Certification Test Report

FCC ID: 2AK2U-101-0001
IC: 24500-101001

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

TÜV SÜD Report Number: RD72134128.100

Manufacturer: Proaxion, Inc.
Model: 101-0001

Test Begin Date: January 17, 2018
Test End Date: March 14, 2018

Report Issue Date: November 30, 2018

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code AT-1921

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

Prepared by:

Jean Tezil
EMC Engineer
TÜV SÜD America, Inc.

Reviewed by:

Randle Sherian
Wireless Engineer
TÜV SÜD America, Inc.

2320 Presidential Dr Suite 101, Durham NC 27703-8077, Ph: 919-381-4235

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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 Radio Standards Specification: RSS-247 Certification.

1.2 Product Description

The Proaxion TACTIX (101-0001) is a Wireless vibration and temperature sensor. It measures the vibrations and temperature readings and stores them until it can report them to its master using a Bluetooth Low Energy transceiver. The TACTIX is battery-powered and is intended for permanent mounting on industrial machinery, such as motors or other machines.

Technical Information:

Details	Description
Frequency Range	2402-2480
Number of Channels	80
Modulation Format	GFSK
Data Rates	1 Mbps
Number of Inputs/Outputs	1T/1R
Operating Voltage	3.6-Internal Battery
Antenna Type / Gain	u/FL connector Trace Antenna/ 4 dBi

Manufacturer Information:
Proaxion, Inc.
2416 Castleburg Drive
Apex, NC 27523

EUT Serial Numbers: For Conducted measurements, D083 (2480MHz), D983 (2440MHz), and EF03 (2402 MHz). For Radiated measurements, E705 (2480MHz), ED83 (2440MHz), and F102 (2402MHz).

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

1.3 Test Methodology and Considerations

The BTLE transceiver was preconfigured by the client for each test. The nominal power setting of 0 dBm configured by the client was used along the entire test suite. The EUT was programmed to generate a continuously modulated signal on each channel investigated. This evaluation was performed using a unique modulation scheme and data rates as declared in the manufacturer provided documents supporting the present filing.

The EUT was evaluated in three orthogonal orientations to identify the worst-case configuration. The worst-case configuration was in the Z-orientation.

For RF conducted measurements, a u/fl to SMA short RF cable was used to tap into a connector on the RF board which provides connection to the Front-end of the transceiver.

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America Inc.
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ANAB program and has been issued certificate number AT-1921 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

FCC Registered Test Site Number: 637011
ISED Canada Test Site Registration Number: 20446

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 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.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

