

Test report

470645-2TRFWL

Date of issue: September 13, 2022

Applicant:

ZADI S.p.A. – Via C.Marx, 138 – 41012 Carpi (MO) – Italy

Product: **Keyless Ride System Main Unit**

Model: **ZB005**

FCC ID: **VFZKLRMZB005** IC Registration number: **22239-KLRMZB005**

Specifications:

◆ **FCC 47 CFR Part 15 Subpart C**

Intentional radiators

◆ **RSS-210, Issue 10, December 2019 + Amendment (April 2020)**

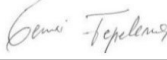
Licence-Exempt Radio Apparatus: Category I Equipment

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Doc. n. TRF001; Rev. 0; Date: 2020-11-30

Test location

Company name	Nemko Spa
Address	Via del Carroccio, 4 – 20853 Biassono (MB) – Italy
City	Biassono –
Province	(MB) – Italy
Postal code	20853
Country	Italy
Telephone	+39 039 2201201
Facsimile	--
Website	--
Site number	www.nemko.com
Company name	FCC: 682159; IC: 9109A (10 m semi anechoic chamber)

Tested by	Genci Tepelena Wireless/EMC Specialist 
Reviewed by	Paolo Barbieri Senior/EMC Specialist
Date	September 13, 2022
Signature of reviewer	

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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Section 1. Report summary

1.1 Applicant and manufacturer

Company name:	ZADI S.p.A.
Address:	Via C.Marx, 138
City:	Carpi
Province/State:	Modena Italy
Postal/Zip code:	41012
Country:	Italy

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C	Intentional radiators
RSS-210, Issue 10, Section 2.5	General field strength limits

1.3 Test methods

ANSI C64.3 v 2003	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
RSS-Gen, Issue 5, April 2018 + Amendment 1 (March 2019) + Amendment 2 (February 2021)	General Requirements for Compliance of Radio Apparatus

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable
§15.31(e)	Variation of power source	Pass ¹
§15.203	Antenna requirement	Pass ²
§15.209	Radiated emission limits; general requirements.	Pass
§15.215 ©	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 IC RSS-GEN, Issue 5 test results

Part	Test description	Verdict
6.7	Occupied bandwidth	Pass
6.11	Transmitter frequency stability	Not applicable
7.3	Receiver spurious emissions limits (radiated)	Pass
7.4	Receiver spurious emissions limits (antenna conducted)	Not applicable
8.8	AC power lines conducted emission limits	Not applicable

Notes: ¹ According to Notice 2012-DRS0126 (from January 2012) section 2.2 of RSS-Gen, Issue 3 has been revised. The EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.3 IC RSS-210, Issue 10, test results

Part	Test description	Verdict
7.2	General field strength limits	Pass
7.3	Transmitters with Wanted Emissions that are Within the General Field Strength Limits	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 13, 2022
Nemko sample ID number	

3.2 EUT information

Product name	Keyless Ride System Main Unit
Model and brand	Model: ZB005 Brand :ZADI
Model variant	--
Serial number	4706450001 assigned by Nemko

3.3 Technical information

Operating band	134.5 kHz
Operating frequency	134.5 kHz
Modulation type	ASK
20 dB bandwidth	6.993 kHz
Occupied bandwidth (99 %)	13.9 kHz
Emission designator	13K9A1D
Power requirements	13 Vdc
Antenna information	The EUT is professionally installed.

3.4 Product description and theory of operation

EUT is the Main Unit model ZB005 of Keyless ride system (transmits LF 134,5 kHz and receives 433 MHz).

The Keyless Ride System (KAX) is an electronic unit for vehicles. The system is composed by:

1. 1x Main Unit (transmits LF 134,4 kHz and receives 433 MHz) Model: ZB005
2. 1x Active Key (transmits 433 MHz and receive 134,4 kHz) Model: ZB006

installation will be with a separation distance of approximately 1.5 meters separation between the two panels

3.5 EUT exercise details

The EUT has been tested with the Main Unit (TX) supplied by an external DC power source and with the loop antenna connected by a 570 mm length cable (antenna EL0359)

3.6 EUT setup diagram

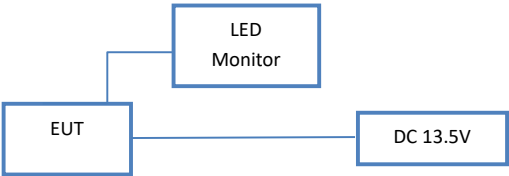


Figure 3.6-1: Setup diagram

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
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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 $\pm 5\%$, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Table 6.1-1: Measurement uncertainty

