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Test report

296004-1TRFWL

Date of issue: April 29, 2016

Applicant:

Bosch Security Systems

Product:

RADION Motion Sensor

Model:

RFDL-ZB

Model variants:

RFDL-ZB-ES and RFDL-ZB-MS

FCC ID:

T3X-DL-ZB

IC Registration number:

1249A-DLZB

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

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	David Duchesne, Senior EMC/Wireless Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Review date	April 29, 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.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Bosch Security Systems
Address	130 Perinton Parkway, Fairport, NY 14450, USA

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 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

1.3 Test methods

558074 D01 DTS Meas Guidance v03 r05 (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	Not applicable[3]
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes:
[1] The testing was performed with fully charged battery
[2] The antenna is located within the enclosure of EUT and not user accessible.
[3] EUT is a battery powered device

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

Notes: None

2.3 IC RSS-GEN, Issue 4, test results

Part	Test description	Verdict
7.1.2	Receiver radiated emission limits	Not applicable[1]
7.1.3	Receiver conducted emission limits	Not applicable[1]
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Not applicable[2]

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 EUT is a battery powered device

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	December 7, 2015
Nemko sample ID number	133-001888 (Conducted sample) and 133-001886 (Radiated sample)

3.2 EUT information

Product name	RADION Motion Sensor
Model	RFDL-ZB
Model variant	– RFDL-ZB-ES – RFDL-ZB-MS *Models RFDL-ZB, RFDL-ZB-ES and RFDL-ZB-MS all use the same PCB's just marking information is different. –ES is for a specific customer and –MS is for any customer other than Bosch or –ES.*
Serial number	102815-0024 (Conducted sample), 102818-0020 (Radiated sample)

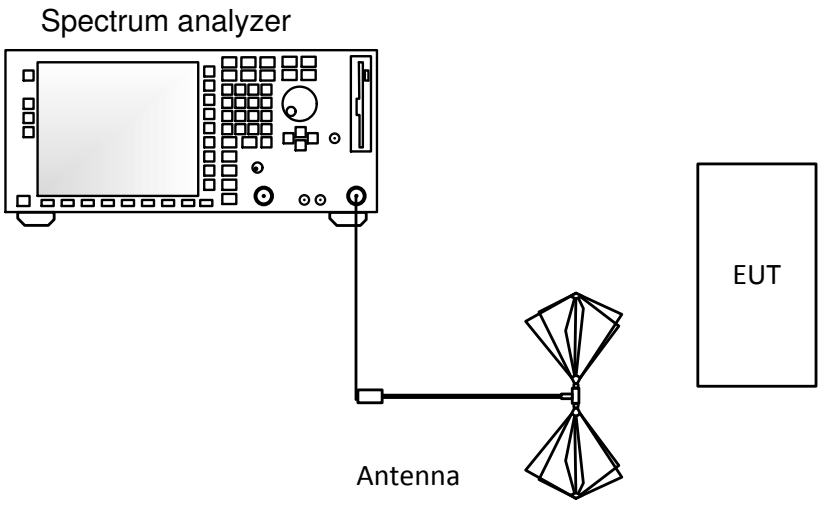
3.3 Technical information

All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-247 Issue 1, May 2015
Frequency band (MHz)	2400–2483.5
Frequency Min (MHz)	2405
Frequency Max (MHz)	2480
RF power Min (W)	0.010 Watts **or** 10.10 dBm
RF power Max (W), Conducted	0.082 Watts **or** 19.15 dBm
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	1650.6
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification	F1D
Transmitter spurious, Units @ distance	64.24 dBµV/m Peak and 53.39 dBµV/m Average @ 3 m @ 2483.5 MHz
Power requirements	3 V_{DC} (2x Lithium battery)
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. – Inverted F antenna –1.3 dBi – Circular SEMI-Loop antenna 1.5 dBi The antennas are a proprietary design by Bosch and are integrated into the printed circuit board.

3.4 Product description and theory of operation

The EUT was set to continuous transmit state.

3.5 EUT exercise details



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

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
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/17
Biconical antenna (30–300 MHz)	Sunol	BC2	FA002078	1 year	Mar. 04/17
Log periodic antenna (200–5000 MHz)	Sunol	LP5	FA002077	1 year	Mar. 14/17
Horn antenna (1–18 GHz)	EMCO	3115	FA000649	1 year	Aug. 31/16
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	April 26/17
50 Ω coax cable	C.C.A.	None	FA002555	1 year	April 26/17
50 Ω coax cable	Huber + Suhner	None	FA002074	1 year	April 26/17

Notes: None

Section 8. Testing data

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

8.1.1 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.

8.1.2 Test summary

Verdict	Pass				
Test date	April 28, 2016	Test engineer	David Duchesne		
Temperature	24 °C	Relative humidity	28 %	Air pressure	1005 mbar

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	10 MHz
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: *6 dB bandwidth results*

Frequency, MHz	6 dB bandwidth, kHz	Minimum limit, kHz	Margin, kHz
2405.00	1618.6	500	1118.6
2440.00	1618.6	500	1118.6
2475.00	1650.6	500	1150.6
2480.00	1586.5	500	1086.5

