

RADIO TEST REPORT – 465448-1TRFWL

Type of assessment:

Final product testing

Applicant:

ProMinent GmbH

Description of product:

Radar level sensor

Model (HVIN):

1120573

Product marketing name (PMN):

DulcoLevel

FCC identifier:

FCC ID: 2BBPH-1120573

ISED certification number:

IC: 30005-1120573

Specifications:

- ◆ **FCC 47 CFR Part 15 Subpart C, §15.256**
- ◆ **RSS-211, Issue 1, March 2015**

Date of issue: August 31, 2023

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Signature

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SCC File Number: 15064 (Ottawa/Almonte); 151100 (Montreal); 151097 (Cambridge)



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	Test site identifier	Organization	Ottawa/Almonte	Montreal
	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

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

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.256	Operation of level probing radars within the bands 5.925–7.250 GHz, 24.05–29.00 GHz, and 75–85 GHz.
RSS-211, Issue 1, March 2015, Section 5	Level Probing Radar Equipment

1.2 Test methods

890966 D01 Meas level Probing Radars v01r01	Measurement procedure for level probing radars
RSS-Gen, Issue 5, April 2018	General Requirements for Compliance of Radio Apparatus
ETSI EN 302 729 V2.1.1 (2016-12)	Short Range Devices (SRD); Level Probing Radar (LPR) equipment operating in the frequency ranges 6 GHz to 8,5 GHz, 24,05 GHz to 26,5 GHz, 57 GHz to 64 GHz, 75 GHz to 85 GHz; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

Determining compliance is based on the results of the compliance measurement, not taking into account measurement uncertainty, in accordance with section 1.3 of ANSI C63.10 v2013.

See “Summary of test results” for full details.

1.5 Test report revision history

Table 1.5-1: Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	August 31, 2023	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

2.2 Technical judgment

Co-location testing (radiated spurious emissions) of the LPR with Bluetooth simultaneous operation was assessed – no intermodulation product of the 2.4 GHz and 77 GHz was observed.

The DulcoLevel contains FCC ID: QQQGM210P, IC: 5123A-GM210P

2.3 Model variant declaration

There were no model variants declared by the applicant.

2.4 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (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.

3.2 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 $\pm 5\%$, for which the equipment was designed.

Section 4 Measurement uncertainty

4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

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

Table 4.1-1: Measurement uncertainty calculations

Test name	Measurement uncertainty, \pm dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 5 Information provided by the applicant

5.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

5.2 Applicant / Manufacturer

Applicant name	ProMinent GmbH
Applicant address	Im Schuhmachergewann 5-11, 69123 Heidelberg, Germany
Manufacturer name	Same as applicant
Manufacturer address	Same as applicant

5.3 EUT information

Product description	Radar level sensor
Model name (PMN)	DulcoLevel
Model number (HVIN)	1120573
Serial number	203981046
Part number	1120573
Power supply requirements	DC: 24 V from external 100–240 V(AC) power adapter
Product description and theory of operation	The EUT is a FMCW radar system operating in frequency range from 77 to 81 GHz (W-band). It's intended to measure the distance to, or the level of, liquids or solids in tanks, enclosed containers, open systems like bunkers or open containers on stock piles. The EUT will be delivered with fixed lens antenna, which is part of the housing. The device has to be mounted above the solids or liquids to be measured. The antenna is pointing downwards to the surface of the solids or liquids.
Firmware information	Sensor MCU V0.02.08 and V1.00.00 Radar SOC V0.02.08 and V1.00.00 COM-Board V00.04.01.00
Hardware information	RADAR-Board 4008368101 rev D COM-Board 734883 rev 05

5.4 Radio technical information

Category of the device	<input type="checkbox"/> TLPT <input checked="" type="checkbox"/> LPR
Frequency band	75–85 GHz
Frequency Min	77 GHz
Frequency Max	81 GHz
Field strength, dB μ V/m @ 3 m	125.63 (Peak) or 30.4 dBm (EIRP)
Measured BW, 99% OBW	3946 MHz
Type of modulation	FMCW
Emission classification	3G94PXN
Transmitter spurious, dB μ V/m @ 3 m	52.22
Antenna information	Integral antenna, type: PEEK/DN40 (1.5" lens) with 28.3 dBi gain and a maximum beam width at 3 dB of 6.2° for the E-Plane and 7.8° for the H-Plane.

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	<p>The EUT was configured to measure its highest possible radiation level. The test modes selected are according to EUT instruction manual.</p> <p>The EUT has been tested supplied by an external AC/DC adapter and connected to a notebook with BLE radio link. The following software has been used to force the EUT in TX and RX mode (according to manufacturer request):</p> <p>The EUT has been tested in normal working condition with the "ProTestSuite" software running on the PC. The software is used only for see the distance measured.</p>
Transmitter state	<p>Transmitter set into normal working measuring a distance with the FMCW radar working with a TSWEEP of 342 μs and a TCYCLE of 500 ms at maximum power (0 dBm peak power at the antenna connector).</p>

5.5.2 EUT setup configuration

Table 5.5-1: EUT sub assemblies

Description	Brand name	Model, Part number, Serial number, Revision level
EUT	ProMinent GmbH	MN: 112053, PN: 1120573, SN: 203981046

Table 5.5-2: EUT interface ports

Description	Qty.
M12 connector	1

Table 5.5-3: Support equipment

Description	Brand name	Model, Part number, Serial number, Revision level
Notebook	Dell	ProMinent-ID DE1-PC1742
Power Supply	MEANWELL	MN: GSM25E24-SC, SN: ECOB1J3314