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
			0.009 MHz ÷ 30 MHz	1.1 dB	(1)
		Carrier power	30 MHz ÷ 18 GHz	1.5 dB	(1)
		RF Output Power	18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
			0.009 MHz ÷ 18 GHz	3.0 dB	(1)
		Conducted spurious emissions	18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter– Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
		Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
Receiver	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
	Conducted	Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)

NOTES:

(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95 %

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Description	Manufacturer	Model	Identifier	Cal Date	Due Date
Loop antenna	Teseq	HLA6121+PI6121	45749	2021-07	2023-07
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2021-07	2024-07
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152	2021-09	2024-09
Broadband Amplifier	Schwarzbeck Mess-Elektronik	BBV9718C	00121	2022-01	2023-01
EMI receiver 20 Hz ÷ 8 GHz	R&S	ESU8	100202	2021-09	2022-09
Semi-anechoic chamber	Nemko	10m semi-anechoic chamber	530	2021-09	2023-09
Shielded room	Siemens	10m control room	1947	NSC	NSC
Note: N/A = Not Applicable, NCR = No Cal Required, COU = CAL On Use					

Section 8. Testing data

8.1 FCC 15.31(m) and RSS-Gen 6.9 Number of frequencies

8.1.1 Definitions and limits

FCC:

Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

ISED:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.1-1: Frequency Range of Operation

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Note: “near” means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.1.2 Test date

Start date September 12, 2022

8.1.3 Observations, settings and special notes

None

8.1.4 Test data

Table 8.1-2: Test channels selection

Start of Frequency range, kHz	End of Frequency range, kHz	Frequency range bandwidth, MHz	Low channel, kHz	Mid channel, kHz	High channel, MHz
134.5	134.5	--	134.5	134.5	134.5

8.2 FCC 15.203 and RSS-Gen, section 6.8 Antenna requirement

8.2.1 Definitions and limits

FCC:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

ISED:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

8.2.2 Test date

Start date	September 12, 2022
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8.2.3 Observations, settings and special notes

None

8.2.4 Test data

Must the EUT be professionally installed?	☒ YES	☐ NO
Does the EUT have detachable antenna(s)?	☒ YES	☐ NO
If detachable, is the antenna connector(s) non-standard?	☒ YES	☐ NO ☐ N/A

Detailed photo of antenna



8.3 FCC 15.215(c) and RSS-210 Emission bandwidth

8.3.1 Definitions and limits

FCC:

The bandwidth of the emission shall be no wider than 0.25 % of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5 % of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

ISED:

The 99% bandwidth of momentarily operated devices shall be less or equal to 0.25% of the centre frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the 99% bandwidth shall be less or equal to 0.5% of the centre frequency.

8.3.2 Test summary

Test date: September 12, 2022

8.3.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission bandwidth
Video bandwidth	$\geq 3 \times \text{RBW}$
Frequency span	Wider than emission bandwidth
Detector mode	Peak

