of the occupied bandwidth and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

4.3.2 Measurement Results

Performed by: Tyler Leeson

20dB Bandwidth

Modulation	Frequency (MHz)	20dB Bandwidth (kHz)
GFSK / 1Mbps	902.4	572.4
	915.2	572.4
	927.6	566.4

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Sample Plot – 20dB BW


16:01:07 21.09.2021

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4.4 Fundamental Emission Output Power - FCC: 15.247(b)(3), ISED Canada: RSS-247 5.4(d)
4.4.1 Measurement Procedure

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

4.4.2 Measurement Results

Performed by: Tyler Leeson

Conducted Output Power

Modulation	Frequency (MHz)	Peak Power (dBm)
EA / 35 kbps	902.4	22.99
	915.2	22.65
	927.6	22.56
EA / 1472 kbps	902.4	22.74
	915.2	22.6
	927.6	22.52

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4.5 Number of hopping channels / Dwell Time – FCC: 15.247(a)(1), ISED Canada: RSS-247 5.1(d)
4.5.1 Measurement Procedure

The Number of hopping channels / Dwell Time was measured in accordance with the FCC KDB 558074 D01 Section 9 which references Subclause 7.8 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 Dwell Time. Worst-case data rate was determined by RF Conducted Output Power.

4.5.2 Measurement Results

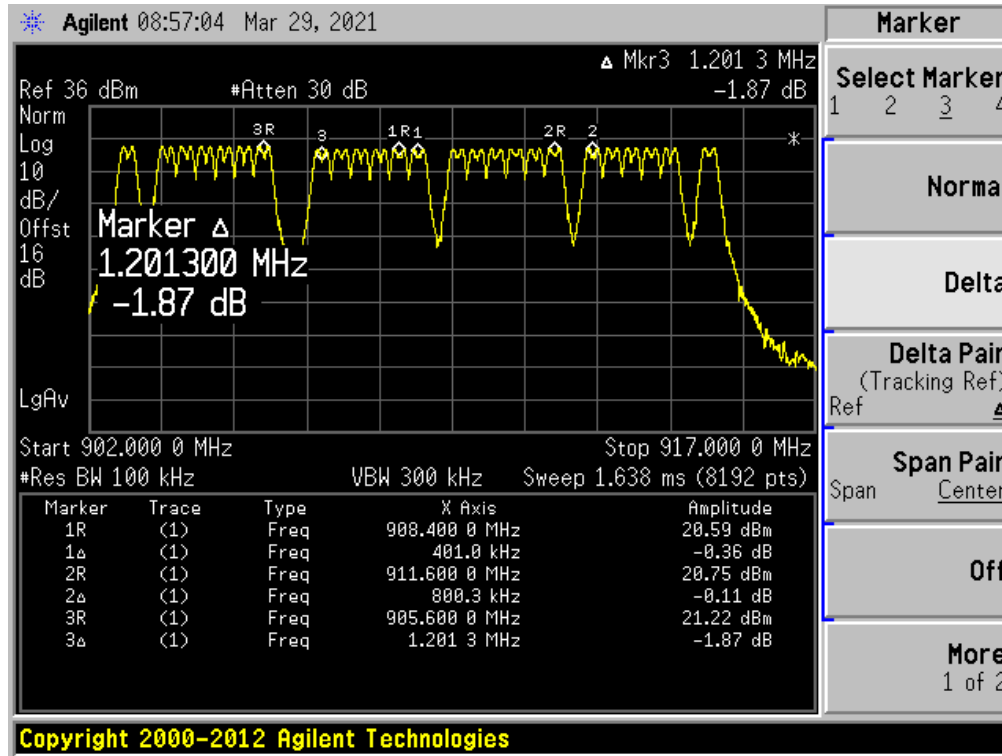
Performed by: Tyler Leeson

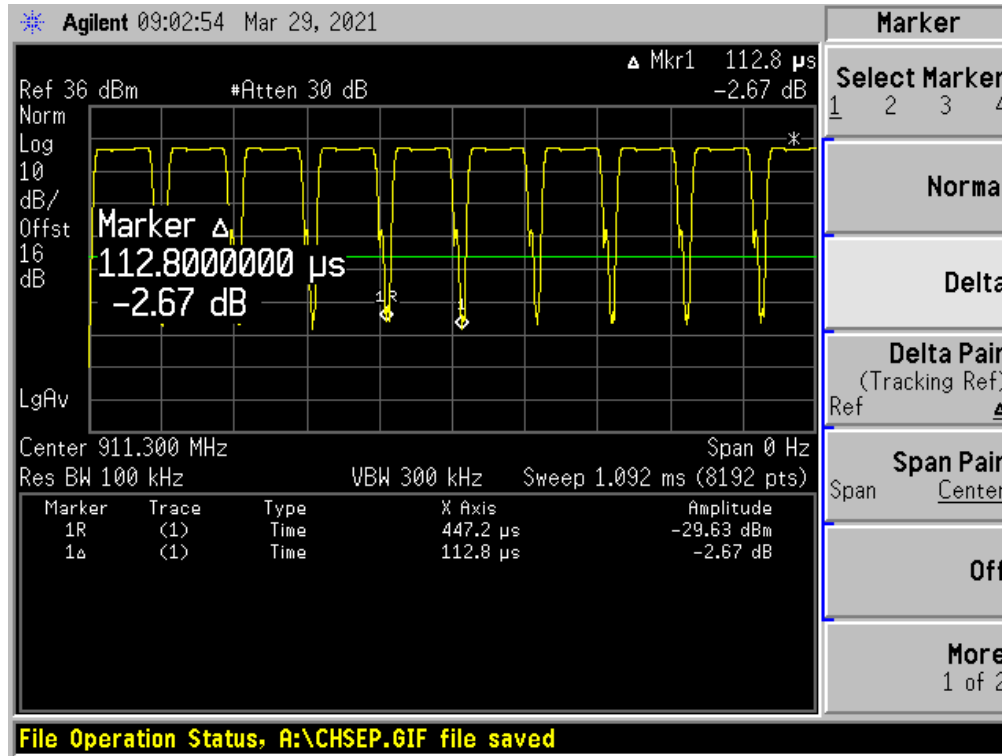
Number of Channels / Dwell Time

Modulation	Number of Channels	Dwell Time (us)
EA / 35 kbps	25	112.8

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Number of Channels



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Dwell Time


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4.6 RF Channel Separation – FCC: 15.247(a)(1) / ISED Canada: RSS-247 5.1(a)
4.6.1 Measurement Procedure

The RF Channel Separation was measured in accordance with the FCC KDB 558074 D01 Section 9 which references Subclause 7.8 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 Dwell Time. Worst-case data rate was determined by RF Conducted Output Power.

