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Test report

289364-2TRFWL

Date of issue: August 9, 2016

Applicant:

Cryopak

Product:

xTagDisplay

Model:

xTagDisplay

FCC ID:

PBX-XTAGDISPLAY

IC Registration number:

10568A-XTAGDISPLAY

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

- RSS-247, Issue 1, May 2015, Section 5

  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada. The tests included in this report are within the scope of this accreditation

Test location

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Website	www.nemko.com
Site number	FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Review date	August 9, 2016
Reviewer signature	

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 contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Table of contents

Table of contents **3**
Section 1. Report summary **4**
1.1 Applicant and manufacturer 4
1.2 Test specifications 4
1.3 Test methods 4
1.4 Statement of compliance 4
1.5 Exclusions 4
1.6 Test report revision history 4
Section 2. Summary of test results **5**
2.1 FCC Part 15 Subpart C, general requirements test results 5
2.2 FCC Part 15 Subpart C, intentional radiators test results 5
2.3 IC RSS-GEN, Issue 4, test results 5
2.4 IC RSS-247, Issue 1, test results 6
Section 3. Equipment under test (EUT) details **7**
3.1 Sample information 7
3.2 EUT information 7
3.3 Technical information 7
3.4 Product description and theory of operation 7
3.5 EUT exercise details 7
3.6 EUT setup diagram 8
3.7 EUT sub assemblies 8
Section 4. Engineering considerations **9**
4.1 Modifications incorporated in the EUT 9
4.2 Technical judgment 9
4.3 Deviations from laboratory tests procedures 9
Section 5. Test conditions **10**
5.1 Atmospheric conditions 10
5.2 Power supply range 10
Section 6. Measurement uncertainty **11**
6.1 Uncertainty of measurement 11
Section 7. Test equipment **12**
7.1 Test equipment list 12
Section 8. Testing data **13**
8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits 13
8.2 FCC 15.247(a)(2) and RSS-247 5.2(1) Minimum 6 dB bandwidth for systems using digital modulation techniques 17
8.3 FCC 15.247(b) and RSS-247 5.4 (4) Transmitter output power and e.i.r.p. requirements 19
8.4 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions 22
8.5 FCC 15.247(e) and RSS-247 5.2(2) Power spectral density for digitally modulated devices 28
Section 9. Block diagrams of test set-ups **30**
9.1 Radiated emissions set-up for frequencies below 1 GHz 30
9.2 Radiated emissions set-up for frequencies above 1 GHz 30
9.3 Conducted emissions set-up 31

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Cryopak Verification Technologies
Address	11000 Boulevard Parkway
City	Anjou
Province/State	QC
Postal/Zip code	H1J 1R6
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz
RSS-247, Issue 1, May 2015, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

558074 D01 DTS Meas Guidance v03r05 (April 8, 2016)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed 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.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1] Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2] The Antennas are located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

2.3 IC RSS-GEN, Issue 4, test results

Part	Test description	Verdict
7.1.2	Receiver radiated emission limits	Not applicable
7.1.3	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 IC RSS-247, Issue 1, test results

Part	Test description	Verdict
5.1	Frequency Hopping Systems (FHSs)	
5.1 (1)	Bandwidth of a frequency hopping channel	Not applicable
5.1 (2)	Minimum channel spacing for frequency hopping systems	Not applicable
5.1 (3)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.1 (4)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.1 (5)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
5.2	Digital Transmission Systems (DTSs)	
5.2 (1)	Minimum 6 dB bandwidth	Pass
5.2 (2)	Maximum power spectral density	Pass
5.3	Hybrid Systems	
5.3 (1)	Digital modulation turned off	Not applicable
5.3 (2)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
5.4 (1)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.4 (2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.4 (3)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
5.4 (4)	Systems employing digital modulation techniques	Pass
5.4 (5)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (6)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Out-of-band emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	June 22, 2015
Nemko sample ID number	133001281

3.2 EUT information

Product name	xTagDisplay
Model	xTagDisplay
Serial number	1615

3.3 Technical information

Applicant IC company number	10568A
IC UPN number	XTAGDISPLAY
All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-247 Issue 1, May 2015
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2405
Frequency Max (MHz)	2475
RF power Max (W), Conducted	0.038 (15.77 dBm)
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	1680
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	QPSK
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	69.92 dBµV/m (peak) and 38.52 dBµV/m (average) at 2483.5 MHz @ 3 m
Power requirements	1.85A/H, Li-ion Polymer (All tests were performed with new battery)
Antenna information	3.0 dBi, 50 Ω, Reverse SMA (male), One-quarter wavelength dipole configuration. The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

EUT is a Wireless/wired temperature and humidity sensor, which is a part of the Mirador real time monitoring platform.

3.5 EUT exercise details

The laptop was connected to the EUT's USB port and special test software was used to communicate with an xTagDisplay to invoke a transmission.