8.3.4 Test data

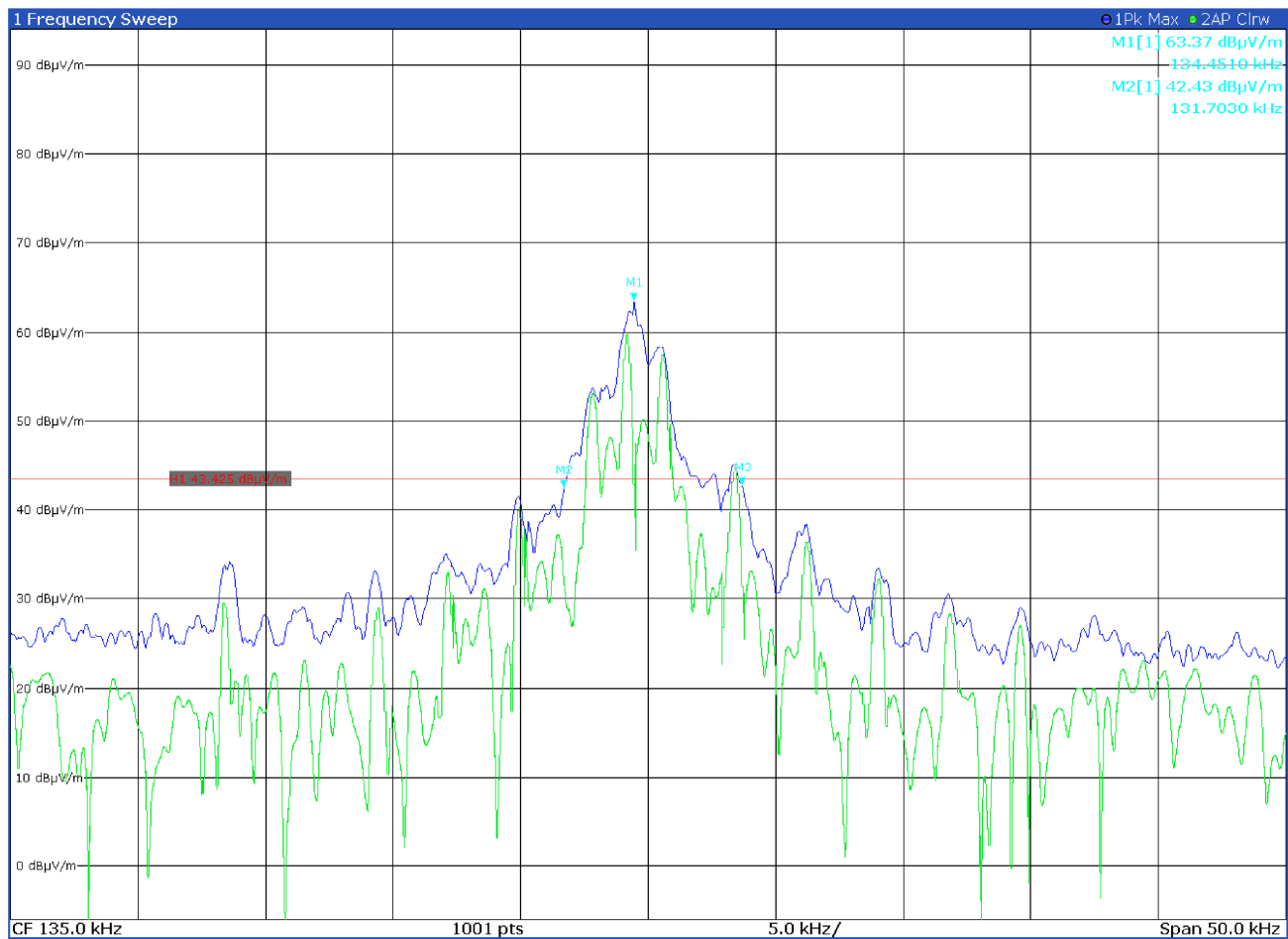
Table 8.3-1: Occupied bandwidth measurement result 20 dB

Occupied bandwidth per frequency, kHz	Limit, MHz	Margin, MHz
6.993	--	--

Table 8.3-2: 99 % bandwidth results

Modulation	99 % bandwidth, MHz
ASK	0.0139

8.3.4 Test data, continued



2 Marker Table						
Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	134.451 kHz	63.37 dBµV/m		
M2		1	131.703 kHz	42.43 dBµV/m		
M3		1	138.696 kHz	42.69 dBµV/m		

Figure 8.3-1: 20 dB Occupied bandwidth measurement=138.696 kHz-131.703 kHz=6.993 kHz

