Choose Scandinavian trust

RADIO TEST REPORT –REP037312

Type of assessment:

Final product testing

Applicant:

IDS GeoRadar Srl

Via Augusto Righi 6,6A,8

56121 - Pisa (PI), Italy

Product:

Cable Detector Transmitter

Model:

DA300

FCC ID:

UFW-DA300

IC Registration number:

8991A-DA300

Specifications:

- FCC 47 CFR Part 15 Subpart C §15.213, §15.209
- RSS-210, Issue 10, December 2019, Amendment (April 2020)
- RSS-310, Issue 5, January 2020 — Licence-Exempt Radio Apparatus: Category II Equipment: 10.2 Cable-locating equipment (Band 9-490 kHz)

Date of issue: April 16, 2024

D. Guarnone	
Tested by	Signature
O. Frau	
Reviewed by	Signature

Lab locations

Company name	Nemko Spa
Address	Via del Carroccio, 4
City	Biassono
Province	MB
Postal code	20853
Country	Italy
Telephone	+39 039 220 12 01
Facsimile	+39 039 220 12 21
Website	www.nemko.com
Site number	682159 (FCC) and 9109A (ISED), 10 m semi anechoic chamber

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 Spa ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Table of contents **3**

Section 1. Report summary **4**

1.1 Test specifications 4
1.2 Test methods 4
1.3 Statement of compliance 4
1.4 Exclusions 4
1.5 Test report revision history 4

Section 2. Summary of test results **5**

2.1 FCC Part 15 Subpart C, general requirements test results 5
2.2 IC RSS-GEN, Issue 5, test results 5
2.3 IC RSS-210, Issue 10, test results 5

Section 3. Equipment under test (EUT) details **6**

3.1 Applicant/Manufacture 6
3.2 Sample information 6
3.3 EUT information 6
3.4 Technical information 6
3.5 Product description and theory of operation 7
3.6 EUT exercise details 8
3.7 EUT interface ports 8
3.8 Support equipment 8

Section 4. Engineering considerations **9**

4.1 Modifications incorporated in the EUT 9
4.2 Technical judgment 9
4.3 Deviations from laboratory tests procedures 9

Section 5. Test conditions **10**

5.1 Atmospheric conditions 10
5.2 Power supply range 10

Section 6. Measurement uncertainty **11**

6.1 Uncertainty of measurement 11

Section 7. Test equipment **12**

7.1 Test equipment list 12

Section 8. Testing data **13**

8.1 FCC 15.213, RSS-310, Peak output power 13
8.2 RSS-Gen 6.7 Occupied bandwidth 20
8.3 FCC 15.209(a) and RSS-210, Radiated emissions limits 25

Section 9. Block diagrams of test set-ups and EUT photos **55**

9.1 Radiated emissions set-up below 30 MHz 55
9.2 Radiated emissions set-up below 1 GHz 56
9.3 Radiated emissions set-up above 1 GHz 57
9.4 Set-up photos 58
9.5 External photos 60

Section 1. Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C	Intentional radiators
December 2019, Amendment (April 2020)	General field strength limits

1.2 Test methods

ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen, Issue 5, April 2018 Amendment 1 (March 2019) Amendment 2 (February 2021)	General Requirements for Compliance of Radio Apparatus

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
REP037312	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
FCC 15.213, RSS-310,	Peak output power	Pass
§15.207(a)	Conducted limits	Not applicable
§15.31(e)	Variation of power source	Pass[1]
§15.31(m)	Number of operating frequencies	Pass[2]
§15.203	Antenna requirement	Pass[3]
§15.209	Radiated emission limits; general requirements.	Pass

Notes: The EUT is supplied by a vehicle battery.

[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 and

[2] The E.U.T. use 8 kHz and 33 kHz in induction mode; use frequencies 131 kHz + 33 kHz in direct connection mode and mixed mode.
The E.U.T. use frequencies 131 kHz, 83 kHz, 33 kHz, 8 kHz, 640 Hz, 512 Hz in direct connection mode

[3] The Antennas use a unique coupling to the intentional radiator.

2.2 IC RSS-GEN, Issue 5, test results

Part	Test description	Verdict
6.7	Occupied bandwidth	Pass
6.9	Operating bands and selection of test frequencies	Pass[1]
6.11	Transmitter frequency stability	Not applicable[2]

Notes: The EUT is supplied by a battery.

[1] The E.U.T. use 8 kHz and 33 kHz in induction mode; use frequencies 131 kHz + 33 kHz in mixed mode.
The E.U.T. use frequencies 131 kHz, 83 kHz, 33 kHz, 8 kHz, 640 Hz, 512 Hz in direct connection mode

[2] 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. No requirements for temperature variation.

2.3 IC RSS-210, Issue 10, test results

Part	Test description	Verdict
7.2	General field strength limits	Pass

Notes:

Section 3. Equipment under test (EUT) details

3.1 Applicant/Manufacture

Applicant name	IDS GeoRadar Srl
Applicant address	Via Augusto Righi 6,6A,8
Manufacture name	56121 - Pisa (PI), Italy
Manufacture address	Same as applicant

3.2 Sample information

Receipt date	March 18, 2024
Nemko sample ID number	PRJ0053024

3.3 EUT information

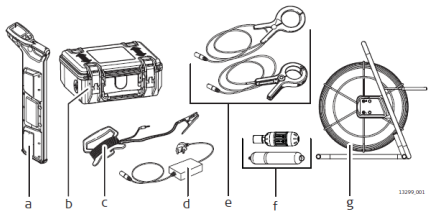
Product name	Cable Detector Transmitter
Model	DA300
Model variant	--
Serial number	PRJ00530240002 assigned by Nemko S.p.A.

3.4 Technical information

Operating frequency	8 kHz and 33 kHz by induction coil
	Mixed 131 kHz + 33 kHz, 131 kHz, 83 kHz, 33 kHz, 8 kHz, 640 Hz, 512 Hz: direct connection mode (using direct connection clamps)
Modulation type	CW
Occupied bandwidth (99 %)	267.62 Hz
Field strength, dBµV/m @ 10 m	95.23 dBµV/m
Emission designator	N0N
Spurious emission, dBµV/m @ 10 m	66.0
Power supply requirements	7.4 V DC from Lithium battery or 4 x Alkaline 1.6 V battery type D
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.5 Product description and theory of operation

The EUT is a (transmitter) is part of system composed of:



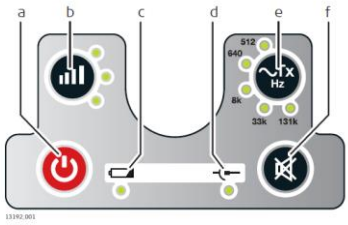
a Locator
b Transmitter
c Transmitter Cable Set Extension
d Property Plug Connector
e Transmitter Clamps
f Sondes
g Trace Rod (non-metallic utility tracer)

Locators are used to detect buried conductive utilities that emit an electromagnetic signal. Such a signal is generated as an electrical current passes through the utility.
Signal transmitters are used to apply a distinct signal to utilities with the following intention:
• To improve the detection success.
• To trace the route of a utility.
• To make a depth or current measurement.
Accessories are used with the locator and transmitter to localise the position of utilities, including some that are non-metallic.

3.6 EUT exercise details

The EUT has been tested in normal working conditions.

Transmitter keyboard



a Power key
b Power Output key and LED indicators
c Low Battery LED indicator
d Connection Mode LED indicator
e Frequency key and LED indicators
f Mute key

The operational modes, frequencies and power output levels have been selected pushing the properly buttons.

.

3.7 EUT interface ports

Description	Qty.
Transmitter Clamps	1

3.8 Support equipment

Description	Brand name	Model, Part number, Serial number, Revision level

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 °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.

The following instruments are used to monitor the environmental conditions:

Equipment	Manufacturer	Model no.	Asset no.	Cal date	Next cal.
Thermo-hygrometer data loggers	Testo	175-H2	20012380/305	2022-12	2024-12
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703	2022-12	2024-12
Barometer	Castle	GPB 3300	072015	2023-04	2024-04

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

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002.
The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:
P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.
F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.
Hereafter Nemko's measurement uncertainties are reported:

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	0.009 MHz ÷ 30 MHz	1.1 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			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)
		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)
		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)
		Occupied Channel Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
	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)

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*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI receiver	R&S	ESU8	100202	2023-09	2024-09
EMI Receiver	Rohde & Schwarz	ESW44	101620	2023-09	2024-09
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2021-07	2024-07
Antenna Loop Attiva	Teseq	HLA6121+PI6121	45749	2023-07	2026-07
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530	2023-09	2025-09
3m Semi anechoic chamber	Comtest	SAC-3	1711-150	2022-09	2024-09

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

Section 8. Testing data

8.1 FCC 15.213, RSS-310, Peak output power

8.1.1 Definitions and limits

An intentional radiator used as cable locating equipment, as defined in § 15.3(d), may be operated on any frequency within the band 9-490 kHz, subject to the following limits: Within the frequency band 9 kHz, up to, but not including, 45 kHz, the peak output power from the cable locating equipment shall not exceed 10 watts; and, within the frequency band 45 kHz to 490 kHz, the peak output power from the cable locating equipment shall not exceed one watt. If provisions are made for connection of the cable locating equipment to the AC power lines, the conducted limits in § 15.207 also apply to this equipment.

8.1.2 Test summary

Verdict	Pass		
Tested by	D. Guarnone	Test date	March 27/28, 2024

8.1.3 Observations, settings and special notes

This test is applicable at the frequency:

8 kHz and 33 kHz: induction mode

Mixed direct connection mode 131 kHz + 33 kHz, 131 kHz, 83 kHz, 33 kHz, 8 kHz, 640 Hz, 512 Hz: direct connection mode

Spectrum analyser settings:

Resolution bandwidth:	300 Hz
Video bandwidth:	≥ 3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI Receiver	Rohde & Schwarz	ESW44	101620
Antenna Loop Attiva	Teseq	HLA6121+PI6121	45749
Controller	Maturo	FCU3.0	10041
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
3m Semi anechoic chamber	Comtest	SAC-3	1711-150

8.1.5 Test data

Table 8.1-1: *Peak output power 33 kHz induction mode*

Field strength at 10 m	Field strange at 300 m	Power (W)	Limit (W)	Margin
95.2 dBµV/m	35.2 dBµV/m	9.93E-06 W	10 W	-9.999990066066 W

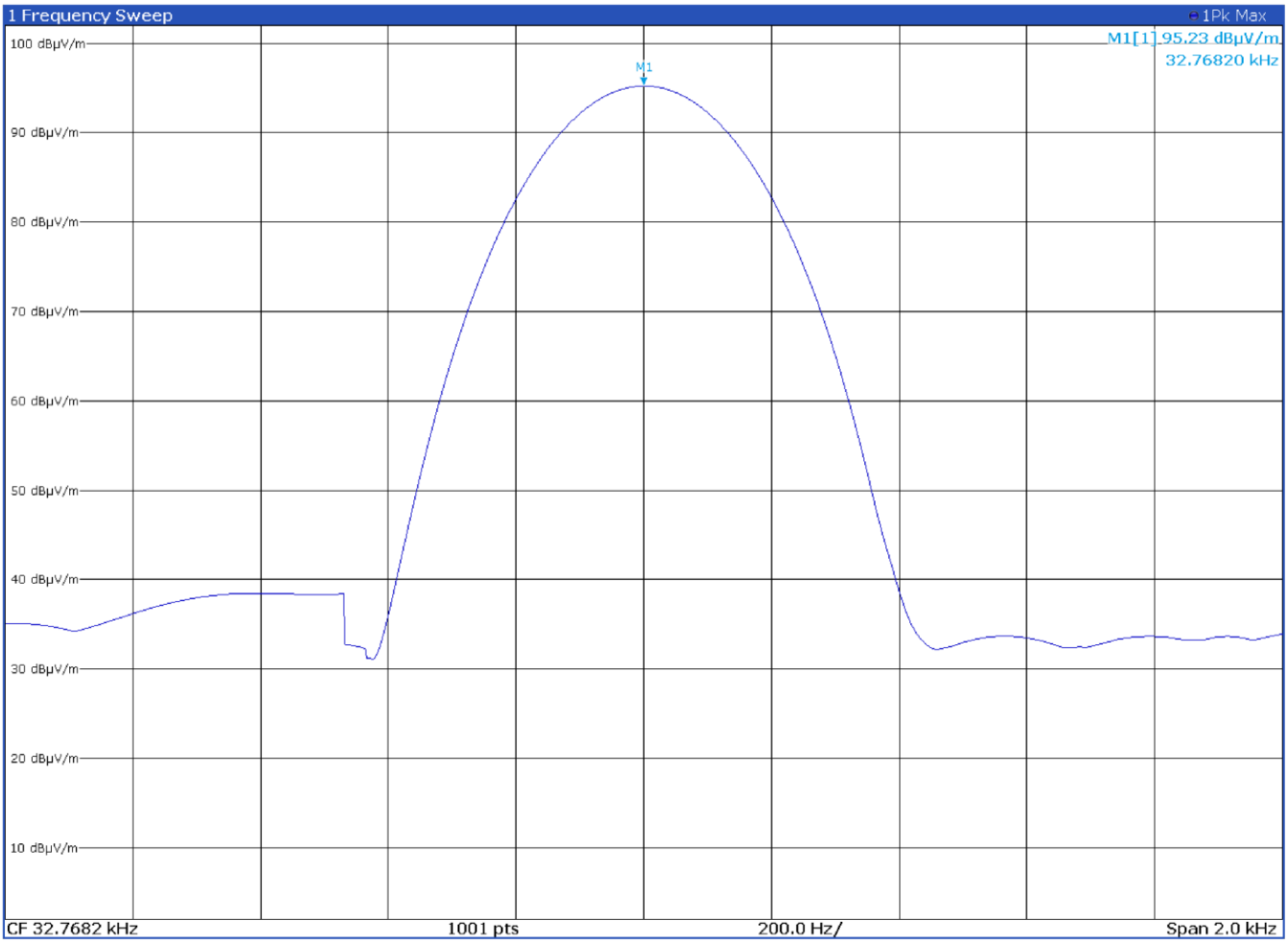
Note: the power has been calculated with the following formula:

$$S_{media}\ \left[W/m^2\right] = \frac{P_t}{4\pi d^2} = \frac{|E|^2}{2Z_0}$$

Where, free space impedance $Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}}$ = 120π = 377 Ω

$$|E|\ \left[V/m\right] = \frac{\sqrt{60P_t}}{d} \rightarrow E_{eff}\ \left[V/m\right] = \frac{\sqrt{60P_t}}{d\sqrt{2}} \rightarrow P_t[W] = \frac{2d^2{E_{eff}}^2}{60}$$

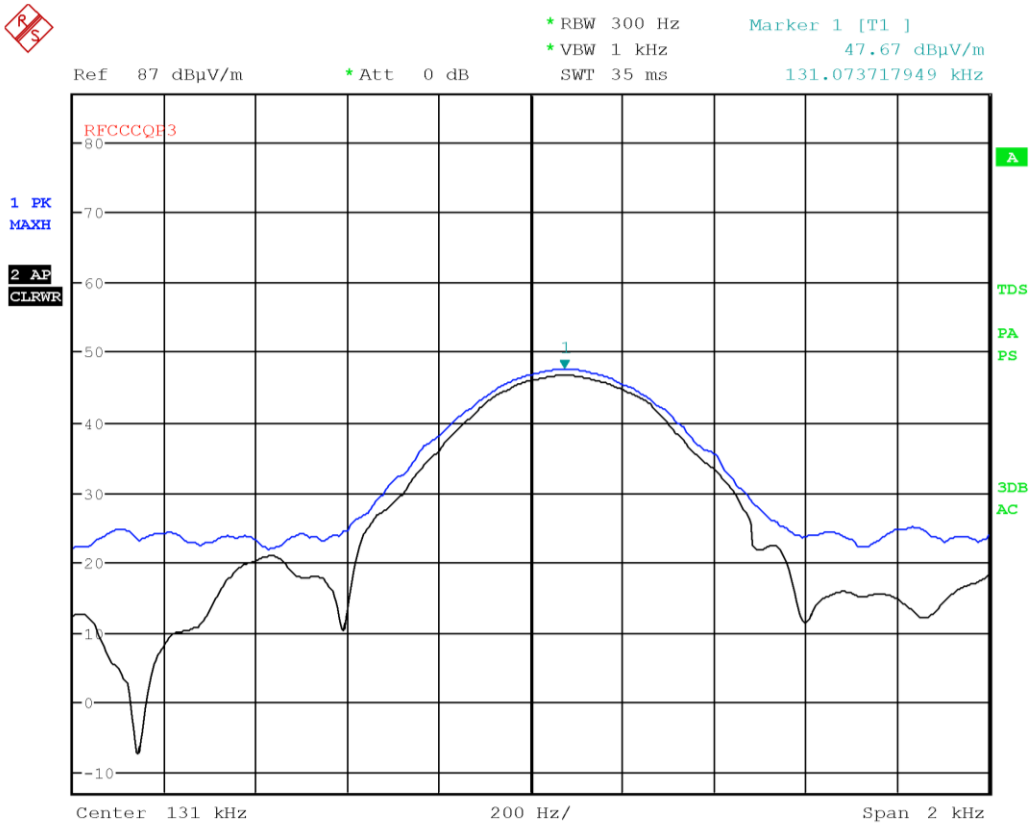
Example of calculation: $E_{eff} = 10^{\frac{35.2}{20}} * 10^{-6} = 5.7544\text{E}^{-05}$, $P_t[W] = \frac{2*300^2(5.7544\text{E}^{-05})^2}{60}$ = 9.93E-06 W



05:16:54 PM 03/27/2024 **Page 1/1**

Table 8.1-2: *Peak output power 131 kHz direct connection mode and mixed mode*

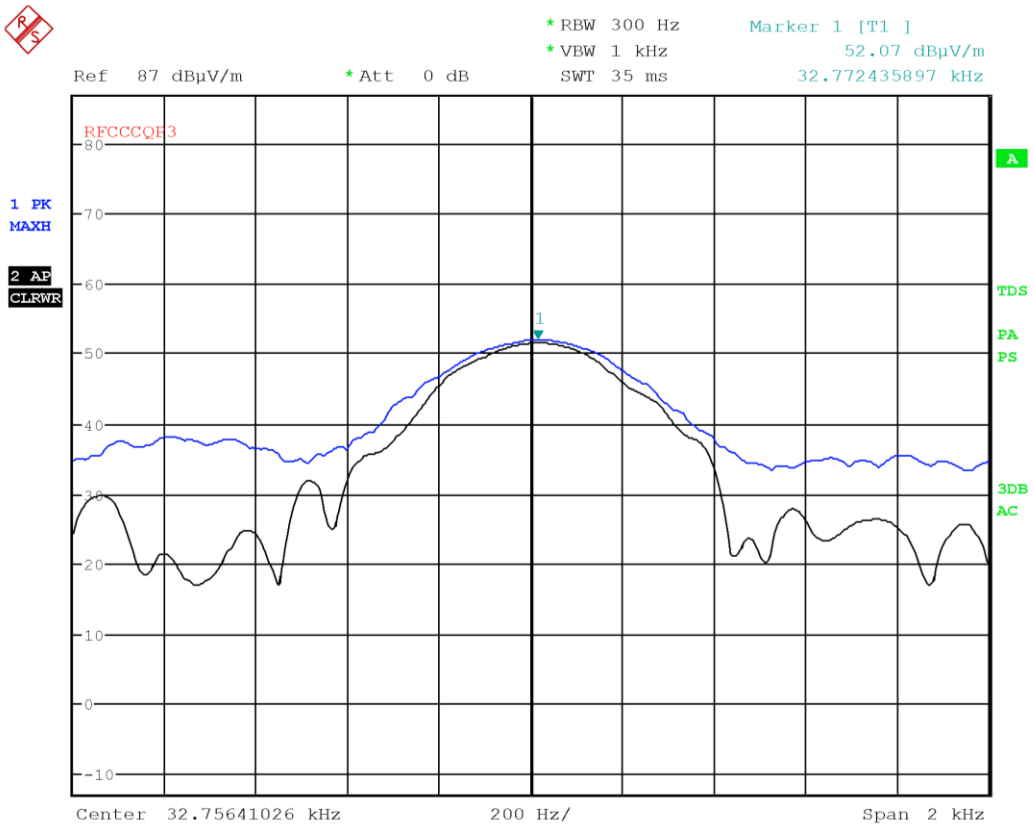
Field strength at 3 m	Field strange at 300 m	Power (W)	Limit (W)	Margin
47.7 dBµV/m	-32.2 dBµV/m	1.80768E-12 W	1 W	-0.9999999999982 W