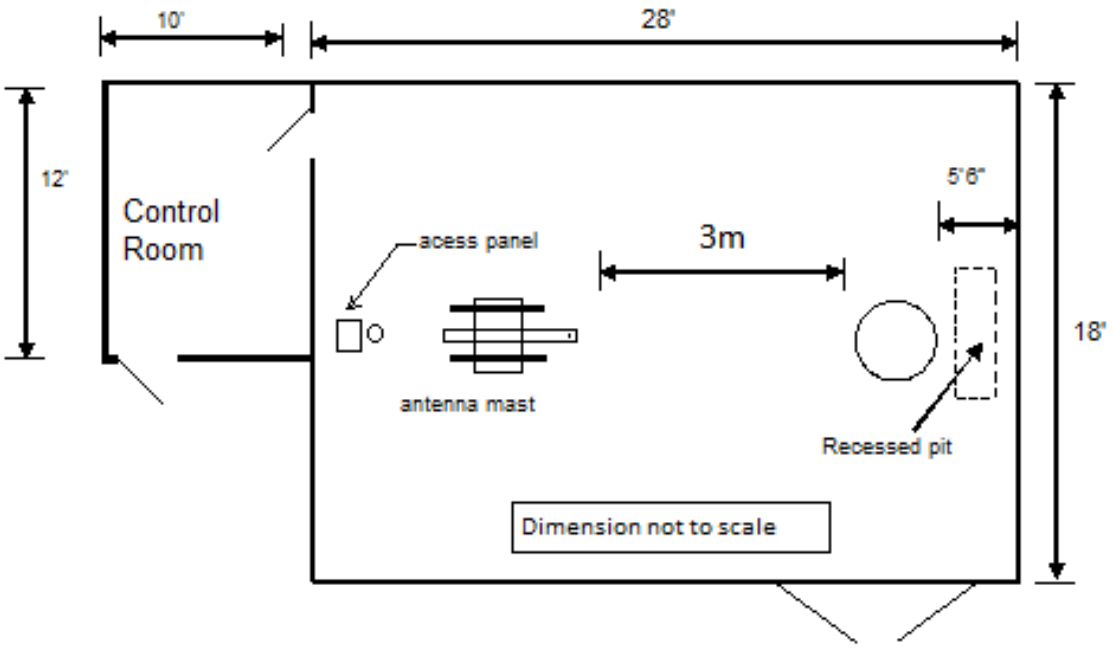

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 10' sheet galvanized steel horizontal ground reference plane (GRP) bonded every 6" to an 8' X 8' aluminum vertical ground plane.

A diagram of the room is shown below in figure 2.4-1:

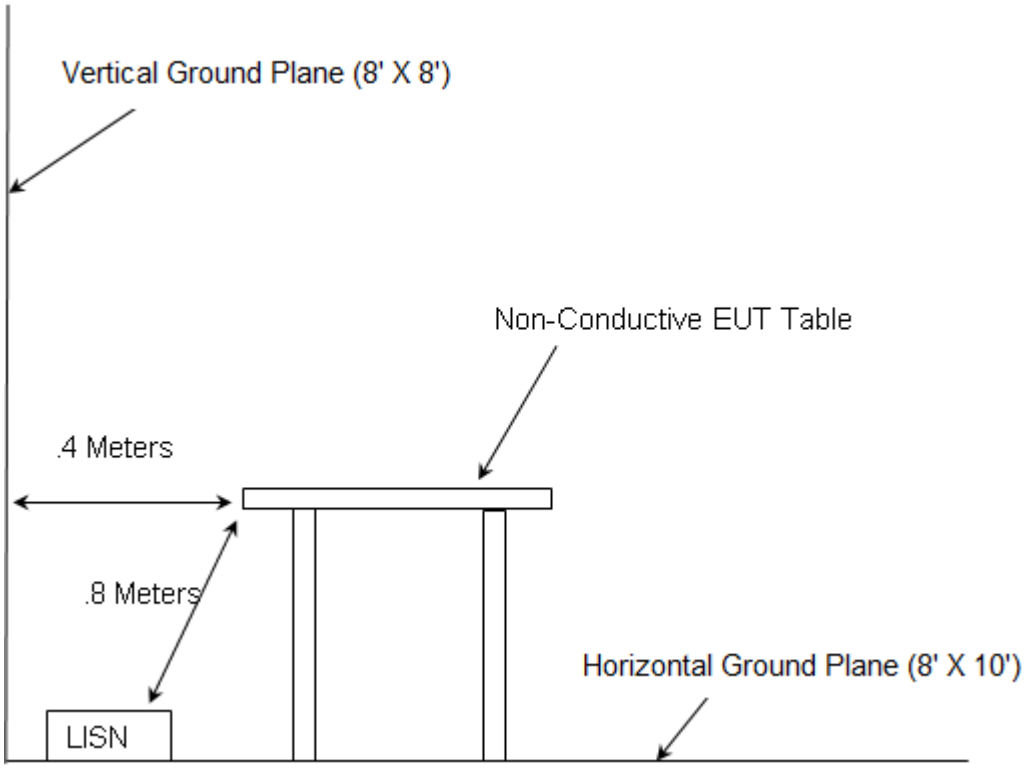

Figure 2.4-1: AC Mains Conducted EMI Site

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, 2017
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2017
- FCC KDB 558074 D01 DTS Meas Guidance v04 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 5, 2017
- 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 4, Nov 2014

