Wireless Test Report

FCC ID: TMAELK-6051
IC: 4353A-6051

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

Report Number: RD72126638.100

Manufacturer: ELK Products, Inc.
Model: ELK-6051

Test Begin Date: May 08, 2017
Test End Date: May 10, 2017

Report Issue Date: May 16, 2017

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.

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This report contains 21 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 ISED Canada's Radio Standards Specification RSS-247 Certification.

1.2 Product description

The ELK-6051 CO detector contains a frequency hopping spread spectrum (FHSS) radio operating in the 902.8-927.2 MHz ISM frequency band. It also contains circuitry for application control and communications with the CO detector circuits. The transceiver utilizes the Silicon Labs, Si1000 MCU and Transceiver Processor on a daughter board that plugs into an Ei Electronics OEM CO (carbon dioxide) Detector housing.

The ELK-6051 CO detector is powered with two AAA batteries with a battery life of 3 to 5 years in normal operation. The batteries are located in the CO detector plastic housing. The CO detector circuit feeds the transceiver board with the 3 Volts of power from the batteries.

Technical Information:

Frequency Range (MHz)	Number of Channels	Data Rates Supported (kbps)
903.015 - 927.015	25	128 kbps

Modulation Format: GFSK
Operating Voltage: 3Vdc
Antenna Type: 22 AWG 6.9 cm Wire
Antenna Gain: 0 dBi

Manufacturer Information:
ELK Products, Inc.
3266 US Hwy70 West
Hildebran, NC 28637

EUT Serial Numbers: RF conducted emissions: TUV #1 , radiated emissions: TUV #2

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

1.3 Test Methodology and Considerations

The ELK-6051 radio transmits at a unique data rate set at 128kbps and at maximum power. The highest software power settings, which is level 7, was used during the test. The channels are changed through DIP switching on the module board using a 2-digit binary set. The low channel is selected with [00], mid [01], high [10], and hopping mode [11]. The EUT utilizes 25 hopping channels in the range from 903.015 MHz to 927.015 MHz.

For radiated emissions, the EUT was evaluated in three orthogonal orientations with the EUT set on the high channel. The worst-case orientation was the X-orientation.

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:

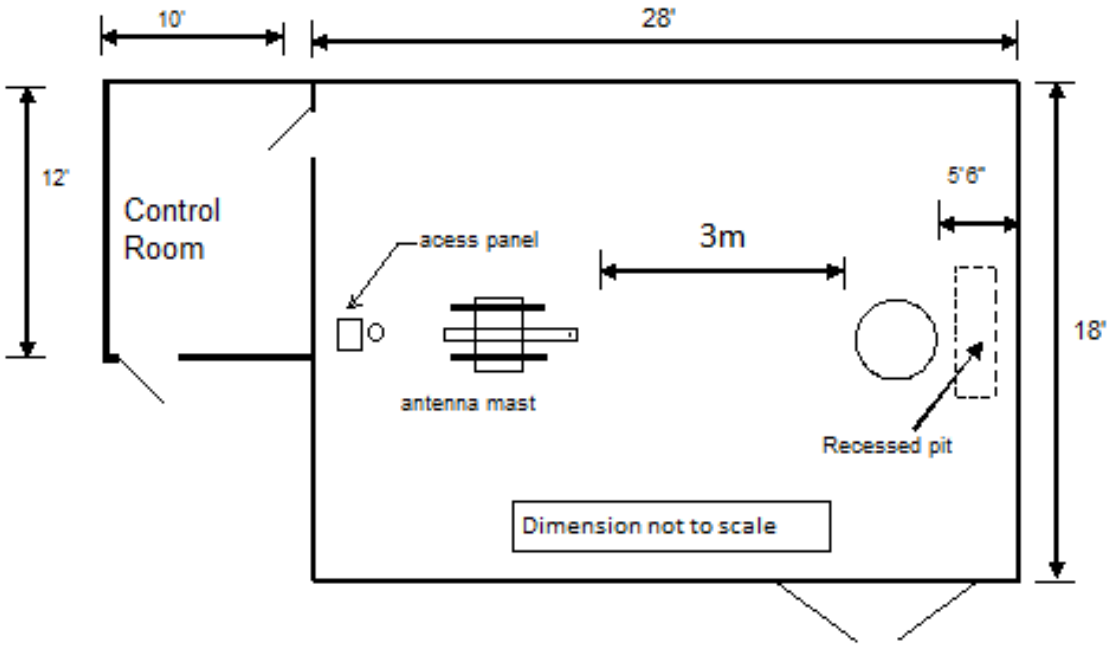

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

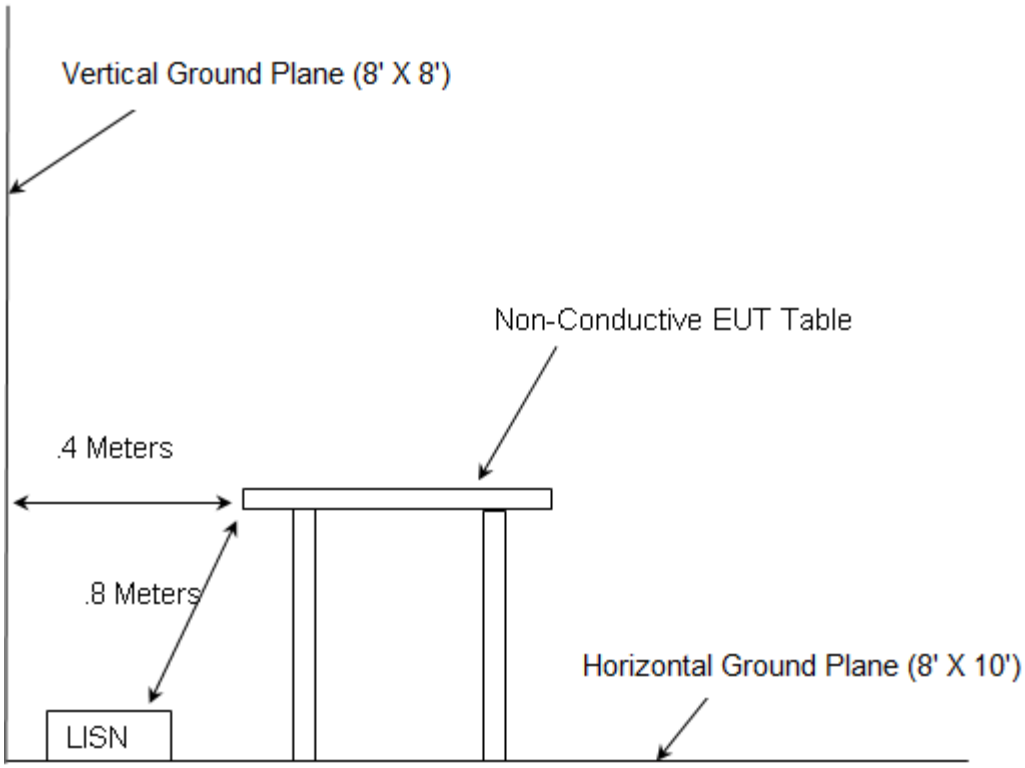

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2014: American National Standard for Methods of Measurement of Radio-Noise Emissions from low-voltage electrical and electronic equipment in the range of 9kHz to 40 GHz.
- 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 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2017
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2017
- ISED Canada Radio Standards Specification: RSS-247, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-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
277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
626	EMCO	3110B	Antennas	9411-1945	3/21/2017	3/21/2019
3002	Rohde & Schwarz	ESU40	Receiver	100346	1/12/2017	1/12/2018
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	1/11/2017	1/11/2018
3008	Rohde & Schwarz	NRP2	Meter	103131	2/6/2017	2/6/2018
3009	Rohde & Schwarz	NRP-Z81	Meter	102397	2/6/2017	2/6/2018
3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/26/2016	1/26/2018
3029	Micro-Tronics	HPM50108	Filter	134	1/13/2017	1/13/2018
3036	Hasco, Inc.	HLL142-S1-S1-24	Cables	2450	1/11/2017	1/11/2018
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/3/2017	1/3/2018
3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/3/2017	1/3/2018
3049	Aeroflex Inmet	26AH-20	Attenuator	1443	1/11/2017	1/11/2018
3055	Rohde & Schwarz	3005	Cables	3055	1/3/2017	1/3/2018
3085	Rohde & Schwarz	FSW43	Spectrum Analyzer	103997	8/9/2016	8/9/2017

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 2.41 SP1

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	ELK Products	ELK-6051	TUV #1, TUV #2

