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Test report

358412-1TRFWL

Date of issue: October 24, 2018

Applicant:

2N TELEKOMUNIKACE a.s.

Product:

RFID Reader

Model:

2N RFID Reader

FCC ID:

2AQPZ-NFC2F

IC Registration number:

22140-NFC2F

Specifications:

FCC 47 CFR Part 15.225

Operation within the band 13.110–14.010 MHz

RSS-210 Issue 9, August 2016, Annex B.6

Devices operating in 13.110–14.010 MHz frequency band for any application

Test location

Company name	Nemko Canada Inc.
Address	292 Labrosse Avenue
City	Pointe-Claire
Province	QC
Postal code	H9R 5L8
Country	Canada
Telephone	+1 514 694 2684
Facsimile	+1 514 694 3528
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2041; IC: 2040G-5 (3 m semi anechoic chamber)

Tested by	Yong Huang, Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Date	October 24, 2018
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 Applicant and manufacturer

Company name	2N TELEKOMUNIKACE a.s.
Address	Modranska 621/72 CZ-14301 Prague Czech Republic

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.225	Operation in the 13.110–14.010 MHz
RSS-210 Issue 9, August 2016, Annex B.6	Devices operating in 13.110–14.010 MHz frequency band for any application
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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	Pass
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]
§15.215(c)	20 dB bandwidth	Pass

Notes: EUT was powered via AC/DC adapter provided by client.

[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

Part	Test description	Verdict
§15.225(a)	Field strength within 13.553–13.567 MHz band	Pass
§15.225(b)	Field strength within 13.410–13.553 MHz and 13.567–13.710 MHz bands	Pass
§15.225(c)	Field strength within 13.110–13.410 MHz and 13.710–14.010 MHz bands	Pass
§15.225(d)	Field strength outside 13.110–14.010 MHz band	Pass
§15.225(e)	Frequency tolerance of carrier signal	Pass

Notes: None

2.3 ISED RSS-GEN, Issue 5, test results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

EUT is an AC powered device.

2.4 ISED RSS-210, Issue 9, test results

Annex	Test description	Verdict
B.6 (a)	The field strength within the band 13.553–13.567 MHz	Pass
B.6 (b)	The field strength within the bands 13.410–13.553 MHz and 13.567–13.710 MHz	Pass
B.6 (c)	The field strength within the bands 13.110–13.410 MHz and 13.710–14.010 MHz	Pass
B.6 (d)	The field strength outside the band 13.110–14.010 MHz	Pass
B.6	Carrier frequency stability	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	August 31, 2018
Nemko sample ID number	Item #1, #5

3.2 EUT information

Product name	RFID Reader
Model	2N RFID Reader
Serial number	None

3.3 Technical information

Operating band	13.553–13.567 MHz
Operating frequency	13.56 MHz
Modulation type	ASK
Occupied bandwidth (99 %)	2.46 kHz
Power requirements	3.3 to 5.0 V_{DC}
Emission designator	K1D
Antenna information	The EUT uses a non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The 2N® RFID Reader is a modular transceiver primarily intended for use in 2N door stations. The device consists of two independent readers – LF (125 kHz) and HF (13.56 MHz). It uses 4-layer PCB of size 19 x 31 mm. The device is equipped with RF shielding. The reader is not intended for standalone use. The 2N ® RFID Reader is able to work in LF mode, HF mode or both modes simultaneously. 2N ® RFID Reader consists of the MCU STM32L451RCT6, the PN5180 radio frontend for HF and the analog radio part for LF. The connection between MCU and HF frontend is provided with SPI bus. The data from LF part are obtained via AD convertor integrated into MCU. The MCU firmware upgrade is available via IAP (In Application Programming) interface. The reader is also equipped with the onboard power supply regulation (LDO). The output voltage of LDO is 3.3 V. The HF frequency is derived from the external quartz clock (27.12 MHz). The complementary output stage pins (TX1, TX2) are used to generate the output signal into antenna via onboard EMC filter and capacitors on antenna side. The LF frequency is derived from MCU quartz (24 MHz) and delivered to antenna via correspondent output booster and tuning capacitors.

3.5 EUT exercise details

EUT was configured per client's instruction and set up with client's test firmware, continuous transmit mode was configured during transmitter tests.
The EUT goes into search mode and transmits continuously on operating frequencies after being powered on. There is no need to setup or adjust the EUT during tests.

3.6 EUT setup diagram

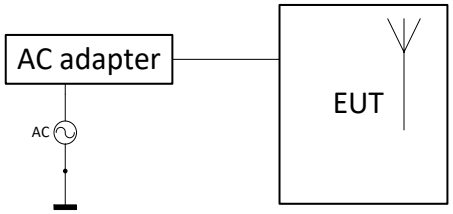


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
RFID Reader	2N	NFC2F	None

Table 3.7-2: *Support equipment*

Description	Brand name	Model/Part number	Serial number
AC power adapter	ADAPTOR	WT0502500	none

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

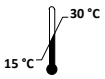
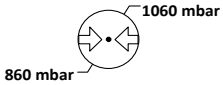
None

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

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002532	2 year	June 5/19
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Oct. 18/18
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Dec. 6/18
Active loop antenna (9 kHz–30 MHz)	COM-POWER	AL-130	FA002722	1 year	Aug. 10/19
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	Sucoflex	None	FA002563	—	VOU
50 Ω coax cable	C.C.A.	None	FA002831	—	VOU
Environmental Chamber	ESPEC	EPX-4H	FA002736	1 year	May 16/19