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 #	Last Calibration Date	Calibration Due Date
DEMC0277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
DEMC0626	EMCO	3110B	Antennas	9411-1945	3/21/2017	3/21/2019
DEMC3002	Rohde & Schwarz	ESU40	Receiver	100346	7/24/2017	7/24/2018
DEMC3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	1/10/2018	1/10/2019
DEMC3007	Rohde & Schwarz	TS-PR26	Amplifiers	100051	1/10/2018	1/10/2019
DEMC3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
DEMC3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/26/2016	2/7/2020
DEMC3027	Micro-Tronics	BRM50702	Filter	175	1/7/2018	1/7/2019
DEMC3028	Micro-Tronics	HPM50111	Filter	122	1/7/2018	1/7/2019
DEMC3033	Hasco, Inc.	HLL142-S1-S1-36	Cables	1435	1/9/2018	1/9/2019
DEMC3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/5/2018	1/5/2019
DEMC3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/5/2018	1/5/2019
DEMC3042	Aeroflex Inmet	18N10W-10	Attenuator	1444	1/8/2018	1/8/2019
DEMC3046	Aeroflex Inmet	26AH-10	Attenuator	1443	1/9/2018	1/19/2019
DEMC3055	Rohde & Schwarz	3005	Cables	3055	1/8/2018	1/8/2019
DEMC3057	Advanced Technical Materials	42-441-6/BR	Antennas	R110602	NCR	NCR
DEMC3059	Mountain View Cable	A	Cables	3059	1/9/2018	1/9/2019
DEMC3085	Rohde & Schwarz	FSW43	Spectrum Analyzer	103997	6/9/2017	6/9/2018

NCR = No Calibration Required
DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.
Asset 3002: Firmware Version: ESU40 is 4.73 SP4
Asset 3012: Software Version: EMC32-B is 9.15
Asset 3085: Instrument Firmware 2.90 SP1

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Proaxion, Inc	101-0001	See EUT Serial Numbers