Notes: None

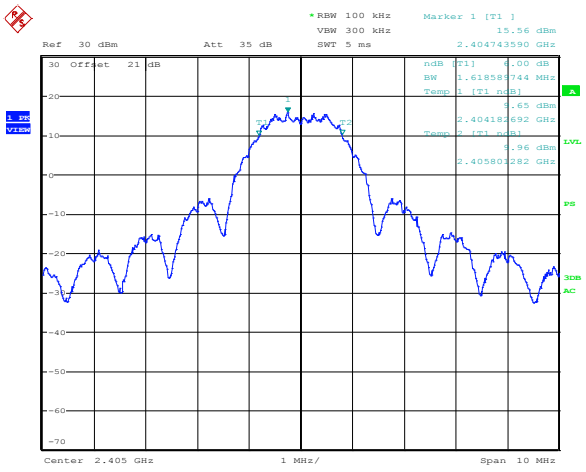


Figure 8.1-1: *6 dB bandwidth (2405 MHz)*

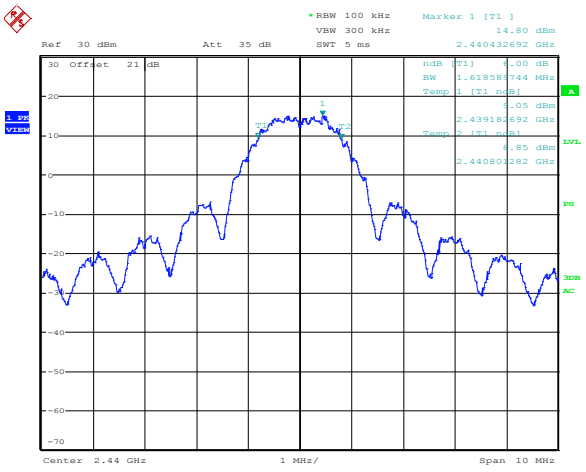


Figure 8.1-2: *6 dB bandwidth (2440 MHz)*

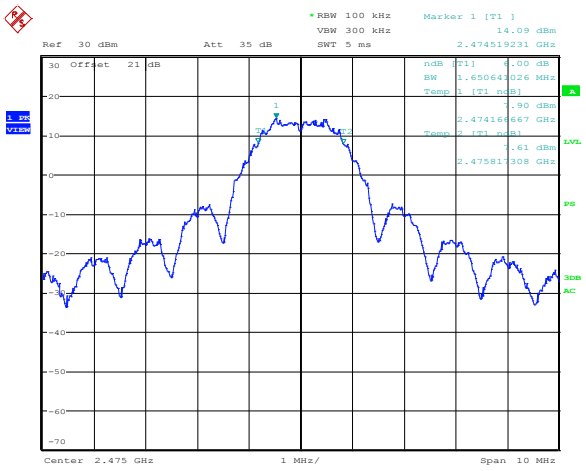


Figure 8.1-3: *6 dB bandwidth (2475 MHz)*

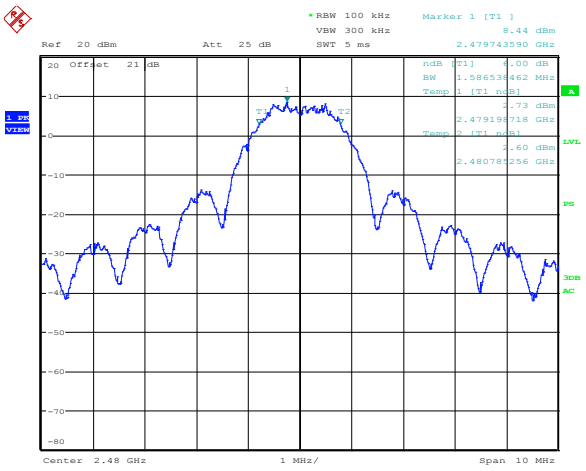


Figure 8.1-4: *6 dB bandwidth (2480 MHz)*

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

8.2.1 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.

8.2.2 Test summary

Verdict	Pass				
Test date	April 28, 2016	Test engineer	David Duchesne		
Temperature	24 °C	Relative humidity	28 %	Air pressure	1005 mbar

8.2.3 Observations, settings and special notes

Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05 (The test was performed using method described in section 9.1.1)

Spectrum analyser settings:

Resolution bandwidth	2 MHz
Video bandwidth	≥3 × RBW
Frequency span	20 MHz
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *Output power and EIRP results*

Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
2405.00	19.15	30.00	10.85	−1.30 [1]	17.85	36.00	18.15
2440.00	18.92	30.00	11.08	−1.30 [1]	17.62	36.00	18.38
2475.00	18.15	30.00	11.85	−1.30 [1]	16.85	36.00	19.15
2480.00	10.10	30.00	19.90	−1.30 [1]	8.80	36.00	27.20
2405.00	19.15	30.00	10.85	1.50 [2]	20.65	36.00	15.35
2440.00	18.92	30.00	11.08	1.50 [2]	20.42	36.00	15.58
2475.00	18.15	30.00	11.85	1.50 [2]	19.65	36.00	16.35
2480.00	12.09	30.00	17.91	1.50 [2]	13.59	36.00	22.41

Notes: EIRP = Output power + Antenna gain
For Tx 2405, 2440, and 2475 MHz, The SI Chip was set to −5 dBm
For Tx 2480 MHz , The SI Chip was set to −14 dBm for Inverted F antenna and −12 dBm for SEMI-Loop antenna
[1] Inverted F antenna (Measured gains inside enclosure as provided by client)
[2] Circular SEMI-Loop antenna. (Measured gains inside enclosure as provided by client)