Table 5.5-4: Inter-connection cables

Cable description	From	To	Length (m)
Y cable	EUT	Power Supply	>30
	EUT	Multimeter	>30

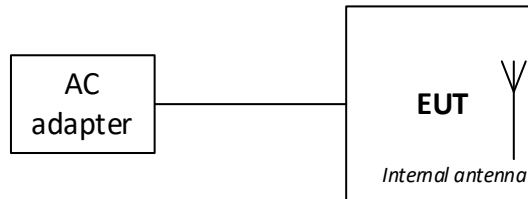


Figure 5.5-1: Testing block diagram

Section 6 Summary of test results

6.1 Testing location

Test location (s) Ottawa

6.2 Testing period

Test start date October 7, 2022 Test end date December 8, 2022

6.3 Sample information

Receipt date September 19, 2022 Nemko sample ID number(s) 4654480006

6.4 FCC test results

Table 6.4-1: FCC requirements results

Part	Test description	Verdict
§15.256(h)	Spurious emissions	Pass
§15.256(f)	Fundamental bandwidth	Pass
§15.256(g)	Fundamental emissions limits (Maximum peak output power & Power spectral density)	Pass
§15.256(i)	Antenna beamwidth	Pass
§15.256(j)	Antenna side lobe gain	Pass
§15.215(c)	Frequency stability	Pass

Notes: None

6.5 ISED test results

Table 6.5-1: ISED requirements results

RSS-211 Part	Test description	Verdict
5.1(d)	Unwanted emissions	Pass
5.1(a)(b)(c)	Fundamental bandwidth	Pass
5.2(b)	Fundamental emissions limits (Maximum peak output power & Power spectral density)	Pass
5.2(a)	Antenna beamwidth	Pass
5.2(c)	Antenna side lobe gain	Pass
5.3(b)	RF field leakage for TLPR	Not applicable*
RSS-Gen, 8.11	Frequency stability	Pass

Notes: *The product is not TLPR

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	January 20, 2023
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
61505 AC source	Chroma	61509	FA003036	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	November 28, 2023
Horn (1–18 GHz)	ETS Lindgren	3117	FA002840	1 year	February 10, 2023
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002873	1 year	August 16, 2023
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	February 14, 2023
Signal and Spectrum Analyzer	Rhode&Schwarz	FSW50	FA003267	1 year	December 8, 2023
Horn antenna (18–26.5 GHz)	Electro-metrics	SH-50/60-1	FA000479	—	VOU
Horn antenna 26.5–40 GHz	Electro-metrics	SH-50/60-2	FA000485	—	VOU
40–60 GHz Harmonic mixer	OML	WR19 M19HWD	FA002322	3 year	December 8, 2023
40–60 GHz Standard gain horn	Millitech	U SGH-19	FA002322a	—	VOU
60–90 GHz Harmonic mixer	OML	WR12 M12HWD	FA001524	3 year	December 8, 2023
60–90 GHz Standard gain horn	Millitech	U SGH-12	FA001524a	—	VOU
90–140 GHz Harmonic mixer	OML	WR08 M08HWD	FA001525	3 year	December 8, 2023
90–140 GHz Standard gain horn	Millitech	U SGH-08	FA001525a	—	VOU
140–220 GHz Harmonic mixer	OML	WR05 M05HWD	FA001526	3 year	December 8, 2023
140–220 GHz Standard gain horn	Millitech	U SGH-05	FA001526a	—	VOU
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
Temperature chamber	Espec	EPX-4H	FA002735	1 year	January 16, 2023

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

Section 8 Testing data

8.1 Fundamental bandwidth

8.1.1 References, definitions and limits

FCC §15.256:

- (f) The fundamental bandwidth of an LPR emission is defined as the width of the signal between two points, one below and one above the center frequency, outside of which all emissions are attenuated by at least 10 dB relative to the maximum transmitter output power when measured in an equivalent resolution bandwidth.
- (1) The minimum fundamental emission bandwidth shall be 50 MHz for LPR operation under the provisions of this section.
- (2) LPR devices operating under this section must confine their fundamental emission bandwidth within the 5.925-7.250 GHz, 24.05-29.00 GHz, and 75-85 GHz bands under all conditions of operation.

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.

RSS-211, Clause 5.1:

- (a) The minimum fundamental emission bandwidth shall be 50 MHz.
- (b) The fundamental emission bandwidth shall be confined within the designated device operating bands under all conditions.
- (c) The sweep, step or hop function is never stopped with the fundamental emission within any restricted band specified in RSS-Gen

RSS-Gen, Clause 6.7:

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

8.1.2 Test summary

Verdict	Pass		
Tested by	Moustapha Salah Toubeh	Test date	November 30, 2022

8.1.3 Observations, settings and special notes

The test was performed as per KDB 890966 D01, section D with reference to ANSI C63.10 subclause 6.9.

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	$\geq 3 \times \text{RBW}$
Frequency span	10 GHz
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: 99% occupied bandwidth results

Fundamental frequency, GHz	99% occupied bandwidth, MHz
77–81	3946

Notes: There is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

Table 8.1-2: 10 dBc bandwidth results

Fundamental frequency, GHz	10 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
77–81	3976	50.00	3926

Table 8.1-3: 20 dBc bandwidth results

Fundamental frequency, GHz	20 dB bandwidth, MHz
77–81	3976

Note: there are no limits for the 20 dB BW. These results are required for Frequency stability test.