3.6 EUT setup diagram

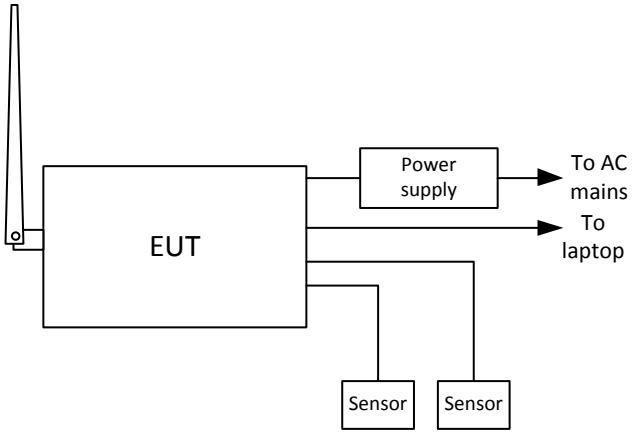


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number	
Power supply	V-INFINITY	EPS120050	–	–
Sensor	–	–	08000003F5F86328	–
Sensor	–	–	0C0000024E848928	–

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

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	860–1060 mbar

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

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 01/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
AC Power source	California Instruments	3001i	FA001021	1 year	Aug. 27/16
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/17
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Apr. 15/17
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 28/17
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 26/17
Horn antenna 18–40 GHz	EMCO	3116	FA001847	1 year	Apr.15/17
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	April 26/17
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Mar. 08/17

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.1-1: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.1.2 Test summary

Verdict	Pass		
Test date	June 23, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1005 mbar
Test location	Ottawa	Relative humidity	41 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings for preview measurements:

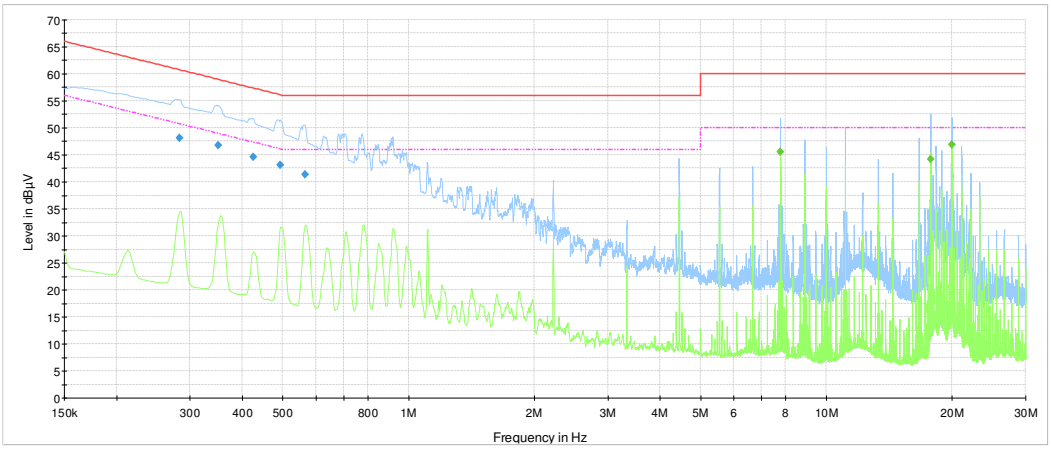
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.1.4 Test data

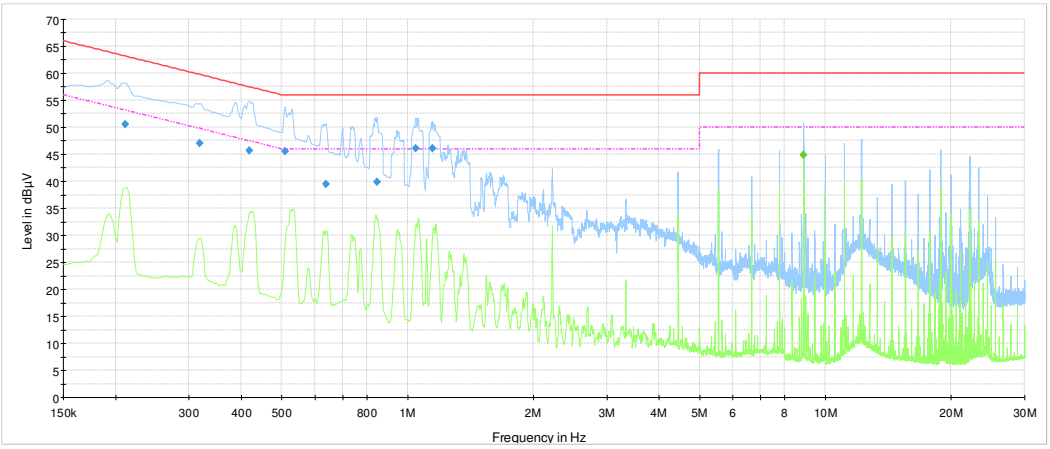
8.1.5 Test data



NEX-289364 CE Scan Phase 120 VAC 60 Hz
CISPR 22 Mains QP Class B
CISPR 22 Mains AV Class B
Preview Result 1-PK+
Preview Result 2-AVG
Final Result 1-QPK
Final Result 2-AVG

The spectral plot has been corrected with transducer factors. (i.e. cable loss, LISN factors, and attenuators)

Figure 8.1-1: *Conducted disturbance at mains port spectral plot on phase line*



NEX-289364 CE Scan Neutral 120 VAC 60 Hz
CISPR 22 Mains QP Class B
CISPR 22 Mains AV Class B
Preview Result 1-PK+
Preview Result 2-AVG
Final Result 1-QPK
Final Result 2-AVG

The spectral plot has been corrected with transducer factors. (i.e. cable loss, LISN factors, and attenuators)

Figure 8.1-2: *Conducted disturbance at mains port spectral plot on neutral line*

