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Test report

296003-1TRFWL

Date of issue: May 9, 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 15.245 Subpart C

  Operation within the bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz, and 24075-24175 MHz.

- RSS-210 Issue 8, December 2010, Annex 7

  Field Disturbance Sensors Operating in the Bands 902–928 MHz, 2435–2465 MHz, 5785–5815 MHz, 10.5–10.55 GHz and 24.075–24.175 GHz.

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:	Kevin Rose, Wireless/EMC Specialist
Date:	May 9, 2016
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

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Section 1. Report summary

1.1 Test specifications

FCC 47 CFR Part 15.245, Subpart C RSS-210, Issue 8, December 2010, Annex 7	Operation within the bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz, and 24075-24175 MHz. Field Disturbance Sensors Operating in the Bands 902–928 MHz, 2435–2465 MHz, 5785–5815 MHz, 10.5–10.55 GHz and 24.075–24.175 GHz.

1.2 Test methods

ANSI C63.10 v2013	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

1.3 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 Exclusions

None

1.5 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

Table 2.1-1: *FCC 47 CFR Part 15, Subpart C general requirements results*

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]
§15.215(c)	20 dB bandwidth	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 Antennas are located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart C, Intentional radiators test results

Table 2.2-1: *FCC 47 CFR Part 15, Subpart C §15.245 results*

Part	Test description	Verdict
§15.245(b)	Radiated emission Intentional radiators	Pass
§15.245(b)(1)	Radiated emission unintentional radiators	Pass
§15.245(b)(3)	Radiated emission outside of the specified frequency bands	Pass

Notes: None

2.3 IC RSS-GEN, Issue 4, test results

Table 2.3-1: *IC RSS-GEN results*

Part	Test description	Verdict
6.6	Occupied bandwidth	Pass
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	Not applicable

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-210, Issue 8, test results

Table 2.4-1: *IC RSS-210 Annex 7 results*

Part	Test description	Verdict
1	Radiated emission Intentional radiators	Pass
2	Radiated emission unintentional radiators	Pass
3	Radiated emission unintentional radiators. (field sensors designed for motor vehicles)	Not applicable
4	Radiated emission outside of the specified frequency bands	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Applicant and manufacturer

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

3.2 Sample information

Receipt date	October 26, 2015
Nemko sample ID number	133-000395

3.3 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	070215-0023

3.4 Technical information

Operating band	10500 MHz-10550 MHz
Operating frequency	10527 MHz
Modulation type	Pulsed 1 kHz sinusoid
Occupied bandwidth (99 %)	9.17 MHz
Emission classification	K1D
Power requirements	3 V_{DC} (2x Lithium battery)
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.5 Product description and theory of operation

The EUT is a motion sensor designed to operate on 3V CR123A batteries and pair with standard ZigBee based wireless security and home automation systems that operate in the 2.4GHz band. The two radiative technologies on the product are the DSSS ZigBee communications radiating in the 2.4 GHz-2.4853 GHz ISM band, and a microwave Doppler radar operating at 10.4 GHz. (Additionally, there is a passive infrared sensor that provides the core motion detection operation, but that is not a radiating technology.)

This device is classified as a ZigBee end point. It obeys a controller, and upon network initiation, the controller will do a frequency survey of the energies on each channel and will choose the channel with the least energy/ interference to operate.

Note: The EUT will never radiate microwave and ZigBee at the same time. These lockouts are controlled using the sensor micro during normal operation.

