

Test report

391810-3TRFWL

Date of issue: 2020-04-22

Applicant:

MatiPay Srl

Via San Sabino, 21 – 70041 Mola di Bari (BA) – Italy

Product:

WI9250PM1 - MPYV2 SPAY

Model:

WI9250PM1 - MPYV2 SPAY

FCC ID:

2AVPV-MPYV2SPAY

Specifications:

◆ **FCC 47 CFR Part 15 Subpart C, §15.247**

Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz

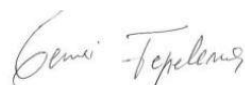

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The test report merely corresponds to the tested sample.

The phase of sampling / collection of equipment under test is carried out by the customer.

Test location

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Country	Italy
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Site number	FCC: 682159 (10 m semi anechoic chamber)

Tested by (name, function and signature)	G. Tepelena	(project handler)	
Reviewed by (name, function and signature)	D. Guarnone	(verifier)	
Date	2020-04-22		

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report. This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Spa ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	MatiPay S.r.l.
Address	Via San Sabino, 21 (Z.I.)
City	Mola di Bari
Province/State	Bari
Postal/Zip code	70042
Country	Italy

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz
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1.3 Test methods

558074 D01 DTS Meas Guidance v03r05 (April 2, 2019)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
662911 D01 Multiple Transmitter Output v02r01 (October 31, 2013)	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
DA 00-705, Released March 30, 2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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
391810-3TRFWL	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of frequencies	Pass
§15.203	Antenna requirement	Pass ¹

Notes: ¹ The Antennas are located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	2020-04-08
Nemko sample ID number	391810-3/3

3.2 EUT information

Product name	WI9250PM1 - MPYV2 SPAY
Model	WI9250PM1 - MPYV2 SPAY
Model variant	--
Serial number	N/A

3.3 Technical information

Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2402 MHz
Frequency Max (MHz)	2480 MHz
RF power Min (W), Conducted	0.00017
RF power Max (W), Conducted	0.00028
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	889
Measured BW (kHz) (99%)	1173
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	1M17F1D
Transmitter spurious, dBμV/m @ 3 m	39.28
Power requirements	12/24 V DC from external power supply
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The "BT Interface" device is a communication interface based on BLE 4.1 technology that works with sub watch and a smartphone to allow data exchange, in particular the download of the dives present on the watch. The basic communication scheme is as follows:

- The watch communicates with the interface via IRDA
- The interface communicates with the smartphone via BLE 4.1
- The smartphone sends data to backend

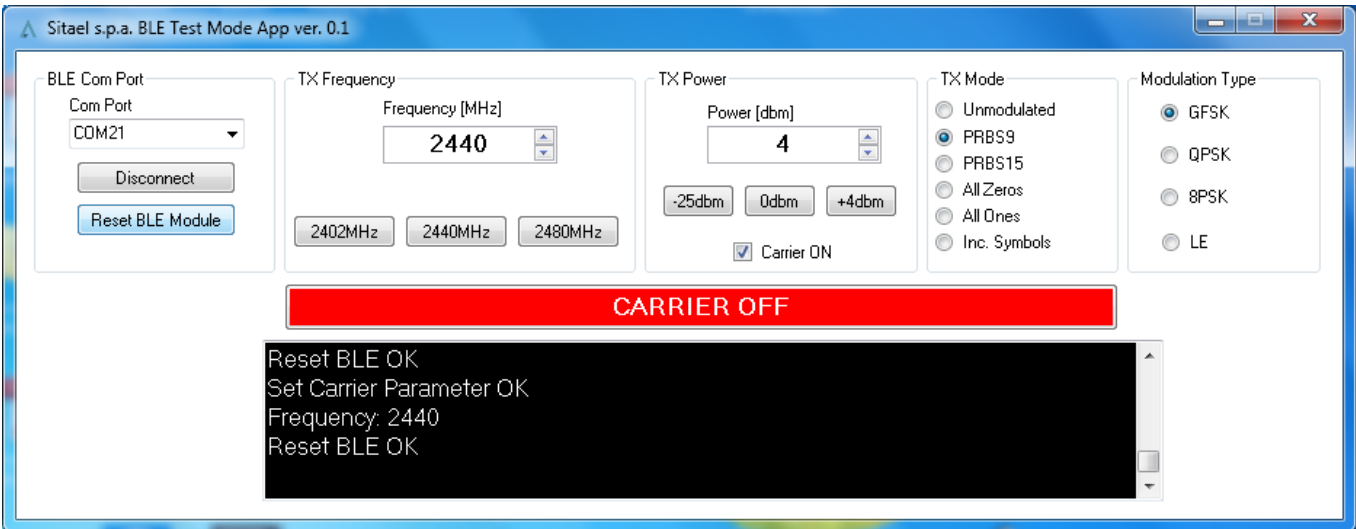
A possible communication alternative is the following:

- The clock communicates with the interface via IRDA
- The interface communicates with a PC by USB cable
- On the PC there is a management application

The device is also equipped with a reset button and two status signaling LEDs

3.5 EUT exercise details

The following software has been used during the tests:



3.6 EUT setup diagram

The EUT is a stand-alone device powered by external power supply

3.7 EUT sub assemblies

The EUT is composed by a single unit

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	18–33 °C
Relative humidity	30–60 %
Air pressure	980–1060 mbar

Test equipment used for the monitoring of the environmental conditions

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Thermohygrometer data logger	Testo	175-H2	20012380/305	2019-01	2021-01
Thermohygrometer data logger	Testo	175-H2	38203337/703	2019-01	2021-01
Barometer data logger	Testo	Severis 2	0054634793	2019-06	2020-06

5.2 Power supply range

For battery operated equipment, the equipment tests shall be performed using a new battery.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

EUT	Type	Test	Range and Setup features	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	10 kHz ÷ 30 MHz	1.0 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.6 dB	(1)
		Conducted spurious emissions	10 kHz ÷ 26 GHz	3.0 dB	(1)
			26 GHz ÷ 40 GHz	4.5 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	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 40 GHz	8.0 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26,5 GHz ÷ 40 GHz	8.0 dB	(1)
Receiver	Radiated	Radiated spurious emissions	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 40 GHz	8.0 dB	(1)
	Conducted	Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
		Conducted spurious emissions	10 kHz ÷ 26 GHz	3.0 dB	(1)
			26 GHz ÷ 40 GHz	4.5 dB	(1)

(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$ which has been derived from the assumed normal probability distribution with infinite degrees of freedom and for a coverage probability of 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 (20 Hz ÷ 8 GHz)	R&S	ESU8	100202	2020-01	2021-01
EMI receiver (20 Hz ÷ 8 GHz)	R&S	ESW44	101620	2019-08	2020-08
Trilog Antenna (30 MHz ÷ 7 GHz)	Schwarzbeck	VULB 9162	9162-025	2018-07	2021-07
Bilog antenna (1 ÷ 18 GHz)	Schwarzbeck	STLP 9148	9148-123	2018-07	2021-07
Horn antenna (4 ÷ 40 GHz)	RFSpin	DRH40	061106A40	2020-02	2023-02
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV 9718	9718-137	2019-09	2020-09
Preamplifier (18 ÷ 40 GHz)	Miteq	JS44-18004000-35-8P-R	1.627	2019-09	2020-09
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
Semi-anechoic chamber	Nemko	10m semi-anechoic chamber	530	2018-09	2021-09
Shielded room	Siemens	10m control room	1947	NCR	NCR
LISN three phase (9 kHz ÷ 30 MHz)	Rohde & Schwarz	ESH2-Z5	872 460/041	2019-09	2020-09
Shielded room	Siemens	Conducted emission test room	1862	NCR	NCR

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

Section 8. Testing data

8.1 FCC 15.207(a) AC power line conducted emissions limits

8.1.1 Definitions and limits

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

Table 8.1-1: Conducted emissions limit

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

Note: * - The level decreases linearly with the logarithm of the frequency.

** - A linear average detector is required.

8.1.2 Test summary

Test date	2020-04-21	Temperature	20 °C
Test engineer	G. Tepelena	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	59 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration. The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance. A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement. The test has been performed with the EUT connected to a PC.

Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.1.4 Test data

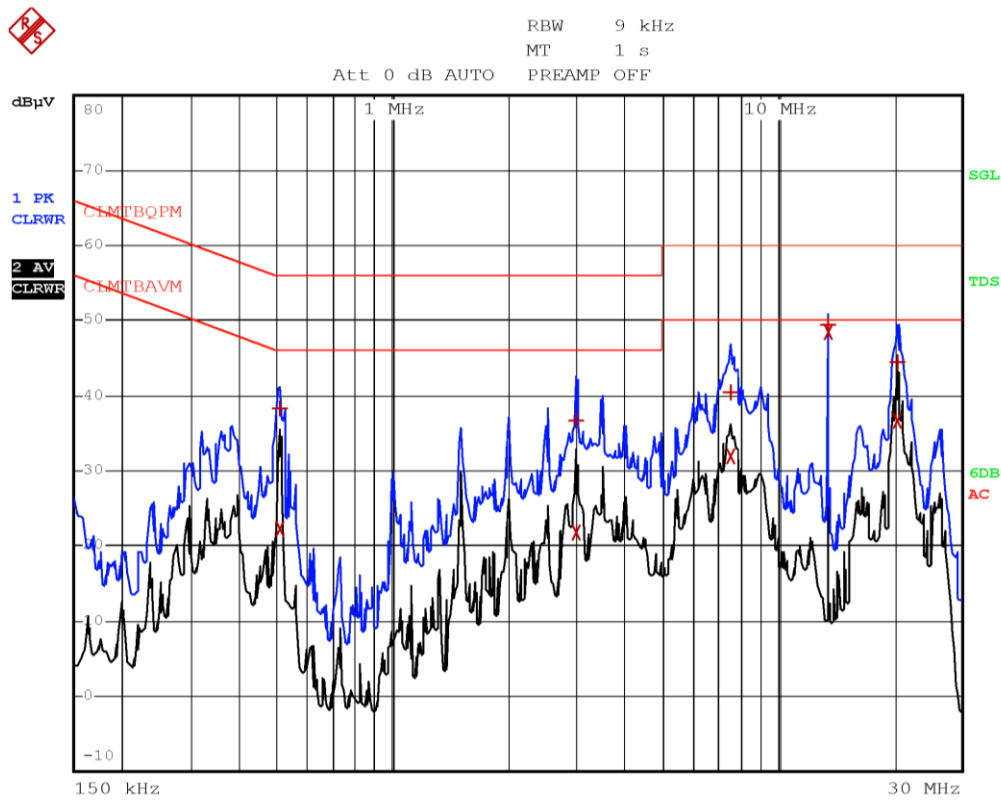


Figure 8.1-1: Conducted emission on Phase line

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Detector
0.510	38.3	57.0	-18.7	Qp
0.510	22.2	47.0	-24.8	Av
3.002	36.7	57.0	-20.3	Qp
3.002	21.69	47.0	-25.31	Av
7.526	31.99	60.0	-28.01	Qp
7.526	40.42	50.0	-9.58	Av
13.562	49.49	60.0	-10.51	Qp
13.562	48.47	50.0	-1.53	Av
20.474	44.54	60.0	-15.46	Qp
20.474	36.62	50.0	-13.38	Av

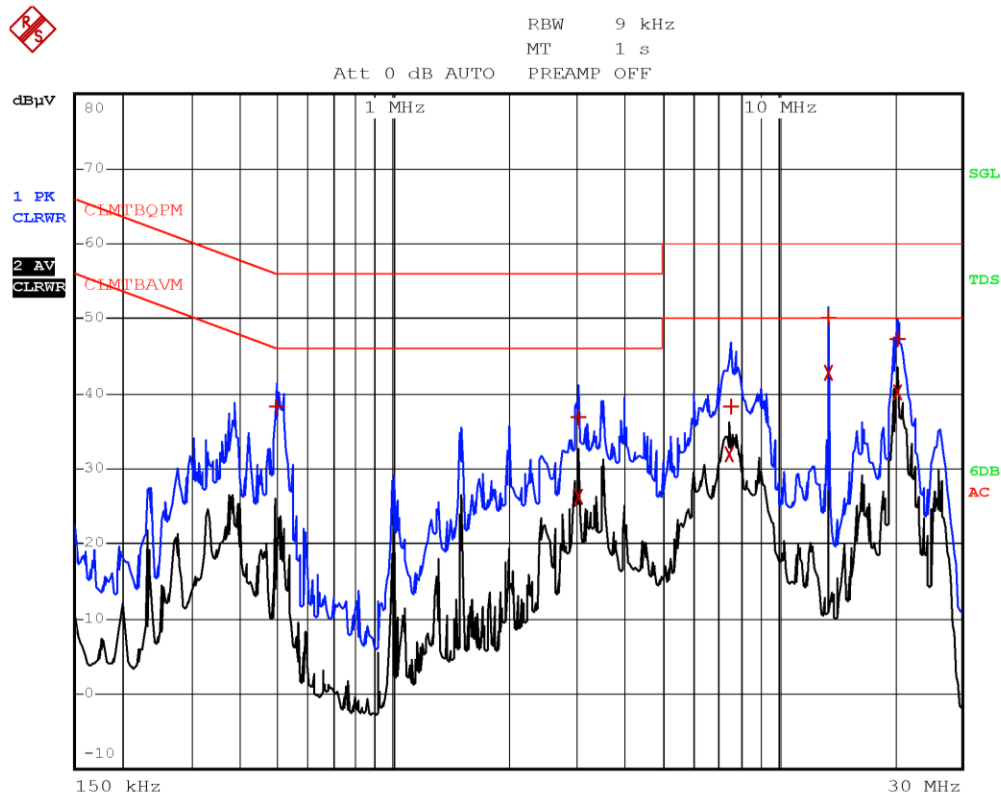


Figure 8.1-2: Conducted emission on Neutral line

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Detector
0.498	38.24	57.0	-18.76	Qp
3.002	36.98	57.0	-20.02	Qp
3.002	26.29	47.0	-20.71	Av
7.506	31.98	60.0	-28.02	Qp
7.542	38.34	50.0	-11.66	Av
13.558	42.76	60.0	-17.24	Qp
13.562	50.22	50.0	0.22	Av
20.570	47.31	60.0	-12.69	Qp
20.570	40.23	50.0	-9.77	Av

8.2 FCC 15.31(m) Number of frequencies

8.2.1 Definitions and limits

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.

Table 8.2-1: 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.

8.2.2 Test summary

Test date	2020-04-21	Temperature	21 °C
Test engineer	G. Tepelena	Air pressure	1025 mbar
Verdict	Pass	Relative humidity	40 %

8.2.3 Observations, settings and special notes

None

8.2.4 Test data

Table 8.2-2: Test channels selection

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
2400	2483.5	83.5	2402	2440	2480

8.3 FCC 15.247(a)(2) Minimum 6 dB bandwidth for systems using digital modulation techniques

8.3.1 Definitions and limits

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
- (2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.3.2 Test summary

Test date	2020-04-21	Temperature	21 °C
Test engineer	G. Tepelena	Air pressure	1025 mbar
Verdict	Pass	Relative humidity	50 %

8.3.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	$\geq 3 \times \text{RBW}$
Frequency span	2.5 MHz
Detector mode	Peak
Trace mode	Max Hold

8.3.4 Test data

Table 8.3-1: 6 dB bandwidth results

Modulation	Frequency, MHz	6 dB bandwidth, MHz	Limit, MHz	Margin, MHz
GFSK	2402	0.864	0.50	0.364
	2440	0.889	0.50	0.389
	2480	0.839	0.50	0.339

Table 8.3-2: 99% occupied bandwidth results

Modulation	Frequency, MHz	99% occupied bandwidth, MHz
BLE	2402	1.173
	2440	1.131
	2480	1.125

