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Test report

233457-1TRFWL

Date of issue: September 12, 2013

Applicant:

Digital Security Controls, a division of Tyco Safety Products Canada Ltd.

Product:

PowerG Wirefree Keypad with Prox

Model:	Model variant:
HS2LCDWFPV9	HS2LCDWF9, HS2LCDWFP9
FCC ID:	IC Registered number:
F5313HS2KWFPV9	160A-HS2KWFPV9

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

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

- RSS-210, Issue 8, Annex 8, December 2010

  Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands

SCC Accredited LAB
LAB Accrédité CCN

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

Lab and test locations

Company name	Nemko Canada Inc.
Designation number	FCC test site registration number: 176392 and IC registered site number: 2040A-4 (3 m semi anechoic chamber)
Facility Name	Ottawa
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Province	ON
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Tested by	David Duchesne, Senior EMC/Wireless Specialist and Daniel Hynes, Senior EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Review date	September 12, 2013
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.

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Chapter 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
RSS-210, Issue 8 Annex 8, December 2010	Frequency Hopping and Digital Modulation Systems Operating in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz Bands
ANSI C64.3 v 2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

1.2 Exclusions

None

1.3 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.

1.4 Test report revision history

Table 1.4-1: 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 – Test results

Table 2.1-1: FCC Part 15 – General requirements results

Part	Test description	Verdict
§15.31(e)	Variation of power source	See Notes [1]
§15.31(m)	Number of operating frequencies	See Notes [2]
§15.203	Antenna requirement	See Notes [3]
§15.207(a)	Conducted limits	Pass

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 frequency range over which the device operates is greater than 10 MHz. Tests were performed on three operating channels. (low, mid and high)
[3] The antenna used for this product is an internal built in wire antenna that no antenna other than that furnished by the responsible party shall be used with the device, The maximum peak gain of this antenna is -3.78 dBi.

Table 2.1-2: FCC Part 15 Subpart C – Intentional Radiators results

Part	Test description	Verdict
§15.247(a)(1)	Frequency hopping systems	
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Pass
§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	Not applicable
§15.247(b)	Maximum conducted peak output power and EIRP	
§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	Pass
§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	Not applicable
§15.247(b)(4)	Conducted peak output power limitations	
§15.247(b)(4)(i)	Maximum peak output power for systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations.	Not applicable
§15.247(b)(4)(ii)	Maximum peak output power for systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations.	Not applicable
§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	Not applicable
§15.247(f)	Time of occupancy and power spectral density for hybrid systems	Not applicable

Notes: None

2.2 IC RSS test results

Table 2.2-1: IC RSS-GEN, Issue 3 – General requirements results

Part	Test description	Verdict
4.6.1	Occupied bandwidth	Pass
6.1	Receiver spurious emissions limits (radiated)	See Notes [1]
6.2	Receiver spurious emissions limits (antenna conducted)	See Notes [1]
7.2.4	AC power lines conducted emission limits	Pass

Notes: [1] According to Notice 2012-DRS0126 (from January 2012) section 2.2 of RSS-Gen, Issue 3 has been revised. The EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

Table 2.2-2: IC RSS-210, Issue 8 – Intentional Radiators results

Part	Test description	Verdict
A8.1	Frequency hopping systems	
A8.1 (a)	Bandwidth of a frequency hopping channel	Pass
A8.1 (b)	Minimum channel spacing for frequency hopping systems	Pass
A8.1 (c)	Frequency hopping systems operating in the 902–928 MHz band	Pass
A8.1 (d)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
A8.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
A8.2	Digital modulation systems	
A8.2 (a)	Minimum 6 dB bandwidth	Not applicable
A8.2 (b)	Maximum power spectral density	Not applicable
A8.3	Hybrid systems	
A8.3 (1)	Digital modulation turned off	Not applicable
A8.3 (2)	Frequency hopping turned off	Not applicable
A8.4	Transmitter output power and e.i.r.p. requirements	
A8.4 (1)	Frequency hopping systems operating in the 902–928 MHz band	Pass
A8.4 (2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
A8.4 (3)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
A8.4 (4)	Systems employing digital modulation techniques	Not applicable
A8.4 (5)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
A8.4 (6)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
A8.5	Out-of-band emissions	Pass

Notes: None

Section 3 Equipment under test (EUT) details

3.1 Applicant

Company name	Digital Security Controls, a division of Tyco Safety Products Canada Ltd.
Address	3301 Langstaff Rd.
City	Concord
Province/State	ON
Postal/Zip code	L4E 0M1
Country	Canada

3.2 Manufacturer

Company name	Digital Security Controls, a division of Tyco Safety Products Canada Ltd.
Address	95 Bridgeland Ave.
City	Toronto
Province/State	ON
Postal/Zip code	M6A 1Y7
Country	Canada

3.3 Sample information

Receipt date	August 21, 2013 and August 23, 2013
Nemko sample ID number	Item # 4 (TX data continuous lowest channel 912.75 MHz) Item # 2 (TX data continuous mid channel 915.863 MHz) Item # 1: (TX data continuous highest channel 919.106 MHz) Item # 3 (RX constant mod lowest channel) Item # 5 (Normal operation, SW: Ver 1.0)

3.4 EUT information

Product name	PowerG Wirefree Keypad with Prox
Model	HS2LCDWFP9
Model variant	HS2LCDWF9, HS2LCDWFP9
Hardware version	UA629 Rev. 03
Serial number	None
Software version	Ver 1.0
Description/theory of operation	The HS2LCDWFPV9 keypad is wirefree a alphanumeric LCD keypad that allows arming/disarming, programming and viewing the status of the compatible control panels NEO Power Series. The keypad is enabled with two way communication utilizing frequency hopping scheme to increase reliability. The HS2LCDWFPV9, HS2LCDWFP9 and HS2LCDWF9 family of models share same PCB assembly UA629 Rev. 03 and same RF interface module. The design uses one microcontroller. STM32L151VCT6TR controls the bus, handles the bus protocol and hosts the radio module RFD PG TRANS. The hardware is built to have support for an optional proximity tag (RFID capability) for models that include the letter “P” in their model names. The RFID circuit allows conventional RFID tags operating in 125 kHz range to be enrolled in the security system to arm or disarm the panel. Following describes some highlights of the design. MCU Clock frequency: – STM32L151VCT6TR: 4 MHz Internal RC Oscillator – RFID operational frequency: 125 kHz – RF Transceiver Clock frequency: 26 MHz and 32.768 kHz

3.5 Technical information

Operating band	902–928 MHz
Operating frequency	912.75–919.106 MHz
Modulation type	FSK/GFSK
Number of channels	50
Channel spacing	131.4 kHz
Occupied bandwidth (99%)	88 kHz
Emission designator	88K0F7D
Power requirements	9 V_{DC} (Powered via an external 120 V_{AC} 60 Hz AC-DC adapter) **or** 1.5 V_{DC} (x4) internal batteries
Antenna information	Integral (-3.78 dBi)

3.6 Operation of the EUT during testing

Separate samples were provided with continuous carrier and continuous modulation transmission at Low, Mid and High channels.

