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EMC TEST REPORT – 350015-1TRFEMC

Applicant:

eleven-x Incorporated

Product name:

Eleven-x Interface Unit

Models:

XIU001001; XIU001002; XIU002001; XIU002002; XIU003001; XIU003002; XIU003003; XIU003004

Specifications:

- FCC 47 CFR Part 15, Subpart B – Verification
- ICES-003 Issue 6 January 2016

Date of issue: April 13, 2018

Test engineer(s):	Predrag Golic, EMC Specialist	Signature:	
Reviewed by:	David Duchesne, Senior EMC/Wireless Specialist	Signature:	

Lab and test locations

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Test site registration	**Organization**	**Recognition numbers and location**	
	FCC	CA2040 (Ottawa); CA2041 (Montreal)	
	ISED	CA2040A-4 (Ottawa); CA2040G-5 (Montreal); CA2040A-3 (Almonte)	
Website	www.nemko.com		

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart B – Verification	Title 47: Telecommunication; Part 15—Radio Frequency Devices
ICES-003 Issue 6 January 2016	Information Technology Equipment (ITE) – Limits and methods of measurement

1.2 Exclusions

None

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.4 Test report revision history

Table 1.4-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
TRF	April 13, 2018	Original report issued

Section 2 Summary of test results

2.1 Testing period

Test start date	March 29, 2018
Test end date	March 29, 2018

2.2 North America test results

Table 2.2-1: *Result summary for emissions*

Standard	Clause	Test description	Verdict
FCC 47 CFR Part 15, Subpart B	§15.109	Radiated emissions limits	Pass [1]
FCC 47 CFR Part 15, Subpart B	§15.107	Conducted emissions limits (AC mains)	Not applicable [2]
ICES-003 Issue 6	6.1	AC Power Line Conducted Emissions Limits[1]	Not applicable [2]
ICES-003 Issue 6	6.2	Radiated Emissions Limits[1]	Pass

Notes: [1] Product classification B
[2] The EUT is battery powered

Section 3 Equipment under test (EUT) details

3.1 Applicant and Manufacturer

Company name	eleven-x Incorporated
Address	300-460 Phillip Street; Waterloo, Ontario, N2L 5J2, Canada

3.2 Sample information

Receipt date	March 27, 2018
Nemko sample ID number	1 through 8

3.3 EUT information

Product name	eleven-x Interface Unit			
Model variants	XIU001001	XIU001002	XIU002001	XIU002002
	XIU003001	XIU003002	XIU003003	XIU003004
Part number	XIU001001 revA	XIU001002 revA	XIU002001 revA	XIU002002 revA
	XIU003001 revA	XIU003002 revA	XIU003003 revA	XIU003004 revA
Serial number	70B3B514900E0065	70B3B514900E0090	70B3B514900E006E	70B3B514900E0071
	70B3B514900E0073	70B3B514900E0068	70B3B514900E006B	70B3B514900E0094
Power requirements	3.6 V_{DC} [powered by internal battery]			
Description/theory of operation	The eleven-x LoRaTM Interface Device module is based on the Semtech SX1272 Transceiver using LoRaTM modulation. It is designed to operate in the 915 MHz ISM band, and implements the LoRaWANTM network protocol. As per LoRaWANTM, the 902-928 MHz ISM band is divided into the following: • 64 uplink (module tx) channels using LoRaTM 125 kHz bandwidth, from 902.3 MHz to 914.9 MHz incrementing linearly by 200 kHz. • 8 uplink (module tx) channels using LoRaTM 500kHz bandwidth, from 903.0 MHz to 914.2 MHz, incrementing linearly by 1.6 MHz. • 8 downlink (module rx) channels using LoRaTM 500 kHz bandwidth, from 923.3 MHz to 927.5 Mhz, incrementing linearly by 600 kHz. In LoRaWANTM, there are 5 transmission data rates used by an end device, all using LoRaTM modulation. • DR0: 125 kHz bandwidth, spreading factor 10 • DR1: 125 kHz bandwidth, spreading factor 9 • DR2: 125 kHz bandwidth, spreading factor 8 • DR3: 125 kHz bandwidth, spreading factor 7 • DR4: 500 kHz bandwidth, spreading factor 8			
Operational frequencies	32.768 kHz XTAL1 (MCU), 32 MHz XTAL2 (Transceiver)			
Software details	Radio FW Version: 72.1.0.0, Apps SW Version: R1.0.0			

3.4 EUT setup details

EUT description of the methods used to exercise the EUT and all relevant ports:

- While powered (battery connector inserted into board), the devices were configured to poll their host sensor (data will be faked for meters, as they are 3rd party devices) and transmit the data over LoRaWAN every 2 minutes, which is much more rapid than normal operation. A typical report time would be every hour. All units are tested simultaneously.