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

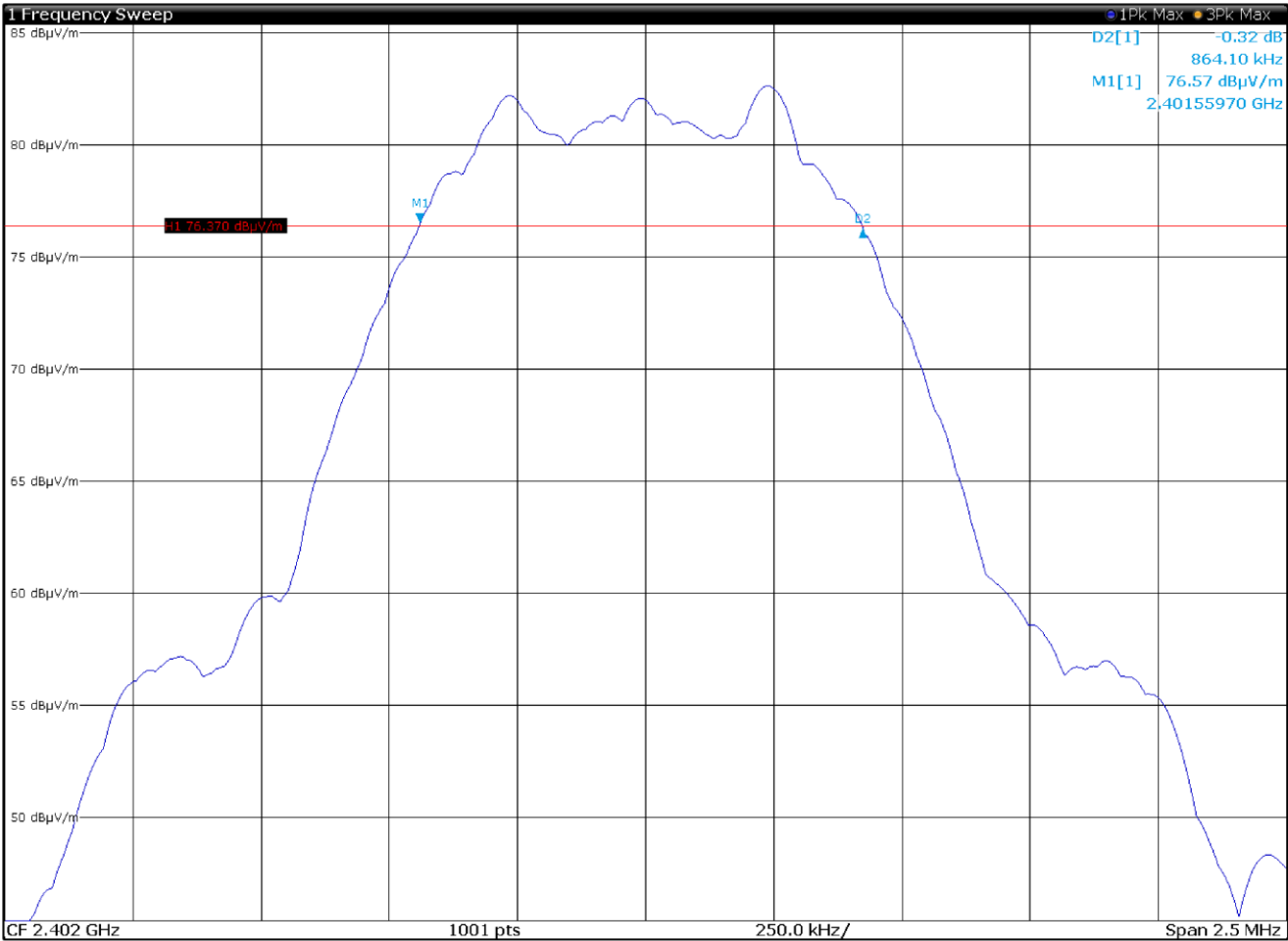


Figure 8.3-1: 6 dB bandwidth on low channel, sample plot

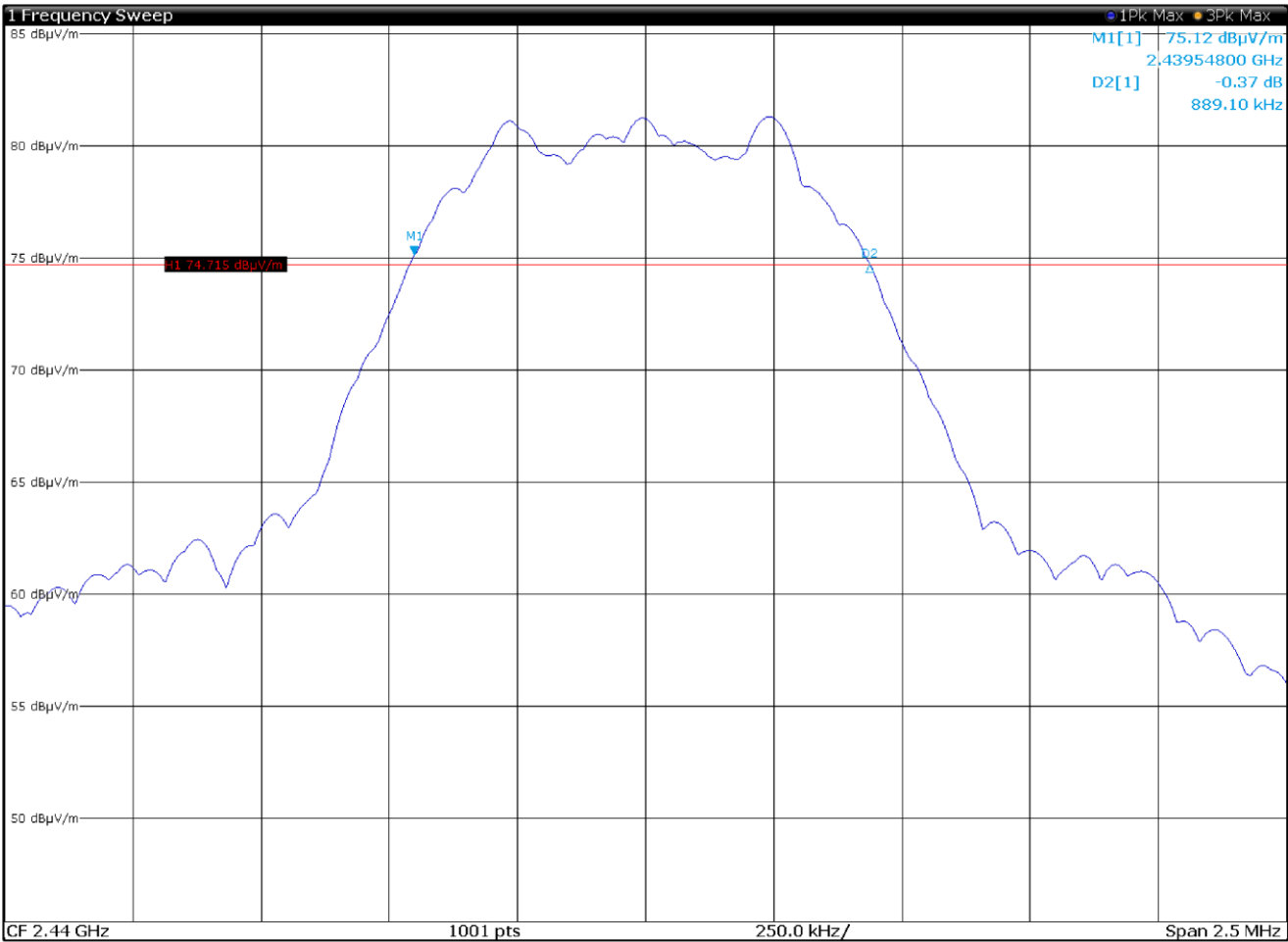


Figure 8.3-2: 6 dB bandwidth on mid channel, sample plot

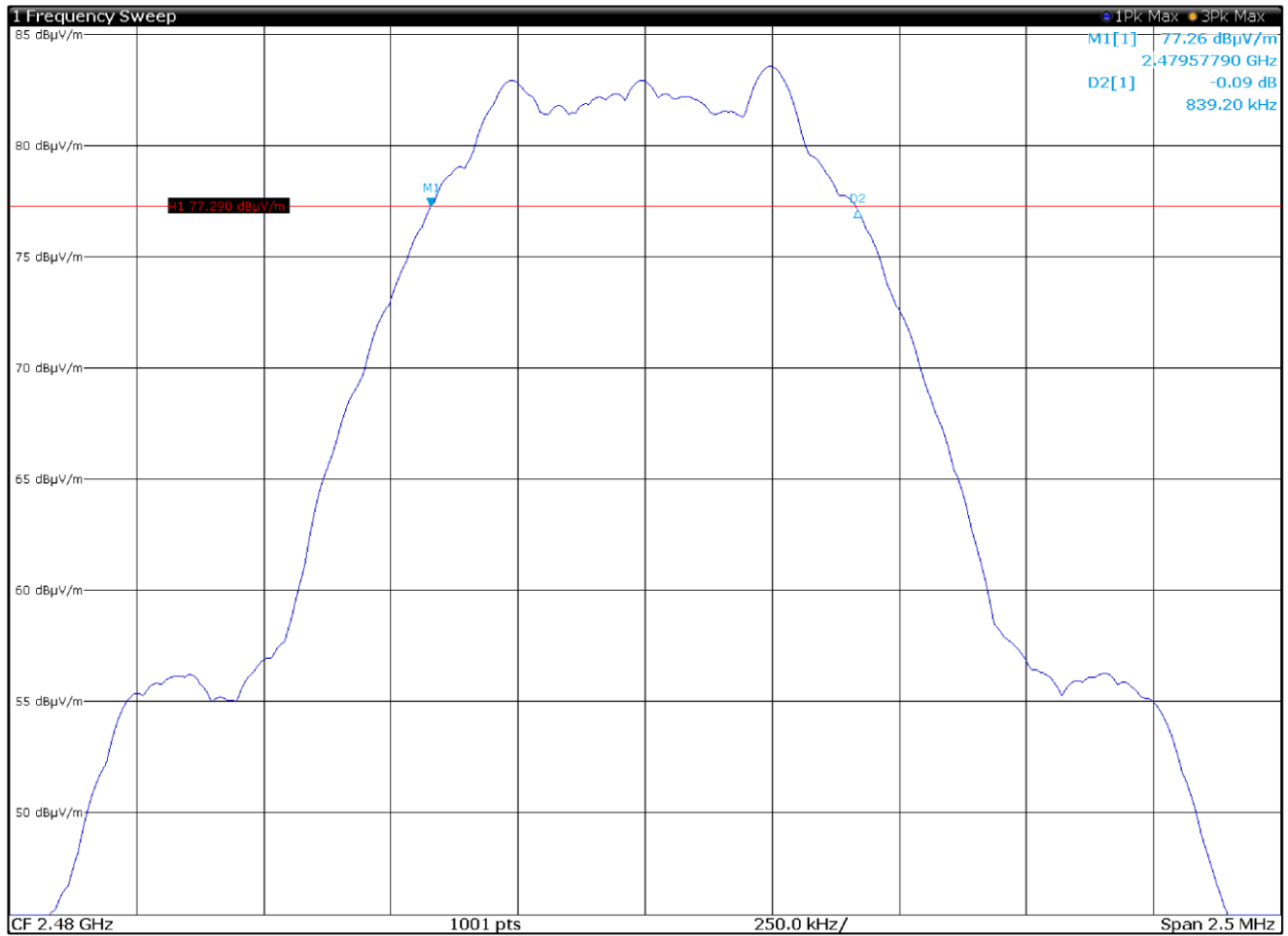


Figure 8.3-3: 6 dB bandwidth on high channel, sample plot

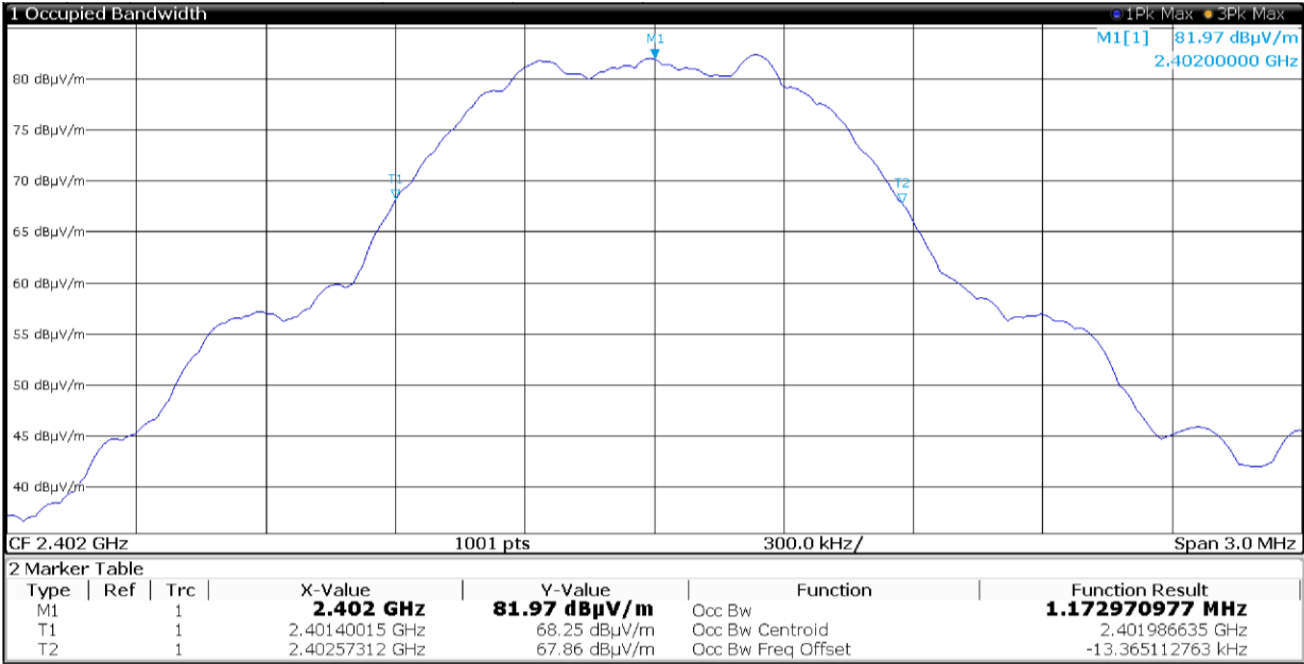


Figure 8.3-4: 99% bandwidth on low channel, sample plot

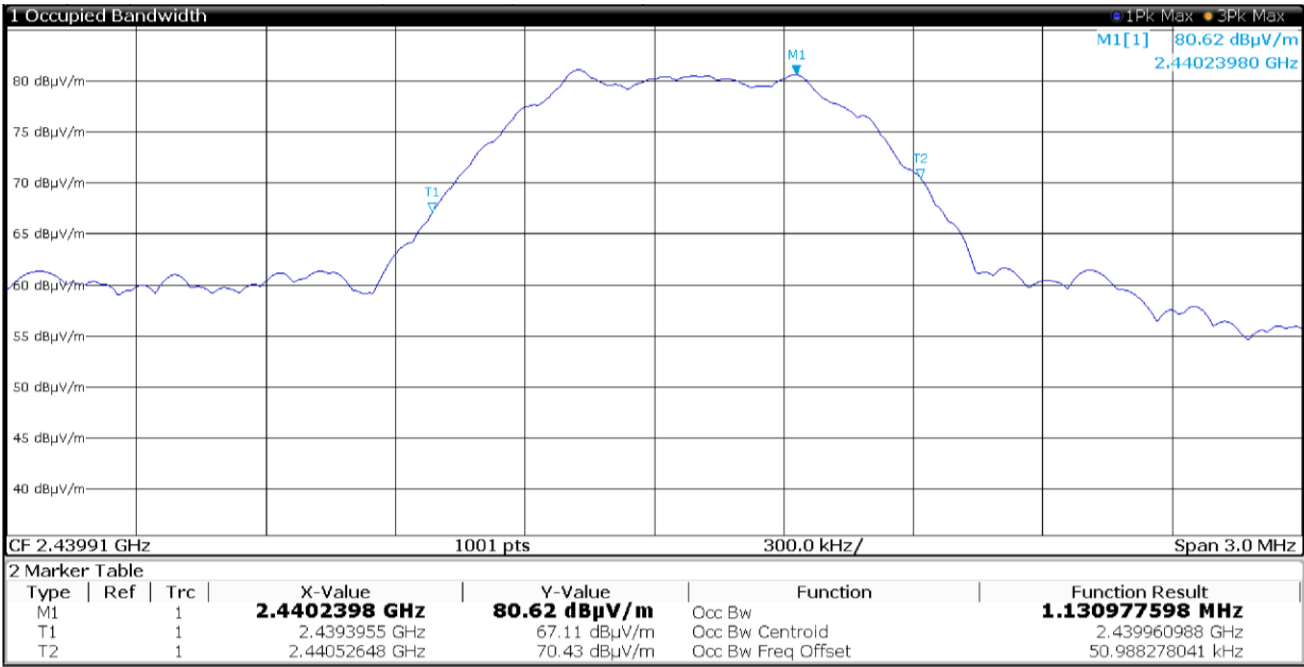


Figure 8.3-5: 99% bandwidth on mid channel, sample plot

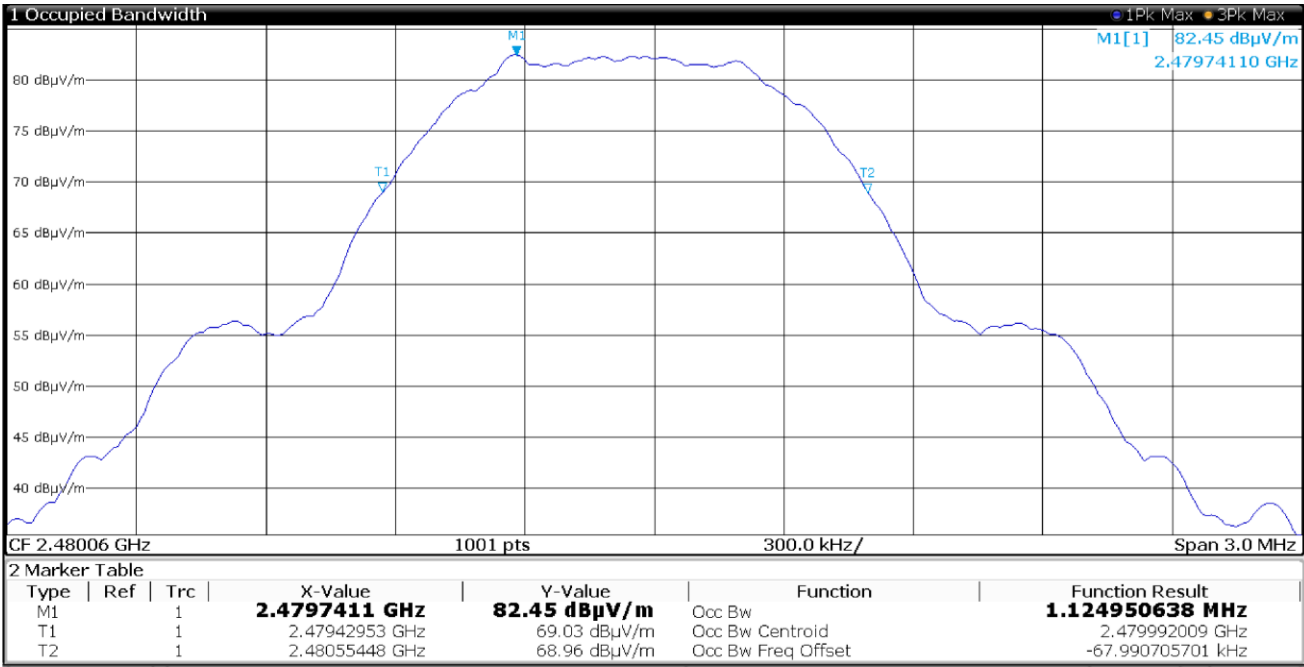


Figure 8.3-6: 99% bandwidth on high channel, sample plot

8.4 FCC 15.247(b) Transmitter output power and e.i.r.p. requirements

8.4.1 Definitions and limits

- (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
- (3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
 - (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

8.4.2 Test summary

Test date	2020-04-21	Temperature	21 °C
Test engineer	G. Tepelena	Air pressure	1025 mbar
Verdict	Pass	Relative humidity	50 %

8.4.3 Observations, settings and special notes

The test was performed according to DTS guidelines section 8.3.1.1: Measurement using a spectrum analyzer with RBW > DTS bandwidth.