4.6.2 Measurement Results

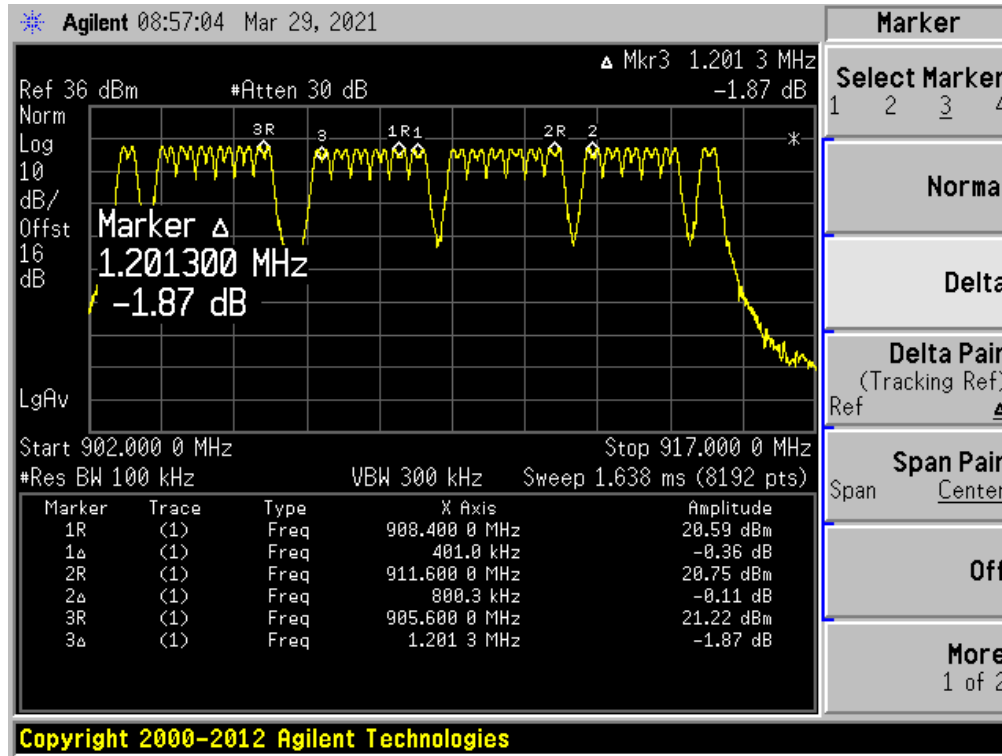
Performed by: Tyler Leeson

Number of Channels / Dwell Time

Modulation	RF Channel Separation
EA / 35 kbps	401 kHz

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RF Channel Separation

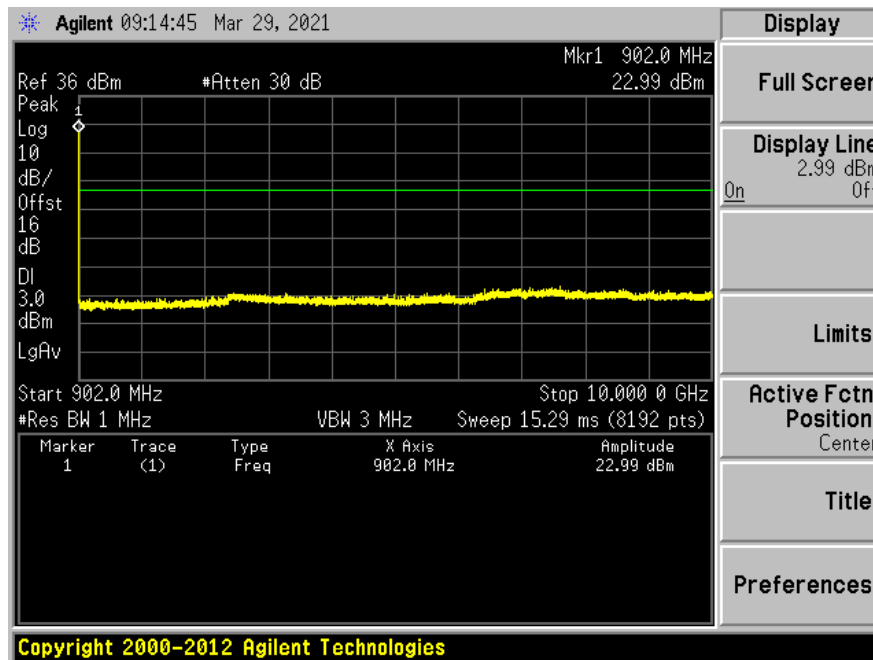


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4.7 Emission Levels
4.7.1 Emissions into Non-restricted Frequency Bands - FCC: 15.247(d); ISED Canada: RSS-247 5.5
4.7.1.1 Measurement Procedure

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 1 MHz. The Video Bandwidth (VBW) was set to ≥ 3 MHz. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit at the band edges. The spectrum span was then adjusted for the measurement of spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. The worst-case for each data rate was investigated at the lower and upper band edges.

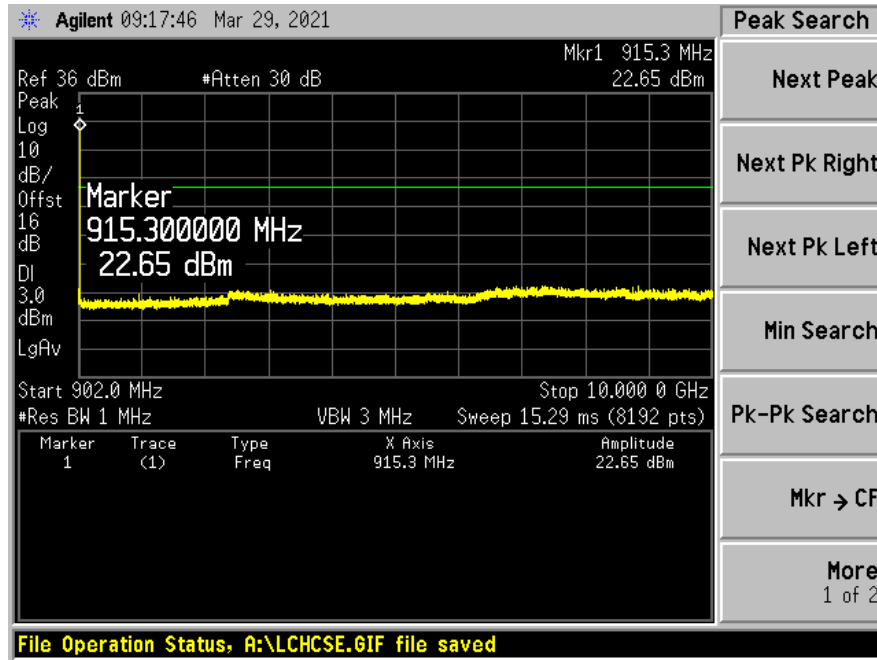
4.7.1.2 Measurement Results

Performed by: Tyler Leeson

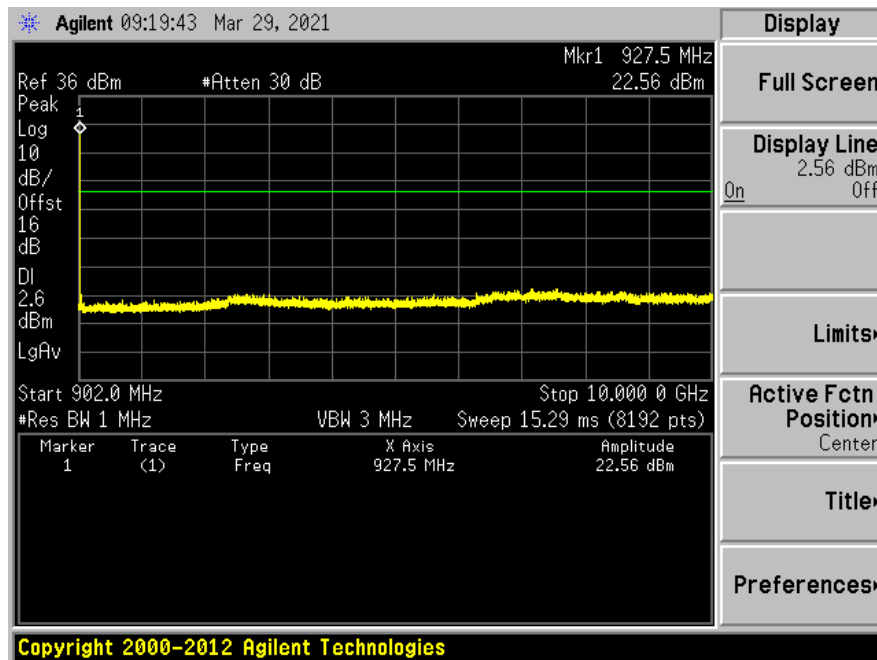
LCH - 30MHz-25GHz (1Mbps)