3.7 EUT setup details

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number	Rev.
Alarm System Keypad with Wireless Transceiver	DSC	HS2LCDWFPV9 / UA629	None	03
I.T.E. Power Supply (120 VAC, 60 Hz)	UNinput	HK-XX11-U09N / WTK5504X	None	---

Table 3.7-2: EUT interface ports

Description	Qty.
DC power from external adaptor	1

Table 3.7-3: Inter-connection cables

Cable description	From	To	Length (m)
2 Conductor DC Power Cable	Keypad with Wireless Transceiver	I.T.E. Power Supply	2

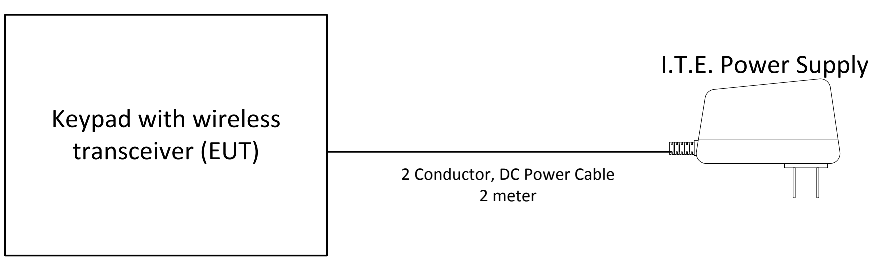


Figure 3.7-1: Setup diagram

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	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 Test equipment

7.1 Test equipment

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	Mar. 09/14
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Feb. 28/14
Bilog antenna	Sunol	JB3	FA002108	1 year	Feb. 21/14
Horn antenna #2	EMCO	3115	FA000825	1 year	Feb. 21/14
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 21/14

Notes: None

Table 7.1-2: Test software details

Test description	Manufacturer of Software	Details
Radiated emissions	Rhode & Schwarz	EMC32, Software for EMC Measurements, Version 8.53.0
Conducted emissions	Rhode & Schwarz	EMC32, Software for EMC Measurements, Version 8.53.0

Notes: None

Section 8 Testing data

8.1 AC power line conducted emissions

8.1.1 Definitions and limits

FCC Clause 15.207(a): Conducted limits
RSS-Gen Clause 7.2.4: AC power line conducted emissions 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:
The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

Except when the requirements applicable to a given device state otherwise, for any licence-exempt radiocommunication device equipped to operate from the public utility AC power supply, either directly or indirectly, the radio frequency voltage that is 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 2. The tighter limit applies at the frequency range boundaries.

The conducted emissions shall be measured with a 50 Ω/50 µH line impedance stabilization network (LISN).

Table 8.1-1: AC power line 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

Notes: * - Decreases with the logarithm of the frequency.

8.1.2 Test summary

Verdict	Pass		
Test date	August 24, 2013	Temperature	25.2 °C
Test engineer	Daniel Hynes	Air pressure	1014.4 mbar
Test location	Ottawa	Relative humidity	40.3 %

8.1.3 Observations/special notes

Test performed with host alarm panel. The EUT was in a normal operating state.

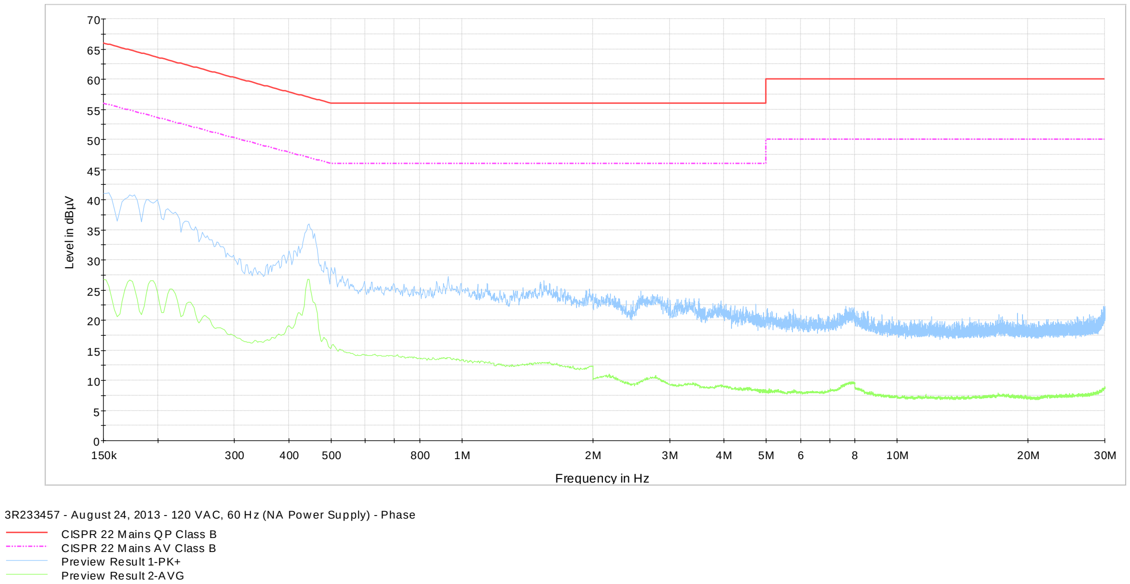
8.1.4 Setup details

Port under test	AC Mains input of I.T.E. power supply
EUT setup configuration	Table top
Measurement details	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:

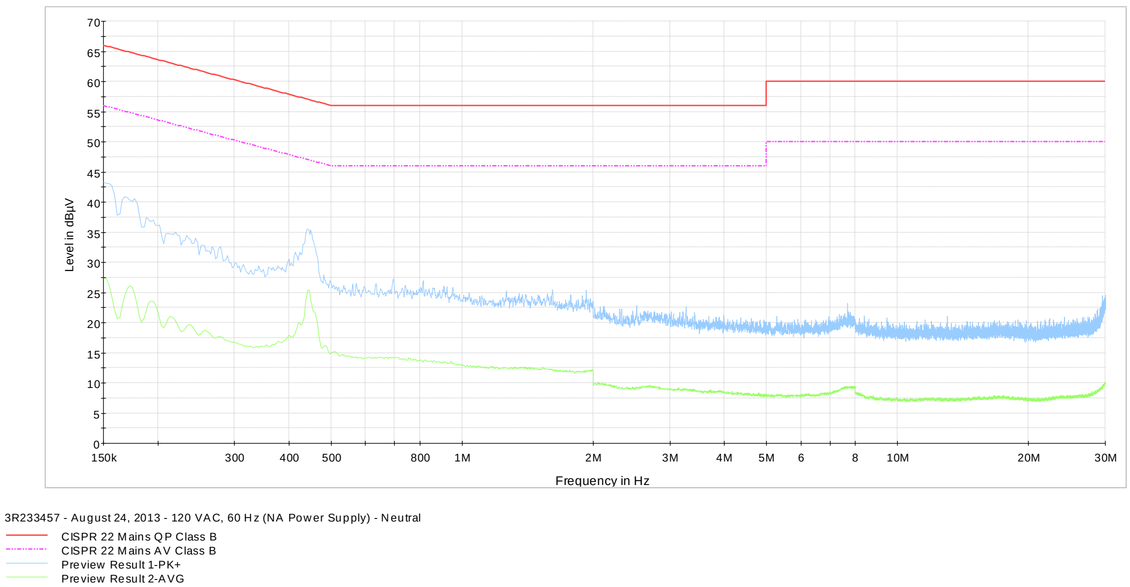
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average (preview measurement); Quasi-peak and Average (final measurement)
Trace mode	Max Hold
Measurement time	100 ms (preview measurement); 1000 ms (final measurement)

