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Test report

292814-1TRFWL

Date of issue: October 21, 2016

Applicant:

Standard Innovation Corporation

Product:

KegelCore

Model:

2000

FCC ID:

ZUE2000

IC Registration number:

9804A-2000

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.249

  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHz and 24.0–24.25 GHz

- RSS-210 Issue 9, August 2016, Annex B.10

  Devices operating in frequency bands 902–928, 2400–2483.5 and 5725–5875 MHz for any application

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:	Kevin Rose, Wireless/EMC Specialist
Reviewed by:	Andrey Adelberg, Senior Wireless/EMC Specialist
Date:	October 21, 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.

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Table of Contents

Section 1 Report summary

1.1 Applicant/Manufacturers

Company name	Standard Innovation Corporation
Address	Suite 330, 1130 Morrison Drive
City	Ottawa
Province/State	Ontario
Postal/Zip code	K2H 9N6
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.249	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHz and 24.0–24.25 GHz
RSS-210 Issue 9, August 2016, Annex B.10	Devices operating in frequency bands 902–928, 2400–2483.5 and 5725–5875 MHz for any application

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

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable
§15.215(c)	20 dB emission bandwidth	Pass

Note: The EUT uses a 3 Vdc cell battery.

2.2 FCC Part 15 Subpart C – Intentional Radiators, test results

Part	Test description	Verdict
§15.249(a)	Field strength of fundamental and harmonics emissions	Pass
§15.249(d)	Spurious emissions (except harmonics)	Pass

2.3 IC RSS-GEN, Issue 4, test results

Clause	Test description	Verdict
6.6	Occupied bandwidth	Pass
7.1.2	Receiver Radiated Limits	Not applicable
7.1.3	Receiver Conducted Limits	Not applicable
8.8	AC power lines conducted emission limits	Not applicable

Note: 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.
The EUT uses a 3 Vdc cell battery.

2.4 RSS-210, Issue 9, test results

Part	Test description	Verdict
§4.1	Emissions Falling Within Restricted Frequency Bands	Pass
§B.10 (a)	Field strength of fundamental and harmonics emissions	Pass
§B.10 (b)	Spurious emissions (except harmonics)	Pass

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	August 17, 2015
Nemko sample ID number	133-000332

3.2 EUT information

Product name	KegelCore
Model	2000
Serial number	None

3.3 Technical information

Operating band	2400–2483.5 MHz
Operating frequency	2402–2480 MHz
Modulation type	GFSK + Digital Modulation Techniques (see Bluetooth Core Specification V4.0)
Occupied bandwidth (99 %)	1.16 MHz
Emission designator	1M16F1D
Power requirements	3.0 V (+10% −20%), 2 mA average, 15 mA peak.
Antenna information	Internal PCB antenna The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The KegelCore is a exerciser together with a Bluetooth Smart enable central device (smart phone or similar) is a complete system for measuring pressure-changes and device orientation (accelerometer based) and transmitting the data wirelessly to the central. The radio parts of the unit are based on the Nordic Semiconductor NRF51 USB dongle reference design with minimal changes.

3.5 EUT exercise details

Customer designed software to control the channels was used.

3.6 EUT setup Figure

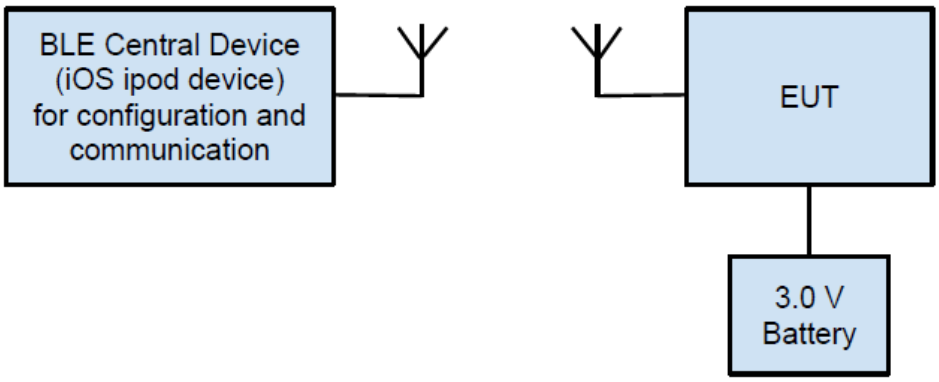


Figure 3.6-1: Setup diagram

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
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7 Test equipment

7.1 Test equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Feb. 25/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
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
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	May 05/16
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	Jan. 09/16
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
50 Ω coax cable	C.C.A.	None	FA002555	1 year	May 05/16
50 Ω coax cable	Huber + Suhner	None	FA002074	1 year	May 05/16
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR

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

Section 8 Testing data

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

8.1.1 Definitions and limits

FCC Part 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 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 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.