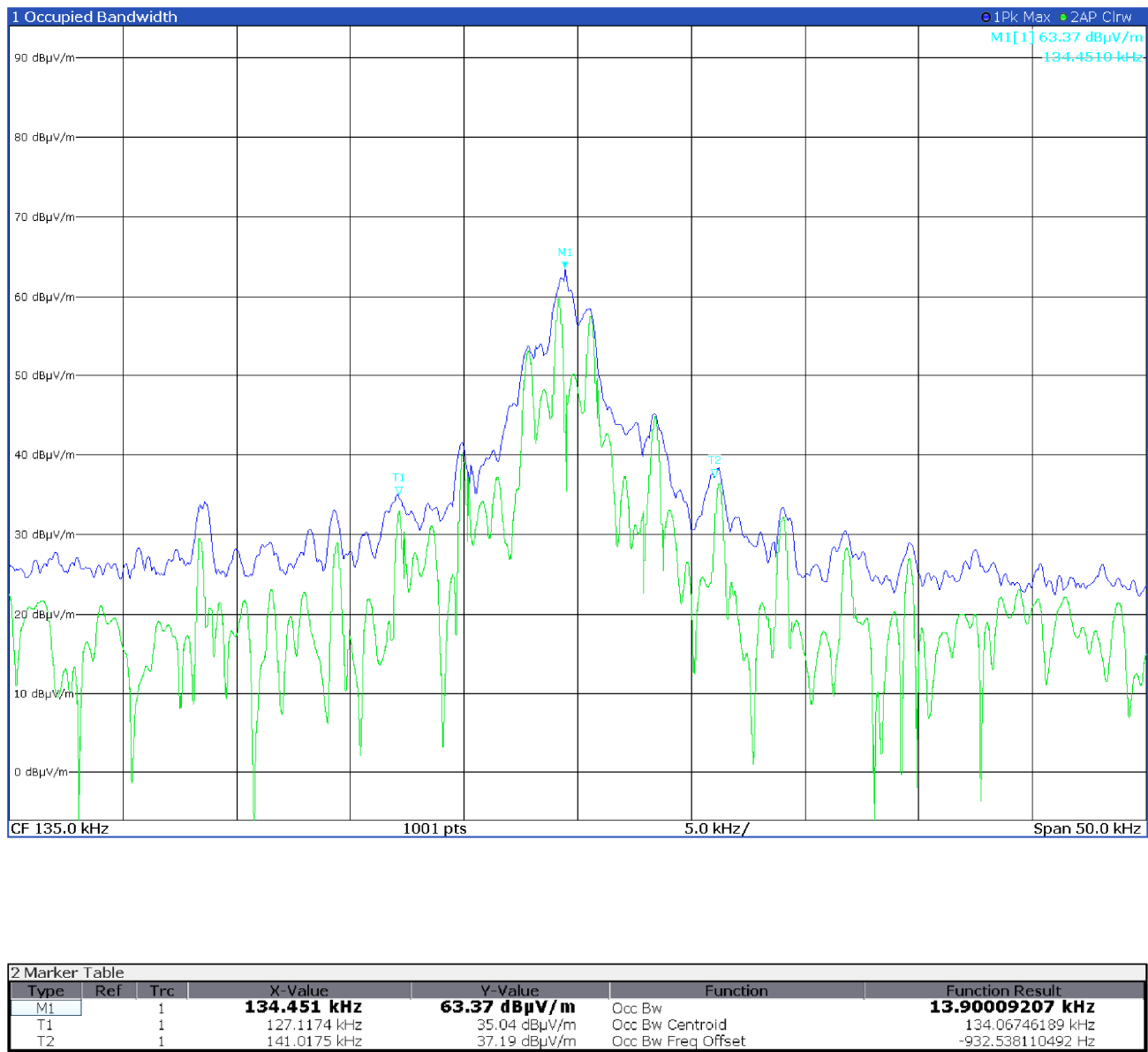


Figure 8.3-2: 99% Occupied bandwidth measurement = 13.9 kHz

8.4 FCC 15.209(a) and RSS-210, 2.5 Radiated emissions limits

8.4.1 Definitions and limits

FCC:

- (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the Table 8.4-1 below.
- (c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
- (d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

IC:

RSS-Gen includes the general field strength limits of unwanted emissions, where applicable, for transmitters and receivers operating in accordance with the provisions specified in this standard.

Unwanted emissions of transmitters and receivers are permitted to fall within the restricted bands listed in RSS-Gen, and including the TV bands, but fundamental emissions are prohibited in the restricted bands bands.

Whether or not their operation is addressed by published RSS standards, transmitters whose wanted and unwanted emissions are within the general field strength limits shown in RSS-Gen, they may operate in any of the frequency bands, other than the restricted bands listed in RSS-Gen and including the TV bands, and shall be certified under RSS-210. Under no conditions may the level of any unwanted emissions exceed the level of the fundamental emission.

Note: Devices operating below 490 kHz in which all emissions are at least 40 dB below the limit listed in RSS-Gen (General Field Strength Limits for Transmitters at Frequencies below 30 MHz) are Category II devices and are subject to RSS-310.

Table 8.4-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$	
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.