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

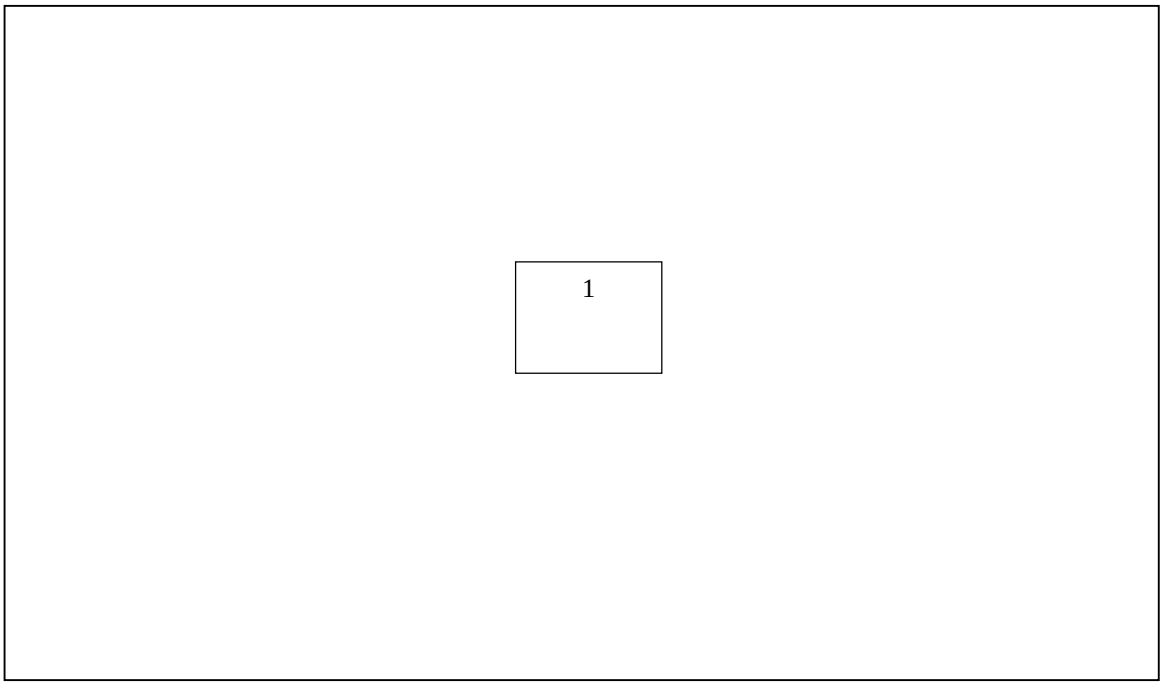

Figure 6-1: Test Setup Block Diagram

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: 15.203

The Antenna is a wire soldered to the module board which satifies the requirements in FCC Part 15.203.

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

The EUT can only be powered via batteries. Therefore, AC powerline conducted emissions evaluation is not required.

7.3 Peak Output Power – FCC: 15.247(b)(2); ISED Canada: RSS-247 5.4(a)

7.3.1 Measurement Procedure (Conducted Method)

The RF output port of the EUT was directly connected to the input of a RF power meter using suitable attenuation. The device employs < 50 channels at any given time therefore the power is limited to 0.25 Watt.

7.3.2 Measurement Results

Performed by: Jean Tezil

Table 7.3.2-1: RF Output Power

Frequency (MHz)	Level (dBm)
903.015	19.34
915.015	19.01
927.015	18.47

7.4 Channel Usage Requirements

7.4.1 Carrier Frequency Separation – FCC: 15.247(a)(1); ISED Canada: RSS-247 5.1(b)

7.4.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks. The RBW was set to approximately 30% of the channel spacing and adjusted as necessary to best identify the center of each channel. The VBW was set equal to the RBW.