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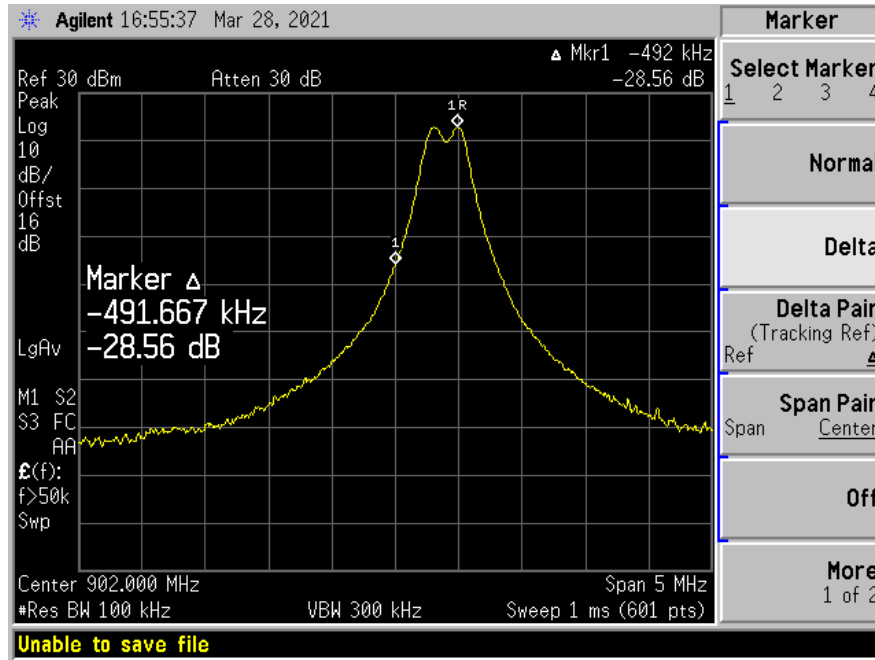
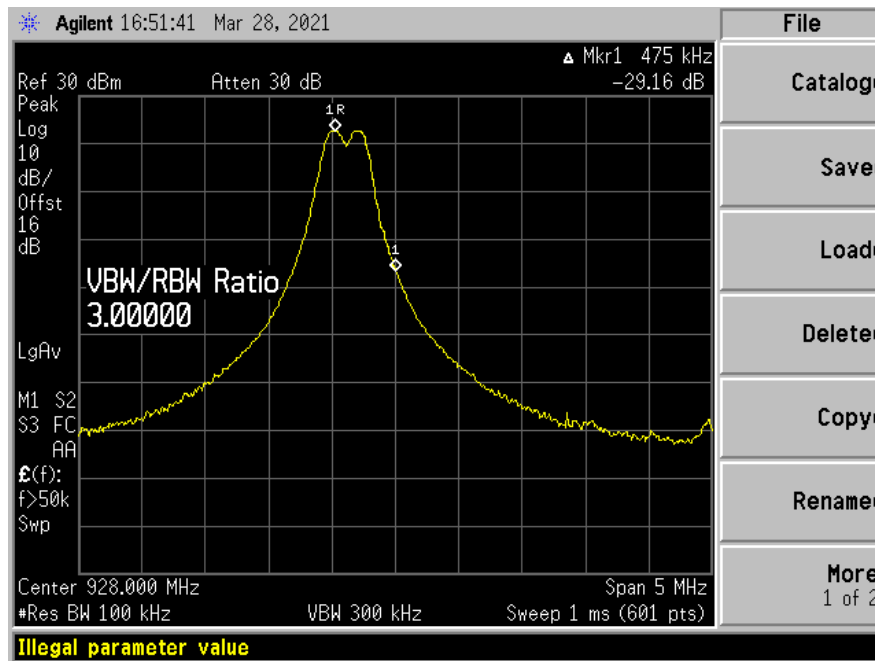
MCH - 30MHz-25GHz (1Mbps)



HCH - 30MHz-25GHz (1Mbps)



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Lower Band-edge (1Mbps)

Upper Band-edge (1Mbps)


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4.7.2 Emissions into Restricted Frequency Bands - FCC: 15.205, 15.209; ISED Canada: RSS-Gen 8.9 / 8.10**4.7.2.1 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.

For testing, worst case data rate was determined to be 35 kbps as per RF Conducted Output Power.