Table 8.1-4: Lower 10 dBc frequency cross result

Fundamental frequency, GHz	Lower 10 dBc frequency cross, GHz	Minimum Limit, GHz	Margin, GHz
77–81	77.023	75.000	2.023

Table 8.1-5: Upper 10 dBc frequency cross result

Fundamental frequency, GHz	Upper 10 dBc frequency cross, GHz	Maximum Limit, GHz	Margin, GHz
77–81	80.969	85.000	4.031

Test data, continued

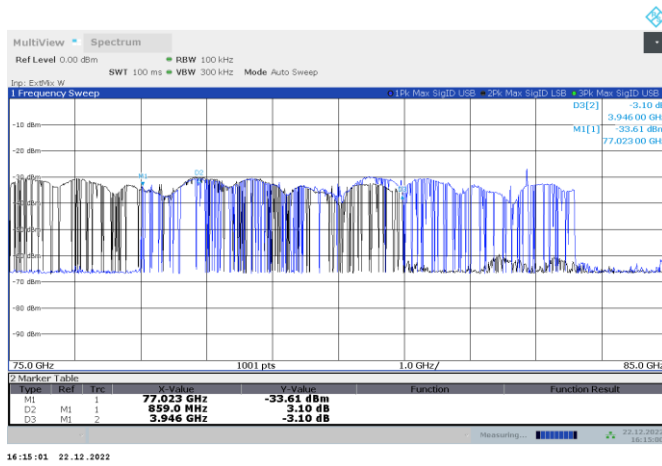


Figure 8.1-1: 99% occupied bandwidth

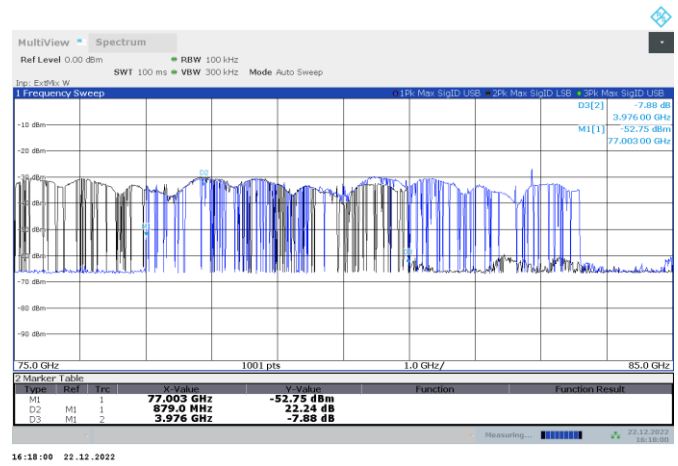


Figure 8.1-2: 10 and 20 dBc occupied bandwidth

8.2 Fundamental emissions limits (Maximum peak output power and Power spectral density)

8.2.1 References, definitions and limits

FCC §15.256:

- (1) All emission limits provided in this section are expressed in terms of Equivalent Isotropic Radiated Power (EIRP).
- (2) The EIRP level is to be determined from the maximum measured power within a specified bandwidth.
 - (i) The EIRP in 1 MHz is computed from the maximum power level measured within any 1-MHz bandwidth using a power averaging detector;
 - (ii) The EIRP in 50 MHz is computed from the maximum power level measured with a peak detector in a 50-MHz bandwidth centered on the frequency at which the maximum average power level is realized and this 50 MHz bandwidth must be contained within the authorized operating bandwidth. For a RBW less than 50 MHz, the peak EIRP limit (in dBm) is reduced by $20 \log(\text{RBW}/50)$ dB where RBW is the resolution bandwidth in megahertz. The RBW shall not be lower than 1 MHz or greater than 50 MHz. The video bandwidth of the measurement instrument shall not be less than the RBW. If the RBW is greater than 3 MHz, the application for certification filed shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.
- (3) The EIRP limits for LPR operations in the bands authorized by this rule section are provided in Table below. The emission limits in Table below are based on boresight measurements (*i.e.*, measurements performed within the main beam of an LPR antenna).

RSS-211, Clause 5.2:

- b For average emission limits, LPR devices shall not exceed the limits provided in Table below measured in a 1 MHz measurement bandwidth with an average detector. For peak emission limits, LPR devices shall not exceed the limits provided in Table below measured in a 50 MHz measurement bandwidth with a peak detector.

Table 8.2-1: LPR EIRP Emission Limits

Frequency band of operation (GHz)	Average emission limit (EIRP in dBm measured in 1 MHz)	Peak emission limit (EIRP in dBm measured in 50 MHz)
5.925–7.250	-33	+7
24.05–29.00	-14	+26
75–85	-3	+34

8.2.2 Test summary

Verdict	Pass		
Tested by	Moustapha Salah Toubeh	Test date	November 30, 2022

8.2.3 Observations, settings and special notes

The test was performed as per KDB 890966 D01, sections E or F

Spectrum analyser settings for EIRP:

Resolution bandwidth	50 MHz
Video bandwidth	≥ RBW
Frequency span	10 GHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for PSD:

Resolution bandwidth	1 MHz
Video bandwidth	≥ 3 × RBW
Frequency span	10 GHz
Detector mode	RMS
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-2: EIRP results (radiated measurement) within 50 MHz

Frequency, GHz	Field strength, dBμV/m	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
77–81	125.63	30.40	34.00	3.60

Note: $EIRP [dBm] = Field\ Strength [dB\mu V/m] + 20 \log_{10}(D) - 104.8$ with D is distance from EUT to antenna

Table 8.2-3: PSD results (radiated measurement)