7.4.1.2 Measurement Results

Performed by: Jean Tezil

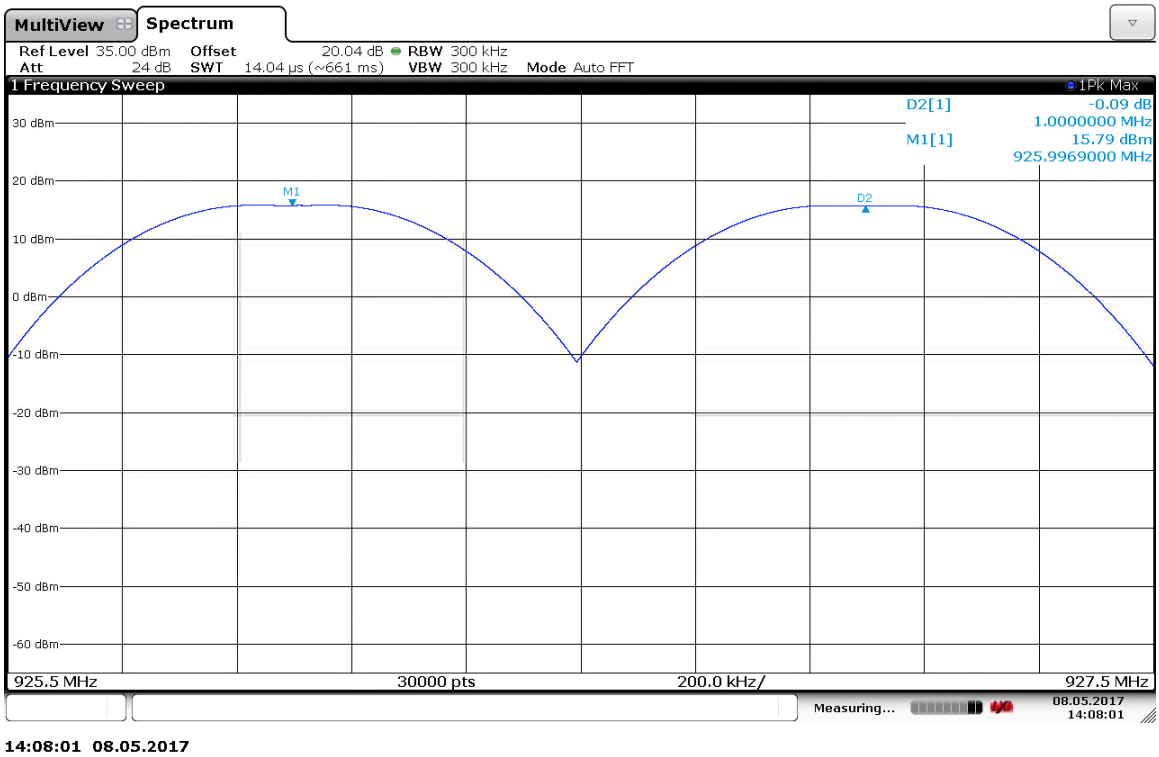

Figure 7.4.1.2-1: Carrier Frequency Separation

7.4.2 Number of Hopping Channels – FCC: 15.247(a)(1)(i); ISED Canada: RSS-247 5.1(c)

7.4.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer was set wide enough to capture the frequency band of operation. The RBW was set to < 30% of the channel spacing and VBW set to ≥ RBW.

7.4.2.2 Measurement Results

Performed by: Jean Tezil

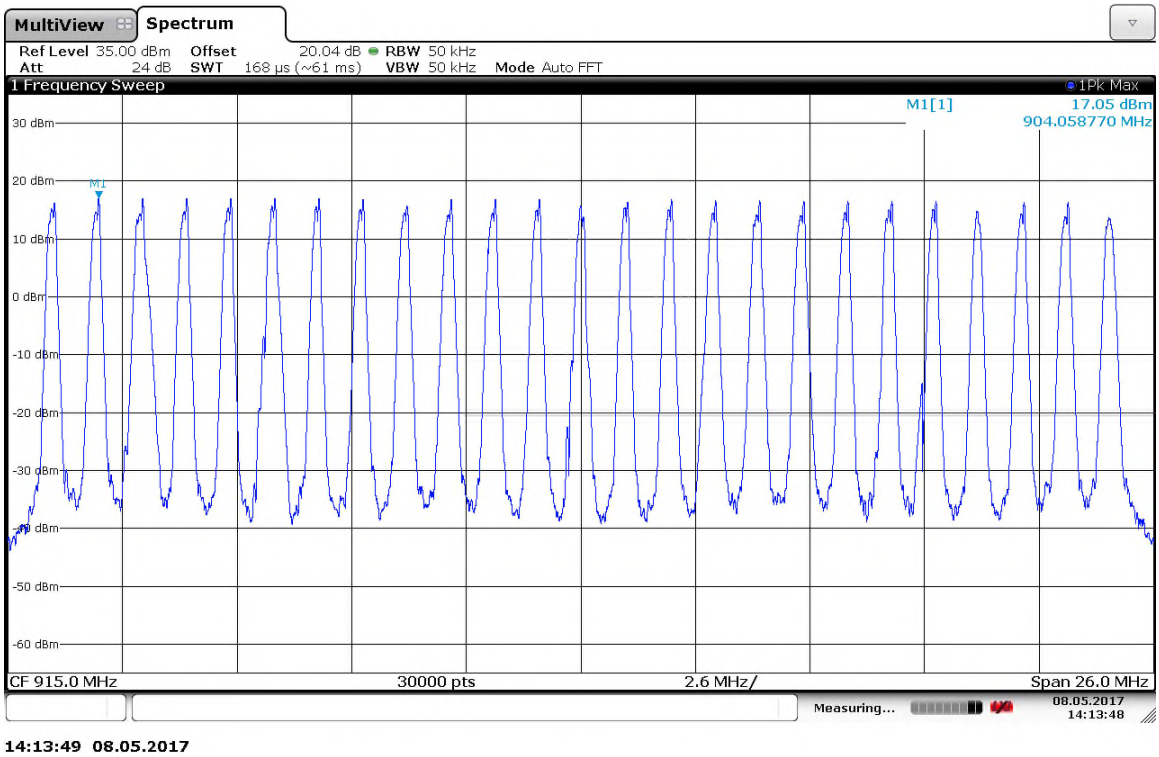

Figure 7.4.2.2-1: Number of Hopping Channels

7.4.3 Channel Dwell Time – FCC: 15.247(a)(1)(i); ISED Canada: RSS-247 5.1(c)

7.4.3.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The span of the spectrum analyzer display was set 0 Hz centered on a hopping channel. The RBW of the spectrum analyzer was set to ≤ the EUT channel spacing and VBW set to ≥ RBW. The Marker Delta function of the analyzer was utilized to determine the dwell time.