8.4.1 Definitions and limits, continued

Table 8.4-2: IC restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677–5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

8.4.2 Definitions and limits, continued

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			

8.4.3 Test summary

Test date:	September 12, 2022	Temperature:	Choose temperature °C
Test engineer:	Select a name	Air pressure:	Select air pressure mbar
Verdict:	Choose verdict	Relative humidity:	Select humidity %

8.4.4 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit with 100 % duty cycle.
Radiated measurements were performed at a distance of 3 m, the EUT was transmitting on both MIMO chains simultaneously.
Since fundamental power was tested using average method, the spurious emissions limit is -30 dBc/100 kHz

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

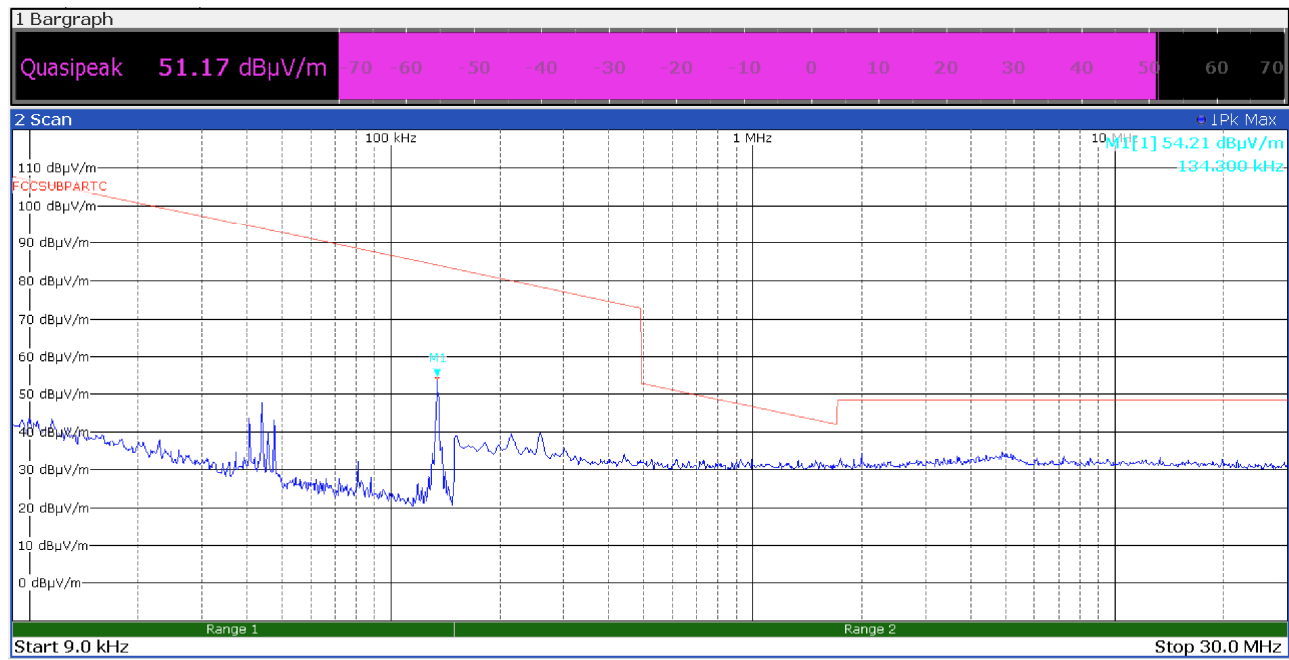
Spectrum analyser settings for conducted spurious emissions measurements:

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



8.4.4 Test data

Loop antennaLoop antenna

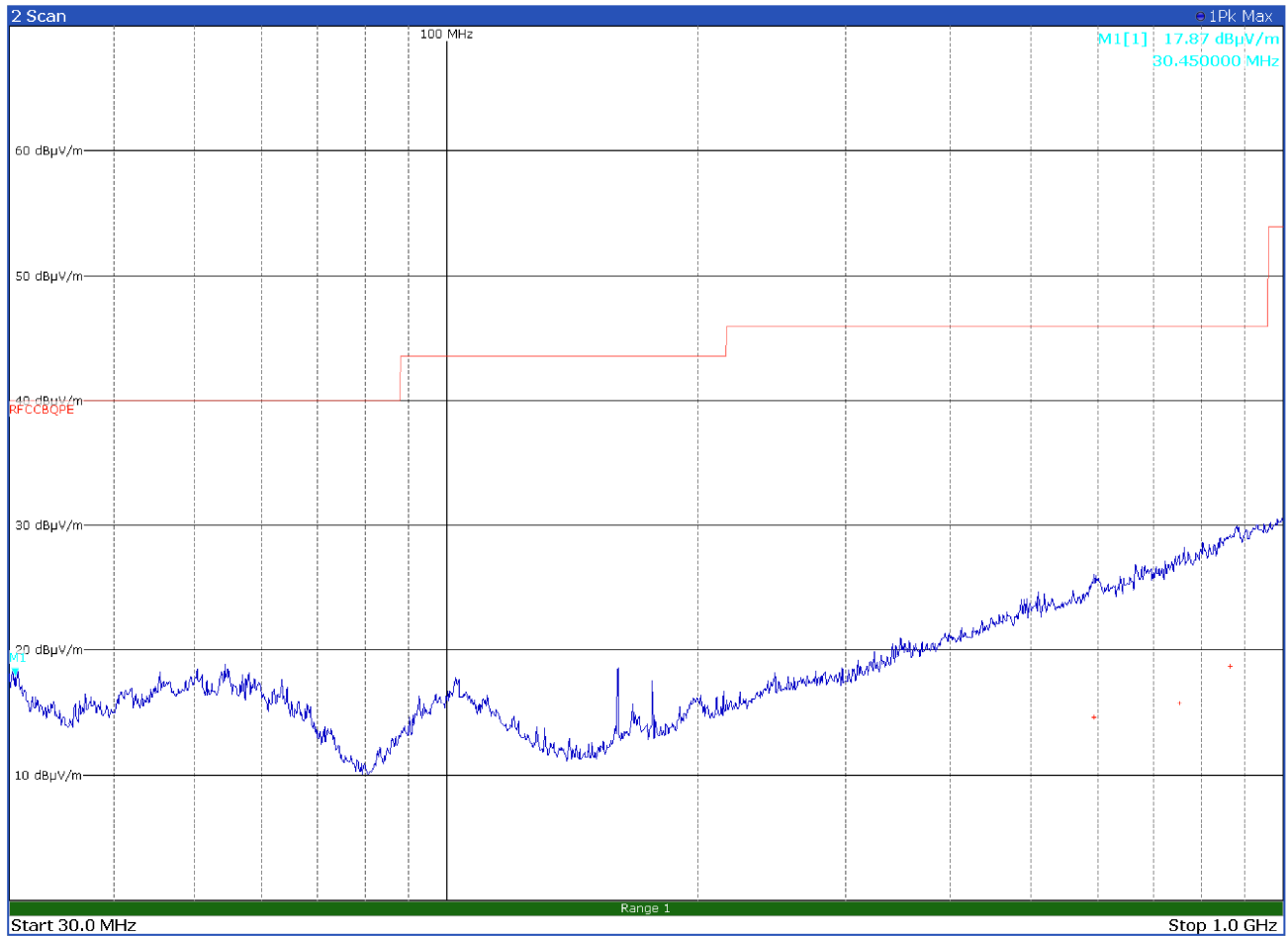


Section 8
Test name
Specification

Testing data
 FCC 15.209(a) and RSS-210, 2.5 Radiated emissions limits
 FCC Part 15 Subpart C and RSS-210