EUT setup/configuration rationale:

- The EUT setup in a configuration that was expected to produce the highest amplitude emissions relative to the limit and that satisfy normal operation/installation practice by the end user.
- The type and construction of cables used in the measurement set-up were consistent with normal or typical use. Cables with mitigation features (for example, screening, tighter/more twists per length, ferrite beads) have been noted below:
  - None
- The EUT was setup in a manner that was consistent with its typical arrangement and use. The measurement arrangement of the EUT, local AE and associated cabling was representative of normal practice. Any deviations from typical arrangements have been noted below:
  - None

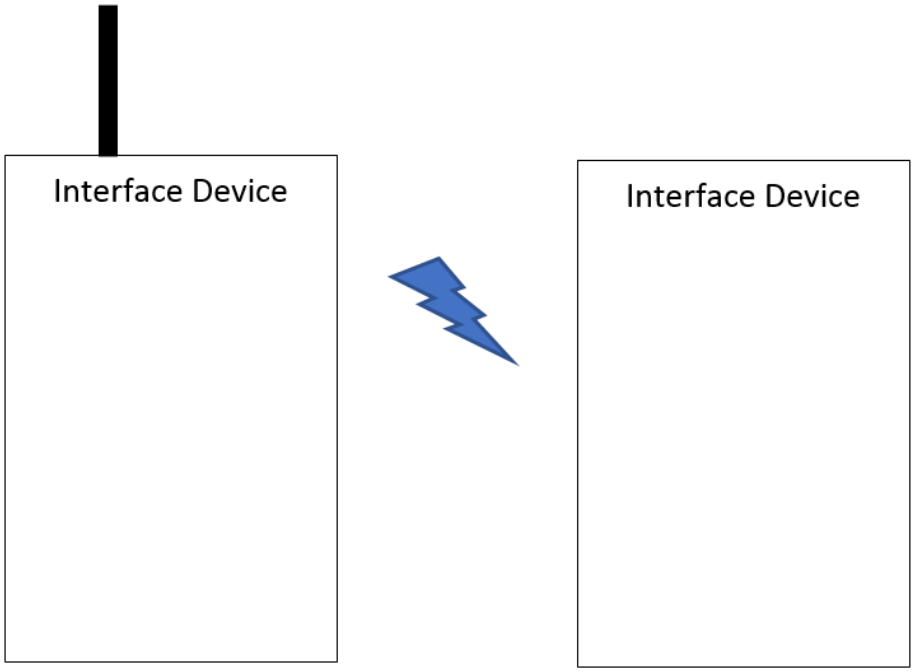


Figure 3.4-1: *Setup block diagram*

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Section 7 Terms and definitions

7.1 Product classifications definitions

7.1.1 Title 47: Telecommunication – Part 15-Radio Frequency devices, Subpart A – General – Equipment classification

Class A digital device	A digital device that is marketed for use in a commercial, industrial or business environment, exclusive of a device which is marketed for use by the general public or is intended to be used in the home.
Class B digital device	A digital device that is marketed for use in a residential environment notwithstanding use in commercial, business and industrial environments. Examples of such devices include, but are not limited to, personal computers, calculators, and similar electronic devices that are marketed for use by the general public. Note: The responsible party may also qualify a device intended to be marketed in a commercial, business or industrial environment as a Class B device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B digital device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B digital device, regardless of its intended use.

7.1.2 ICES-003 – Equipment classification

Class B ITE	limits of radio noise for ITE for residential operation
Class A ITE	limits of radio noise for ITE for non-residential operation
Conditions	Only ITE intended strictly for non-residential use in commercial, industrial or business environments, and whose design or other characteristics strongly preclude the possibility of its use in a residential environment, shall be permitted to comply with the less stringent Class A limits. All ITE that cannot meet the conditions for Class A operation shall comply with the Class B limits. The ITE shall comply with both the power line – conducted and the radiated emissions limits within the same Class, with no intermixing.

7.2 General definitions

7.2.1 Title 47: Telecommunication – Part 15-Radio Frequency devices, Subpart A – General – Digital device definitions

Digital device (Previously defined as a computing device)	An unintentional radiator (device or system) that generates and uses timing signals or pulses at a rate in excess of 9,000 pulses (cycles) per second and uses digital techniques; inclusive of telephone equipment that uses digital techniques or any device or system that generates and uses radio frequency energy for the purpose of performing data processing functions, such as electronic computations, operations, transformations, recording, filing, sorting, storage, retrieval, or transfer. A radio frequency device that is specifically subject to an emanation requirement in any other FCC Rule part or an intentional radiator subject to subpart C of this part that contains a digital device is not subject to the standards for digital devices, provided the digital device is used only to enable operation of the radio frequency device and the digital device does not control additional functions or capabilities. Note: Computer terminals and peripherals that are intended to be connected to a computer are digital devices.