8.4.4 Test data

Table 8.4-1: Output power measurements results

Modulation	Frequency, MHz	Conducted output power, dBm	Limit	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
GFSK	2402	-7.7	30.00	37.7	-1.5	-9.2	36.00	45.2
	2440	-6.5	30.00	36.5	-1.5	-8.0	36.00	44.0
	2480	-5.5	30.00	35.5	-1.5	-7.0	36.00	43.0

$$\text{EIRP[dBm]} = \text{E[dB}\mu\text{V/m]} + 20\text{Log(d [m])} - 104.7$$

$$\text{EIRP[dBm]} = 85.99 + 20\text{Log}(3) - 104.7 = -9.2$$

$$\text{EIRP[dBm]} = 87.16 + 20\text{Log}(3) - 104.7 = -8.0$$

$$\text{EIRP[dBm]} = 88.15 + 20\text{Log}(3) - 104.7 = -7.0$$

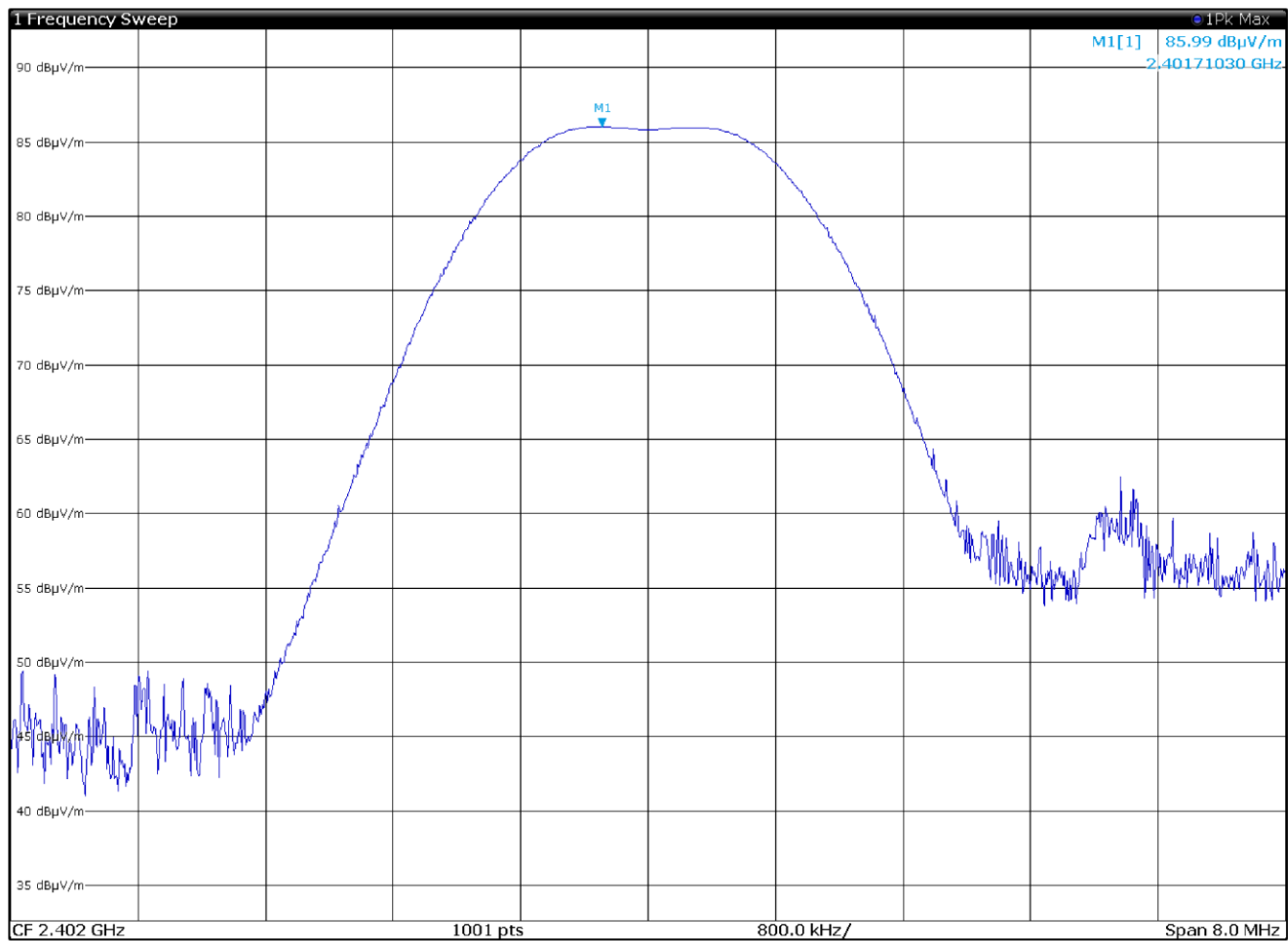


Figure 8.4-1: radiated power on low channel, sample plot

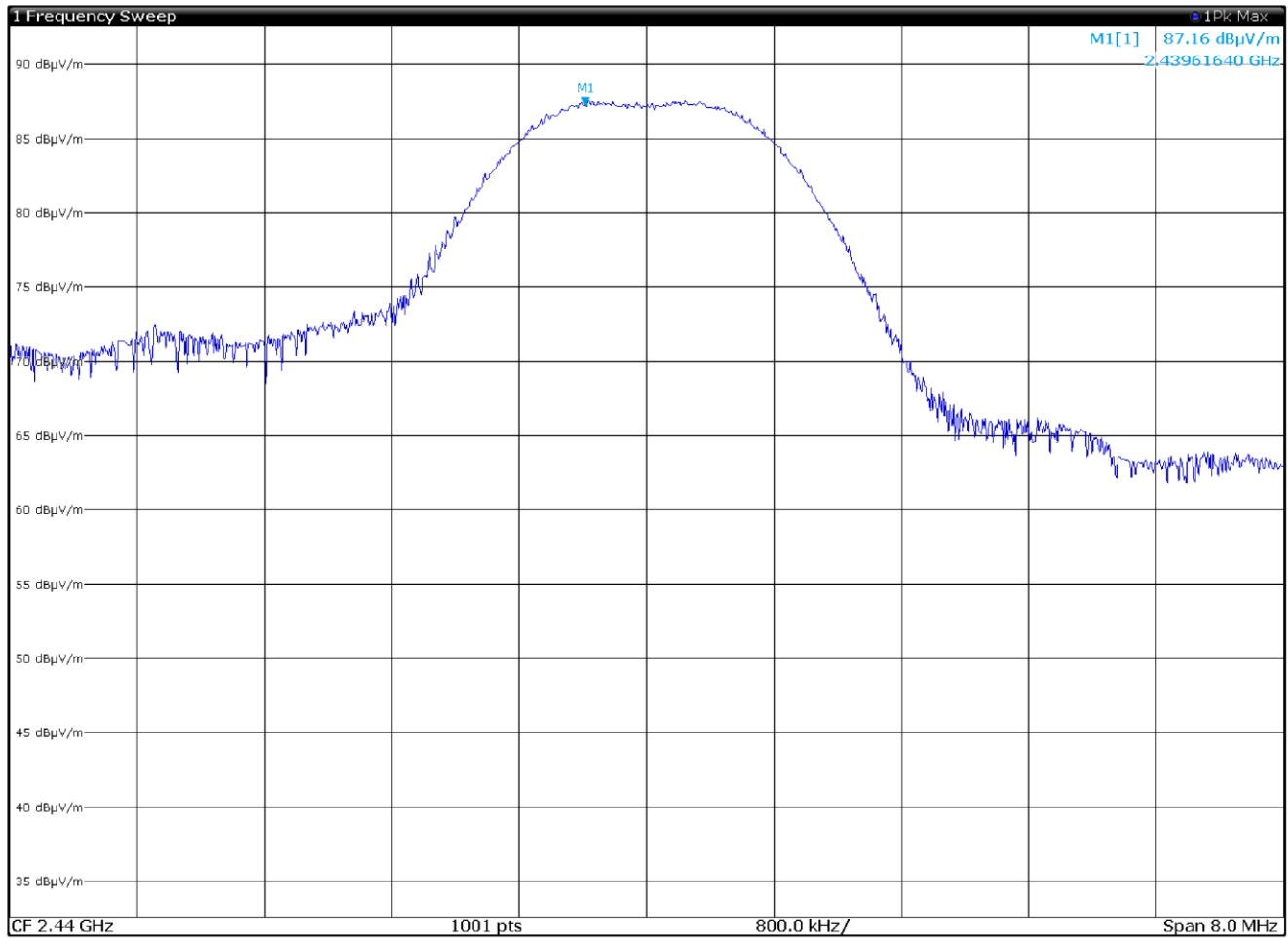


Figure 8.4-2: radiated power on mid channel, sample plot

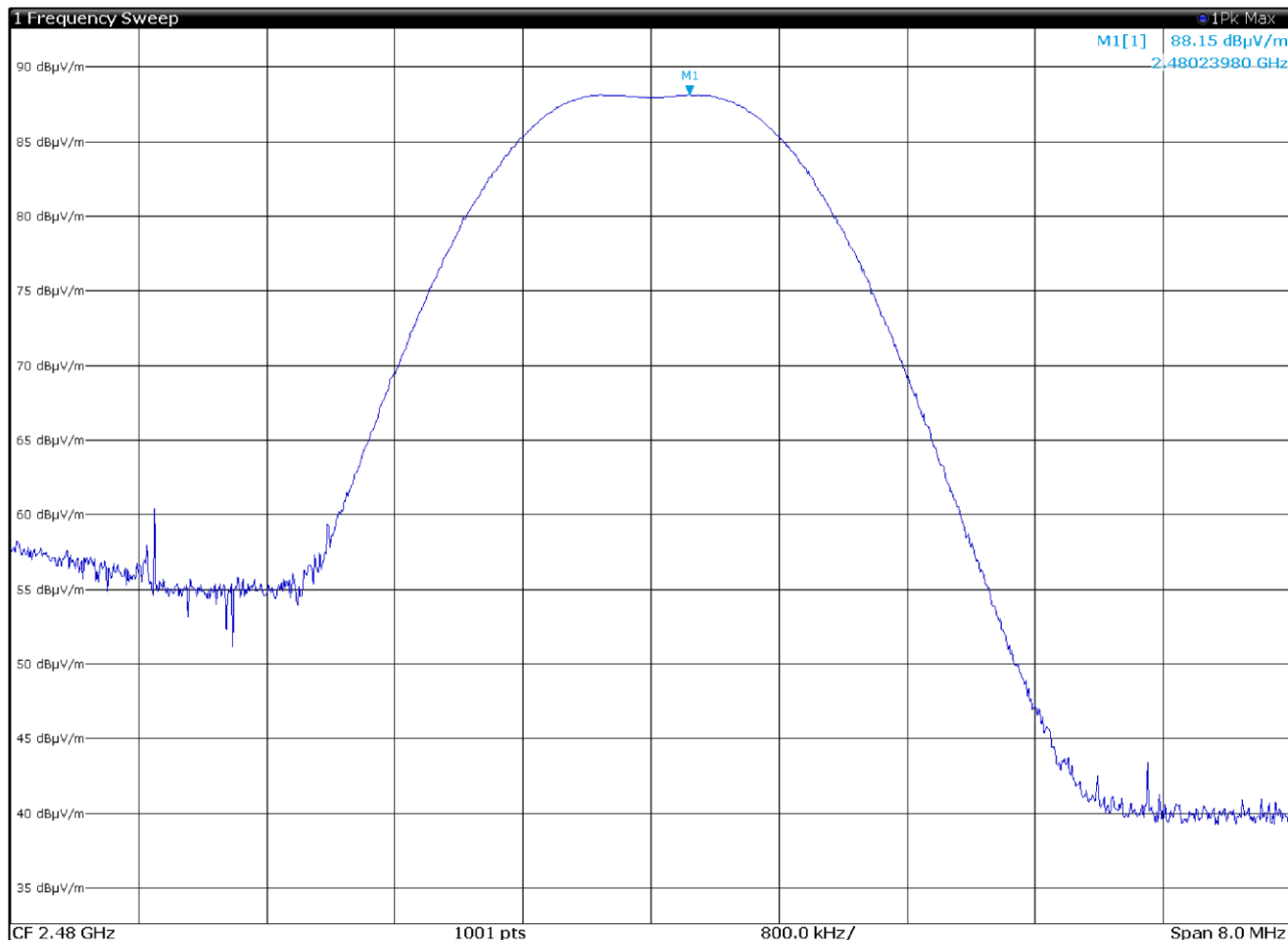


Figure 8.4-3: radiated power on high channel, sample plot

8.5 FCC 15.247(d) Spurious (out-of-band) unwanted emissions

8.5.1 Definitions and limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Table 8.5-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	μV/m	dBμV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.

For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.5-2: 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			

8.5.2 Test summary

Test date	2020-04-21	Temperature	21 °C
Test engineer	G. Tepelena	Air pressure	1025 mbar
Verdict	Pass	Relative humidity	40 %

8.5.3 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.
 Since fundamental power was tested using peak method, the spurious emissions limit is -20 dBc/100 kHz
 EUT tested in three orthogonal axes. Results refer only to worst case EUT orientation.

Receiving settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth:	120 kHz
Detector mode:	Peak
Trace mode:	Max Hold
Final measurement:	Quasi-peak

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

8.5.4 Test data

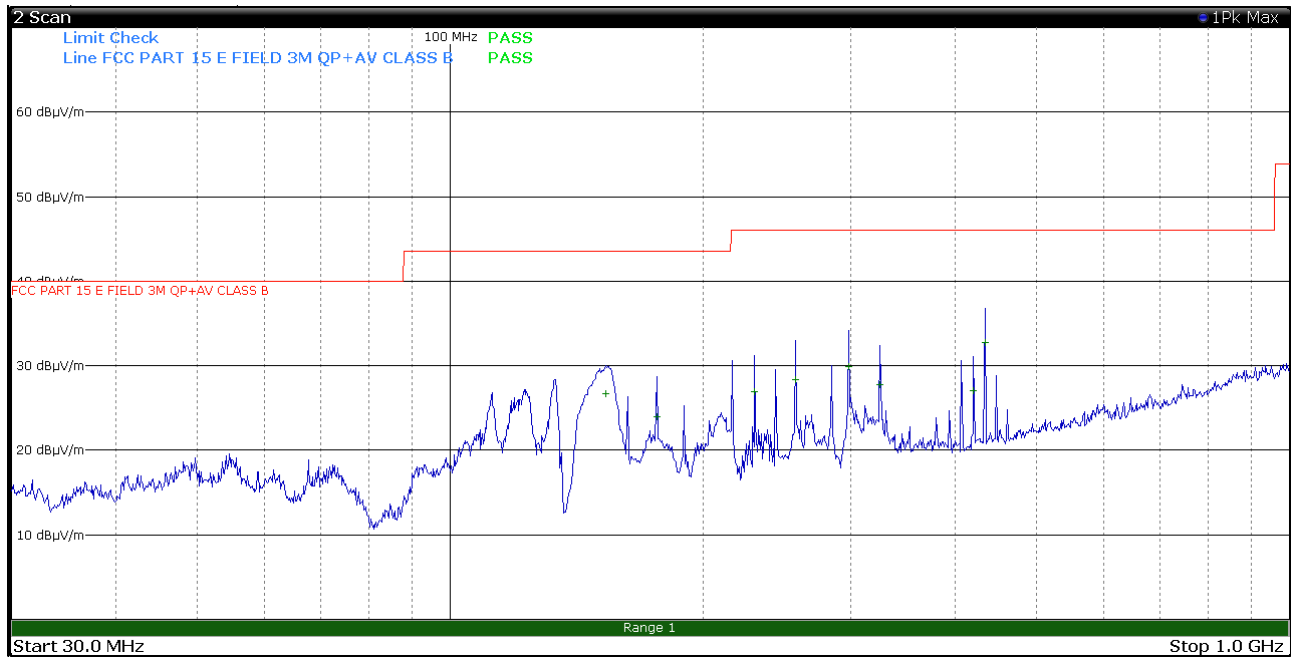


Figure 8.5-1: Radiated spurious emissions with antenna in horizontal polarization, low channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
153.3600	26.8	43.5	-16.7	QP
176.2800	24.0	43.5	-19.5	QP
230.5200	27.0	46.0	-19.0	QP
257.6400	28.5	46.0	-17.5	QP
298.3200	30.0	46.0	-16.0	QP
325.4400	27.8	46.0	-18.2	QP
420.3600	27.1	46.0	-18.9	QP
433.9200	32.8	46.0	-13.2	QP