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

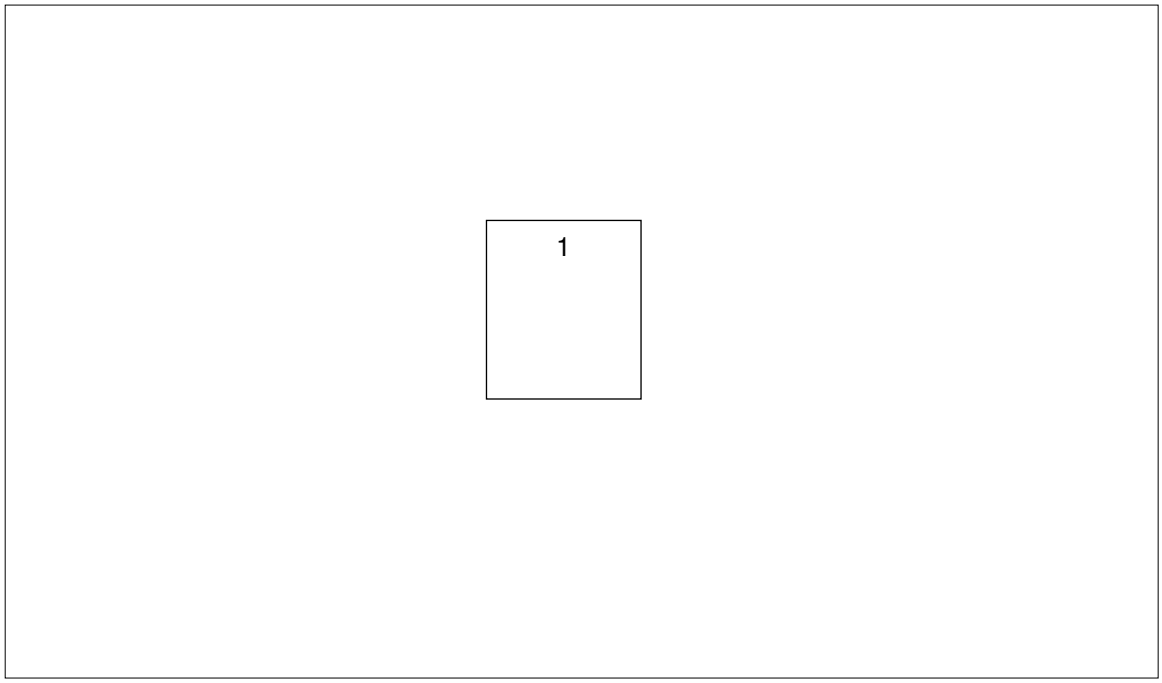

Figure 6-1: EUT Test Setup

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 antenna is connected to the RF output port of the EUT using a non-standard u/fl connector. Therefore, the antenna requirement stated in section 15.203 is met.

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

7.2.1 Measurement Procedure

Powerline Conducted Emissions testing was not performed due to this product utilizing an internal battery and never connected to the public AC power supply.

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

7.3.1 Measurement Procedure

The 6dB bandwidth was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04. 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 to 1% to 5% of the occupied bandwidth. The video bandwidth was set to 3 times the resolution bandwidth.

7.3.2 Measurement Results

Performed by: Jean Tezil

Table 7.3.2-1: 6dB / 99% Bandwidth

Frequency (MHz)	6dB Bandwidth (kHz)	99% Bandwidth (MHz)
2402	733	1.047
2440	735	1.065
2480	796.5	1.068