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

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.1-1: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.1.2 Test summary

Test start date	September 12, 2018
Test engineer	Yong Huang
Verdict	Pass

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

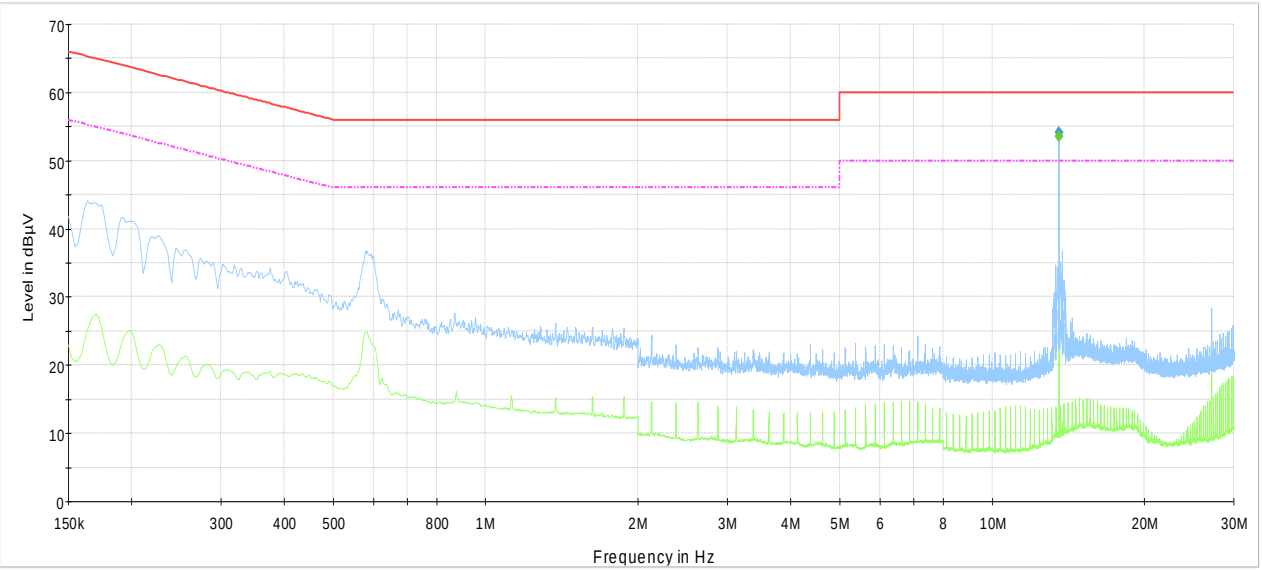
A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Tests were performed according to KDB 174176: (1) perform the AC power-line conducted tests with the antenna connected to determine compliance with Section 15.207 limits outside the transmitter's fundamental emission band; (2) retest with a dummy load in lieu of the antenna to determine compliance with Section 15.207 limits within the transmitter's fundamental emission band.

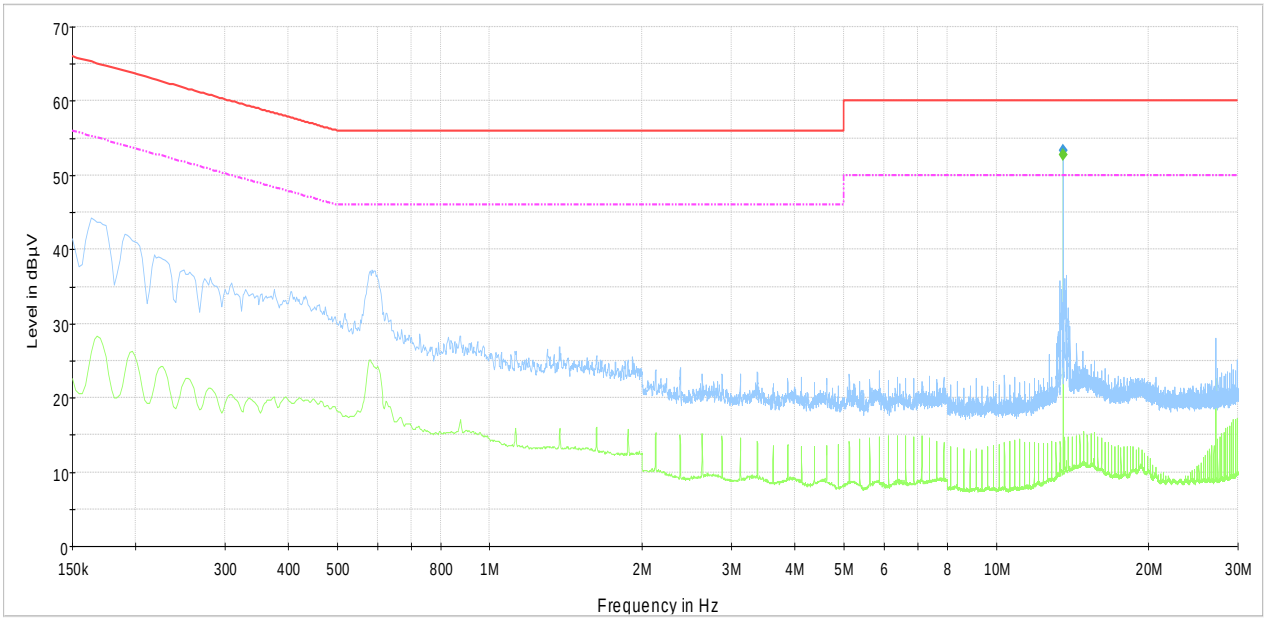
Test receiver settings:

Frequency span	150 kHz to 30 MHz
Detector mode	Peak and Average (preview mode); Quasi-Peak (final measurements)
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	100 ms

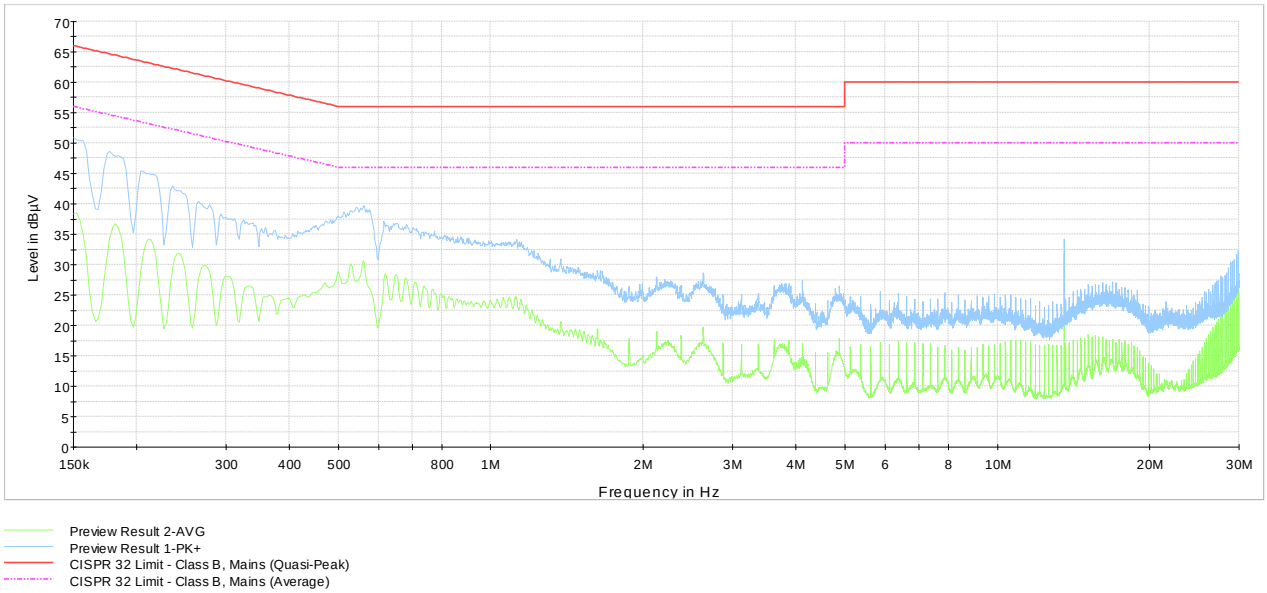
8.1.4 Test data



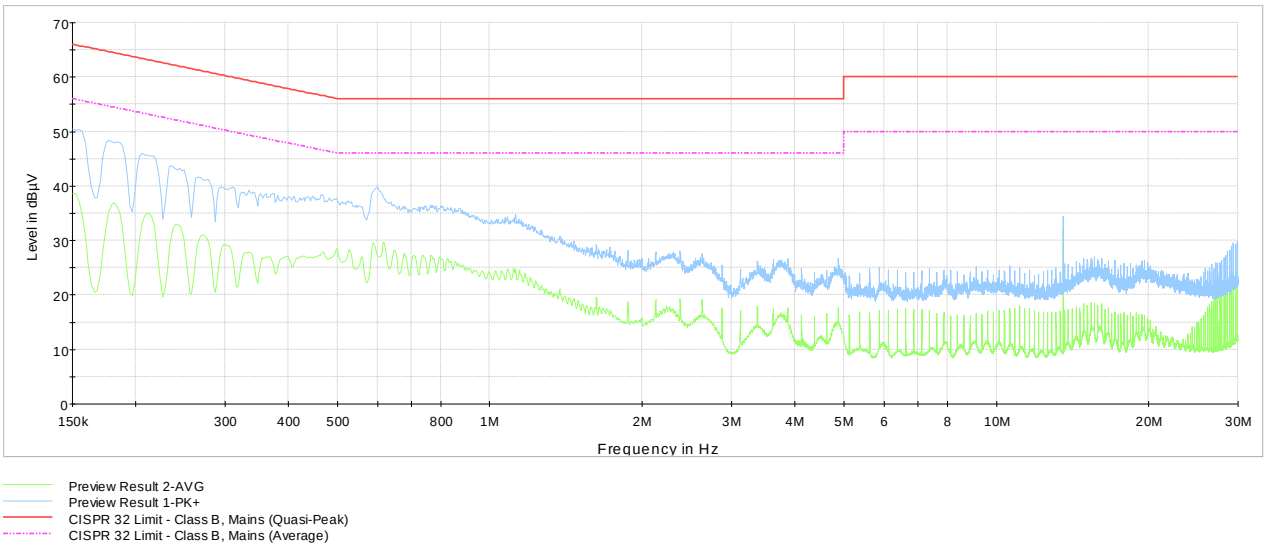
Plot 8.1-1: *Conducted emissions on phase line, with antenna*



Plot 8.1-2: *Conducted emissions on neutral line, with antenna*



Plot 8.1-3: *Conducted emissions on phase line, with dummy load*



Plot 8.1-4: *Conducted emissions on neutral line, with dummy load*

8.2 FCC 15.215(c) and RSS-Gen 6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

8.2.1 Definitions and limits

FCC
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.