Frequency, GHz	Field strength, dBμV/m/1 MHz	EIRPSD, dBm/MHz	EIRPSD limit, dBm/MHz	EIRPSD margin, dB
77–81	87.58	-7.65	-3.00	4.65

Note: $EIRPSD [dBm/1\ MHz] = Field\ Strength [dB\mu V/m/1\ MHz] + 20 \log_{10}(D) - 104.8$ with D is distance from EUT to antenna

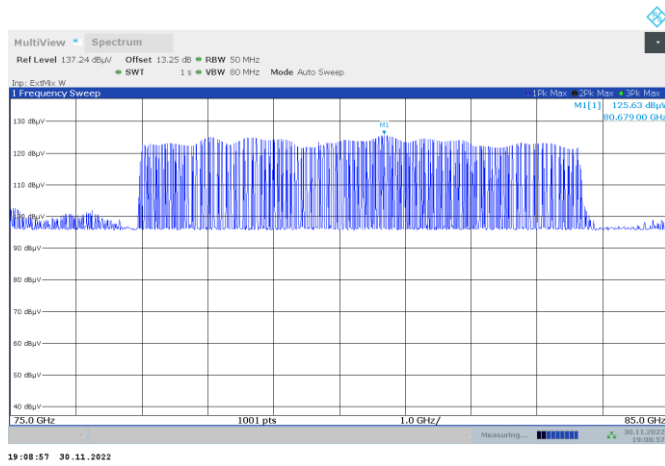


Figure 8.2-1: EIRP per 50 MHz

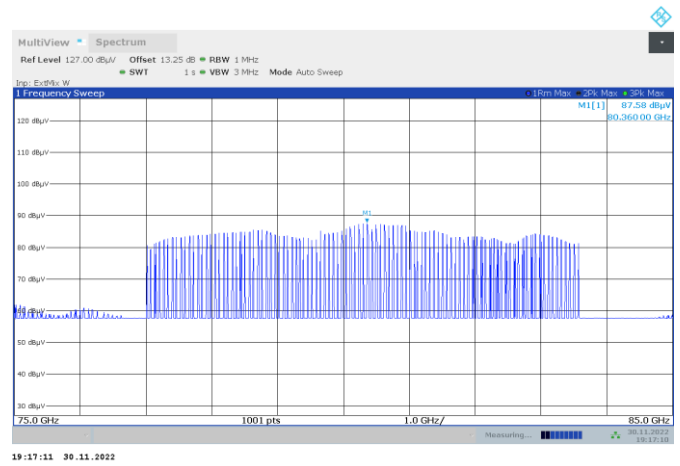


Figure 8.2-2: EIRPSD per 1 MHz



8.3 Antenna beamwidth and side lobe gain

8.3.1 References, definitions and limits

FCC §15.256:

- (i) **Antenna beamwidth.**
- (A) LPR devices operating under the provisions of this section within the 5.925-7.250 GHz and 24.05-29.00 GHz bands must use an antenna with a -3 dB beamwidth no greater than 12 degrees.
- (B) LPR devices operating under the provisions of this section within the 75-85 GHz band must use an antenna with a -3 dB beamwidth no greater than 8 degrees.
- (j) **Antenna side lobe gain.** LPR devices operating under the provisions of this section must limit the side lobe antenna gain relative to the main beam gain for off-axis angles from the main beam of greater than 60 degrees to the levels provided in Table below.

RSS-211, Clause 5.2:

- a. **Antenna beamwidth:** For devices operating in open-air environments, the antenna shall have a maximum half-power beamwidth of 12° for the bands 5.65-8.50 GHz and 24.05-29.00 GHz, and a maximum half power beamwidth of 8° for the band 75-85 GHz.
- c. **Antenna Side Lobe:** LPR devices must limit the antenna side lobe gain relative to the main beam gain for off-axis angles from the main beam of greater than 60° for the levels provided in Table below.

Table 8.3-1: Antenna Side Lobe Gain Limits

Frequency range (GHz)	Antenna side lobe gain limit relative to main beam gain (dB)
5.925–7.250	-22
24.05–29.00	-27
75–85	-38

8.3.2 Test summary

Verdict	Pass		
Tested by	Moustapha Salah Toubeh	Test date	December 8, 2022

8.3.3 Observations, settings and special notes

The antenna characteristics (gain vs angle) were taken from the provided datasheet by the manufacturer.



8.3.4 Test data

Table 8.3-2: Antenna beamwidth results

Frequency, GHz	Main lobe max gain, dBi	Main lobe 3 dBc beamwidth, deg	Main lobe beamwidth Limit, deg	Margin, deg
77	28.05	7.83	8.00	0.17
79	27.22	7.74	8.00	0.26
81	28.29	7.28	8.00	0.72

Table 8.3-3: Antenna Side Lobe Gain results

Frequency, GHz	Antenna side lobe suppression for off-axis angles > 60°, dB	Antenna side lobe suppression minimum limit, dB	Margin, dB
77	38.21	38.00	0.21
79	38.46	38.00	0.46
81	38.72	38.00	0.72

8.4 Unwanted emissions

8.4.1 References, definitions and limits

FCC §15.256:

- (h) Unwanted emissions from LPR devices shall not exceed the general emission limit in § 15.209 of this chapter.
- (k) Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in § 15.209 of this chapter provided it can be clearly demonstrated that those emissions are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in § 15.3(k) of this part, e.g., emissions from digital circuitry used to control additional functions or capabilities other than the operation of the transmitter, are subject to the limits contained in subpart B, part 15 of this chapter. Emissions from these digital circuits shall not be employed in determining the -10 dB bandwidth of the fundamental emission or the frequency at which the highest emission level occurs.