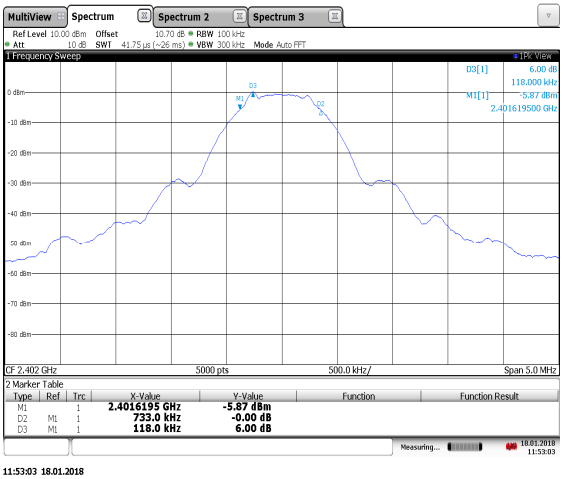

Figure 7.3.2-1: 6dB Bandwidth Low Channel

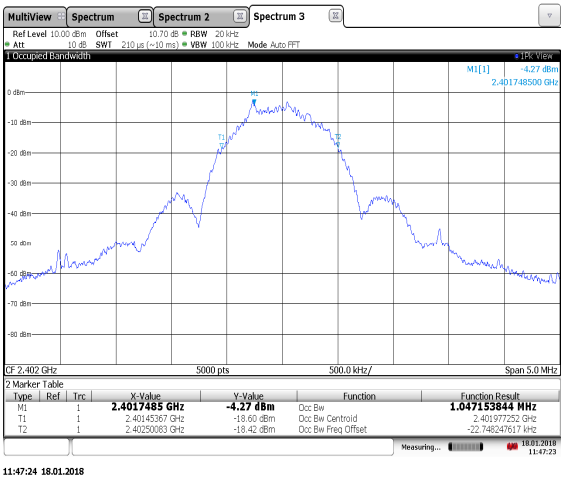

Figure 7.3.2-2: 99% Bandwidth Low Channel

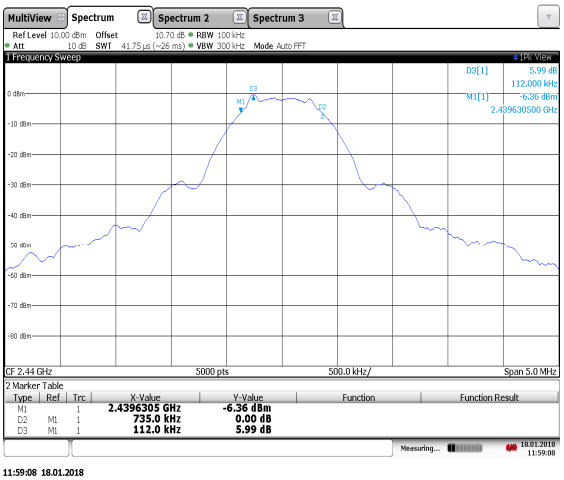

Figure 7.3.2-3: 6dB Bandwidth Mid Channel

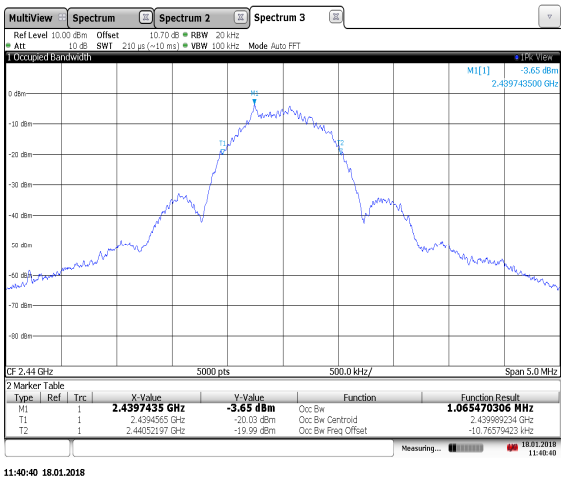

Figure 7.3.2-4: 99% Bandwidth Mid Channel

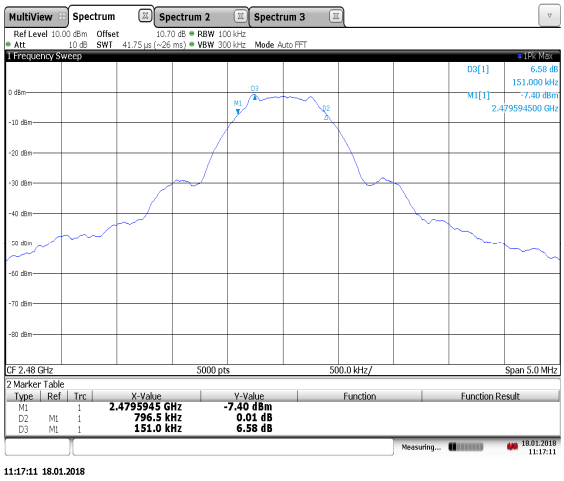

Figure 7.3.2-5: 6dB Bandwidth High Channel

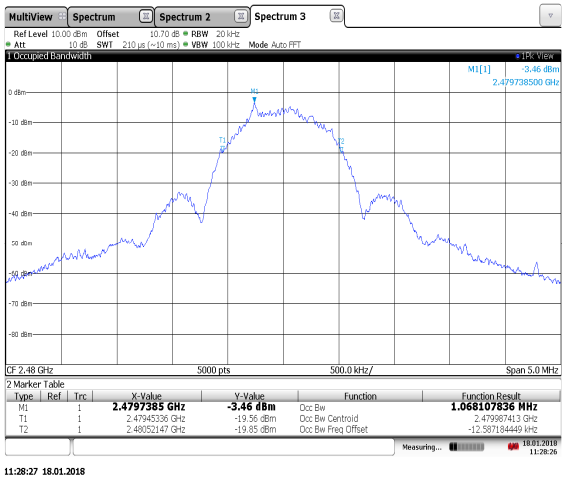

Figure 7.3.2-6: 99% Bandwidth High Channel

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

7.4.1 Maximum peak conducted output power - Measurement Procedure

The maximum peak conducted output power was measured in accordance with FCC KDB 558074 D01 DTS Measurement Guidance v04 utilizing the PKPM1 Peak power meter method. The RF output of the equipment under test was directly connected to the input of the peak power meter applying suitable attenuation.

