LAB N° 1244 L

Wireless test report

Type of assessment:

Modular approval

Report Reference No.:

REP092259

Applicant:

Advanced Microwave Engineering Srl
Via Lucca, 44 – 50142 Firenze (FI) – Italy

Product name:

UWB Radio Module

Model:

UWBTRPHA02

FCC ID:

UKOUWBTRPHA02

Specifications:

- FCC 47 CFR Part 15 Subpart F
  Ultra-Wideband operation

Date of issue: April 18, 2025

Tested by	P. Barbieri	Signature:	Firmato digitalmente da Barbieri Paolo
Reviewed by	O. Frau	Signature:	Firmato digitalmente da Frau Oscar

Test location(s)

Company name	Nemko Spa
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City	Biassono
Province	MB
Postal code	20853
Country	Italy
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Facsimile	+39 039 220 12 21
Website	www.nemko.com
Site number	682159

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

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Advanced Microwave Engineering Srl
Address	Via Lucca, 44 – 50142 Firenze (FI) – Italy

1.2 Test specifications

FCC 47 CFR Part 15, Subpart F	Ultra-Wideband operation

1.3 Test methods

ANSI C63.10-2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.10a-2024	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices Amendment 1
KDB 393764 D01 v02r01 April 2022	Ultra-Wide Band (UWB) Devices – Frequently asked questions

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.5 below. 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 #	Date of issue	Details of changes made to test report
REP092259	April 18, 2025	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart F test results

Table 2.1-1: *FCC 15.519 requirements results*

Part	Test description	Verdict
§15.519(a)	Operational limitations	Pass
§15.519(b)	Emission bandwidth	Pass
§15.519(c)	Radiated emission	Pass
§15.519(d)	Radiated emission within 1164–1240 and 1559–1610 MHz	Pass
§15.519(e)	Peak emissions within 50 MHz band	Pass

Table 2.1-2: *FCC 15.521 requirements results*

Part	Test description	Verdict
§15.521(a)	Operational limitations	Pass
§15.521(b)	Antenna requirement	Pass
§15.521(c)	Emissions from digital circuitry	Pass
§15.521(d)	Radiated emission requirements	Pass
§15.521 (e)	Emission bandwidth	Pass
§15.521 (f)	Imaging systems	Not applicable
§15.521 (g)	Peak emissions within 50 MHz band	Pass
§15.521 (h)	Frequency range of radiated measurements	Pass[2]
§15.521 (i)	Damped wave	Not applicable
§15.521 (j)	Conducted limits	Not applicable [1]

Note 1: the EUT is used inside an hosting device supplied by a vehicle battery.

Note 2: The highest frequency employed in §15.33 to determine the frequency range over which radiated measurements are made shall be based on the center frequency, fC, unless a higher frequency is generated within the UWB device. For measuring emission levels, the spectrum shall be investigated from the lowest frequency generated in the UWB transmitter, without going below 9 kHz, up to the frequency range shown in §15.33(a) or up to fC + 3/(pulse width in seconds), whichever is higher. There is no requirement to measure emissions beyond 40 GHz provided fC is less than 10 GHz; beyond 100 GHz if fC is at or above 10 GHz and below 30 GHz; or beyond 200 GHz if fC is at or above 30 GHz. The center frequency of the EUT is 4 GHz. Spectrum investigated from 30 MHz to 40 GHz.

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	April 7, 2025
Testing start date	April 10, 2025
Testing termination date	April 18, 2025
Nemko sample ID number	PRJ0077480001

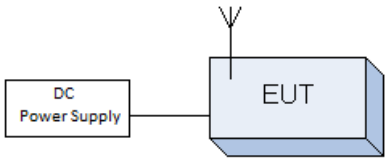
3.2 EUT information

Product name	UWB Radio Module
Model	UWBTRPHA02

3.3 Technical information

Frequency	3774 to 4243.2 GHz
RF power Max (dBm)	-0.6 dBm
Measured BW (MHz) (10 dB)	570.3 MHz
Measured BW (MHz) (99%)	799.3 MHZ
Type of modulation	UWB
Emission classification (F1D, G1D, D1D)	W7D
Power requirements	12 / 24 V DC
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 EUT setup diagram



3.5 Product description and theory of operation

The EUT is a radio module that uses UWB type signals to detect the spatial position of a nearby tag. The device is typically used on mobile means such as lift trucks but can also be installed in a fixed position near static machines.

3.6 EUT exercise details

The EUT has been modified by the manufacturer to transmit in continuous mode.

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

No technical judgment

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

In the laboratory, the following ambient conditions are respected for each test reported below:

Temperature	18 – 33 °C
Relative humidity	25 – 70 %
Air pressure	860 – 1060 mbar

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	2025-01	2027-01
Thermo-hygrometer data loggers	Testo	175-H2	20013013/305	2025-01	2027-01
Barometer	Castle	GPB 3300	072015	2025-03	2026-03

5.2 Power supply range

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

EUT Power requirements:	☐ AC	☒ DC	☐ Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed?	☐ YES	☒ NO	☐ N/A
If EUT is battery operated, was the testing performed using fresh batteries?	☐ YES	☐ NO	☒ N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?	☐ YES	☐ NO	☒ N/A

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, ETSI TR 100 028-1, ETSI TR 100 028-2 and other specific test standards and is documented in Nemko Spa working manuals WML1002 and WML0078.

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. Testing data

7.1 Operational requirements for hand held UWB systems

7.1.1 Definitions and limits

FCC §15.519:

(a) UWB devices operating under the provisions of this section must be hand held, i.e., they are relatively small devices that are primarily hand held while being operated and do not employ a fixed infrastructure.

(1) A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

(3) UWB devices operating under the provisions of this section may operate indoors or outdoors.

FCC §15.521:

Technical requirements applicable to all UWB devices.

(a) UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited.

7.1.2 Test date

Start date	April 10, 2025

7.1.3 Observations, settings and special notes

None

7.1.4 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2024-09	2025-09
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STPL 9148-123	2024-08	2027-08
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV9718C	00121	2025-01	2026-01
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
Software turntable and mast	Maturo	mcApp	8.1.0.5410	NCR	NCR
Semi-anechoic chamber	Comtest	SAC-3	1711-150	2024-09	2026-09
Cable set	Rosenberger and Huber + Suhner	RE01+RE02	1.654+1.655	2025-01	2026-01
Coaxial cable	Rosenberger	ST.ALO-05	1.669	2025-03	2026-03

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

7.1.5 Test data

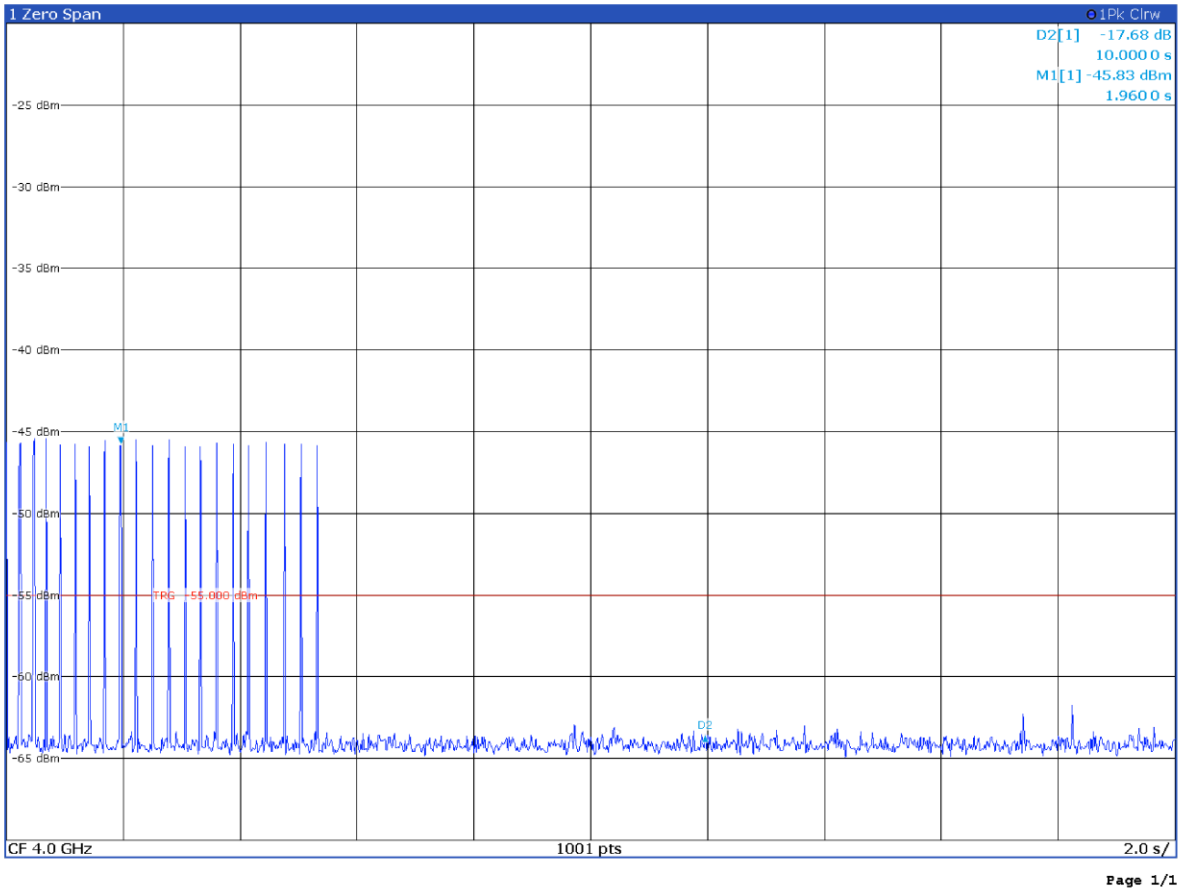


Figure 7.1-1: *Cease plot*

With the V2V option enabled, the UWB device ceases transmitting any information other than periodic signals used for the establishment or re-establishment of a communication link with an associated receiver, as show in the following plot:

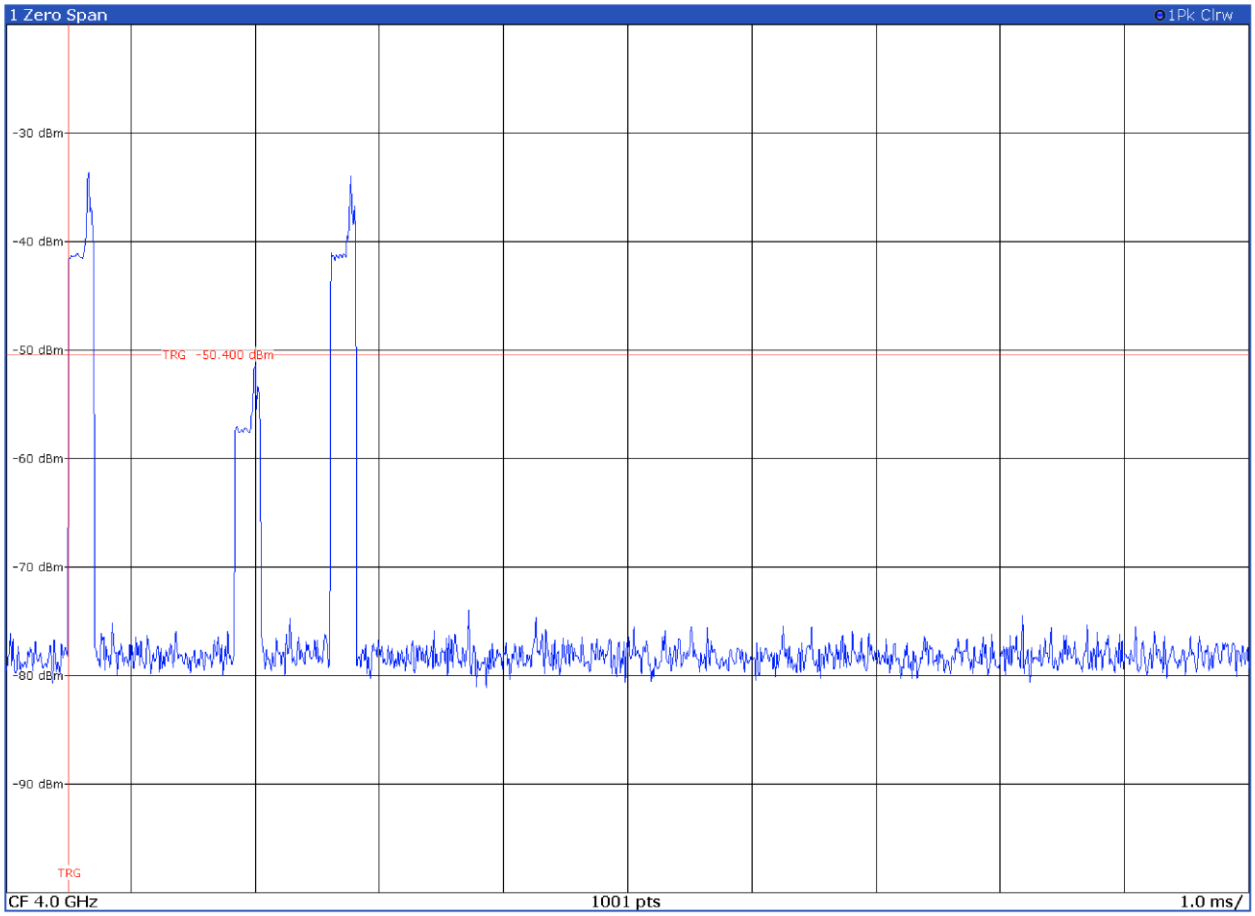


Figure 7.1-2: *EUT transmitting information to an associated receiver*

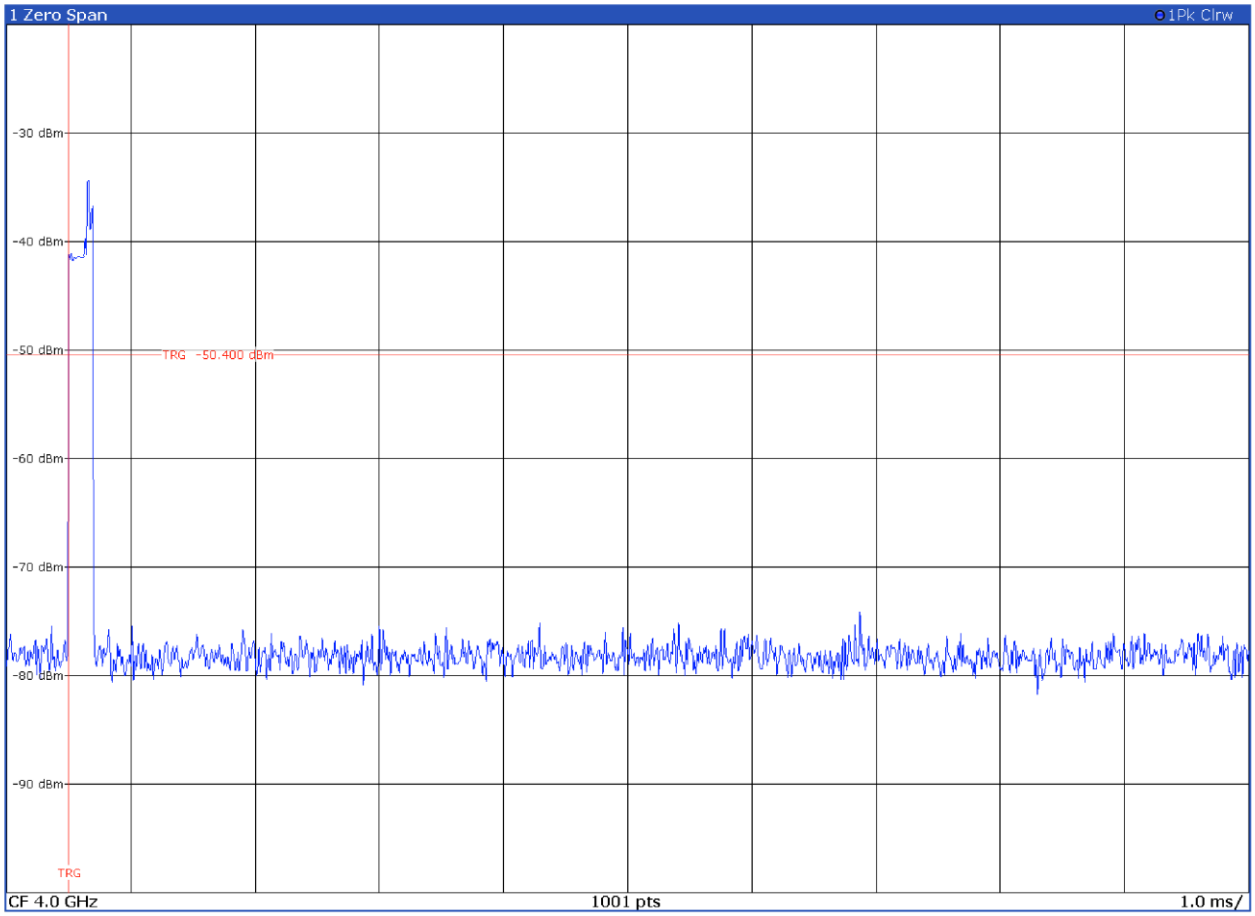


Figure 7.1-3: *EUT stops transmitting information except for periodic signals*

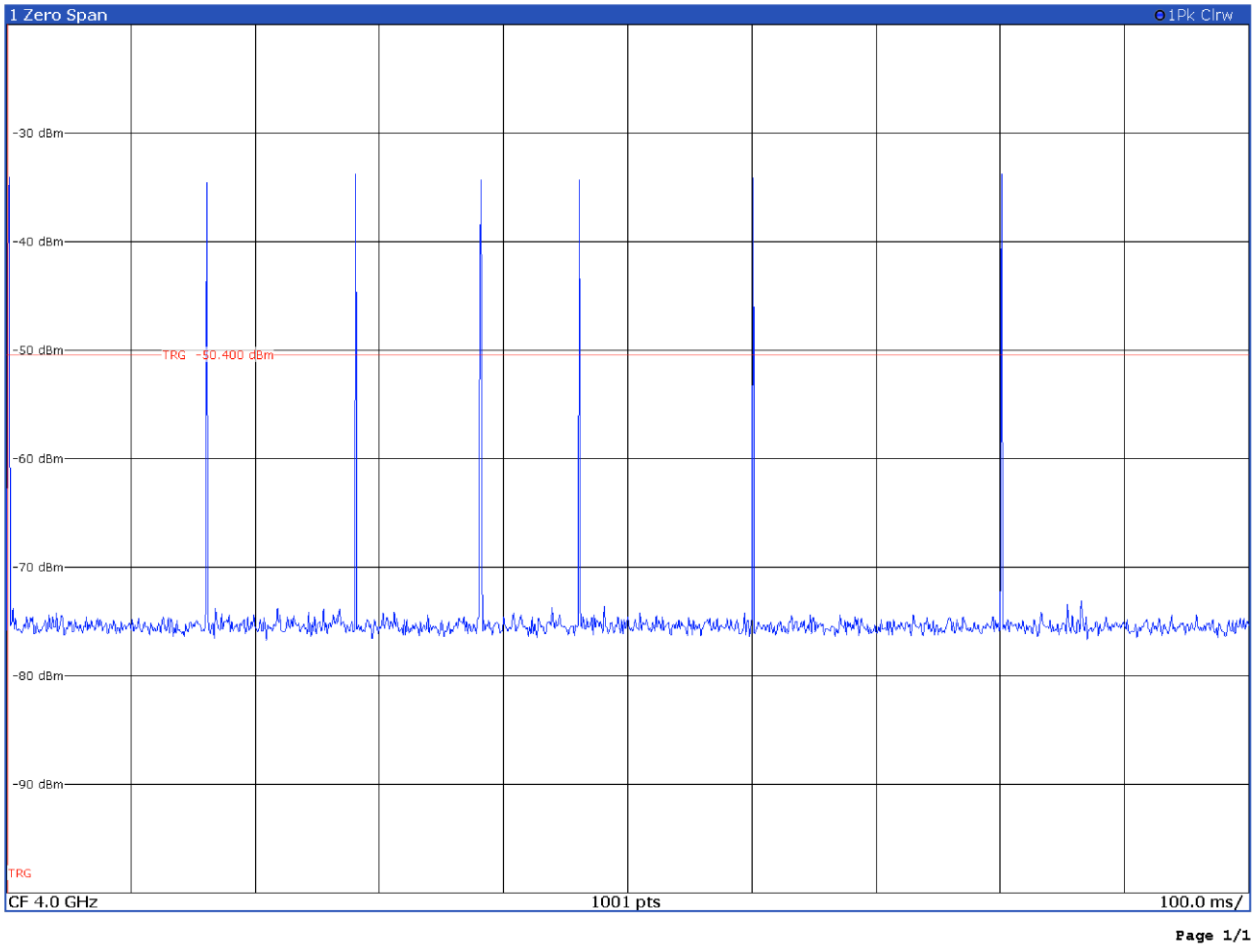


Figure 7.1-4: *EUT stops transmitting information except for periodic signals*

7.2 Antenna requirement

7.2.1 Definitions and limits

FCC §15.203:

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 carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, 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.

FCC §15.519:

(a)(2) The use of antennas mounted on outdoor structures, e.g., antennas mounted on the outside of a building or on a telephone pole, or any fixed outdoors infrastructure is prohibited. Antennas may be mounted only on the hand held UWB device.

7.2.2 Test date

Start date	April 10, 2025

7.2.3 Observations, settings and special notes

The EUT use permanently attached antenna.

7.2.4 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

7.3 Emission bandwidth

7.3.1 Definitions and limits

FCC §15.519:

(b) The UWB bandwidth of a device operating under the provisions of this section must be contained between 3.1–10.6 GHz.

ANSI C6.10, Clause 10:

10.1 Evaluation of −10 dB bandwidth

The frequency at which the maximum power level is measured with the peak detector is designated f_M. The peak power measurements shall be made using a spectrum analyzer or EMI receiver with a 1 MHz resolution bandwidth and a video bandwidth of 1 MHz or greater. The instrument shall be set to peak detection using the maximum-hold trace mode. The outermost 1 MHz segments above and below f_M, where the peak power falls by 10 dB relative to the level at f_M, are designated as f_H and f_L, respectively:

a. For the lowest frequency bound f_L, the emission is searched from a frequency lower than f_M that has, by inspection, a peak power much lower than 10 dB less than the power at f_M and increased toward f_M until the peak power indicates 10 dB less than the power at f_M. The frequency of that segment is recorded.

b. This process is repeated for the highest frequency bound f_H, beginning at a frequency higher than f_M that has, by inspection, a peak power much lower than 10 dB below the power at f_M. The frequency of that segment is recorded.

c. The two recorded frequencies represent the highest f_H and lowest f_L bounds of the UWB transmission, and the −10 dB bandwidth (B – 10) is defined as ($f_H - f_L$) The center frequency (f_c) is mathematically determined from ($f_H - f_L$) / 2

d. The fractional bandwidth is defined as $2(f_H - f_L) / (f_H + f_L)$.

e. Determine whether the −10 dB bandwidth ($f_H - f_L$) is 500 MHz, or whether the fractional bandwidth $2(f_H - f_L) / (f_H + f_L)$ is 0.2.

FCC §15.503:

(a) UWB bandwidth. For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L. The frequency at which the highest radiated emission occurs is designated f_M.

(d) Ultra-wideband (UWB) transmitter. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

7.3.1 Test date

Start date	April 11, 2025

7.3.2 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission bandwidth
Video bandwidth	≥ 3 × RBW
Frequency span	Wider than emission bandwidth
Detector mode	Peak

7.3.3 Test equipment list

Table 7.3-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2024-09	2025-09
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STPL 9148-123	2024-08	2027-08
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV9718C	00121	2025-01	2026-01
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
Software turntable and mast	Maturo	mcApp	8.1.0.5410	NCR	NCR
Semi-anechoic chamber	Comtest	SAC-3	1711-150	2024-09	2026-09
Cable set	Rosenberger and Huber + Suhner	RE01+RE02	1.654+1.655	2025-01	2026-01
Coaxial cable	Rosenberger	ST.ALO-05	1.669	2025-03	2026-03

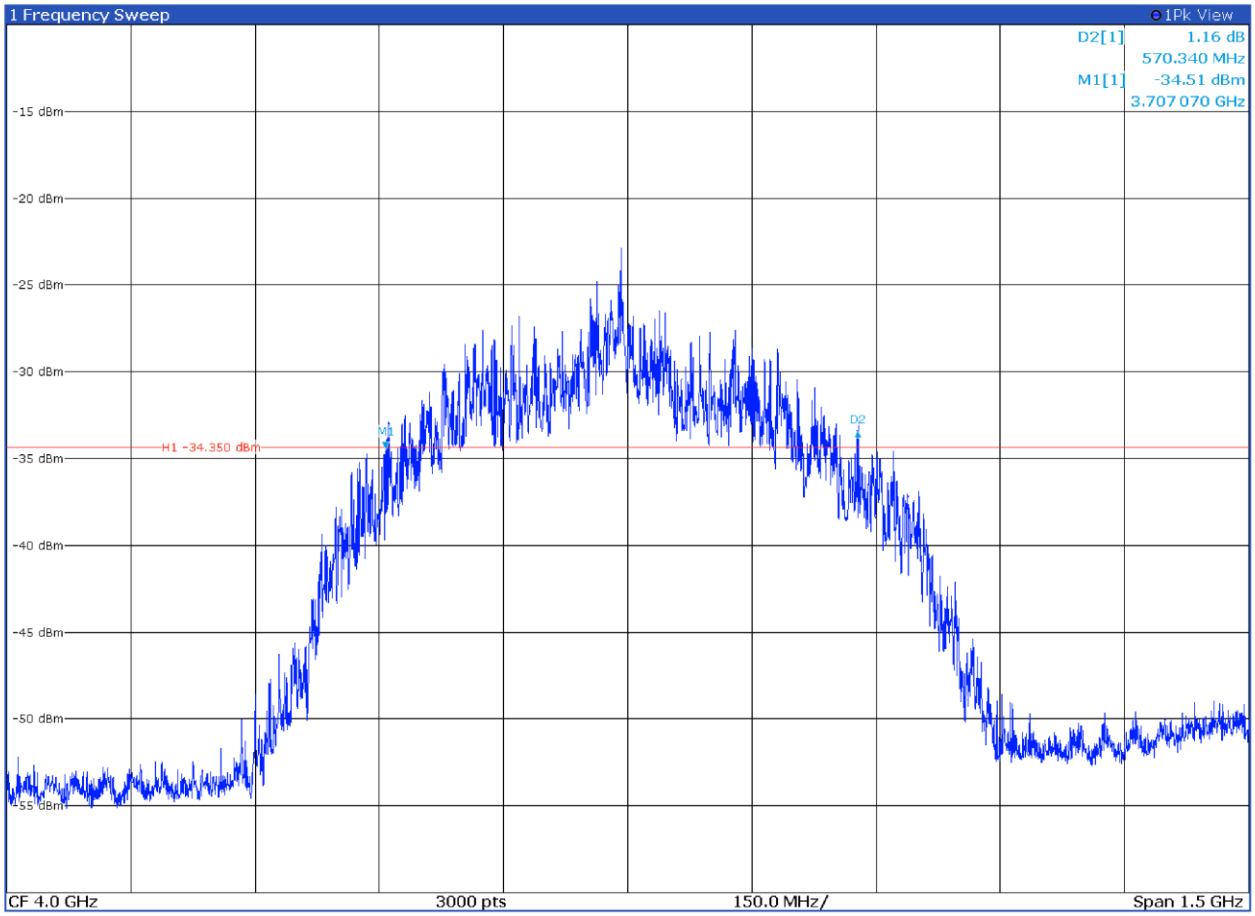
Note: NCR - no calibration required, VOU - verify on use

7.3.4 Test data

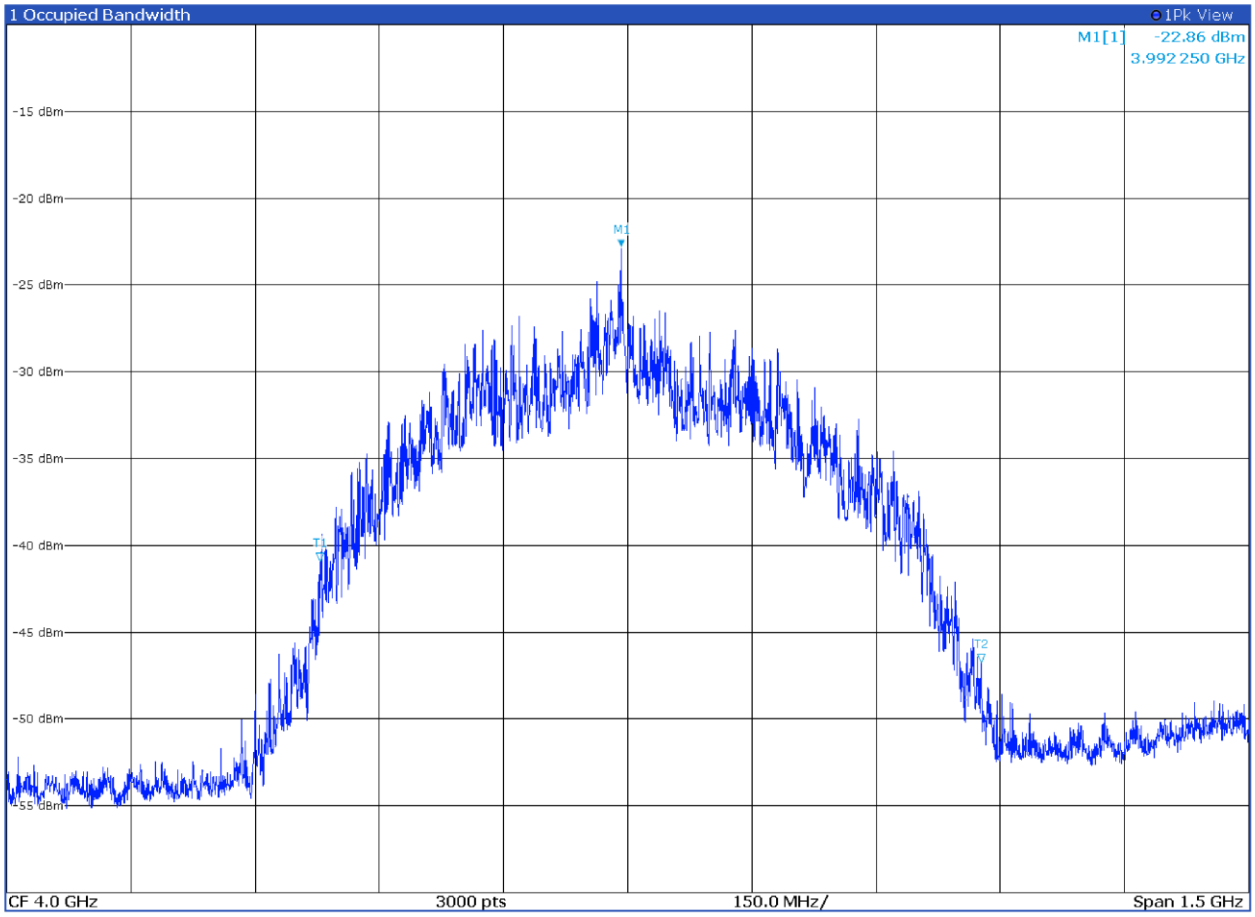
Table 7.3-2: *Bandwidth measurements results*

Frequency, (MHz)	10 dB Bandwidth (MHz)	99% Bandwidth (MHz)	Limit for 10 dB Bandwith (MHz)	Margin (MHz)
4000	570.3	799.2	500	70.3

Frequency (MHz)	Lower Frequency (MHz)	Limit (MHz) Lower frequency	Upper frequency (MHz)	Limit (MHz) Upper frequency
4000	3707.1	3100	4277.4	10600



Plot 7.3-1: *10 dB Bandwidth*



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**3.992 25 GHz**	**-22.86 dBm**	Occ Bw	**799.263 279 341 MHz**
T1		1	3.628 158 GHz	-40.93 dBm	Occ Bw Centroid	4.027 789 411 GHz
T2		1	4.427 421 GHz	-46.73 dBm	Occ Bw Freq Offset	27.789 411 263 MHz

Plot 7.3-2: *99 % Bandwidth*

7.4 Peak emissions above 1 GHz

7.4.1 Definitions and limits

FCC §15.519:

(e) There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M. That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

FCC §15.521:

Technical requirements applicable to all UWB devices.

(g) When a peak measurement is required, it is acceptable to use a resolution bandwidth other than the 50 MHz specified in this subpart. This resolution bandwidth shall not be lower than 1 MHz or greater than 50 MHz, and the measurement shall be centered on the frequency at which the highest radiated emission occurs, f_M. If a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be 20 × Log_{10} (RBW/50) dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 meters using E(dBµV/m) = P(dBm EIRP) + 95.23. If RBW is greater than 3 MHz, the application for certification filed with the Commission must contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

7.4.2 Test date

Start date	April 11, 2025

7.4.3 Observations, settings and special notes

Spectrum analyser settings for peak radiated measurements above 1 GHz:

Resolution bandwidth	50 MHz
Video bandwidth	50 MHz
Detector mode	Peak
Trace mode	Max Hold