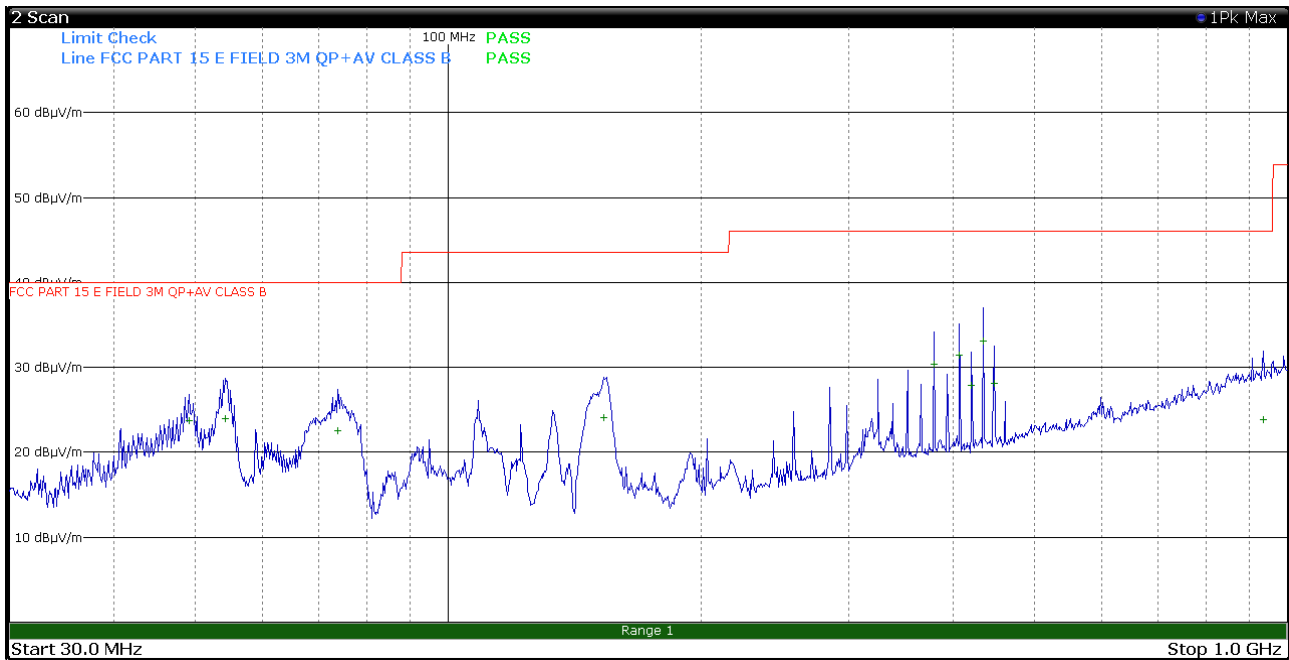


Figure 8.5-2: Radiated spurious emissions with antenna in vertical polarization, low channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
49.1100	23.8	40.0	-16.2	QP
54.2400	24.0	40.0	-16.0	QP
73.9200	22.6	40.0	-17.4	QP
153.3900	24.2	43.5	-19.3	QP
379.6800	30.4	46.0	-15.6	QP
406.8000	31.5	46.0	-14.5	QP
420.3600	27.9	46.0	-18.1	QP
433.9200	33.1	46.0	-12.9	QP
447.4800	28.2	46.0	-17.8	QP
935.6400	23.9	46.0	-22.1	QP

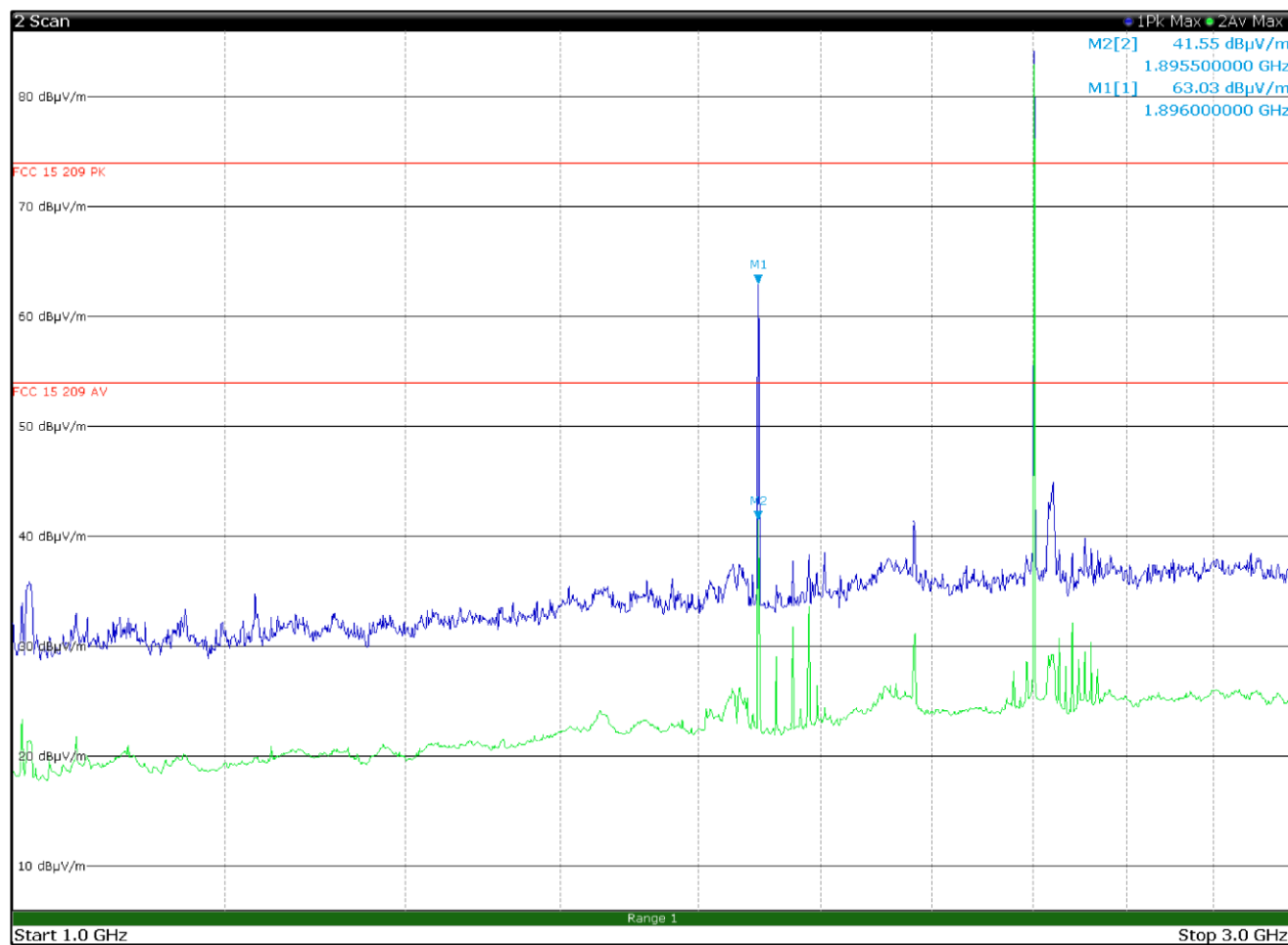


Figure 8.5-3: Radiated spurious emissions with antenna in horizontal polarization, low channel

All the peaks are below the general limits specified in §15.209(a)

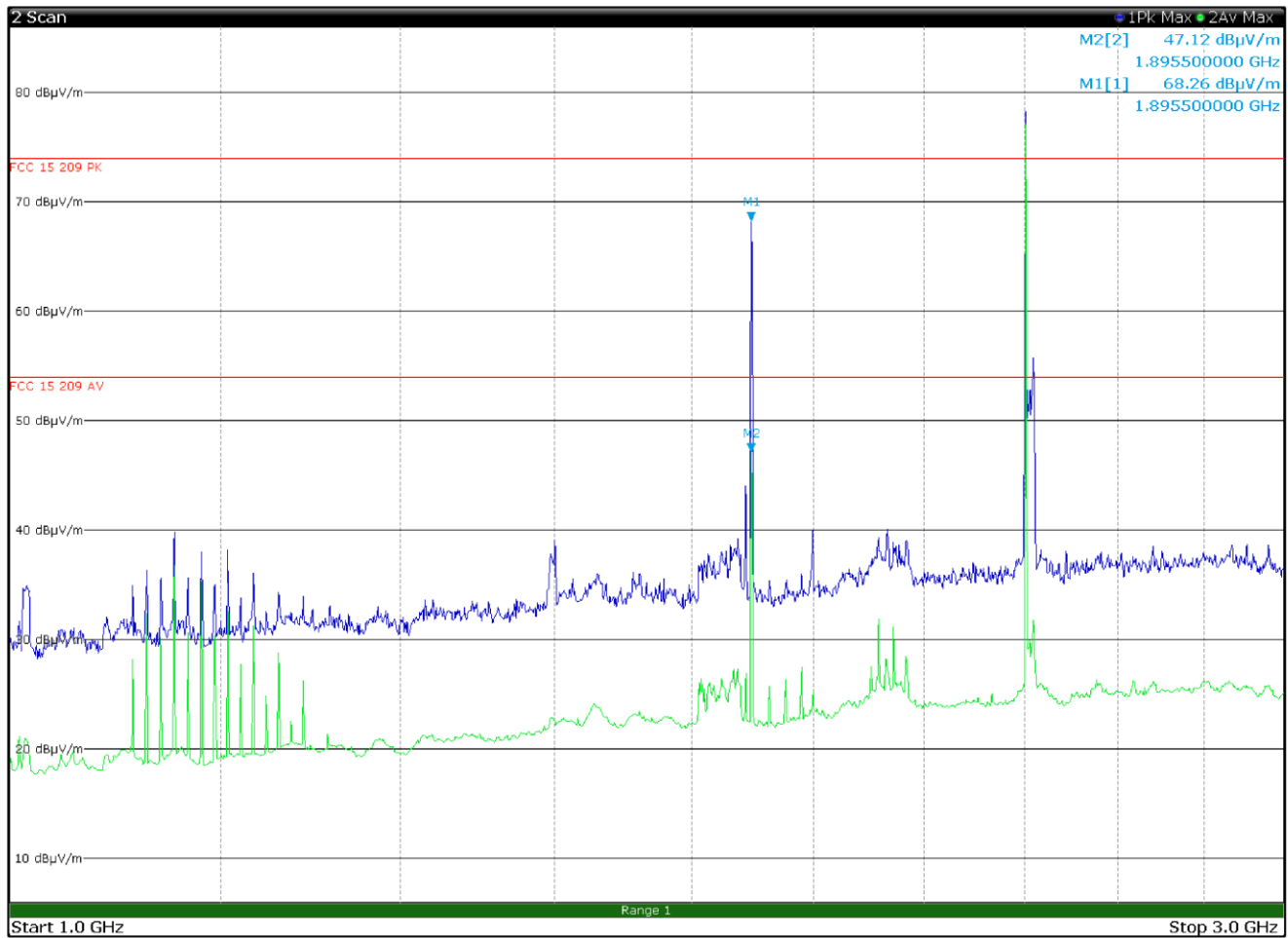


Figure 8.5-4: Radiated spurious emissions with antenna in vertical polarization, low channel

All the peaks are below the general limits specified in §15.209(a)

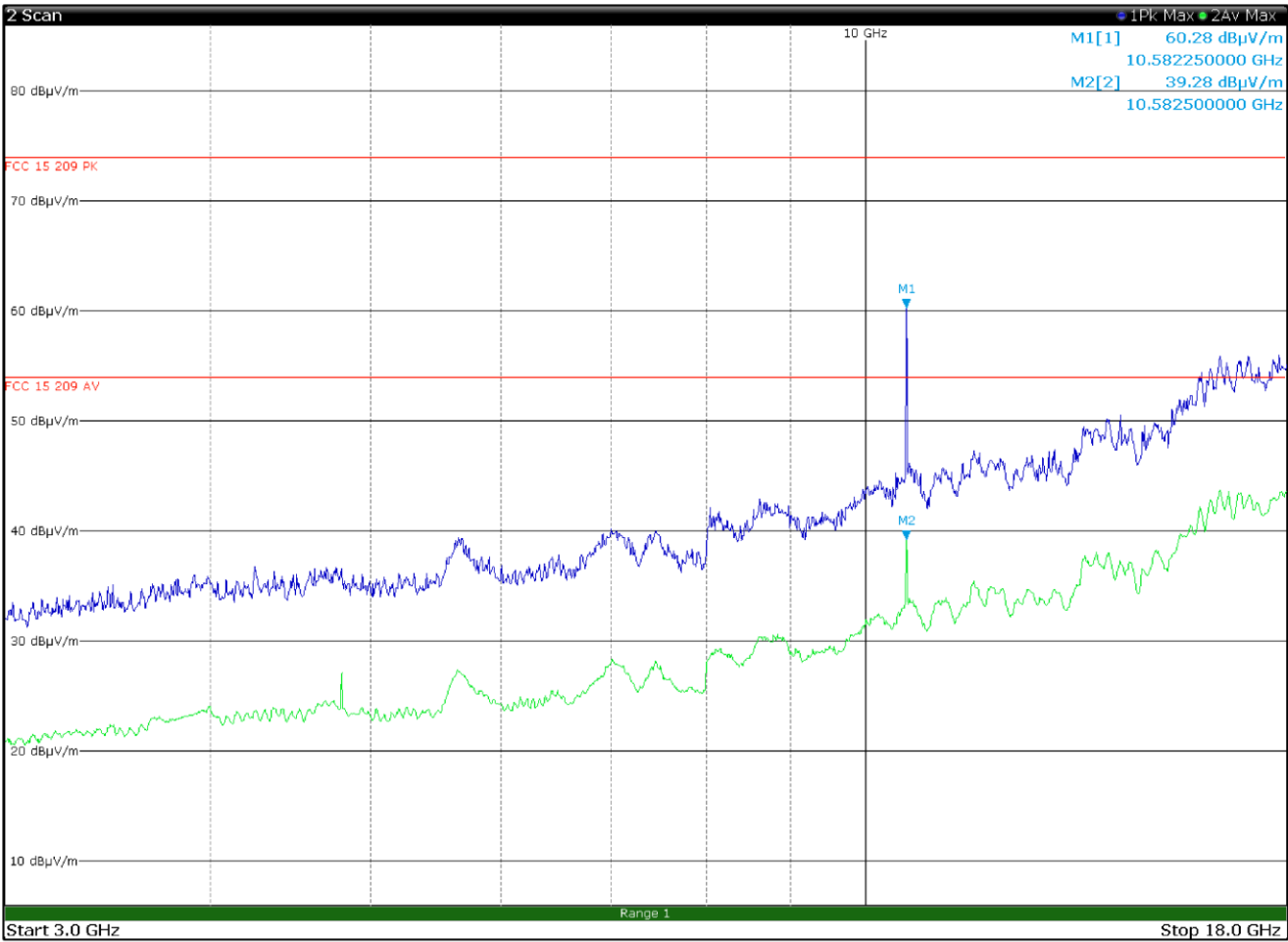


Figure 8.5-5: Radiated spurious emissions with antenna in horizontal polarization, low channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
10582.2500	60.28	74.0	-13.72	Pk
10582.2500	39.28	54.0	-14.72	Av

Av detector measured as state in clause 8.5.3

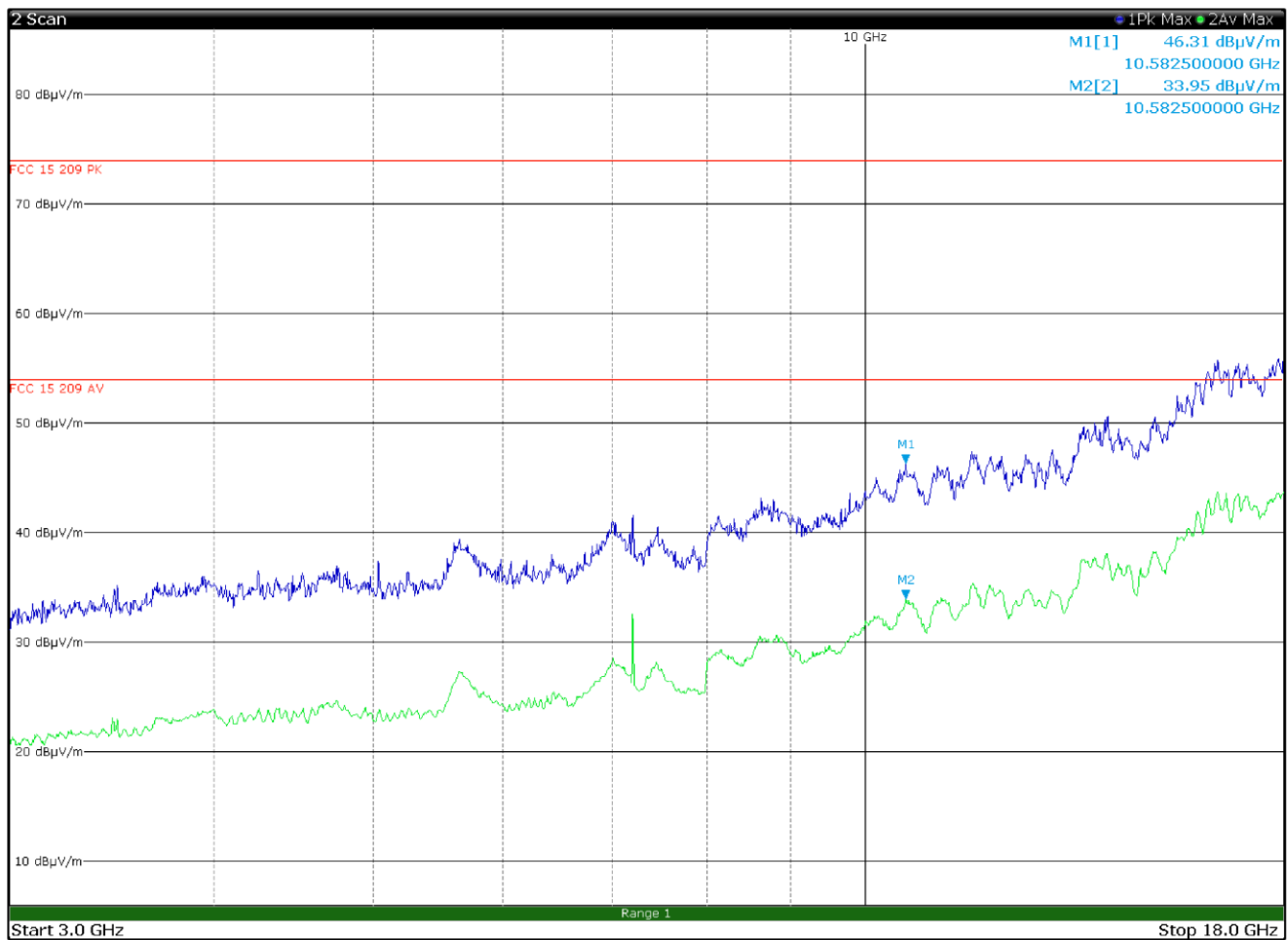


Figure 8.5-6: Radiated spurious emissions with antenna in vertical polarization, low channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
10582.2500	46.31	74.0	-27.69	Pk
10582.2500	33.95	54.0	-20.05	Av