8.1.2 Test summary

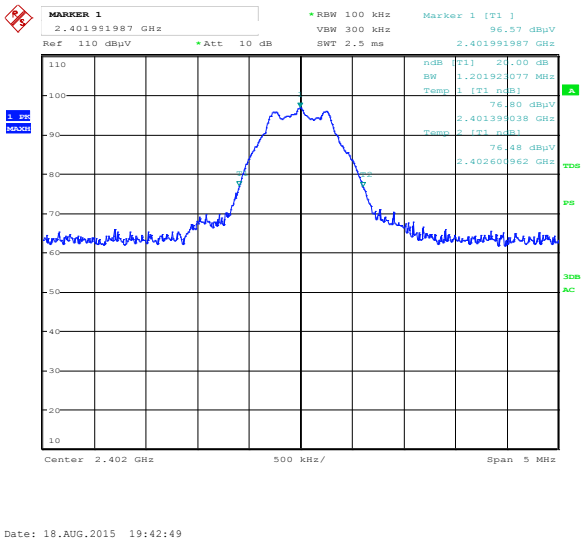
Verdict	Pass		
Test date	August 18, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1001 mbar
Test location	Ottawa	Relative humidity	51.3 %

8.1.3 Observations, settings and special notes

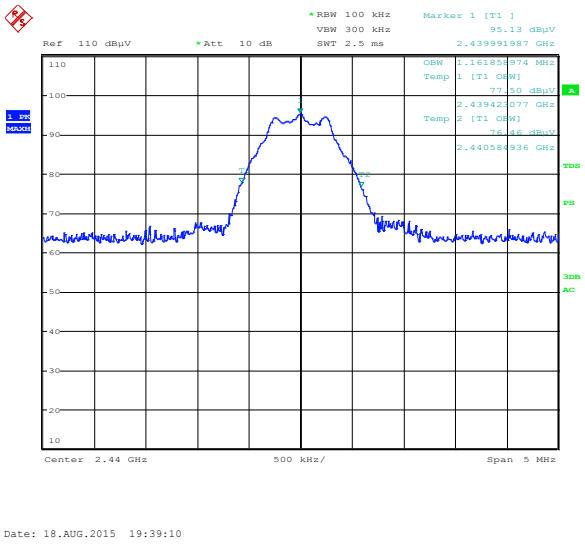
Spectrum analyzer settings:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold
Function:	20 dB BW (for FCC); 99 % bandwidth (for IC)

8.1.4 Test data



Plot 8.1-1: 20 dB bandwidth example



Plot 8.1-2: 99 % occupied bandwidth example

Table 8.1-1: 20 dB bandwidth results

Lower 20 dBc Freq., MHz	Lower 20 dBc Freq. limit, MHz	Lower margin, MHz	Upper 20 dBc Freq., MHz	Upper 20 dBc Freq. limit, MHz	Upper margin, MHz
2401.399	2400	1.399	2480.617	2483.5	2.883

Table 8.1-2: 99% bandwidth results

Frequency (MHz)	99 % bandwidth (MHz)
2402	1.12
2440	1.16
2480	1.09

8.2 FCC Clause 15.249(a) and RSS-210 B.10 (a) Field strength of fundamental and harmonics emissions

8.2.1 Definitions and limits

In addition to the provisions of §15.205 and RSS Gen the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Table 8.2-1: Field strength limits

Fundamental frequencies	Field strength of fundamental		Field strength of harmonics	
(MHz)	(mV/m)	(dBµV/m)	(µV/m)	(dBµV/m)
902–928	50	94	500	54
2400–2483.5	50	94	500	54
5725–5875	50	94	500	54
24.0–24.25*	250	108	2500	68

Note: * - Only FCC band.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter (128 dBµV/m) at 3 meters along the antenna azimuth.