8.1.5 Test data, continued

Table 8.1-2: *Conducted disturbance at mains port (Quasi-Peak) results for AC Mains*

Frequency (MHz)	Quasi-Peak result[1] (dBµV)	Measurement time (ms)	Bandwidth (kHz)	Filter	Conductor	Correction factor[2] (dB)	Margin (dB)	Quasi-Peak limit (dBµV)
0.282750	48.1	1000	9	On	L1	9.9	12.6	60.7
0.350250	46.7	1000	9	On	L1	10.1	12.2	59.0
0.424500	44.6	1000	9	On	L1	10.1	12.8	57.4
0.494250	43.1	1000	9	On	L1	10.2	13.0	56.1
0.566250	41.4	1000	9	On	L1	10.1	14.6	56.0
0.210750	50.5	1000	9	On	N	9.9	12.7	63.2
0.318750	47.0	1000	9	On	N	10.0	12.7	59.7
0.417750	45.7	1000	9	On	N	10.1	11.8	57.5
0.510000	45.6	1000	9	On	N	10.1	10.4	56.0
0.638250	39.5	1000	9	On	N	10.1	16.5	56.0
0.845250	39.9	1000	9	On	N	10.0	16.1	56.0
1.045500	46.1	1000	9	On	N	10.0	9.9	56.0
1.146750	46.1	1000	9	On	N	10.0	9.9	56.0

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

Sample calculation: 48.1 dBµV (result) = 35.5 dBµV (receiver reading) + 12.6 dB (Correction factor)

Table 8.1-3: *Conducted disturbance at mains port (Average) results for AC Mains*

Frequency (MHz)	Average result[1] (dBµV)	Measurement time (ms)	Bandwidth (kHz)	Filter	Conductor	Correction factor[2] (dB)	Margin (dB)	Average limit (dBµV)
7.770750	45.5	1000	9	On	L1	10.2	4.5	50
17.764750	44.2	1000	9	On	L1	10.5	5.8	50
19.983250	46.9	1000	9	On	L1	10.5	3.1	50
8.880000	44.8	1000	9	On	N	10.3	5.2	50

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

Sample calculation: 45.5 dBµV (result) = 35.3 dBµV (receiver reading) + 10.2 dB (Correction factor)

8.2 FCC 15.247(a)(2) and RSS-247 5.2(1) Minimum 6 dB bandwidth for systems using digital modulation techniques

8.2.1 Definitions and limits

FCC and IC:

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2.2 Test summary

Verdict	Pass		
Test date	June 29, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1006 mbar
Test location	Ottawa	Relative humidity	44 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	1–5 % of DTS BW (no wider than 100 kHz)
Video bandwidth	≥3 × RBW
Frequency span	30 MHz for 20 MHz channel; 70 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *6 dB bandwidth results*

Frequency, MHz	6 dB bandwidth, MHz	Limit, MHz	Margin, MHz
2405	1.58	0.50	1.08
2440	1.58	0.50	1.08
2475	1.68	0.50	1.18