8.1.5 Test data



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

Figure 8.1-1: AC power line conducted emissions spectral plot on phase line



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

Figure 8.1-2: AC power line conducted emissions spectral plot on neutral line

8.1.5 Setup photos

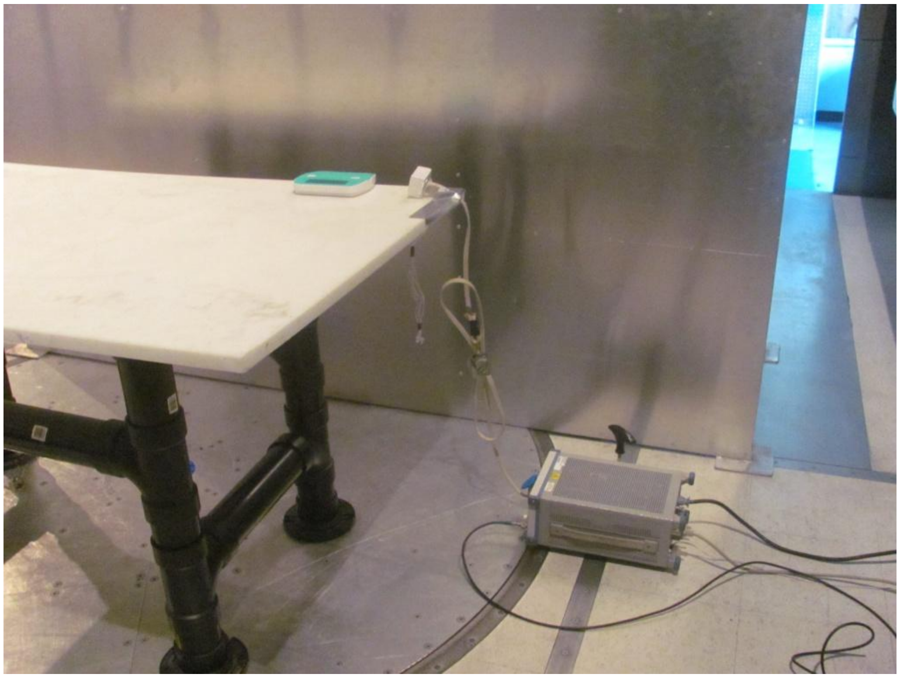


Figure 8.1-3: AC power line conducted emissions setup photo

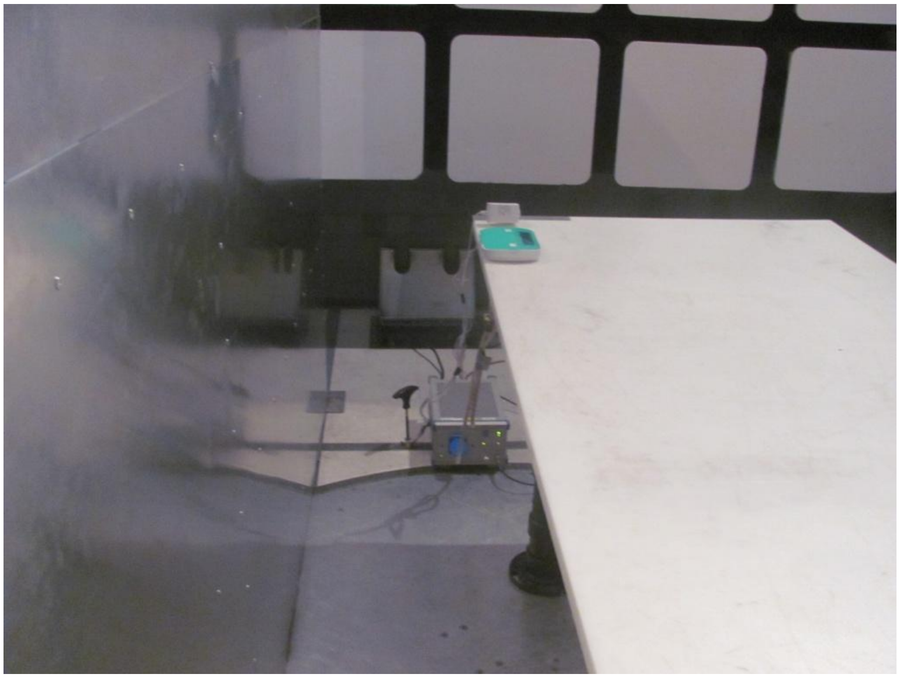


Figure 8.1-4: AC power line conducted emissions setup photo

8.2 Frequency hopping requirements

8.2.1 Definitions and limits

FCC Clause 15.247(a)(1) and (i)
RSS-210 Clause A8.1 (a) and (c)

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

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

IC:

A8.1 (a) Bandwidth of a frequency hopping channel

The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system RF bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset while the long term distribution appears evenly distributed.

A8.1 (c) Frequency hopping systems operating in the 902–928 MHz band

For frequency hopping systems in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

8.2.2 Test summary

Verdict	Pass		
Test date	August 26, 2013	Temperature	24.5 °C
Test engineer	David Duchesne	Air pressure	1001.6 mbar
Test location	Ottawa	Relative humidity	61.2 %

8.2.3 Observations/special notes

- Test performed with modulation enabled.
- Tests were performed with hopping disabled at low, mid and high channel. Tests were additionally performed with hopping enabled.

8.2.4 Test data

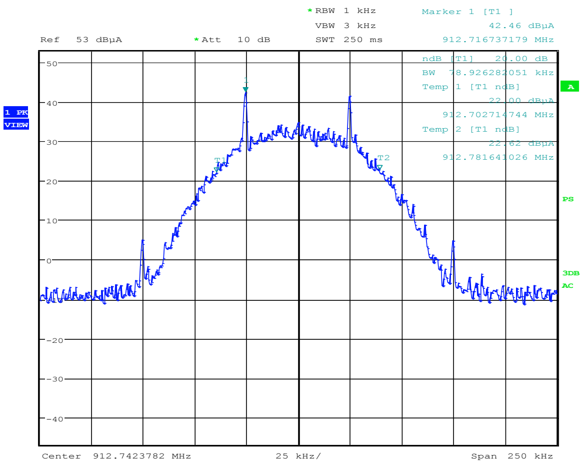


Figure 8.2-1: 20 dB bandwidth – Low channel

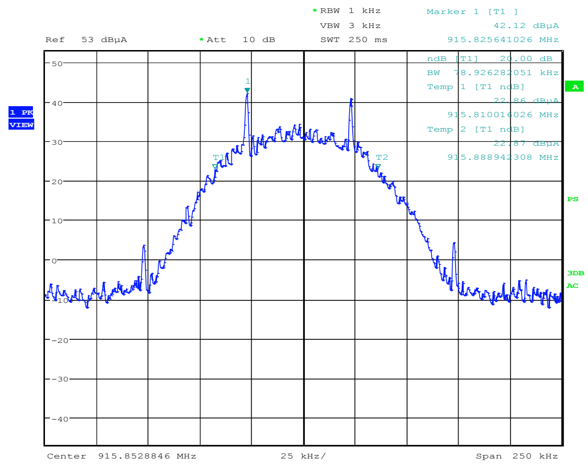


Figure 8.2-2: 20 dB bandwidth – Mid channel

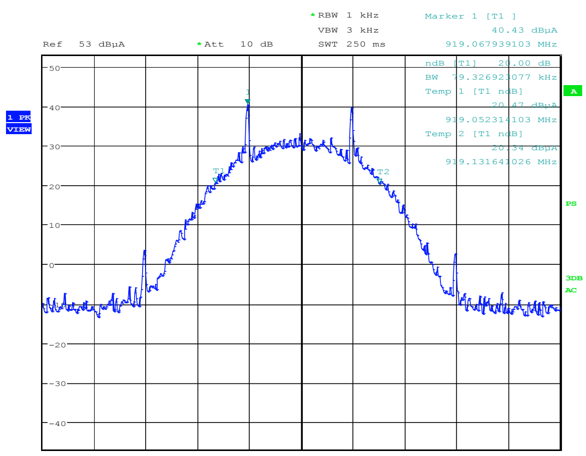


Figure 8.2-3: 20 dB bandwidth – High channel

Table 8.2-1: 20 dB bandwidth results

Frequency (MHz)	20 dB bandwidth (kHz)	Limit (kHz)	Margin (kHz)[1]
912.750 (Low channel)	78.93	500.00	421.07
915.863 (Mid channel)	78.93	500.00	421.07
919.106 (High channel)	79.33	500.00	420.67

Notes: [1] Margin = Limit– 20 dB bandwidth

8.2.4 Test data, continued

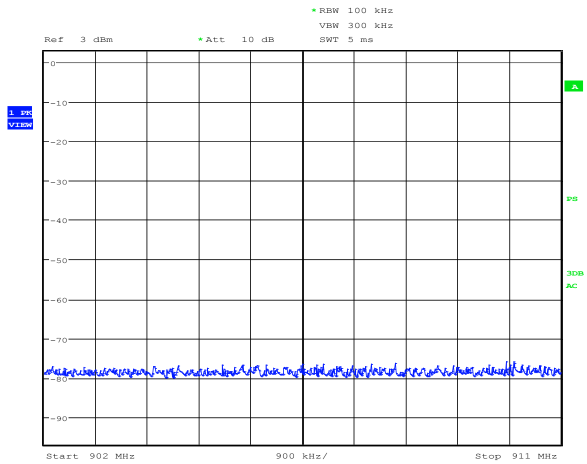


Figure 8.2-4: Number of hopping frequencies in the frequency range 902 to 911 MHz (None)