Av detector measured as state in clause 8.5.3

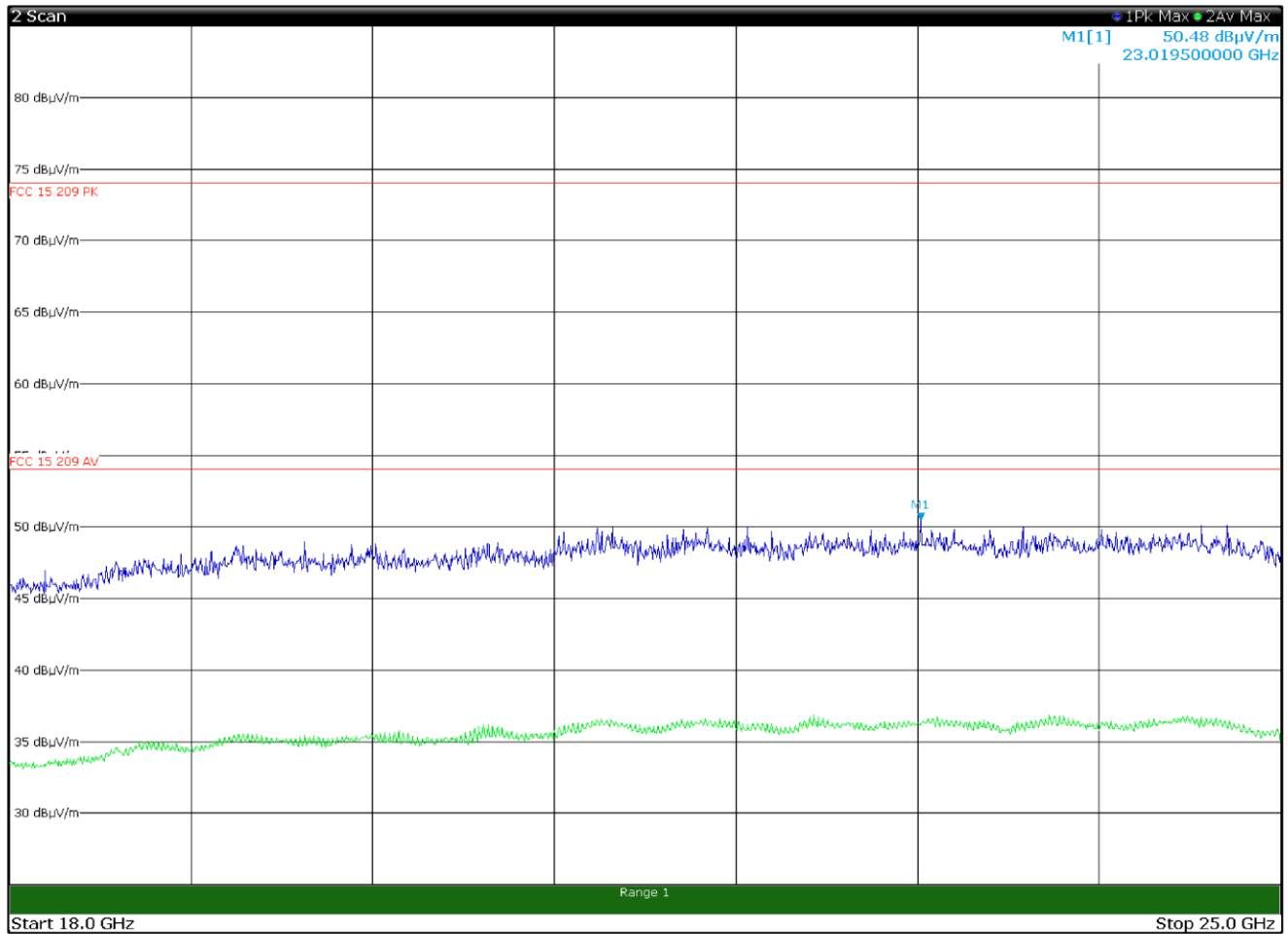


Figure 8.5-7: Radiated spurious emissions with antenna in horizontal polarization, low channel

All the peaks are below the general limits specified in §15.209(a)

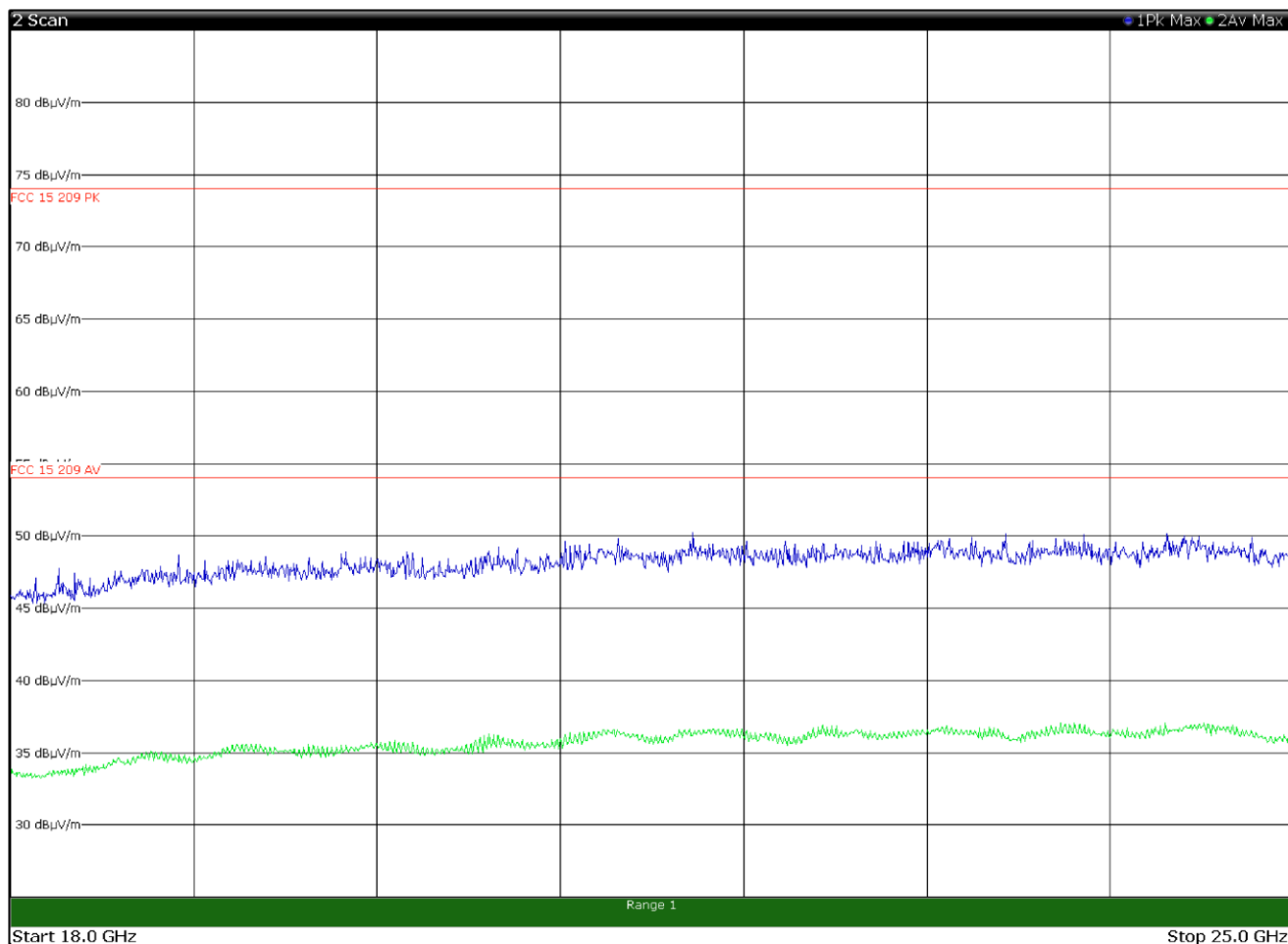


Figure 8.5-8: Radiated spurious emissions with antenna in vertical polarization, low channel

All the peaks are below the general limits specified in §15.209(a)

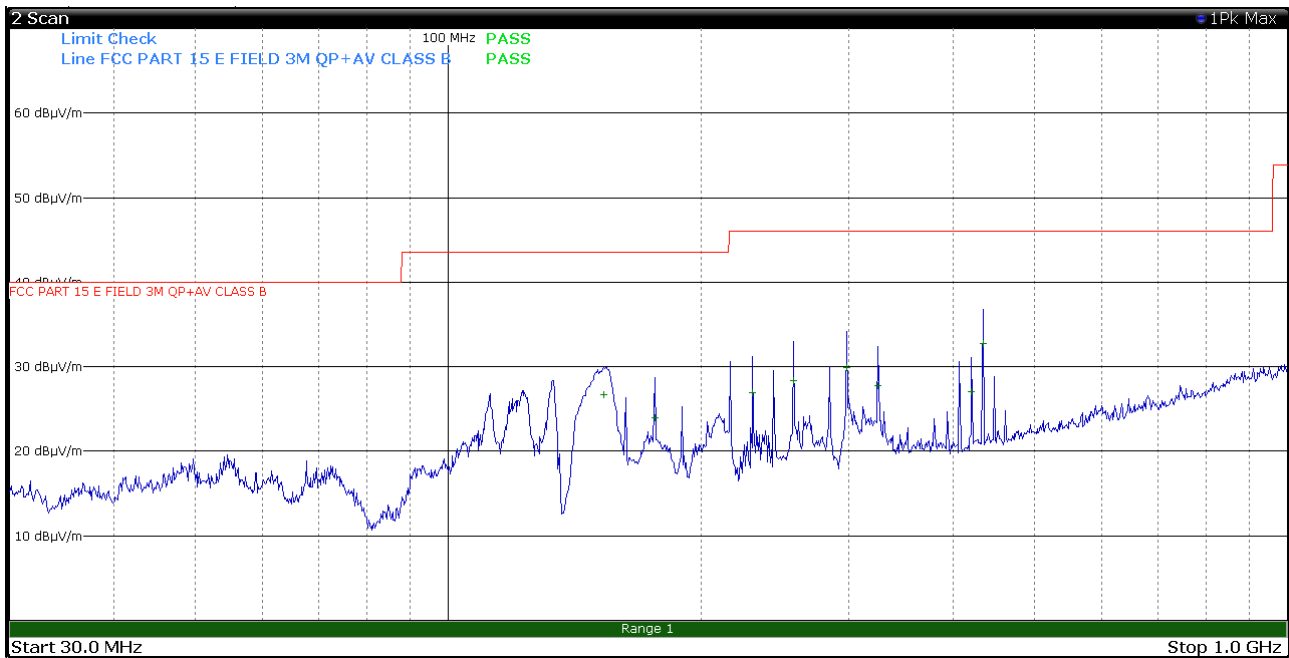


Figure 8.5-9: Radiated spurious emissions with antenna in horizontal polarization, mid channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
153.3600	26.8	43.5	-16.7	QP
176.2800	24.0	43.5	-19.5	QP
230.5200	27.0	46.0	-19.0	QP
257.6400	28.5	46.0	-17.5	QP
298.3200	30.0	46.0	-16.0	QP
325.4400	27.8	46.0	-18.2	QP
420.3600	27.1	46.0	-18.9	QP
433.9200	32.8	46.0	-13.2	QP

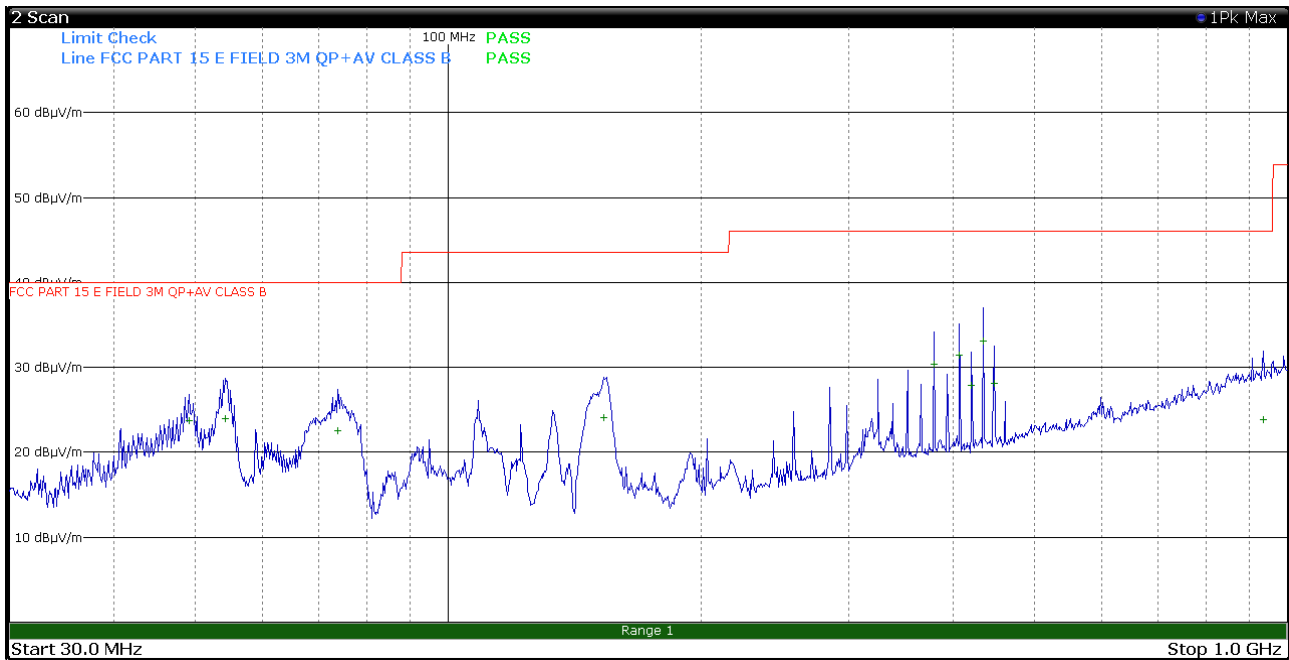


Figure 8.5-10: Radiated spurious emissions with antenna in vertical polarization, mid channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
49.1100	23.8	40.0	-16.2	QP
54.2400	24.0	40.0	-16.0	QP
73.9200	22.6	40.0	-17.4	QP
153.3900	24.2	43.5	-19.3	QP
379.6800	30.4	46.0	-15.6	QP
406.8000	31.5	46.0	-14.5	QP
420.3600	27.9	46.0	-18.1	QP
433.9200	33.1	46.0	-12.9	QP
447.4800	28.2	46.0	-17.8	QP
935.6400	23.9	46.0	-22.1	QP