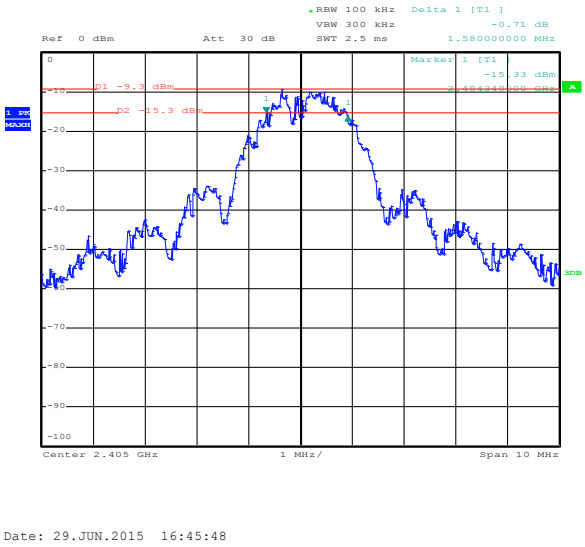


Figure 8.2-1: *6 dB bandwidth Low Channel*

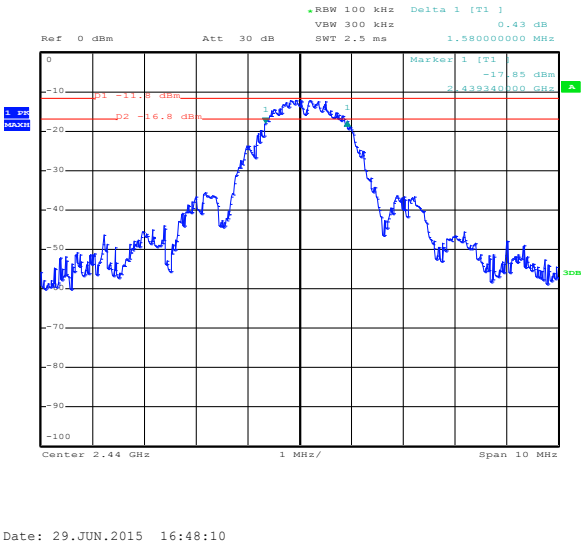


Figure 8.2-2: *6 dB bandwidth Mid Channel*

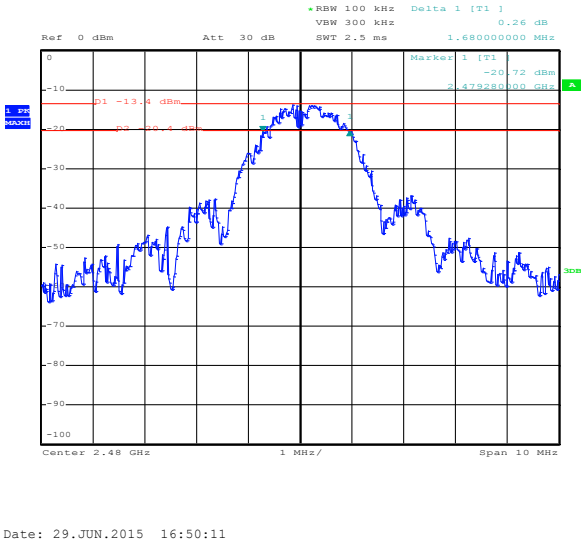


Figure 8.2-3: *6 dB bandwidth High Channel*

8.3 FCC 15.247(b) and RSS-247 5.4 (4) Transmitter output power and e.i.r.p. requirements

8.3.1 Definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(c) Operation with directional antenna gains greater than 6 dBi.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

IC:

For DTSs employing digital modulation techniques operating in the bands 902–928 MHz and 2400–2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(5), the e.i.r.p. shall not exceed 4 W.
Fixed point-to-point systems in the bands 2400-2483.5 MHz and 5725-5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.

8.3.2 Test summary

Verdict	Pass		
Test date	June 15, 2016	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1006 mbar
Test location	Ottawa	Relative humidity	44 %

8.3.3 Observations, settings and special notes

The test was performed according to DTS guidelines section 9.1: Measurement using Maximum peak conducted output power with the EUT transmitting at full power throughout each sweep.

8.3.4 Test data

Table 8.3-1: *Output power and EIRP measurements results*

Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
	Output, dBm	Limit					
2405	15.77	30.00	14.23	3.0	18.77	36.00	17.23
2435	15.47	30.00	14.53	3.0	18.47	36.00	17.53
2475	14.45	30.00	15.55	3.0	17.45	36.00	18.55

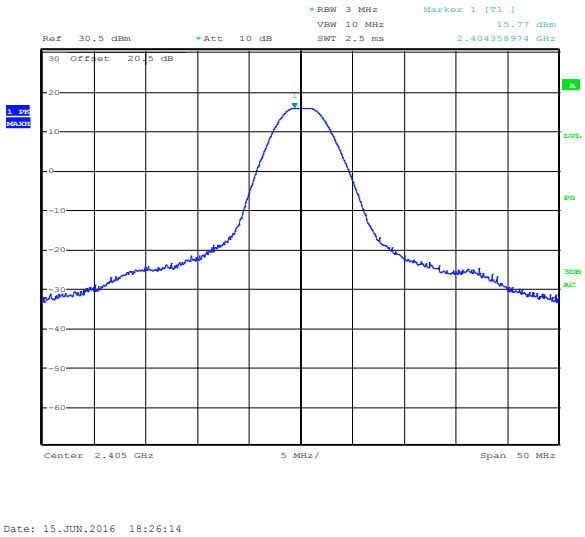


Figure 8.3-1: *Conducted output power at low channel*

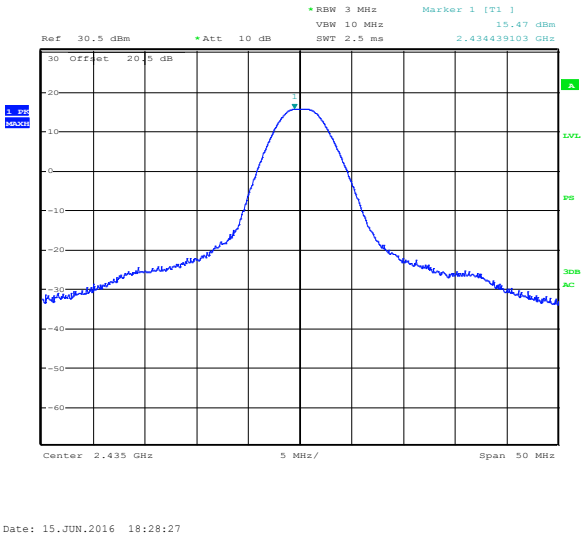


Figure 8.3-2: *Conducted output power at mid channel*

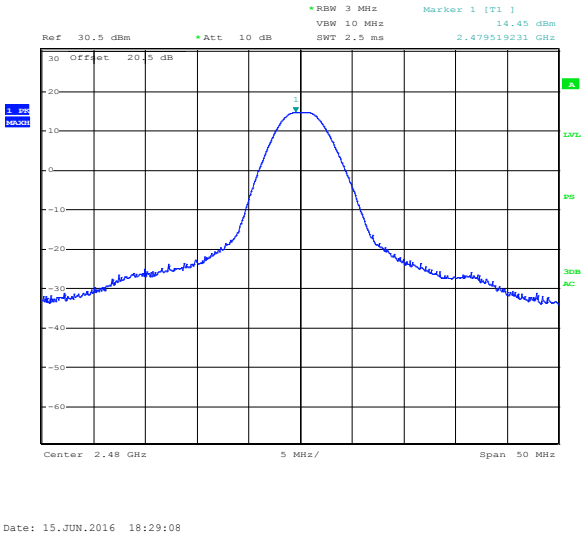


Figure 8.3-3: *Conducted output power at high channel*

8.4 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions

8.4.1 Definitions and limits

FCC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

IC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Table 8.4-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions µV/m	dBµV/m	Measurement distance, m
0.009–0.490	2400/F	$67.6 – 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 – 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.4-2: *IC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677-5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