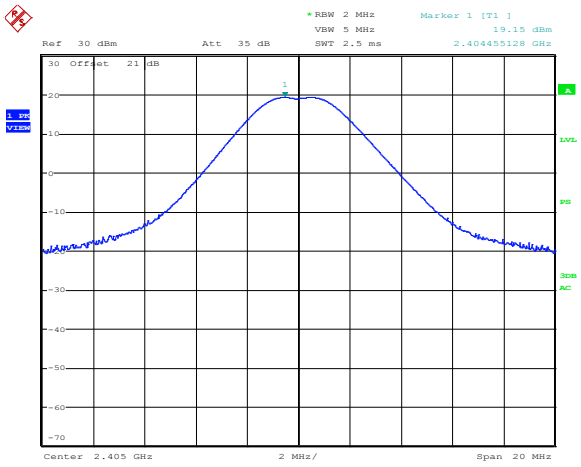


Figure 8.2-1: *Conducted output power (2405 MHz)*

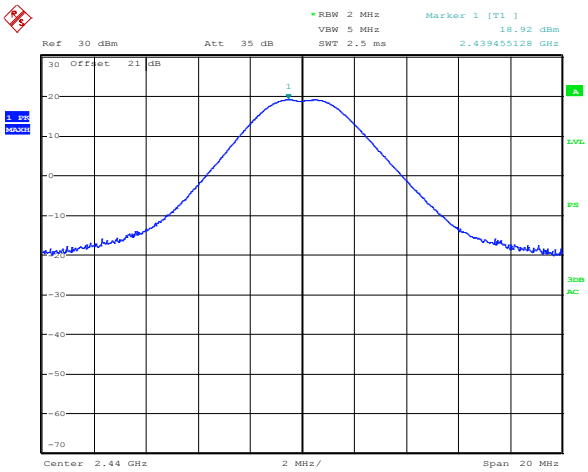


Figure 8.2-2: *Conducted output power (2440 MHz)*

8.2.4 Test data, continued

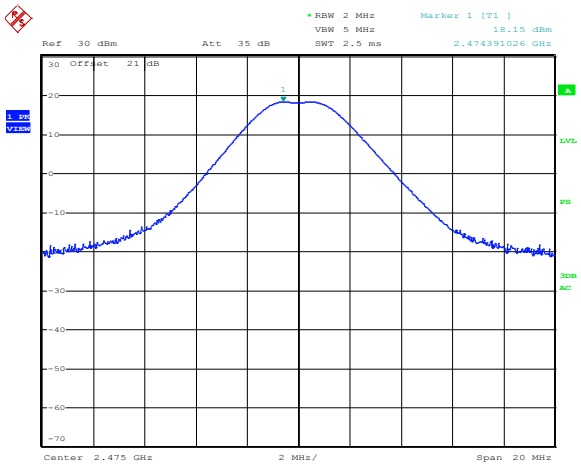


Figure 8.2-3: *Conducted output power (2475 MHz)*

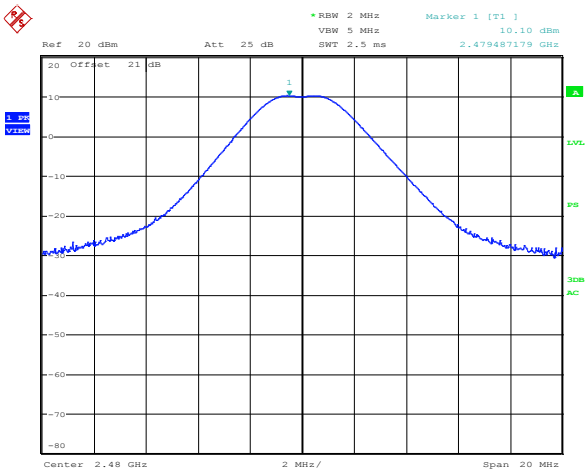


Figure 8.2-4: *Conducted output power (2480 MHz) @ −14 dBm*

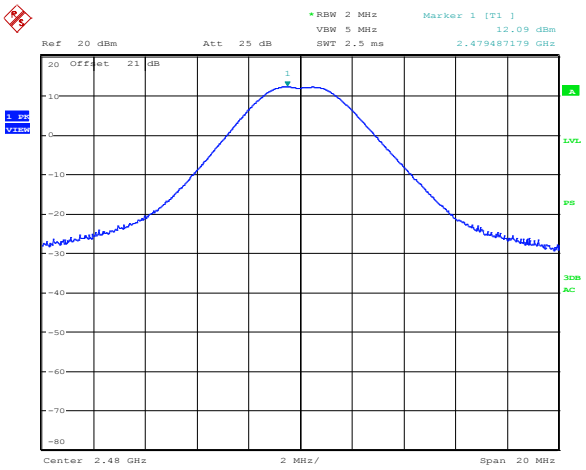


Figure 8.2-5: *Conducted output power (2480 MHz) @ −12 dBm*

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

8.3.1 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 8.3-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/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 8.3-2: *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

Notes: Certain frequency bands listed in
Table 8.3-2 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 8.3-3: *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			

8.3.2 Test summary

Verdict	Pass				
Test date	April 28, 2016	Test engineer	David Duchesne		
Temperature	24 °C	Relative humidity	28 %	Air pressure	1005 mbar

8.3.3 Observations, settings and special notes

- The spectrum was searched from 30 MHz to the 10th harmonic.
- EUT was set to transmit with 100 % duty cycle.
- Since fundamental power was tested using peak method, the spurious emissions limit is −20 dBc/100 kHz
- For Tx 2405, 2440, and 2475 MHz, The SI Chip was set to −5 dBm. For Tx 2480 MHz , The SI Chip was set to −14 dBm for Inverted F antenna and −12 dBm for SEMI-Loop antenna

Spectrum analyser settings for radiated measurements within un-restricted bands:

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

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

8.3.4 Test data

Conducted spurious emissions within non-restricted bands, test results

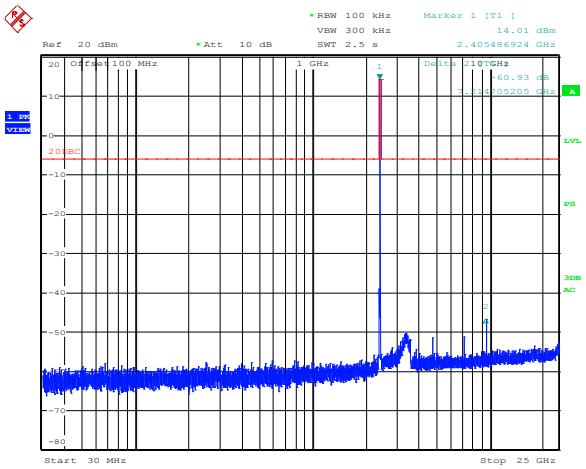


Figure 8.3-1: Conducted (TX 2402 MHz)

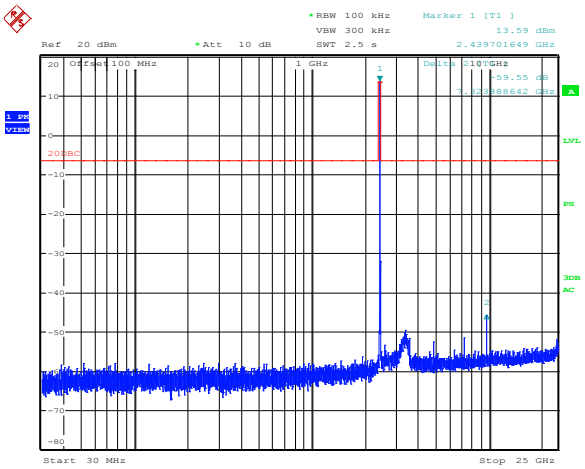


Figure 8.3-2: Conducted (TX 2440 MHz)

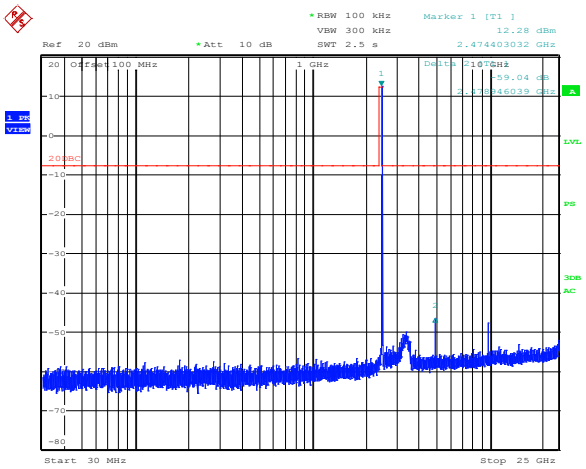


Figure 8.3-3: Conducted (TX 2475 MHz)