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4.7.2.2 Measurement Results

Performed by: Tyler Leeson

Radiated Spurious Emissions Tabulated Data

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
Channel 0 (2402MHz) 1Mbps										
2708.4	48.25	40.70	H	-4.75	43.50	35.95	74.0	54.0	30.50	18.05
2708.4	52.00	47.80	V	-4.75	47.25	43.05	74.0	54.0	26.75	10.95
3611.2	50.90	46.00	H	-1.28	49.62	44.72	74.0	54.0	24.38	9.28
3611.2	49.70	44.90	V	-1.28	48.42	43.62	74.0	54.0	25.58	10.38
4514	42.30	28.20	H	-0.01	42.29	28.19	74.0	54.0	31.71	25.81
4514	42.10	28.40	V	-0.01	42.09	28.39	74.0	54.0	31.91	25.61
5416.8	41.90	28.40	H	2.72	44.62	31.12	74.0	54.0	29.38	22.88
5416.8	41.30	28.60	V	2.72	44.02	31.32	74.0	54.0	29.98	22.68
915.2 MHz										
2745.6	49.40	42.70	H	-4.73	44.67	37.97	74.0	54.0	29.33	16.03
2745.6	52.10	47.90	V	-4.73	47.37	43.17	74.0	54.0	26.63	10.83
3660.8	51.20	47.30	H	-0.92	50.28	46.38	74.0	54.0	23.72	7.62
3660.8	52.50	48.90	V	-0.92	51.58	47.98	74.0	54.0	22.42	6.02
4576	51.30	47.40	H	0.22	51.52	47.62	74.0	54.0	22.48	6.38
4576	52.20	48.30	V	0.22	52.42	48.52	74.0	54.0	21.58	5.48
927.6 MHz										
2782.8	48.20	40.80	H	-4.66	43.54	36.14	74.0	54.0	30.46	17.86
2782.8	51.80	47.90	V	-4.66	47.14	43.24	74.0	54.0	26.86	10.76
3710.4	51.50	47.50	H	-0.64	50.86	46.86	74.0	54.0	23.14	7.14
3710.4	49.50	45.00	V	-0.64	48.86	44.36	74.0	54.0	25.14	9.64

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4.7.2.3 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 – 4576 MHz - Vertical

$$\begin{aligned} \text{Corrected Level: } & 52.2 + 0.22 = 52.42\text{dBuV/m} \\ \text{Margin: } & 74\text{dBuV/m} - 52.42\text{dBuV/m} = 21.58\text{dB} \end{aligned}$$

Example Calculation: Average – 4576 MHz - Vertical

$$\begin{aligned} \text{Corrected Level: } & 48.30 + 0.22 - 0 = 48.52\text{dBuV} \\ \text{Margin: } & 54\text{dBuV} - 48.52\text{dBuV} = 5.48\text{dB} \end{aligned}$$

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Section 5 – Estimation of Measurement Uncertainty

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

Estimation of Measurement Uncertainty

Parameter	ULab
Occupied Channel Bandwidth	±0.009%
RF Conducted Output Power	±0.689 dB
Power Spectral Density	±0.367 dB
Antenna Port Conducted Emissions	±2.717 dB
Radiated Emissions ≤ 1 GHz	±5.877 dB
Radiated Emissions > 1 GHz	±5.877 dB
Temperature	±0.860 °C
Radio Frequency	±2.832 x 10 ⁻⁸
AC Power Line Conducted Emissions	±1.90 dB

Section 6 – Conclusion

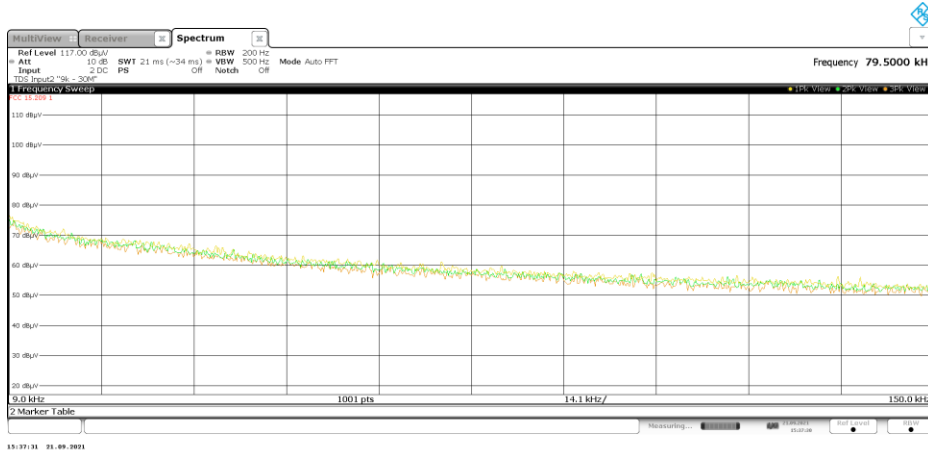
In the opinion of Keystone Compliance, LLC the A4MGK4, manufactured by Elster Solutions, LLC, meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247 for the tests documented herein.