RSS-211, Clause 5.1:

- (d) Unwanted emissions shall not exceed the general field strength limits set out in RSS-Gen

RSS-Gen:

- 8.9 Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table below.
- 8.10 Restricted frequency bands are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. The following conditions related to the restricted frequency bands apply:
 - a The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands.
 - b Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table below.
 - c Unwanted emissions that do not fall within the restricted frequency bands shall comply either with the limits specified in the applicable RSS or with those specified in table below.

Table 8.4-1: 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.

References, definitions and limits, continued

Table 8.4-2: ISED restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	
8.41425–8.41475	167.72–173.2	3500–4400	Above 38.6
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 8.4-3: FCC restricted frequency bands

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

8.4.2 Test summary

Verdict	Pass		
Tested by	Moustapha Salah Toubeh	Test date	October 7, 2022 to November 30, 2022

8.4.3 Observations, settings and special notes

- As part of the current assessment, the test range of 9 kHz to 10th harmonic has been fully considered and compared to the actual frequencies utilized within the EUT. Since the EUT contains a transmitter in the GHz range, the EUT has been deemed compliant without formal testing in the 9 kHz to 30 MHz test range, therefore formal test results (tabular data and/or plots) are not provided within this test report.
- All measurements corrected to 3 m distance.
- LPR emissions test was performed as per KDB 890966 D01, section G with reference to ANSI C63.10 subclause 6.

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

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

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

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

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

Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for conducted spurious emissions measurements:

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

8.4.4 Test data

Table 8.4-4: Radiated field strength measurement results

Frequency, GHz	Peak Field strength, dB μ V/m		Margin, dB	Average Field strength, dB μ V/m		Margin, dB
	Measured	Limit		Measured	Limit	
14.401	57.03	74.00	16.97	36.61	54.00	17.39
31.569	59.33	74.00	14.67	35.32	54.00	18.68
48.757	61.68	74.00	12.32	39.35	54.00	14.65
55.307	71.98	74.00	2.02	45.37	54.00	8.63
73.289	72.69	74.00	1.31	52.22	54.00	1.78
103.829	66.53	74.00	7.47	37.50	54.00	16.50
150.875	64.56	74.00	9.44	34.83	54.00	19.17
188.263	62.48	74.00	11.52	34.26	54.00	19.74