7.4.2 Measurement Results

Performed by: Jean Tezil

Table 7.4.2-1: Maximum Peak Conducted Output Power

Frequency (MHz)	Output Power (dBm)
2402	4.62
2440	4.67
2480	4.41

7.5 Emission Levels – FCC: 15.247(d), 15.205, 15.209; ISED Canada RSS-247 5.5, RSS-Gen 8.9/8.10

7.5.1 Emissions into Non-Restricted Frequency Bands

7.5.1.1 Measurement Procedure

The unwanted emissions into non-restricted bands were measured conducted in accordance with FCC KDB 558074 D01 DTS Measurement Guidance v04. 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 trace was set to max hold with a peak detector active. The resulting spectrum analyzer peak level was used to determine the reference level with respect to the 20 dBc limit. The spectrum span was then adjusted for the measurement of spurious emissions from 30 MHz to 25GHz, 10 times the highest fundamental frequency.

Band-edge compliance was determined using the conducted marker-delta method in which the radio frequency power that is produced by the EUT is at least 20 dBc below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

7.5.1.2 Measurement Results

Performed by: Jean Tezil

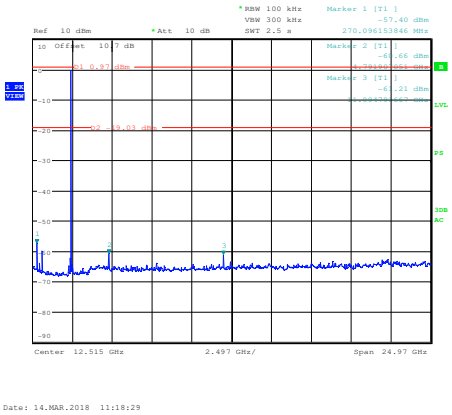

Figure 7.5.1.2-1: 30 MHz – 25 GHz – LCH

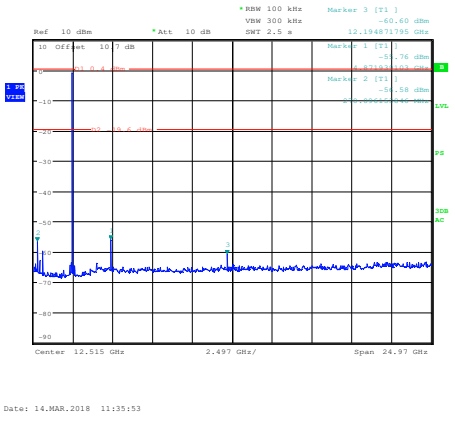

Figure 7.5.1.2-2: 30 MHz – 25 GHz – MCH

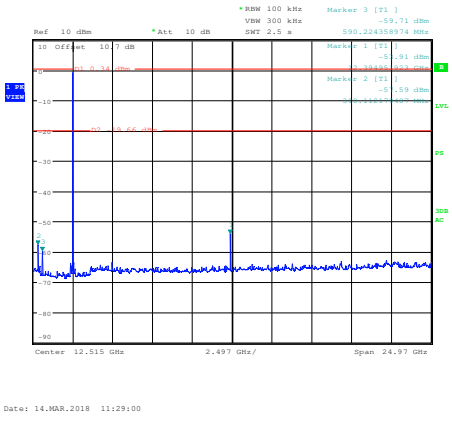

Figure 7.5.1.2-3: 30 MHz – 25 GHz – HCH

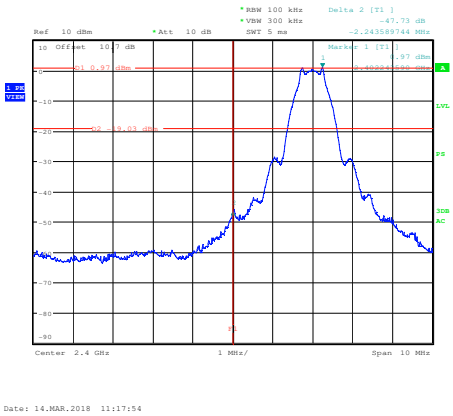

Figure 7.5.1.2-4: Lower Band-edge – LCH

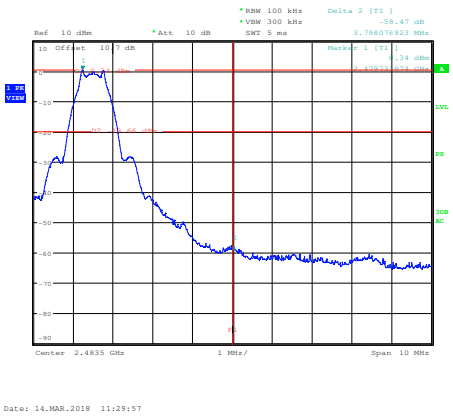

Figure 7.5.1.2-5: Upper Band-edge – HCH

7.6 Emissions into Restricted Frequency Bands

7.6.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated over the frequency range of 30MHz to 24GHz, 10 times the highest fundamental frequency.