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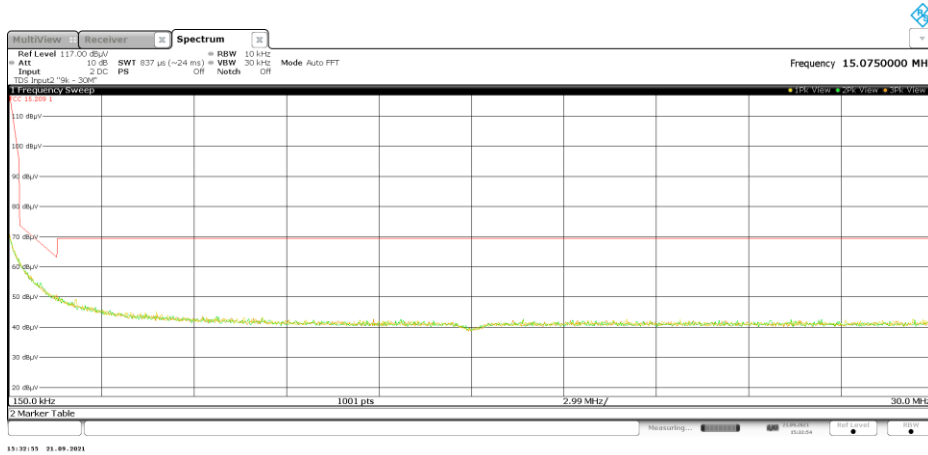
Appendix A: Plots