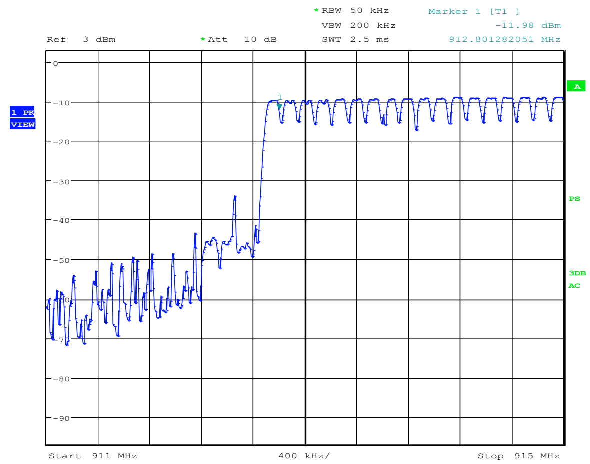


Figure 8.2-5: Number of hopping frequencies in the frequency range 911 to 915 MHz (Eighteen)

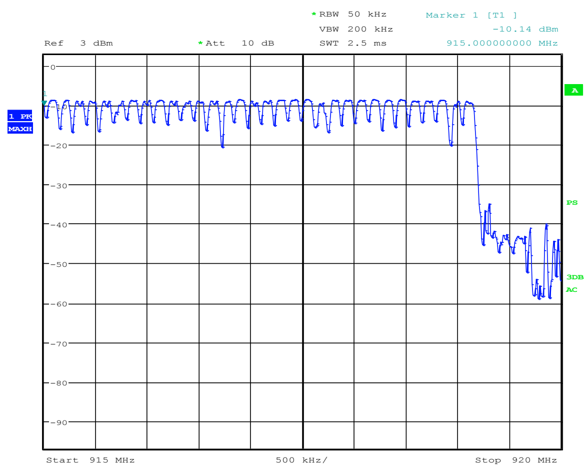


Figure 8.2-6: Number of hopping frequencies in the frequency range 915 to 920 MHz (Thirty two)

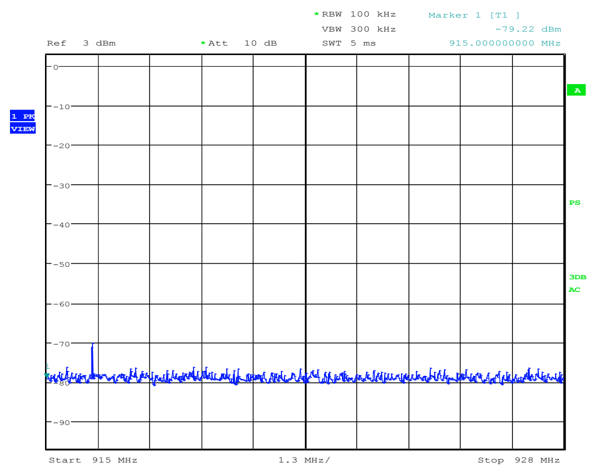


Figure 8.2-7: Number of hopping frequencies in the frequency range 915 to 928 MHz (None)

Table 8.2-2: Number of hopping frequencies

Number of hopping frequencies	Minimum required number of hopping frequencies
50	50

Notes: None

8.2.4 Test data, continued

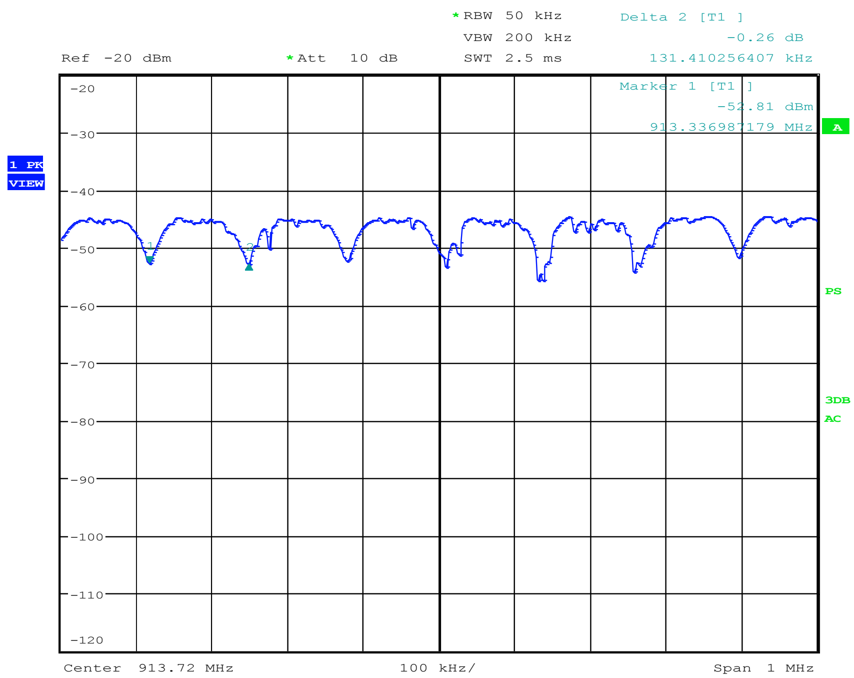


Figure 8.2-8: Carrier frequency separation

Table 8.2-3: Carrier frequency separation

Carrier frequency separation (kHz)	Minimum limit (kHz)[1]	Margin (kHz)[2]
131.41	79.33	52.08

Notes: [1] Limit = 20 dB bandwidth
[2] Margin = Carrier frequency separation – Minimum limit

8.2.4 Test data, continued

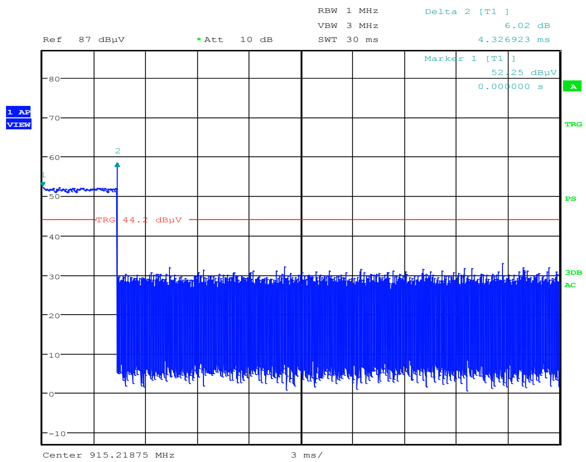


Figure 8.2-9: Average time of occupancy (dwell time)

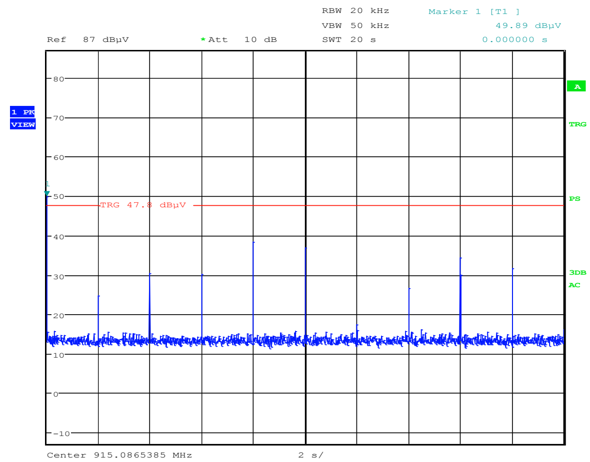


Figure 8.2-10: Average time of occupancy (hop interval)

Table 8.2-4: Average time of occupancy results

Assigned frequency range (MHz)	Average time of occupancy* (s)	Average time of occupancy limit (s)	Margin (s)
902–928	0.00432	0.40000	0.39568

Notes: Dwell time = 4.32 ms
Hop interval > 20 s
Number of hopping frequencies is 50
Period = 0.4 (seconds/channel) × 50 (channels) = 20 s

*Average time of occupancy calculation:
Average time of occupancy = (Period / hop interval) × Dwell time
Average time of occupancy = (20 s/20 s) × 0.00432 s
Average time of occupancy = 4.32 ms

8.3 Occupied bandwidth

8.3.1 Definitions and limits

RSS-Gen Clause 4.6.1 Occupied bandwidth

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 percent emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1 percent of the selected span as is possible without being below 1 percent. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used since a peak or, peak hold, may produce a wider bandwidth than actual.