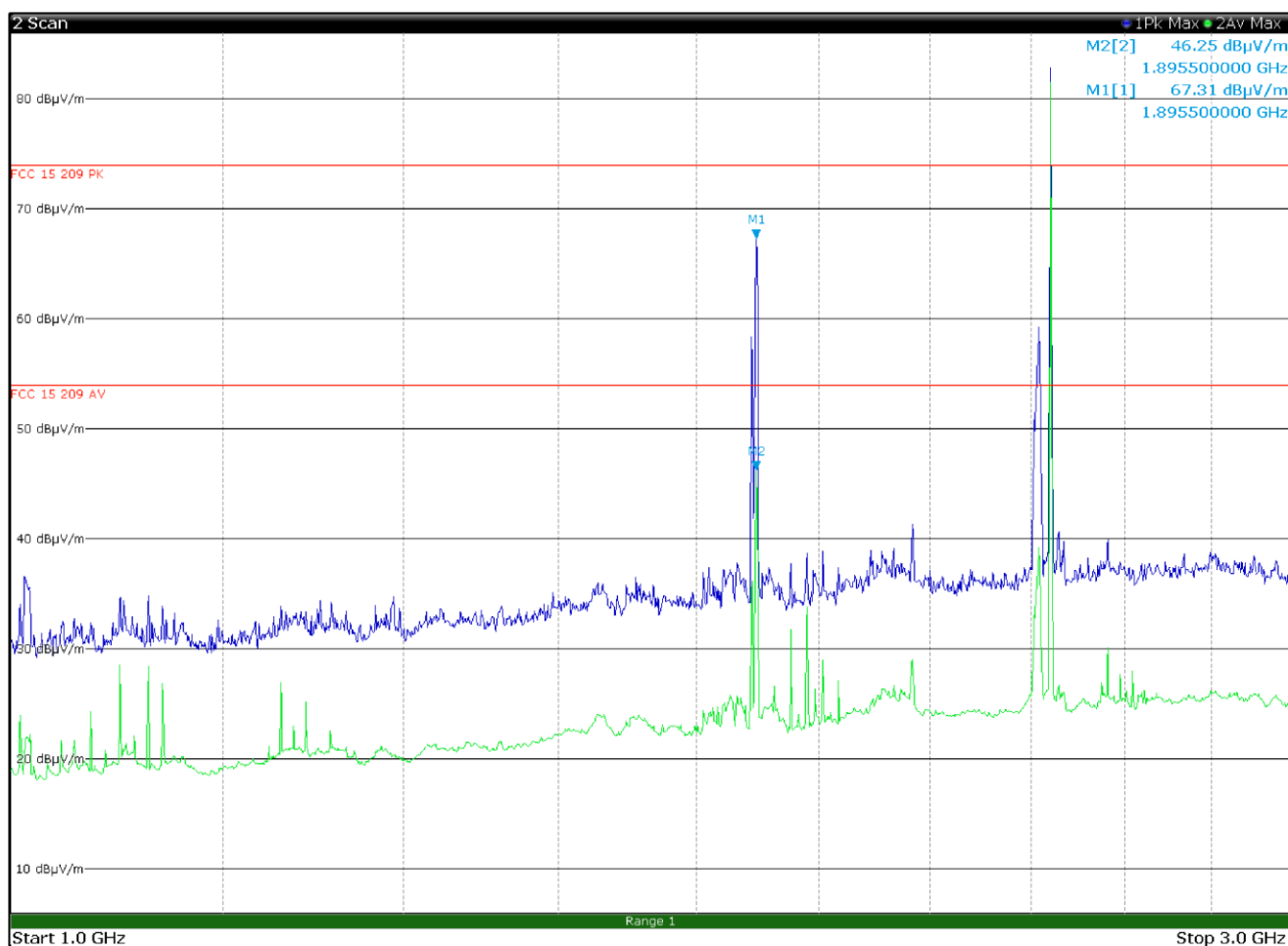


Figure 8.5-11: Radiated spurious emissions with antenna in horizontal polarization, mid channel

All the peaks are below the general limits specified in §15.209(a)

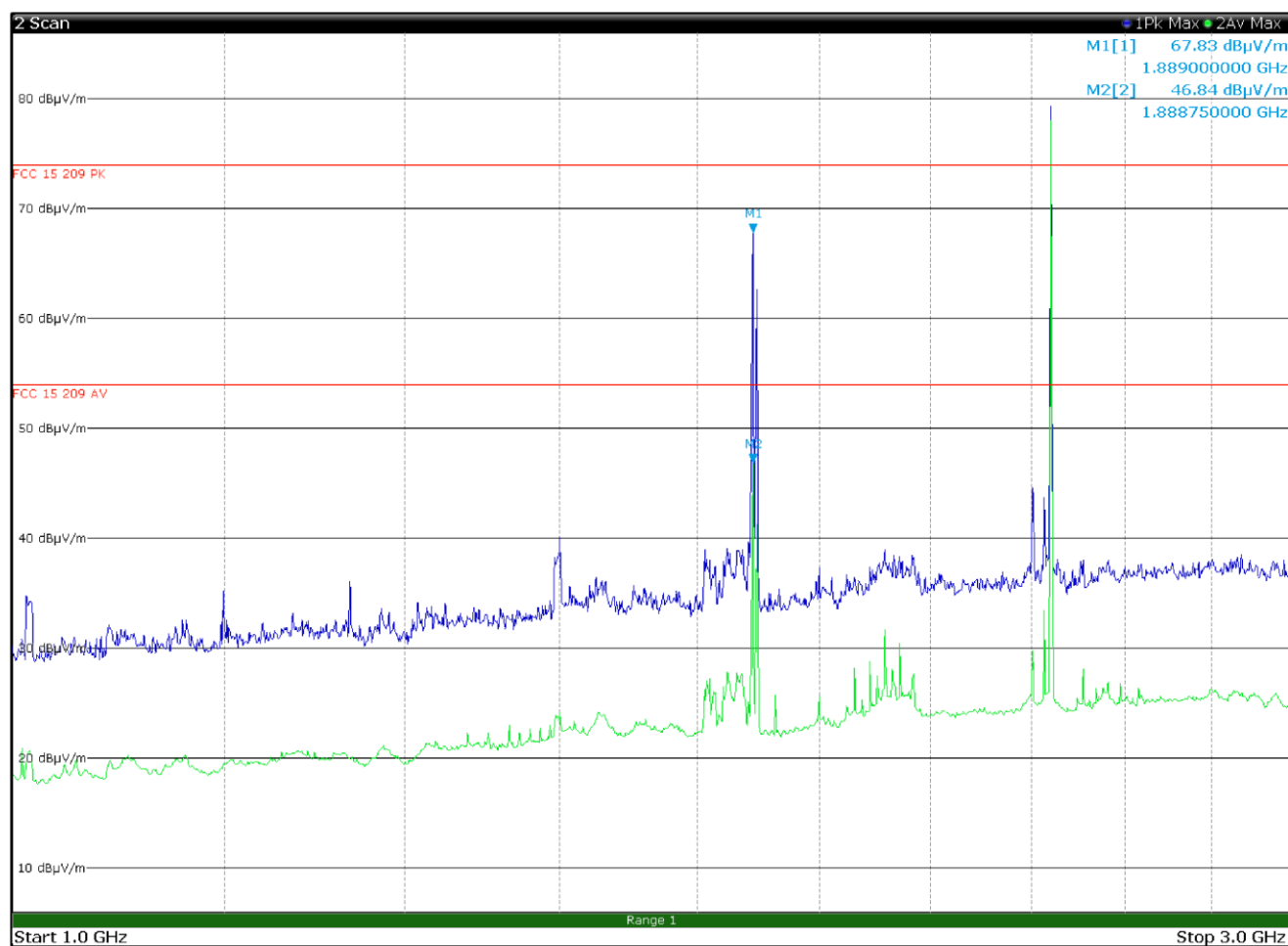


Figure 8.5-12: Radiated spurious emissions with antenna in vertical polarization, mid channel

All the peaks are below the general limits specified in §15.209(a)

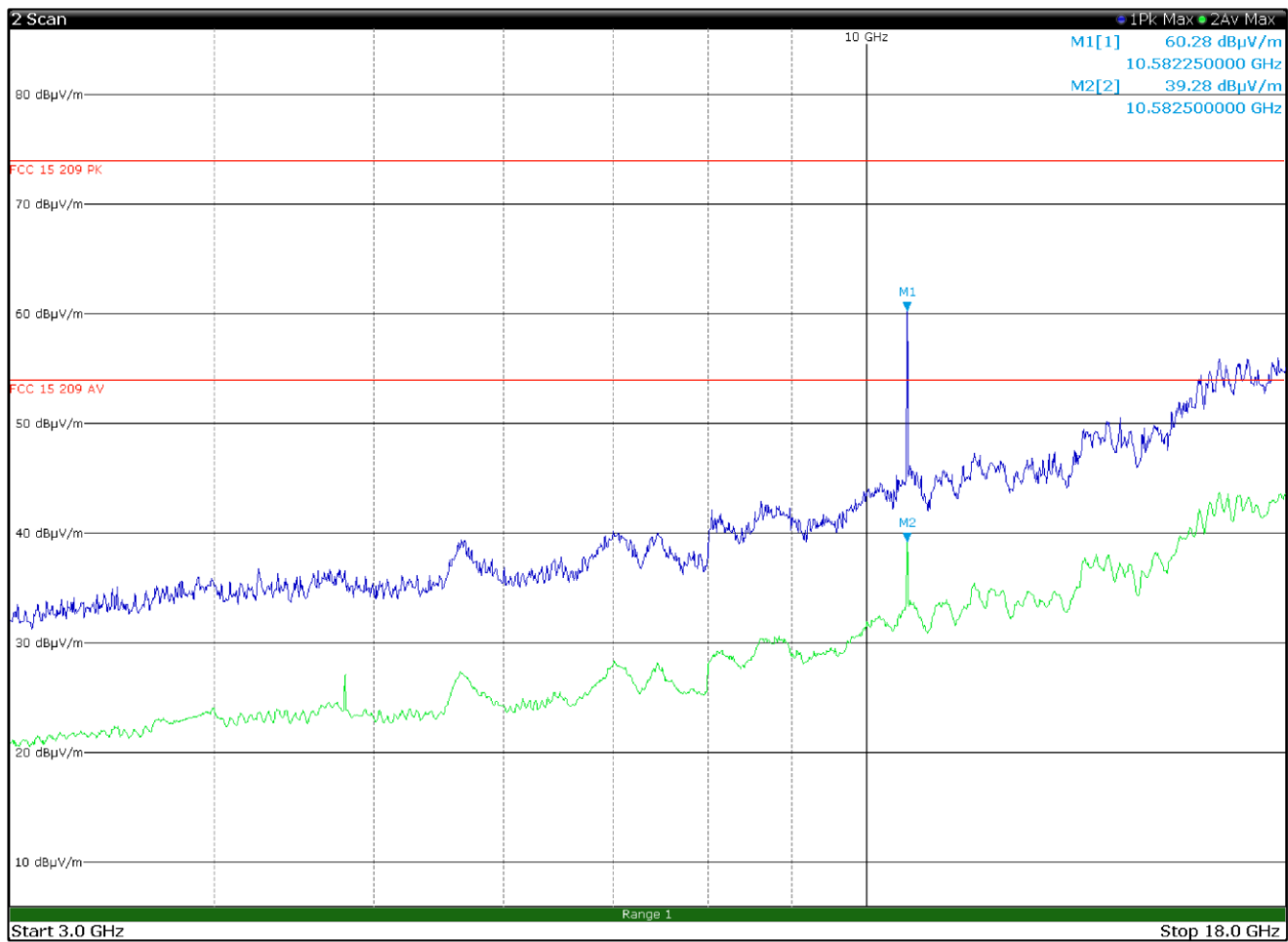


Figure 8.5-13: Radiated spurious emissions with antenna in horizontal polarization, mid channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
10582.2500	60.28	74.0	-13.72	Pk
10582.2500	39.28	54.0	-14.72	Av

Av detector measured as state in clause 8.5.3

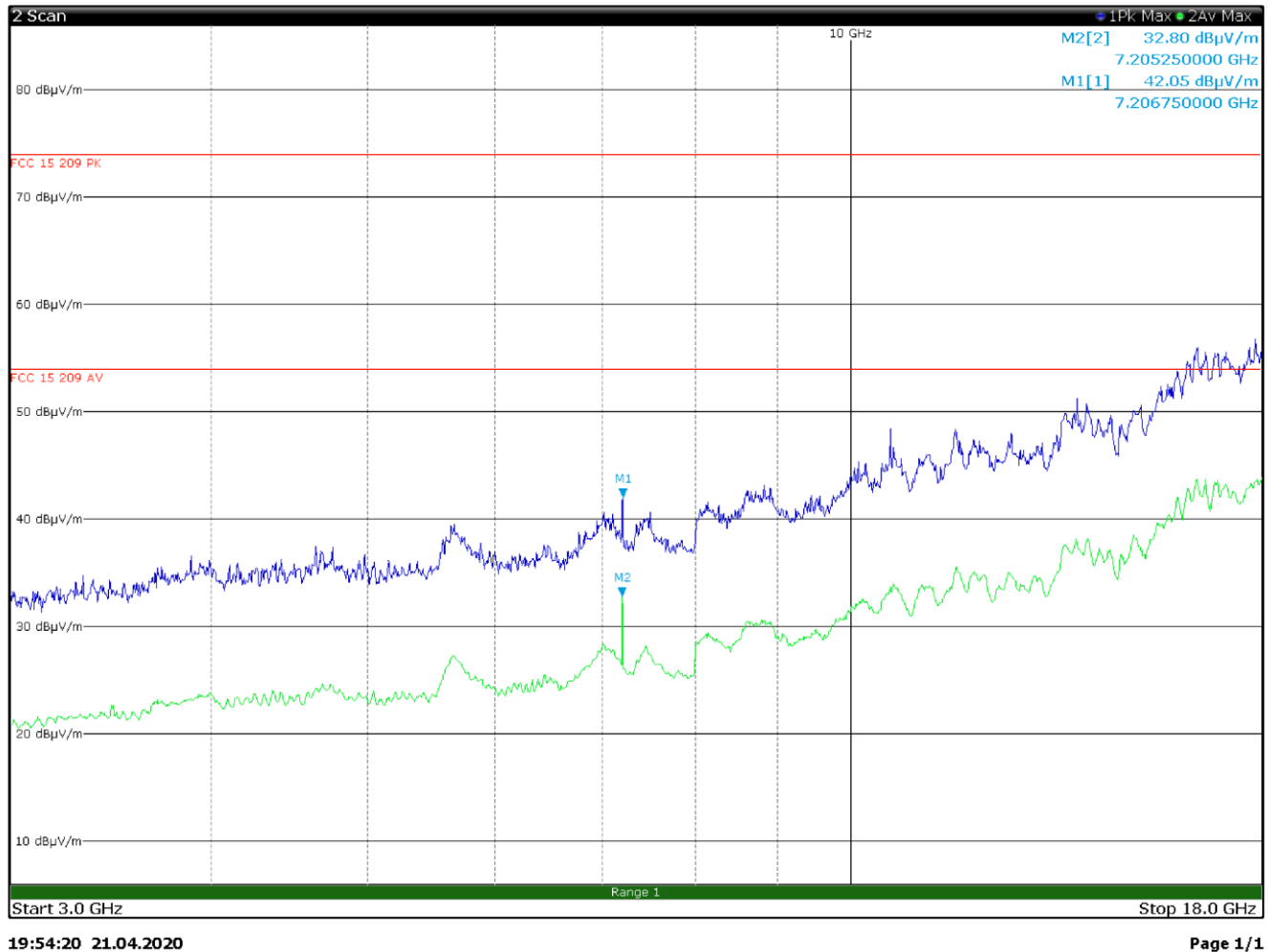


Figure 8.5-14: Radiated spurious emissions with antenna in vertical polarization, mid channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
7205.25000	42.05	74.0	-31.95	Pk
7206.75000	32.80	54.0	-21.20	Av

Av detector measured as state in clause 8.5.3

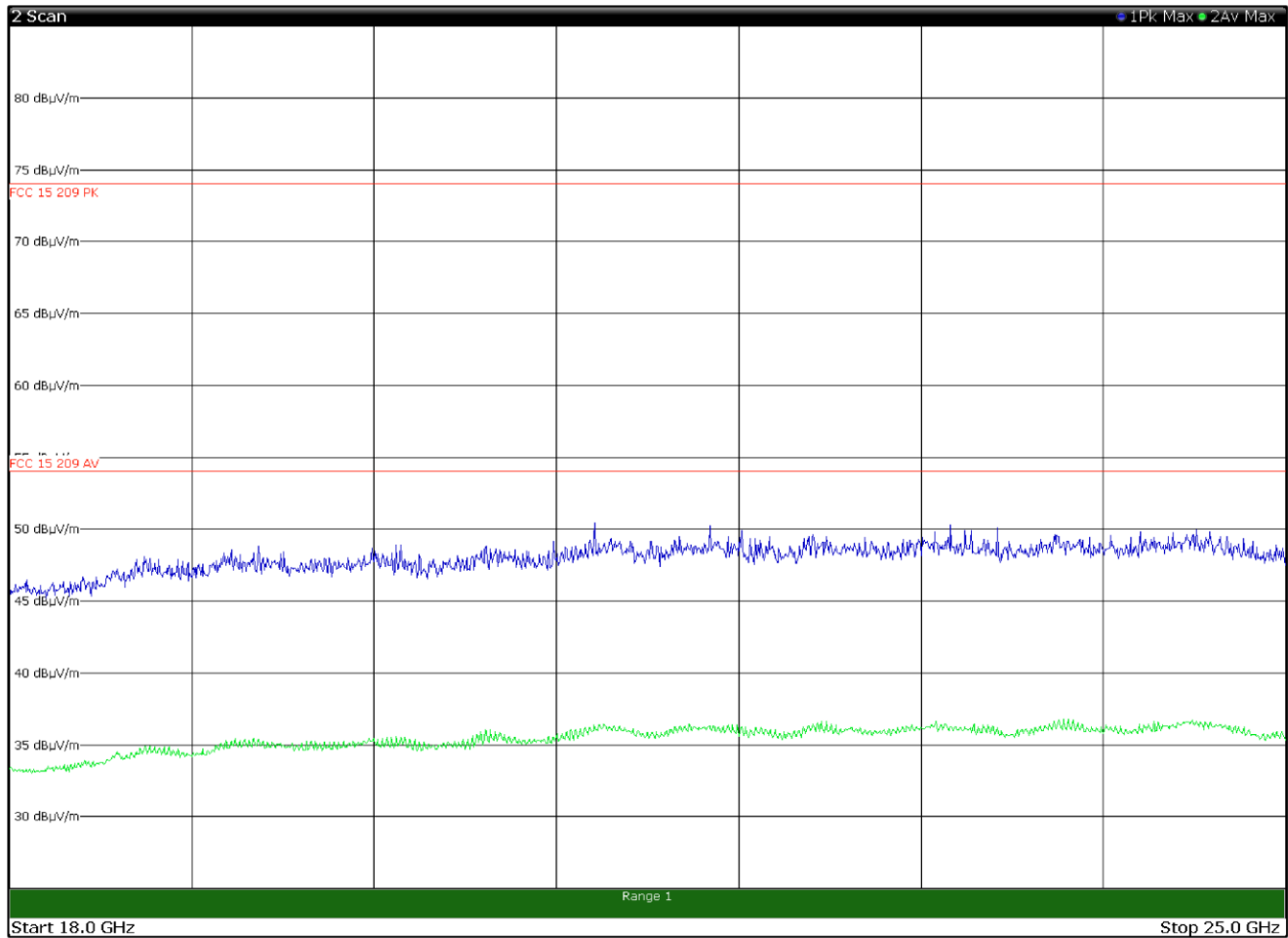


Figure 8.5-15: Radiated spurious emissions with antenna in horizontal polarization, mid channel