Vertical polarization



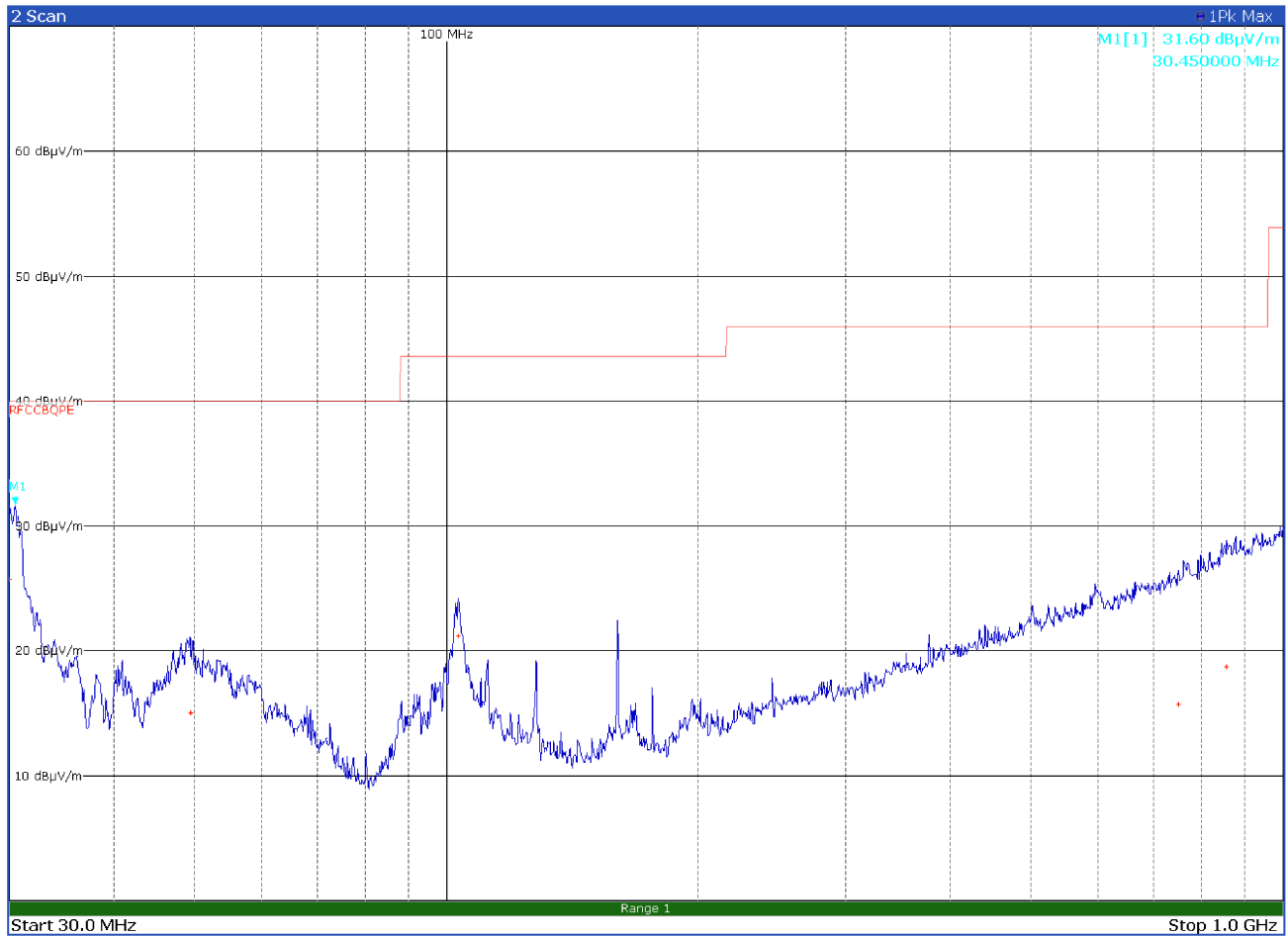
Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
594.0900	14.7	46.0	-31.3	QP
750.9600	15.8	46.0	-30.2	QP
864.6900	18.8	46.0	-27.2	QP

Section 8
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Testing data
 FCC 15.209(a) and RSS-210, 2.5 Radiated emissions limits
 FCC Part 15 Subpart C and RSS-210