3.6 EUT exercise details

The EUT was in normal operation mode

3.7 EUT setup diagram

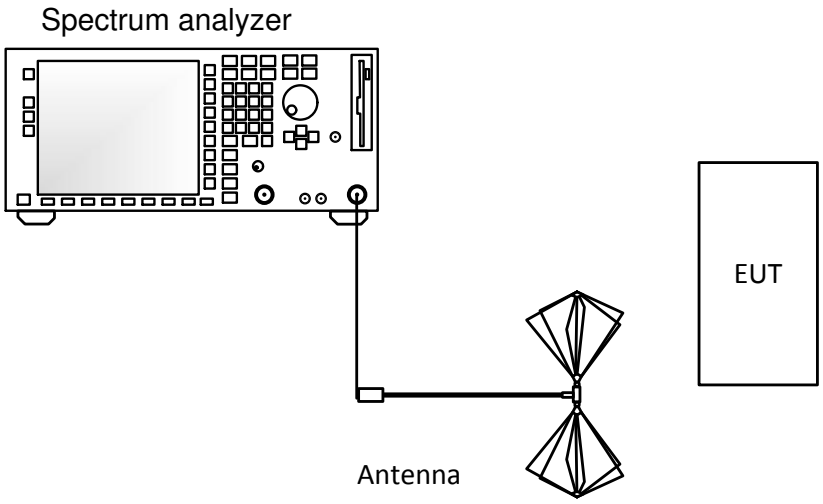


Figure 3.7-1: *Setup diagram*

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	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
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
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Mar. 27/16
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 12/16
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 01/16
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	Mar. 09/16
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	May 05/16
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU

Notes: VOU - verify on use

Section 8. Testing data

8.1 Clause 15.215(c) and RSS-Gen 6.6 Occupied (Emission) bandwidth

8.1.1 Definitions and limits

FCC §15.215

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80 % of the permitted band in order to minimize the possibility of out-of-band operation.

RSS-Gen Clause 6.6

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

8.1.2 Test summary

Verdict	Pass				
Test date	February 25, 2016	Test engineer	David Duchesne		
Temperature	25 °C	Relative humidity	32.4 %	Air pressure	996 mbar

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	1% to 5% of the occupied bandwidth
Video bandwidth:	3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test data

Table 8.1-1: *Lower 20 dBc frequency-cross result*

Fundamental frequency, MHz	Lower 20 dBc frequency cross, GHz	Limit, GHz	Margin, MHz
10.527	10.526	10.500	26

Table 8.1-2: *Upper 20 dBc frequency-cross result*

Fundamental frequency, MHz	Upper 20 dBc frequency cross, GHz	Limit, GHz	Margin, MHz
10.527	10.530	10.550	20