All the peaks are below the general limits specified in §15.209(a)

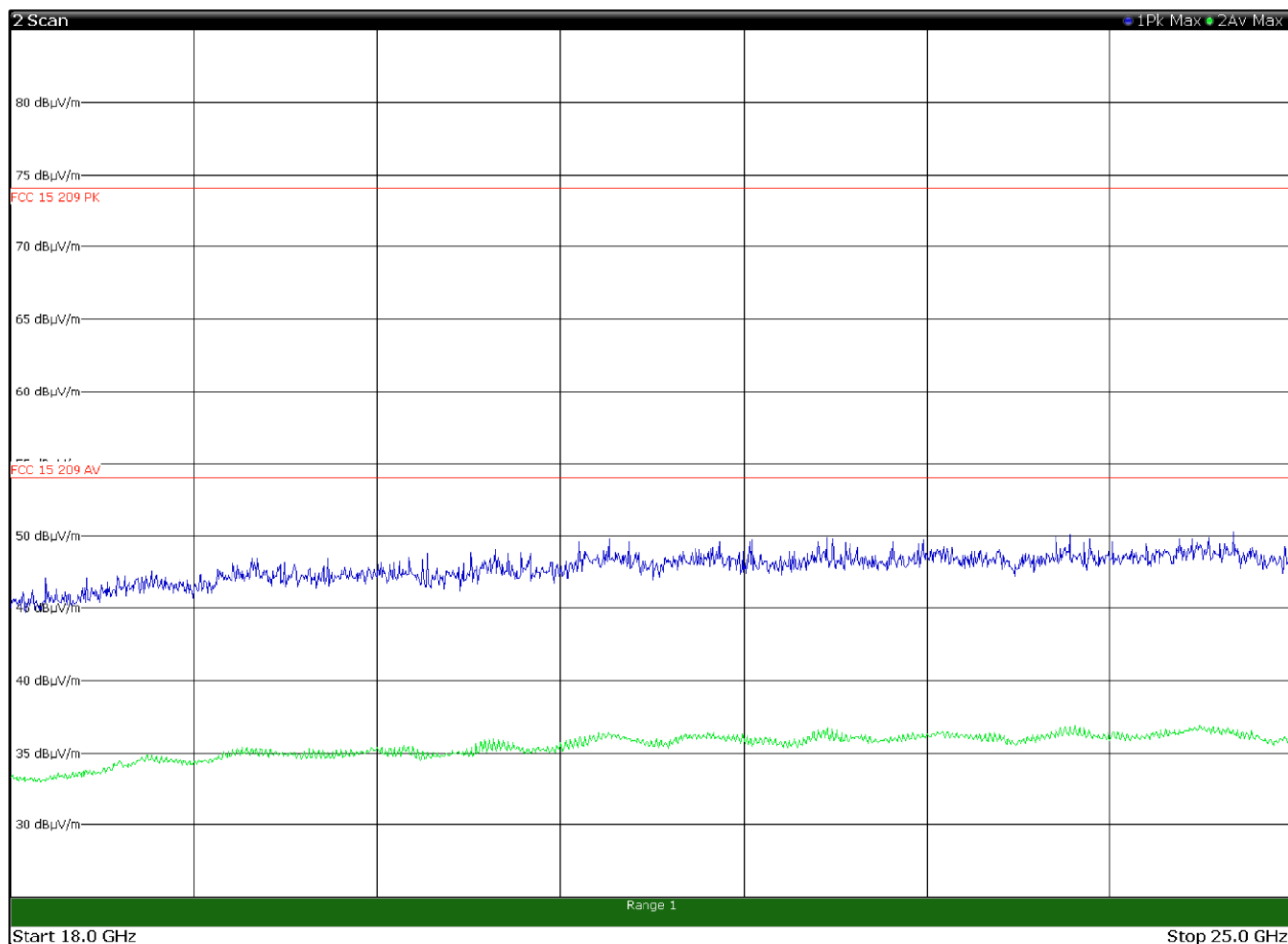


Figure 8.5-16: Radiated spurious emissions with antenna in vertical polarization, mid channel

All the peaks are below the general limits specified in §15.209(a)

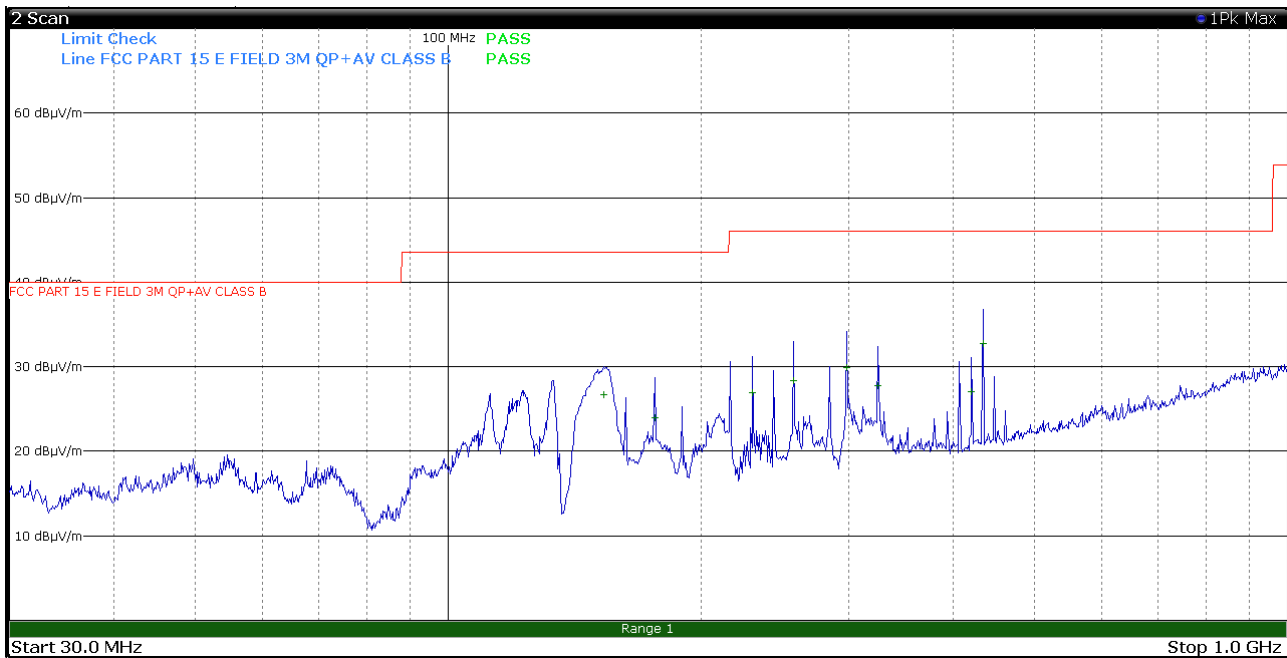


Figure 8.5-17: Radiated spurious emissions with antenna in horizontal polarization, high channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
153.3600	26.8	43.5	-16.7	QP
176.2800	24.0	43.5	-19.5	QP
230.5200	27.0	46.0	-19.0	QP
257.6400	28.5	46.0	-17.5	QP
298.3200	30.0	46.0	-16.0	QP
325.4400	27.8	46.0	-18.2	QP
420.3600	27.1	46.0	-18.9	QP
433.9200	32.8	46.0	-13.2	QP

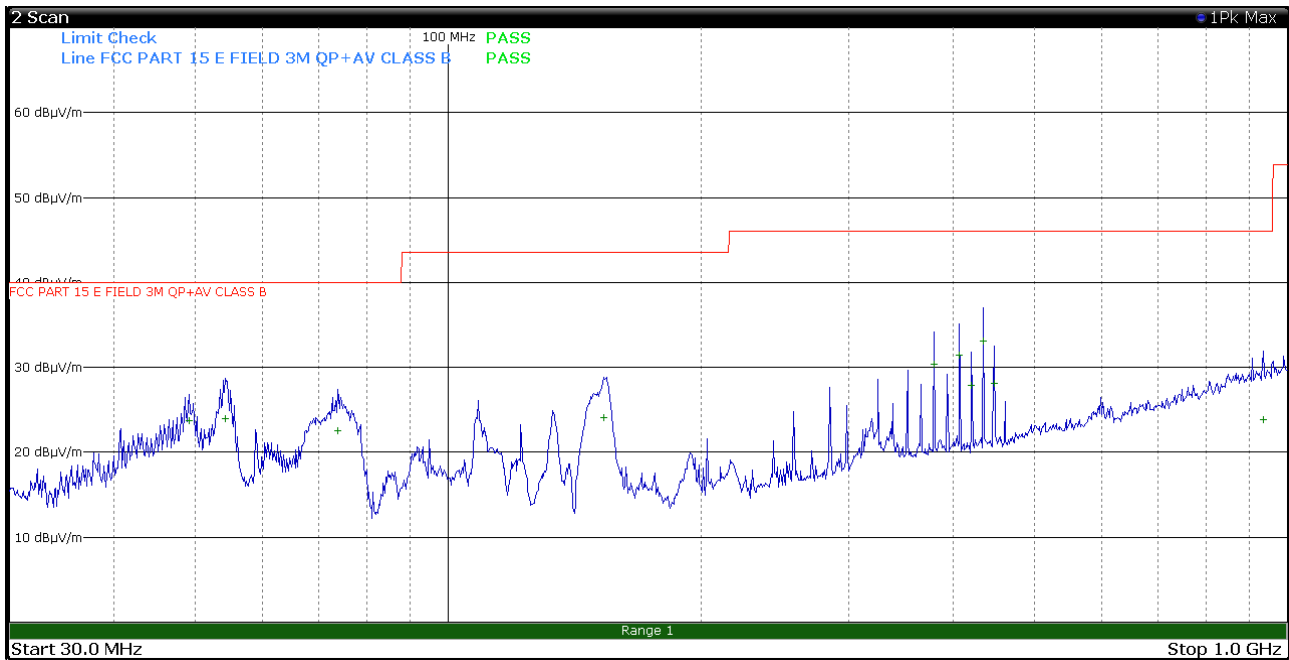


Figure 8.5-18: Radiated spurious emissions with antenna in vertical polarization, high channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
49.1100	23.8	40.0	-16.2	QP
54.2400	24.0	40.0	-16.0	QP
73.9200	22.6	40.0	-17.4	QP
153.3900	24.2	43.5	-19.3	QP
379.6800	30.4	46.0	-15.6	QP
406.8000	31.5	46.0	-14.5	QP
420.3600	27.9	46.0	-18.1	QP
433.9200	33.1	46.0	-12.9	QP
447.4800	28.2	46.0	-17.8	QP
935.6400	23.9	46.0	-22.1	QP

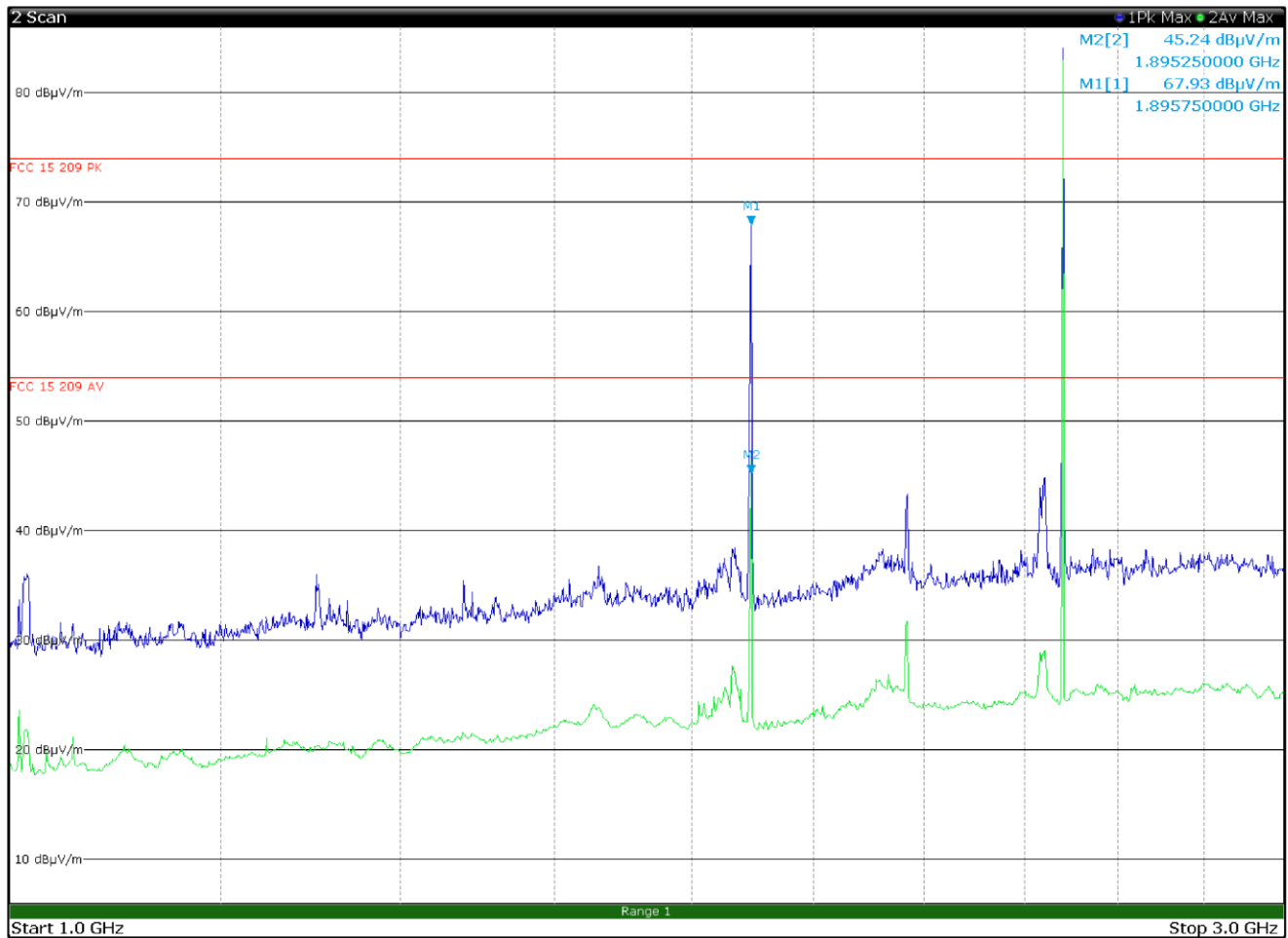


Figure 8.5-19: Radiated spurious emissions with antenna in horizontal polarization, high channel

All the peaks are below the general limits specified in §15.209(a)

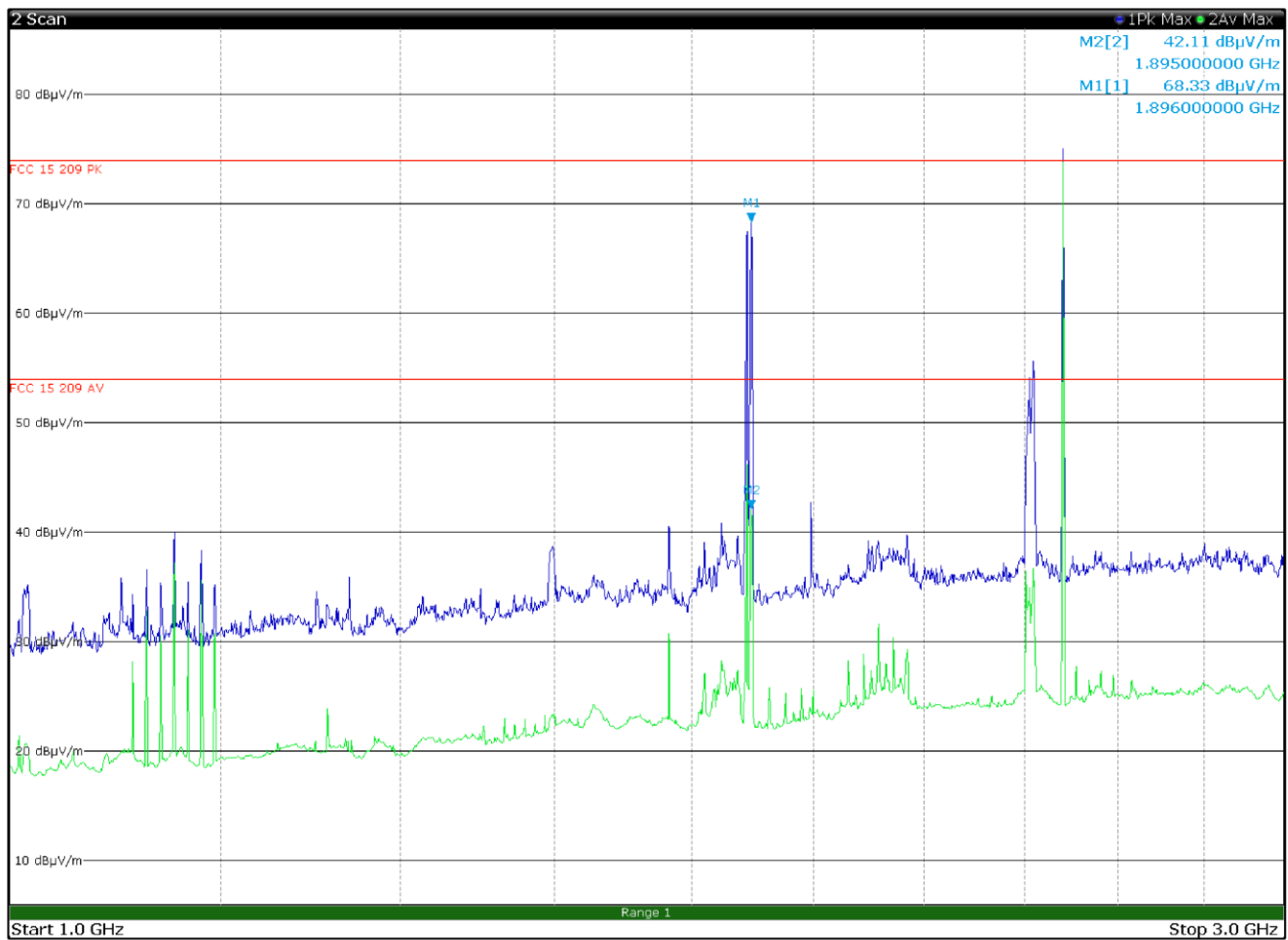


Figure 8.5-20: Radiated spurious emissions with antenna in vertical polarization, high channel