The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 percent of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded.

The span between the two recorded frequencies is the occupied bandwidth.

8.3.2 Test summary

Verdict	Pass		
Test date	August 26, 2013	Temperature	24.5 °C
Test engineer	David Duchesne	Air pressure	1001.6 mbar
Test location	Ottawa	Relative humidity	61.2 %

8.3.3 Observations/special notes

- Test performed with modulation enabled.
- Tests were performed with hopping disabled at low, mid and high channel.

8.3.4 Setup details

Spectrum analyzer settings

Resolution bandwidth	3 kHz
Video bandwidth	30 kHz
Span	300 kHz
Sweep	Auto
Detector mode	Peak
Trace mode	Max Hold

8.3.5 Test data

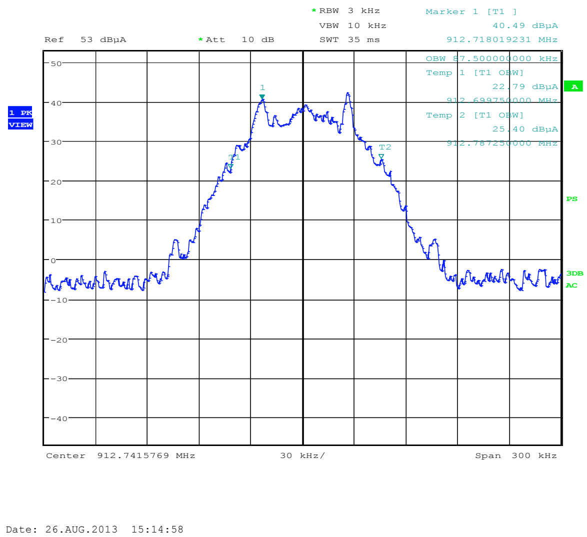


Figure 8.3-1: 99 % bandwidth – Low channel

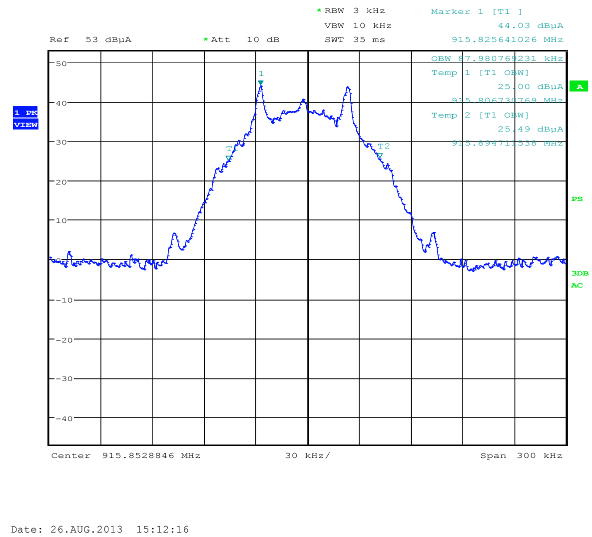


Figure 8.3-2: 99 % bandwidth – Mid channel

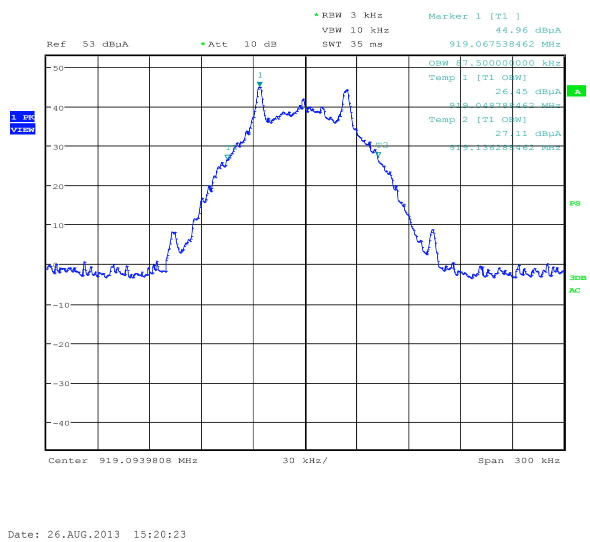


Figure 8.3-3: 99 % bandwidth – High channel

Table 8.3-1: 99 % bandwidth results

Frequency (MHz)	99% bandwidth (kHz)
912.750 (Low channel)	87.50
915.863 (Mid channel)	87.98
919.106 (High channel)	87.50

Notes: None

8.4 Transmitter output power and EIRP requirements for frequency hopping systems

8.4.1 Definitions and limits

FCC Clause 15.247(b) (2)
RSS-210 Clause A8.4 (1)

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

(2) For frequency hopping systems operating in the 902–928 MHz band: 1 W (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 W (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

IC:
With the digital modulation operation of the hybrid system turned off, the frequency hopping operation shall have an average time of occupancy on any frequency not exceeding 0.4 seconds within a duration in seconds equal to the number of hopping frequencies multiplied by 0.4.

A8.4 (1) Transmitter Output Power and e.i.r.p. Requirements for Frequency hopping systems operating in the 902–928 MHz band
For frequency hopping systems operating in the band 902–928 MHz, the maximum peak conducted output power shall not exceed 1 W (30 dBm), and the e.i.r.p. shall not exceed 4 W (36 dBm), if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W (24 dBm), and the e.i.r.p. shall not exceed 1 W (30 dBm), if the hopset uses less than 50 hopping channels.

8.4.2 Test summary

Verdict	Pass		
Test date	August 26, 2013	Temperature	24.5 °C
Test engineer	Daniel Hynes	Air pressure	1001.6 mbar
Test location	Ottawa	Relative humidity	61.2 %

8.4.3 Observations/special notes

- Test performed with modulation enabled.
- Tests were performed with hopping disabled at low, mid and high channel.

8.4.4 Setup details

EUT setup configuration	Table top
Test facility	3 m Semi anechoic chamber
Measuring distance	3 m
Antenna height variation	1–4 m
Turn table position	0–360°

Spectrum analyzer settings

Resolution bandwidth	1 MHz (RBW > the 20 dB bandwidth of the emission being measured)
Video bandwidth	3 MHz
Span	Approximately 5 times the 20 dB bandwidth, centered on a hopping channel
Sweep	Auto
Detector mode	Peak
Trace mode	Max Hold

8.4.5 Test data

Table 8.4-1: EIRP measurement and calculation results

Frequency (MHz)	Antenna polarization	Field strength (dBµV/m)[1]	Theoretical conversion factor (dB)[2]	EIRP (dBm)	EIRP limit (dBm)	Margin (dB)
912.750	V	106.51	−95.23	11.28	36.00	24.72
	H	112.59	−95.23	17.36	36.00	18.64
915.853	V	105.86	−95.23	10.63	36.00	25.37
	H	115.23	−95.23	20.00	36.00	16.00
919.106	V	100.99	−95.23	5.76	36.00	30.24
	H	111.61	−95.23	16.38	36.00	19.62

Notes: [1] Field strength (dBµV/m) = spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor = antenna factor ACF (dB) + cable loss (dB)
Sample calculation: 114.07 dBµV/m (field strength) = 88.07 dBµV (receiver reading) + 26 dB (Correction factor)

[2] Theoretical conversion from field strength measured at 3 m to power conducted from the intentional radiator to the antenna:

$$\frac{P \times G}{4\pi \times d^2} = \frac{E^2}{120\pi}$$

$$P = \frac{E^2 \times 4\pi \times d^2}{120\pi \times G} = \frac{E^2 \times d^2}{30 \times G}$$

P = Output power (W)
E = Measured field strength value (V/m)
d = Measurement distance (m)
G = Antenna Gain (numeric)