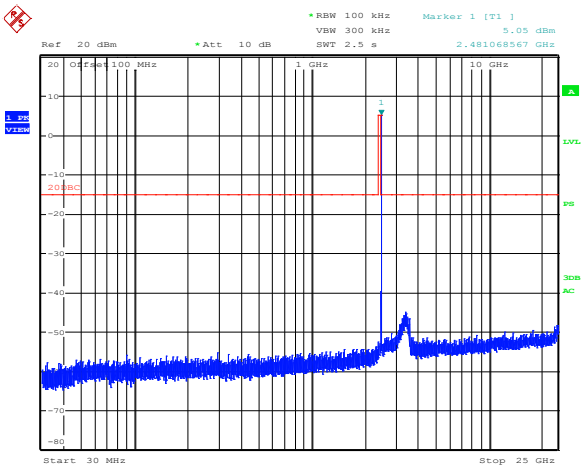


Figure 8.3-4: Conducted (TX 2480 MHz) *@ −14 dBm*

8.3.4 Test data, continued

Conducted spurious emissions within non-restricted bands, test results

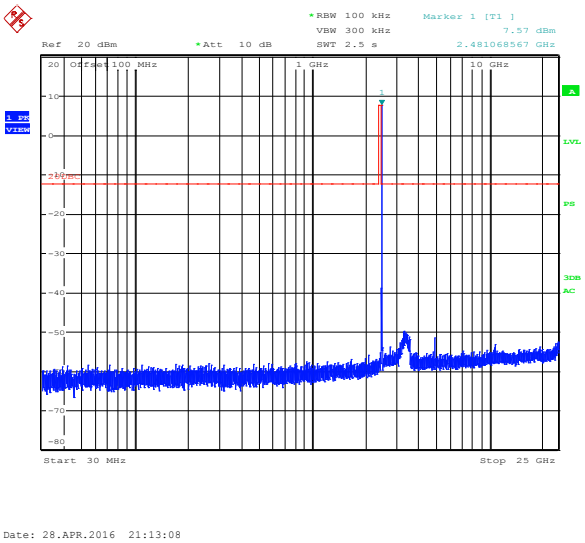


Figure 8.3-5: Conducted (TX 2480 MHz) *@ −12 dBm*

8.3.4 Test data, continued

Conducted spurious emissions within non-restricted bands, test results

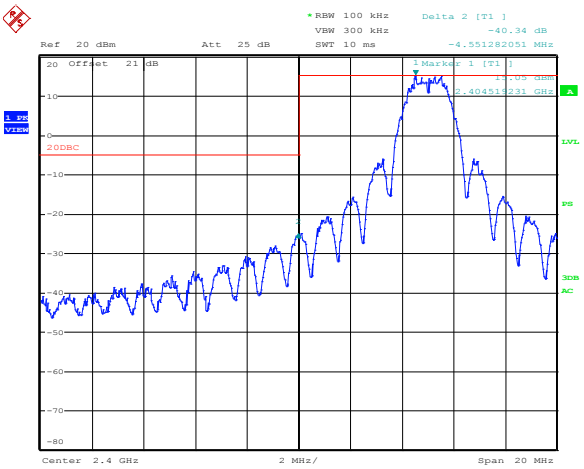


Figure 8.3-6: *Lower band edge,* Conducted (TX 2405 MHz)

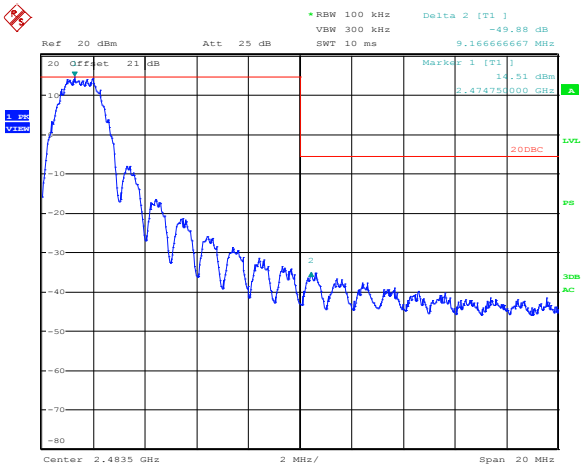


Figure 8.3-7: *Upper band edge,* Conducted (TX 2475 MHz)