Table 8.1-3: *Bandwidth results*

Frequency, GHz	20 dB bandwidth, MHz	99% occupied bandwidth, MHz
10.527	3.30	9.17

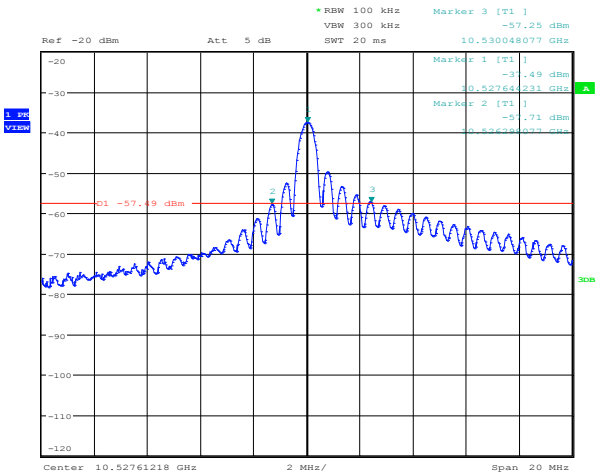


Figure 8.1-1: *20 dBc*

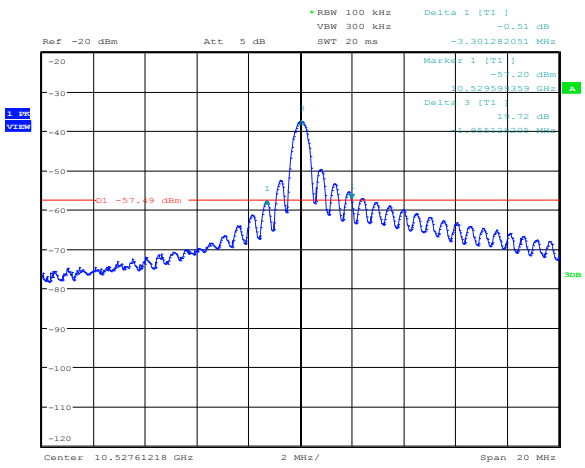


Figure 8.1-2: *20 dB bandwidth*

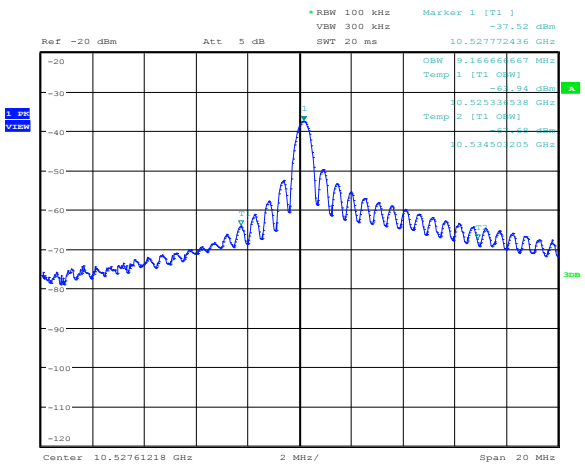


Figure 8.1-3: *99% occupied bandwidth*

8.2 FCC 15.245((b)1 and (b) 3) Radiated emission and RSS-210 Annex 7 (1, 2)

8.2.1 Definitions and limits

FCC §15.245

(b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with ***Table 8.2–1.***

(1) Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

(i) For the second and third harmonics of field disturbance sensors operating in the 24075-24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.
(ii) For all other field disturbance sensors, 7.5 mV/m.
(iii) Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands, other than the second and third harmonics from devices operating in the 24075-24175 MHz band, fully comply with the limits given in §15.209. Continuous operation of field disturbance sensors designed to be used in farm equipment, vehicles such as fork lifts that are intended primarily for use indoors or for very specialized operations, or railroad locomotives, railroad cars and other equipment which travels on fixed tracks is permitted. A field disturbance sensor will be considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g., putting a vehicle into reverse gear, activating a turn signal, etc.).

(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

RSS-210 Annex 7

1. The field strength measured at 3 metres shall not exceed the limits shown in the ***Table 8.2–1.***:
2. Additionally, harmonic emissions falling into a restricted band of RSS-Gen and below 17.7 GHz shall meet the general field strength limits of RSS-Gen. Those falling into restricted bands above 17.7 GHz shall not exceed the following field strength limits measured at a distance of 3 metres:
   (i) 25 mV/m for the second and third harmonics of field disturbance sensors operating in the 24075–24175 MHz band and for devices designed for use only within buildings or for intermittent use, such as to open building doors;
   (ii) 7.5 mV/m for all other devices.
4. Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general field strength limits specified in RSS-Gen, whichever is less stringent.

Table 8.2-1: *Radiated emission limits*

Fundamental frequency (MHz)	Field strength of fundamental @ 3m		Field strength of harmonics @ 3m	
(MHz)	(mV/m)	(dBµV/m)	(mV/m)	(dBµV/m)
902-928	500	114	1.6	64
2435-2465	500	114	1.6	64
5785-5815	500	114	1.6	64
10500-10550	2500	128	25	88
24075-24175	2500	128	25	88

Notes: The emission limits shown above are based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply.

8.2.1 Definitions and limits, continued

Table 8.2-2: *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			

Table 8.2-3: *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 this table and above 38.6 GHz are designated for low-power license-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this standard

Table 8.2-4: *15.209 and RSS-Gen emissions field strength limits*

Frequency	Field strength of emissions		Measurement distance
MHz	µV/m	dBµV/m	m
0.009–0.490	2400/*F*	67.6 – 20 × $\log_{10}$(*F*)	300
0.490–1.705	24000/*F*	87.6 – 20 × $\log_{10}$(*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. *F* is in kHz. 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

8.2.2 Test summary

Verdict	Pass				
Test date	February 25, 2016	Test engineer	David Duchesne		
Temperature	25 °C	Relative humidity	32.4 %	Air pressure	996 mbar

8.2.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 40 GHz.
Radiated measurements were performed at a distance of 3 m

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:

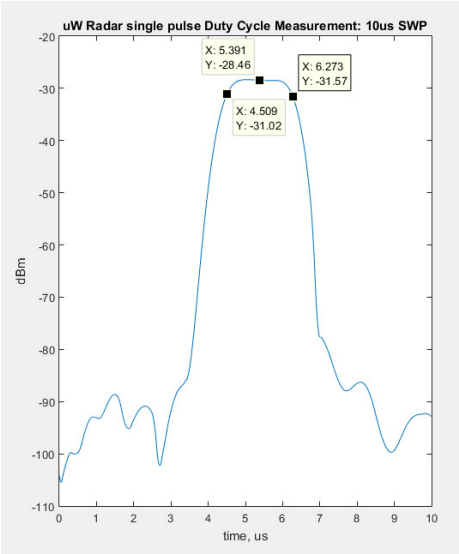
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