8.2.2 Test summary

Verdict	Pass		
Test date	August 18, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1001 mbar
Test location	Ottawa	Relative humidity	51.3 %

8.2.3 Observations, settings and special notes

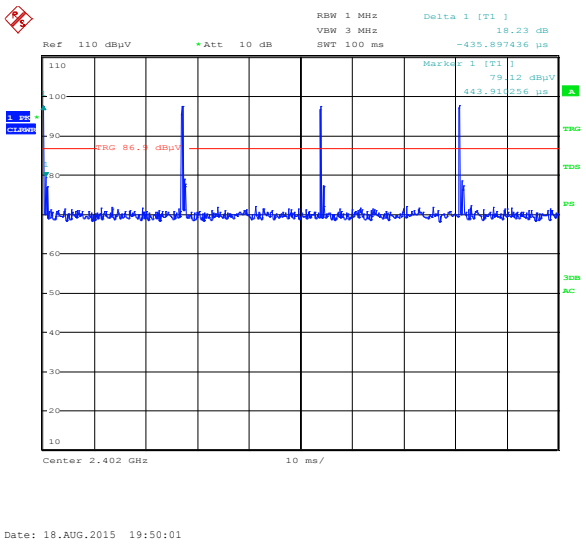
- The spectrum was searched from 2.4 GHz to the 10th harmonic at a distance of 3 m.
- The test was performed with vertical and horizontal antenna polarizations and the EUT was measured on three orthogonal axis, only the highest emissions were reported.

Spectrum analyzer/receiver settings:

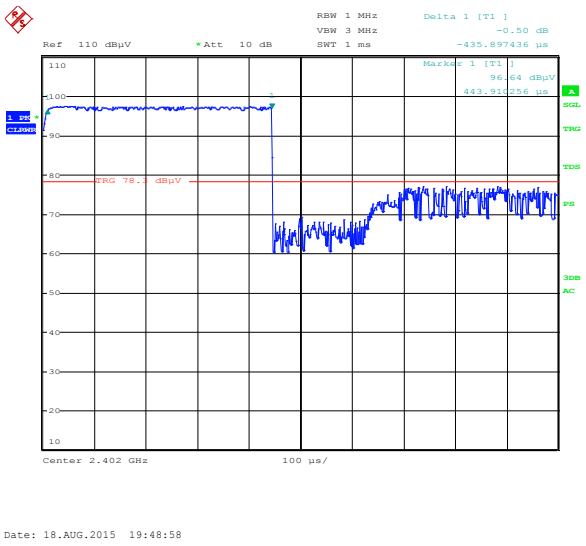
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold
Average measurements:	Duty cycle/average factor was used for calculation of the average level.

8.2.4 Test data, continued

Duty cycle correction factor measurement:



Plot 8.2-1: 100 ms transmissions



Plot 8.2-2: Single transmission duration

Duty cycle calculation: $20 \times \log_{10} (Tx_{100\ ms} / 100\ ms) = 20 \times \log_{10} (4 \times 443.9\ \mu s / 100\ ms) = -47.05$ dB

Table 8.2-2: Field strength of fundamental measurement results

Channel	Frequency, (MHz)	Peak field strength, (dBµV/m)	Peak limit, (dBµV/m)	Margin, (dB)	Duty cycle factor, (dB)	Average field strength, (dBµV/m)	Average limit, (dBµV/m)	Margin, (dB)
Low	2402	97.70	114	16.30	-47.05	50.65	94	43.35
Mid	2440	98.37	114	15.63	-47.05	51.32	94	42.68
High	2480	98.34	114	15.66	-47.05	51.29	94	42.71

Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable. Average field strength was calculated as follows: Peak field strength (dBµV/m) + duty cycle factor (dB).

Table 8.2-3: Field strength of harmonics measurement results

Channel	Frequency, (MHz)	Peak field strength, (dBµV/m)	Peak limit, (dBµV/m)	Margin, (dB)	Duty cycle factor, (dB)	Average field strength, (dBµV/m)	Average limit, (dBµV/m)	Margin, (dB)
Low	4804	54.84	74	19.16	-47.05	7.79	54	46.21
Mid	4880	54.91	74	19.09	-47.05	7.86	54	46.14
High	4960	52.19	74	21.81	-47.05	5.14	54	48.86

Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable. Average field strength was calculated as follows: Peak field strength (dBµV/m) + duty cycle factor (dB).

8.3 FCC Clause 15.249(d) and RSS-210 B.10 (b) Spurious emissions (except for harmonics)

8.3.1 Definitions and limits

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 FCC §15.209 and RSS-Gen, whichever is the lesser attenuation.