7.4.3.2 Measurement Results

Performed by: Jean Tezil

Table 7.4.3.2-1: Channel Dwell Time (10 Second Sweep)

Single Occurrence	Number of Occurrences	Total Dwell Time (ms)
13.63 ms	29	395.27 ms

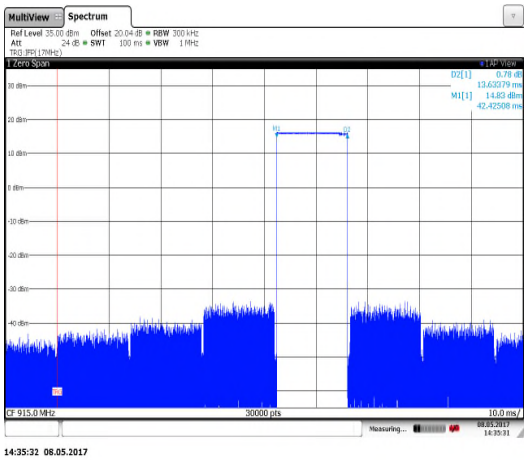

Figure 7.4.3.2-1: Dwell Time

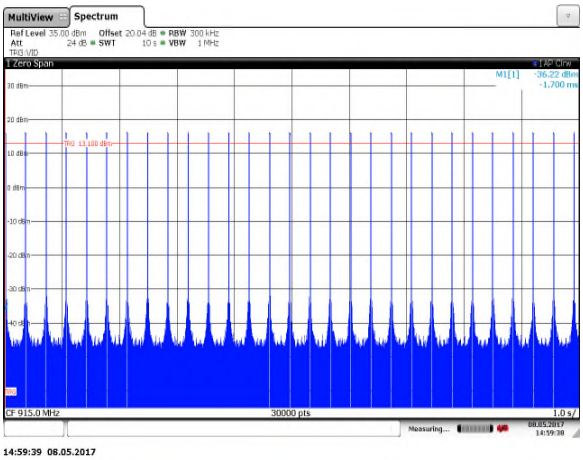

Figure 7.4.3.2-2: Number of Occurrences

7.4.4 20dB / 99% Bandwidth – FCC: 15.247(a)(1)(i), ISED Canada: RSS-247 5.1(c)

7.4.4.1 Measurement Procedure

The EUT was set on a tabletop inside a 3 meter chamber, and a receive antenna connected to the input of the spectrum analyzer was used. The span of the spectrum analyzer display was set between two times and five times the occupied bandwidth (OBW) of the emission. The RBW of the spectrum analyzer was set to approximately 1 % to 5 % of the OBW. The trace was set to max hold with a peak detector active. The marker delta measurement function of the analyzer was utilized to determine the 20 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. A peak detector was used.

7.4.4.2 Measurement Results

Performed by: Jean Tezil

Table 7.4.4.2-1: 20dB / 99% Bandwidth

Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
903.015	272.24	342.00
915.015	263.25	308.00
927.015	274.84	269.00