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Test data, continued

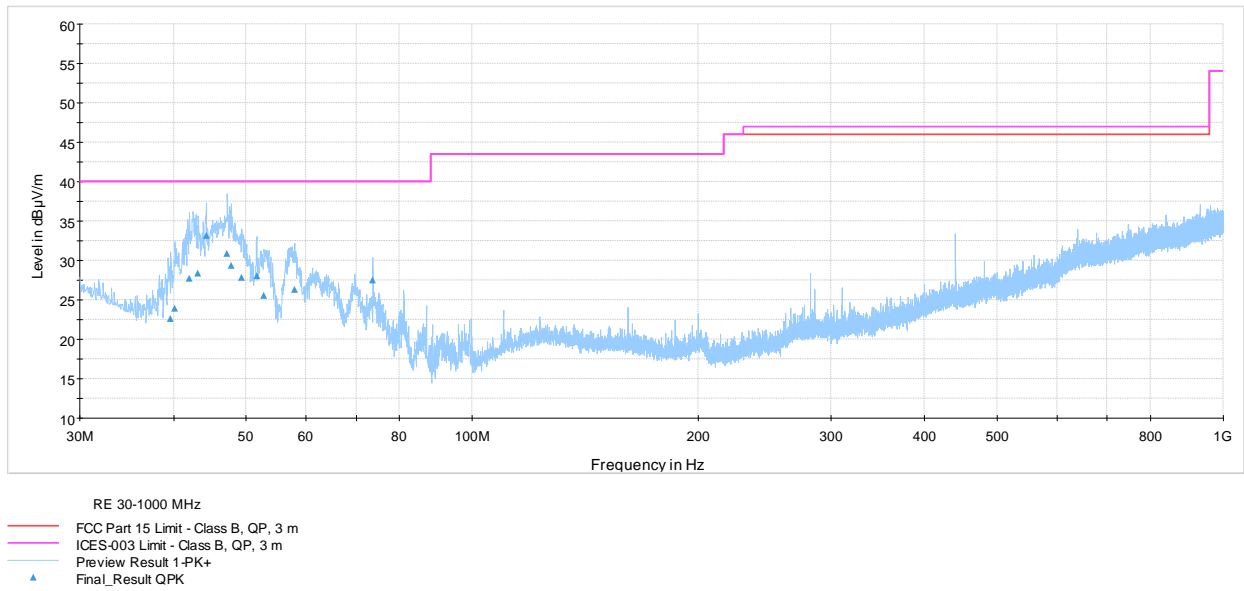


Figure 8.4-1: Radiated spurious emissions below 1 GHz

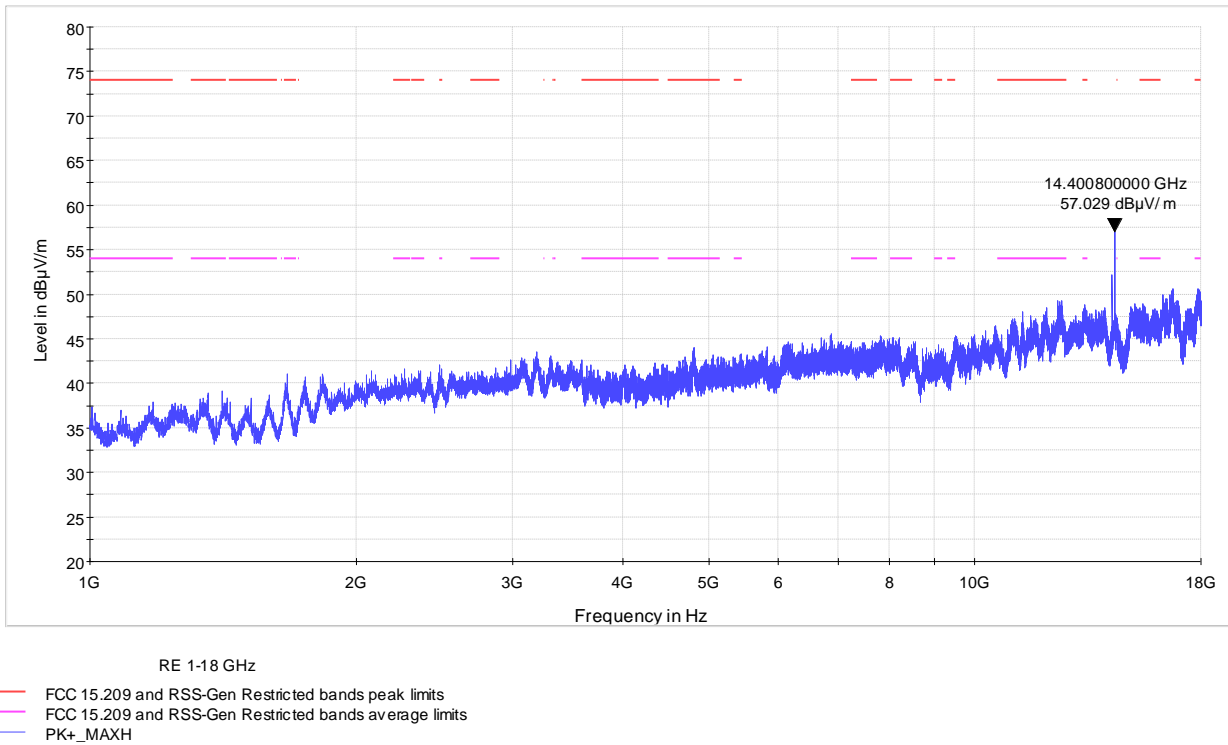


Figure 8.4-2: Radiated spurious emissions within 1-18 GHz

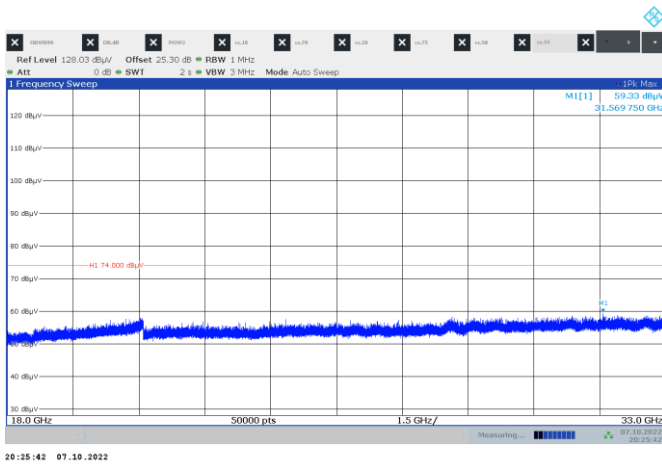


Figure 8.4-3: Radiated spurious emissions within 18–33 GHz

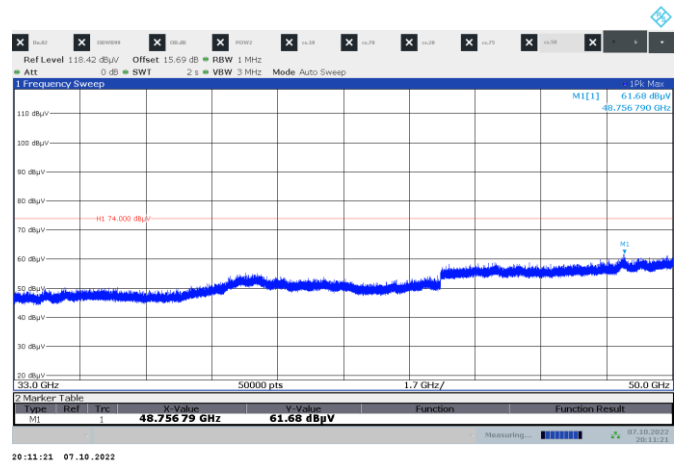


Figure 8.4-4: Radiated spurious emissions within 33–50 GHz

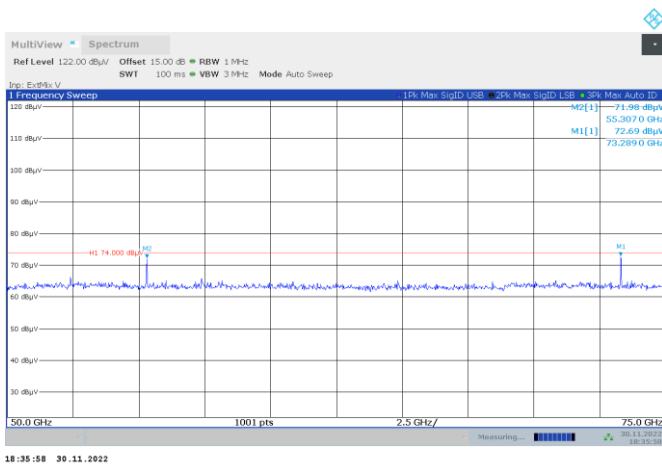


Figure 8.4-5: Radiated spurious emissions within 50–75 GHz



Figure 8.4-6: Radiated spurious emissions within 75–110 GHz

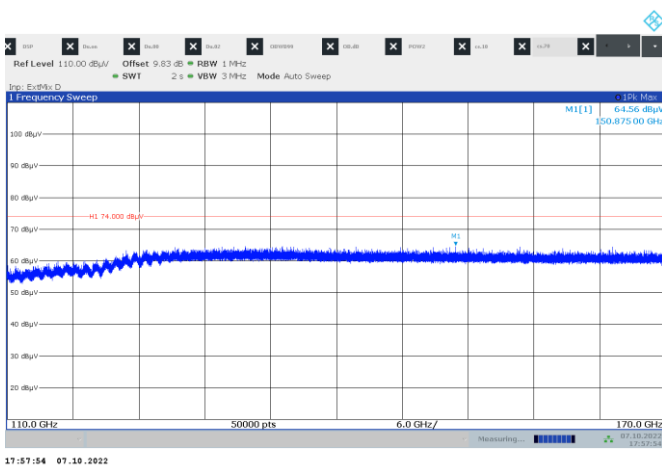


Figure 8.4-7: Radiated spurious emissions within 110–170 GHz

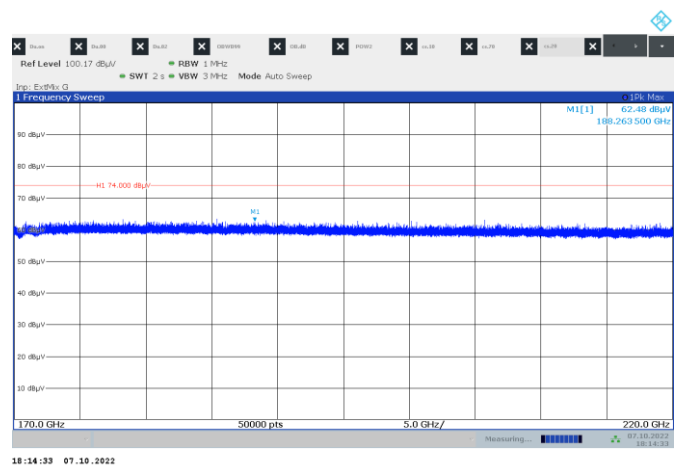


Figure 8.4-8: Radiated spurious emissions within 170–220 GHz