Table 8.4-3: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.4.2 Test summary

Verdict	Pass		
Test date	June 15, 2016	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1006 mbar
Test location	Ottawa	Relative humidity	44 %

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
Radiated measurements were performed at a distance of 3 m.
Since fundamental power was tested using peak method, the conducted spurious emissions limit is −20 dBc/100 kHz

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for conducted spurious emissions measurements:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.4.4 Test data

Duty cycle correction factor was calculated as follows. As per customer declaration:

The xTagDisplay sends an acknowledgement to xTag2 after each received packet.
This acknowledgement duration is 2.7 ms.

The normal installation counts up to 10 xTag2 attached to one xTagDisplay with a sampling rate of 5 minutes.
That gives for the xTagDisplay: One Tx burst of 2.7 ms every 30 seconds.

Duty cycle correction factor (DCCF) = 20 × Log_{10} (2.7 ms / 100 ms) = −31.4 dB

Table 8.4-4: *Radiated field strength measurement results*

Channel	Frequency, MHz	Peak field strength, dBµV/m		Margin, dB	Average field strength, dBµV/m		Margin, dB
		Measured	Limit		Calculated	Limit	
Low	2390.0	64.90	74.00	9.10	33.50	54.00	20.50
Low	4809.3	69.01	74.00	4.99	37.61	54.00	16.39
Low	7213.6	63.98	74.00	10.02	32.58	54.00	21.42
Low	9622.4	56.29	74.00	17.71	24.89	54.00	29.11
Mid	4869.3	59.89	74.00	14.11	28.49	54.00	25.51
Mid	7307.2	62.54	74.00	11.46	31.14	54.00	22.86
Mid	9738.4	51.76	74.00	22.24	20.36	54.00	33.64
High	2483.5	69.92	74.00	4.08	38.52	54.00	15.48
High	4959.3	59.02	74.00	14.98	27.62	54.00	26.38
High	7438.8	58.79	74.00	15.21	27.39	54.00	26.61

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
Average field strength was calculated as follows: Peak field strength – 31.4 dB (DCCF).