Date: 28.MAR.2024 15:42:26

Table 8.1-3: *Peak output power 33 kHz direct connection mode and mixed mode*

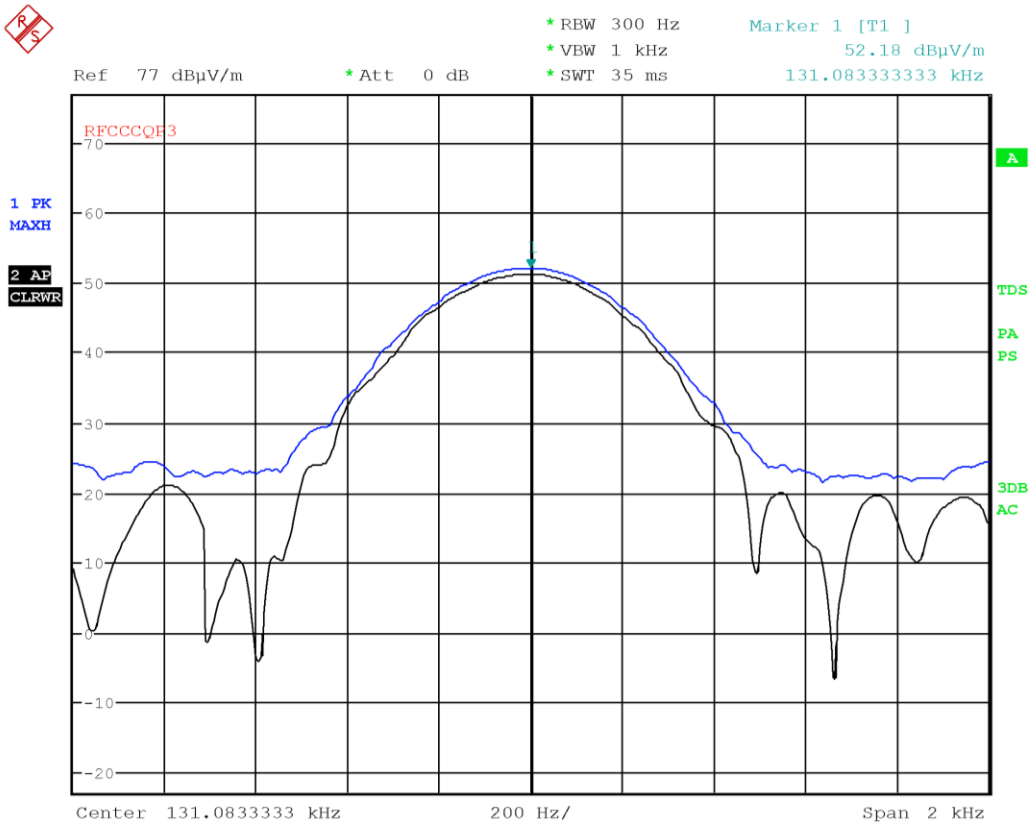
Field strange at 3 m	Field strange at 300 m	Power (W)	Limit (W)	Margin
52.1 dBµV/m	-27.9 dBµV/m	4.86543E-12 W	10 W	-9.999999999995 W



Date: 28.MAR.2024 15:44:04

Table 8.1-4: *Peak output power 131 kHz direct connection mode*

Field strange at 3 m	Field strange at 300 m	Power (W)	Limit (W)	Margin
52.2 dBµV/m	-27.8 dBµV/m	4.97876E-12 W	1 W	-0.999999999995 W



Date: 28.MAR.2024 15:46:10

Table 8.1-5 *Peak output power 83 kHz direct connection mode*

Field strange at 3 m	Field strange at 300 m	Power (W)	Limit (W)	Margin
53.8 dBµV/m	-26.7 dBµV/m	6.41389E-12 W	1 W	-0.999999999994 W

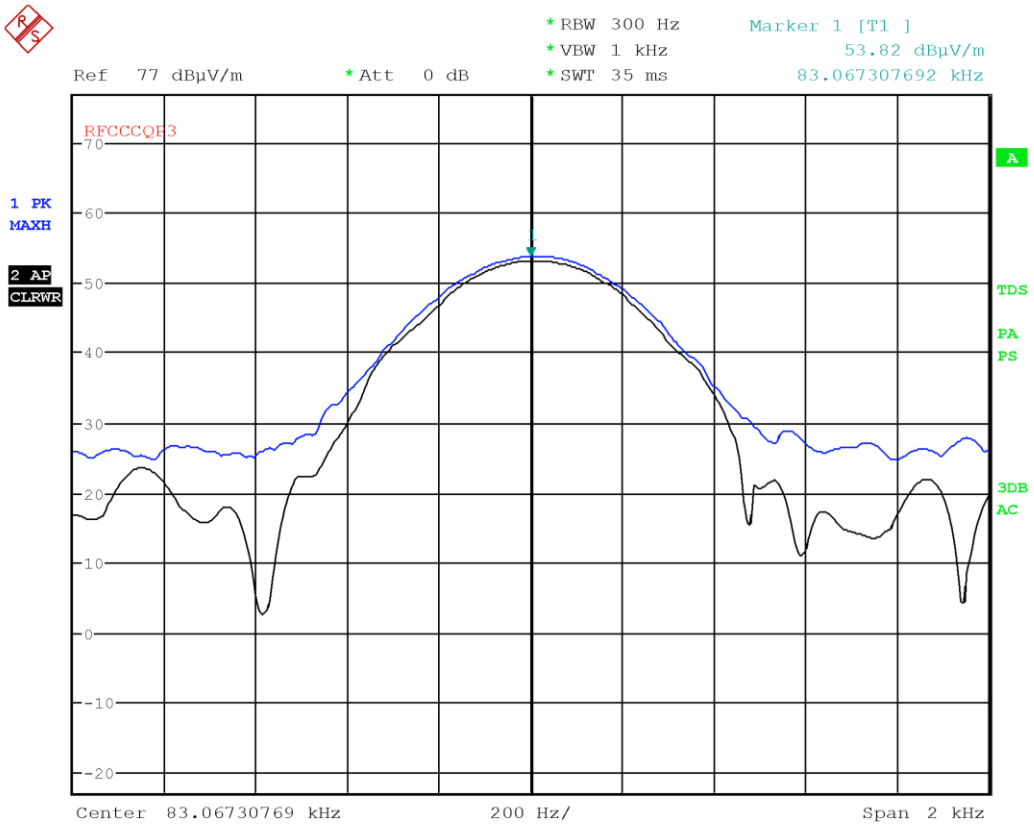
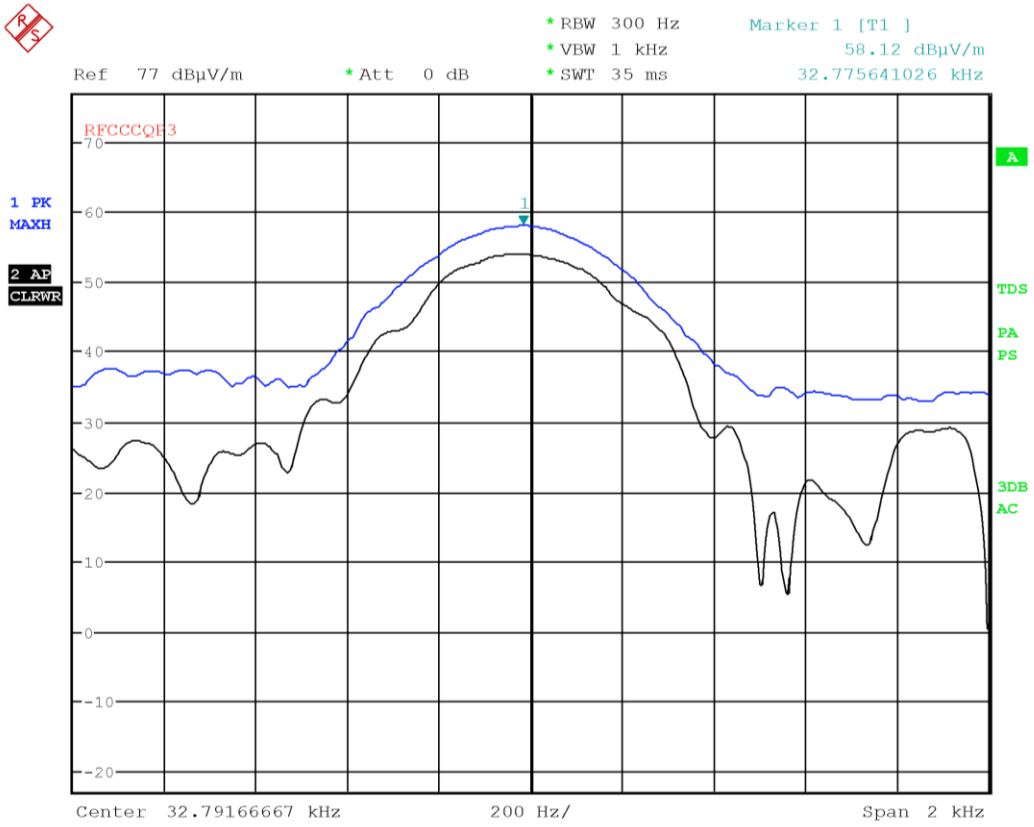


Table 8.1-6 *Peak output power 33 kHz direct connection mode*

Field strange at 3 m	Field strange at 300 m	Power (W)	Limit (W)	Margin
58.1 dBµV/m	-21.9 dBµV/m	1.93696E-11 W	10 W	-9.999999999981 W



8.2 RSS-Gen 6.7 Occupied bandwidth

8.2.1 Definitions and limits

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.
The following conditions shall be observed for measuring the occupied bandwidth:
The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.
Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
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).

8.2.2 Test summary

Verdict	Pass		
Tested by	D. Guarnone	Test date	April 11, 2024

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

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

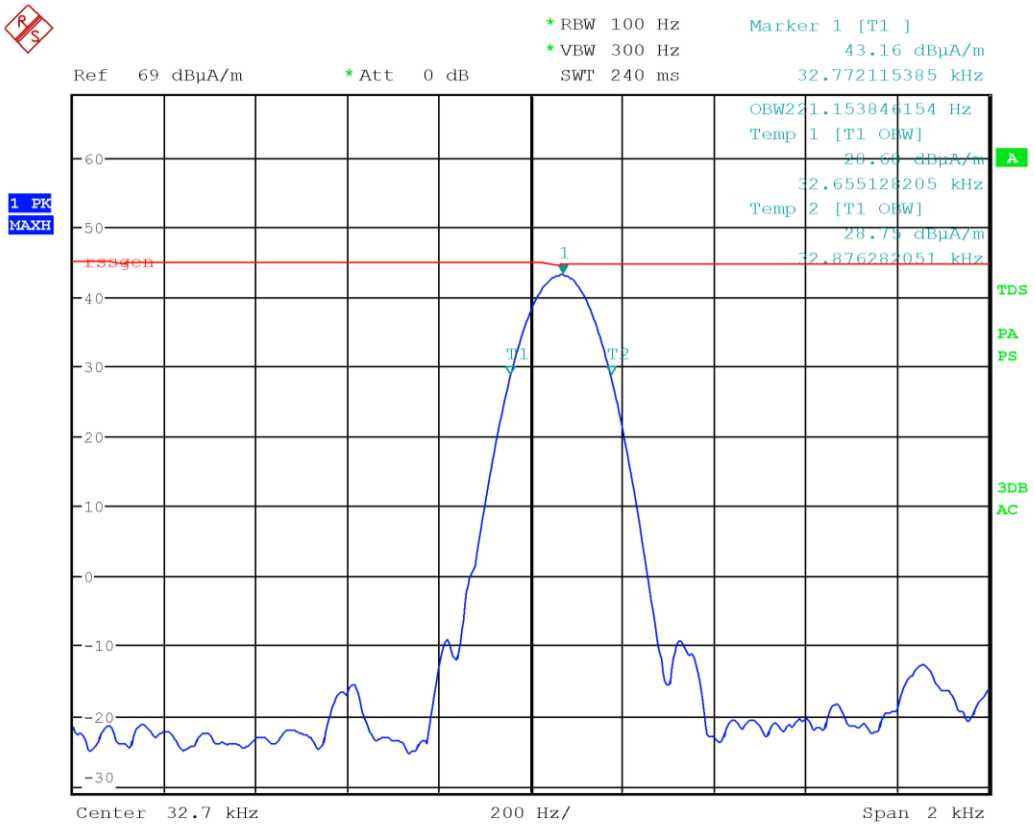
8.2.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI receiver	R&S	ESU8	100202
Antenna Loop Attiva+Power Inseter	Teseq	HLA6121+PI6121	45749
Controller	Maturo	FCU3.0	10041
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530

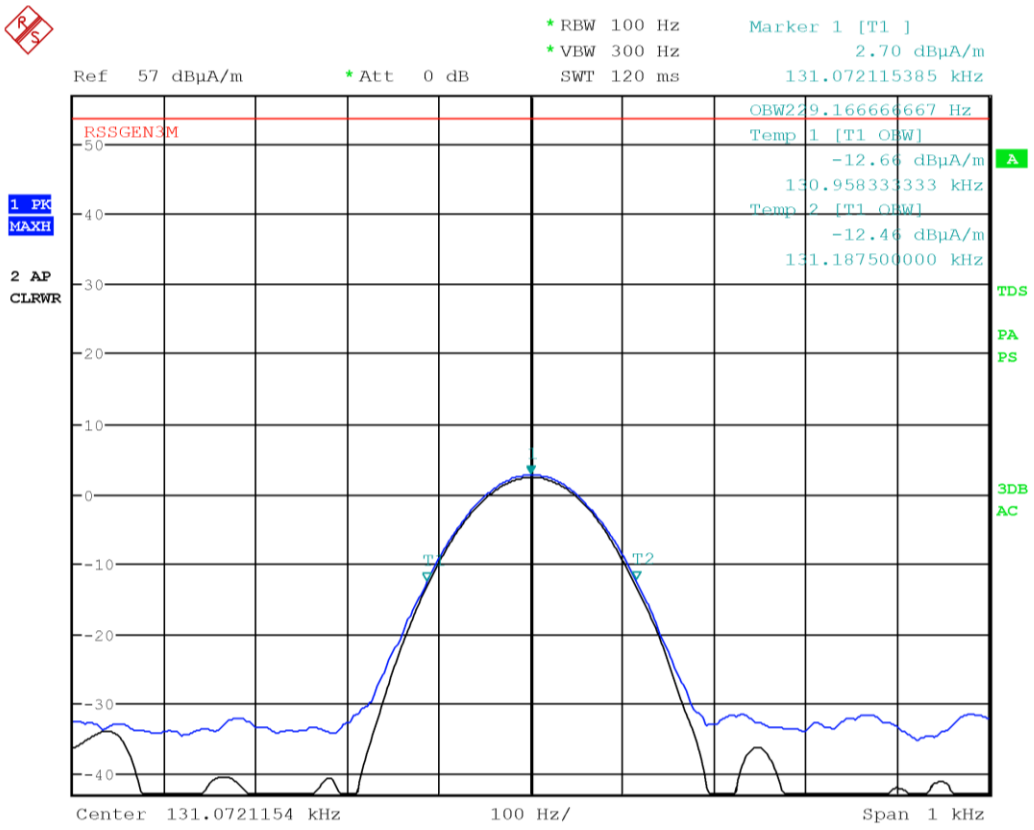
8.2.5 Test data

Table 8.2-1: *99 % bandwidth results*

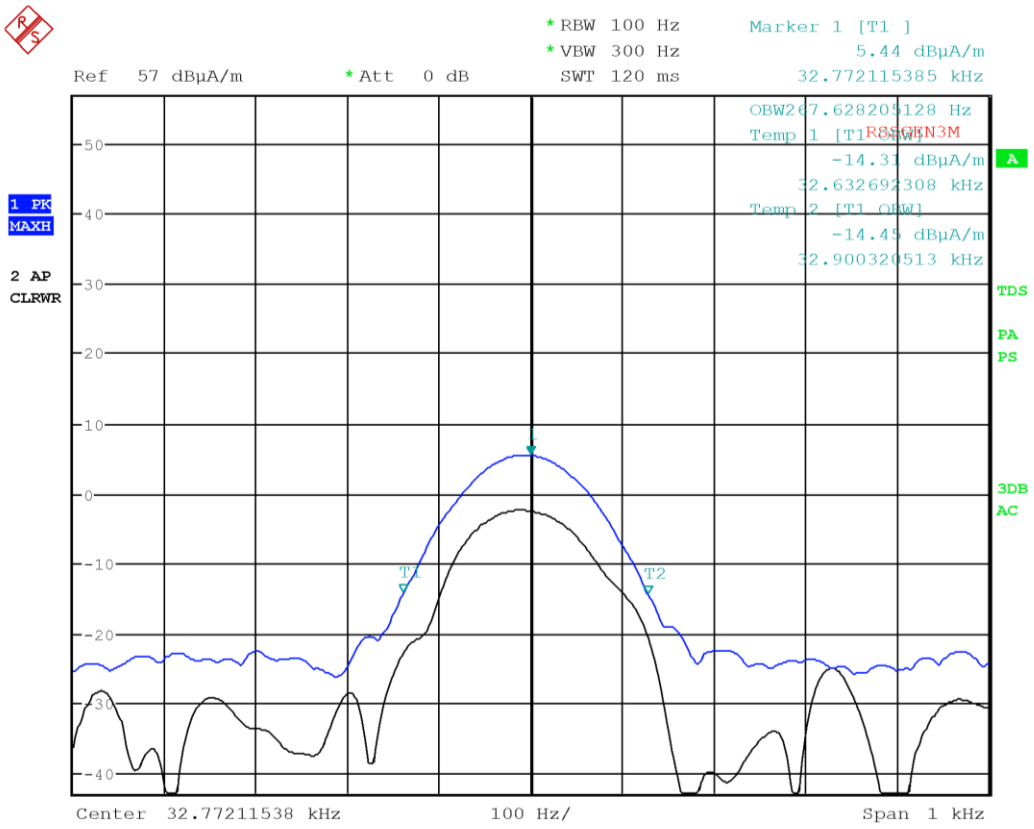
Frequency (kHz)	Modulation	99 % bandwidth
33 (Induction mode)	CW	**221.15 Hz**
131 (direct mode)	CW	**229.16 Hz**
33 (direct mode)	CW	**267.62 Hz**
83 (direct mode)	CW	**230.76 Hz**