Therefore for *d* = 3 m,

$$P[dBW] = E[dBV/m] + 20 \cdot Log_{10}(3)[dB] - 10 \cdot Log_{10}(30)[dB] - 10 \cdot Log_{10}(G)[dBi]$$

$$P[dBW] = E[dBV/m] + 9.54\ [dB] - 14.77\ [dB] - 10 \cdot Log_{10}(G)[dBi] = E[dBV/m] - 5.23\ [dB] - 10 \cdot Log_{10}(G)[dBi]$$

where

$$P[W] = P[mW] \div 1{,}000 \rightarrow\ P[dBW] = P[dBmW] - 10 \times Log_{10}(1{,}000)[dB] \rightarrow P[dBW] = P[dBmW] - 30\ [dB]$$

$$E[V/m] = E[\mu V/m] \div 1{,}000{,}000 \rightarrow\ E[dBV/m] = E[dB\mu V/m] - 20 \times Log_{10}(1{,}000{,}000)[dB] \rightarrow E[dBV/m] = E[dB\mu V/m] - 120\ [dB]$$

From which we obtain

$$P[dBmW] = P[dBm] = E[dB\mu V/m] - 120\ [dB] - 5.23\ [dB] - 10 \cdot Log_{10}(G)[dBi] + 30\ [dB]$$

$$P[dBm] = E[dB\mu V/m] - 95.23\ [dB] - 10 \cdot Log_{10}(G)[dBi]$$
$$Output\ power\ [dBm] = Field\ strength\ [dB\mu V/m] - 95.23\ [dB] - Antenna\ gain\ [dBi]$$
$$EIRP\ [dBm] = Field\ strength\ [dB\mu V/m] - 95.23\ [dB]$$

Table 8.4-2: Output power calculation results

Frequency (MHz)	EIRP (dBm)	Antenna gain (dBi)	Output power (dBm)	Output power limit (dBm)	Margin (dB)
912.750	17.36	-3.78	21.14	30.00	8.86
915.853	20.25	-3.78	24.03	30.00	5.97
919.106	16.38	-3.78	20.16	30.00	9.84

Notes: Output power [dBm] = EIRP [dBm] − Antenna gain [dBi]; Margin = Limit – Output power

8.4.6 Setup photos

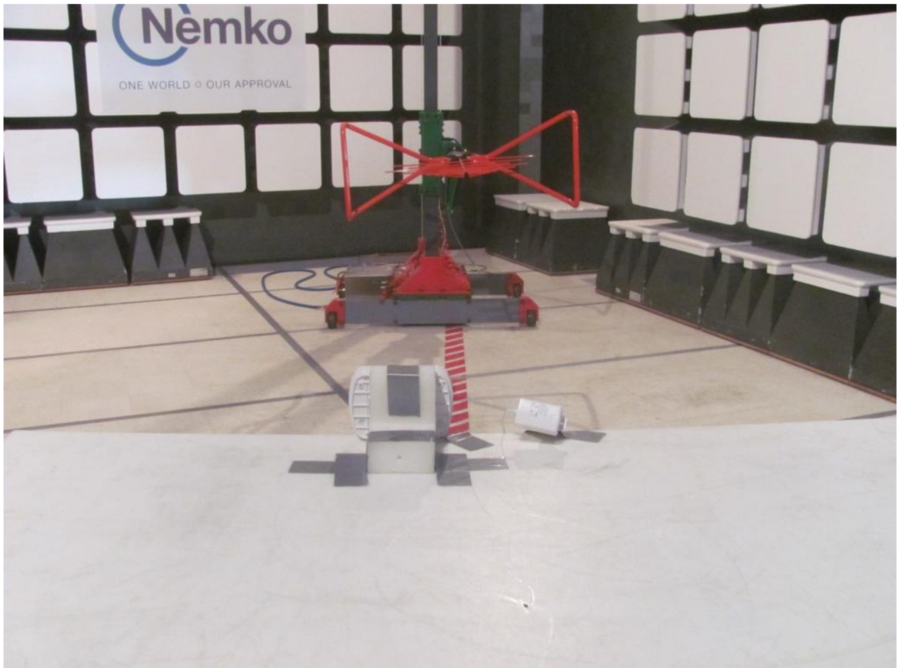


Figure 8.4-1: Transmitter output power and e.i.r.p. setup photo

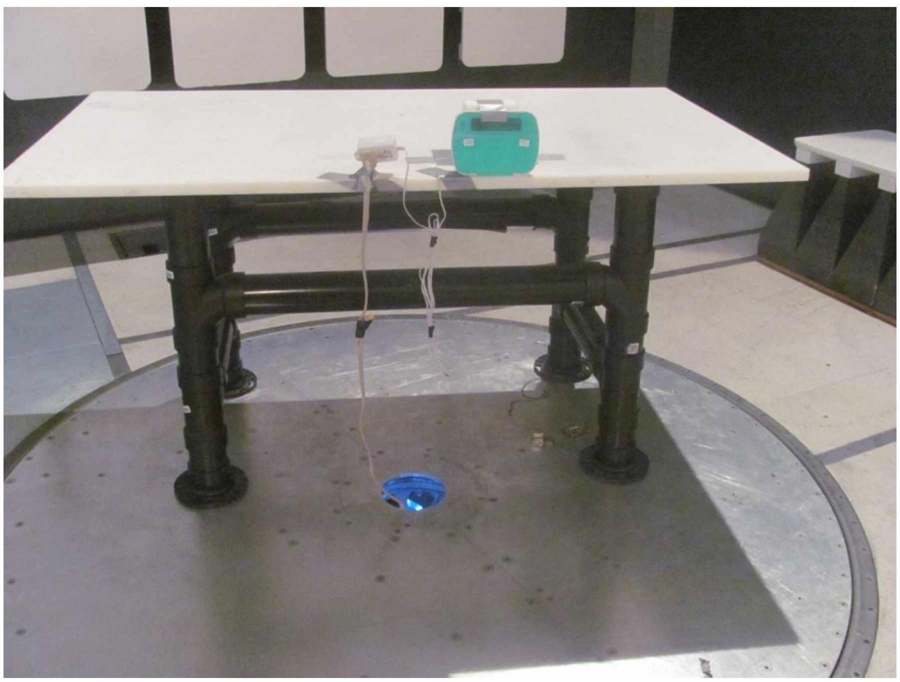


Figure 8.4-2: Transmitter output power and e.i.r.p. setup photo

8.5 Spurious (out-of-band) emissions

8.5.1 Definitions and limits

FCC Clause 15.247(d): Spurious emissions
RSS-210 Clause A8.5 Out-of-band emissions

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 radio frequency 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 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 Section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in **Table 8.5–1** is not required.

Table 8.5-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency (MHz)	Field strength (µV/m)	Field strength (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: *– applicable only to FCC requirements

8.5.1 Definitions and limits, continued

Table 8.5-2: FCC Restricted bands of operation

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			

Notes: *– applicable only to FCC requirements

Table 8.5-3: IC Restricted bands of operation

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

Notes: Certain frequency bands listed in
Table 8.5-3 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

8.5.2 Test summary

Verdict	Pass		
Test date	August 26, 2013	Temperature	24.5 °C
Test engineer	Daniel Hynes	Air pressure	1001.6 mbar
Test location	Ottawa	Relative humidity	61.2 %

8.5.3 Observations/special notes

- The spectrum was searched from 30 MHz to the 10th harmonic.
- Test performed with modulation enabled.
- Tests were performed with hopping disabled at low, mid and high channel. Tests were additionally performed with hopping enabled.

8.5.4 Setup details

EUT setup configuration	Table top
Test facility	3 m Semi anechoic chamber
Measuring distance	3 m
Antenna height variation	1–4 m
Turn table position	0–360°

Spectrum analyzer settings for emissions that fall outside restricted bands:

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

Spectrum analyzer settings for emissions that fall within restricted bands below 1 GHz:

Resolution bandwidth	100 kHz (120 kHz for Q-Peak)
Video bandwidth	300 kHz
Sweep	Auto
Detector mode	Peak or Quasi-Peak
Trace mode	Max Hold

Spectrum analyzer settings for emissions that fall within restricted bands above 1 GHz:

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

8.5.5 Test data

Spurious (Out of band) emissions

- All spurious peak emissions outside of the authorized frequency band with a 100 kHz bandwidth were greater than 30 dB below the transmitter output power.
- Radiated spurious emissions that fell within restricted bands that were within 20 dB of the limit have been recorded. See Table 8.5–4

Table 8.5-4: Radiated spurious emissions within restricted bands.