8.2.4 Test data

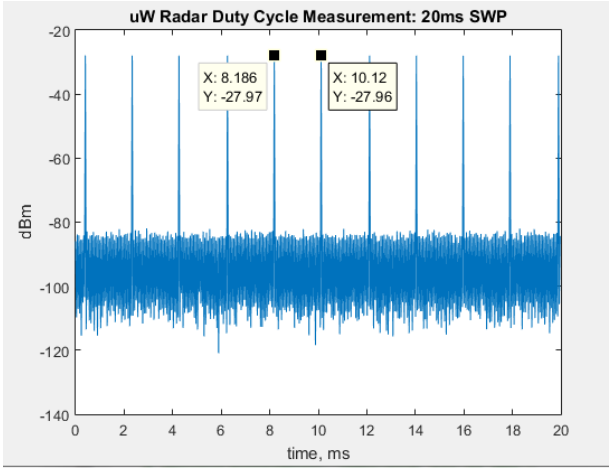
Duty cycle/average factor calculations

§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.

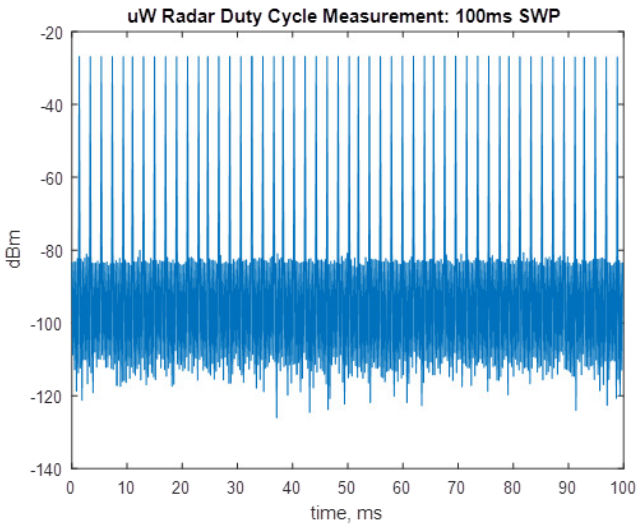
$$Duty\,cycle\,/\,average\,factor = 20 \times \log_{10}\left(\frac{Tx_{100ms}}{100\,ms}\right)$$



Plot 8.2-1: *Single pulse*



Plot 8.2-2: *20 ms measurement time*



Plot 8.2-3: *100 ms measurement time*

Pulse width = 1.764 µs (6.273 µs – 4.509 µs)
Total pulse intervals in 100ms: 51
Assume 52 pulses wost case in 100 ms: 52*1.764 µs =91.728 µs on time

Maximum Tx on time is 1.8 us as declared by client.
DCCF (dB) = 20 × Log_{10} ($Tx_{100\,ms}$ / 100 ms) = 20 × Log_{10} (0.91 / 100) = −40.8 dB.
(Maximum DCCF is limited to −20 dB)

8.2.4 Test data, continued

Table 8.2-5: *Radiated field strength measurement Fundamental results*

Frequency, GHz	Peak			DCCF, dB	Average		
	Measured dBµV/m	Limit dBµV/m	Margin, dB		Calculated dBµV/m	Limit dBµV/m	Margin, dB
10.527	102.42	148.00	45.58	-20	82.42	128.00	45.58

Notes:
- Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
- Calculated Average results were calculated as follows: Peak Field strength + DCCF
- DCCF = −20 dB

Table 8.2-6: *Radiated field strength measurement Emissions radiated outside of the specified frequency bands results*

Frequency, GHz	Peak			DCCF, dB	Average		
	Measured dBµV/m	Limit dBµV/m	Margin, dB		Calculated dBµV/m	Limit dBµV/m	Margin, dB
21.006	87.37	97.50	10.13	-20	67.37	77.50	10.13
31.509	86.34	97.50	11.16	-20	66.34	77.50	11.16

Notes:
- Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
- Calculated Average results were calculated as follows: Peak Field strength + DCCF
- DCCF = −20 dB
- All other radiated emissions were greater than 20 dB From limit.