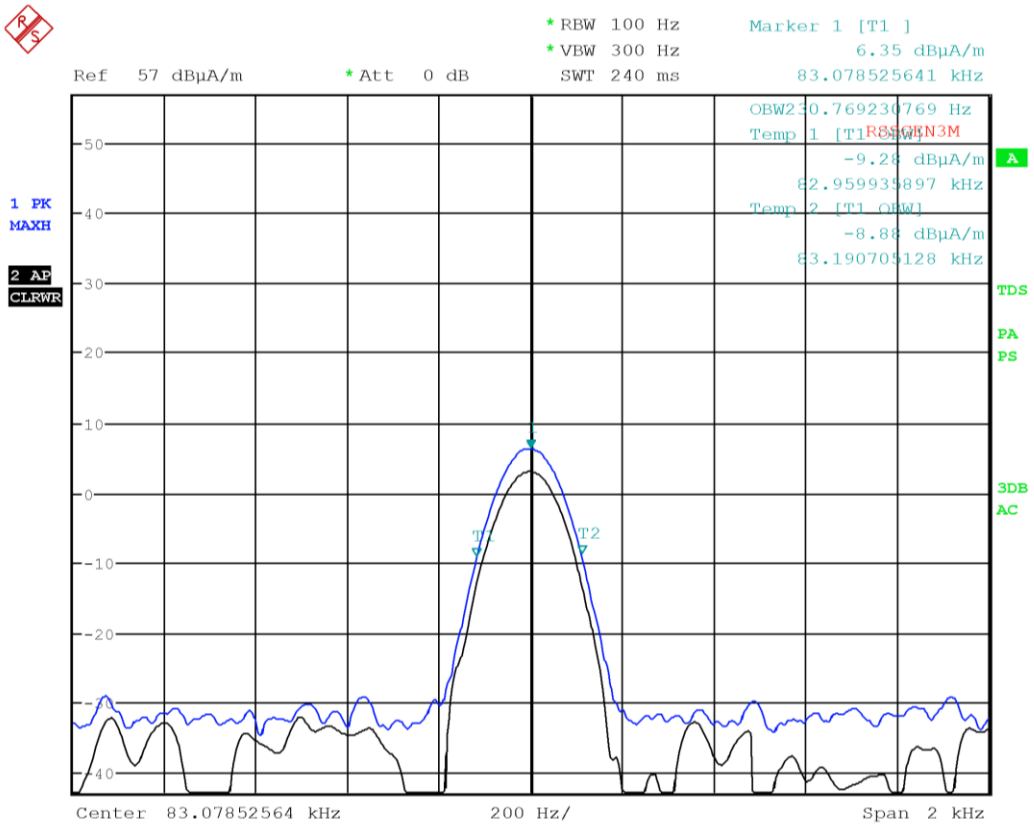
33 (Induction mode)



131 (direct mode)



33 (direct mode)



Date: 11.APR.2024 13:15:48

83 (direct mode)

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

8.3.1 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 8.3-1 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:

Unless otherwise indicated, equipment for which emissions fall within the restricted frequency bands listed in RSS-Gen shall comply with the provisions set forth in RSS-Gen.

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.

Unless otherwise indicated, unwanted emissions of transmitters and receivers are permitted to fall within the restricted frequency bands listed in RSS-Gen and the TV bands 54-72 MHz, 76-88 MHz, 174-216 MHz and 470-602 MHz; however, fundamental emissions are prohibited in these bands, except where equipment operation is permitted in the applicable RSS.

Transmitters whose wanted and unwanted emissions fall within the general field strength limits specified in RSS-Gen may operate licence-exempt in any of the frequency bands, other than the restricted frequency bands listed in RSS-Gen and the TV bands 54-72 MHz, 76-88 MHz, 174-216 MHz and 470-602 MHz, and shall be certified under RSS-210. Under no circumstances shall the level of any unwanted emissions exceed the level of the fundamental emissions

Devices operating below 490 kHz for which all emissions are at least 40 dB below the general field strength limit listed in RSS-Gen (for transmitters at frequencies below 30 MHz) are Category II devices and are subject to the requirements specified in RSS-310, Licence-Exempt Radio Apparatus: Category II Equipment.

Table 8.3-1: *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.

8.3.1 Definitions and limits, continued

Table 8.3-2: *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 8.3-2 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

8.3.2 Definitions and limits, continued

Table 8.3-3: *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			

8.3.3 Test summary

Verdict	Pass		
Tested by	D. Guarnone	Test date	March 26,27,28, 2024

8.3.4 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to receiving mode.
Radiated measurements were performed at a distance of 10 m and 3 m.

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

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

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

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

8.3.5 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI Receiver	Rohde & Schwarz	ESW44	101620
Antenna Loop Attiva+Power Inseter	Teseq	HLA6121+PI6121	45749
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152
Broadband Amplifier	Schwarzbeck Mess-Elektronik	BBV9718	BBV9718-137
Controller	Maturo	FCU3.0	10041
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530

8.3.6 Test data

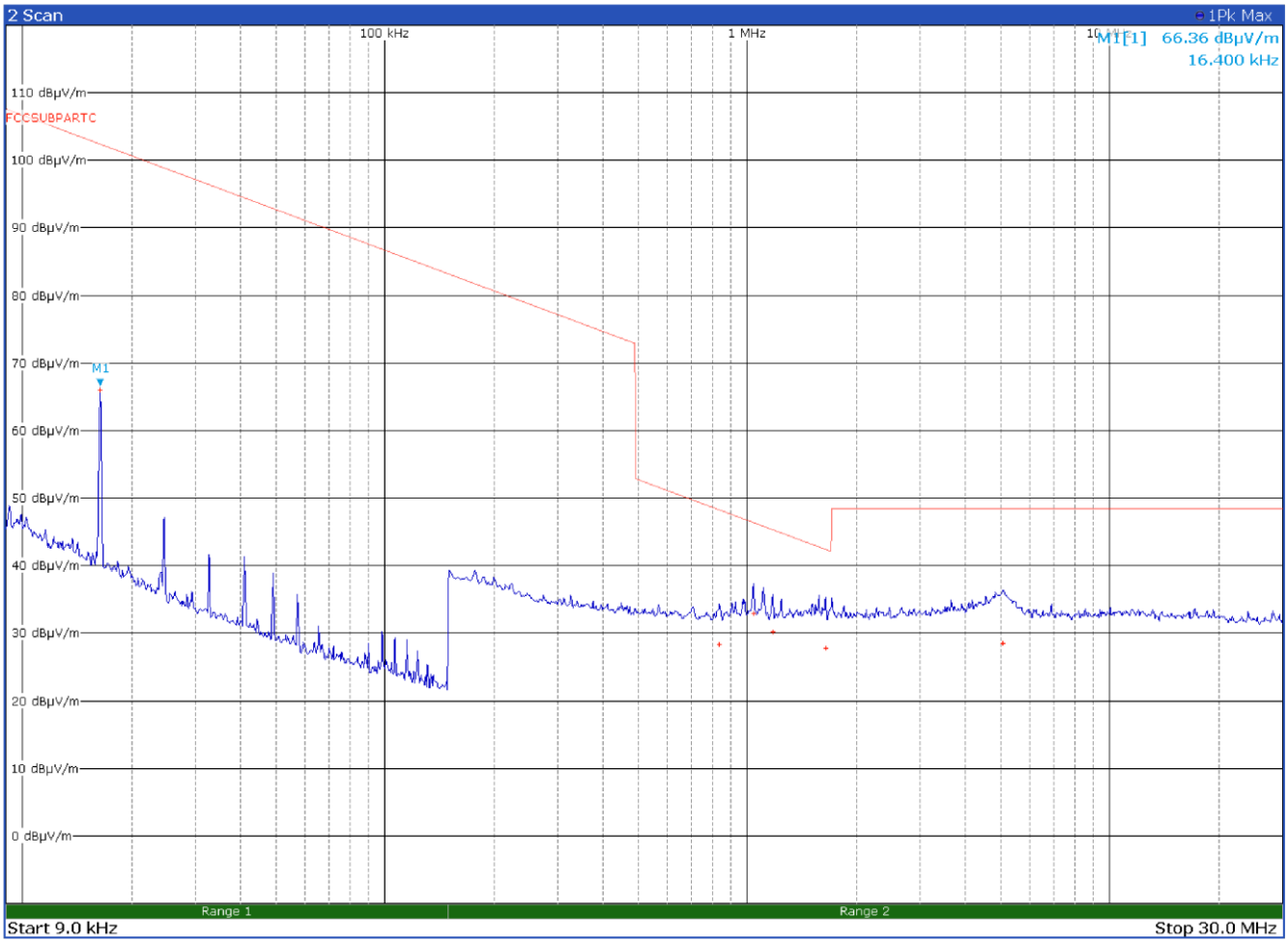


Figure 8.3-1: *Radiated emissions with antenna loop – EUT set at 8 kHz induction mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.0164	66.0	102.4	-36.4	QP
0.8385	28.3	48.3	-20.0	QP
1.0410	33.0	46.4	-13.4	QP
1.1760	30.1	45.3	-15.2	QP
1.6440	27.8	42.4	-14.6	QP
5.0708	28.5	48.5	-20.0	QP

Test data, continue

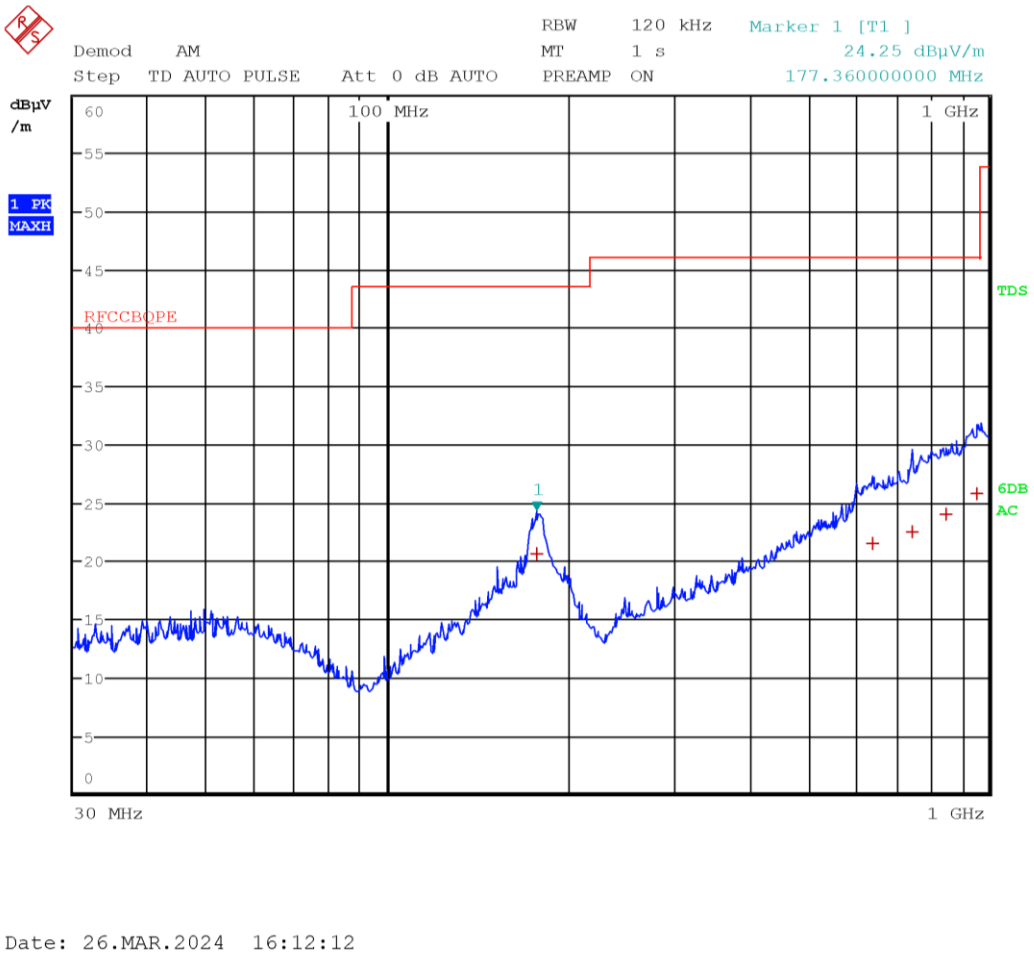


Figure 8.3-2: *Radiated emissions with antenna in horizontal polarization– EUT set at 8 kHz, induction mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
177.3600	20.6	43.5	-22.9	QP
641.3700	21.4	46.0	-24.6	QP
746.1900	22.6	46.0	-23.4	QP
851.4300	24.0	46.0	-22.0	QP
956.4000	25.8	46.0	-20.2	QP

Test data, continue

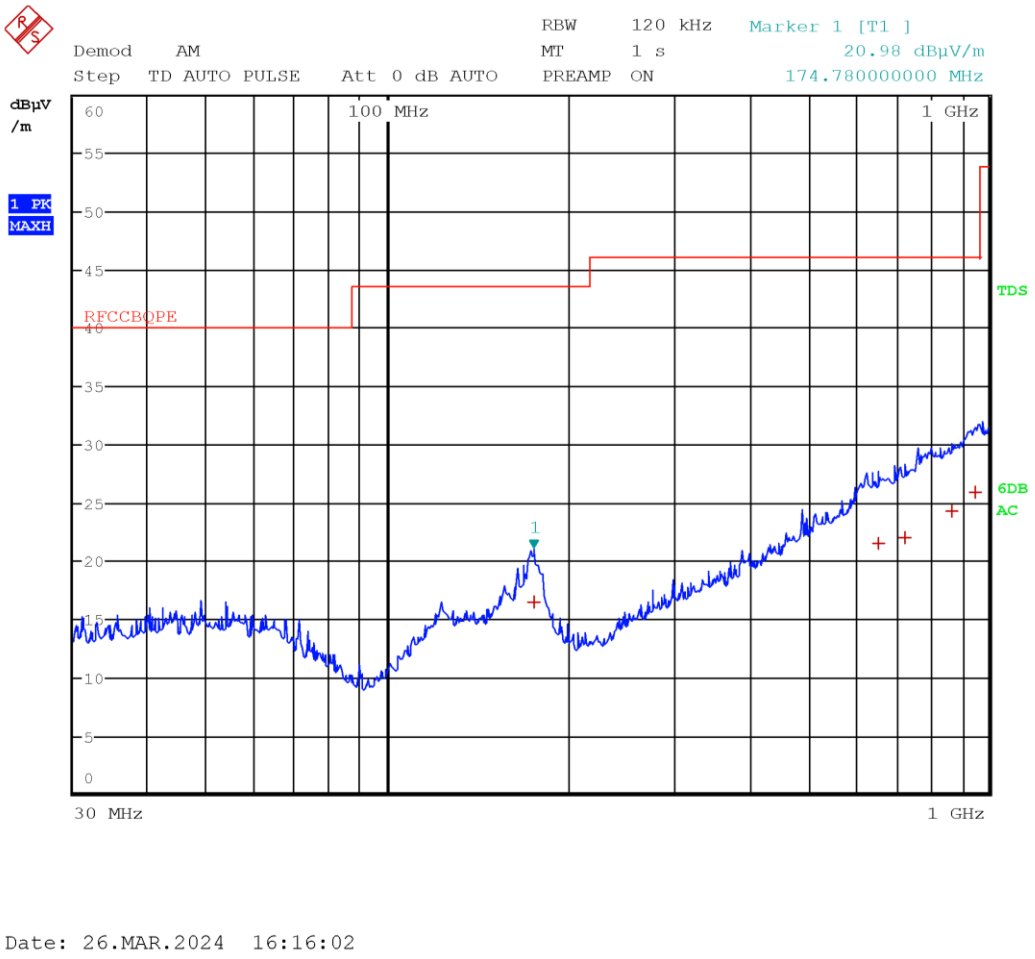


Figure 8.3-3: *Radiated emissions with antenna in vertical polarization – EUT set at 8 kH, z induction mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
174.7800	16.5	43.5	-27.0	QP
655.3500	21.5	46.0	-24.5	QP
726.3000	22.0	46.0	-24.0	QP
868.5300	24.2	46.0	-21.8	QP
951.1500	25.9	46.0	-20.1	QP

Test data, continue

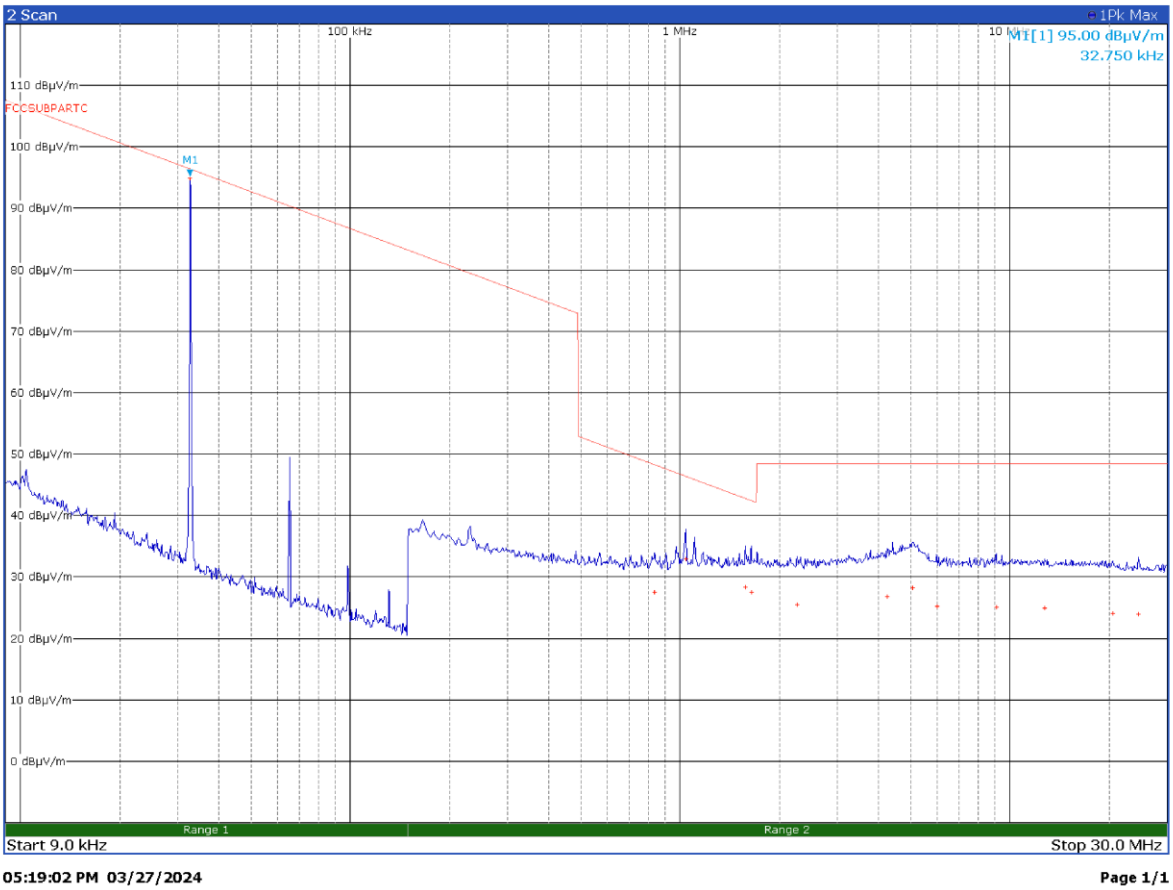


Figure 8.3-4: *Radiated emissions with antenna loop – EUT set at 33 kHz, induction mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.0328	94.9	--	--	--
0.8385	27.5	48.3	-20.8	QP
1.0410	32.9	46.4	-13.5	QP
1.5765	28.3	42.8	-14.5	QP
1.6440	27.5	42.5	-15.0	QP
2.2605	25.5	48.5	-23.0	QP
4.2563	26.7	48.5	-21.8	QP
5.0573	28.2	48.6	-20.4	QP
6.0000	25.2	48.5	-23.3	QP
9.0893	25.0	48.5	-23.5	QP
12.7410	25.0	48.5	-23.5	QP
20.5103	24.1	48.5	-24.4	QP
24.5108	23.9	48.5	-24.6	QP