IC
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.

8.2.2 Test summary

Test start date	September 20, 2018
Test engineer	Yong Huang
Verdict	Pass

8.2.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	≥1 % of span
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *Lower 20 dBc frequency cross result*

Fundamental frequency, MHz	Lower 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.559	13.553	6

Table 8.2-2: *Upper 20 dBc frequency cross result*

Fundamental frequency, MHz	Upper 20 dBc frequency cross, MHz	Limit, MHz	Margin, kHz
13.560	13.562	13.567	5

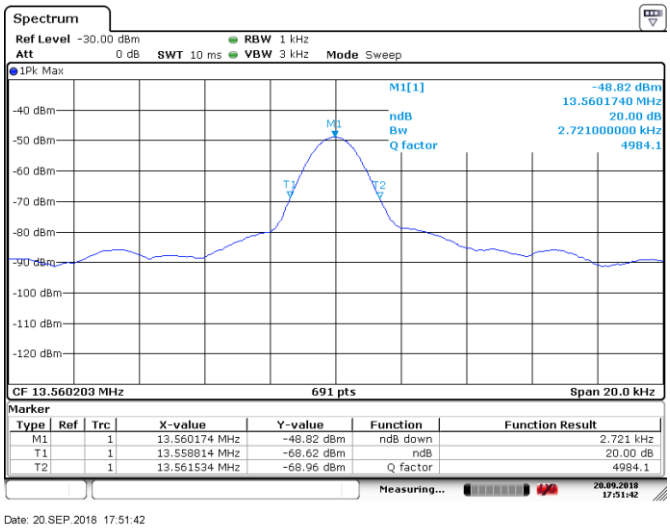


Figure 8.2-1: *20 dB bandwidth*

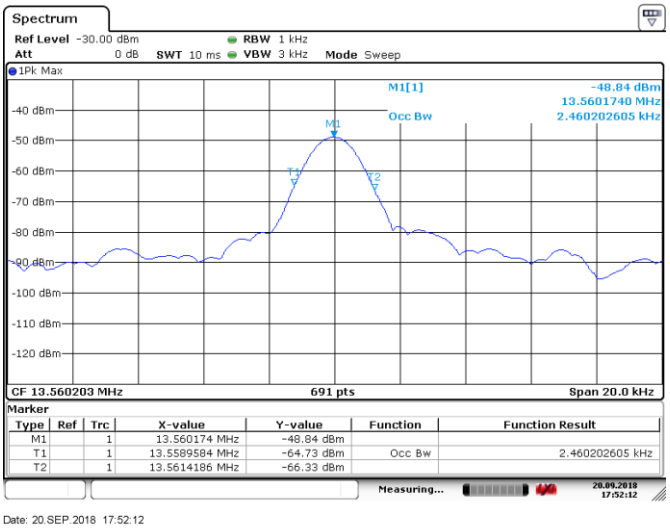


Figure 8.2-2: *99% dB bandwidth*

8.3 FCC 15.225(a–c) and RSS-210 B.6 (a–c) Field strength within the 13.110–14.010 MHz band

8.3.1 Definitions and limits

a) The field strength of any emissions within the band 13.553–13.567 MHz shall not exceed 15848 µV/m (84 dBµV/m) at 30 m.
b) Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m (50.5 dBµV/m) at 30 m.
c) Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 µV/m (40.5 dBµV/m) at 30 m.

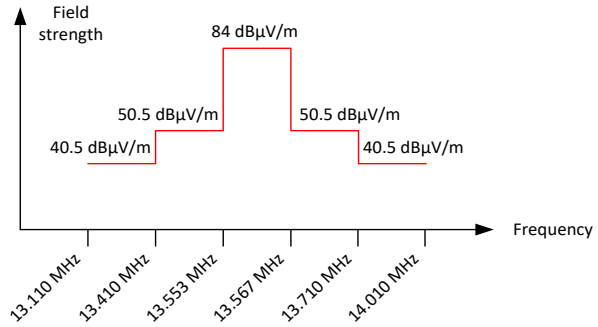


Figure 8.3-1: *In-band spurious emissions limit*

8.3.2 Test summary

Test start date	September 12, 2018
Test engineer	Yong Huang
Verdict	Pass

8.3.3 Observations/special notes

The measurements were performed at the distance of 3 m. 40 dB distance correction factor* was applied to the measurement result in order to comply with 30 m limits.
* 30 m to 3 m distance correction factor calculation (for 13 MHz band):

$$40 \times \text{Log}_{10}\,(3\text{ m}/30\text{ m}) = 40 \times \text{Log}_{10}\,(0.1) = -40\text{ dB}$$

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	10 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold

8.3.1 Test data

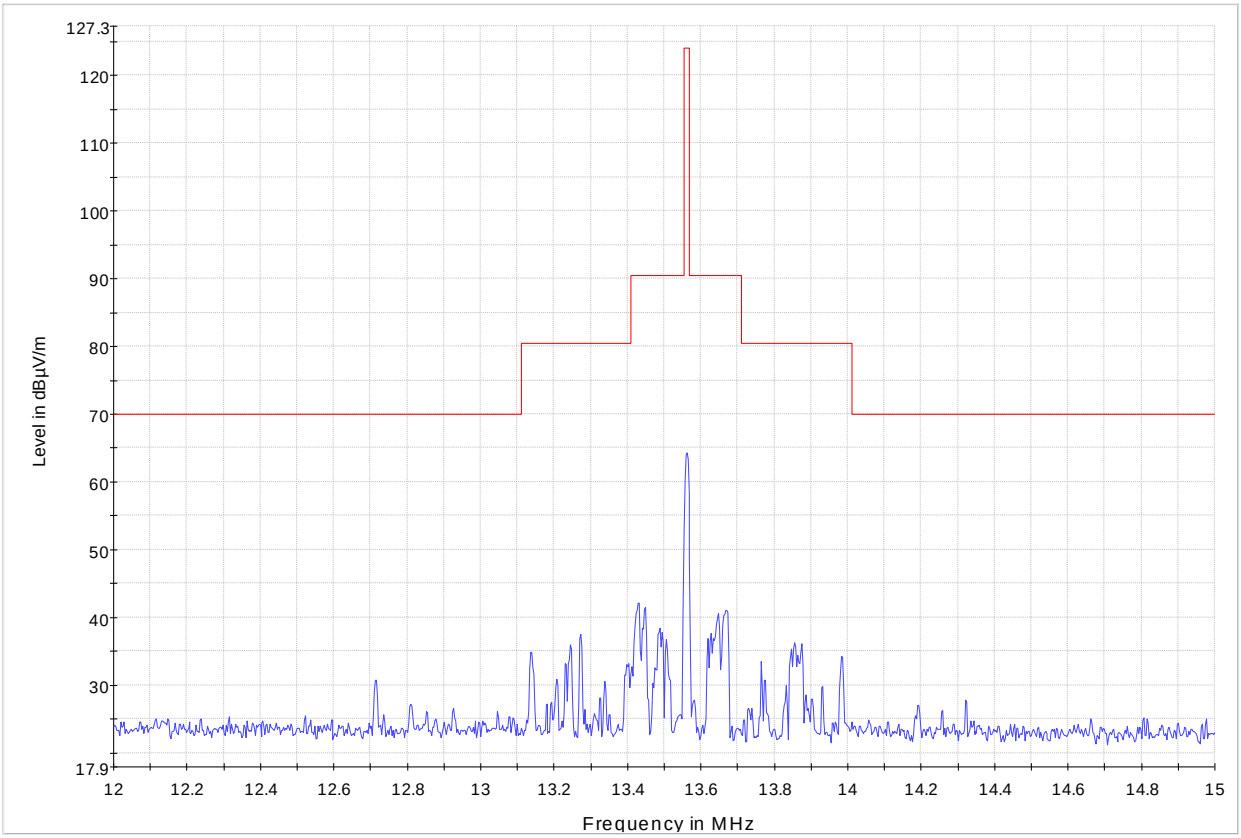


Figure 8.3-2: *Field strength within 13.56 MHz mask*

8.4 FCC 15.225(d) and RSS-210 B.6(d) Field strength of emissions outside 13.110–14.010 MHz band

8.4.1 Definitions and limits

FCC:
The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in §15.209.
The field strength of emissions appearing within restricted bands (as specified in §15.205) shall not exceed the limits from §15.209.
ISED:
RSS-Gen general field strength limits for frequencies outside the band 13.110–14.010 MHz.

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

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	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in **Error! Reference source not found.** and above 38.6 GHz are designated for licence-exempt applications. These f requency 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

Test start date	September 12, 2018
Test engineer	Yong Huang
Verdict	Pass

8.4.3 Observations, settings and special notes

The spectrum was searched from 9 kHz to 1 GHz.
Radiated measurements were performed at a distance of 3 m.

Spectrum analyzer settings for frequencies below 150 kHz:

Detector mode	Quasi-Peak
Resolution bandwidth	300 Hz
Video bandwidth	9 kHz
Trace mode	Max Hold
Measurement time	100 ms

Spectrum analyzer settings for frequencies from 150 kHz to 30 MHz:

Detector mode	Quasi-Peak
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	100 ms

Spectrum analyzer settings for frequencies above 30 MHz:

Detector mode	Peak
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Trace mode	Max Hold
Measurement time	100 ms