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

7.6.1.1 Duty Cycle Correction

No Duty cycle was used during this evaluation.

7.6.1.2 Measurement Results

Performed by: Charles Callis

Table 7.6.1.2-1: Radiated Spurious Emissions Tabulated Data

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
Low Channel = 2402 MHz										
2390	58.10	44.60	H	-3.43	54.67	41.17	74.0	54.0	19.3	12.8
4804	41.70	31.90	H	3.64	45.34	35.54	74.0	54.0	28.7	18.5
4804	40.80	29.50	V	3.64	44.44	33.14	74.0	54.0	29.6	20.9
Middle Channel = 2440 MHz										
4880	44.80	31.20	H	3.60	48.40	34.80	74.0	54.0	25.6	19.2
4880	44.60	35.50	V	3.60	48.20	39.10	74.0	54.0	25.8	14.9
High Channel = 2480 MHz										
2483.5	58.50	44.70	H	-3.18	55.32	41.52	74.0	54.0	18.7	12.5
2483.5	58.80	44.90	V	-3.18	55.62	41.72	74.0	54.0	18.4	12.3
4960	42.80	32.30	H	3.54	46.34	35.84	74.0	54.0	27.7	18.2
4960	43.30	33.30	V	3.54	46.84	36.84	74.0	54.0	27.2	17.2

7.6.1.3 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

Corrected Level: 58.1 - 3.43 = 54.67 dBuV/m
Margin: 74dBuV/m – 54.67dBuV/m = 19.33dB

Example Calculation: Average

Corrected Level: 44.6 - 3.43= 41.17dBuV
Margin: 54dBuV – 41.17dBuV = 12.83dB

7.7 Power Spectral Density – FCC: 15.247(e); ISED Canada: RSS-247 5.2(b)

7.7.1 Measurement Procedure

The power spectral density was measured in accordance with the FCC KDB 558074 D01 DTS Meas Guidance v04 utilizing the PKPSD (peak PSD) method. 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 3 kHz. The Video Bandwidth (VBW) was set to 10 kHz. Span was set to 1.5 times the DTS bandwidth. The trace was set to max hold with a peak detector active.