Test data, continue

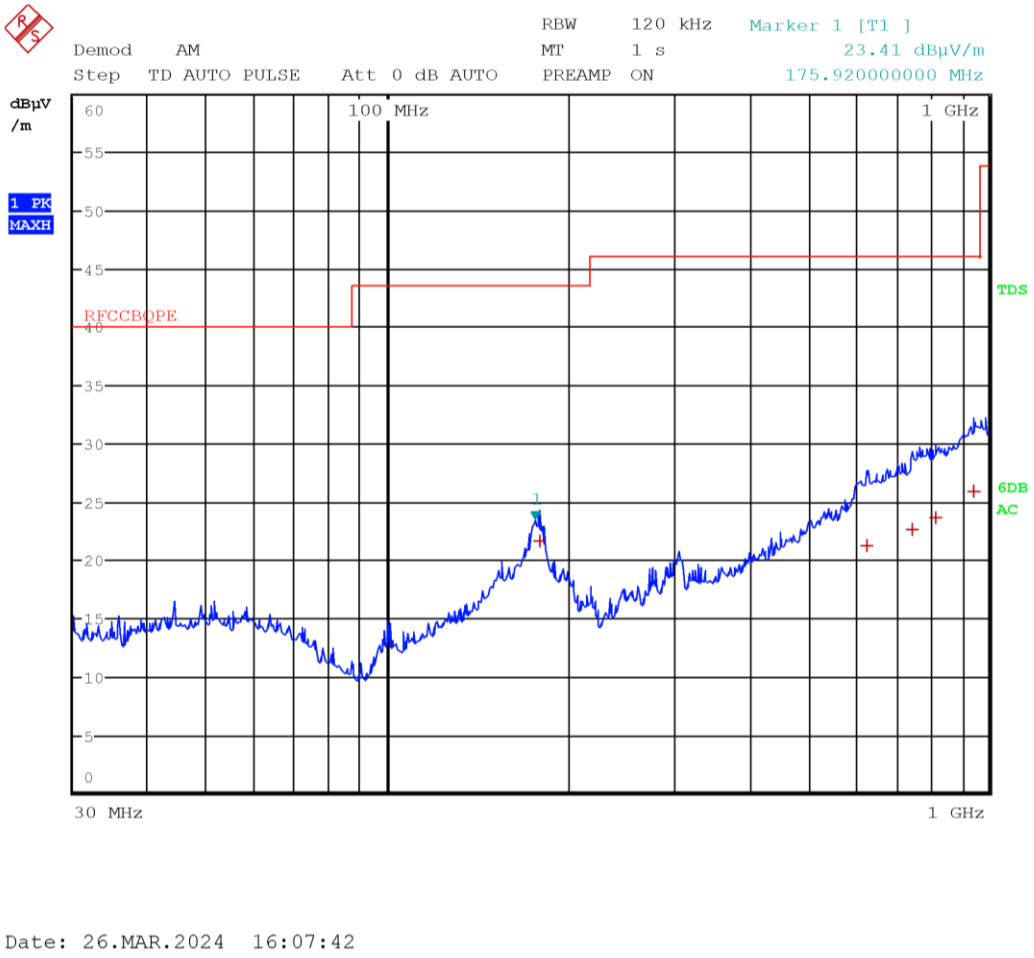


Figure 8.3-5: *Radiated emissions with antenna in horizontal polarization– EUT set at 33 kHz, induction mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
178.6200	21.6	43.5	-21.9	QP
625.9200	21.3	46.0	-24.7	QP
748.1700	22.7	46.0	-23.3	QP
815.8500	23.7	46.0	-22.3	QP
947.6400	25.9	46.0	-20.1	QP

Test data, continue

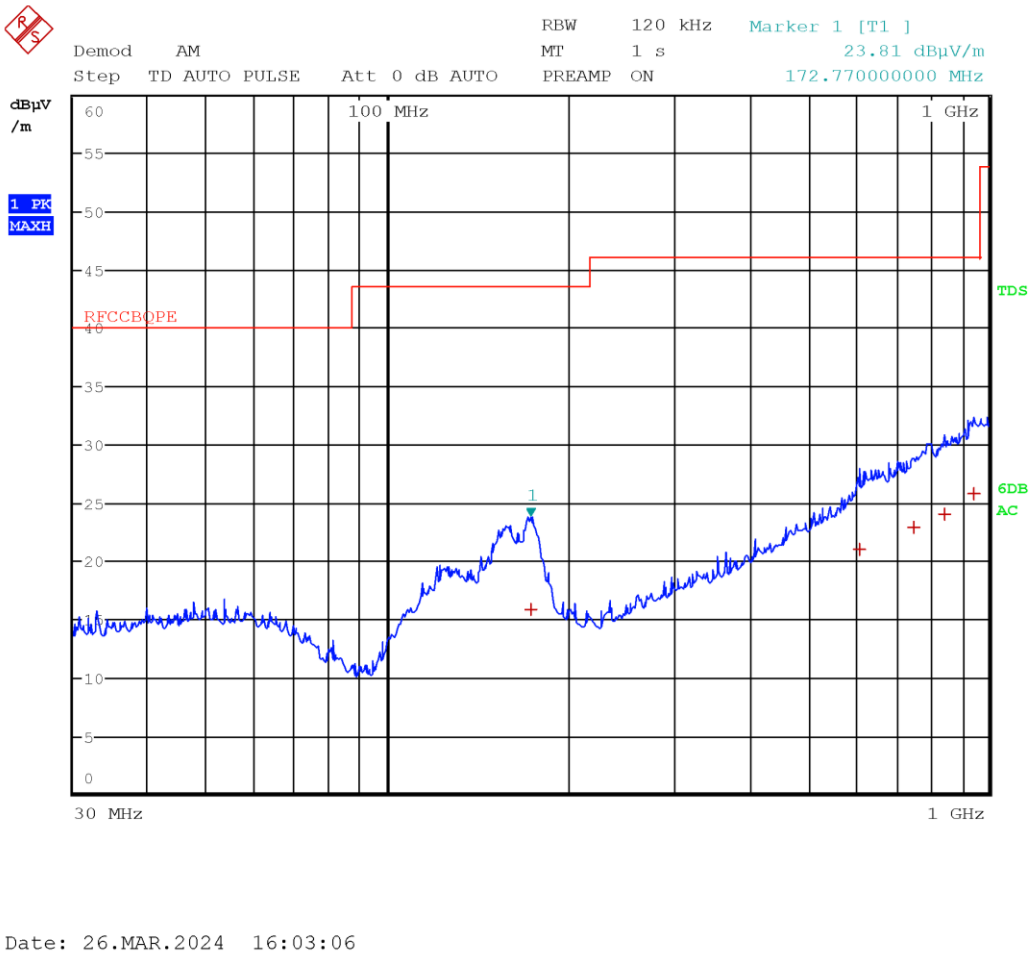


Figure 8.3-6: *Radiated emissions with antenna in vertical polarization – EUT set at 33 kHz, induction mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
172.7700	15.8	43.5	-27.7	QP
610.5900	20.9	46.0	-25.1	QP
751.3200	22.8	46.0	-23.2	QP
846.6000	24.0	46.0	-22.0	QP
945.2100	25.8	46.0	-20.2	QP

Test data, continue

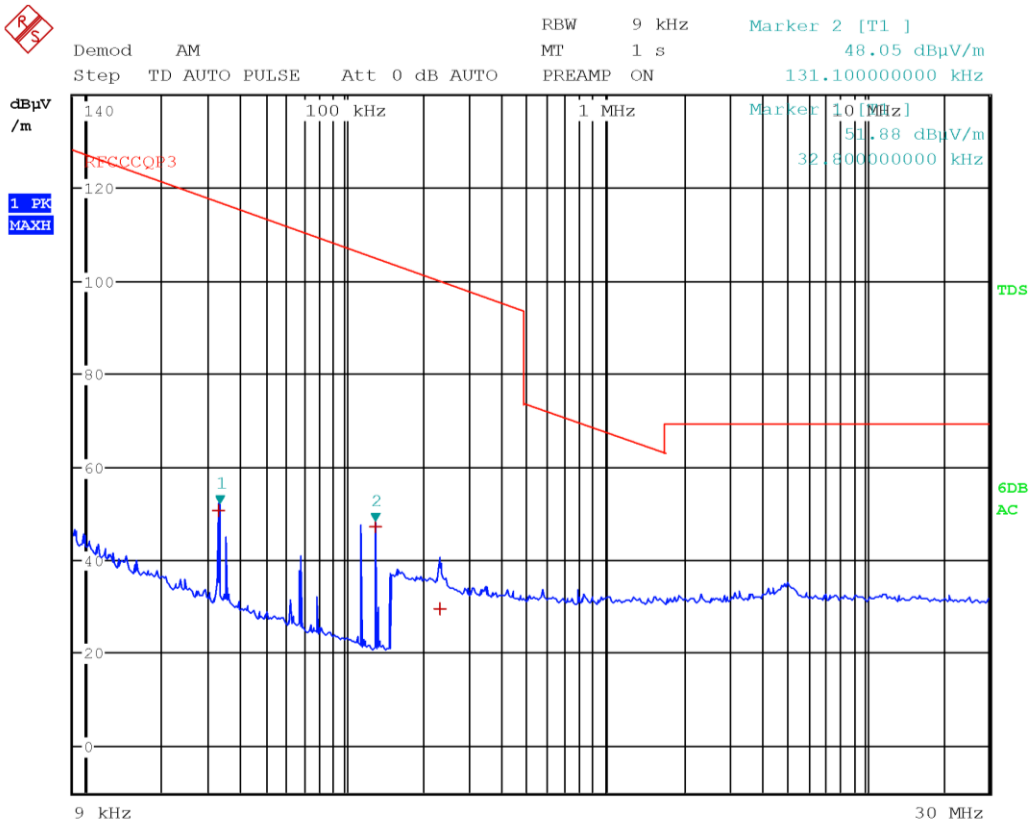


Figure 8.3-7: *Radiated emissions with antenna loop – EUT set at 131 kHz + 33 kHz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.0328	50.8	117.3	-66.5	QP
0.1311	47.3	105.2	-57.9	QP
0.2310	29.4	100.3	-70.9	QP

Test data, continue

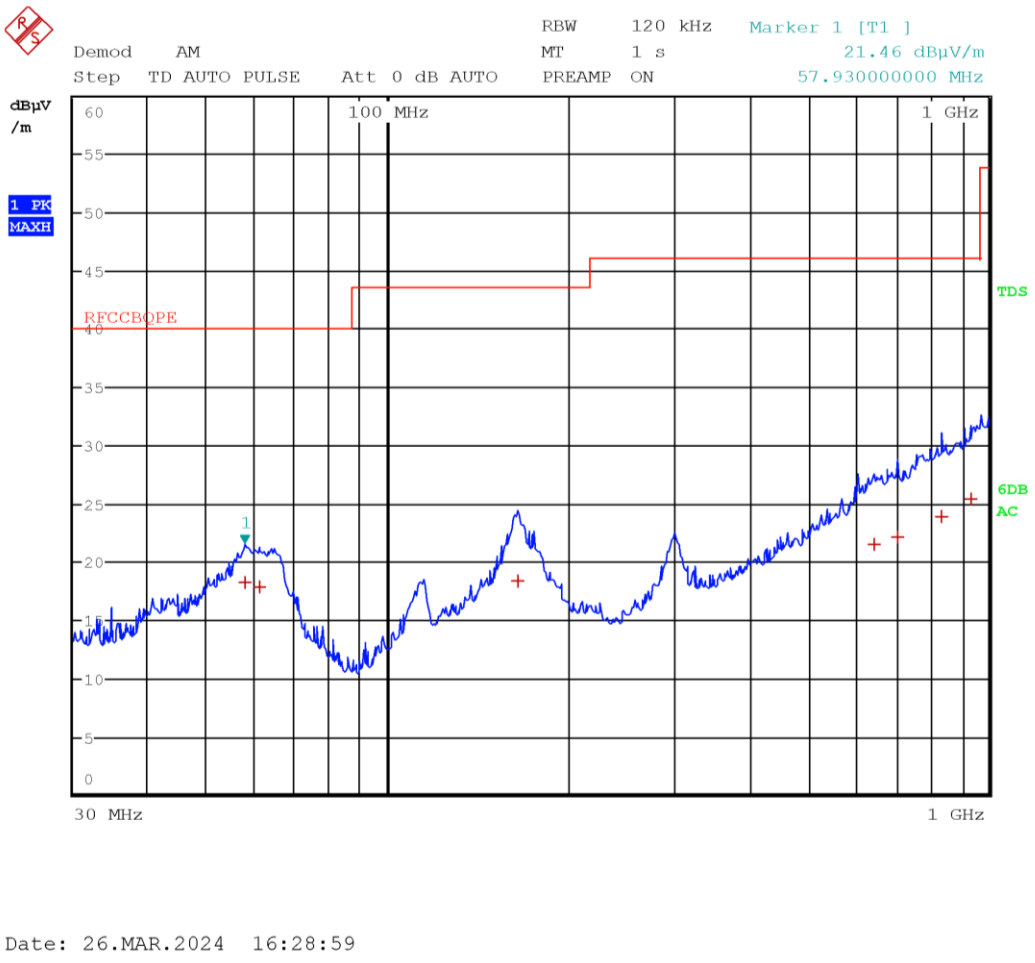


Figure 8.3-8: *Radiated emissions with antenna in horizontal polarization– EUT set at 131 kHz + 33 kHz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.3600	21.3	40.0	-18.7	QP
45.5100	22.7	40.0	-17.3	QP
52.3200	28.6	40.0	-11.4	QP
59.9700	33.8	40.0	-6.2	QP
64.8600	33.8	40.0	-6.2	QP
70.1400	28.7	40.0	-11.3	QP
116.4300	24.3	43.5	-19.2	QP
122.8800	20.6	43.5	-22.9	QP
650.9100	21.5	46.0	-24.5	QP
737.3100	22.2	46.0	-23.8	QP
835.2000	23.9	46.0	-22.1	QP
947.8800	25.9	46.0	-20.1	QP

Test data, continue

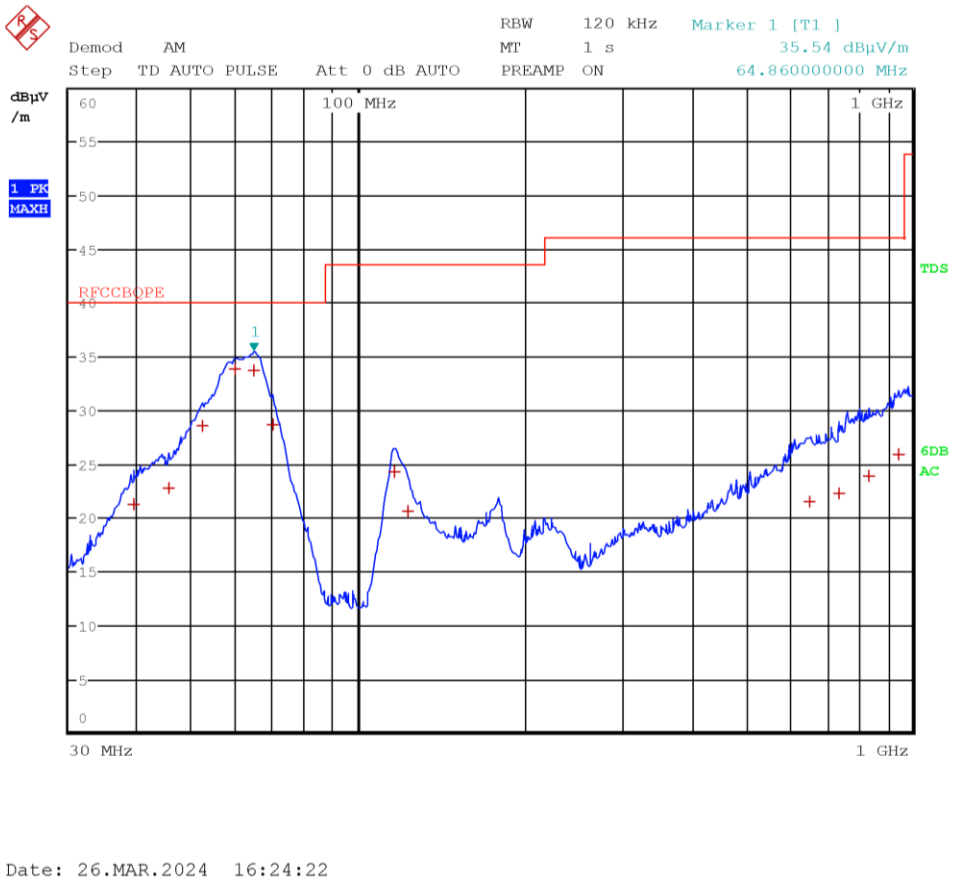


Figure 8.3-9: *Radiated emissions with antenna in vertical polarization – EUT set at 131 kHz + 33 kHz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.3600	21.3	40.0	-18.7	QP
45.5100	22.7	40.0	-17.3	QP
52.3200	28.6	40.0	-11.4	QP
59.9700	33.8	40.0	-6.2	QP
64.8600	33.8	40.0	-6.2	QP
70.1400	28.7	40.0	-11.3	QP
116.4300	24.3	43.5	-19.2	QP
122.8800	20.6	43.5	-22.9	QP
650.9100	21.5	46.0	-24.5	QP
737.3100	22.2	46.0	-23.8	QP
835.2000	23.9	46.0	-22.1	QP
947.8800	25.9	46.0	-20.1	QP