7.2.2 ICES-003 – Definitions

Information technology equipment (ITE)	Information Technology Equipment (ITE) is defined as devices or systems that use digital techniques for purposes such as data processing and computation. ITE is any unintentional radiator (device or system) that generates and/or uses timing signals or pulses having a rate of at least 9 kHz and employs digital techniques for purposes such as computation, display, data processing and storage, and control.

Section 8 Testing data

8.1 Radiated emissions

8.1.1 References and limits

- FCC 47 CFR Part 15, Subpart B: Clause §15.109 (Test method ANSI C63.4:2014)
- ICES-003: Section 6.2

Table 8.1-1: *Requirements as per FCC Part 15 Subpart B and ICES-003 for radiated emissions for Class B*

Frequency range [MHz]	Measurement		limits
	Distance [m]	Detector type/ bandwidth	[dBµV/m]
30–88	3	Quasi Peak/120 kHz	40.0
88–216			43.5
216–960			46.0
960–1000			54.0
>1000	3	Linear average/1 MHz	54.0
		Peak/1 MHz	74.0

Notes: Where there is a step in the relevant limit, the lower value was applied at the transition frequency.

8.1.2 Test summary

Verdict	Pass		
Test date	March 29, 2018	Temperature	23 °C
Test engineer	Predrag Golic	Air pressure	1003 mbar
Test location	Ottawa	Relative humidity	28 %

8.1.3 Notes

- Where tabular data has not been provided, no emissions were observed within 10 dB of the specified limit when measured with the appropriate detector.
- Where less than 6 measurements per detector has been provided, fewer than 6 emissions were observed within 10 dB of the specified limit when measured with the appropriate detector.
- The highest operating frequency of the EUT as provided by the client was 32 MHz. The spectrum was scanned to 1 GHz according to the EUT highest operating frequency.

Table 8.1-2: *Frequency range for FCC Part 15 Subpart B and ICES-003 Issue 6*

Highest internal frequency [F_X]	Highest measured frequency
$F_X \leq 108$ MHz	1 GHz
108 MHz < $F_X \leq 500$ MHz	2 GHz
500 MHz < $F_X \leq 1$ GHz	5 GHz
$F_X > 1$ GHz	$5 \times F_X$ up to a maximum of 40 GHz

Notes: Highest internal frequency [F_X] – highest fundamental frequency generated or used within the EUT or highest frequency at which it operates. This includes frequencies which are solely used within an integrated circuit.
For FM and TV broadcast receivers F_X is determined from the highest frequency generated or used excluding the local oscillator and tuned frequencies.

8.1.4 Setup details

Port under test	Enclosure Port
EUT power input during test	Battery: 3.6 V_{DC}
EUT setup configuration	Table top
Test facility	Semi anechoic chamber
Measuring distance	3 m
Antenna height variation	1–4 m
Turn table position	0–360°
Measurement details	A preview measurement was generated with receiver in continuous scan or sweep mode while the EUT was rotated and antenna adjusted to maximize radiated emission. Emissions detected within 10 dB or above the limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver/spectrum analyzer settings for frequencies below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (Preview measurement), Quasi-peak (Final measurement)
Trace mode	Max Hold
Measurement time	100 ms (Peak preview measurement), 100 ms (Quasi-peak final measurement)