7.4.4 Test equipment list

Table 7.4-1: *Equipment list*

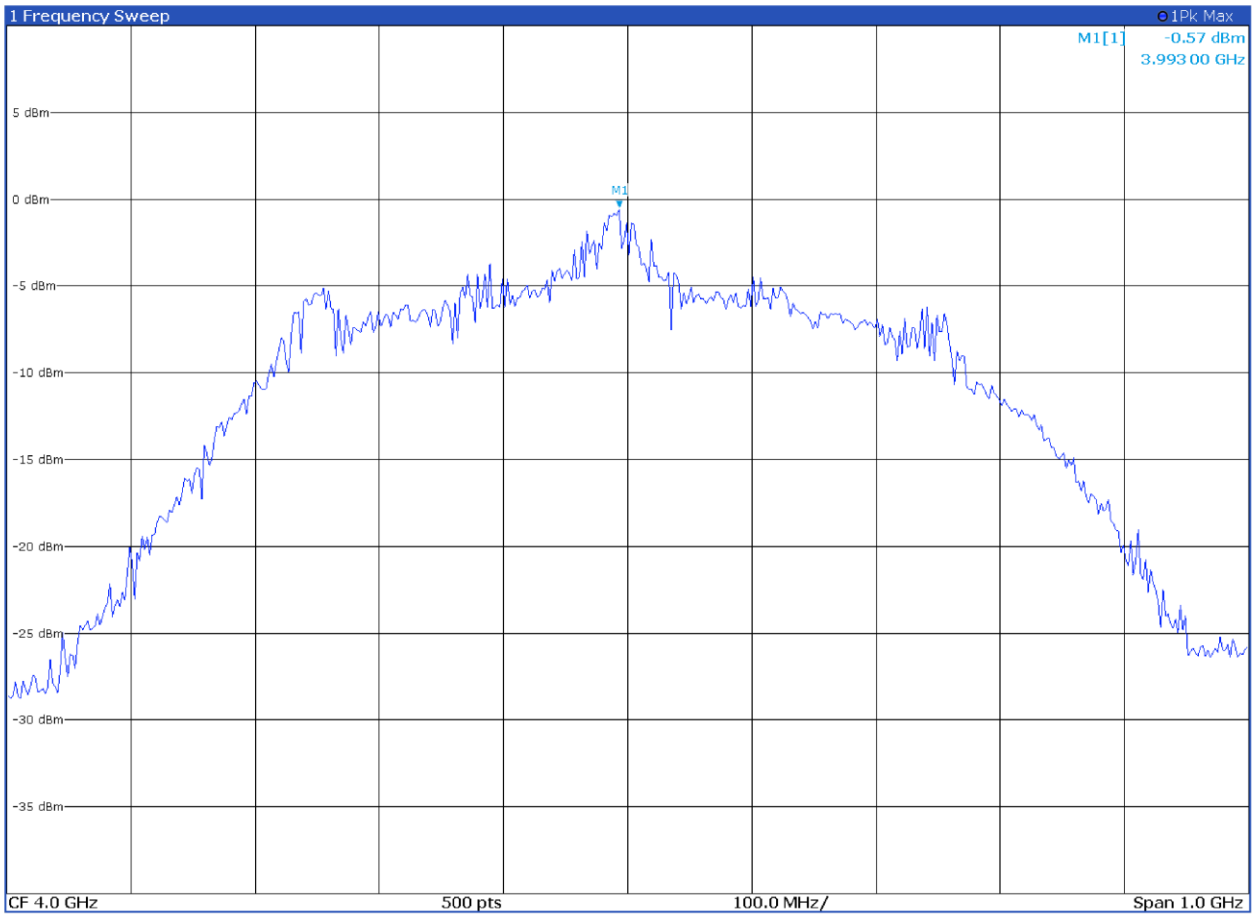
Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2024-09	2025-09
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STPL 9148-123	2024-08	2027-08
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV9718C	00121	2025-01	2026-01
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Software turntable and mast	Maturo	mcApp	8.1.0.5410	NCR	NCR
Semi-anechoic chamber	Comtest	SAC-3	1711-150	2024-09	2026-09
Cable set	Rosenberger and Huber + Suhner	RE01+RE02	1.654+1.655	2025-01	2026-01
Coaxial cable	Rosenberger	ST.ALO-05	1.669	2025-03	2026-03

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

7.4.5 Test data

Table 7.4-2: *Peak emissions measurement results*

Frequency, GHz	Measure Level dBm	Limit dBm	Margin dB	Detector
3.993	-0.6	0	-0.6	PK



Plot 7.4-1: *Peak emissions plot*

7.5 Field strength of emissions

7.5.1 Definitions and limits

FCC §15.519:

(c) The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the average limits when measured using a resolution bandwidth of 1 MHz in the following table.

(d) In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits: −85.3 dBm/kHz EIRP within 1164–1240 MHz and 1559–1610 MHz bands.

FCC §15.521:

Technical requirements applicable to all UWB devices.

(c) Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in § 15.209, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in § 15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of this part.

(d) Radiated emission levels at and below 960 MHz are based on measurements employing a CISPR quasi-peak detector. Radiated emission levels above 960 MHz are based on RMS average measurements over a 1 MHz resolution bandwidth. The RMS average measurement is based on the use of a spectrum analyzer with a resolution bandwidth of 1 MHz, an RMS detector, and a 1 millisecond or less averaging time. Unless otherwise stated, if pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements shall be made with the pulse train gated on. Alternative measurement procedures may be considered by the Commission.

Table 7.5-1: *Radiated average emission limits above 960 MHz*

Frequency in MHz	EIRP in dBm
960 – 1610	-75.3
1610 – 1990	-63.3
1990 – 3100	-61.3
3100 – 10600	-41.3
Above 10600	-61.3

Notes: --

Table 7.5-2: *Radiated emission limits for §15.209*

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.

7.5.2 Test date

Start date	April 11, 2025

7.5.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz according to §15.33(a)(1)

Spectrum analyzer settings for peak radiated measurements below 1000 MHz pre-scan

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

Spectrum analyzer settings for peak radiated measurements above 1000 MHz pre-scan

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

Spectrum analyzer settings for average radiated measurements above 960 MHz pre-scan

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

Spectrum analyzer settings for GPS band:

Resolution bandwidth:	1 kHz
Video bandwidth:	3 kHz
Detector mode Trace 2	RMS
Trace 2 mode :	Max Hold

7.5.4 Test equipment list

Table 7.5-3: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2024-09	2025-09
EMI Receiver	Rohde & Schwarz	ESU8	100202	2024-09	2025-09
Antenna Loop	Teseq	HLA6121+PI6121	45749	2023-08	2026-08
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2024-08	2027-08
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STPL 9148-123	2024-08	2027-08
Double Ridge Horn Antenna	RFSpin	DRH40	061106A40	2023-05	2026-05
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV9718C	00121	2025-01	2026-01
Broadband Bench Top Amplifier	Sage	STB-1834034030-KFKF-L1	18490-01	2024-07	2025-07
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
Software turntable and mast	Maturo	mcApp	8.1.0.5410	NCR	NCR
3m Semi anechoic chamber	Comtest	SAC-3	1711-150	2024-09	2026-09
Semi-anechoic chamber	Nemko Spa	10m SAC	530	2023-09	2025-09
Cable set	Rosenberger and Huber + Suhner	RE01+RE02	1.654+1.655	2025-01	2026-01
Coaxial cable	Rosenberger	ST.ALO-05	1.669	2025-03	2026-03
Coaxial cable	Rosenberger	ST.ALO-02	1.650	2024-12	2025-12

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

7.5.5 Test data

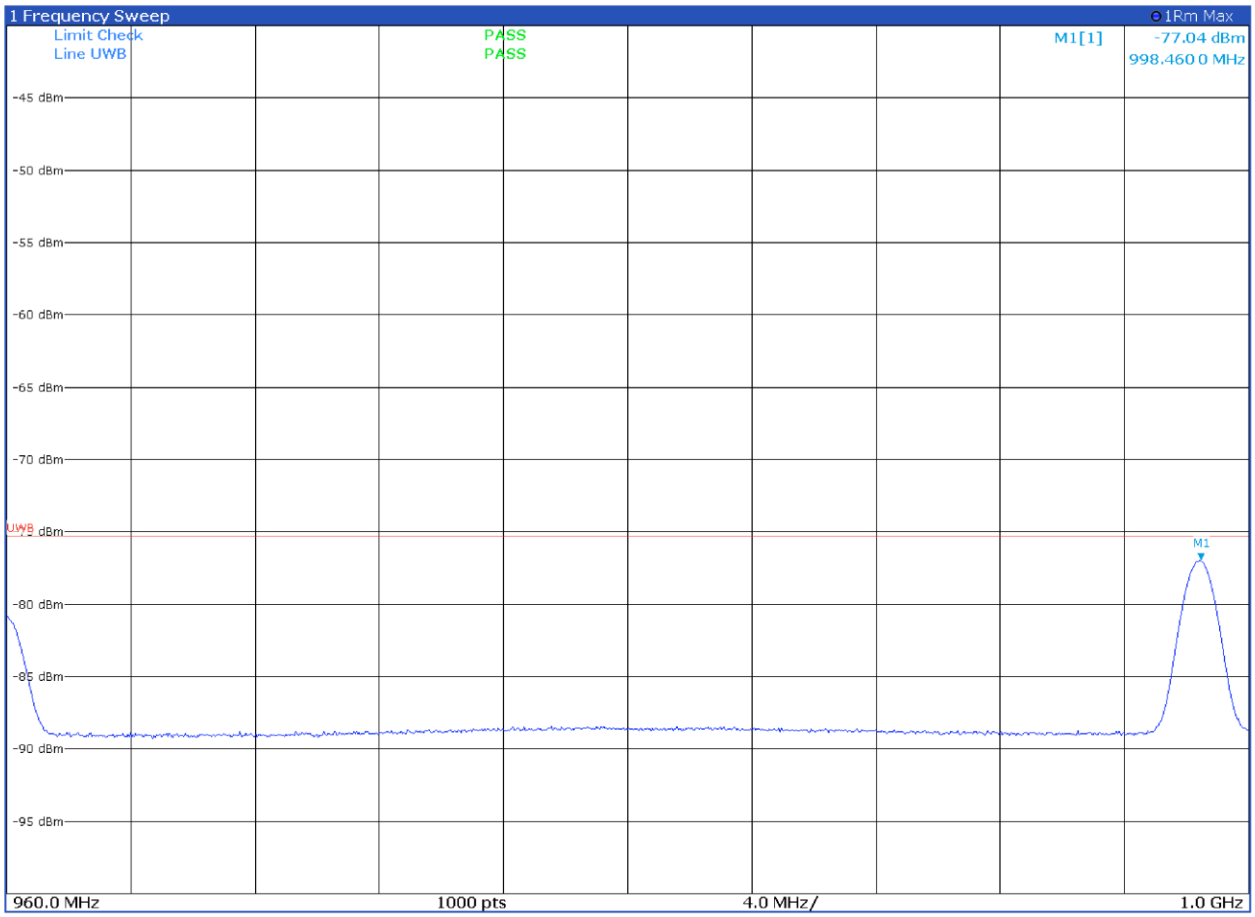


Figure 7.5-1: *Radiated emission with antenna in horizontal polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

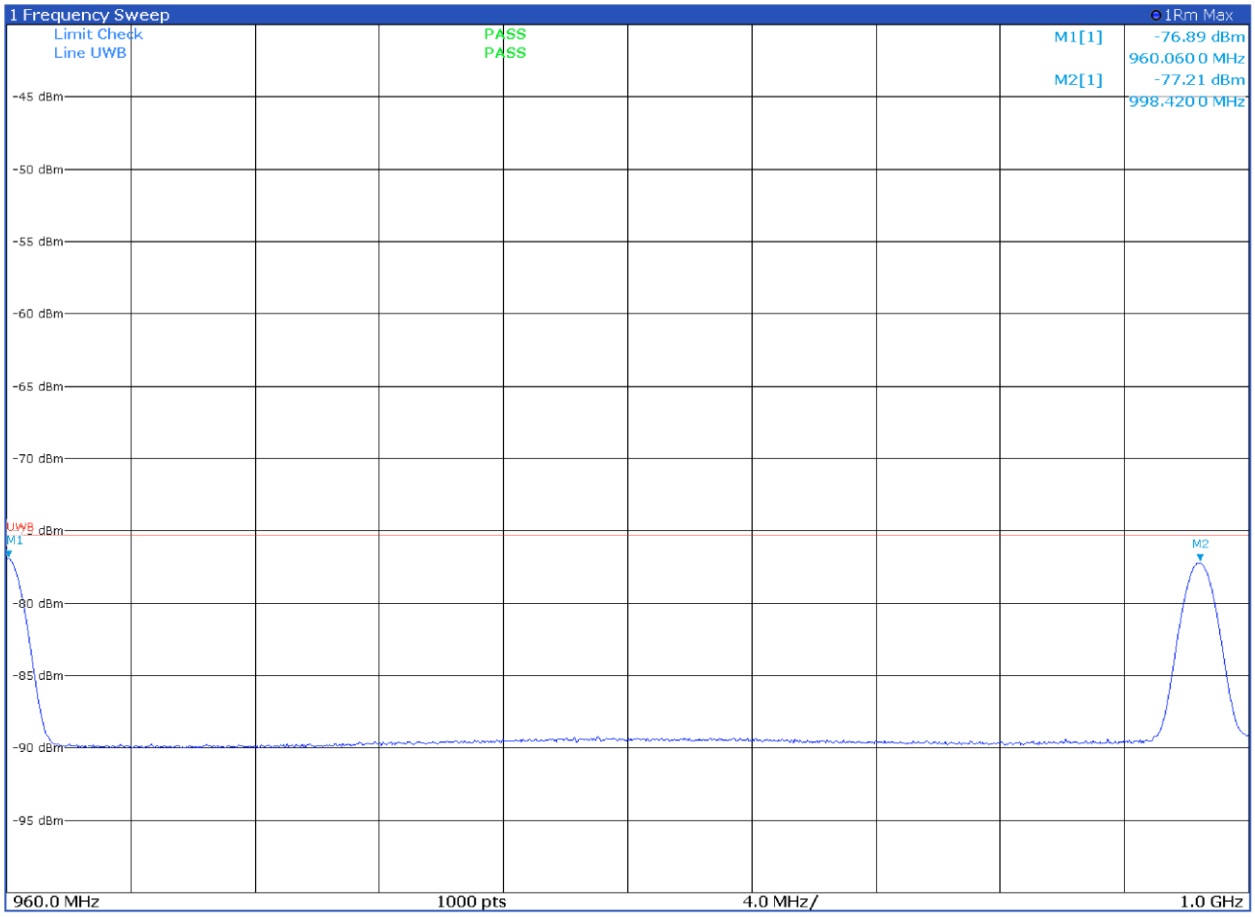


Figure 7.5-2: *Radiated emission with antenna in vertical polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

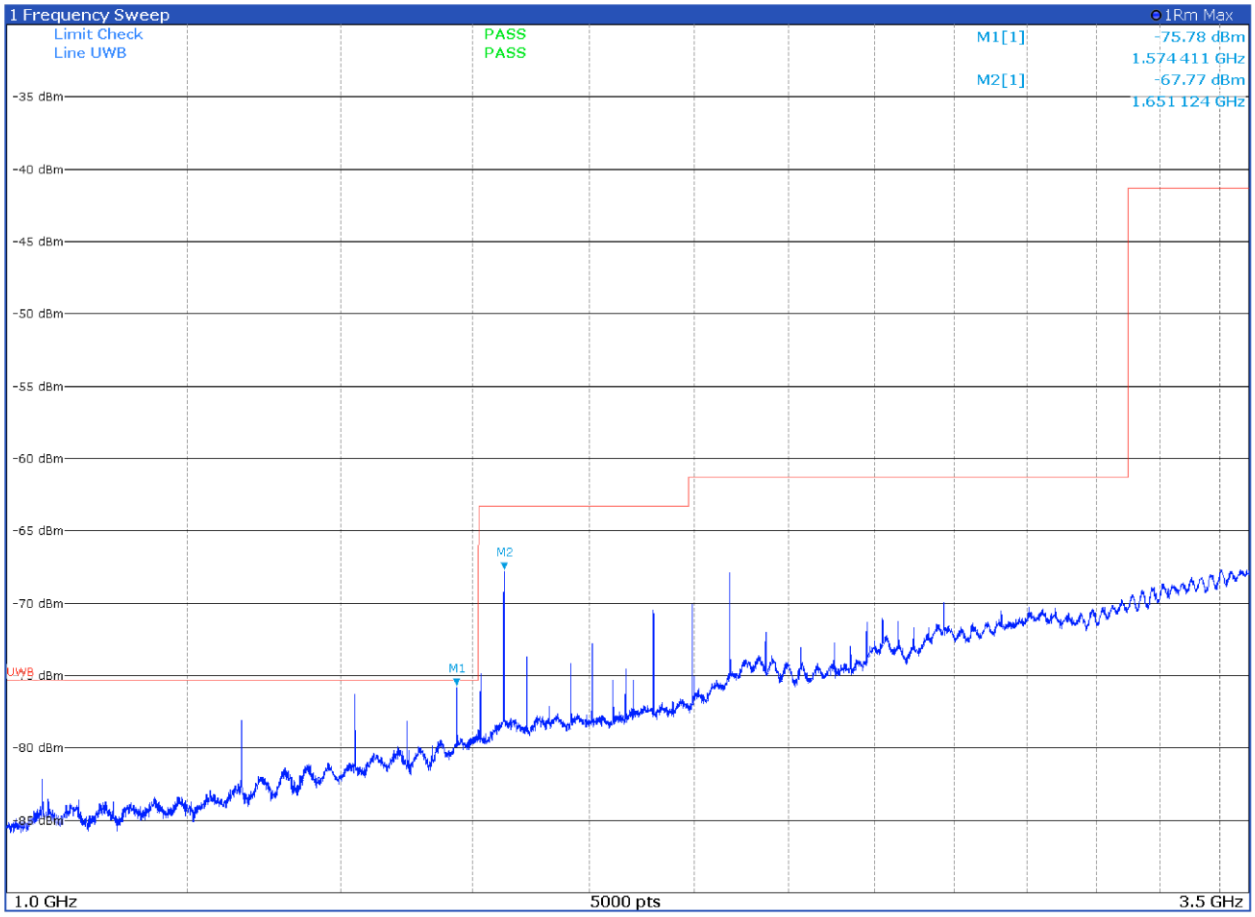


Figure 7.5-3: *Radiated emission with antenna in horizontal polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