Test data, continue

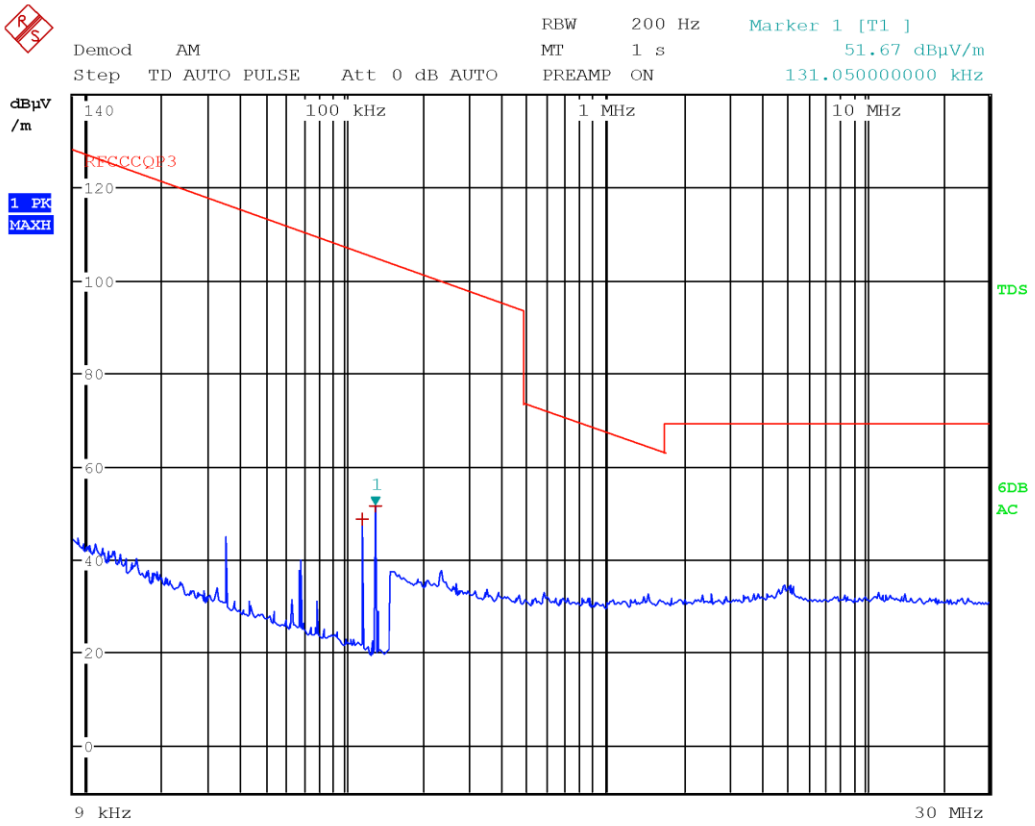


Figure 8.3-10: *Radiated emissions with antenna loop – EUT set at 131 kHz direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.1165	48.7	106.3	-57.6	QP
0.1311	51.6	105.3	-53.7	QP

Test data, continue

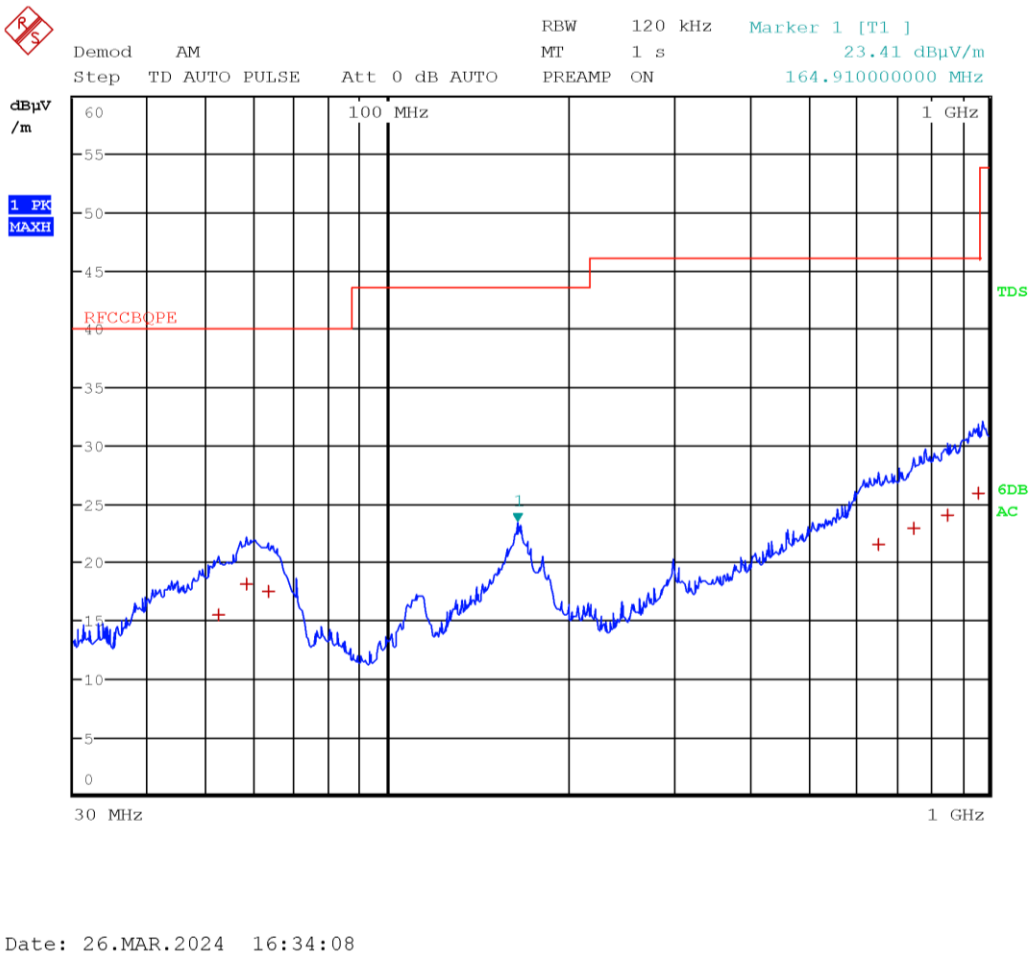


Figure 8.3-11: *Radiated emissions with antenna in horizontal polarization – EUT set at 131 kHz direct connection mode ,*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
52.3800	15.4	40.0	-24.6	QP
58.2000	18.1	40.0	-21.9	QP
63.3000	17.5	40.0	-22.5	QP
656.0100	21.5	46.0	-24.5	QP
751.3800	22.8	46.0	-23.2	QP
855.3600	24.0	46.0	-22.0	QP
958.9800	25.9	46.0	-20.1	QP

Test data, continue

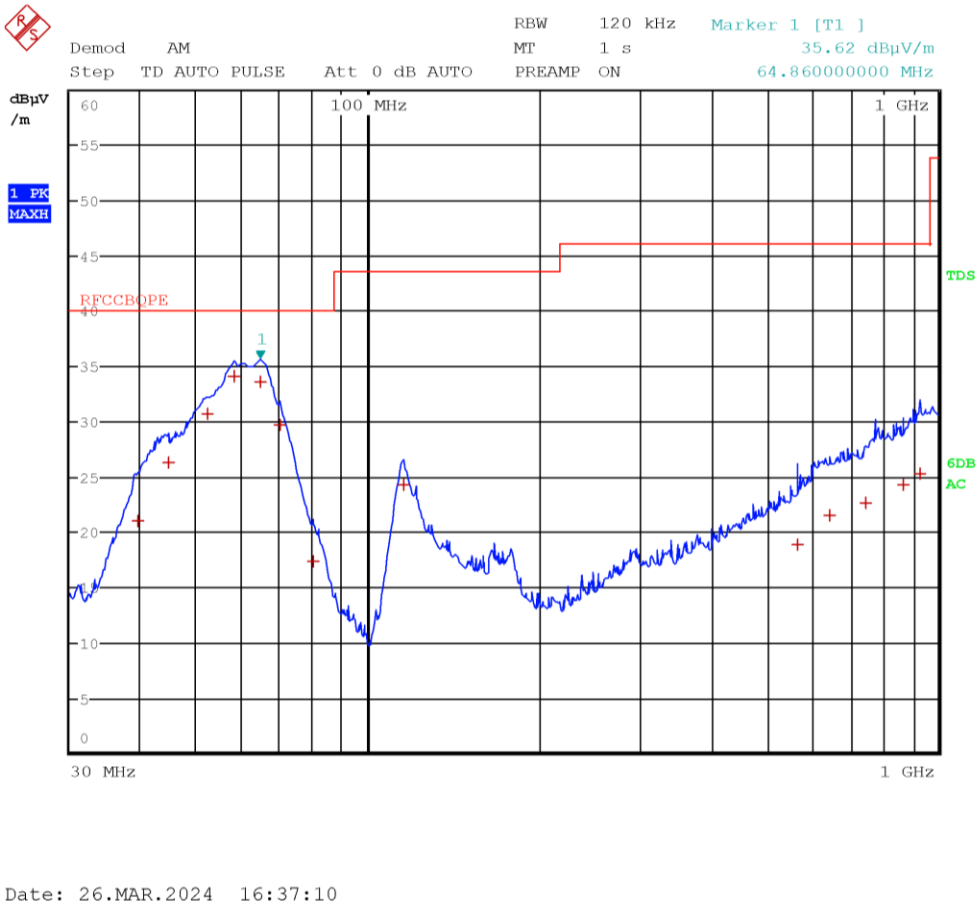


Figure 8.3-12: *Radiated emissions with antenna in vertical polarization – EUT set at 131 kHz , direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.4500	21.0	40.0	-19.0	QP
44.5800	26.2	40.0	-13.8	QP
52.3500	30.7	40.0	-9.3	QP
58.2900	34.1	40.0	-5.9	QP
64.8600	33.6	40.0	-6.4	QP
70.0500	29.7	40.0	-10.3	QP
80.3400	17.3	40.0	-22.7	QP
115.5600	24.3	43.5	-19.2	QP
567.3600	18.8	46.0	-27.2	QP
644.6400	21.5	46.0	-24.5	QP
748.2300	22.6	46.0	-23.4	QP
868.9800	24.3	46.0	-21.7	QP
927.1500	25.3	46.0	-20.7	QP

Test data, continue

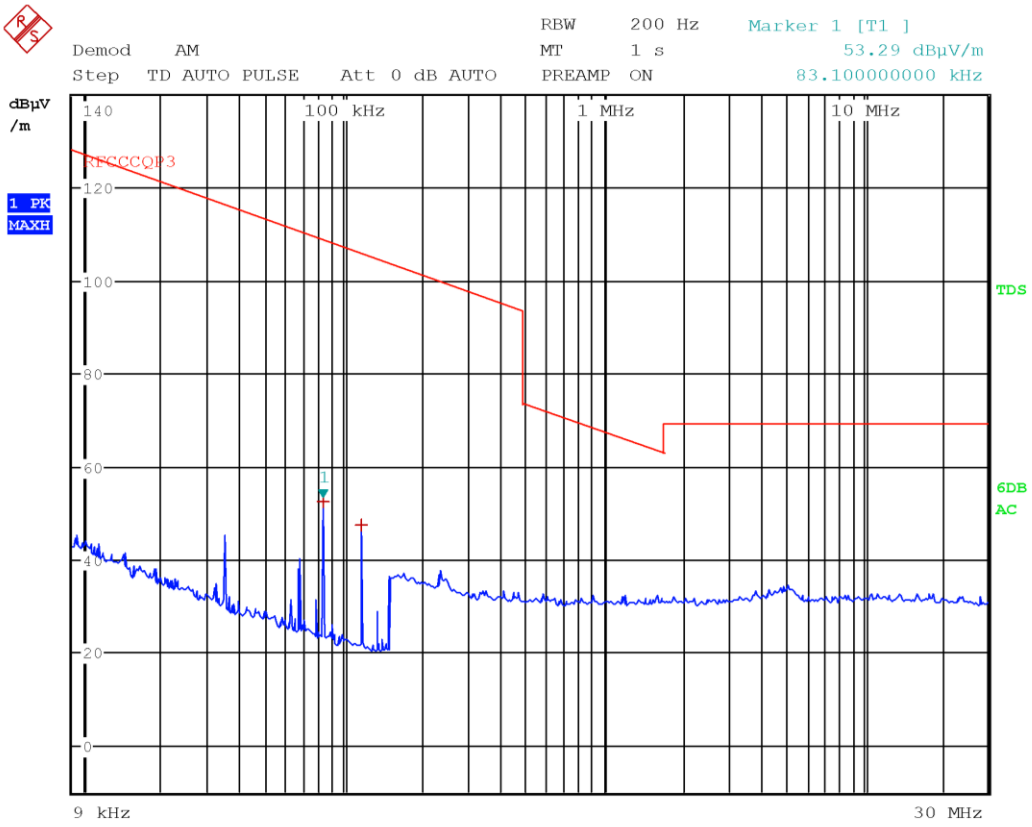


Figure 8.3-13: *Radiated emissions with antenna loop – EUT set at 83 kHz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.0831	52.7	109.2	-56.5	QP
0.1167	47.7	106.3	-58.6	QP

Test data, continue

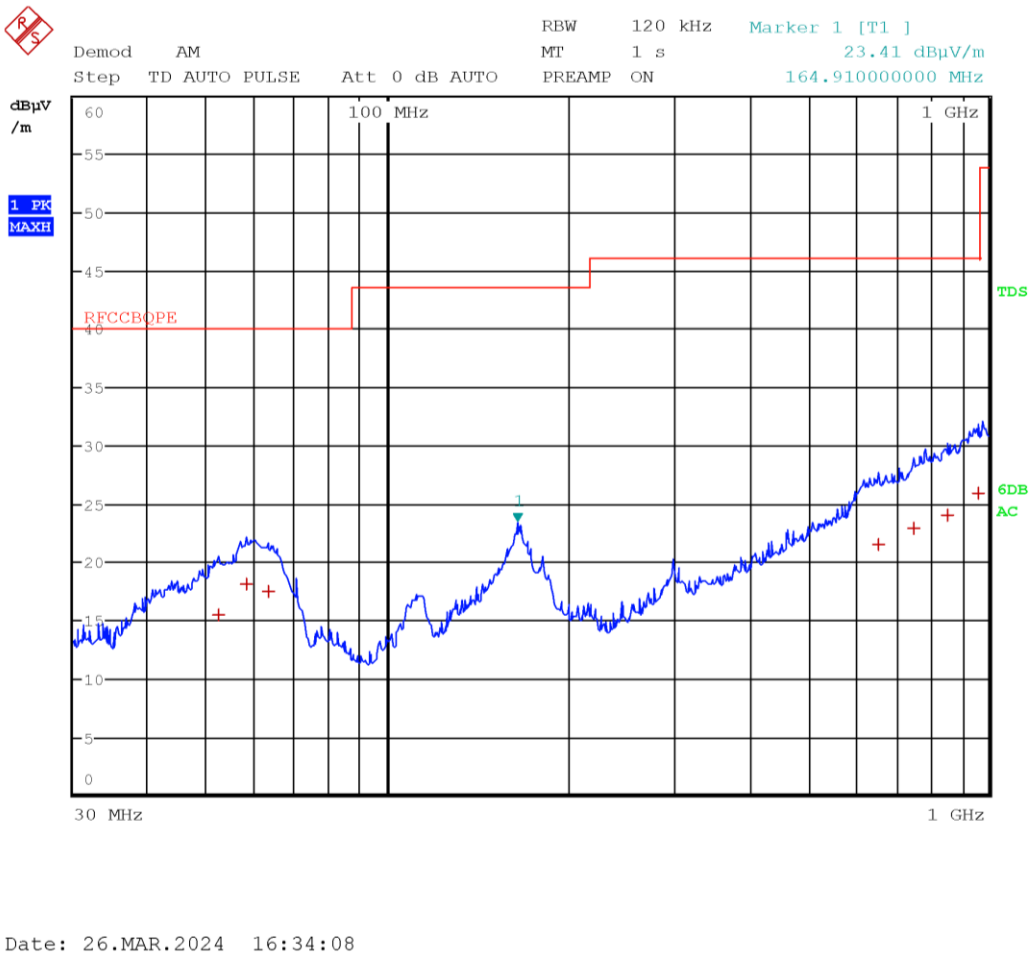


Figure 8.3-14: *Radiated emissions with antenna in horizontal polarization – EUT set at 83 kHz direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
52.3800	15.4	40.0	-24.6	QP
58.2000	18.1	40.0	-21.9	QP
63.3000	17.5	40.0	-22.5	QP
656.0100	21.5	46.0	-24.5	QP
751.3800	22.8	46.0	-23.2	QP
855.3600	24.0	46.0	-22.0	QP
958.9800	25.9	46.0	-20.1	QP

Test data, continue

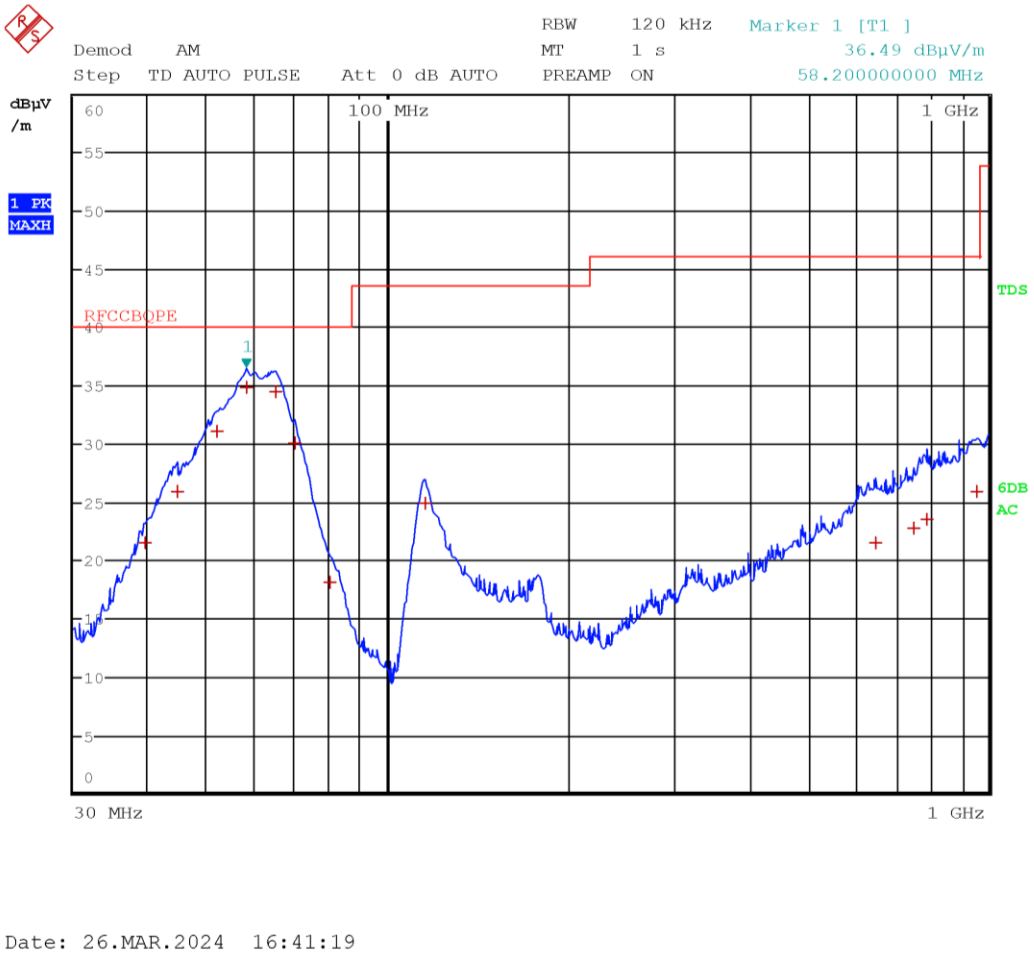


Figure 8.3-15 *Radiated emissions with antenna in vertical polarization – EUT set at 83 kHz , direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.5700	21.4	40.0	-18.6	QP
44.9400	26.0	40.0	-14.0	QP
52.1100	31.1	40.0	-8.9	QP
58.2000	34.8	40.0	-5.2	QP
64.9500	34.5	40.0	-5.5	QP
70.2000	30.1	40.0	-9.9	QP
80.1600	18.1	40.0	-21.9	QP
115.5300	24.9	43.5	-18.6	QP
648.6300	21.5	46.0	-24.5	QP
749.1600	22.8	46.0	-23.2	QP
791.6700	23.5	46.0	-22.5	QP
956.5800	25.9	46.0	-20.1	QP