Table 8.1-3: *Radiated emissions equipment list*

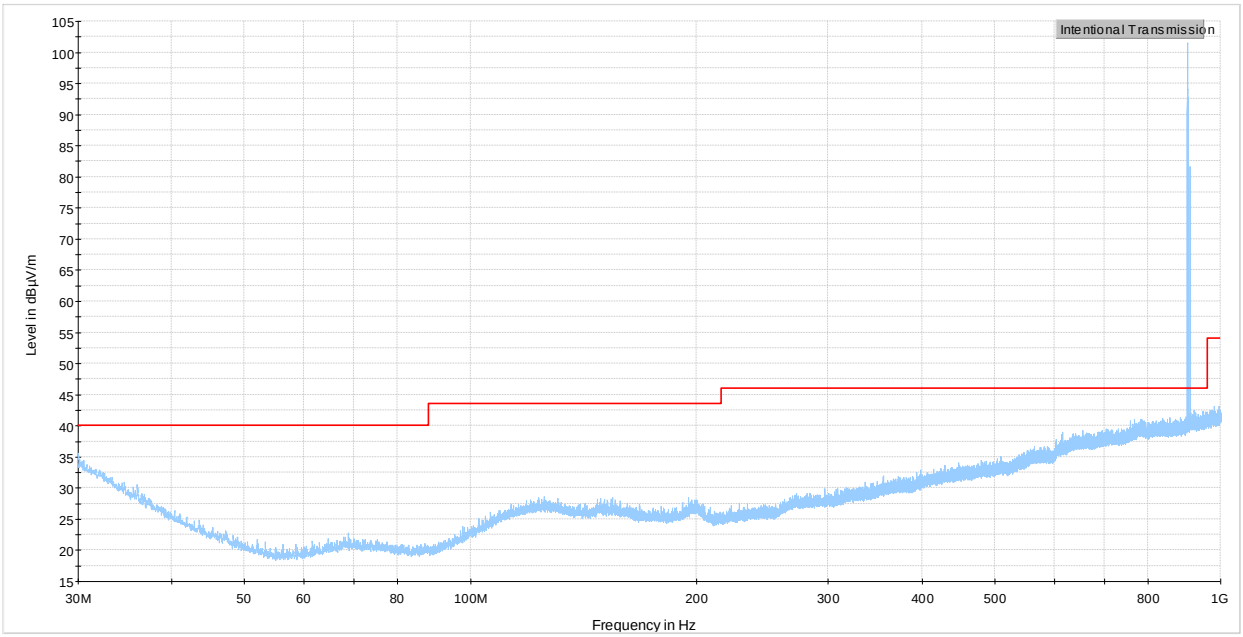
Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 09/18
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Mar. 26/19
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	June 27/18
50 Ω coax cable	Huber + Suhner	None	FA002074	1 year	May 12/18
50 Ω coax cable	Huber + Suhner	None	FA002830	1 year	May 12/18

Notes: NCR - no calibration required

Table 8.1-4: *Radiated emissions test software details*

Manufacturer of Software	Details
Rohde & Schwarz	EMC32, Software for EMC Measurements, Version 9.26.01

8.1.5 Test data



Preview Result 1-PK+
FCC Part 15 - Class B 3m Q-Peak Limit

The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.
ICES-003 Issue 6 limit is identical to FCC Part 15 limit

Figure 8.1-1: *Radiated emissions spectral plot*

8.1.6 Setup photos

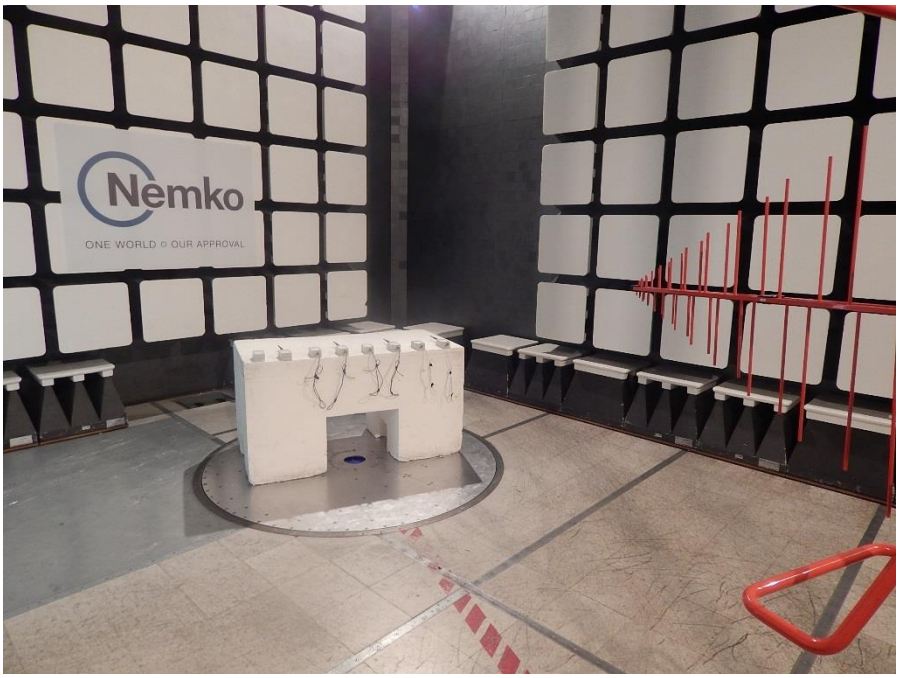


Figure 8.1-2: *Radiated emissions setup photo*

Section 9 EUT photos

9.1 External photos

Figure 9.1-1: *EUT photos*

End of the test report