Table 8.3-1: Field strength of spurious emissions

Frequency (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
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.

8.3.2 Test summary

Verdict	Pass		
Test date	August 18, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1001 mbar
Test location	Ottawa	Relative humidity	51.3 %

8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic at a distance of 3 m.
The test was performed with vertical and horizontal antenna polarizations and the EUT was measured on three orthogonal axis, only the highest emissions were reported.
For duty cycle factor calculation please refer to section 8.3.

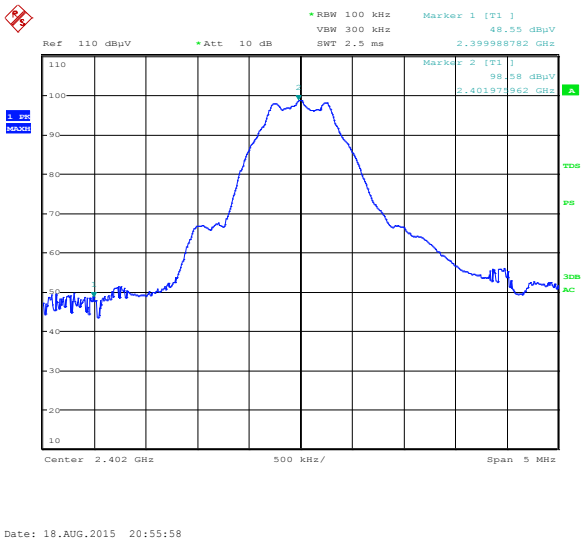
Spectrum analyzer/receiver settings for frequencies below 1 GHz:

Resolution bandwidth:	120 kHz
Video bandwidth:	300 kHz
Detector mode:	Quasi-Peak
Trace mode:	Max Hold

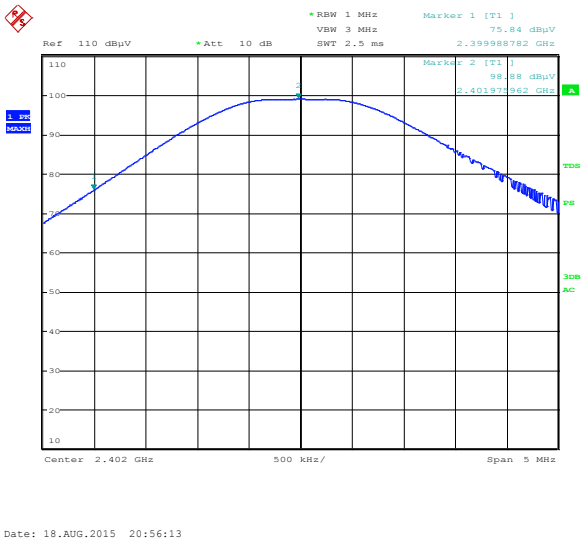
Spectrum analyzer/receiver settings for frequencies above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold
Average measurements:	Duty cycle/average factor was used for calculation of the average level.