Test data, continue

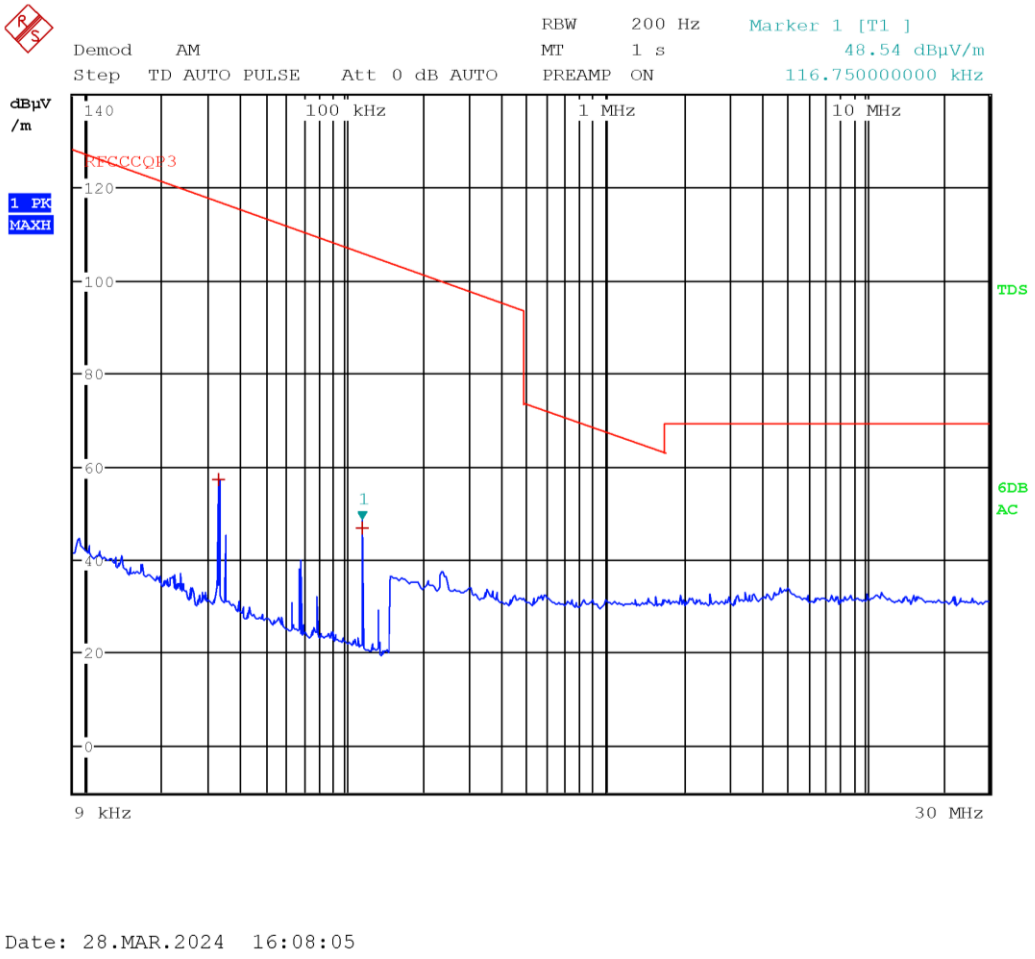


Figure 8.3-16: *Radiated emissions with antenna loop – EUT set at 33 kHz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.0328	57.4	117.3	-59.9	QP
0.1168	46.8	106.2	-59.4	QP

Test data, continue

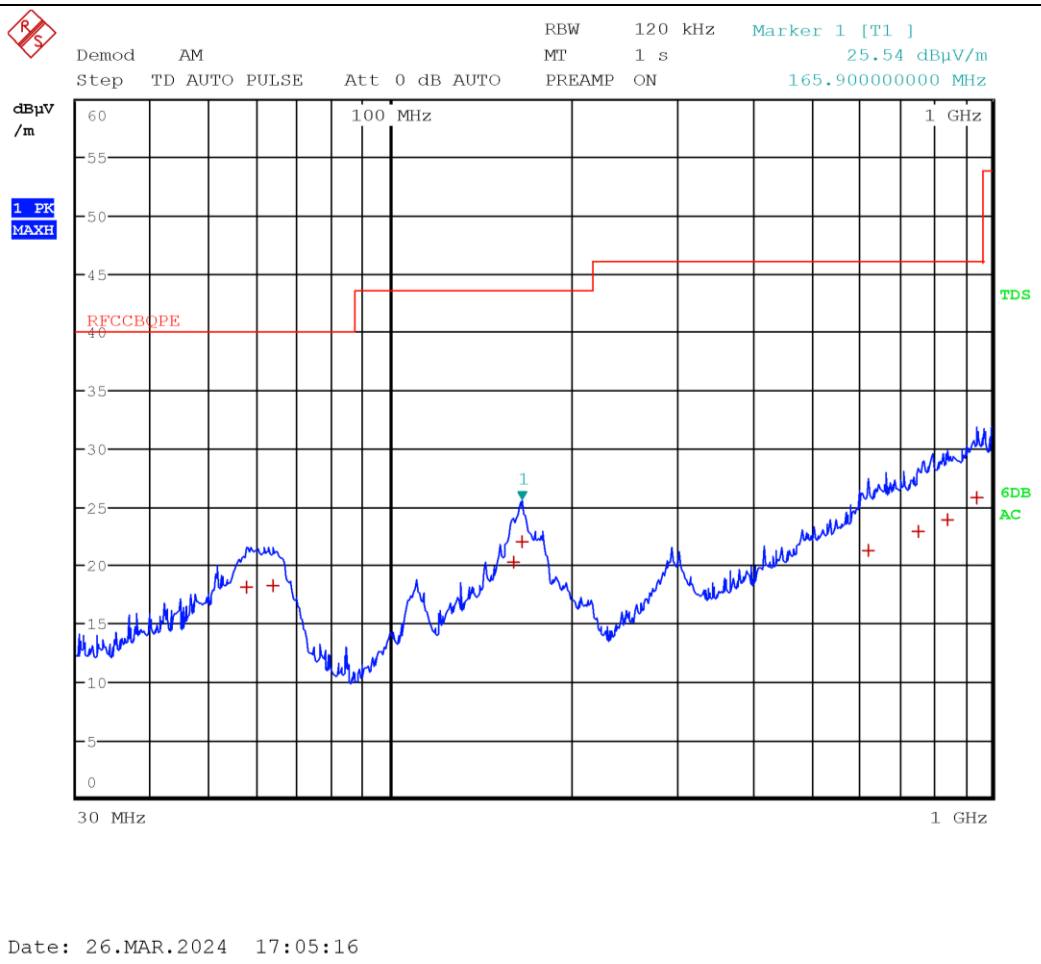


Figure 8.3-17: *Radiated emissions with antenna in horizontal polarization – EUT set at 33 kHz direct connection mode,*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
57.6300	18.1	40.0	-21.9	QP
63.6600	18.2	40.0	-21.8	QP
160.1100	20.2	43.5	-23.3	QP
165.9000	22.0	43.5	-21.5	QP
622.9500	21.2	46.0	-24.8	QP
754.9500	22.9	46.0	-23.1	QP
846.4800	23.9	46.0	-22.1	QP
944.9700	25.7	46.0	-20.3	QP
751.3800	22.8	46.0	-23.2	QP
855.3600	24.0	46.0	-22.0	QP
958.9800	25.9	46.0	-20.1	QP

Test data, continue

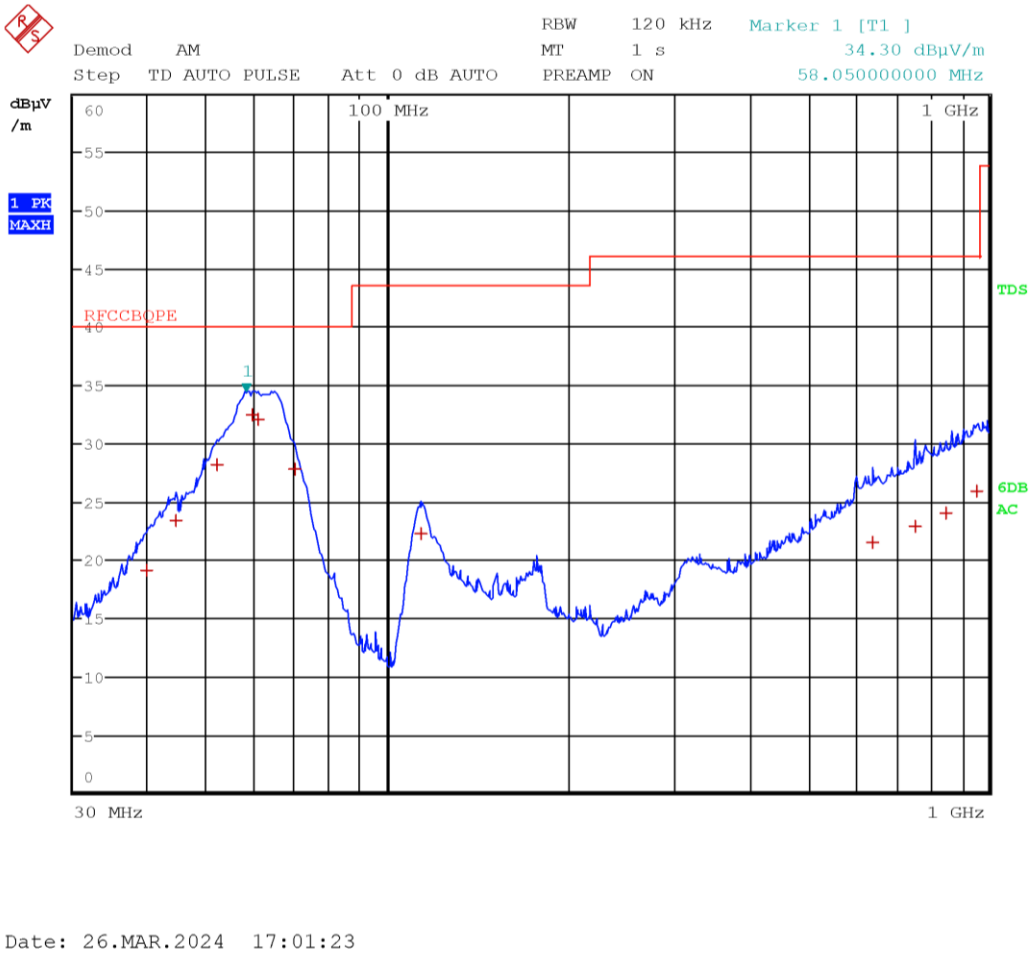


Figure 8.3-18 *Radiated emissions with antenna in vertical polarization – EUT set at 33kHz , direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.6000	19.1	40.0	-20.9	QP
44.4000	23.3	40.0	-16.7	QP
52.1100	28.1	40.0	-11.9	QP
59.5800	32.5	40.0	-7.5	QP
60.8400	32.1	40.0	-7.9	QP
70.1100	27.7	40.0	-12.3	QP
113.8800	22.3	43.5	-21.2	QP
639.9000	21.4	46.0	-24.6	QP
754.8600	22.9	46.0	-23.1	QP
851.2800	24.0	46.0	-22.0	QP
954.4800	25.9	46.0	-20.1	QP

Test data, continue

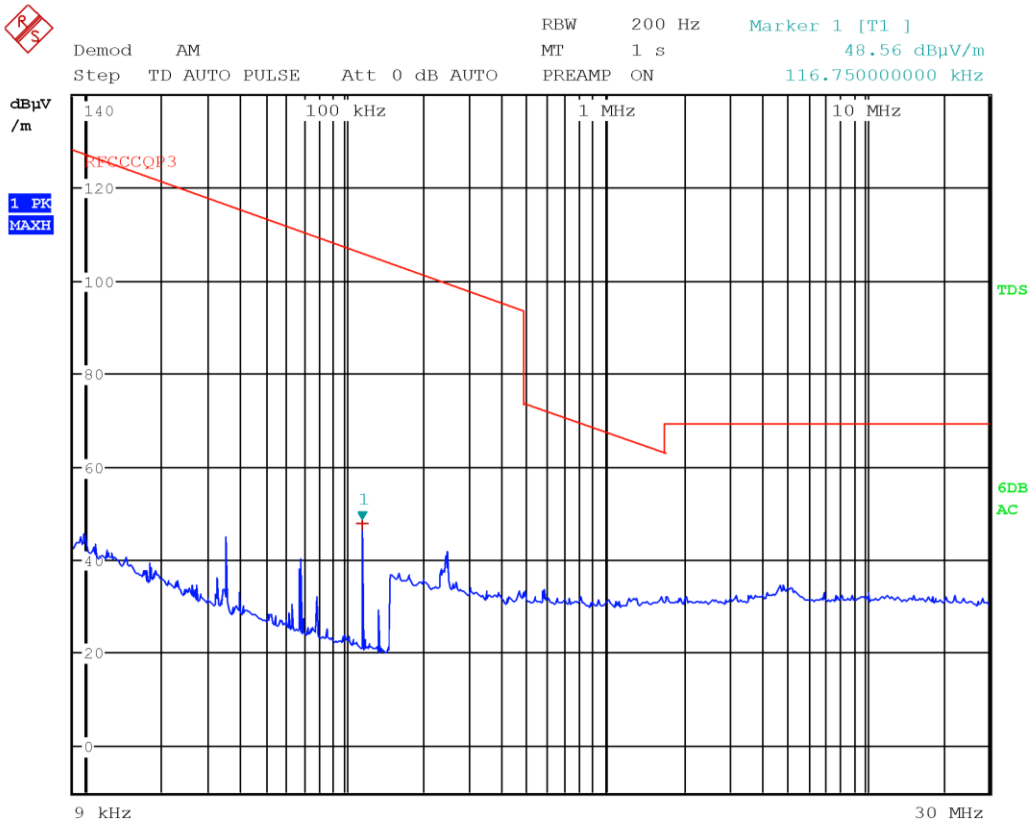


Figure 8.3-19: *Radiated emissions with antenna loop – EUT set at 8 kHz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.1168	47.7	106.2	-58.5	QP

Test data, continue

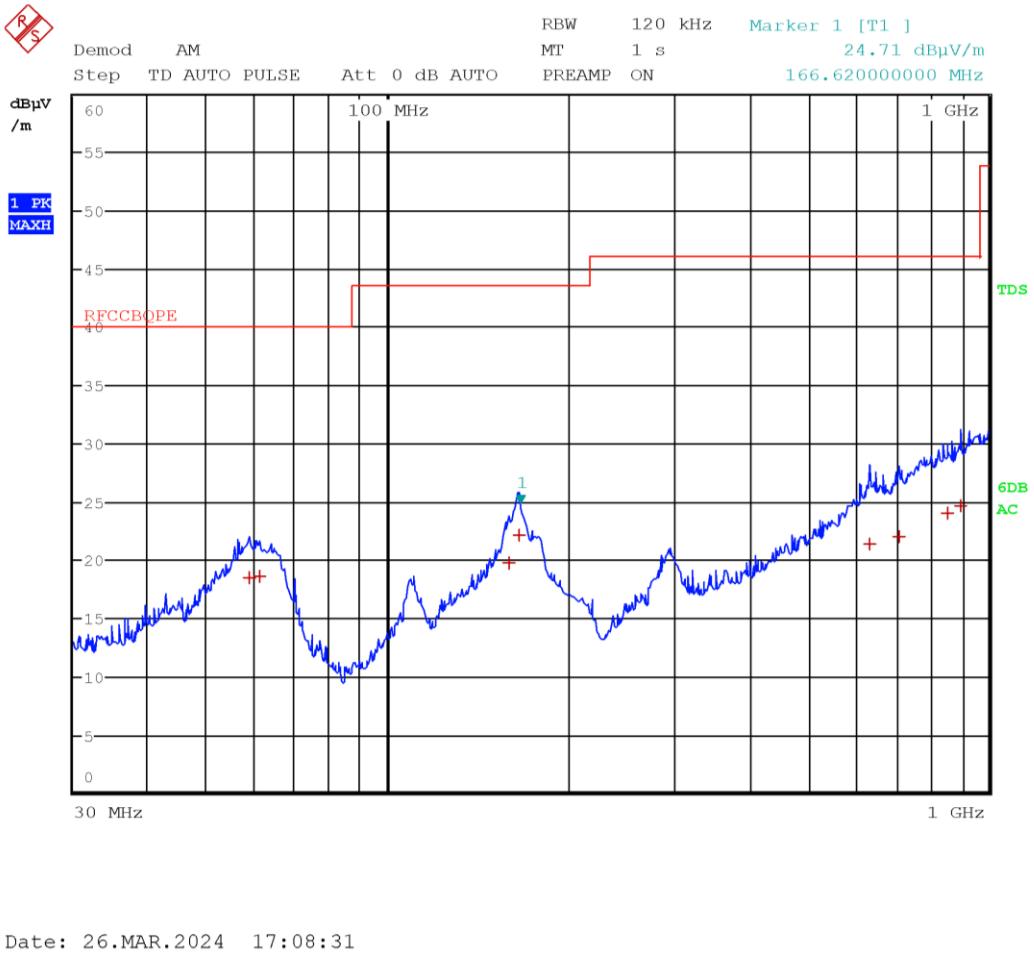


Figure 8.3-20: *Radiated emissions with antenna in horizontal polarization – EUT set at 8 kHz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
58.7400	18.5	40.0	-21.5	QP
61.2000	18.6	40.0	-21.4	QP
158.7300	19.7	43.5	-23.8	QP
165.6900	22.1	43.5	-21.4	QP
634.2300	21.4	46.0	-24.6	QP
710.7300	22.0	46.0	-24.0	QP
856.6500	24.0	46.0	-22.0	QP
896.7000	24.6	46.0	-21.4	QP