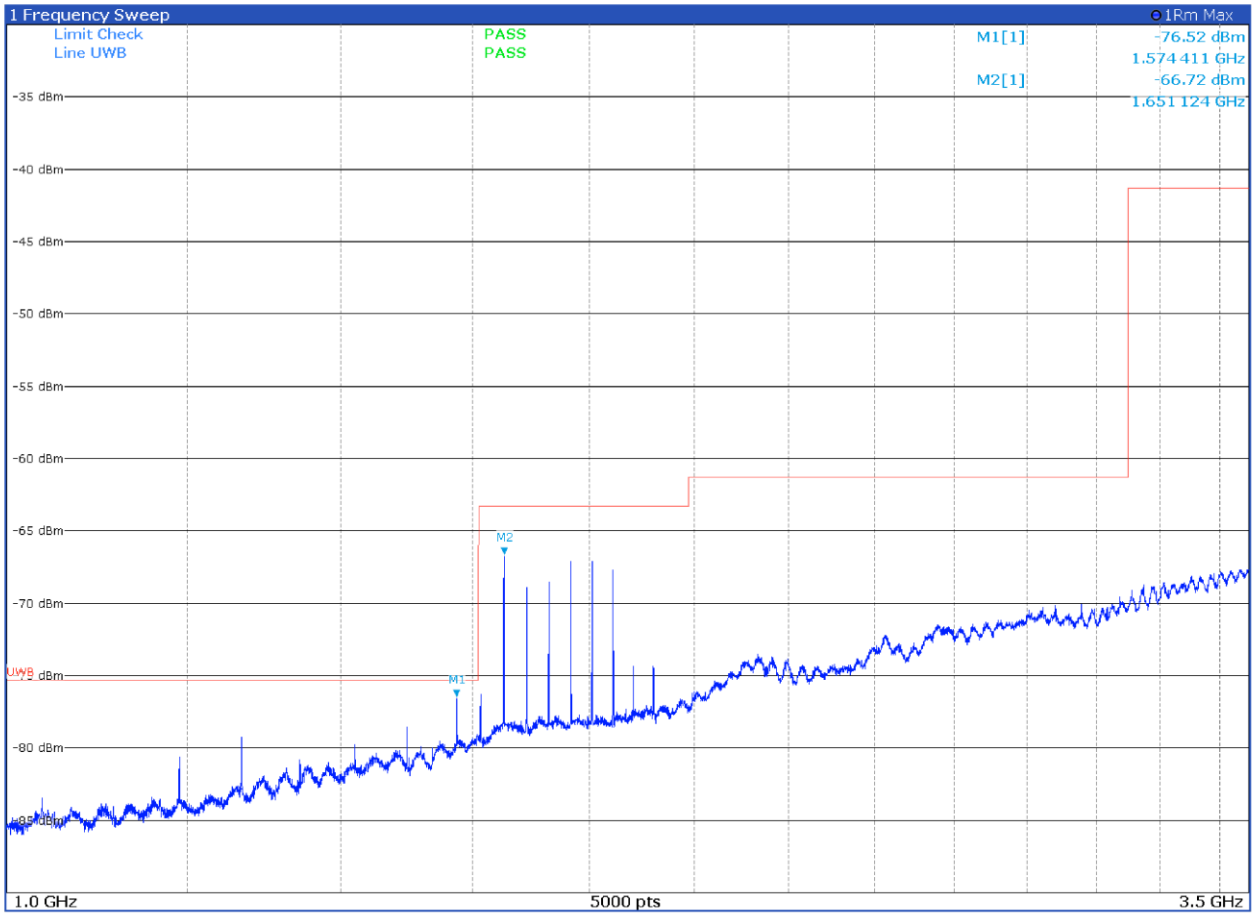


Figure 7.5-4: *Radiated emission with antenna in vertical polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