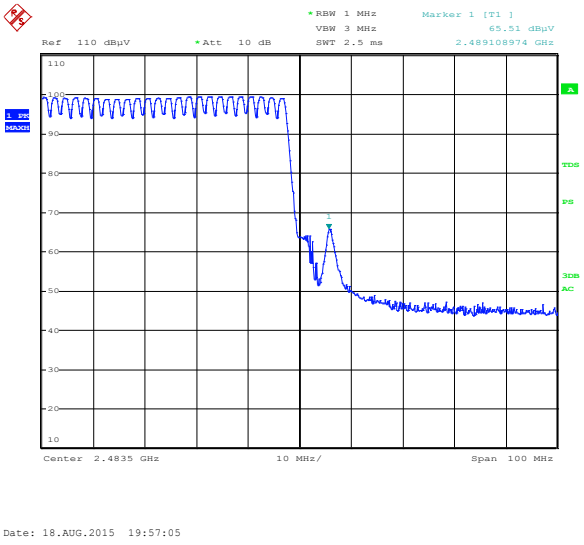
8.3.4 Test data



Plot 8.3-1: Lower band edge measurement 100 kHz Marker delta



Plot 8.3-2: Lower band edge measurement 1 MHz Marker delta



Plot 8.3-3: Upper band edge measurement

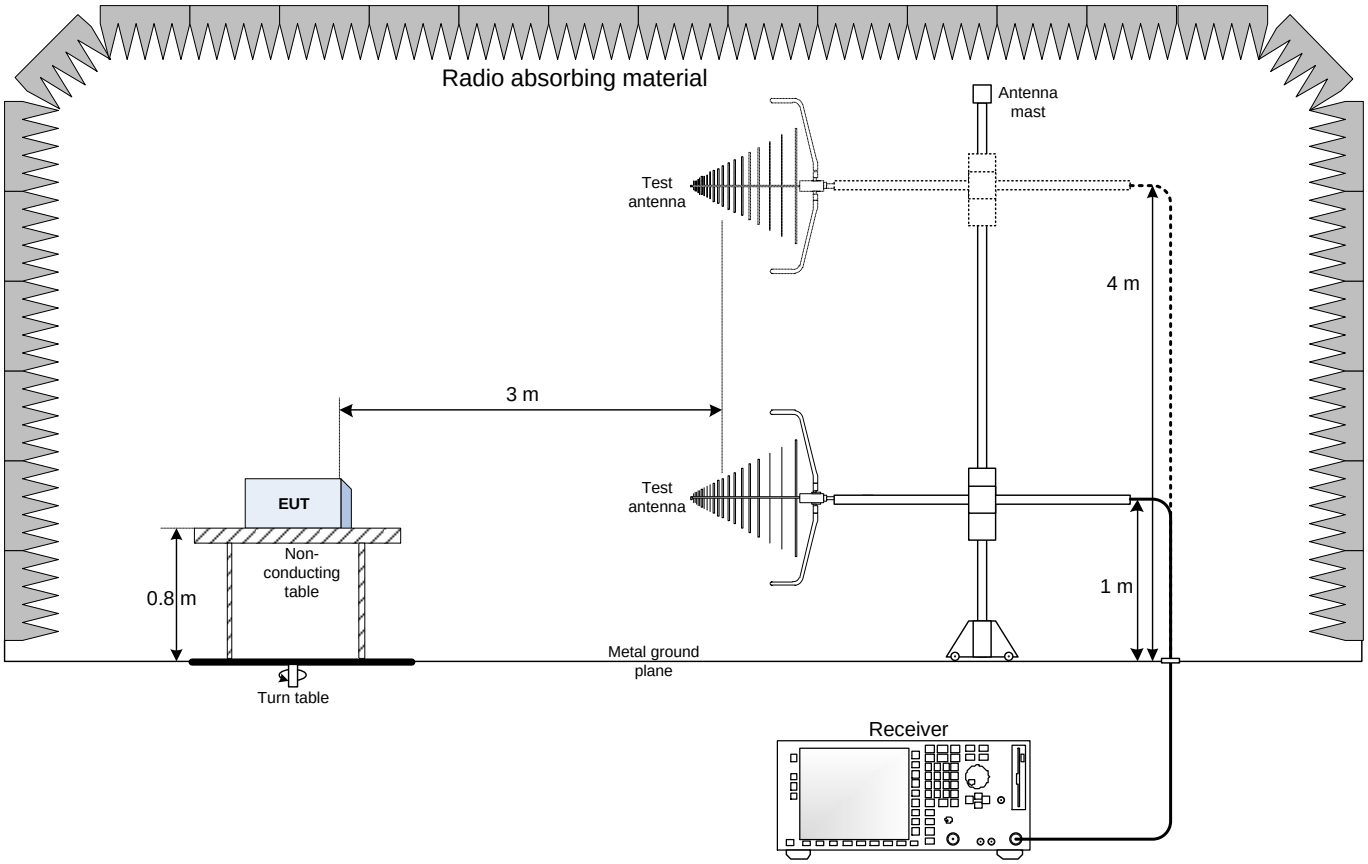
Table 8.3-2: Field strength of spurious emissions measurement results

Channel	Frequency, (MHz)	Peak field strength, (dBµV/m)	Peak limit, (dBµV/m)	Margin, (dB)	Duty cycle factor, (dB)	Average field strength, (dBµV/m)	Average limit, (dBµV/m)	Margin, (dB)
Low	2400.0	48.85	74	25.15	47.05	1.80	54	52.20
High	2483.5	65.51	74	8.49	47.05	18.46	54	35.54

Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable. Average field strength was calculated as follows:
Peak field strength (dBµV/m) + duty cycle factor (dB).
Marker Delta was used to perform the Lower band edge measurement.

Section 9 Block Figures 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