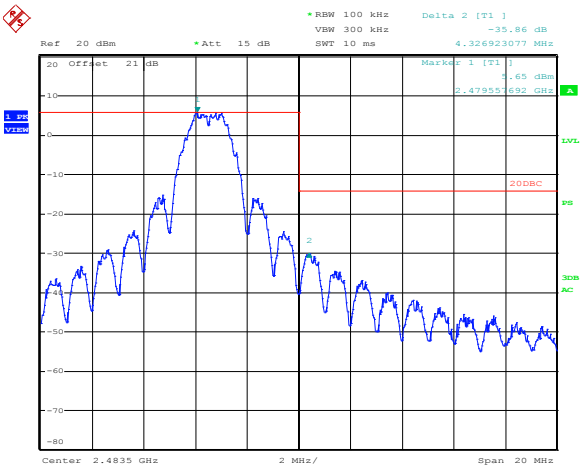


Figure 8.3-8: *Upper band edge,* Conducted (TX 2480 MHz) *@ −14 dBm*

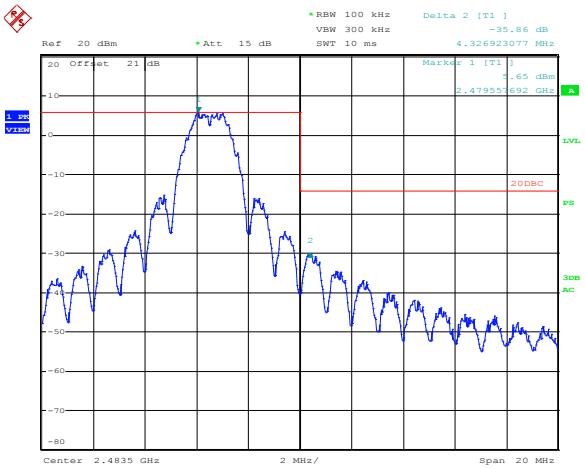


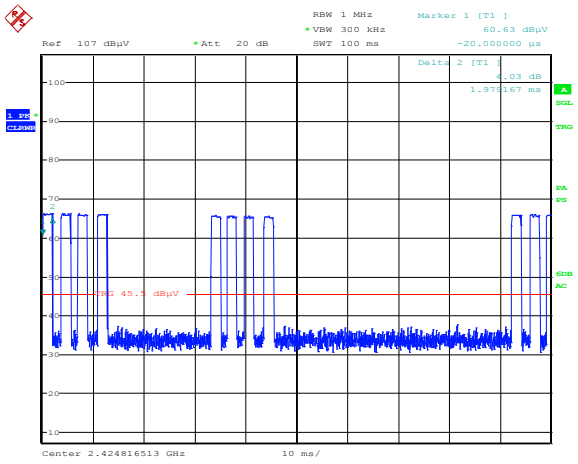
Figure 8.3-9: *Upper band edge,* Conducted (TX 2480 MHz) *@ −12 dBm*

8.3.4 Test data, continued

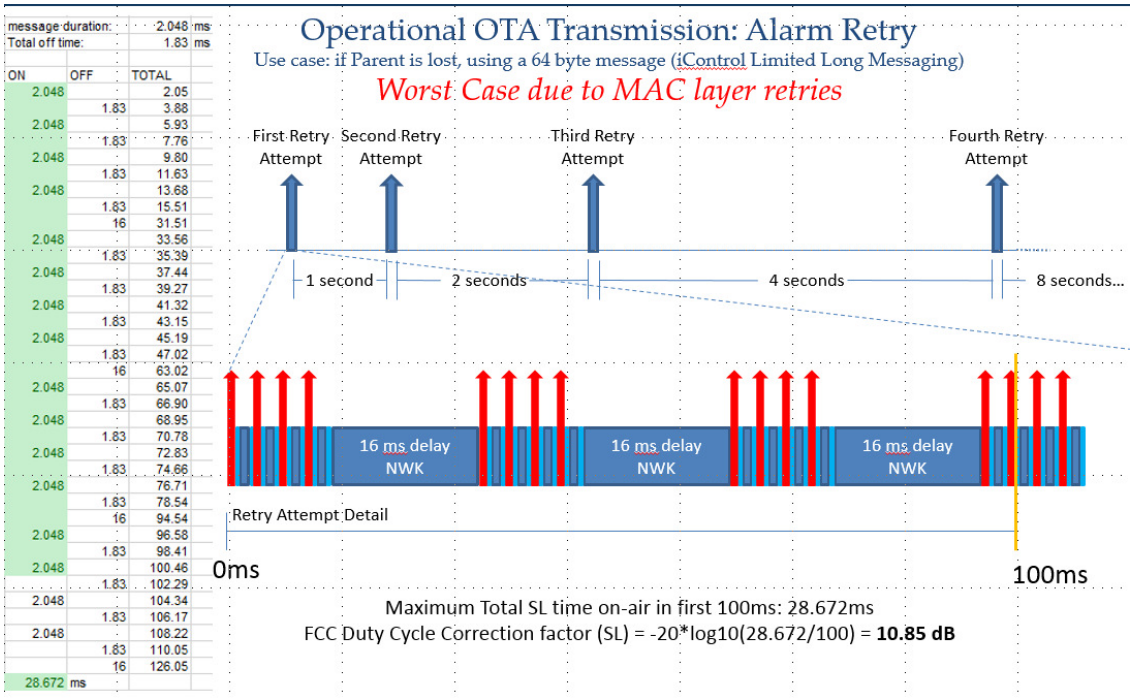
Duty cycle/average factor calculations

§15.35(c) When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed; the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.

$$Duty\ cycle\ /\ average\ factor = 20 \times \log_{10}\left(\frac{Tx_{100ms}}{100\,ms}\right)$$



Plot 8.3-10: *Measured duty cycle*



Plot 8.3-11: *Theoretical worst case duty cycle*

8.3.4 Test data, continued

Spurious emissions within restricted bands, test results

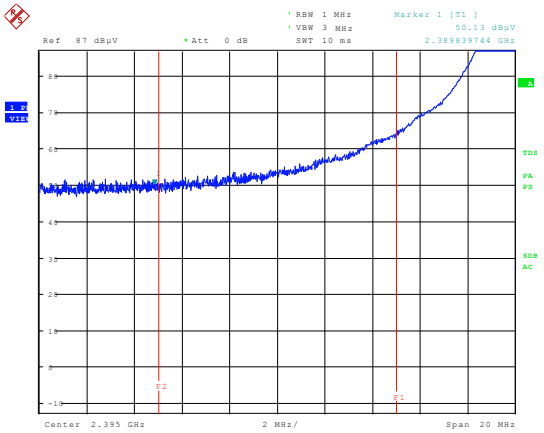


Figure 8.3-12: *Lower band edge, Radiated* (TX 2405 MHz*) – Inverted F Antenna*

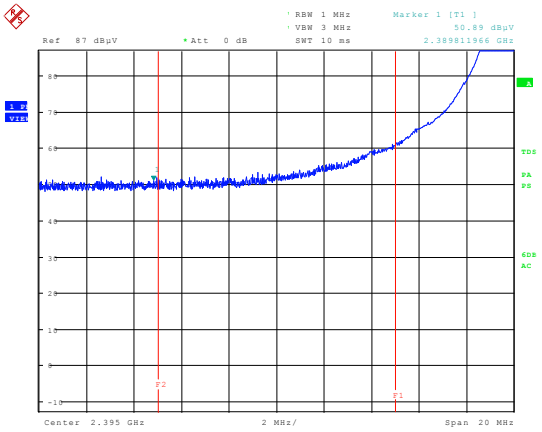
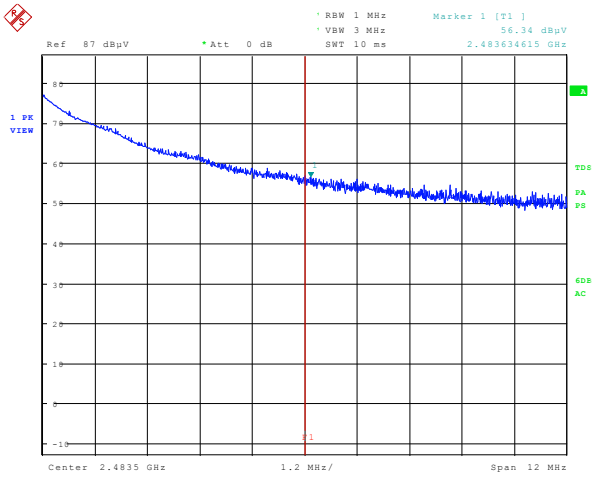