8.5 Frequency stability

8.5.1 References, 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. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. 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, section 8.11:

If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation. In addition, its occupied bandwidth shall be entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, and 470-602 MHz, unless otherwise indicated.

8.5.2 Test summary

Verdict	Pass		
Tested by	Moustapha Salah Toubeh	Test date	October 11, 2022

8.5.3 Observations, settings and special notes

Frequency stability test was performed as per KDB 890966 D01 Section H and ANSI C63.10, Clause 6.8. Spectrum analyser settings:

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

8.5.4 Test data

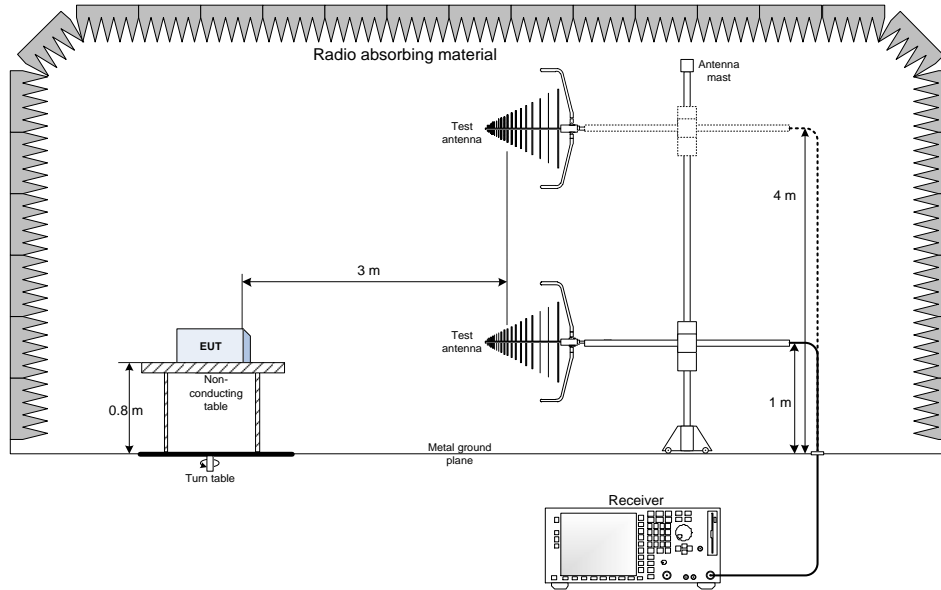
Table 8.5-1: Frequency drift measurement