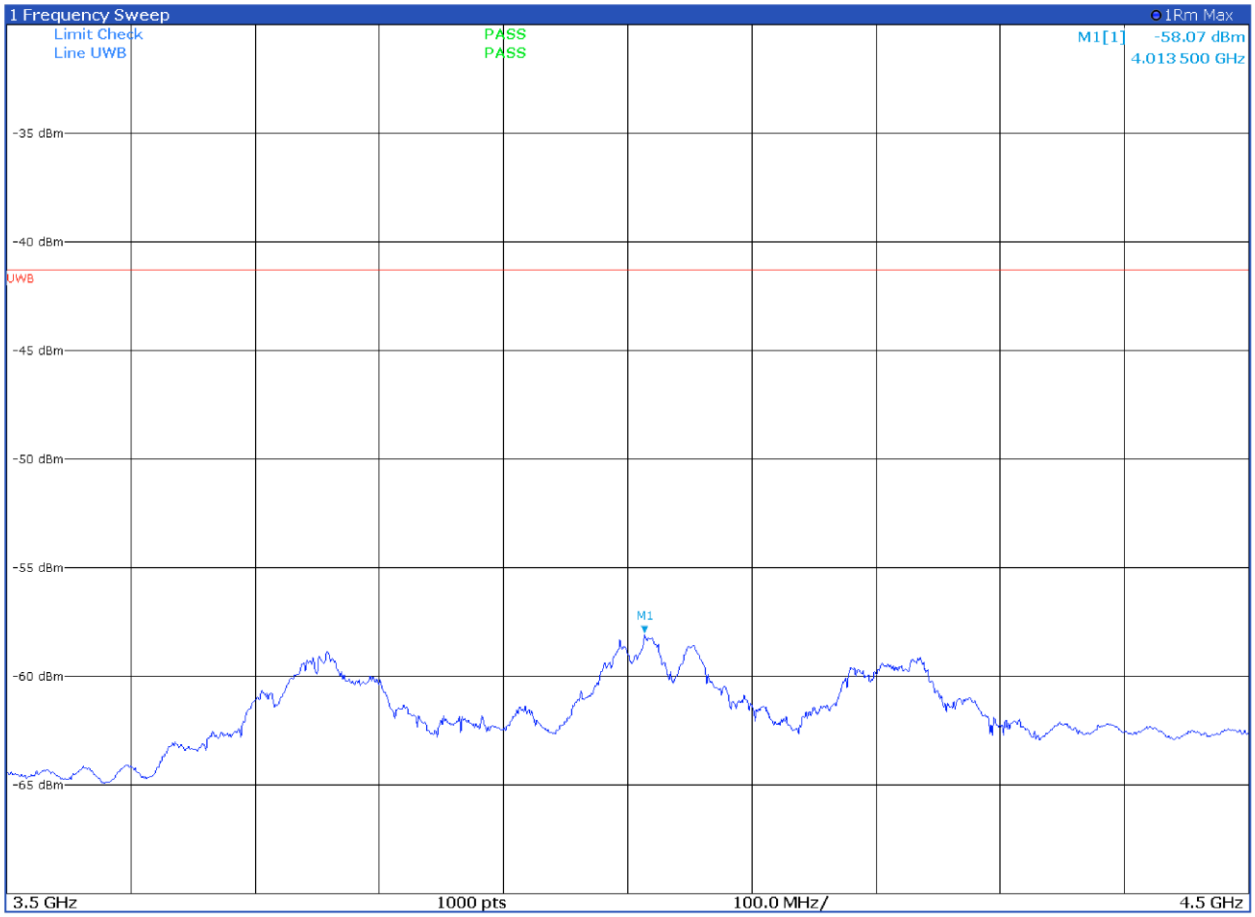


Figure 7.5-5: *Radiated emission with antenna in horizontal polarization*

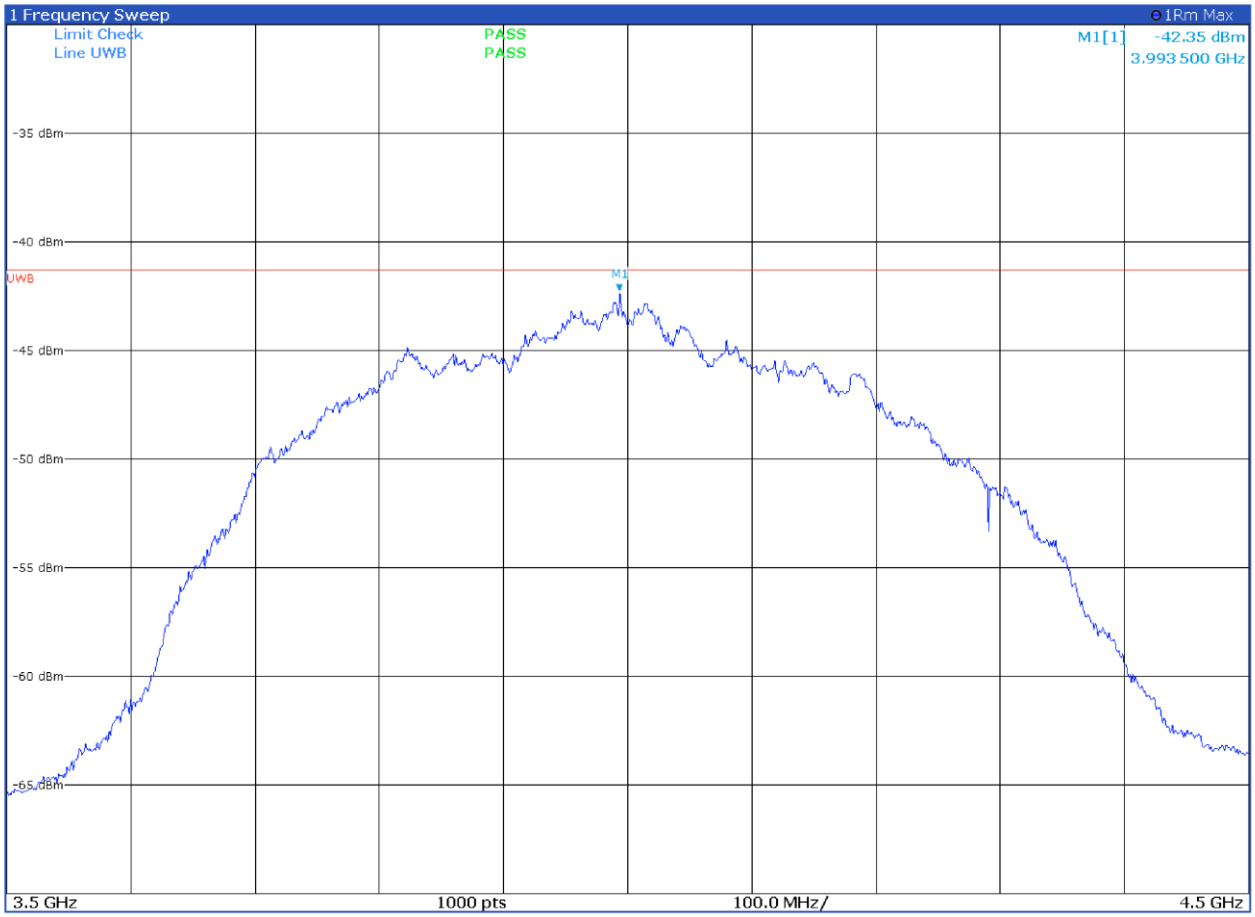


Figure 7.5-6: *Radiated emission with antenna in vertical polarization*

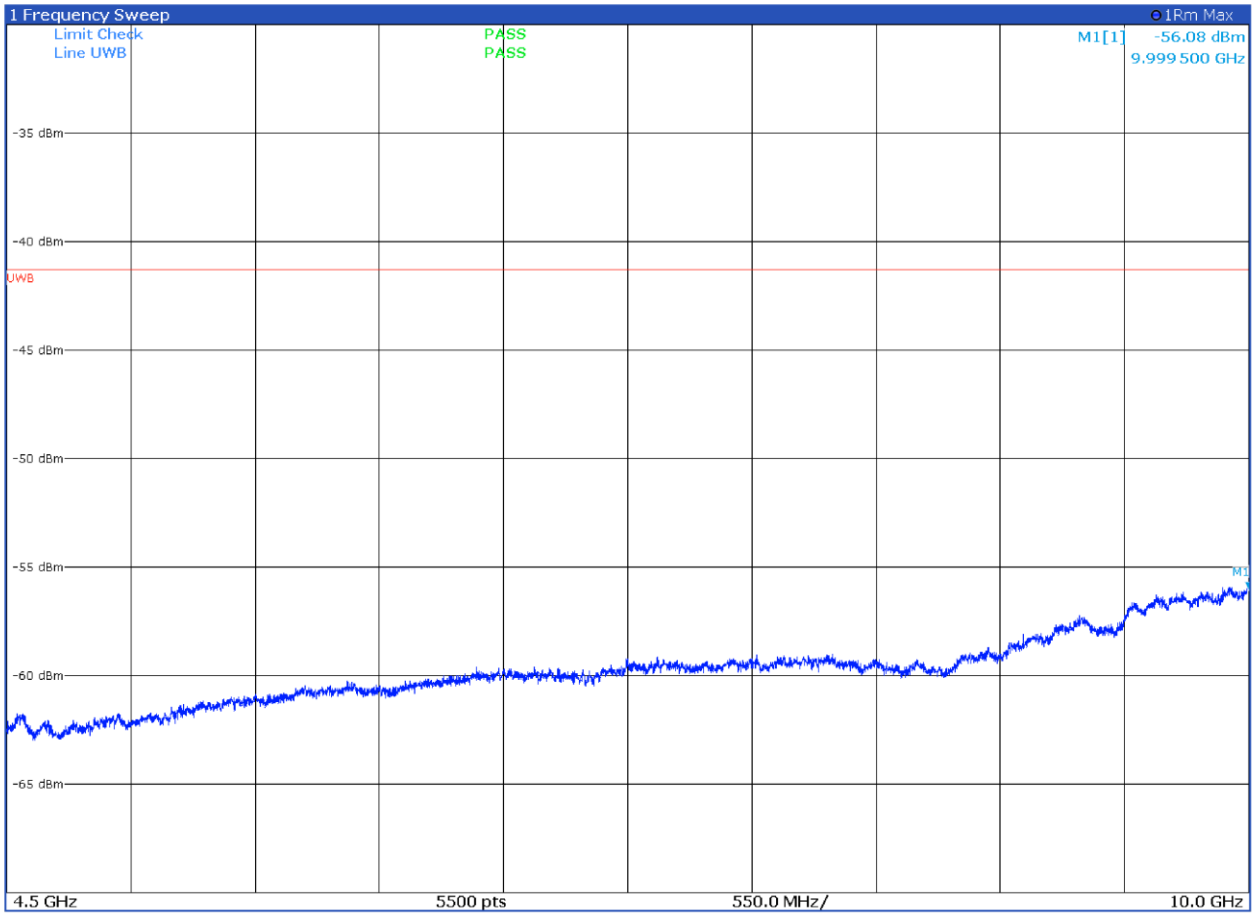


Figure 7.5-7: *Radiated emission with antenna in horizontal polarization*

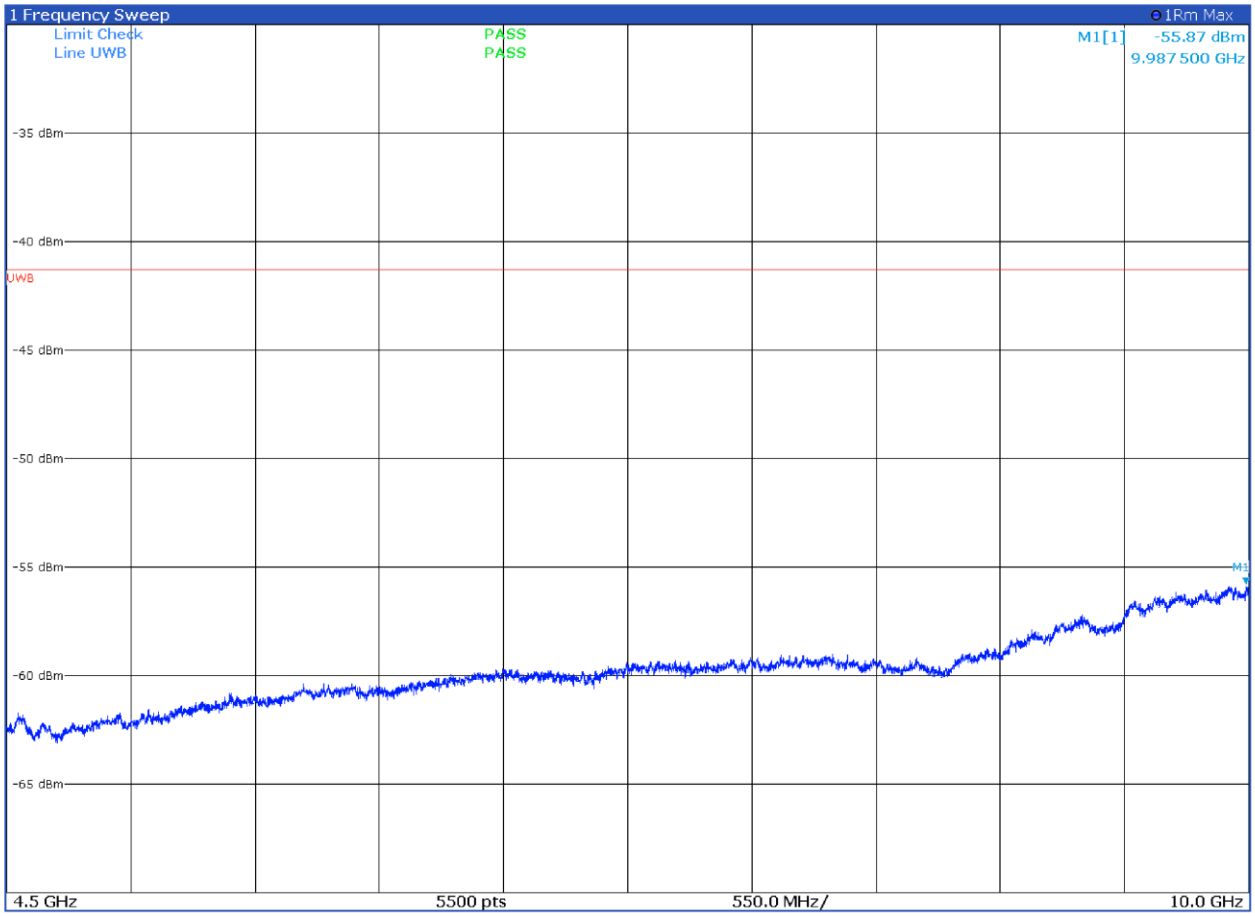


Figure 7.5-8: *Radiated emission with antenna in vertical polarization*

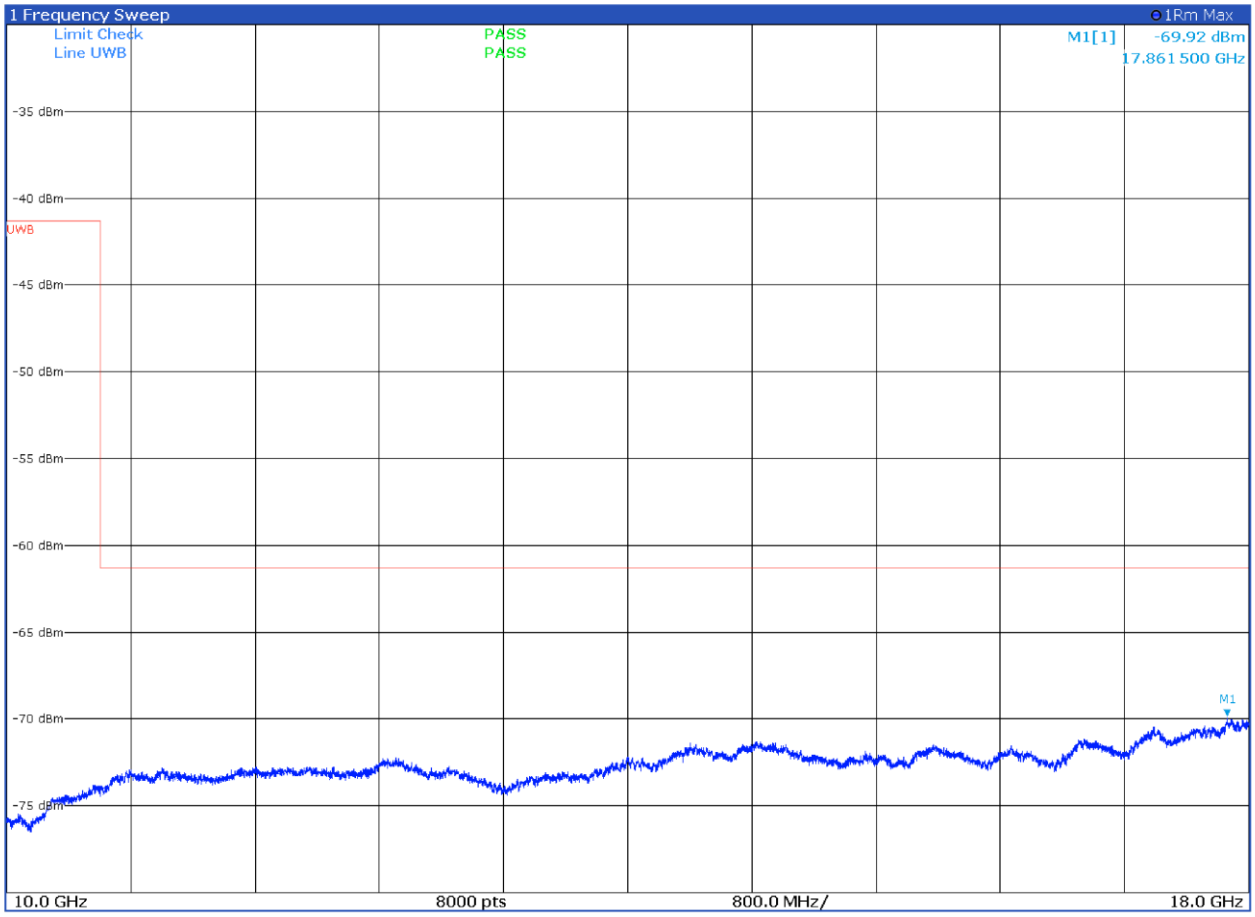


Figure 7.5-9: *Radiated emission with antenna in horizontal polarization*

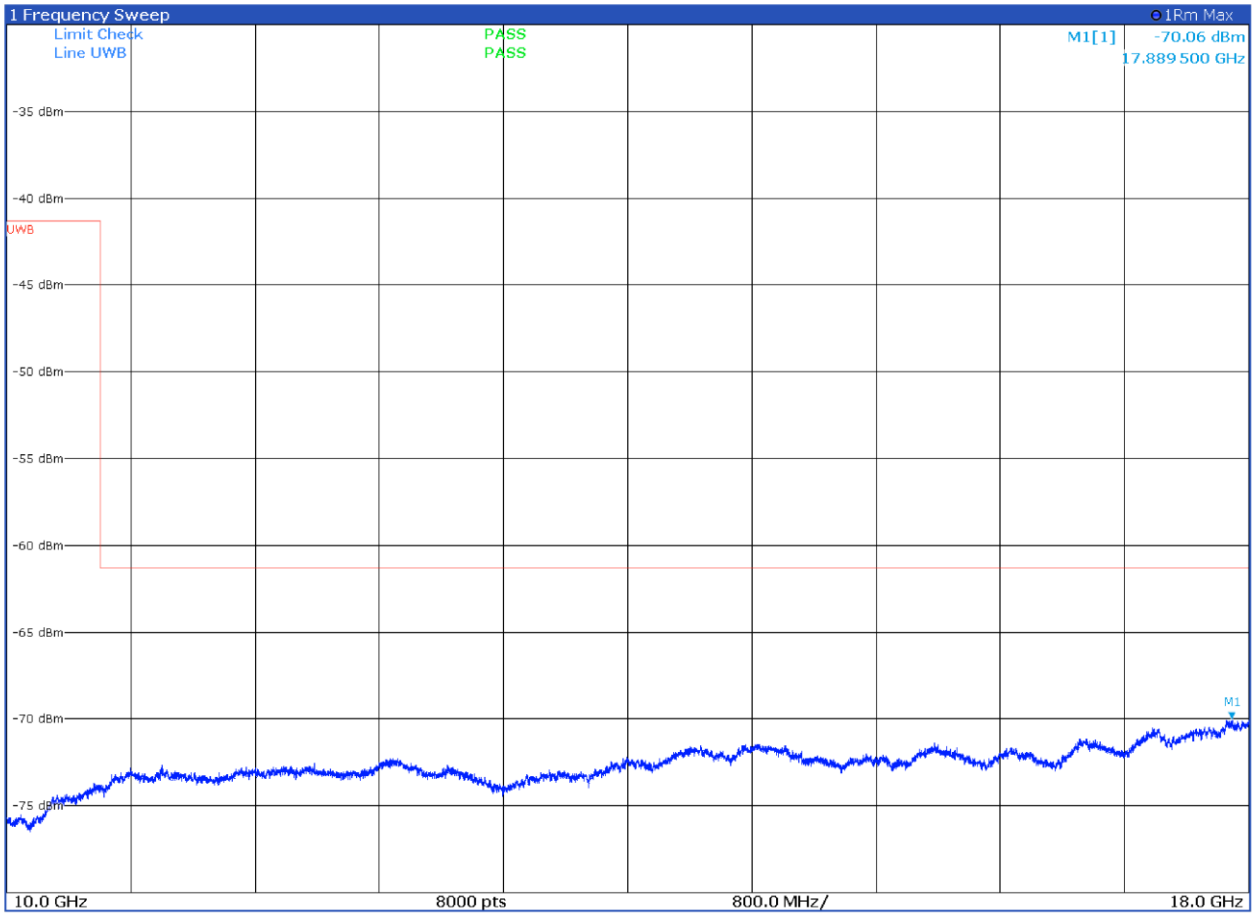


Figure 7.5-10: *Radiated emission with antenna in vertical polarization*

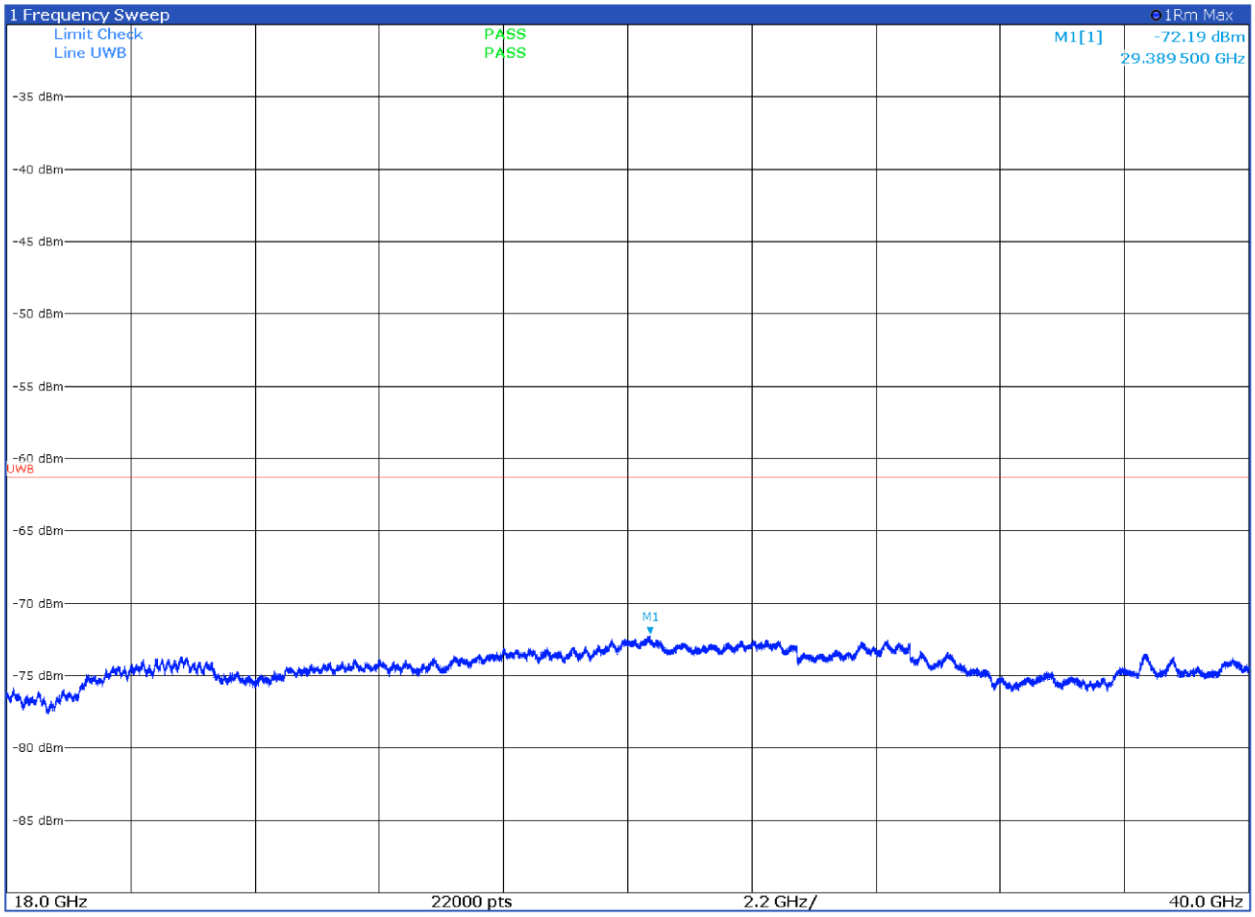


Figure 7.5-11: *Radiated emission with antenna in horizontal polarization*

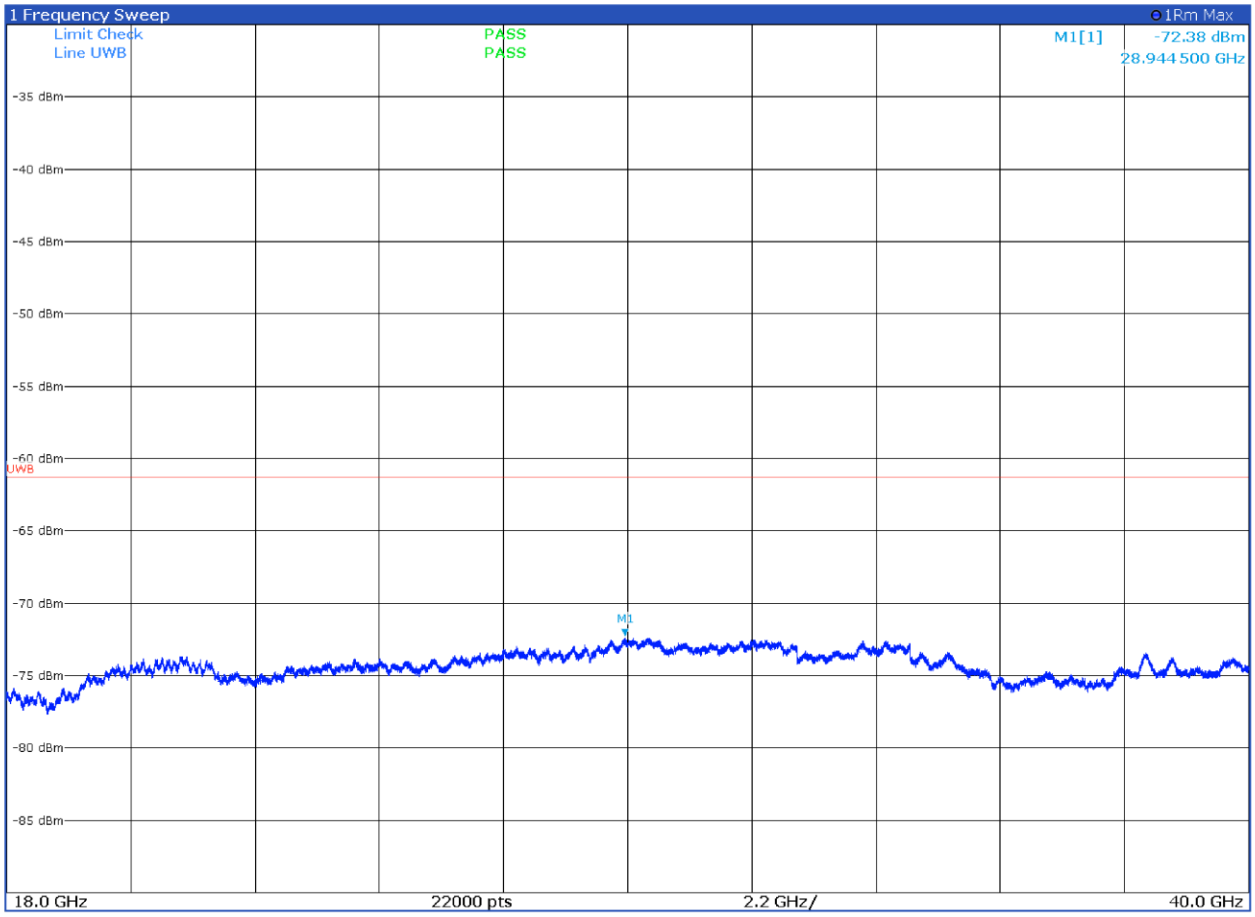


Figure 7.5-12: *Radiated emission with antenna in vertical polarization*

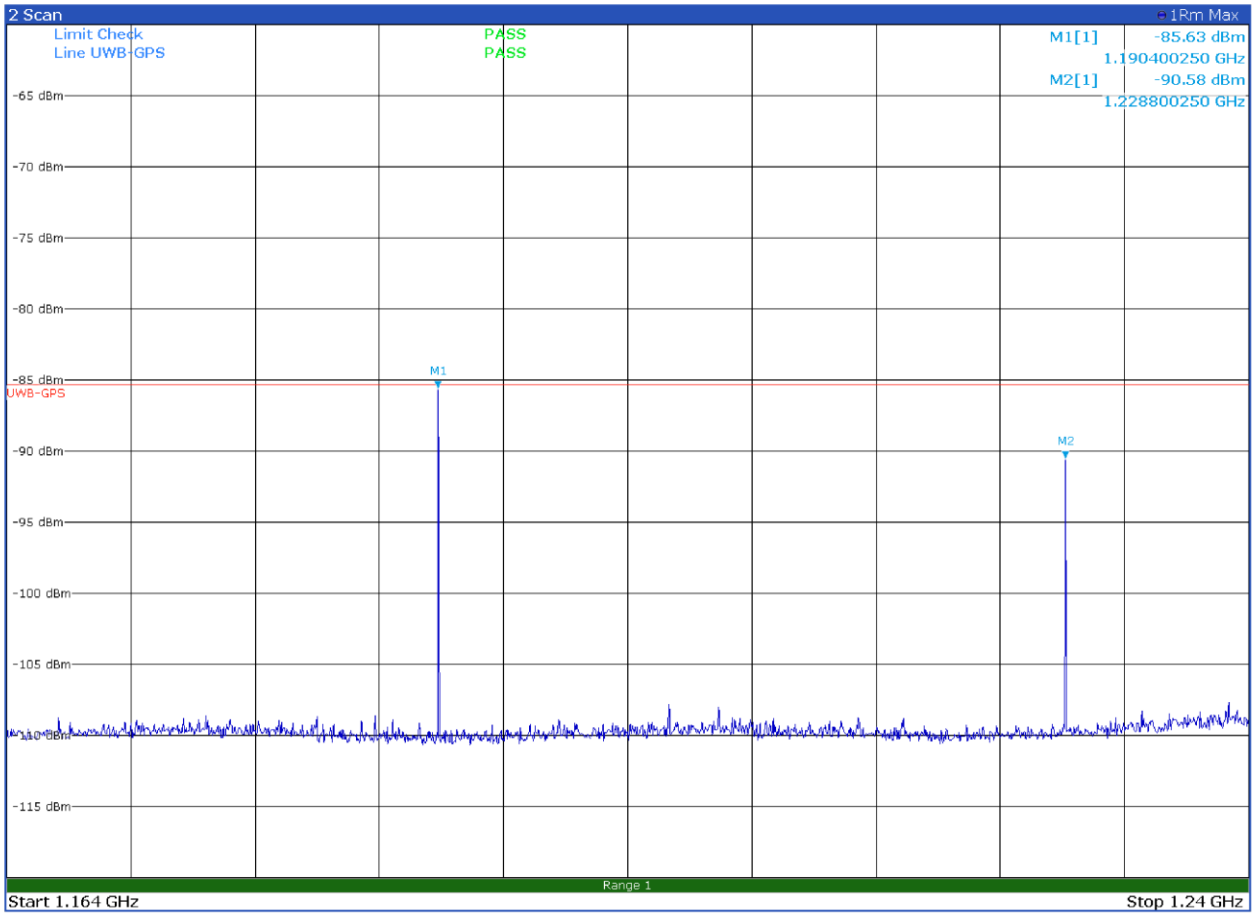


Figure 7.5-13: *Radiated emission with antenna in horizontal polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