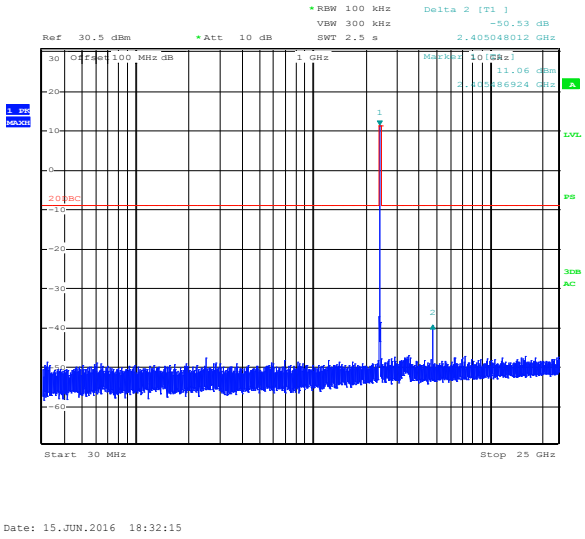


Figure 8.4-1: *Conducted spurious emissions low channel*

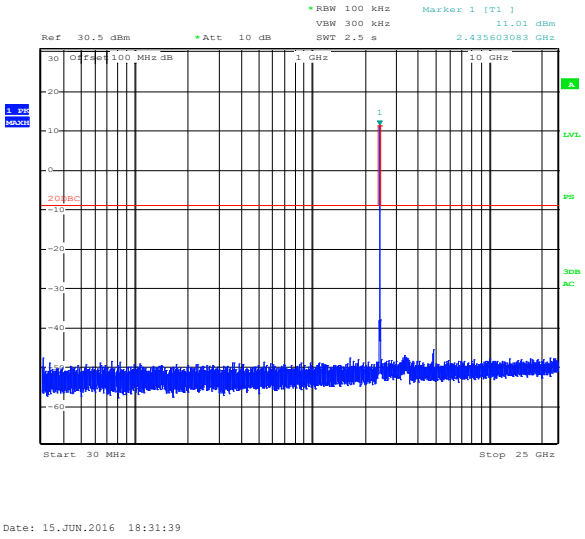


Figure 8.4-2: *Conducted spurious emissions mid channel*

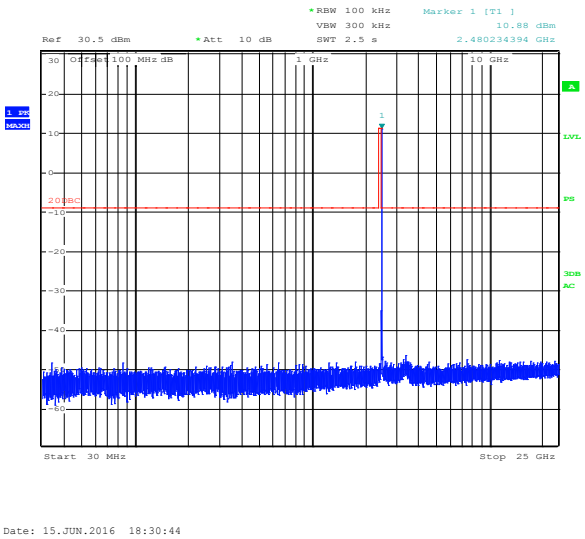


Figure 8.4-3: *Conducted spurious emissions for high channel*

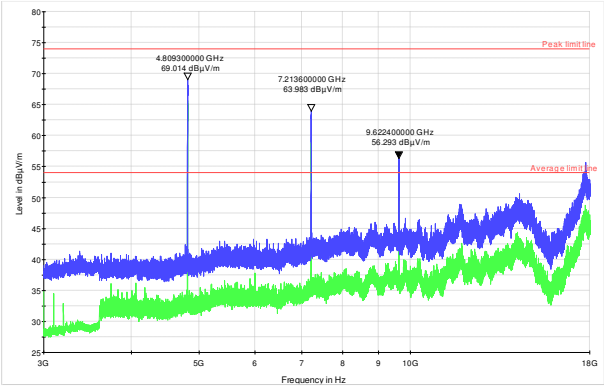


Figure 8.4-4: *Radiated spurious emissions example on low channel*

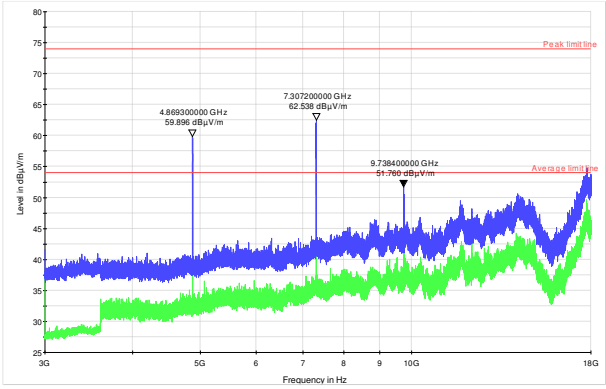


Figure 8.4-5: *Radiated spurious emissions example on mid channel*

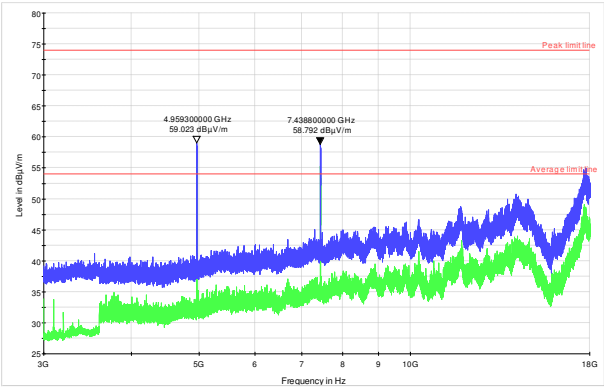


Figure 8.4-6: *Radiated spurious emissions example on high channel*

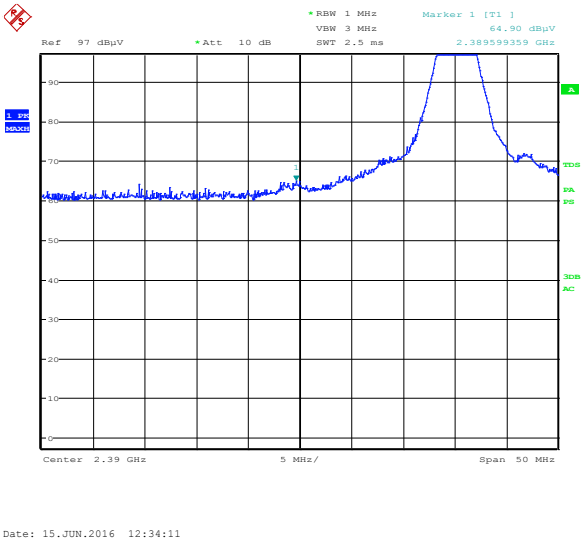


Figure 8.4-7: *Radiated spurious emissions at the lower band edge*

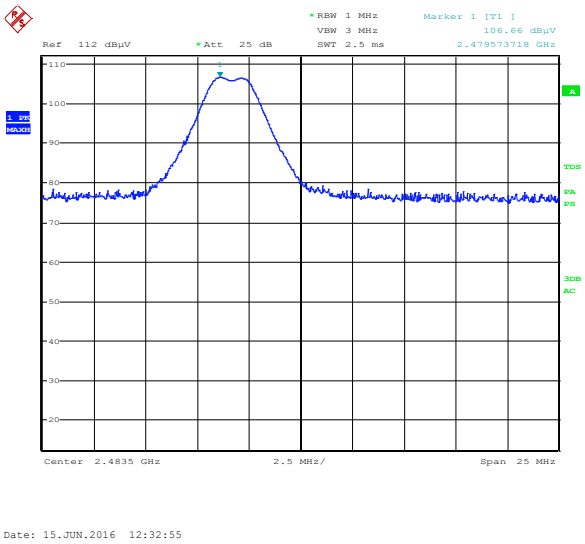


Figure 8.4-8: *Radiated spurious emissions at the upper band edge, delta marker procedure, 1 MHz RBW*