7.7.2 Measurement Results

Performed by: Jean Tezil

Table 7.7.2-1: Peak Power Spectral Density

Frequency (MHz)	PSD Level (dBm)
2402	-9.17
2440	-9.78
2480	-9.85

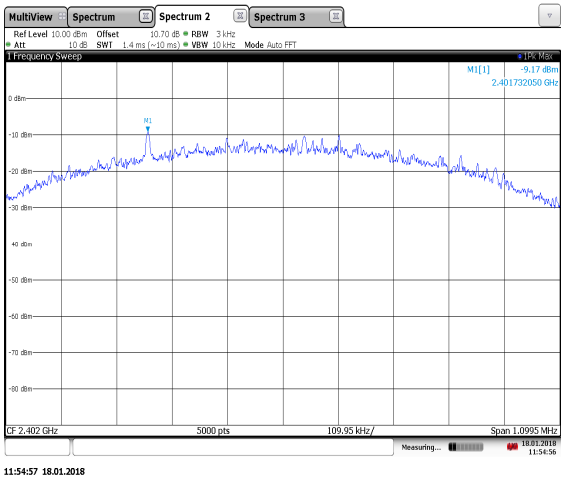

Figure 7.7.2-1: PSD Plot –LCH

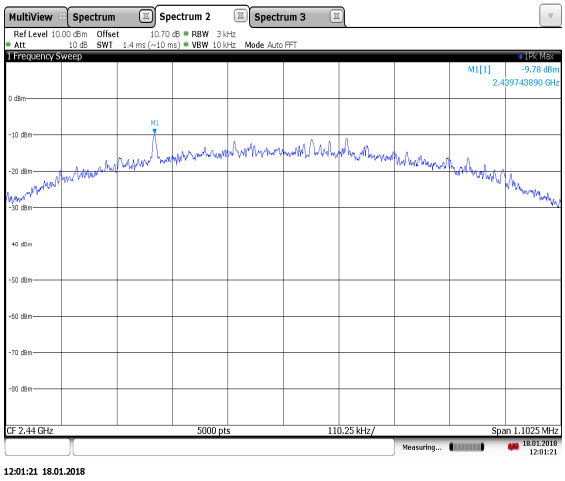

Figure 7.7.2-2: PSD Plot – MCH

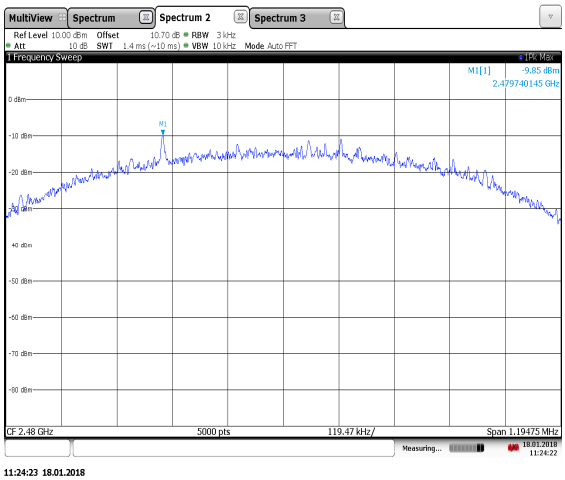

Figure 7.7.2-3: PSD Plot – HCH

8 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%.

Parameter	U_{lab}
Occupied Channel Bandwidth	**± 0.004%**
RF Conducted Output Power	**± 0.689 dB**
Power Spectral Density	**±0.5 dB**
Antenna Port Conducted Emissions	**± 2.717 dB**
Radiated Emissions	**± 5.877 dB**
Temperature	**± 0.860 °C**
Radio Frequency	**±2.832 x 10-8**
AC Power Line Conducted Emissions	**±2.85**

9 CONCLUSION

In the opinion of TÜV SÜD America Inc. the 101-0001, manufactured by Proaxion, Inc. meets the requirements of FCC Part 15 subpart C and ISED Canada Radio Standards Specification: RSS-247 for the tests documented herein.

END REPORT