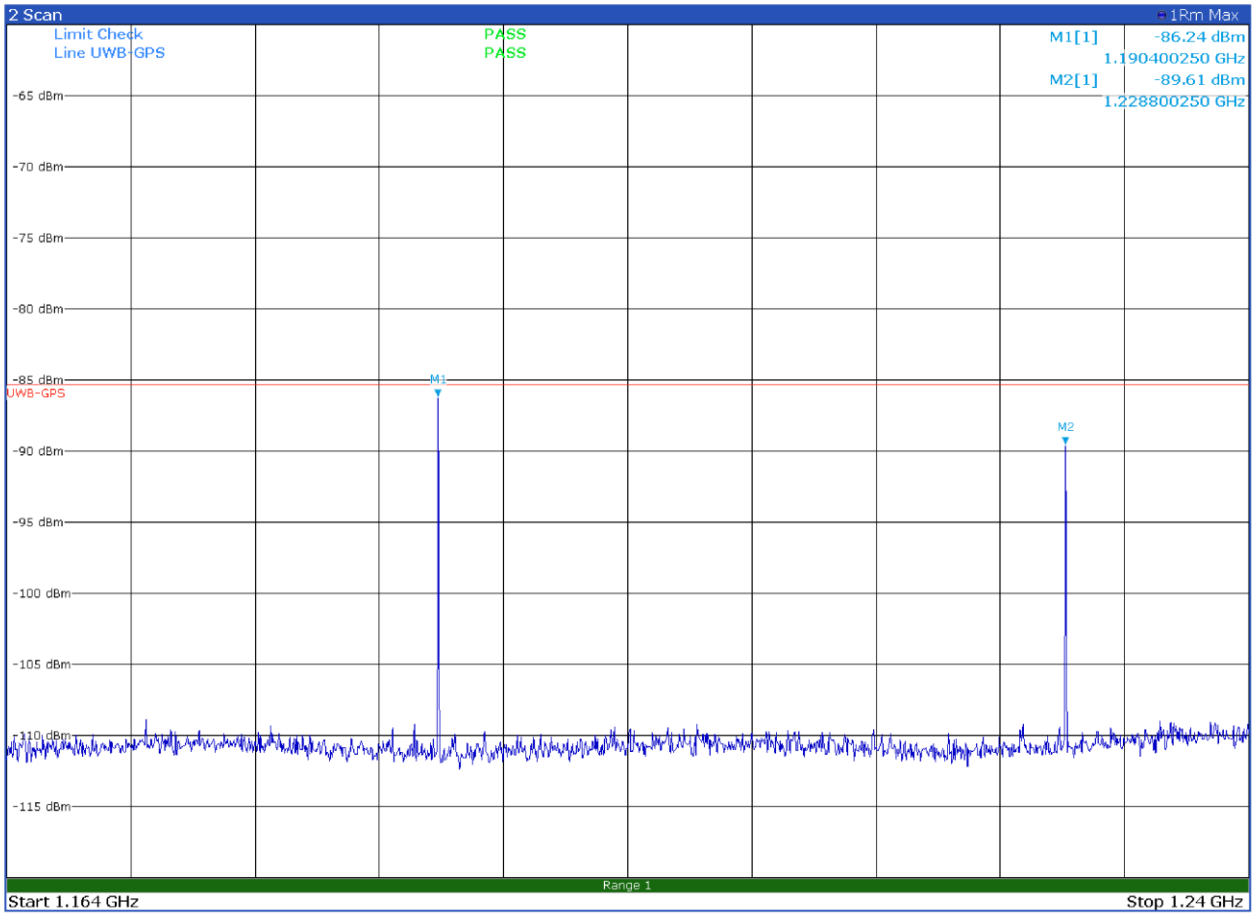


Figure 7.5-14: *Radiated emission with antenna in vertical polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

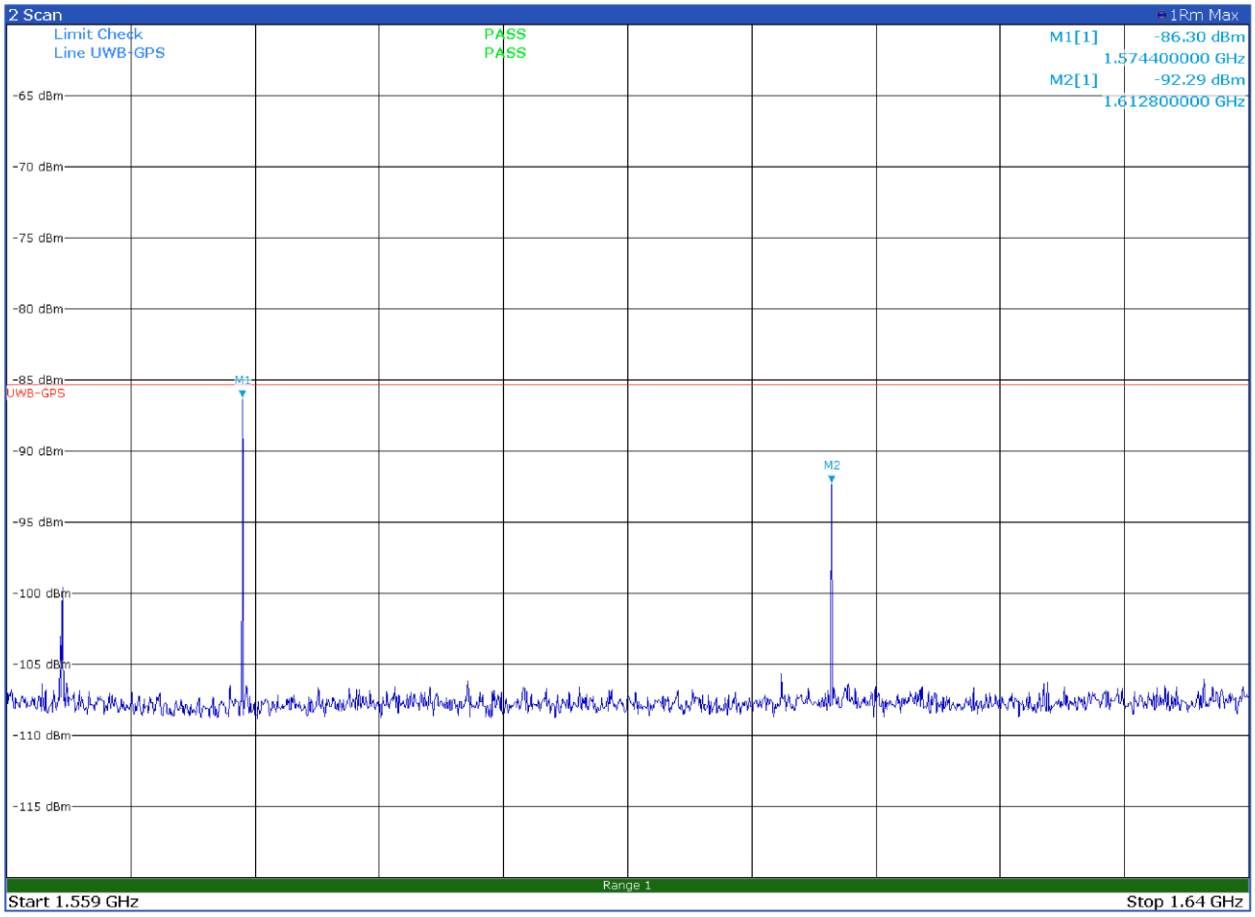


Figure 7.5-15: *Radiated emission with antenna in horizontal polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

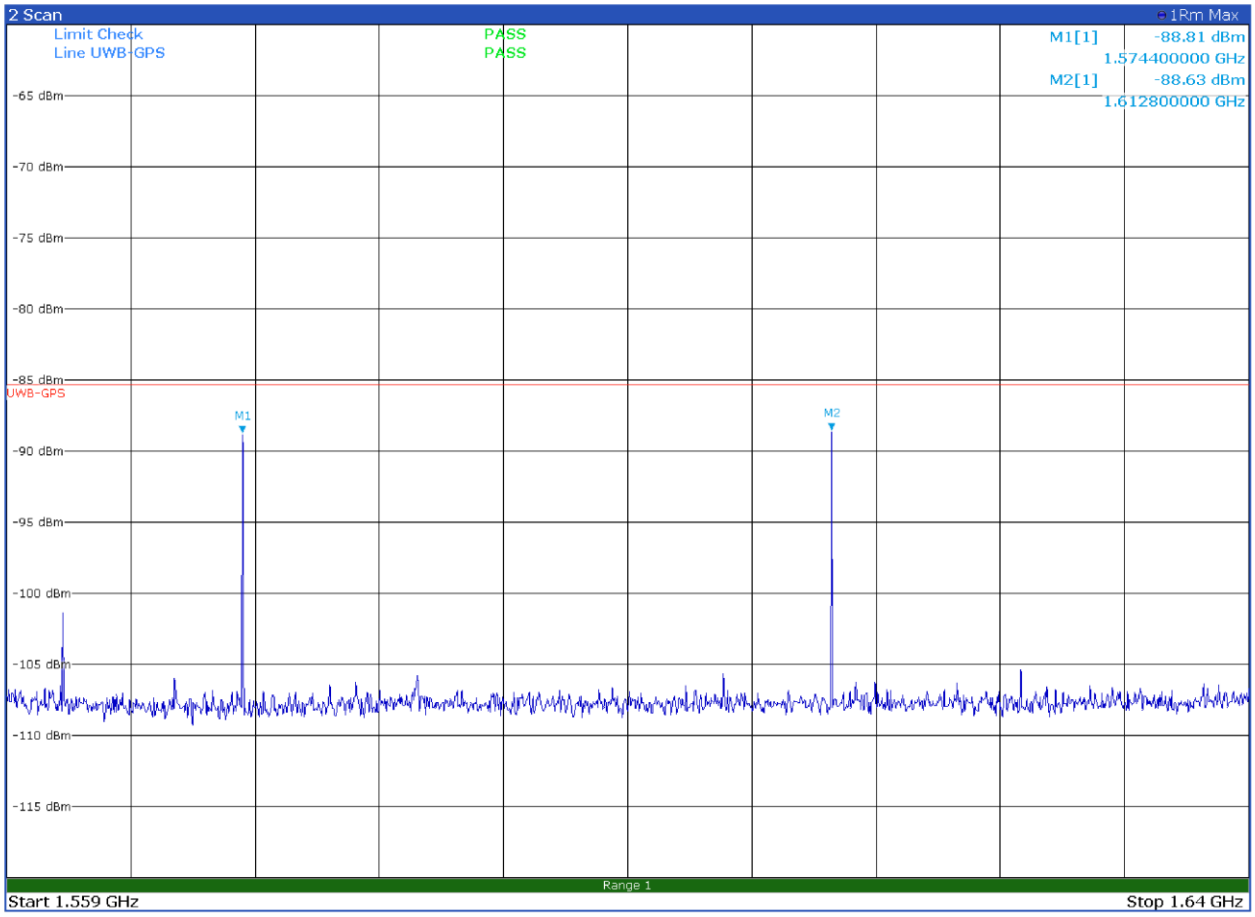


Figure 7.5-16: *Radiated emission with antenna in vertical polarization*

These emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. So, no UWB limits apply to this emission. See graphics in the following page for 15.209 emission plots.

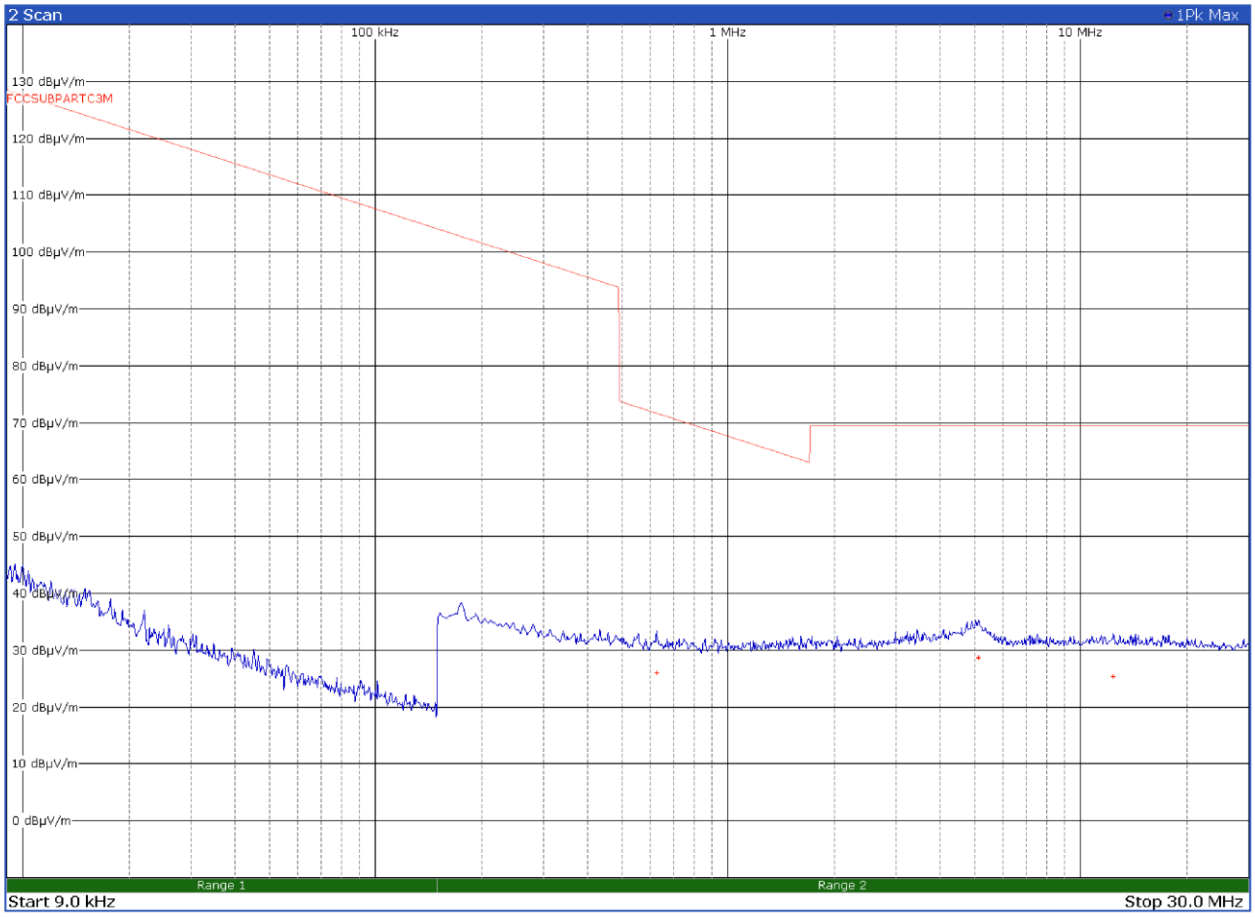


Figure 7.5-17: *Radiated emission with loop antenna*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.6270	26.1	71.7	-45.6	QP
5.1473	28.8	69.5	-40.7	QP
12.3923	25.4	69.5	-44.1	QP