Figure 8.3-13: *Lower band edge, Radiated* (TX 2405 MHz*) – Circular SEMI-Loop Antenna*

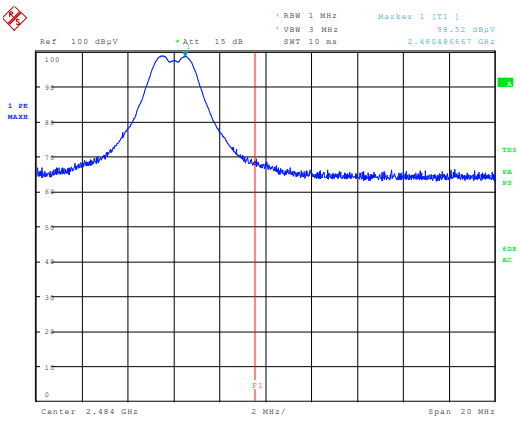
F1= Band Edge 2400 MHz
F2 = Restricted Band edge 2390 MHz
The spectral plot has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

8.3.4 Test data, continued

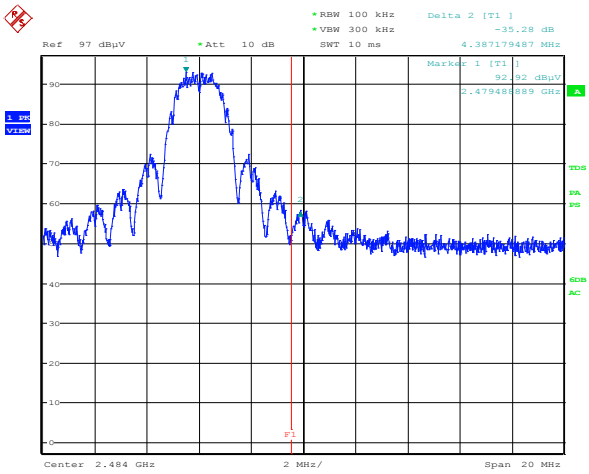
Spurious emissions within restricted bands, test results, continued



Plot 8.3-14: *Upper band edge 1 MHz RBW, 3 MHz VBW, Radiated (TX 2475 MHz) – Inverted F Antenna*



Plot 8.3-15: *Upper band edge 1 MHz RBW, 3 MHz VBW, Radiated (TX 2480 MHz) – Inverted F Antenna*



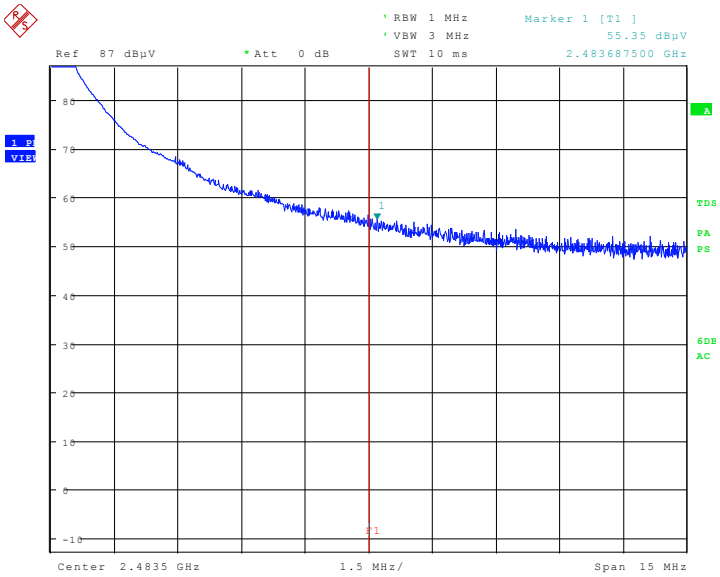
Plot 8.3-16: *Upper band edge 100 kHz RBW, 300 kHz VBW, Radiated (TX 2480 MHz) – Inverted F Antenna*

F1= Band Edge and Restricted Band edge 2483.5 MHz
The spectral plot has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

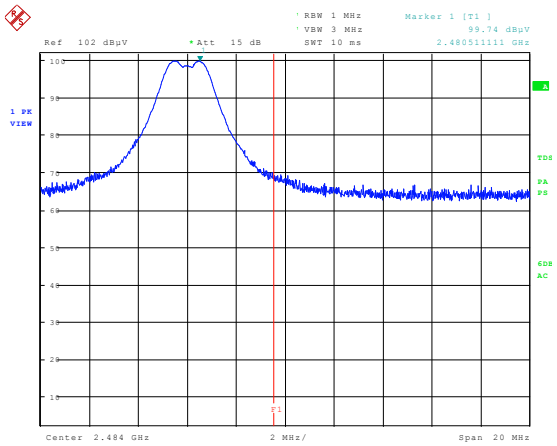
Measured field strength for high channel in 1 MHz/3 MHz RBW/VBW = 98.56 dBµV/m
Delta marker = 35.28 dB
Therefore, Peak field strength is 98.56 dBµV/m – 35.28 dB (Delta marker) = 63.28 dBµV/m

8.3.4 Test data, continued

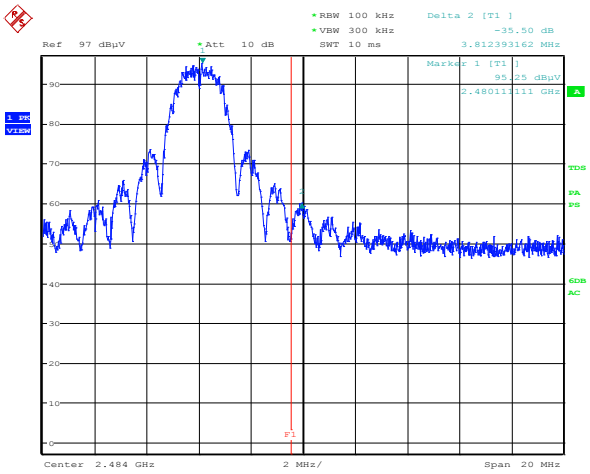
Spurious emissions within restricted bands, test results, continued