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9kHz-150kHz

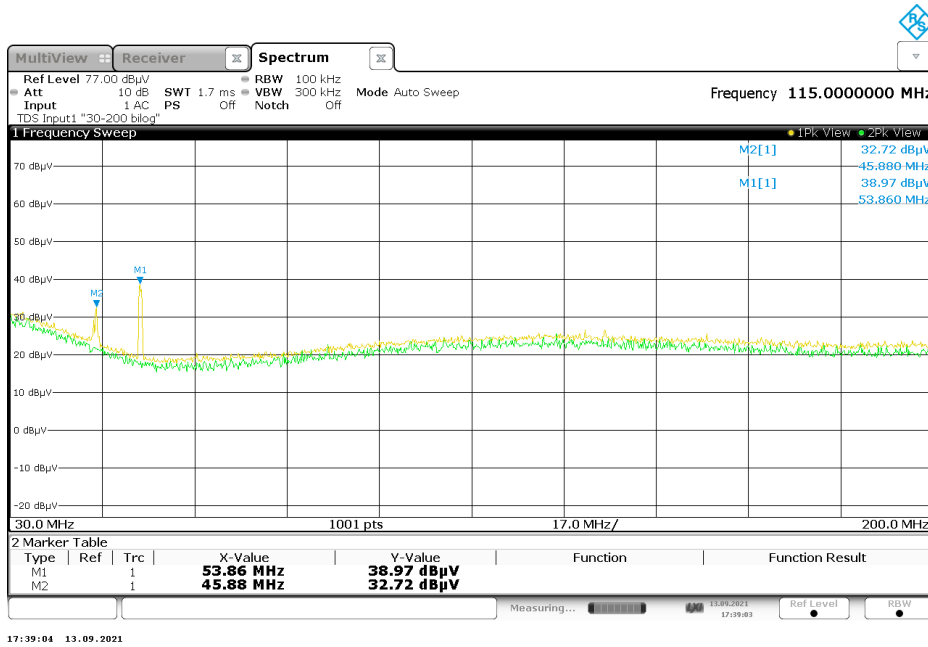


150kHz-30MHz

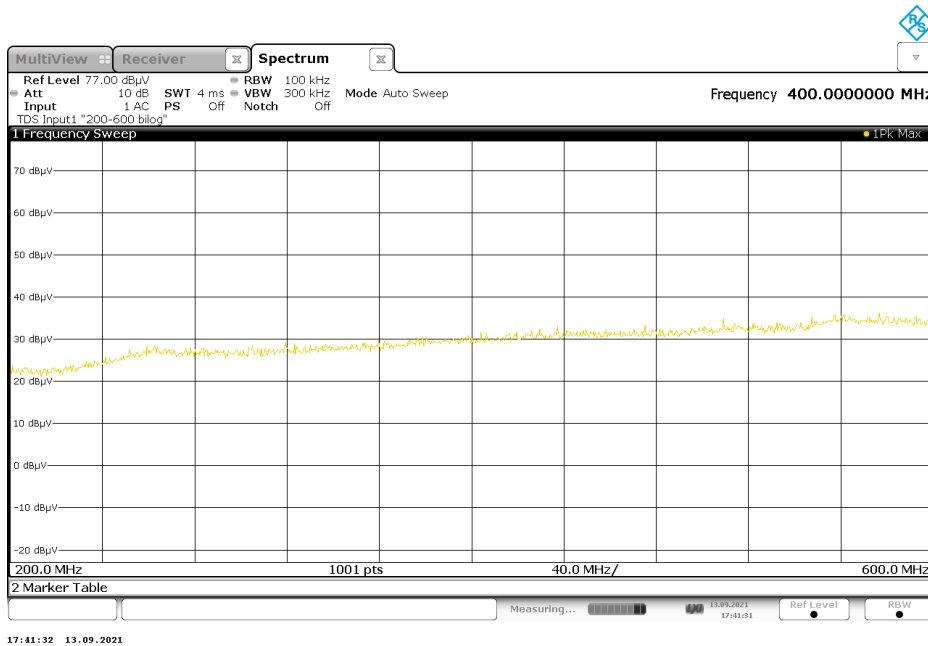


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30MHz-200MHz