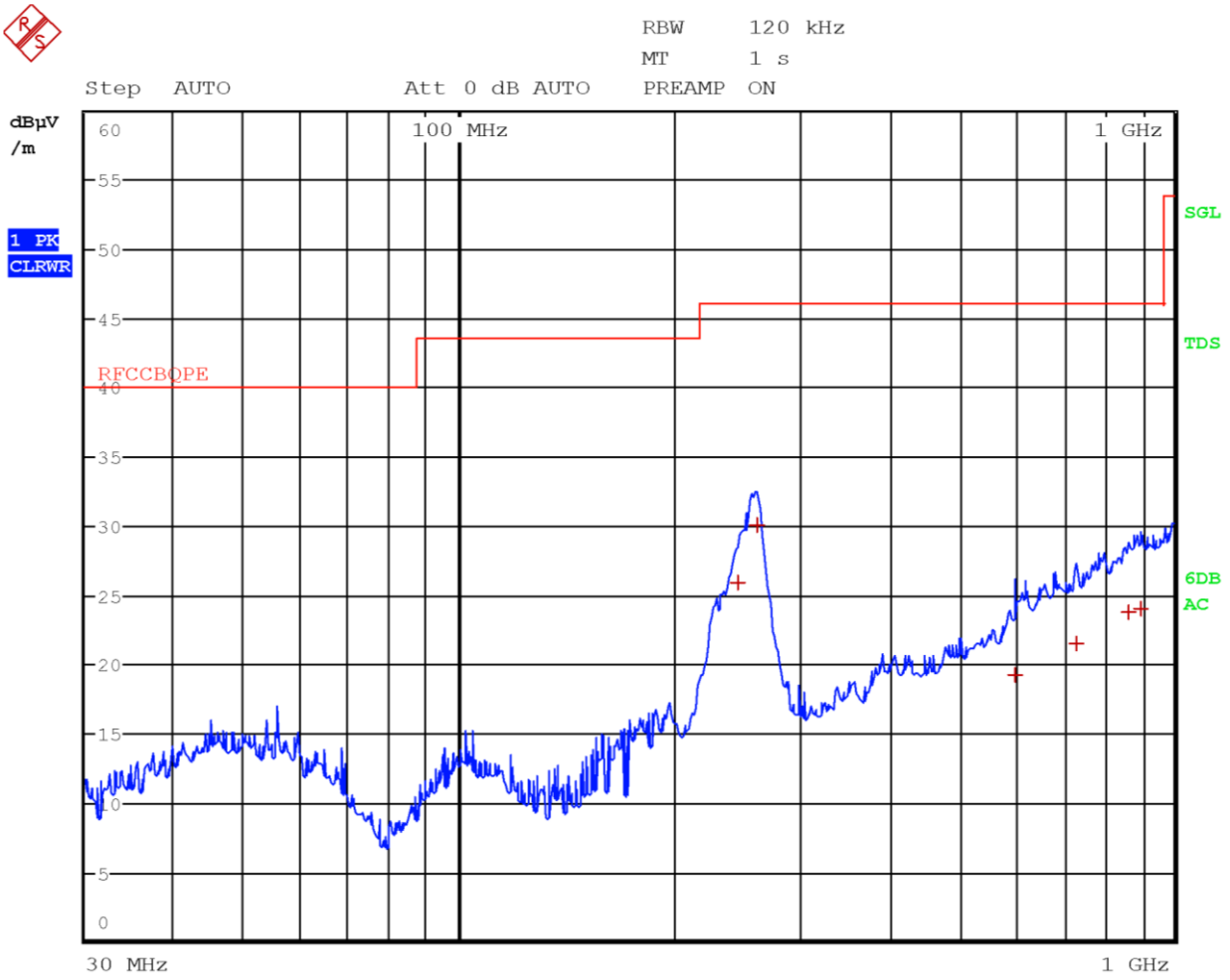


Figure 7.5-18: *Radiated emission with antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
245.7600	25.9	46.0	-20.1	QP
261.0400	30.1	46.0	-15.9	QP
599.0000	19.3	46.0	-26.7	QP
731.5600	21.5	46.0	-24.5	QP
862.4400	23.9	46.0	-22.1	QP
896.5600	24.1	46.0	-21.9	QP

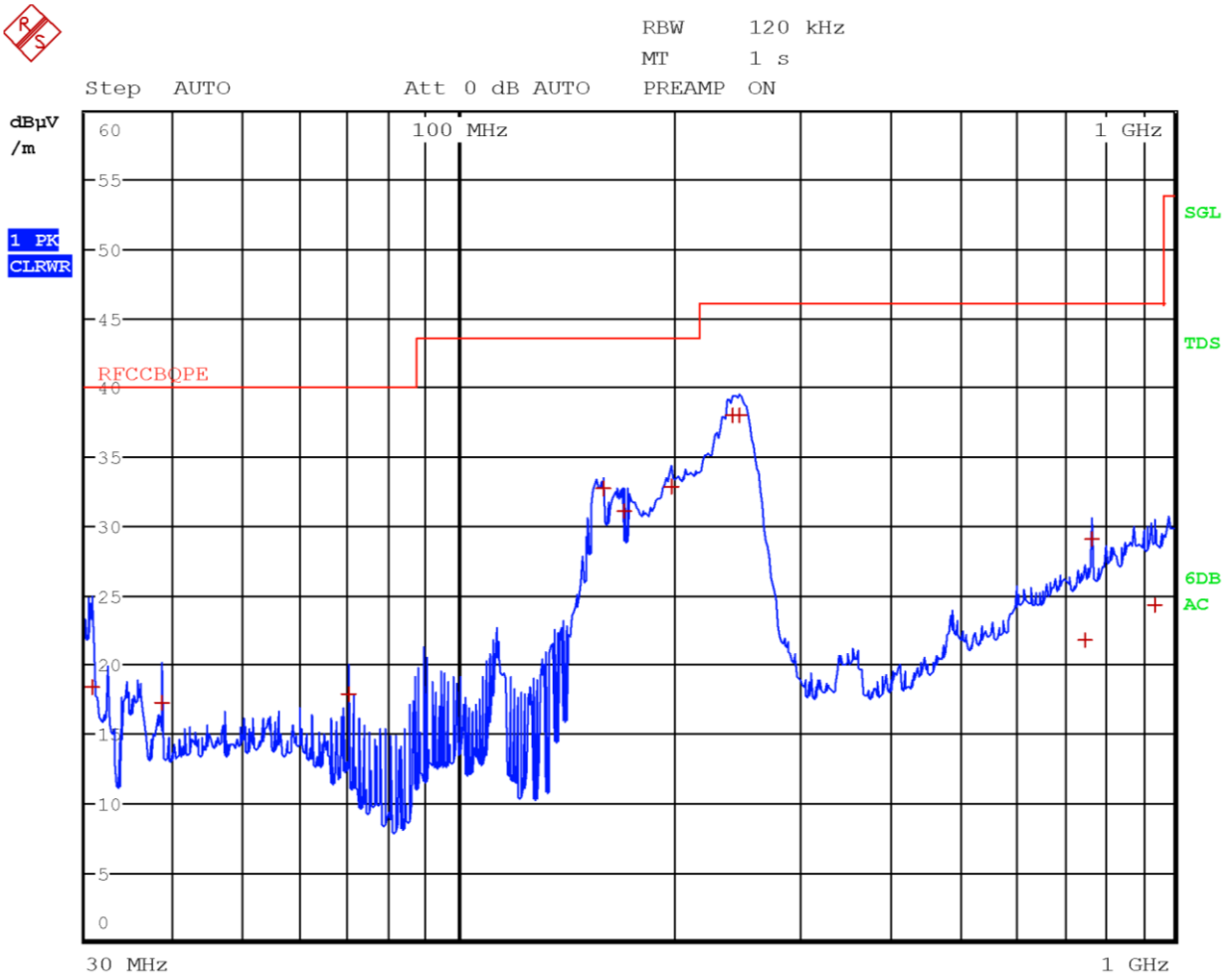


Figure 7.5-19: *Radiated emission with antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
30.6000	18.4	40.0	-21.6	QP
38.4400	17.2	40.0	-22.8	QP
70.0000	17.9	40.0	-22.1	QP
159.0800	32.7	43.5	-10.8	QP
170.6000	31.2	43.5	-12.3	QP
198.5600	32.9	43.5	-10.6	QP
241.7600	38.0	46.0	-8.0	QP
246.8800	38.1	46.0	-7.9	QP
750.9600	21.9	46.0	-24.1	QP
768.0000	29.1	46.0	-16.9	QP
939.1600	24.3	46.0	-21.7	QP

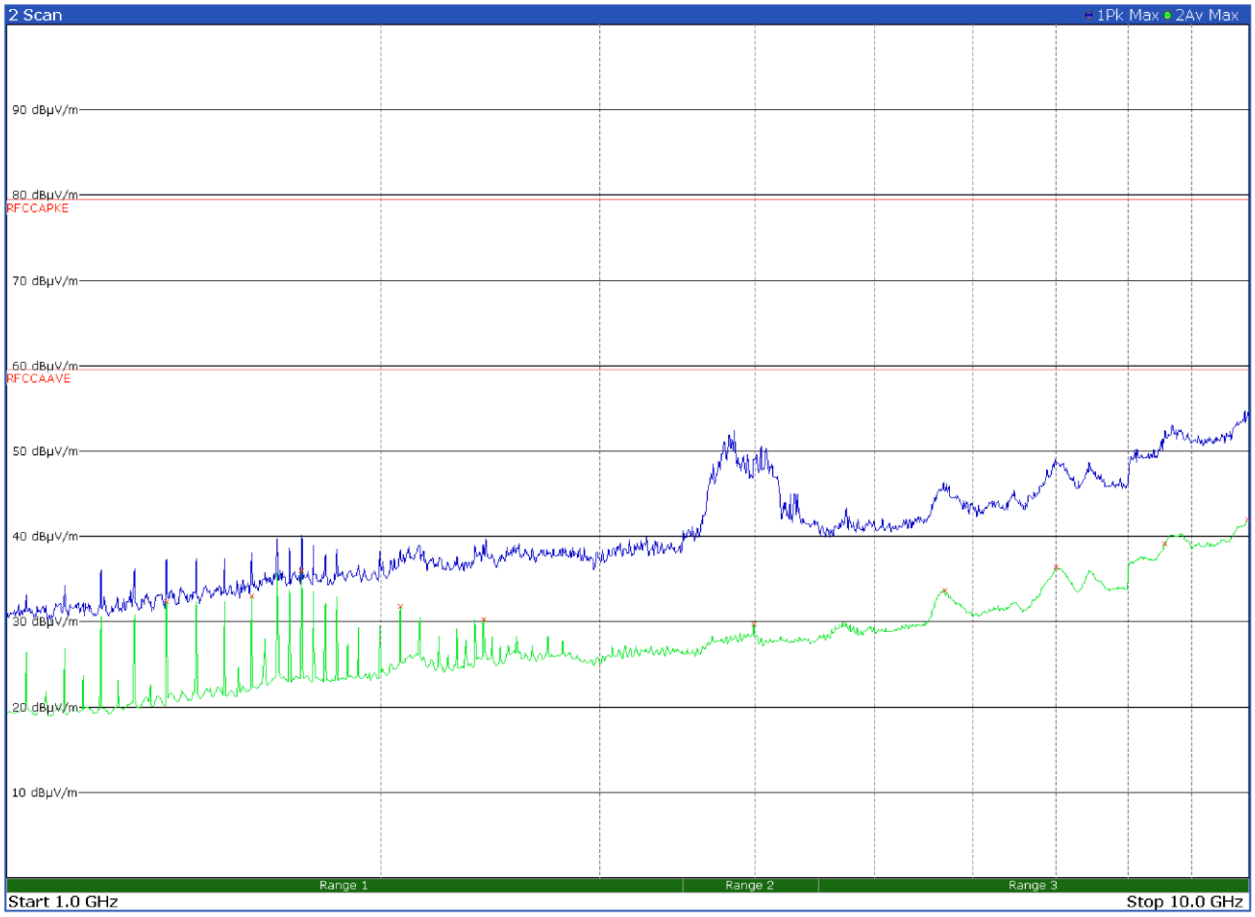


Figure 7.5-20: *Radiated emission with antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1344.0000	32.4	59.5	-27.1	Av
1574.5000	33.0	59.5	-26.5	Av
1728.0000	36.0	59.5	-23.5	Av
2073.5000	31.9	59.5	-27.6	Av
2419.2500	30.3	59.5	-29.2	Av
3993.5000	29.8	59.5	-29.7	Av
5689.2500	33.7	59.5	-25.8	Av
6997.2500	36.4	59.5	-23.1	Av
8560.7500	39.2	59.5	-20.3	Av
9981.0000	42.1	59.5	-17.4	Av

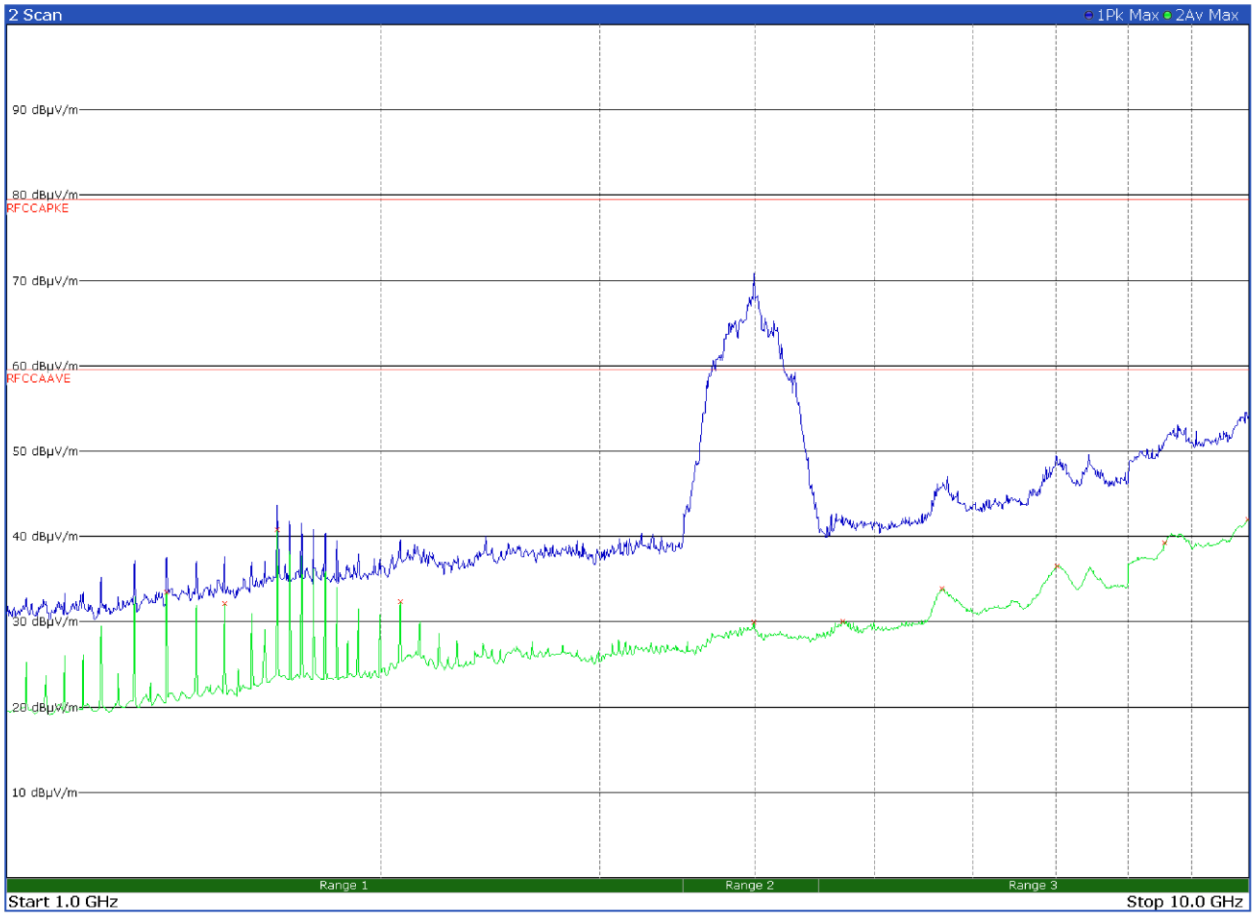


Figure 7.5-21: *Radiated emission with antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1344.0000	33.5	59.5	-26.0	Av
1497.5000	32.2	59.5	-27.3	Av
1651.2500	40.8	59.5	-18.7	Av
2073.5000	32.4	59.5	-27.1	Av
3993.5000	29.9	59.5	-29.6	Av
4711.5000	30.1	59.5	-29.4	Av
5665.0000	33.9	59.5	-25.6	Av
7007.0000	36.6	59.5	-22.9	Av
8560.5000	39.3	59.5	-20.2	Av
9980.7500	42.1	59.5	-17.4	Av

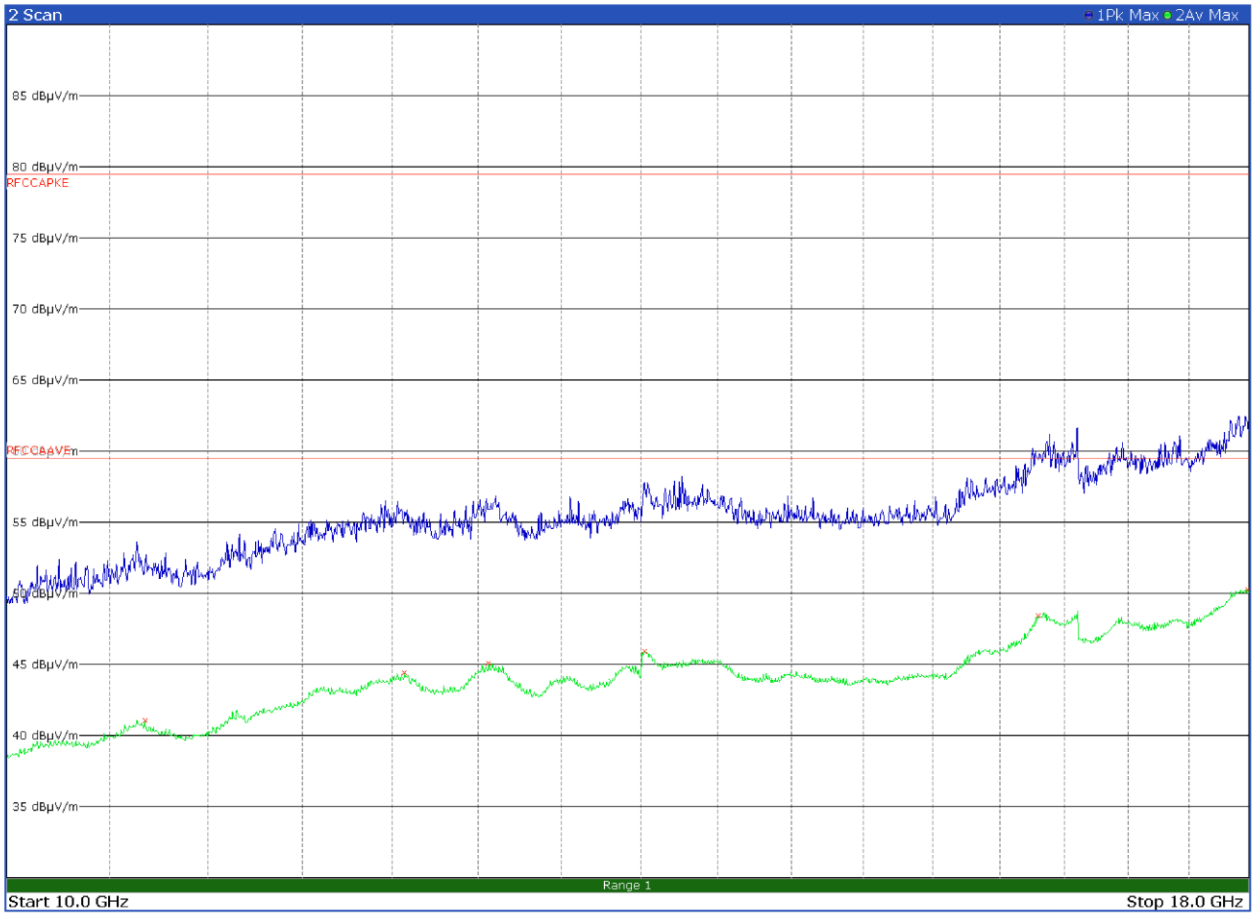


Figure 7.5-22: *Radiated emission with antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
10677.2500	41.1	59.5	-18.4	Av
12070.7500	44.4	59.5	-15.1	Av
12562.5000	45.1	59.5	-14.4	Av
13524.0000	46.0	59.5	-13.5	Av
16250.7500	60.2	79.5	-19.3	Pk
16292.2500	48.5	59.5	-11.0	Av
17916.0000	62.5	79.5	-17.0	Pk
17993.2500	50.3	59.5	-9.2	Av