Test conditions	Frequency, MHz	Lowest 20 dBc cross frequency*	Highest 20 dBc cross frequency**	Lowest 99% OBW cross frequency*	Highest 99% OBW cross frequency**
+50 °C, Nominal	80.3028	77.0211	83.5845	75.4225	84.6831
+40 °C, Nominal	80.3057	77.0111	83.6003	75.4062	84.7052
+30 °C, Nominal	80.3203	77.0237	83.6169	75.4179	84.7227
+20 °C, +15 %	80.3005	77.0339	83.5671	75.4472	84.6538
+20 °C, Nominal	80.3077	77.0079	83.6075	75.4394	84.6760
+20 °C, -15 %	80.3068	77.0113	83.6023	75.4235	84.6901
+10 °C, Nominal	80.3014	77.0107	83.5921	75.4156	84.6872
0 °C, Nominal	80.3068	77.0237	83.5899	75.3909	84.7227
-10 °C, Nominal	80.3081	77.0165	83.5997	75.4098	84.7064
-20 °C, Nominal	80.3141	77.0425	83.5857	75.4173	84.7109

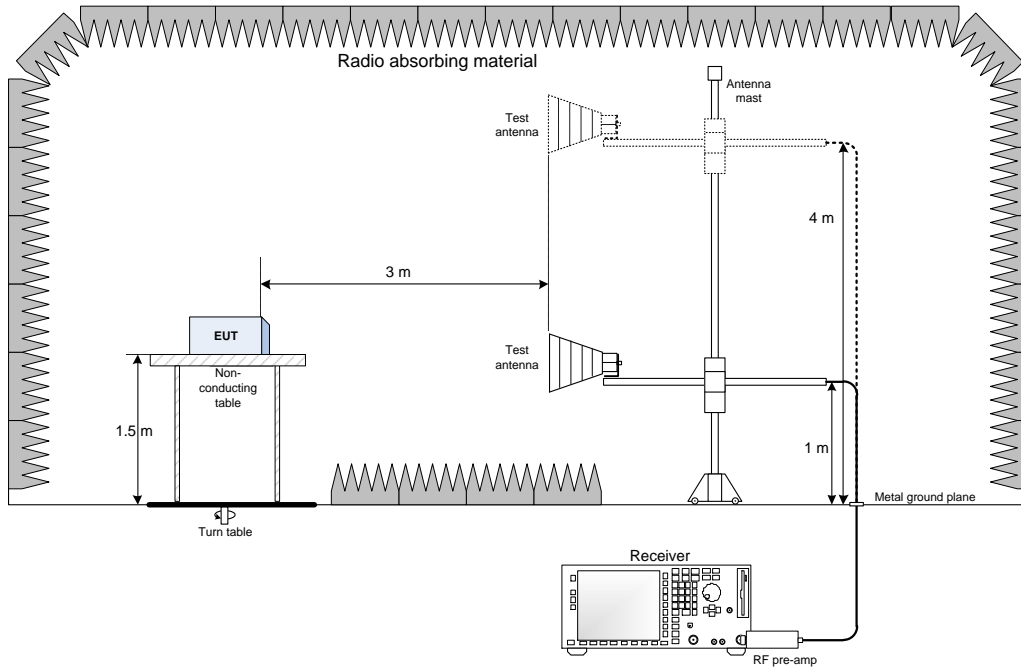
Notes: * the lower limit is >75 GHz; ** the upper limit is <85 MHz

Section 9 Test setup diagrams

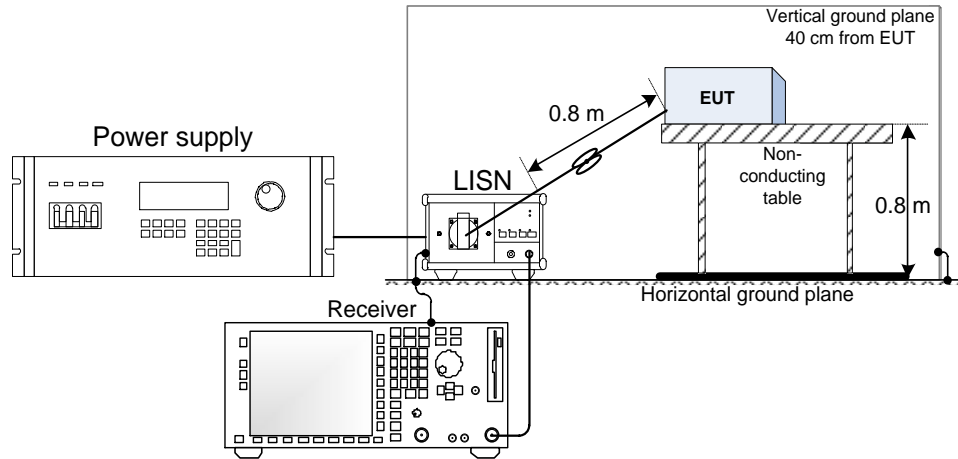
9.1 Radiated emissions set-up for frequencies below 1 GHz



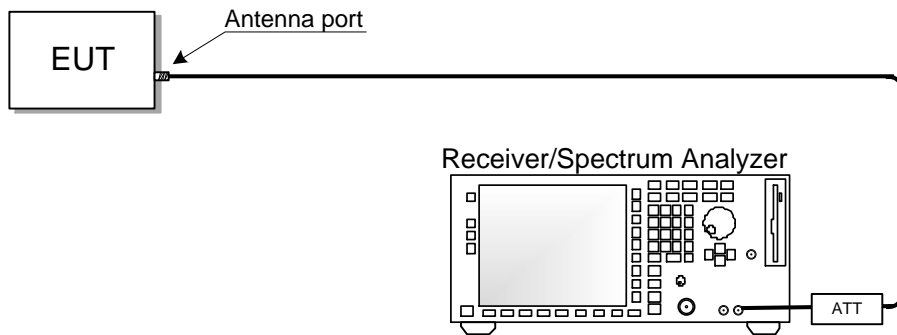
9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 AC mains conducted emissions set-up



9.4 Antenna port set-up



End of the test report