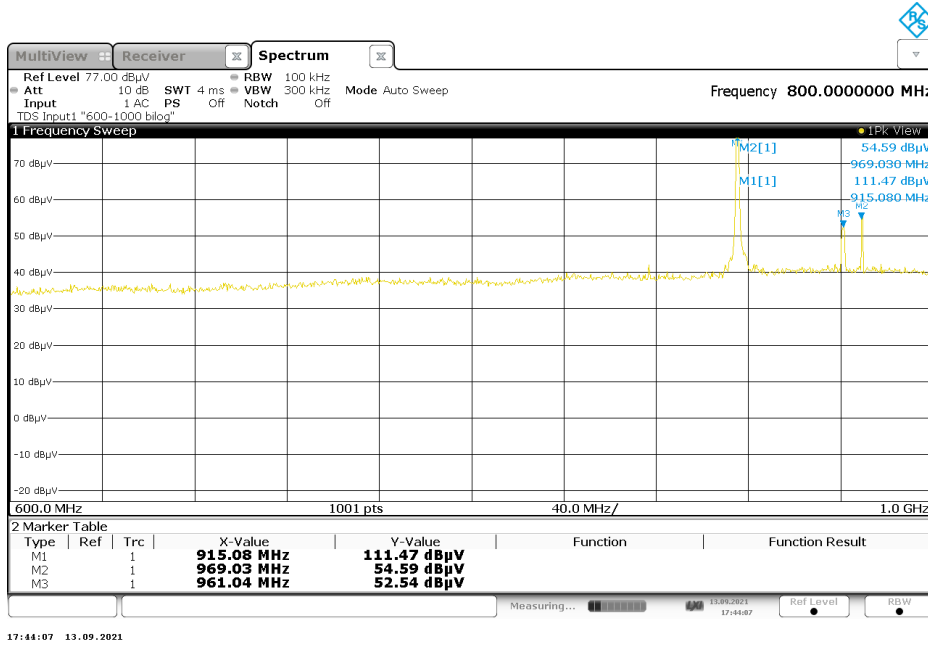


200MHz-600MHz

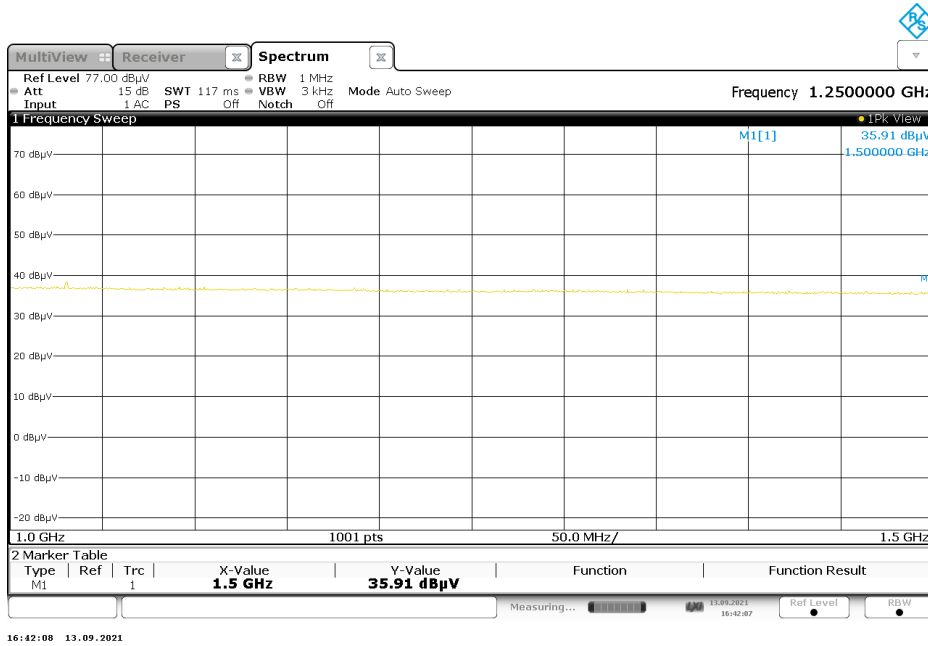


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600MHz-1GHz

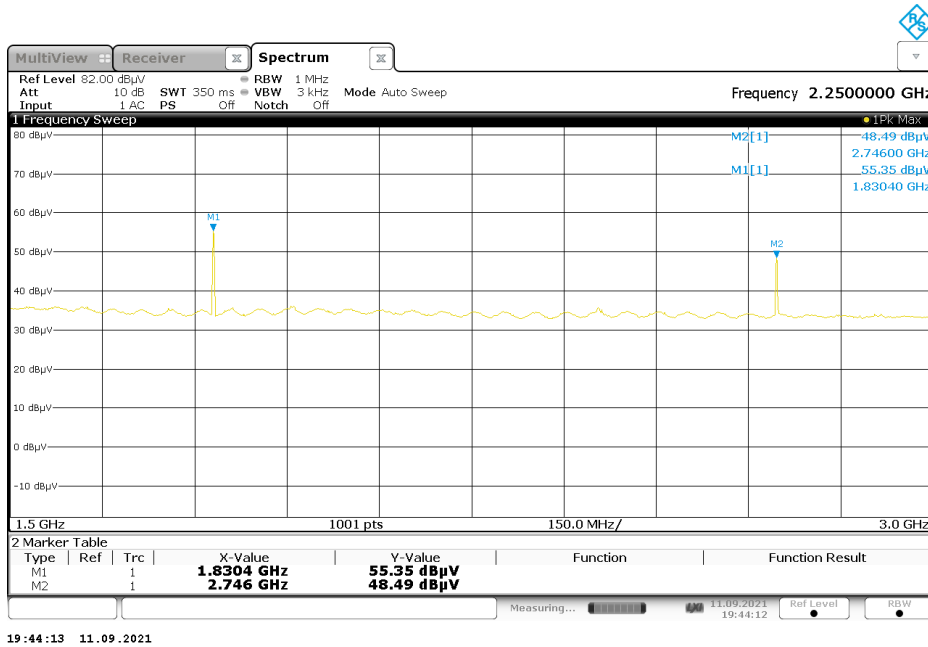


1GHz-1.5GHz

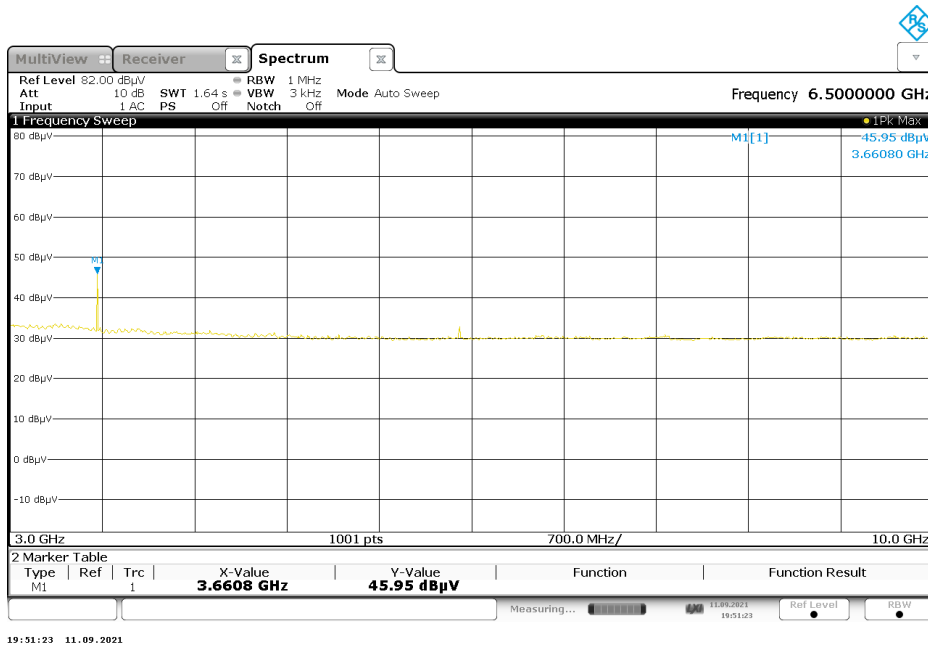