Plot 8.3-17: *Upper band edge 1 MHz RBW, 3 MHz VBW, Radiated (TX 2475 MHz) – Circular SEMI-Loop Antenna*



Plot 8.3-18: *Upper band edge 1 MHz RBW, 3 MHz VBW, Radiated (TX 2480 MHz) – Circular SEMI-Loop Antenna*



Plot 8.3-19: *Upper band edge 100 kHz RBW, 300 kHz VBW, Radiated (TX 2480 MHz) – Circular SEMI-Loop Antenna*

F1= Band Edge and Restricted Band edge 2483.5 MHz
The spectral plot has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

Measured field strength for high channel in 1 MHz/3 MHz RBW/VBW = 99.74 dBµV/m
Delta marker = 35.50 dB
Therefore, Peak field strength is 99.74 dBµV/m – 35.50 dB (Delta marker) = 64.24 dBµV/m

8.3.4 Test data, continued

Spurious emissions within restricted bands, test results continued

Table 8.3-4: *Spurious emissions within restricted bands – Inverted F Antenna results*

Frequency, MHz	Polarization	Peak field strength[1], dBµV/m	Peak field strength limit, dBµV/m	Peak margin, dB	DCCF (dB)	Average field strength[2], dBµV/m	Average field strength limit, dBµV/m	Average margin, dB
Low band edge								
Low channel (2405 MHz)								
2389.80	V	50.13	74.00	23.87	-10.85	39.28	54.00	14.72
High band edge								
High Channel (2475 MHz)								
2483.50	V	56.34	74.00	17.66	-10.85	45.49	54.00	8.51
High Channel (2480 MHz)								
2483.50	V	63.28	74.00	10.72	-10.85	52.43	54.00	1.57
Harmonics								
Low channel (2405 MHz)								
4810.00	V	55.80	74.00	18.20	-10.85	44.95	54.00	9.05
Mid channel (2440 MHz)								
4880.00	V	54.20	74.00	19.80	-10.85	43.35	54.00	10.65
7320.00	V	57.31	74.00	16.69	-10.85	46.46	54.00	7.54
High Channel (2475 MHz)								
4950.00	V	54.20	74.00	19.80	-10.85	43.35	54.00	10.65
7425.00	V	55.60	74.00	18.40	-10.85	44.75	54.00	9.25
High Channel (2480 MHz)								
4960.00	V	50.15	74.00	23.85	-10.85	39.30	54.00	14.70
7440.00	V	50.35	74.00	23.65	-10.85	39.50	54.00	14.50

Notes: [1] Peak field strength (dBµV/m) = Spectrum analyzer value (dBµV) + transducer factors (dB)
Transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.
[2] Average field strength = Peak field strength + DCCF (The theoretical worst case duty cycle of −10.85 dB was utilized to ascertain worst case.)

Table 8.3-5: *Spurious emissions within restricted bands – Circular SEMI-Loop Antenna results*

Frequency, MHz	Polarization	Peak field strength[1], dBµV/m	Peak field strength limit, dBµV/m	Peak margin, dB	DCCF (dB)	Average field strength[2], dBµV/m	Average field strength limit, dBµV/m	Average margin, dB
Low band edge								
Low channel (2405 MHz)								
2389.80	V	50.89	74.00	23.11	-10.85	40.04	54.00	13.96
High band edge								
High Channel (2475 MHz)								
2483.50	V	55.35	74.00	18.65	-10.85	44.50	54.00	9.50
High Channel (2480 MHz)								
2483.50	H	64.24	74.00	9.76	-10.85	53.39	54.00	0.61
Harmonics								
Low channel (2405 MHz)								
4810.00	V	52.78	74.00	21.22	-10.85	41.93	54.00	12.07
Mid channel (2440 MHz)								
4880.00	V	53.80	74.00	20.20	-10.85	42.95	54.00	11.05
7320.00	V	57.66	74.00	16.34	-10.85	46.81	54.00	7.19
High Channel (2475 MHz)								
4950.00	V	53.81	74.00	20.19	-10.85	42.96	54.00	11.04
7425.00	V	55.10	74.00	18.90	-10.85	44.25	54.00	9.75
High Channel (2480 MHz)								
4960.00	V	49.98	74.00	24.02	-10.85	39.13	54.00	14.87
7440.00	V	50.23	74.00	23.77	-10.85	39.38	54.00	14.62

Notes: [1] Peak field strength (dBµV/m) = Spectrum analyzer value (dBµV) + transducer factors (dB)
Transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.
[2] Average field strength = Peak field strength + DCCF (The theoretical worst case duty cycle of−10.85 dB was utilized to ascertain worst case.)

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

8.4.1 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).

8.4.2 Test summary

Verdict	Pass				
Test date	April 28, 2016	Test engineer	David Duchesne		
Temperature	24 °C	Relative humidity	28 %	Air pressure	1005 mbar

8.4.3 Observations, settings and special notes

Measurements were performed as per 558074 D01 DTS Meas Guidance v03r05. (The test was performed using method described in section 10.2 Method PKPSD)

Resolution bandwidth:	3 kHz
Video bandwidth:	10 kHz
Frequency span:	10 MHz
Detector mode:	Peak Detector
Trace mode:	Max hold

8.4.4 Test data

Table 8.4-1: *PSD measurements results*

SI Chip power Set, dBm	Frequency, MHz	PSD, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
-5	2405.00	3.01	8.00	4.99
-5	2440.00	3.48	8.00	4.52
-5	2475.00	1.75	8.00	6.25
-12	2480.00	-3.63	8.00	11.63
-14	2480.00	-6.33	8.00	14.33

Notes: For Tx 2405, 2440, and 2475 MHz, The SI Chip was set to −5 dBm,
For Tx 2480 MHz , The SI Chip was set to −14 dB for Inverted F antenna and −12 dBm for SEMI-Loop antenna