Freq. (MHz)	Ant. Pol. (V/H)	Meas. peak field strength[1] (dBμV/m)	Peak field strength limit (dBμV/m)	Peak field strength margin[3] (dB)	Duty cycle cor. factor[4] (dB)	Calculated average field strength[2] (dBμV/m)	Average field strength limit (dBμV/m)	Average field strength margin (dB)
912.750 (Low-Channel)								
2738.25	H	61.62	74.00	12.38	-27.29	34.33	54.00	19.67
3651.00	H	61.18	74.00	12.82	-27.29	33.89	54.00	20.11
4563.75	H	66.75	74.00	7.25	-27.29	39.46	54.00	14.54
7302.00	H	62.86	74.00	11.14	-27.29	35.57	54.00	18.43
8214.75	H	62.62	74.00	11.38	-27.29	35.33	54.00	18.67
9127.50	V	61.10	74.00	12.90	-27.29	33.81	54.00	20.19
915.863 (Mid-Channel)								
2747.59	H	64.10	74.00	9.90	-27.29	36.81	54.00	17.19
3663.45	V	65.95	74.00	8.05	-27.29	38.66	54.00	15.34
4579.32	V	67.20	74.00	6.80	-27.29	39.91	54.00	14.09
7326.90	H	60.12	74.00	13.88	-27.29	32.83	54.00	21.17
8242.77	V	65.78	74.00	8.22	-27.29	38.49	54.00	15.51
9158.63	V	64.97	74.00	9.03	-27.29	37.68	54.00	16.32
919.106 (High Channel)								
2757.32	H	61.03	74.0	12.97	-27.29	33.74	54.0	20.26
3676.42	H	60.77	74.0	13.23	-27.29	33.48	54.0	20.52
4595.53	V	66.75	74.0	7.25	-27.29	39.46	54.0	14.54
7352.84	V	62.80	74.0	11.20	-27.29	35.51	54.0	18.49
8271.95	V	63.62	74.0	10.38	-27.29	36.33	54.0	17.67
9191.05	V	62.59	74.0	11.41	-27.29	35.30	54.0	18.70

Notes: [1] Field strength (dBμV/m) = spectrum analyzer value (dBμV) + correction factor (dB)
Correction factor = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (dB)
Sample calculation: 66.68 dBμV/m (field strength) = 77.58 dBμV (receiver reading) + (−10.9 dB) (Correction factor)

[2] Calculated average field strength (dBμV/m) = measured Average field strength (dBμV/m) + Duty cycle correction factor (dB). Duty cycle correction factor as calculated from §15.35 (c)

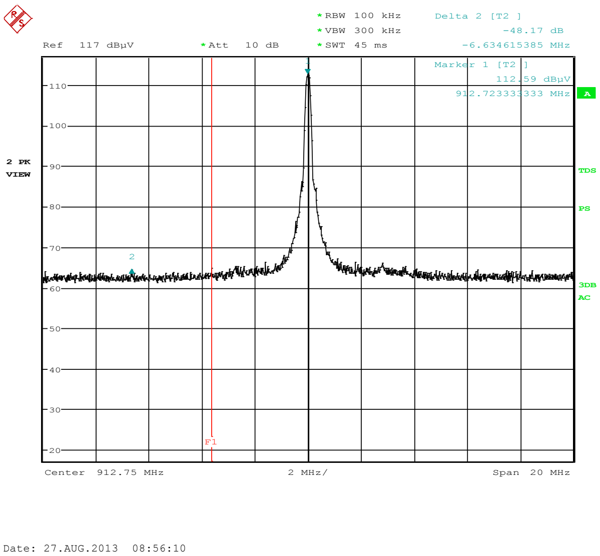
[3] Margin (dB) = field strength limit - field strength

[4] Duty cycle correction factor = −27.29 dB Tx$_{100\ ms}$ = 4.32 ms

$$Dutycycle/averagefactor = 20 \times \log_{10}\left(\frac{Tx_{100ms}}{100ms}\right)$$

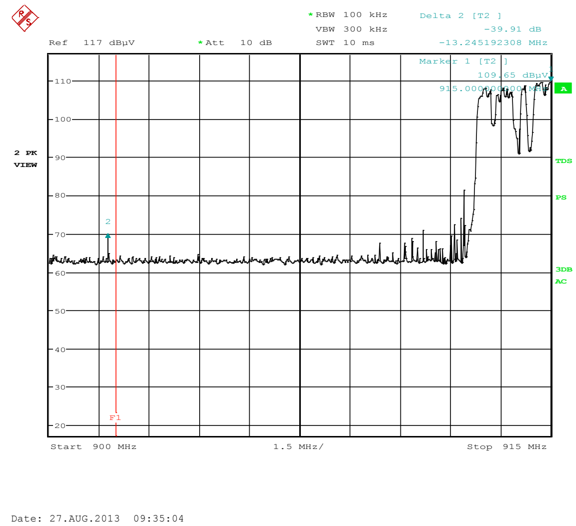
$$Dutycycle/averagefactor = 20 \times \log_{10}\left(\frac{4.32ms}{100ms}\right) = -27.29[dB]$$

8.5.5 Test data, continued



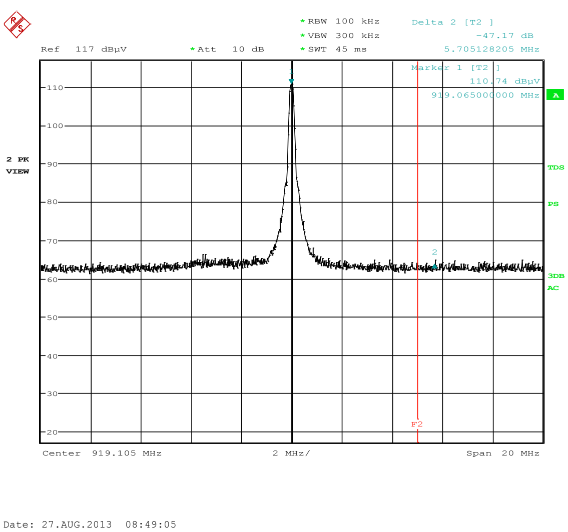
F1 = 902 MHz (Lower band edge)

Figure 8.5-1: Radiated spurious emissions Lower band edge (Tx at lowest channel)



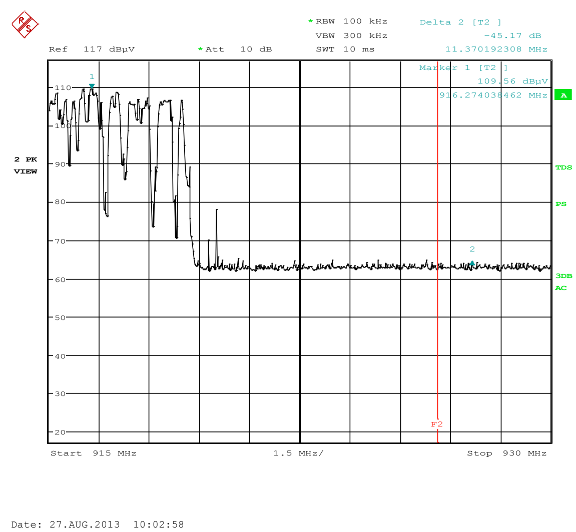
F1 = 902 MHz (Lower band edge)

Figure 8.5-2: Radiated spurious emissions Lower band edge (Tx Hopping)



F2 = 928 MHz (Upper band edge)

Figure 8.5-3: Radiated spurious emissions Lower band edge (Tx at highest channel)



F2 = 928 MHz (Upper band edge)