8.2.5 Setup photos

Figure 8.2-1: *Radiated emissions setup photo – 30 to 1000 MHz*

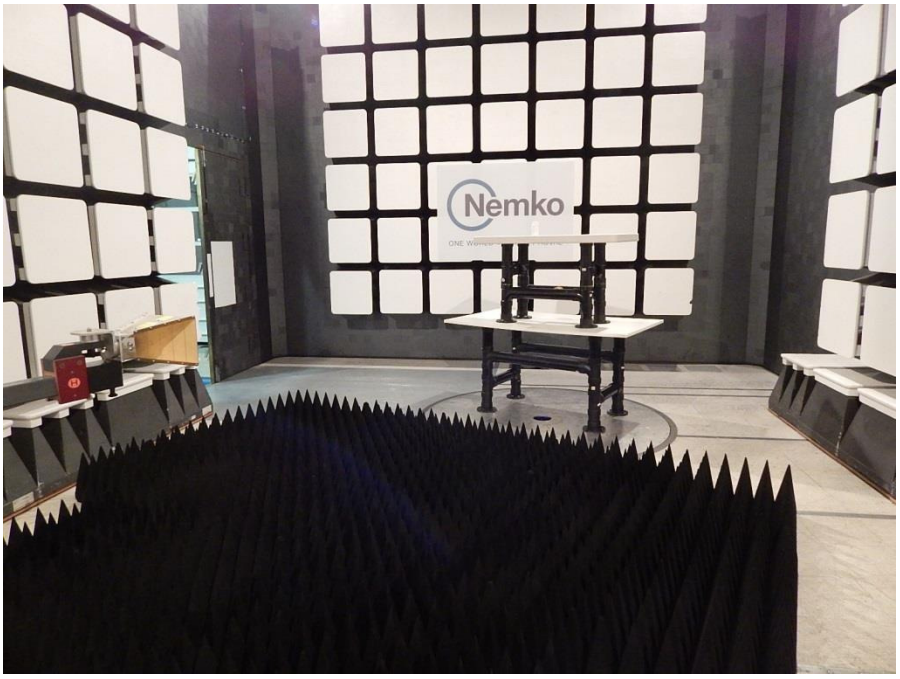
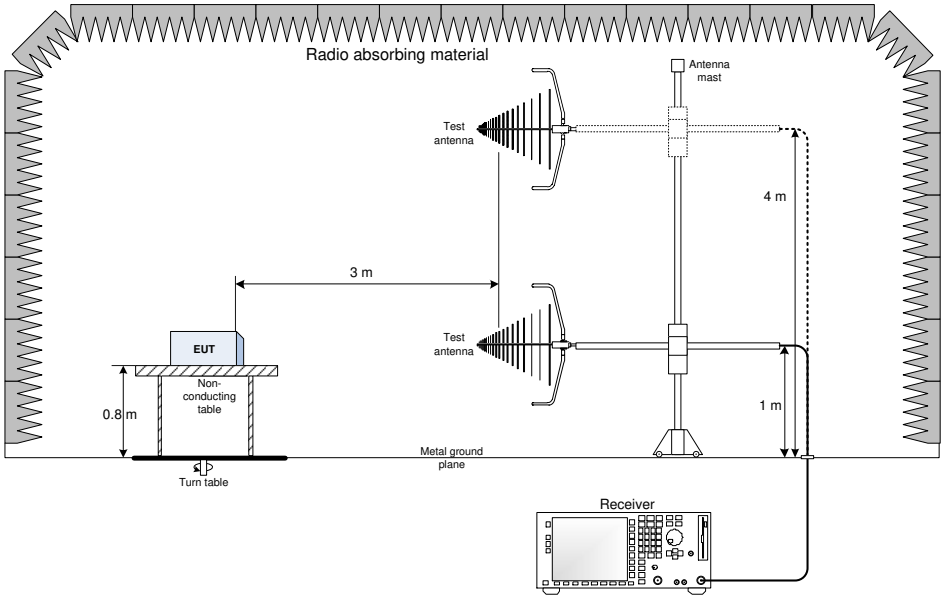


Figure 8.2-2: *Radiated emissions setup photo – above 1 GHz*

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