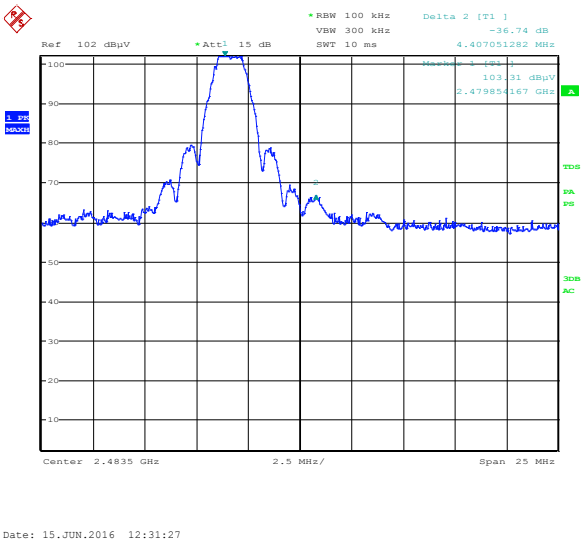


Figure 8.4-9: *Radiated spurious emissions at the upper band edge, delta marker procedure, 100 kHz RBW*

Delta marker for peak field strength at the 2483.5 MHz calculation:

106.66 dBµV/m/MHz – 36.74 dB = 69.92 dBµV/m/MHz

8.5 FCC 15.247(e) and RSS-247 5.2(2) Power spectral density for digitally modulated devices

8.5.1 Definitions and limits

FCC:
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

IC:
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

8.5.2 Test summary

Verdict	Pass		
Test date	June 15, 2016	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1006 mbar
Test location	Ottawa	Relative humidity	44 %

8.5.3 Observations, settings and special notes

The test was performed using method described in section 10.2 Method PKPSD-1. Spectrum analyser settings:

Resolution bandwidth:	3 kHz
Video bandwidth:	10 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.5.4 Test data

Table 8.5-1: *PSD measurements results*

Frequency, MHz	PSD, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
2405	-0.02	8.00	8.02
2435	0.95	8.00	7.05
2475	-1.20	8.00	9.20