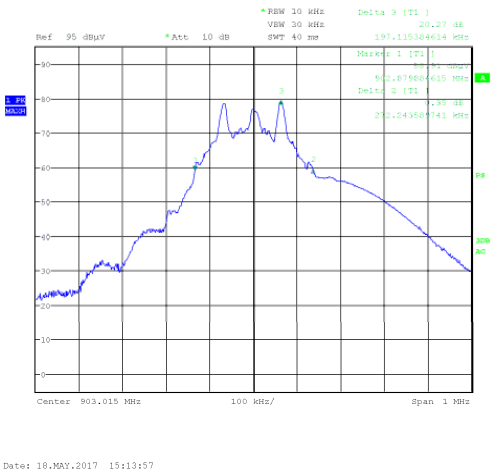

Figure 7.4.4.2-1: 20dB BW Low Channel

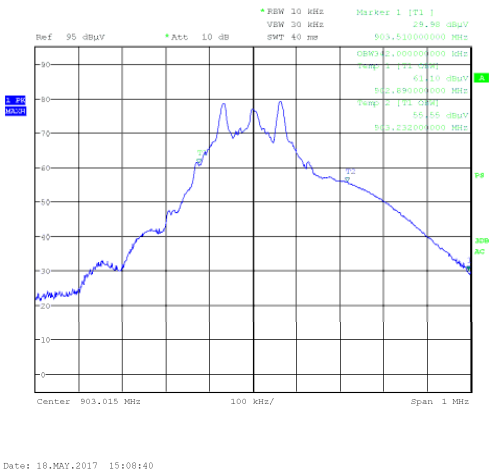

Figure 7.4.4.2-2: 99% OBW Low Channel

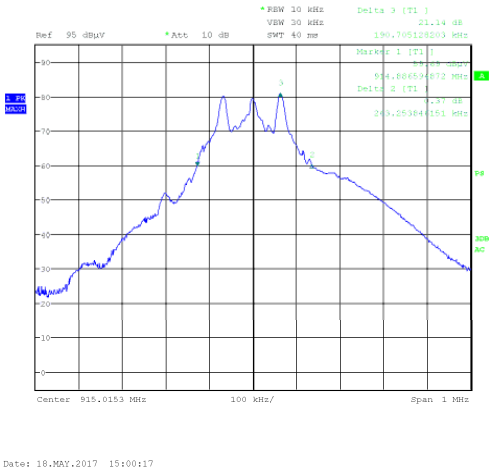

Figure 7.4.4.2-3: 20dB BW Mid Channel

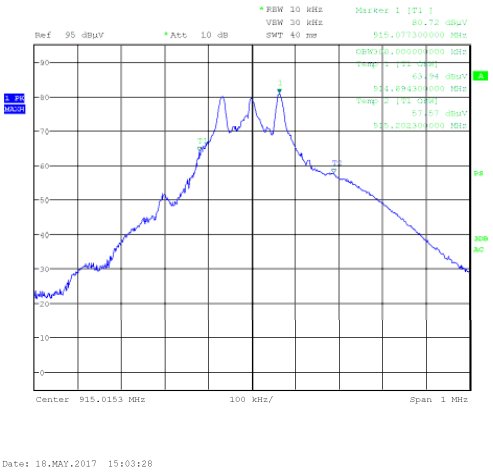

Figure 7.4.4.2-4: 99% OBW Mid Channel

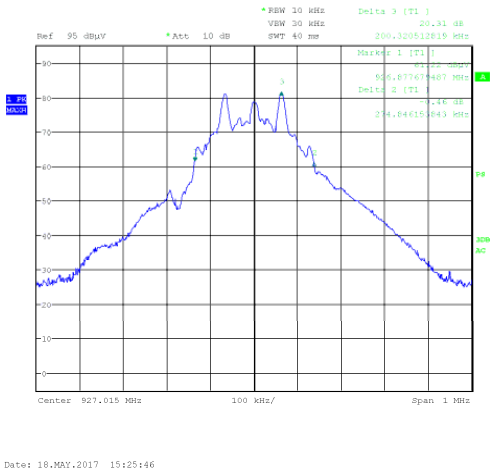

Figure 7.4.4.2-5: 20dB BW High Channel

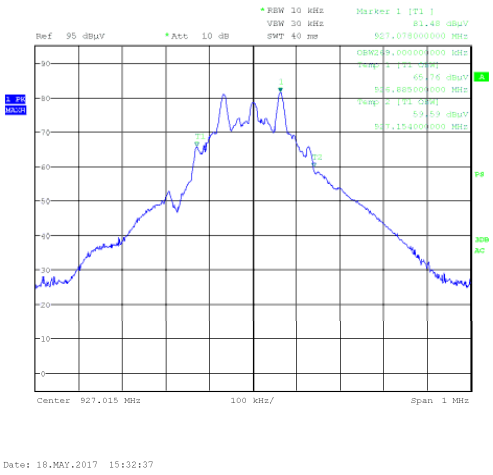

Figure 7.4.4.2-6: 99% OBW High Channel

7.5 Band-Edge Compliance and Spurious Emissions

7.5.1 Band-Edge Compliance of RF Conducted Emissions – FCC: 15.247(d); ISED Canada RSS-247 5.5

7.5.1.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement, the spectrum analyzer's RBW was set to 100 kHz, and the VBW was set to 300 kHz.

7.5.1.2 Measurement Results

Performed by: Jean Tezil

NON-HOPPING MODE:

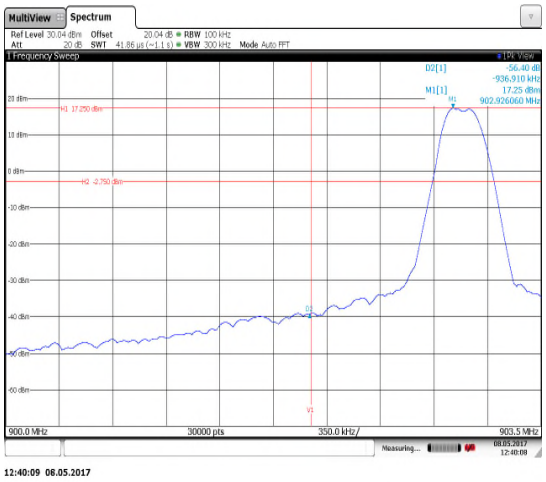

Figure 7.5.1.2-1: Lower Band-edge

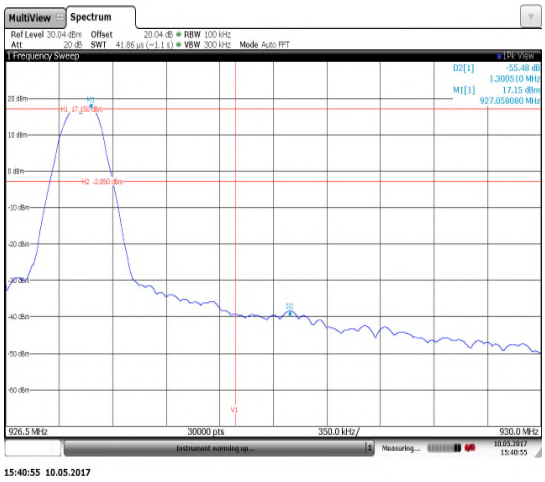

Figure 7.5.1.2-2: Upper Band-edge

HOPPING MODE:

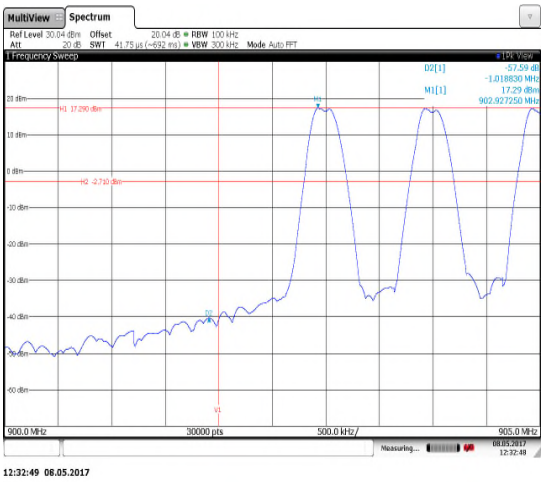

Figure 7.5.1.2-3: Lower Band-edge

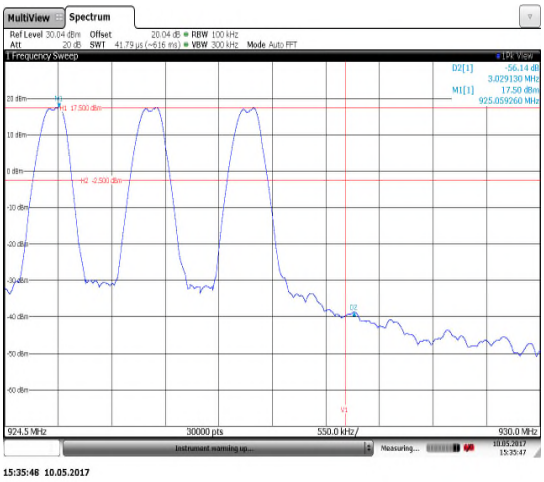

Figure 7.5.1.2-4: Upper Band-edge

7.5.2 RF Conducted Spurious Emissions – FCC: 15.247(d); ISED Canada RSS-247 5.5

7.5.2.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer using suitable attenuation. The EUT was investigated for conducted spurious emissions from 30MHz to 10GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100kHz. A peak detector function was used with the trace set to max hold.

7.5.2.2 Measurement Results

Performed by: Jean Tezil

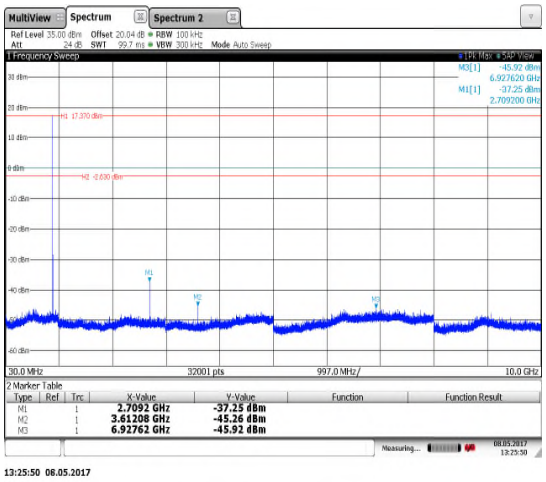

Figure 7.5.2.2-1: 30MHz–10GHz Low Channel

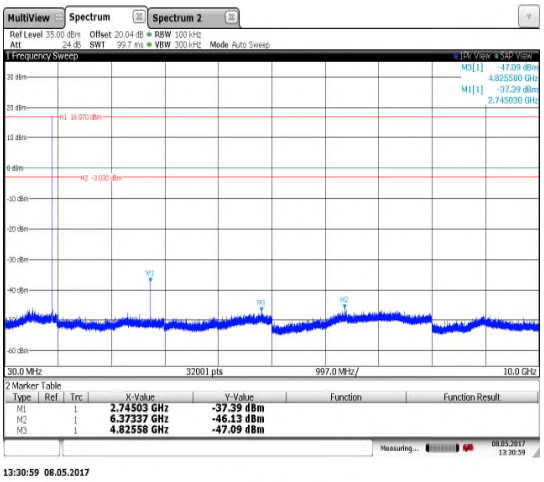

Figure 7.5.2.2-2: 30MHz–10GHz Mid Channel

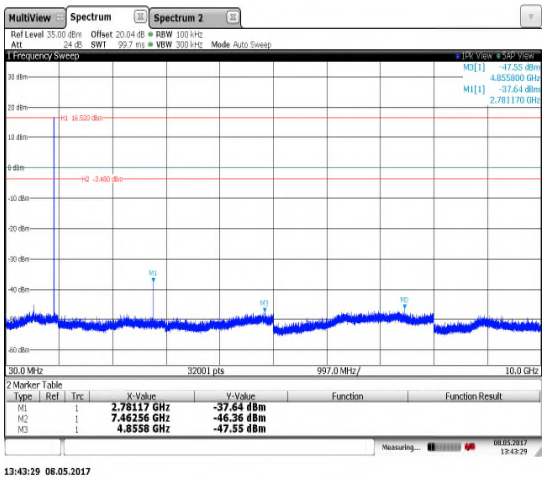

Figure 7.5.2.2-3: 30MHz–10GHz High Channel

7.5.3 Radiated Spurious Emissions – FCC: 15.205, 15.209; RSS-Gen 8.9/8.10

7.5.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 10GHz, 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 resolution bandwidth RBW of 120kHz and a video bandwidth VBW of 300kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1MHz and 3MHz respectively.