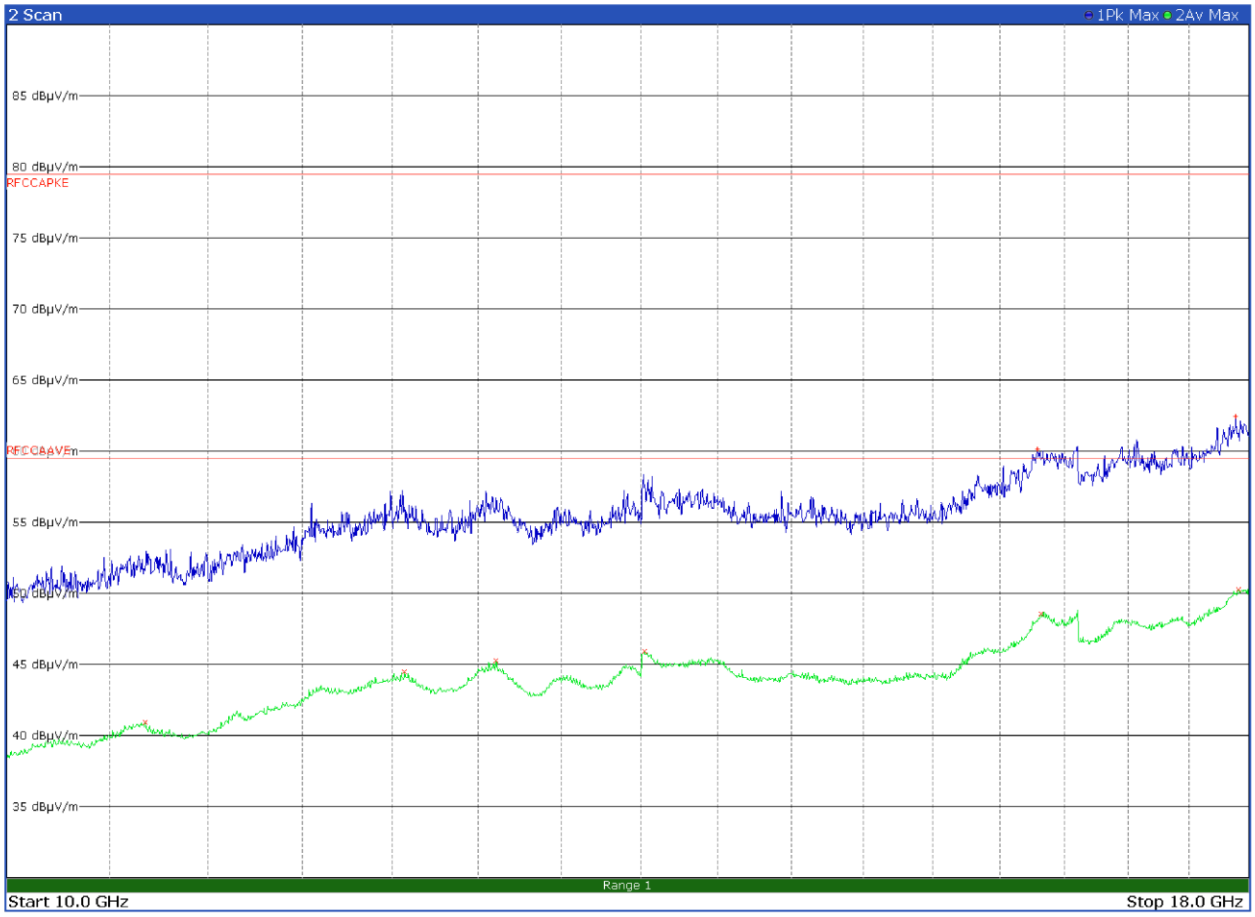


Figure 7.5-23: *Radiated emission with antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
10677.0000	41.0	59.5	-18.5	Av
12070.7500	44.5	59.5	-15.0	Av
12606.0000	45.3	59.5	-14.2	Av
13524.2500	46.0	59.5	-13.5	Av
16287.5000	60.1	79.5	-19.4	Pk
16313.0000	48.6	59.5	-10.9	Av
17886.5000	62.5	79.5	-17.0	Pk
17910.5000	50.3	59.5	-9.2	Av

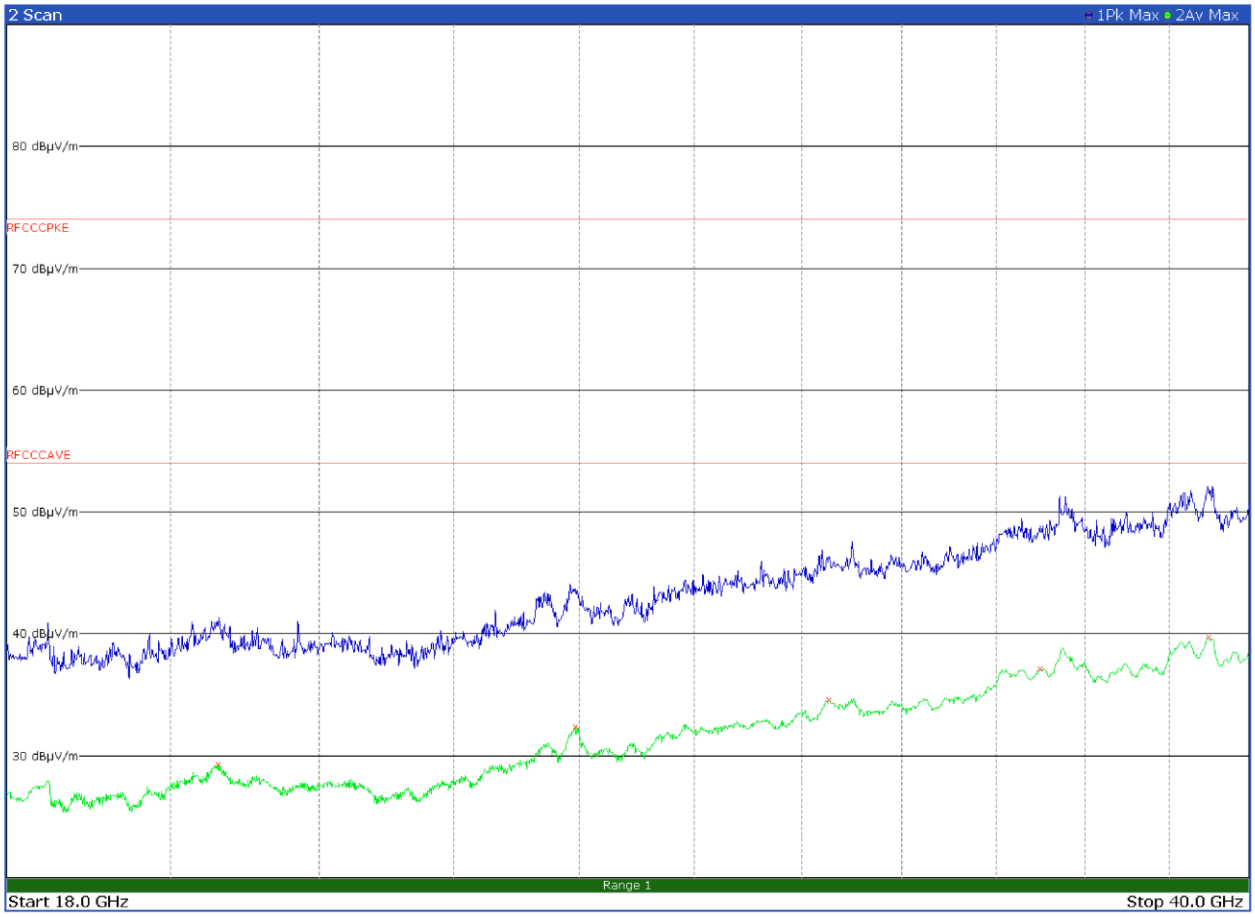


Figure 7.5-24: *Radiated emission with antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
20625.5000	29.3	54.0	-24.7	Av
25940.0000	32.4	54.0	-21.6	Av
30527.7500	34.6	54.0	-19.4	Av
34975.7500	37.2	54.0	-16.8	Av
38988.0000	39.8	54.0	-14.2	Av

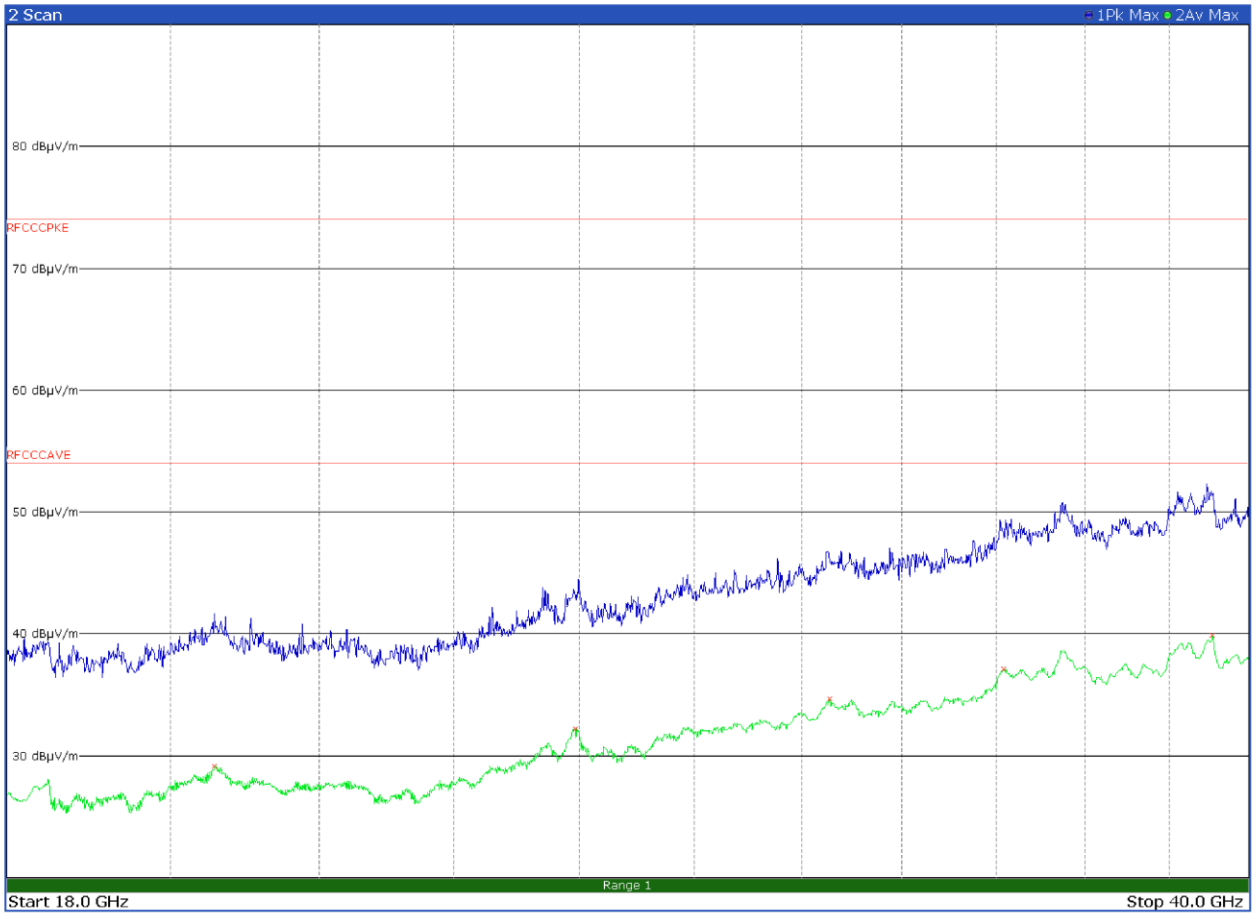
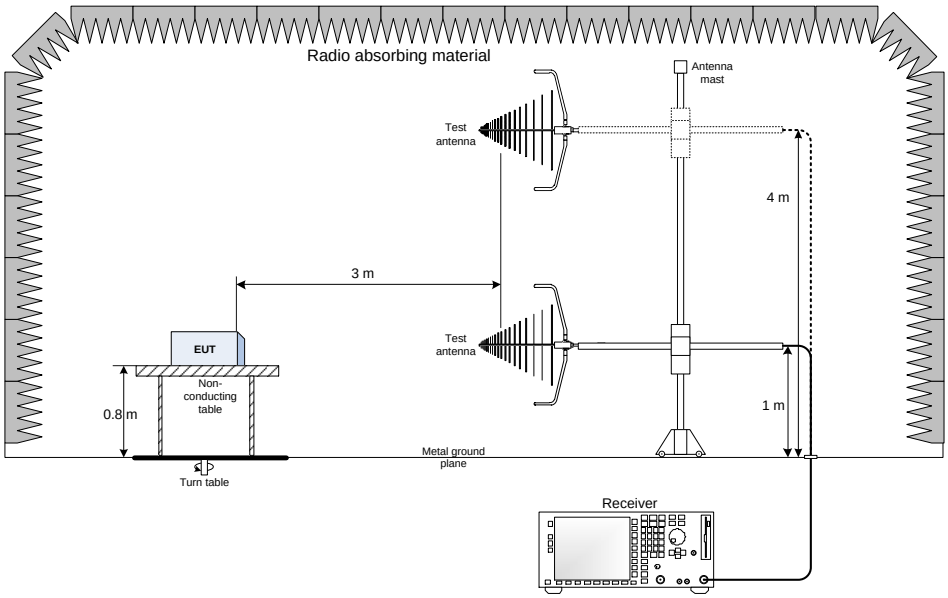


Figure 7.5-25: *Radiated emission with antenna in vertical polarization*

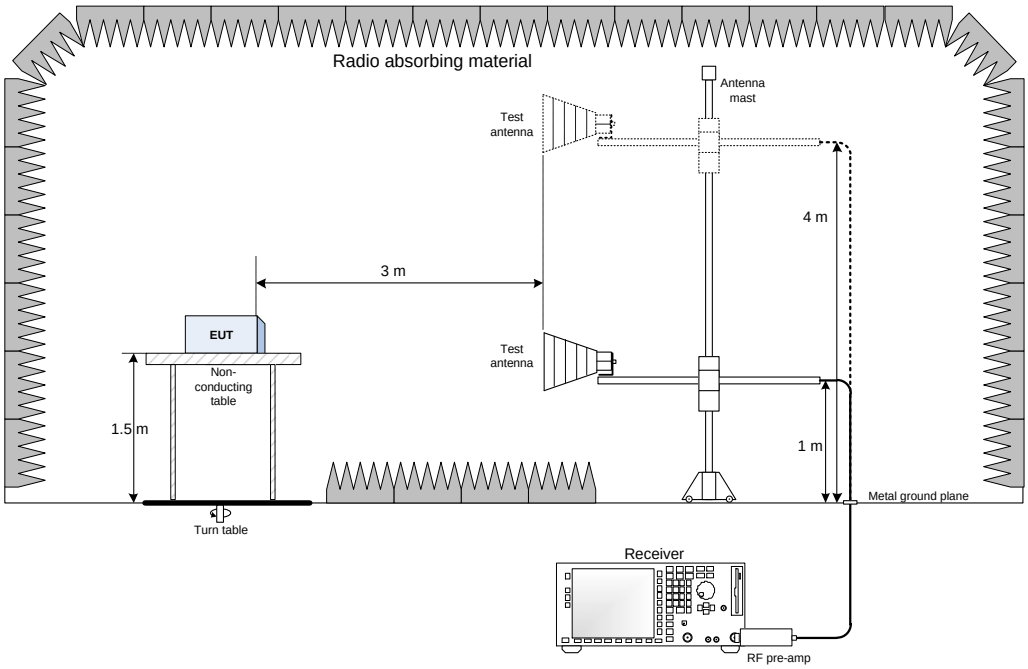
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
20570.0000	29.2	54.0	-24.8	Av
25939.5000	32.2	54.0	-21.8	Av
30558.2500	34.7	54.0	-19.3	Av
34160.2500	37.1	54.0	-16.9	Av
39078.5000	39.9	54.0	-14.1	Av

Section 8. Block diagrams of test set-ups

8.1 Radiated emissions set-up for frequencies below 1 GHz



8.2 Radiated emissions set-up for frequencies above 1 GHz



Section 9. Photos

9.1 Photos of the test set-up

See “Annex A” exhibit.

9.2 Photos of the EUT

See “Annex A” exhibit.

End of report