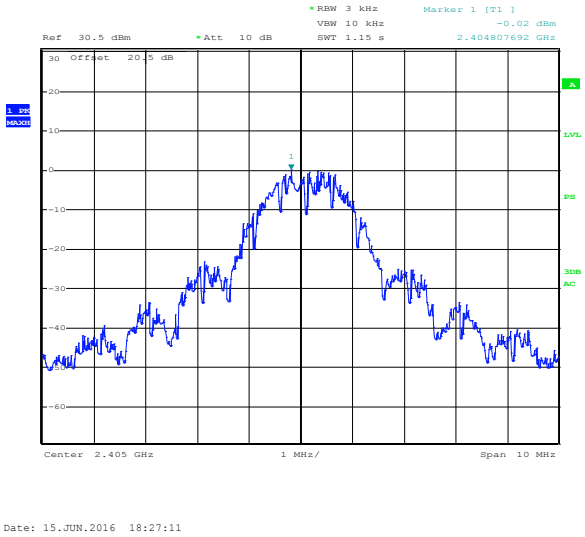


Figure 8.5-1: *PSD measurement result on low channel*

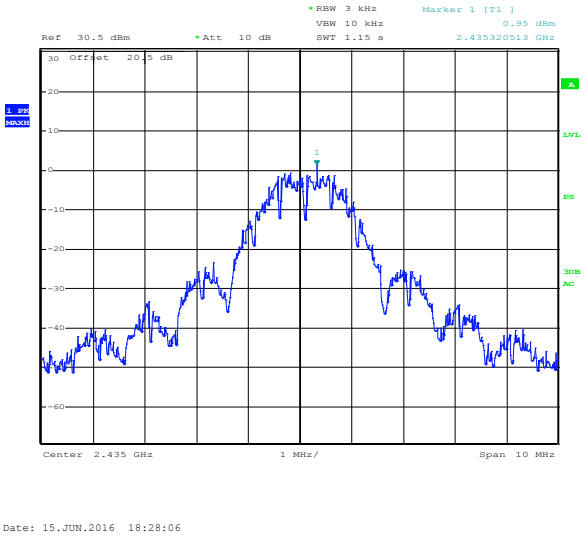


Figure 8.5-2: *PSD measurement result on mid channel*

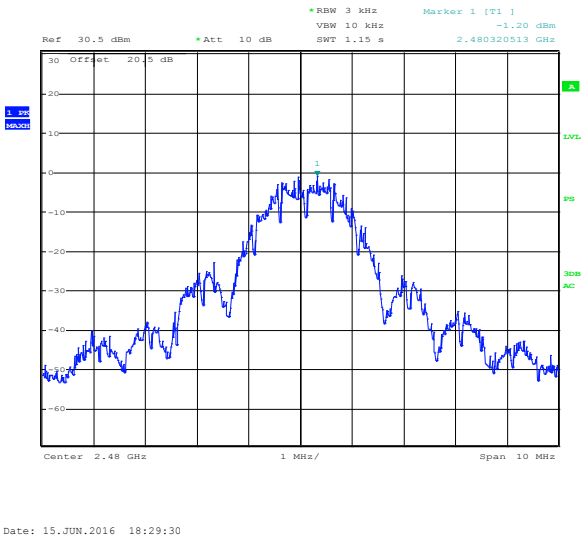
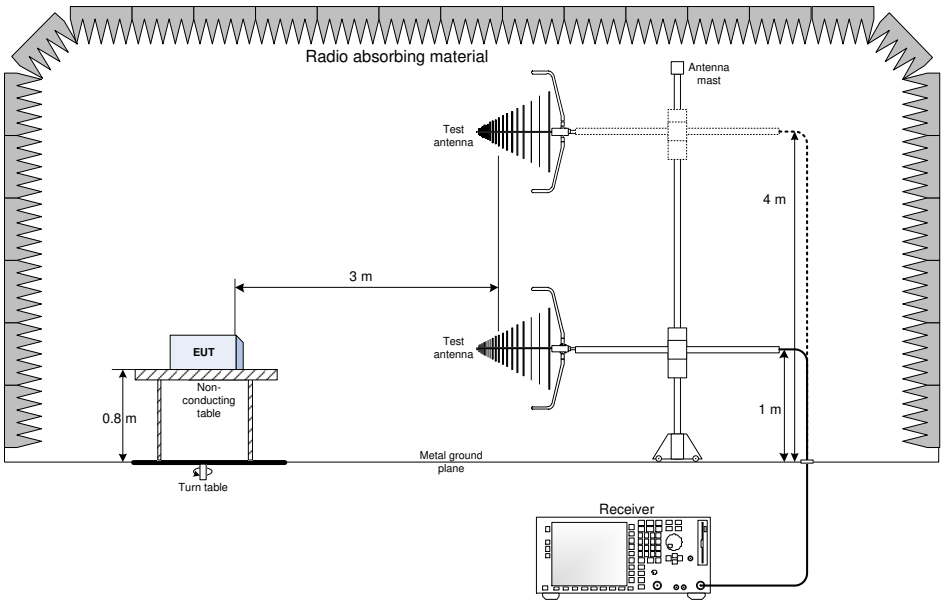


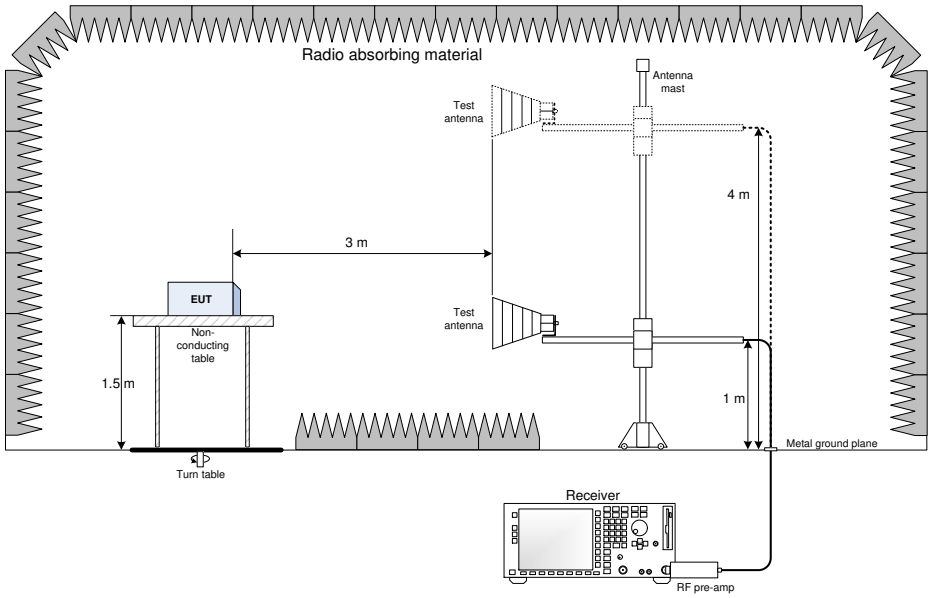
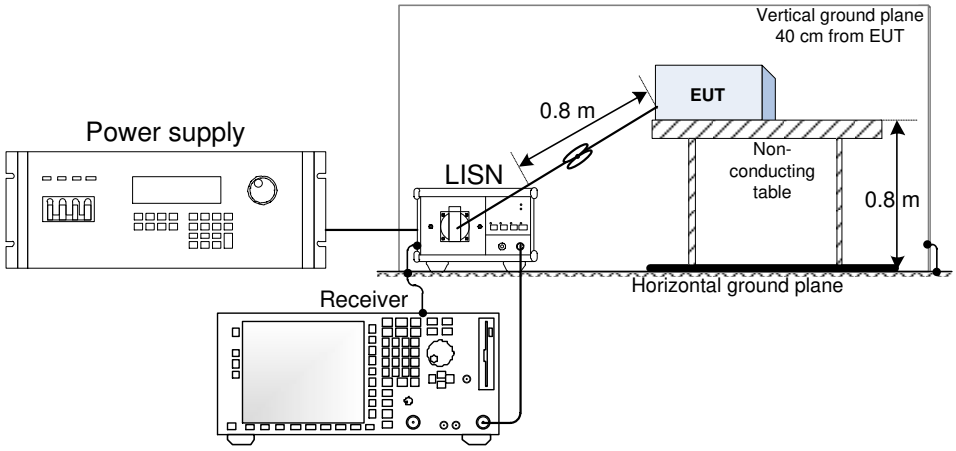
Figure 8.5-3: *PSD measurement result on high channel*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up