8.4.4 Test data

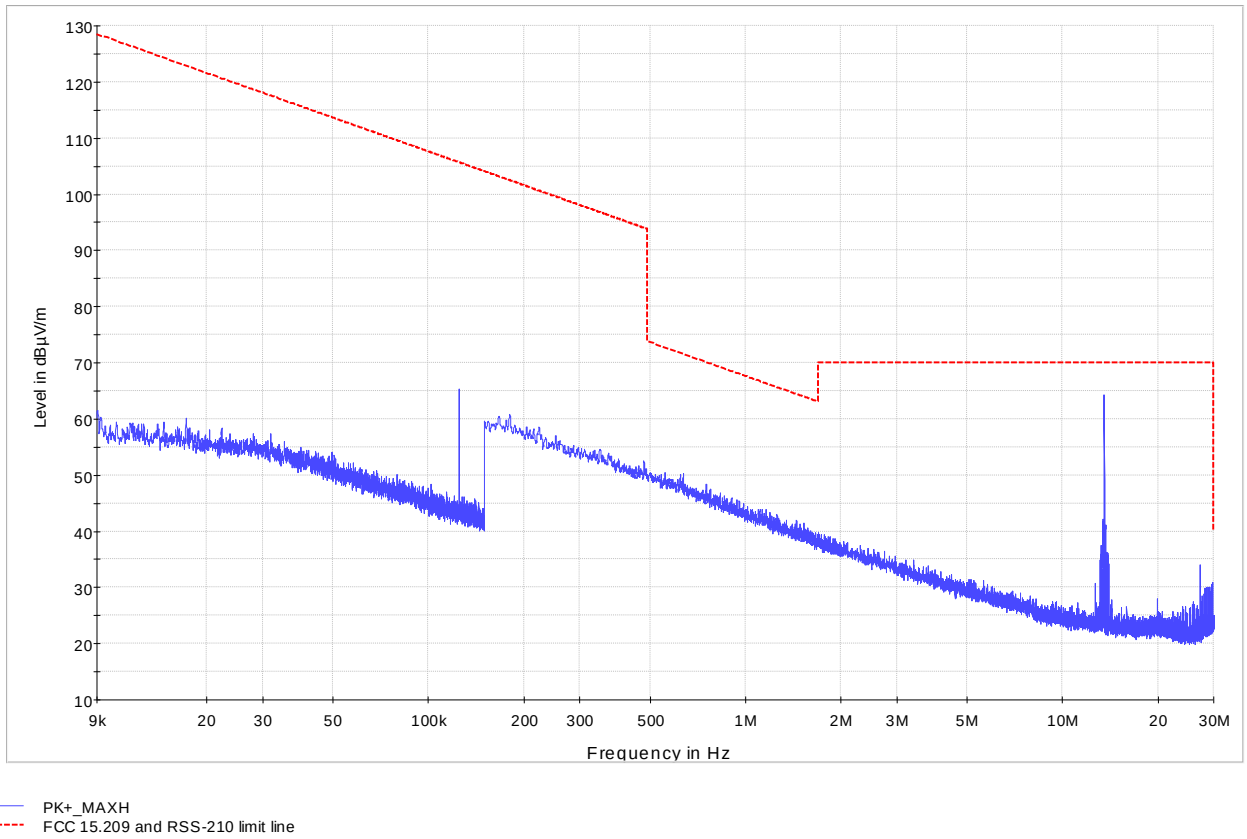


Figure 8.4-1: *Field strength of spurious emissions below 30 MHz*

Note: Emissions on 13.56 MHz and 125 kHz are from intentional transmission of EUT.

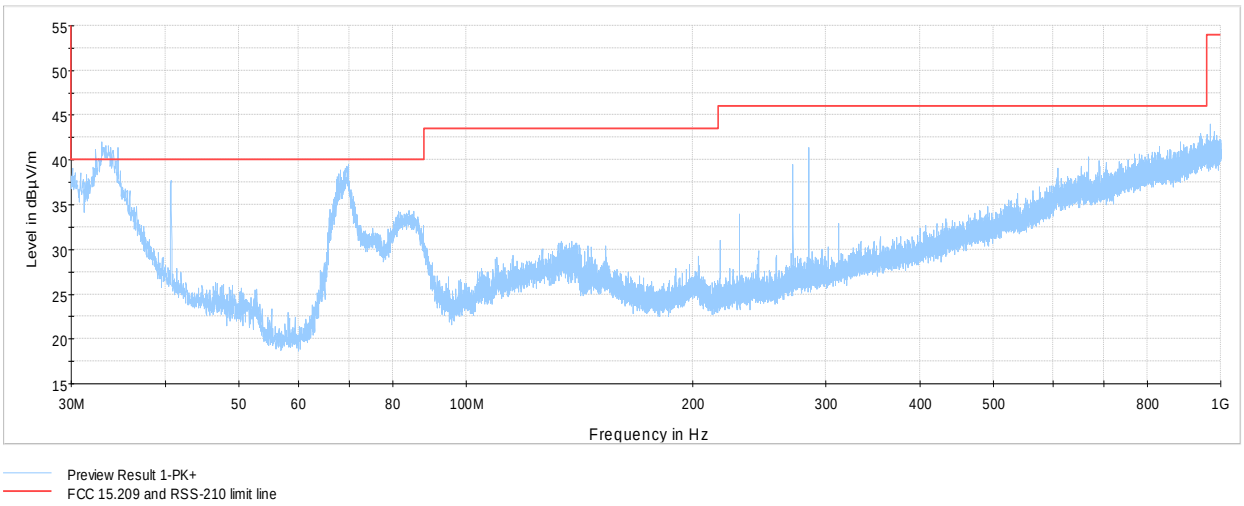


Figure 8.4-2: *Field strength of spurious emissions above 30 MHz*

Note: all measurement results indicated in the plot were taken with a peak detector, which is more stringent measurement, and still comply with quasi-peak limit.

Table 8.4-4: *Radiated emissions (Quasi-Peak) results*

Frequency (MHz)	Quasi-Peak field strength[1] (dBµV/m)	3 m Quasi-Peak limit [3] (dBµV/m)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Antenna height (cm)	Pol. (V/H)	Turn table position (°)	Correction factor[2] (dB)
30.135	33.6	40.0	6.5	100	120	115	V	170	23.2
32.943	35.7	40.0	4.3	100	120	103	V	264	21.2
40.665	36.5	40.0	3.5	100	120	102	V	83	14.8
69.852	36.0	40.0	4.0	100	120	103	V	164	9.5
284.772	40.5	46.0	5.5	100	120	102	H	89	16.0

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Sample calculation: 32.2 dBµV/m (field strength) = 9.0 dBµV (receiver reading) + 23.2 dB (Correction factor)

8.5 FCC 15.225(e) and RSS-210 B.6 Frequency tolerance of the carrier signal

8.5.1 Definitions and limits

The frequency tolerance of the carrier signal shall be maintained within ±0.01 % (±100 ppm) of the operating frequency over a temperature variation of −20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 °C. For battery operated equipment, the equipment tests shall be performed using a new battery.