Test data, continue

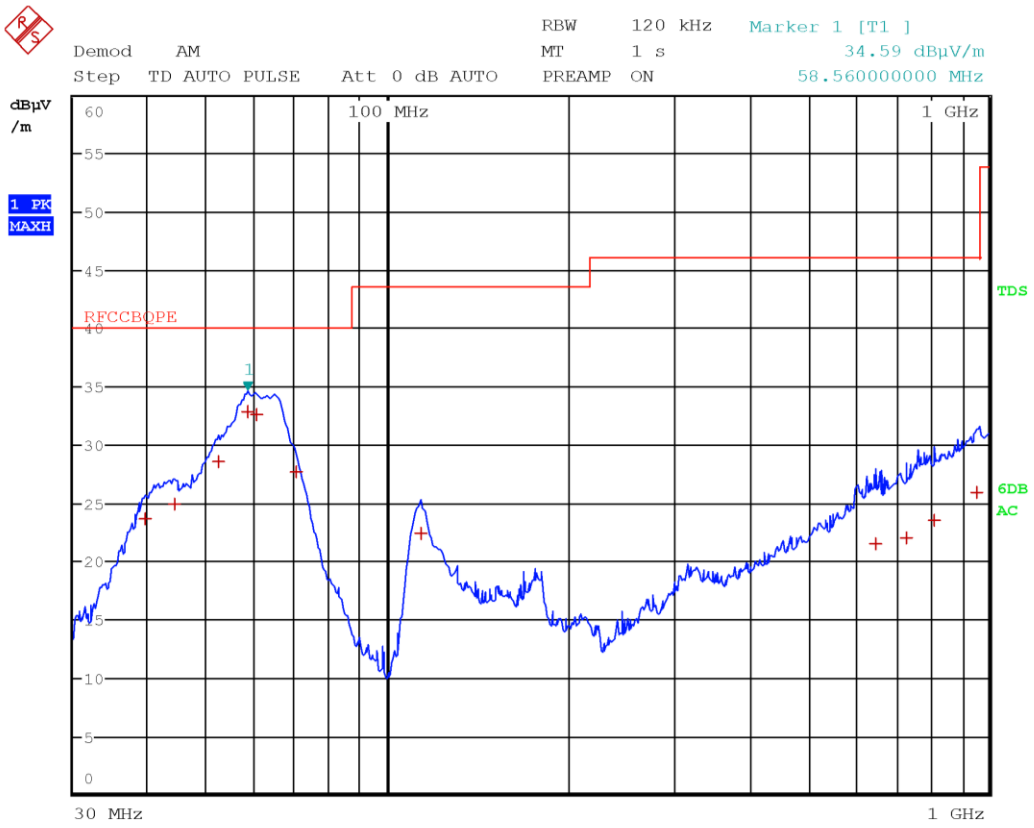


Figure 8.3-21 *Radiated emissions with antenna in vertical polarization – EUT set at 8 kHz , direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.6000	19.1	40.0	-20.9	QP
44.4000	23.3	40.0	-16.7	QP
52.1100	28.1	40.0	-11.9	QP
59.5800	32.5	40.0	-7.5	QP
60.8400	32.1	40.0	-7.9	QP
70.1100	27.7	40.0	-12.3	QP
113.8800	22.3	43.5	-21.2	QP
639.9000	21.4	46.0	-24.6	QP
754.8600	22.9	46.0	-23.1	QP
851.2800	24.0	46.0	-22.0	QP
954.4800	25.9	46.0	-20.1	QP

Test data, continue

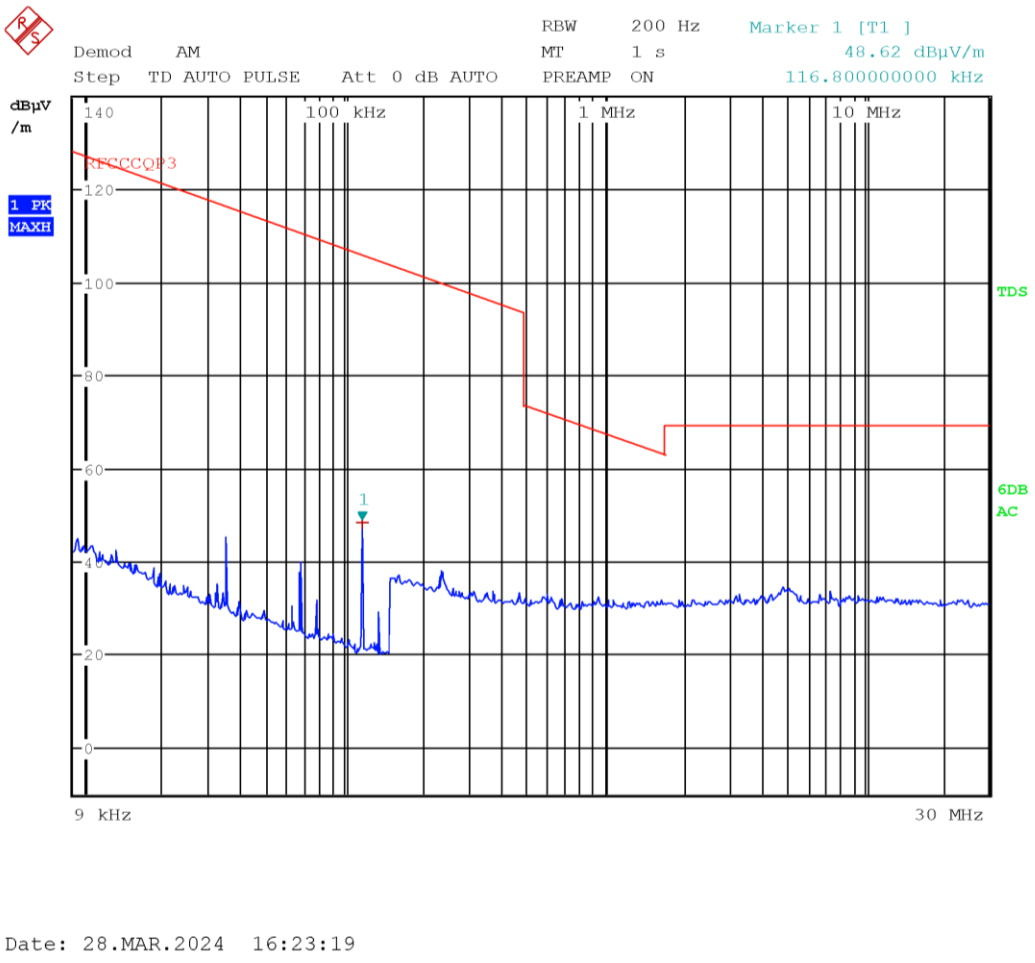


Figure 8.3-22: *Radiated emissions with antenna loop – EUT set at 640 Hz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.1168	48.5	106.2	-57.7	QP

Test data, continue

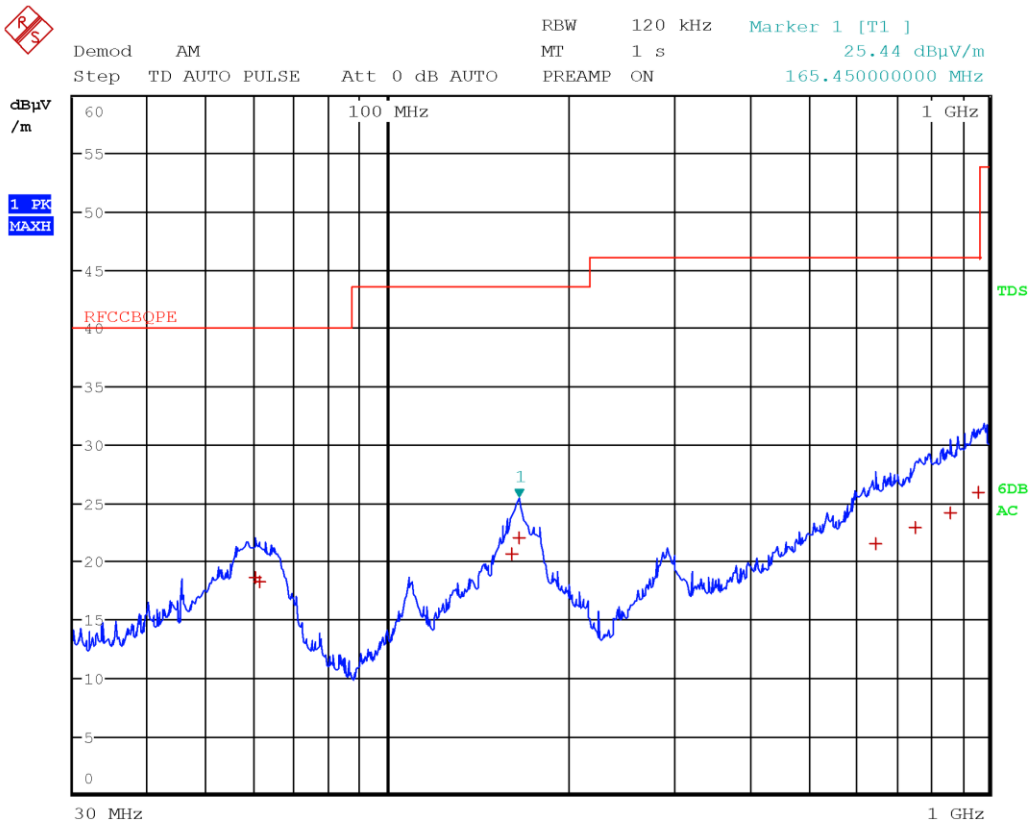


Figure 8.3-23: *Radiated emissions with antenna in horizontal polarization – EUT set at 640 Hz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
60.1500	18.5	40.0	-21.5	QP
61.1400	18.3	40.0	-21.7	QP
161.4000	20.7	43.5	-22.8	QP
165.4500	22.0	43.5	-21.5	QP
650.4900	21.5	46.0	-24.5	QP
754.8300	22.9	46.0	-23.1	QP
864.0900	24.1	46.0	-21.9	QP
958.8900	25.9	46.0	-20.1	QP
896.7000	24.6	46.0	-21.4	QP

Test data, continue

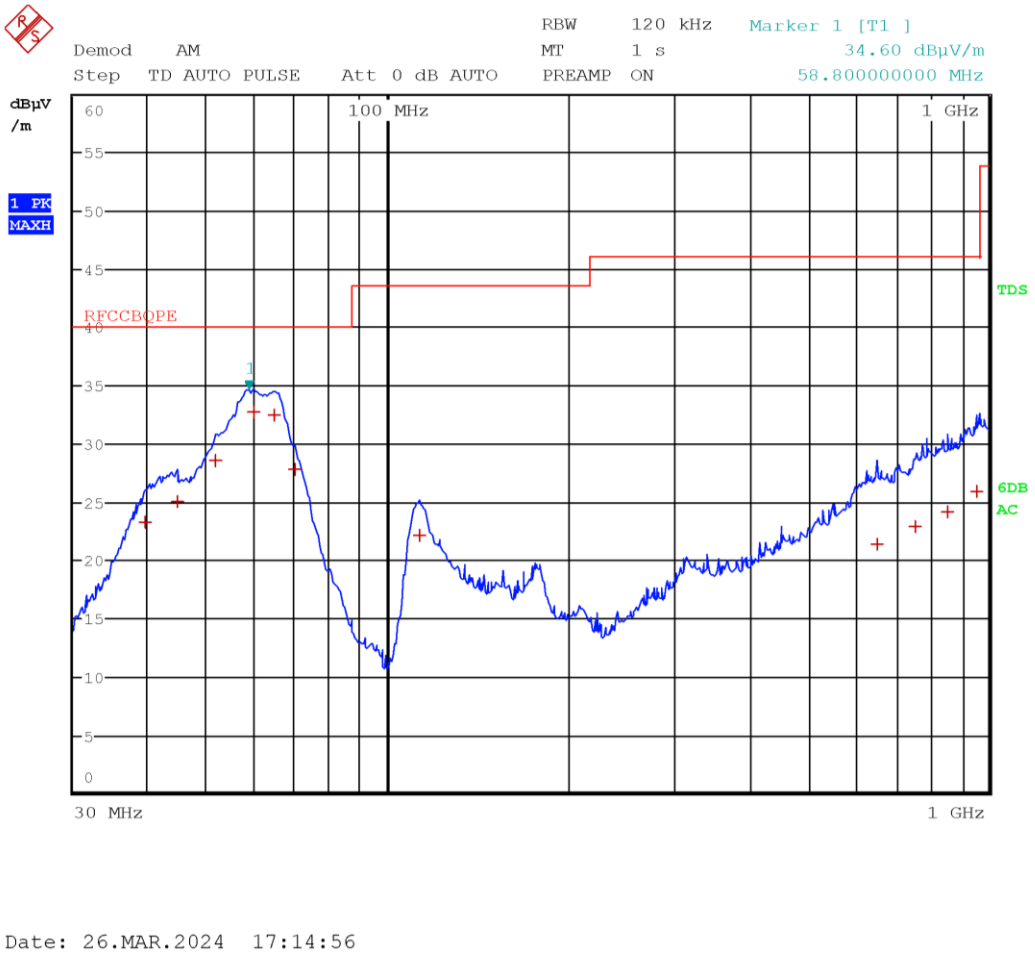


Figure 8.3-24 *Radiated emissions with antenna in vertical polarization – EUT set at 640 Hz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.5700	23.2	40.0	-16.8	QP
44.5800	25.1	40.0	-14.9	QP
51.7500	28.5	40.0	-11.5	QP
59.9700	32.7	40.0	-7.3	QP
64.7700	32.4	40.0	-7.6	QP
70.0200	27.8	40.0	-12.2	QP
112.8000	22.1	43.5	-21.4	QP
652.4100	21.4	46.0	-24.6	QP
753.2700	22.8	46.0	-23.2	QP
856.5600	24.1	46.0	-21.9	QP
956.5500	25.9	46.0	-20.1	QP

Test data, continue

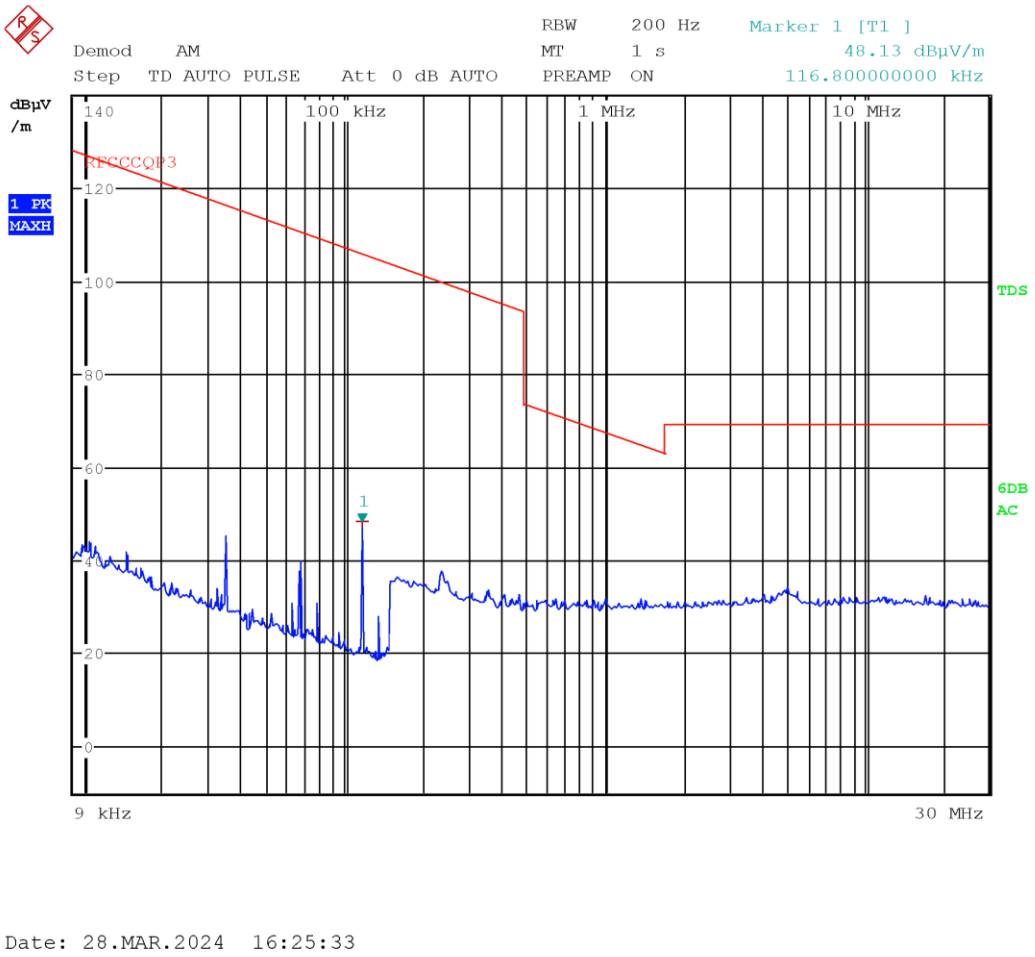


Figure 8.3-25: *Radiated emissions with antenna loop – EUT set at 512 Hz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.1168	48.5	106.2	-57.7	QP

Test data, continue

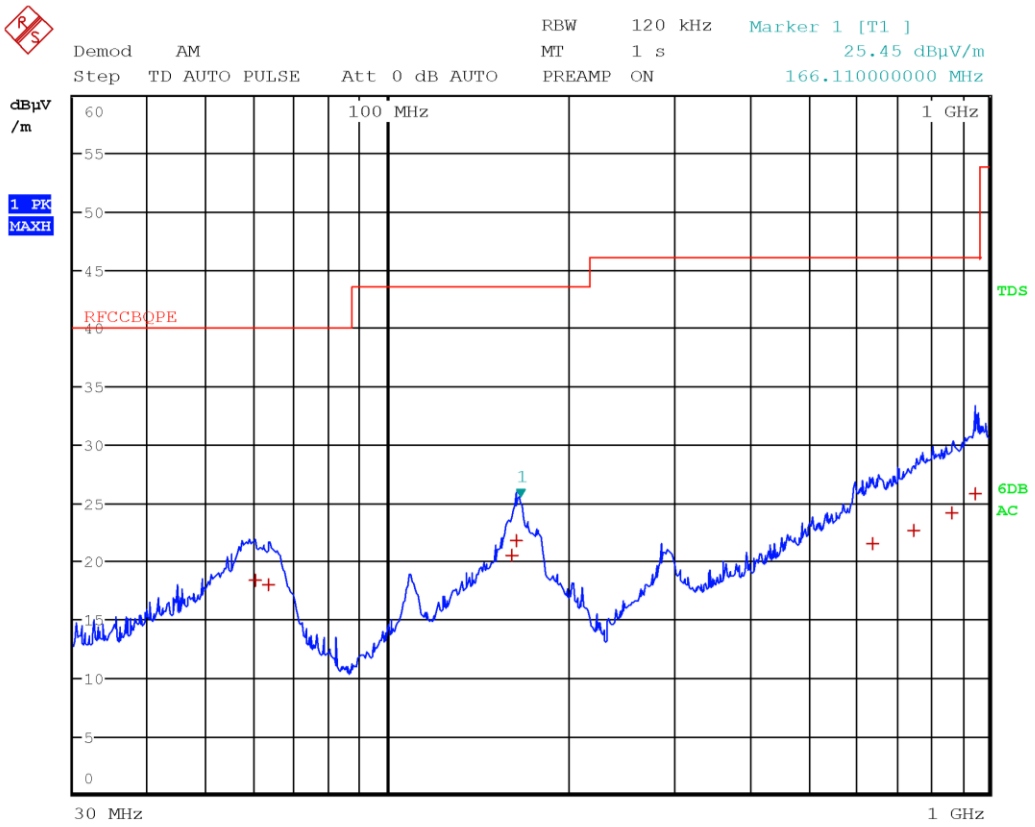


Figure 8.3-26: *Radiated emissions with antenna in horizontal polarization – EUT set at 512Hz, direct connection mode*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
58.7400	18.5	40.0	-21.5	QP
61.2000	18.6	40.0	-21.4	QP
158.7300	19.7	43.5	-23.8	QP
165.6900	22.1	43.5	-21.4	QP
634.2300	21.4	46.0	-24.6	QP
710.7300	22.0	46.0	-24.0	QP
856.6500	24.0	46.0	-22.0	QP
896.7000	24.6	46.0	-21.4	QP