8.4.4 Test data, continued

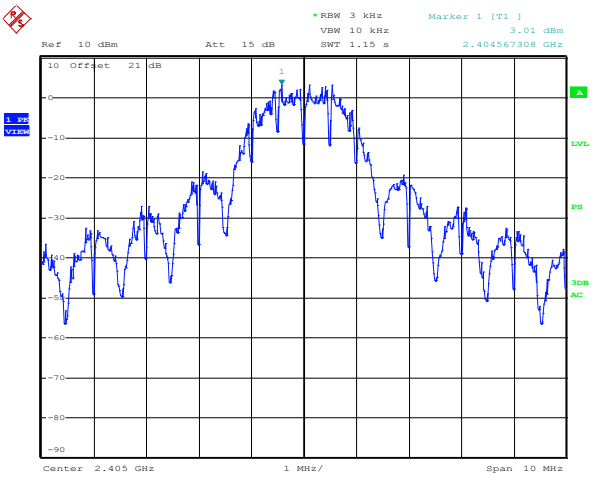


Figure 8.4-1: *PSD (2405 MHz)*

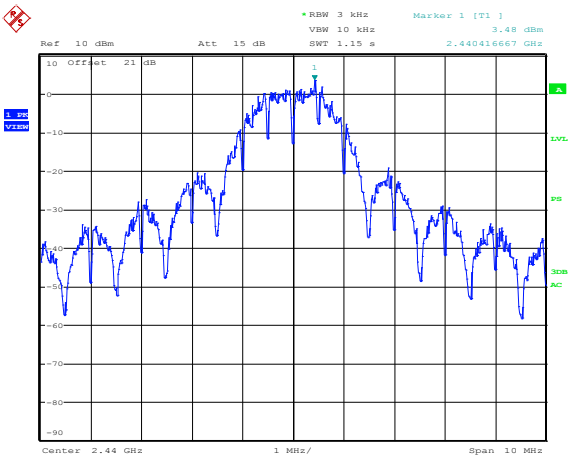


Figure 8.4-2: *PSD (2440 MHz)*

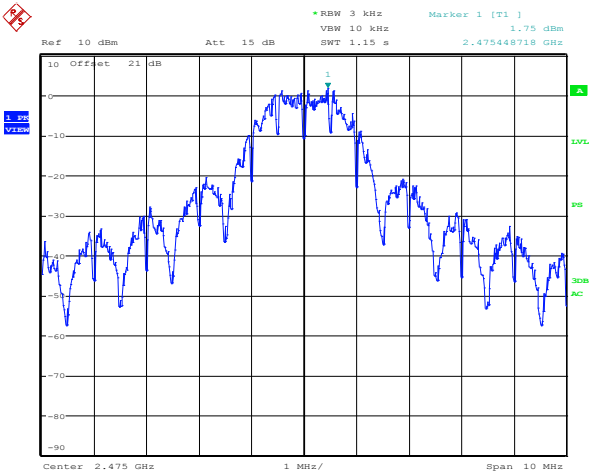


Figure 8.4-3: *PSD (2475 MHz)*

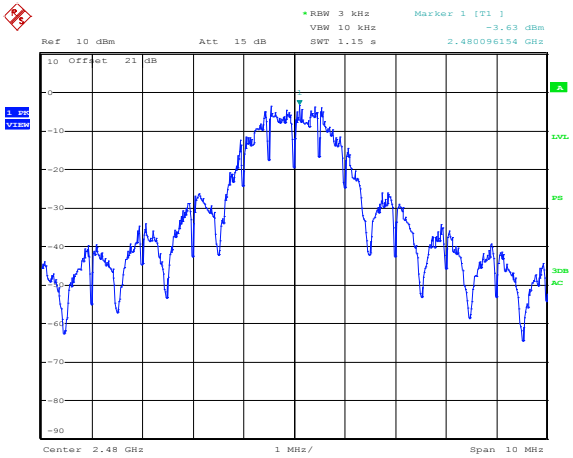


Figure 8.4-4: *PSD (2480 MHz) @ −12 dBm*

8.4.4 Test data, continued

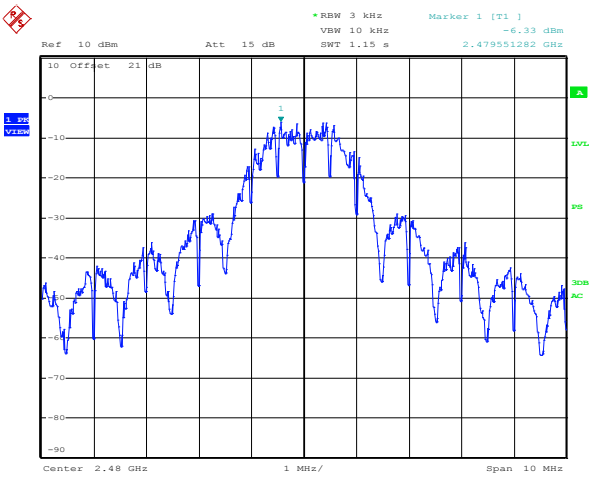
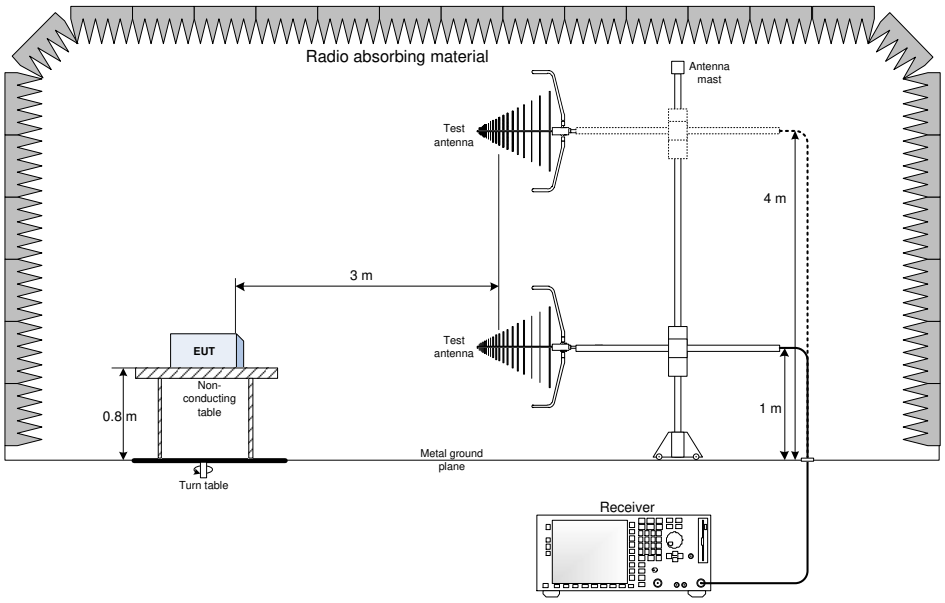


Figure 8.4-5: *PSD (2405 MHz) @ −14 dBm*

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