8.5.2 Test summary

Test start date	September 20, 2018
Test engineer	Yong Huang
Verdict	Pass

8.5.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	≥1 % of emission bandwidth
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.5.4 Test data

Table 8.5-1: *Frequency drift measurements results*

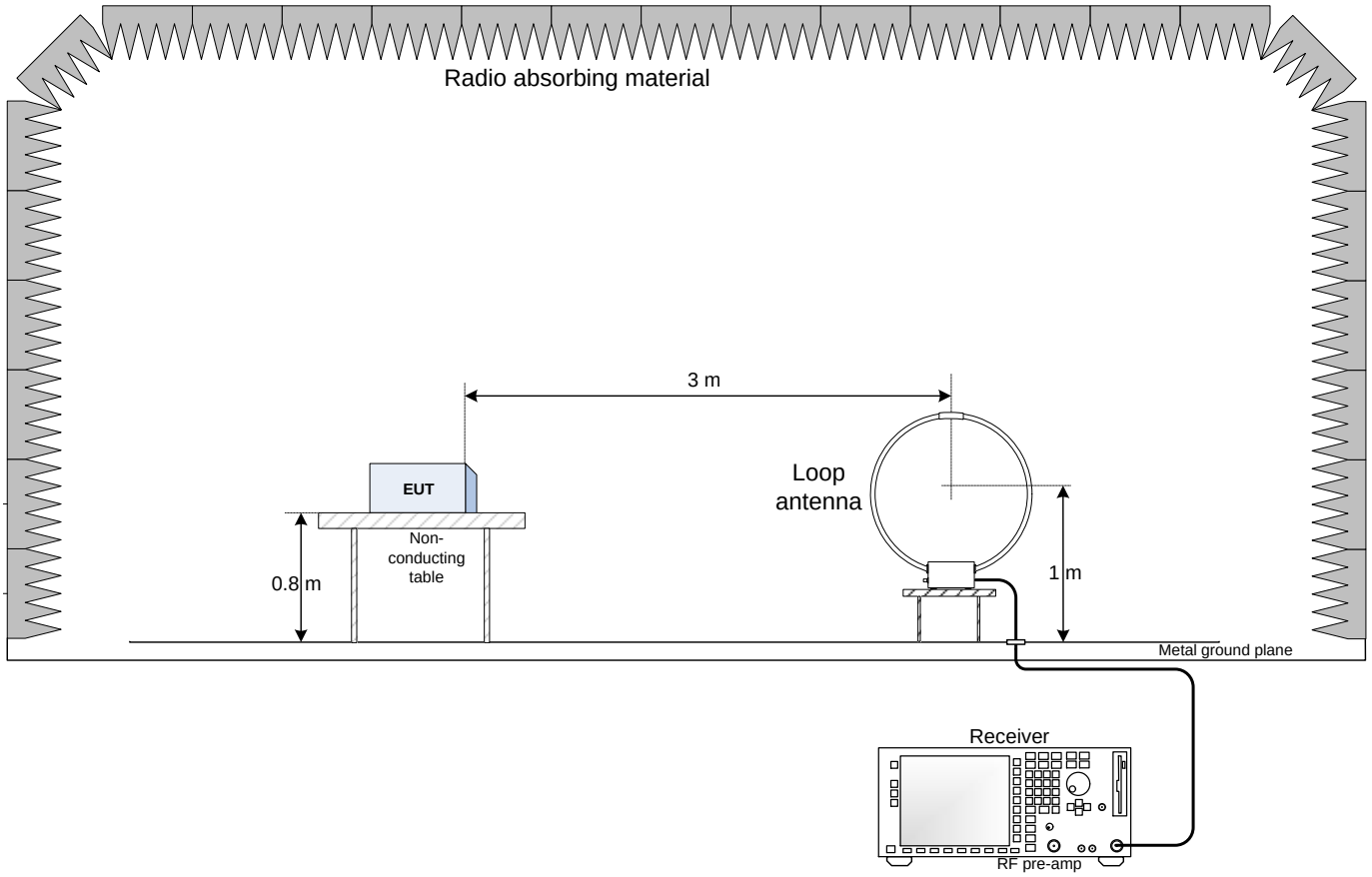
Test conditions	Frequency, MHz	Frequency drift, ±ppm	Limit, ±ppm	Margin, ppm
+50 °C, Nominal	13.5602030	0	100	100
+20 °C, +15 %	13.5602030	0	100	100
+20 °C, Nominal	13.5602030	*Reference*	*Reference*	*Reference*
+20 °C, −15 %	13.5602030	0	100	100
−20 °C, Nominal	13.5602610	4.3	100	95.7

Note: frequency drift was calculated as follows:

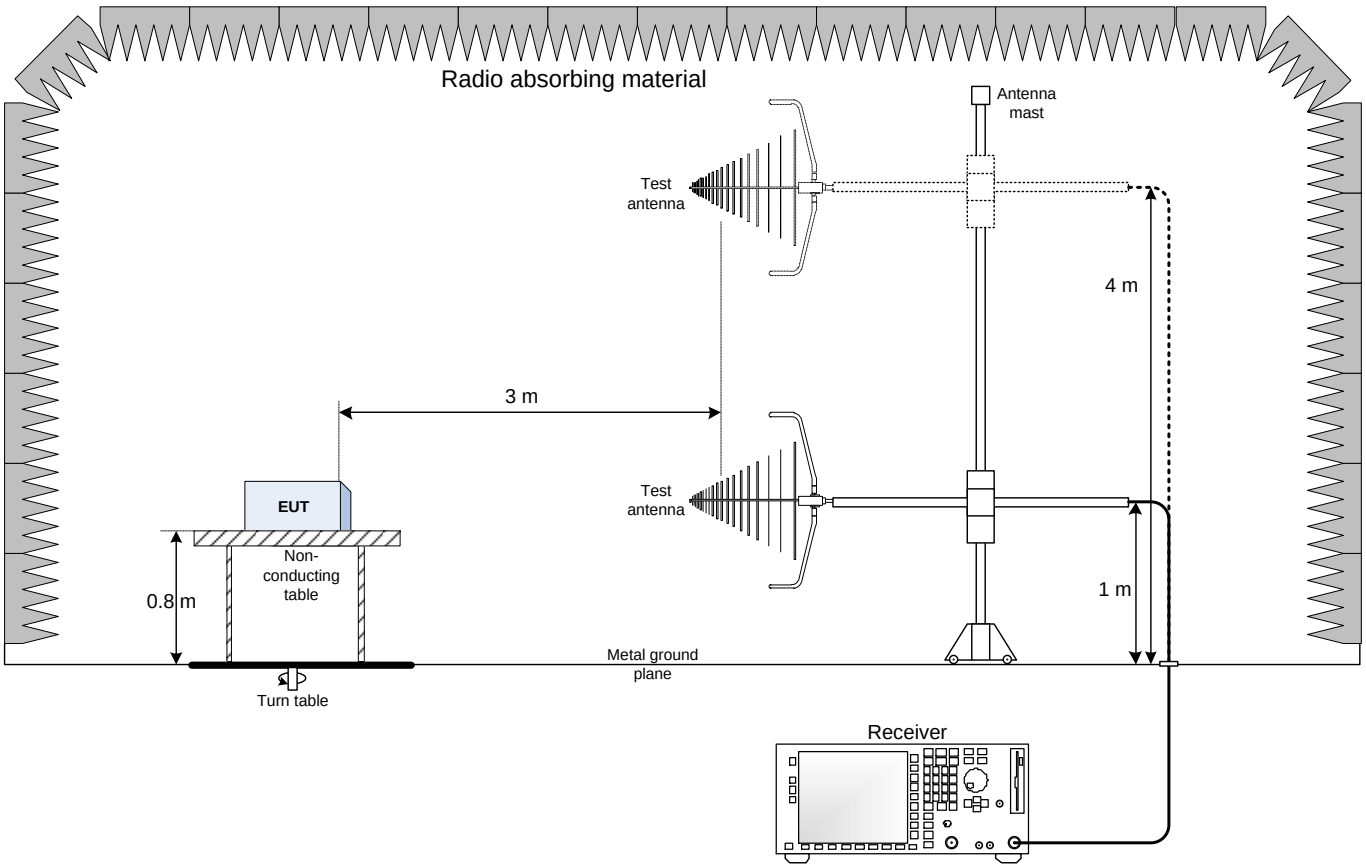
Frequency drift (ppm) = $((F_{measured} - F_{reference}) \div F_{reference}) \times 1{\times}10^{6}$

Section 9. Block diagrams of test set-ups

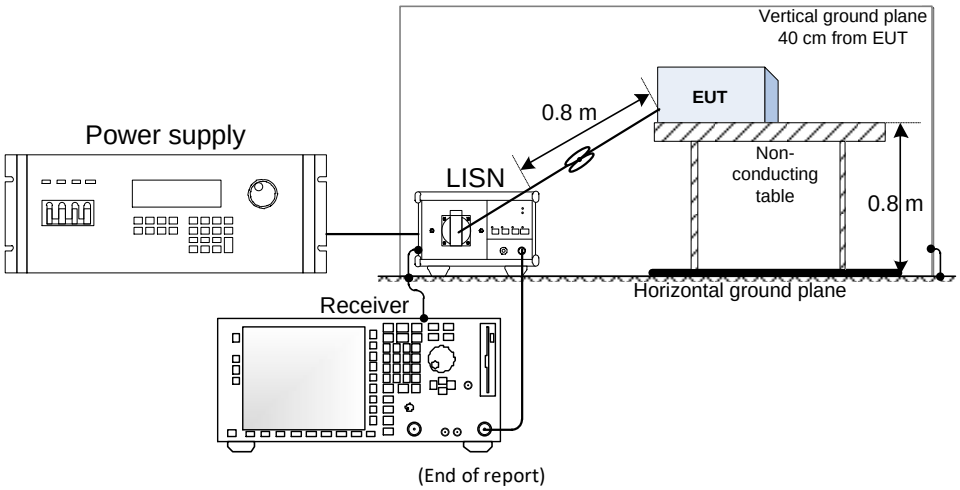
9.1 Radiated emissions set-up below 30 MHz



9.2 Radiated emissions set-up above 30 MHz



9.3 Conducted emissions set-up



(End of report)