Figure 8.5-4: Radiated spurious emissions Lower band edge (Tx Hopping**)**

8.5.5 Setup photos

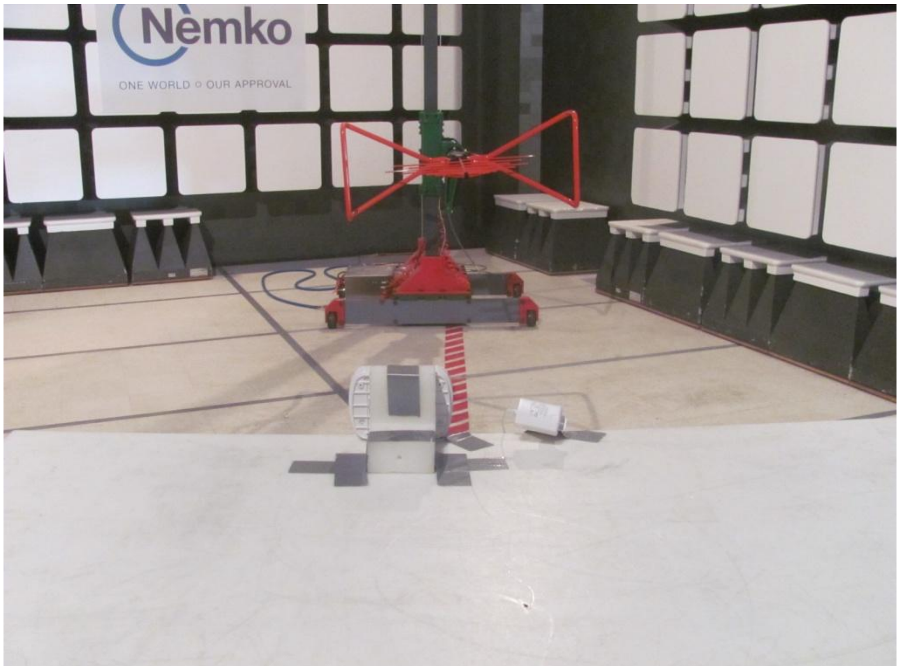


Figure 8.5-5: Radiated spurious emissions setup photo

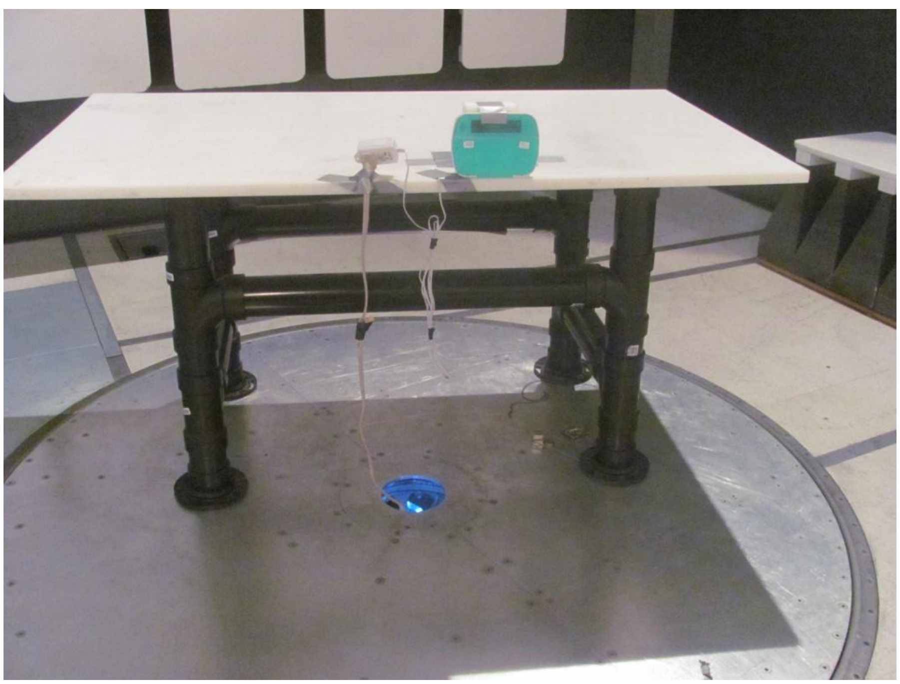
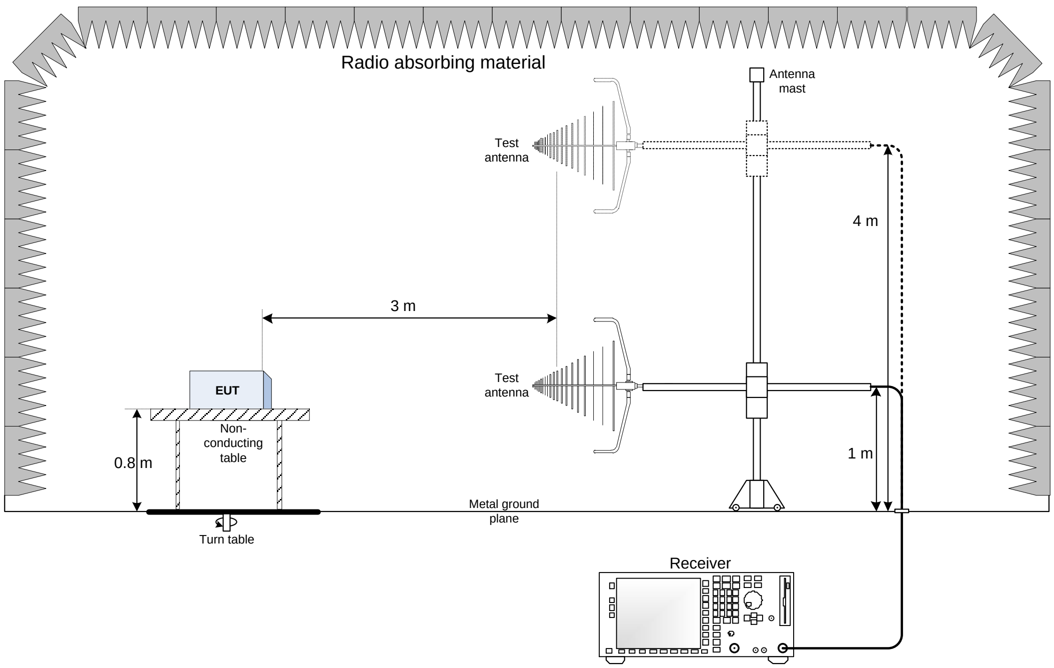


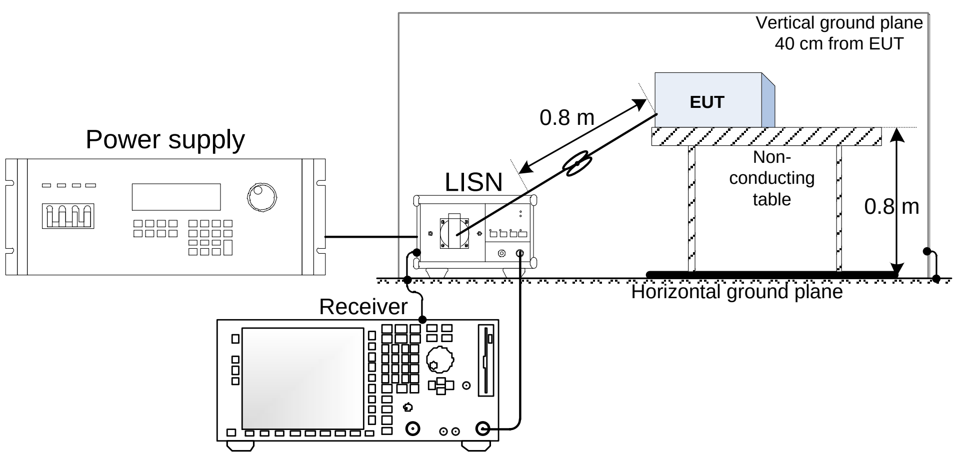
Figure 8.5-6: Radiated spurious emissions setup photo

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Conducted emissions set-up



Section 10 EUT detailed photos

10.1 External photos