Test data, continue

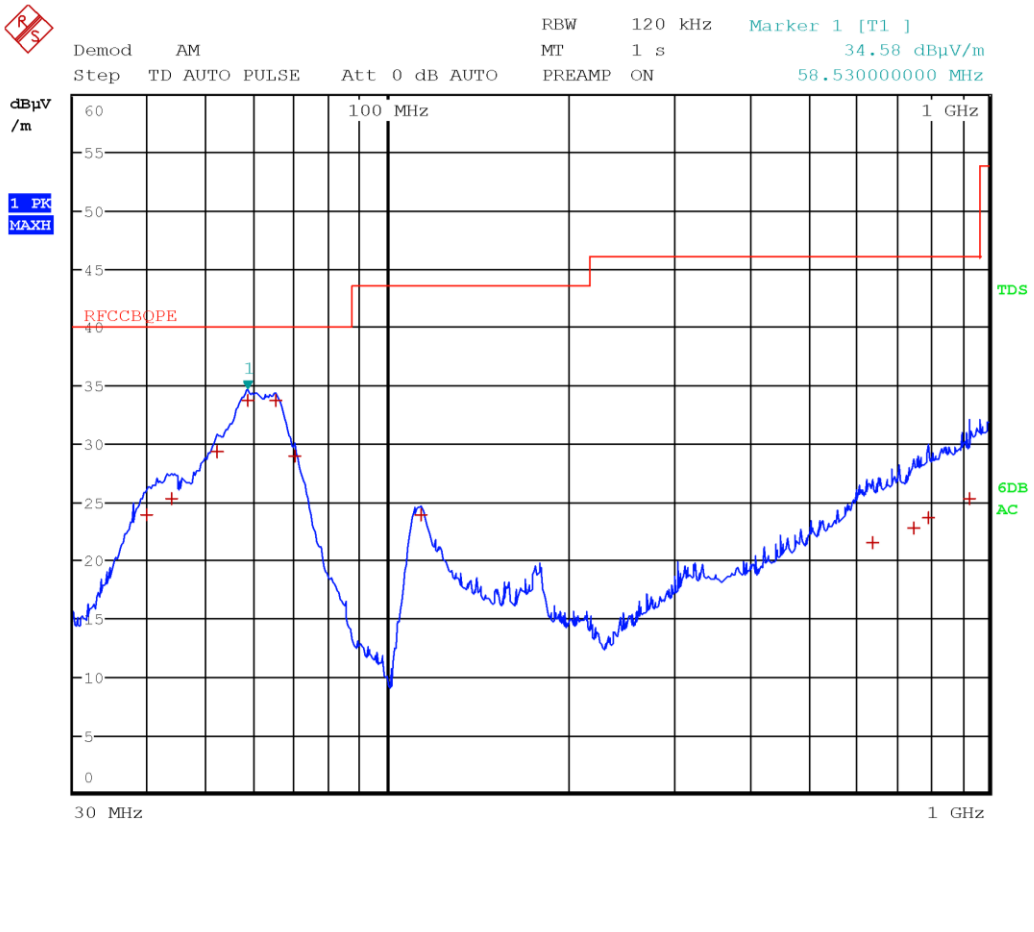
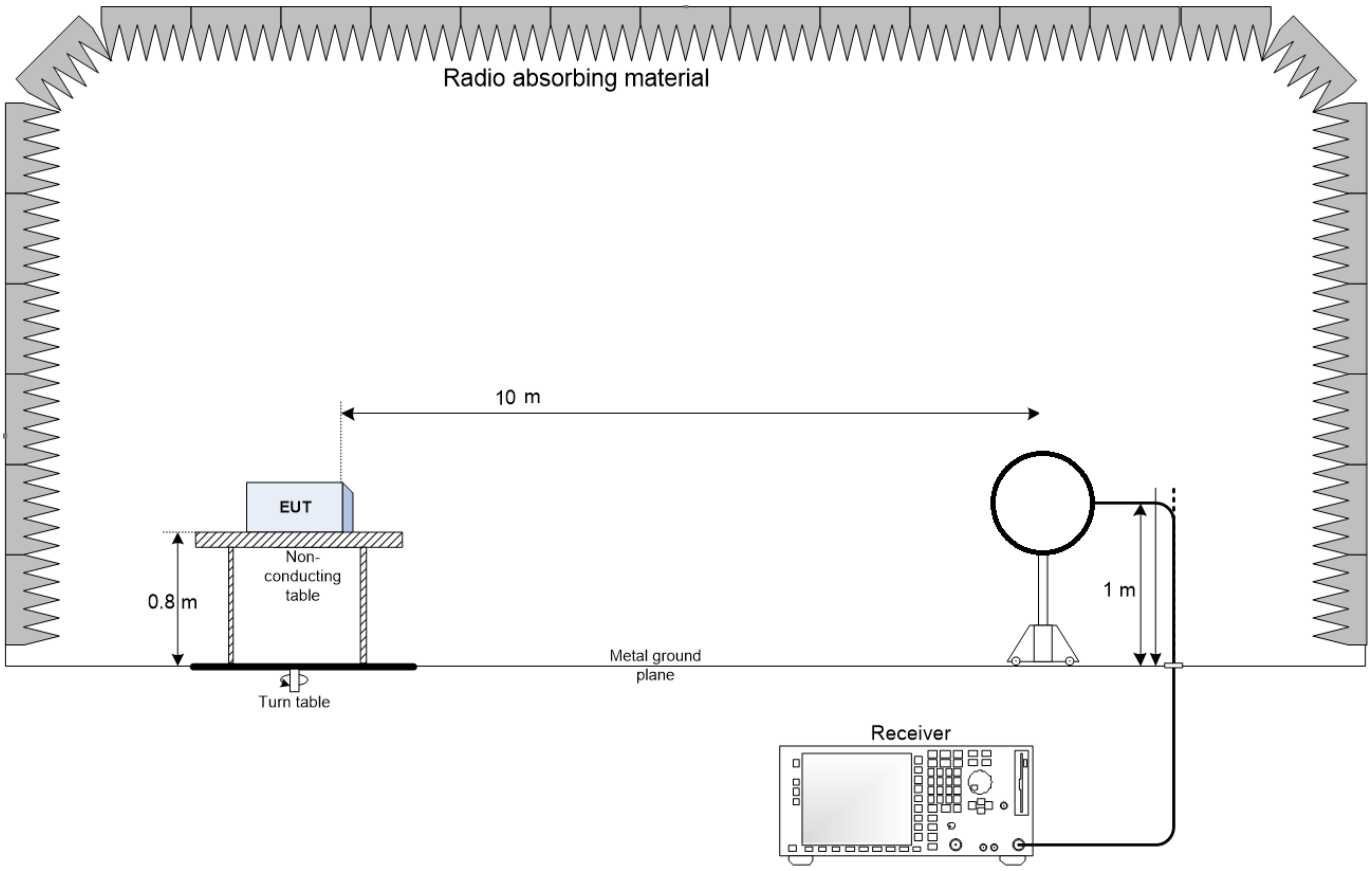


Figure 8.3-27 *Radiated emissions with antenna in vertical polarization – EUT set at 512 Hz*

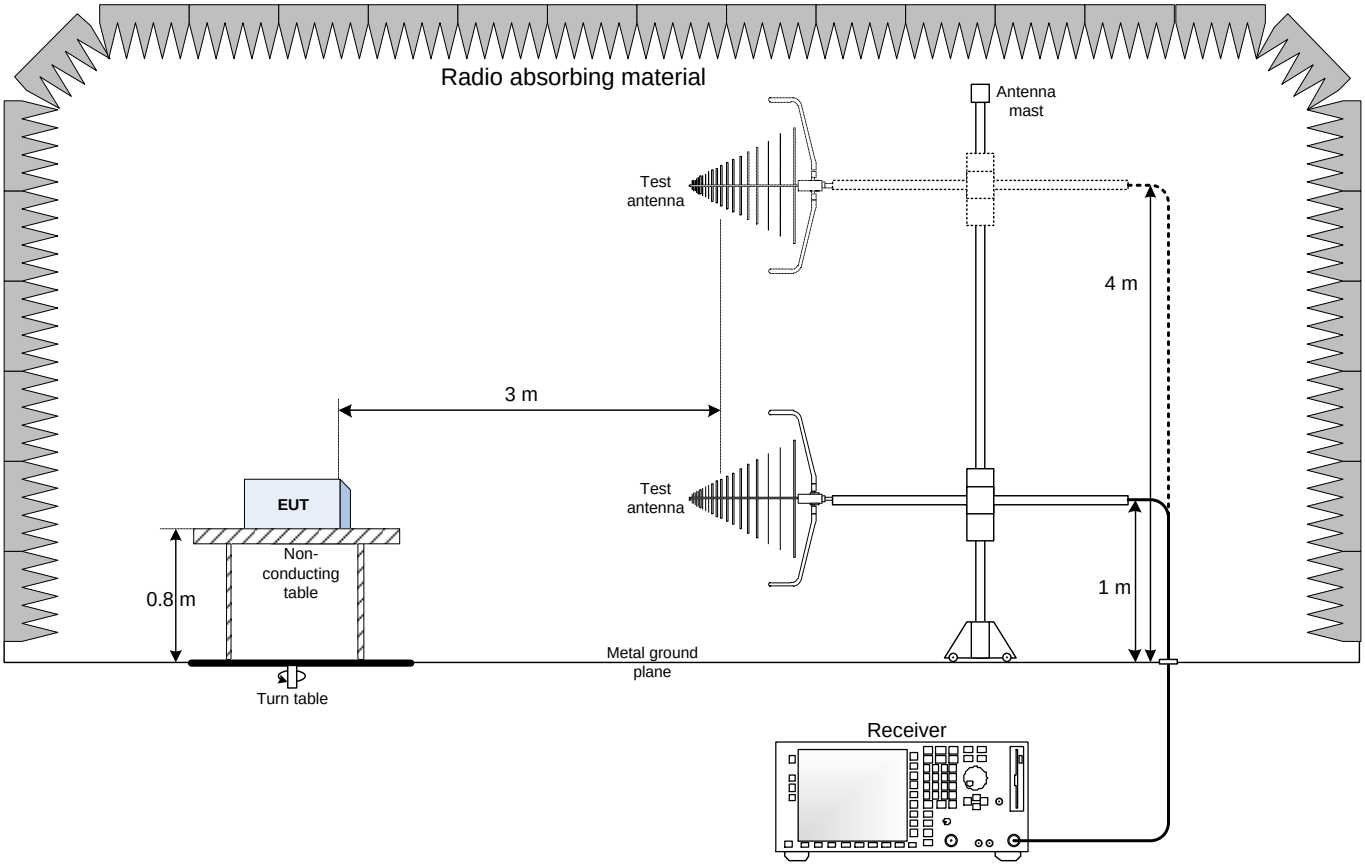
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
39.6300	23.9	40.0	-16.1	QP
43.5900	25.3	40.0	-14.7	QP
51.9300	29.3	40.0	-10.7	QP
58.5300	33.7	40.0	-6.3	QP
65.2800	33.7	40.0	-6.3	QP
70.1400	28.9	40.0	-11.1	QP
113.4600	23.9	43.5	-19.6	QP
640.4100	21.4	46.0	-24.6	QP
750.9600	22.8	46.0	-23.2	QP
794.4300	23.6	46.0	-22.4	QP
928.1400	25.3	46.0	-20.7	QP

Section 9. Block diagrams of test set-ups and EUT photos

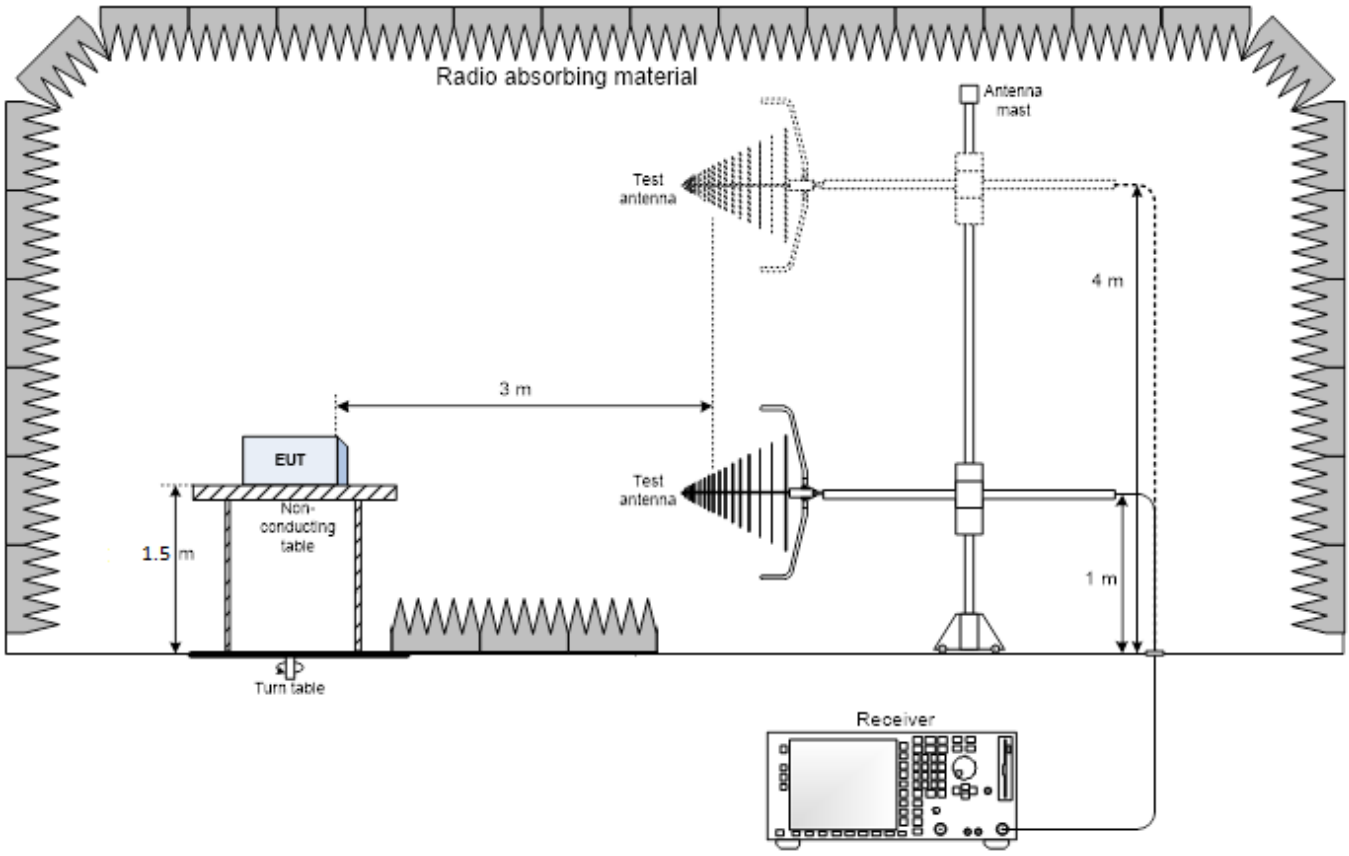
9.1 Radiated emissions set-up below 30 MHz



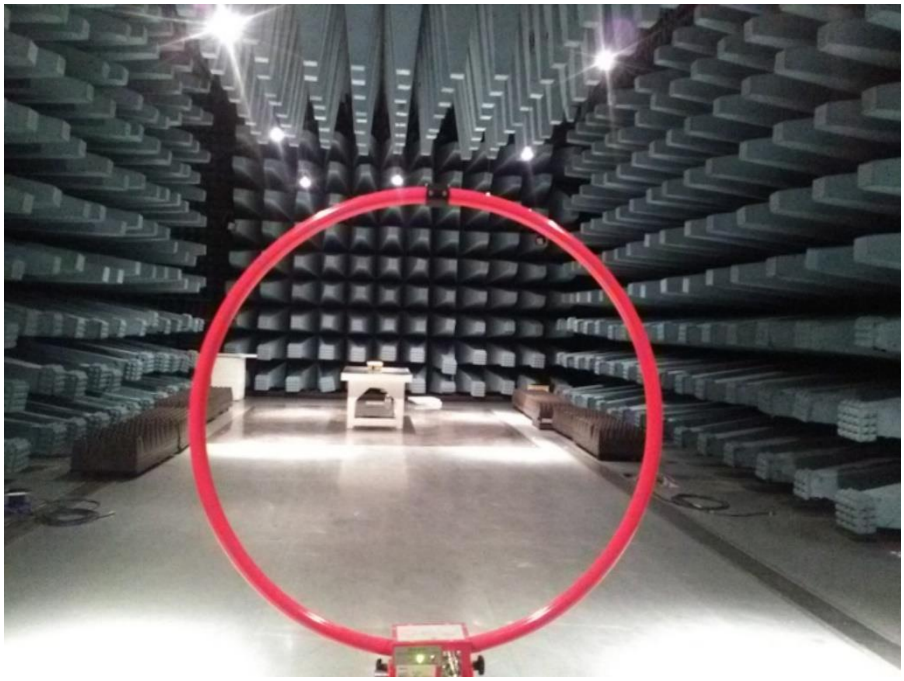
9.2 Radiated emissions set-up below 1 GHz



9.3 Radiated emissions set-up above 1 GHz



9.4 Set-up photos



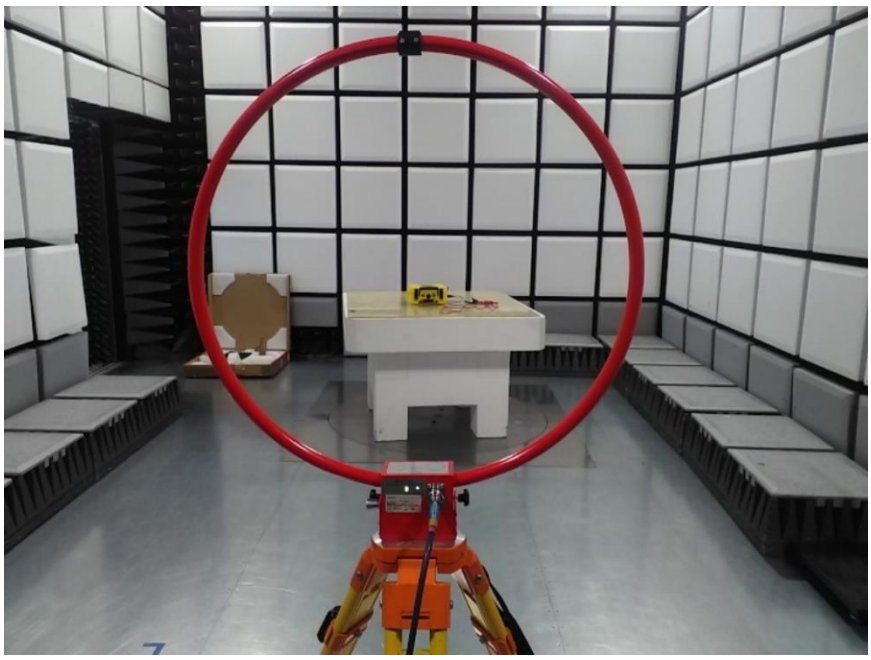


Figure 9.4-1: *Radiated emissions set-up for frequencies below 30 MHz*

Figure 9.4-2: Radiated emissions set-up for frequencies above 30 MHz

9.5 External photos

EUT

End of the test report