The EUT was caused to generate a continuous modulated carrier on the hopping channel.

Each emission found to be in a restricted band was compared to the applicable radiated emission limits.

7.5.3.2 Duty Cycle Correction

For average radiated measurements, using a 13.44% duty cycle, the measured level was reduced by a factor 17.432 dB. The duty cycle correction factor is determined using the formula: 20log (13.44/100) = - 17.432 dB.

A detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying the application for certification.

7.5.3.3 Measurement Results

Performed by: Jean Tezil

Table 7.5.3.3-1: Radiated Spurious Emissions Tabulated

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										
2708.901	60.90	59.50	H	-2.44	58.46	39.62	74.0	54.0	15.5	14.4
2708.901	63.60	62.00	V	-2.44	61.16	42.12	74.0	54.0	12.8	11.9
3611.868	64.70	63.10	H	0.94	65.64	46.61	74.0	54.0	8.4	7.4
3611.868	63.50	61.70	V	0.94	64.44	45.21	74.0	54.0	9.6	8.8
4514.835	57.50	55.20	H	3.55	61.05	41.32	74.0	54.0	12.9	12.7
4514.835	59.30	55.70	V	3.55	62.85	41.82	74.0	54.0	11.1	12.2
5417.802	56.20	53.10	H	4.02	60.22	39.68	74.0	54.0	13.8	14.3
5417.802	58.63	55.60	V	4.02	62.65	42.18	74.0	54.0	11.4	11.8
8126.703	42.90	34.70	H	9.75	52.65	27.02	74.0	54.0	21.3	27.0
8126.703	46.40	39.70	V	9.75	56.15	32.02	74.0	54.0	17.8	22.0
9029.67	43.20	33.90	H	11.61	54.81	28.08	74.0	54.0	19.2	25.9
9029.67	49.80	41.00	V	11.61	61.41	35.18	74.0	54.0	12.6	18.8
Middle Channel										
2745	60.50	58.70	H	-2.35	58.15	38.92	74.0	54.0	15.8	15.1
2745	64.10	63.10	V	-2.35	61.75	43.32	74.0	54.0	12.2	10.7
3660	64.49	63.30	H	1.09	65.58	46.95	74.0	54.0	8.4	7.0
3660	63.70	62.30	V	1.09	64.79	45.95	74.0	54.0	9.2	8.0
4575	56.40	54.30	H	3.54	59.94	40.41	74.0	54.0	14.1	13.6
4575	58.90	55.50	V	3.54	62.44	41.61	74.0	54.0	11.6	12.4
7320	43.20	33.80	H	7.67	50.87	24.03	74.0	54.0	23.1	30.0
7320	43.20	35.20	V	7.67	50.87	25.43	74.0	54.0	23.1	28.6
8235	43.40	35.30	H	10.23	53.63	28.10	74.0	54.0	20.4	25.9
8235	46.30	40.10	V	10.23	56.53	32.90	74.0	54.0	17.5	21.1
9150	41.80	34.00	H	11.23	53.03	27.80	74.0	54.0	21.0	26.2
9150	47.10	40.50	V	11.23	58.33	34.30	74.0	54.0	15.7	19.7
High Channel										
2781	60.10	58.20	H	-2.25	57.85	38.52	74.0	54.0	16.1	15.5
2781	64.10	62.80	V	-2.25	61.85	43.12	74.0	54.0	12.1	10.9
3708	62.60	60.70	H	1.23	63.83	44.50	74.0	54.0	10.2	9.5
3708	62.70	60.80	V	1.23	63.93	44.60	74.0	54.0	10.1	9.4
4635	57.90	55.20	H	3.52	61.42	41.29	74.0	54.0	12.6	12.7
4635	59.20	56.50	V	3.52	62.72	42.59	74.0	54.0	11.3	11.4
7416	45.50	38.30	H	8.16	53.66	29.03	74.0	54.0	20.3	25.0
7416	46.70	39.80	V	8.16	54.86	30.53	74.0	54.0	19.1	23.5
8343	43.30	34.40	H	10.70	54.00	27.67	74.0	54.0	20.0	26.3
8343	48.40	41.40	V	10.70	59.10	34.67	74.0	54.0	14.9	19.3

Note: Duty Cycle correction factor used: 13.44%

7.5.3.4 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: 60.90 - 2.44 = 58.46dBuV/m
Margin: 74dBuV/m – 58.46dBuV/m = 15.54dB

Example Calculation: Average

Corrected Level: 59.5 - 2.44 – 17.432 = 39.62dBuV
Margin: 54dBuV – 39.62dBuV = 14.38dB

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 ELK-6051, manufactured by ELK Products, Inc. meets the requirements of FCC Part 15 Subpart C and ISED Canada's Radio Standards Specification RSS-247 for the tests documented herein.

END REPORT