Horizontal polarization



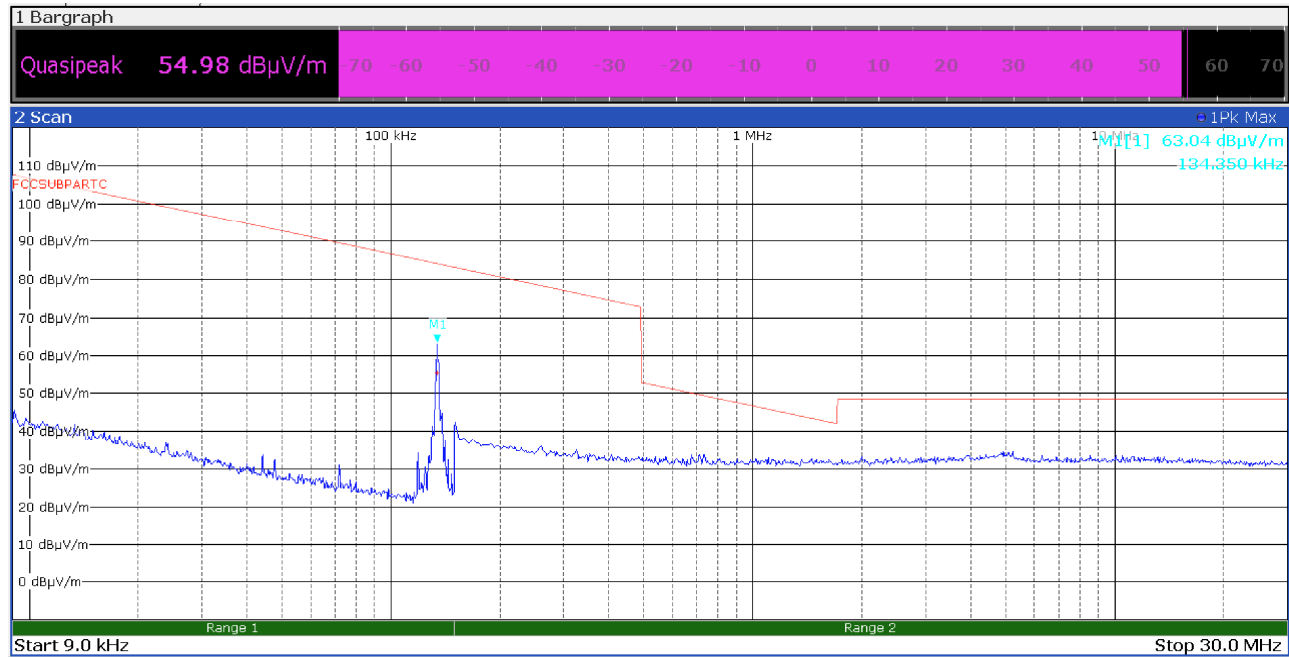
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
30.0000	25.8	40.0	-14.2	QP
49.3500	15.0	40.0	-25.0	QP
103.1400	21.2	43.5	-22.3	QP
749.2500	15.7	46.0	-30.3	QP
855.9300	18.7	46.0	-27.3	QP

Section 8
Test name
Specification

Testing data
FCC 15.209(a) and RSS-210, 2.5 Radiated emissions limits
FCC Part 15 Subpart C and RSS-210

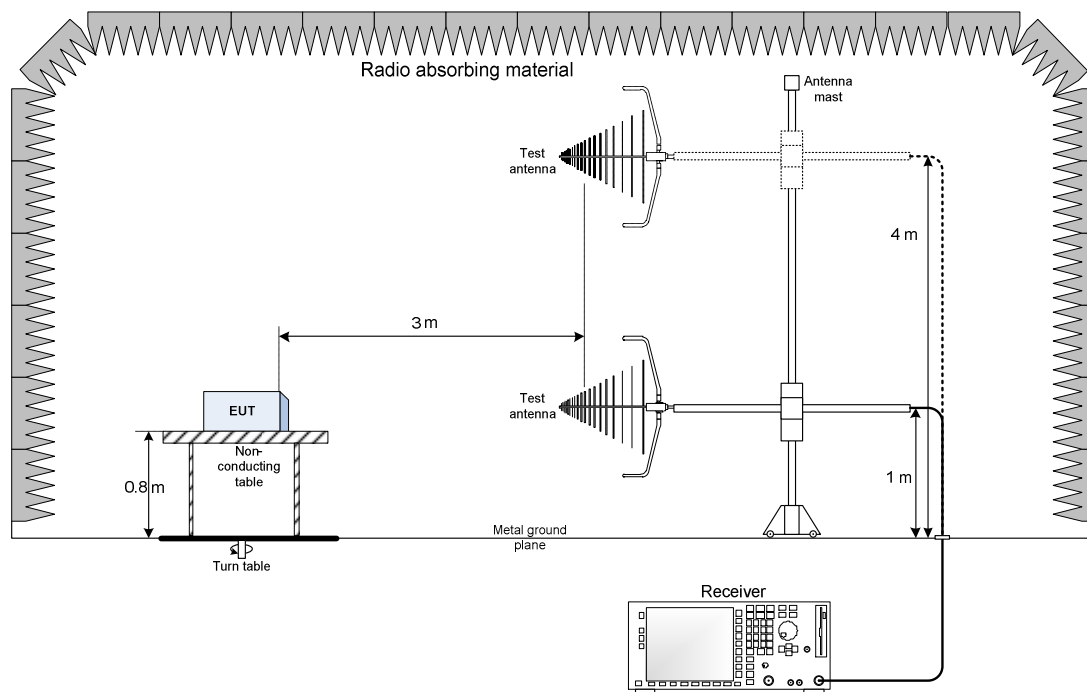


E Field



Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up 30 MHz to 1 GHz



Radiated emissions set-up 9 kHz to 30 MHz