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1.5GHz-3GHz

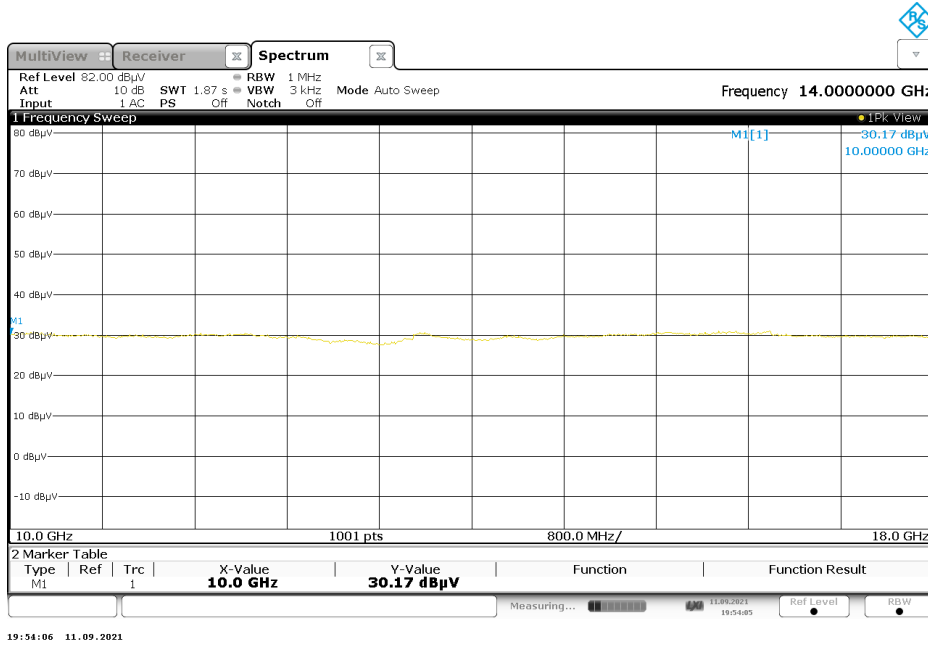


3GHz-10GHz



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10GHz-18GHz





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End of Report