All the peaks are below the general limits specified in §15.209(a)

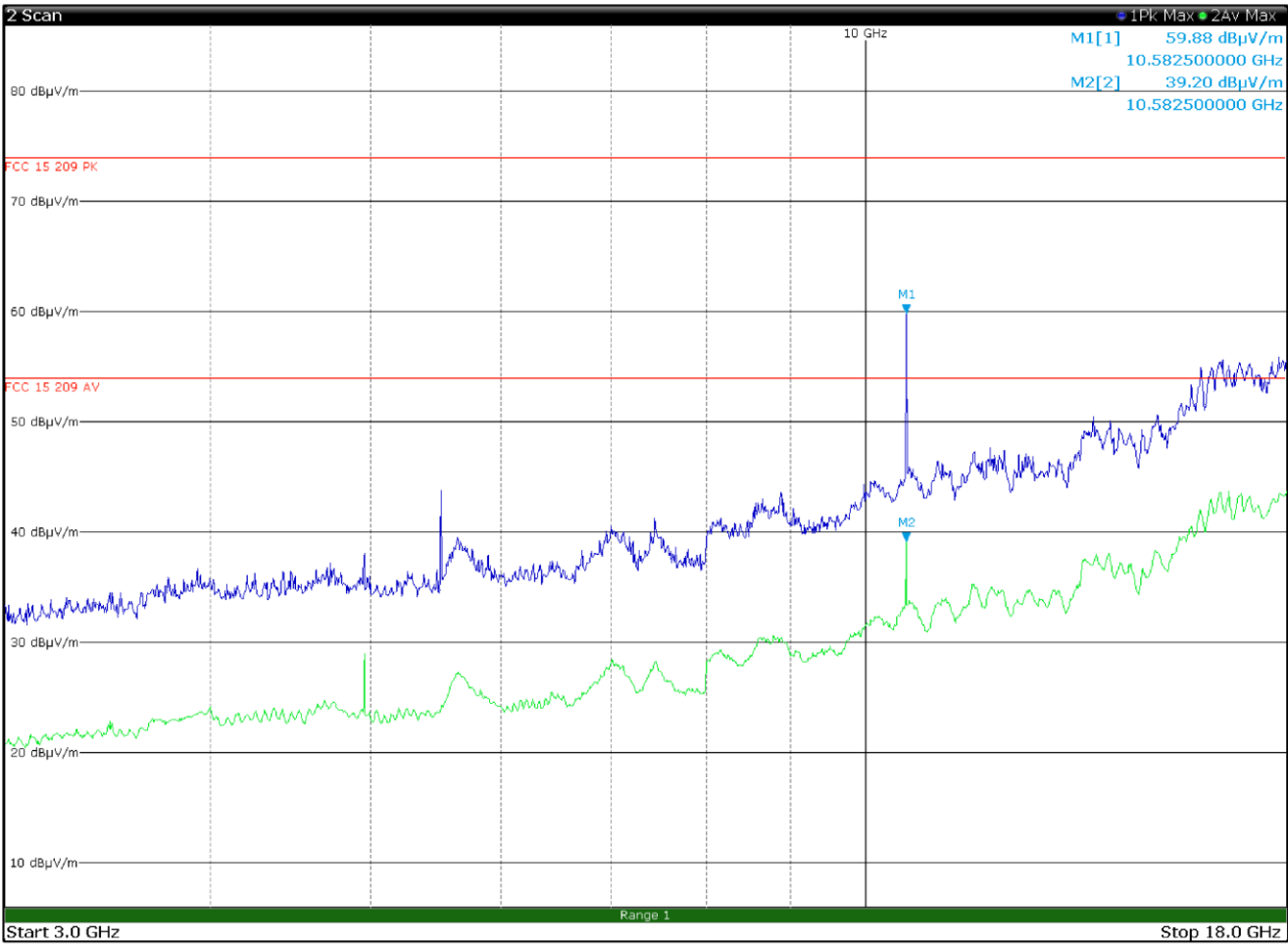


Figure 8.5-21: Radiated spurious emissions with antenna in horizontal polarization, high channel

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
10582.5000	59.88	74.0	-14.12	Pk
10582.5000	39.20	54.0	-14.80	Av

Av detector measured as state in clause 8.5.3

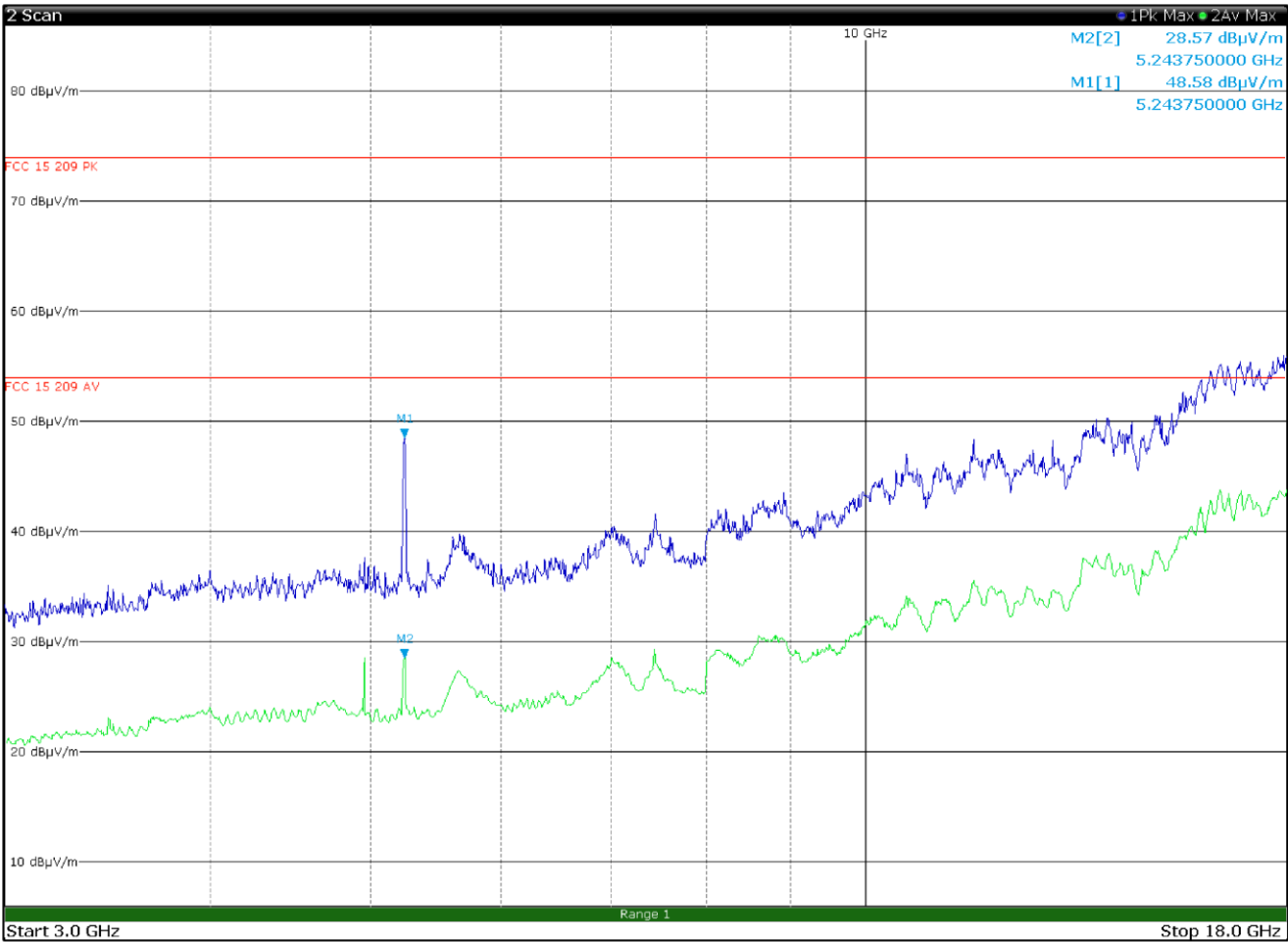


Figure 8.5-22: Radiated spurious emissions with antenna in vertical polarization, high channel

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
5243.7500	48.58	74.0	-25.42	Pk
5243.7500	28.57	54.0	-25.43	Av

Av detector measured as state in clause 8.5.3

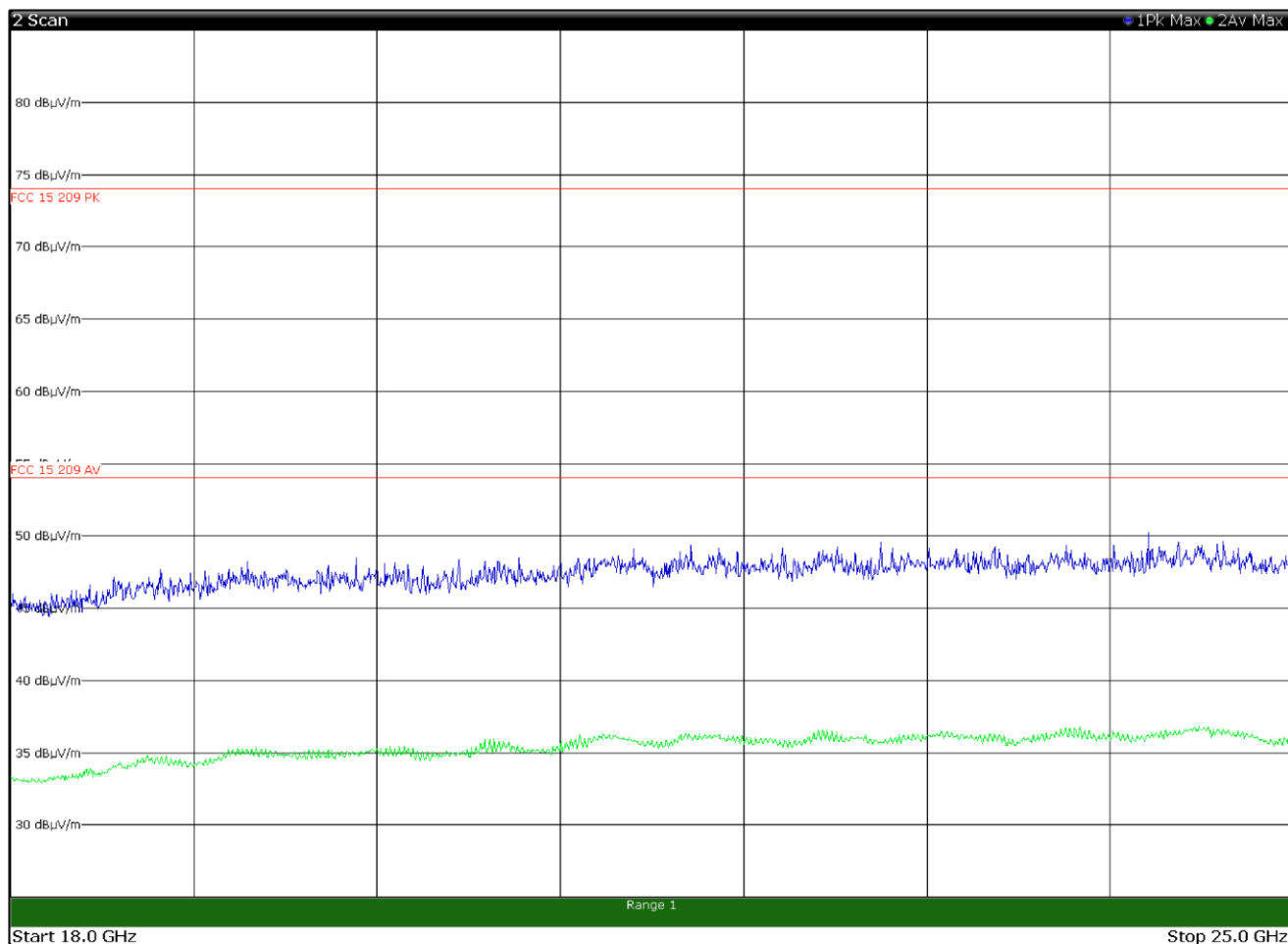


Figure 8.5-23: Radiated spurious emissions with antenna in horizontal polarization, high channel

All the peaks are below the general limits specified in §15.209(a)

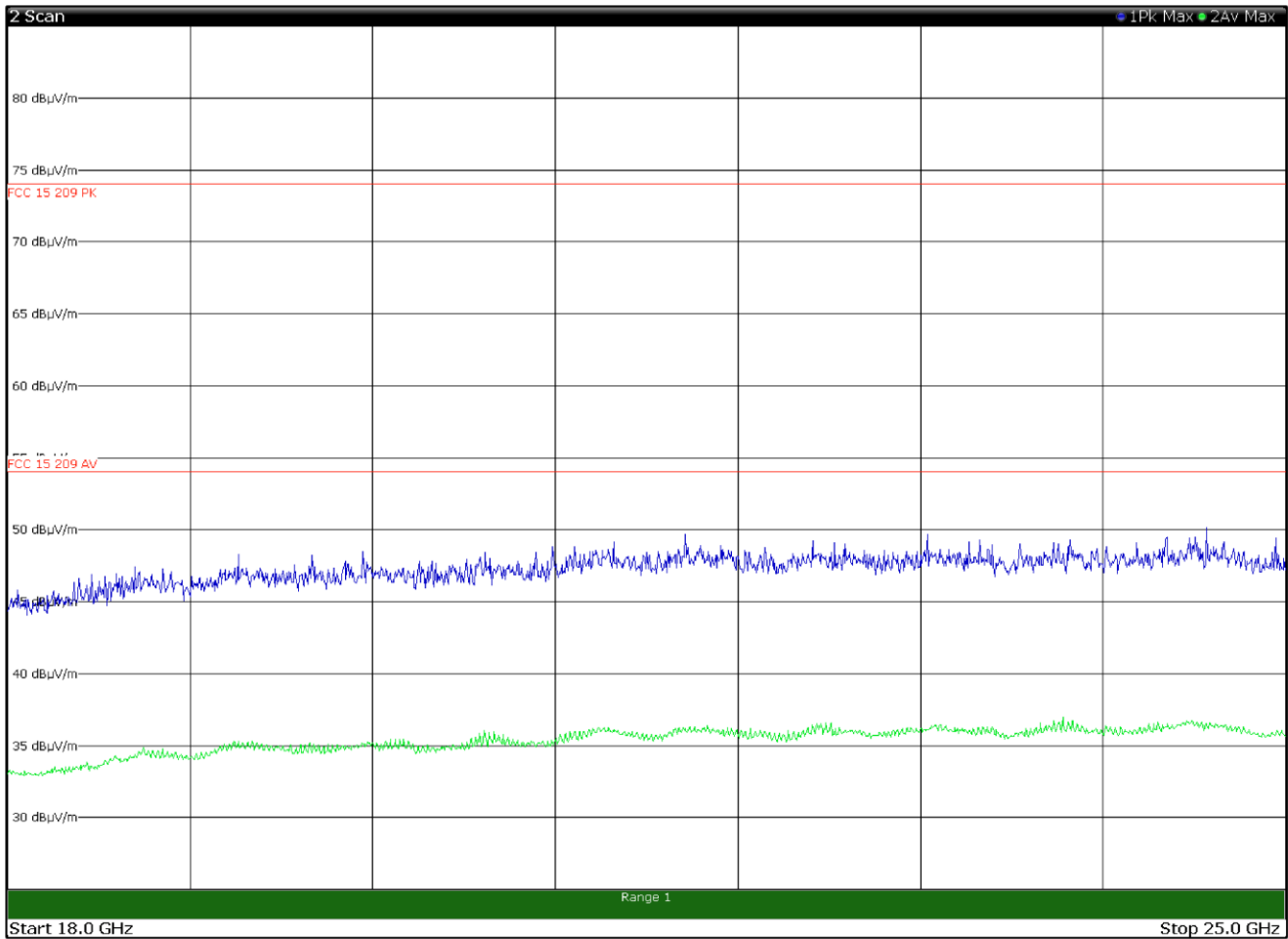


Figure 8.5-24: Radiated spurious emissions with antenna in vertical polarization, high channel

All the peaks are below the general limits specified in §15.209(a)

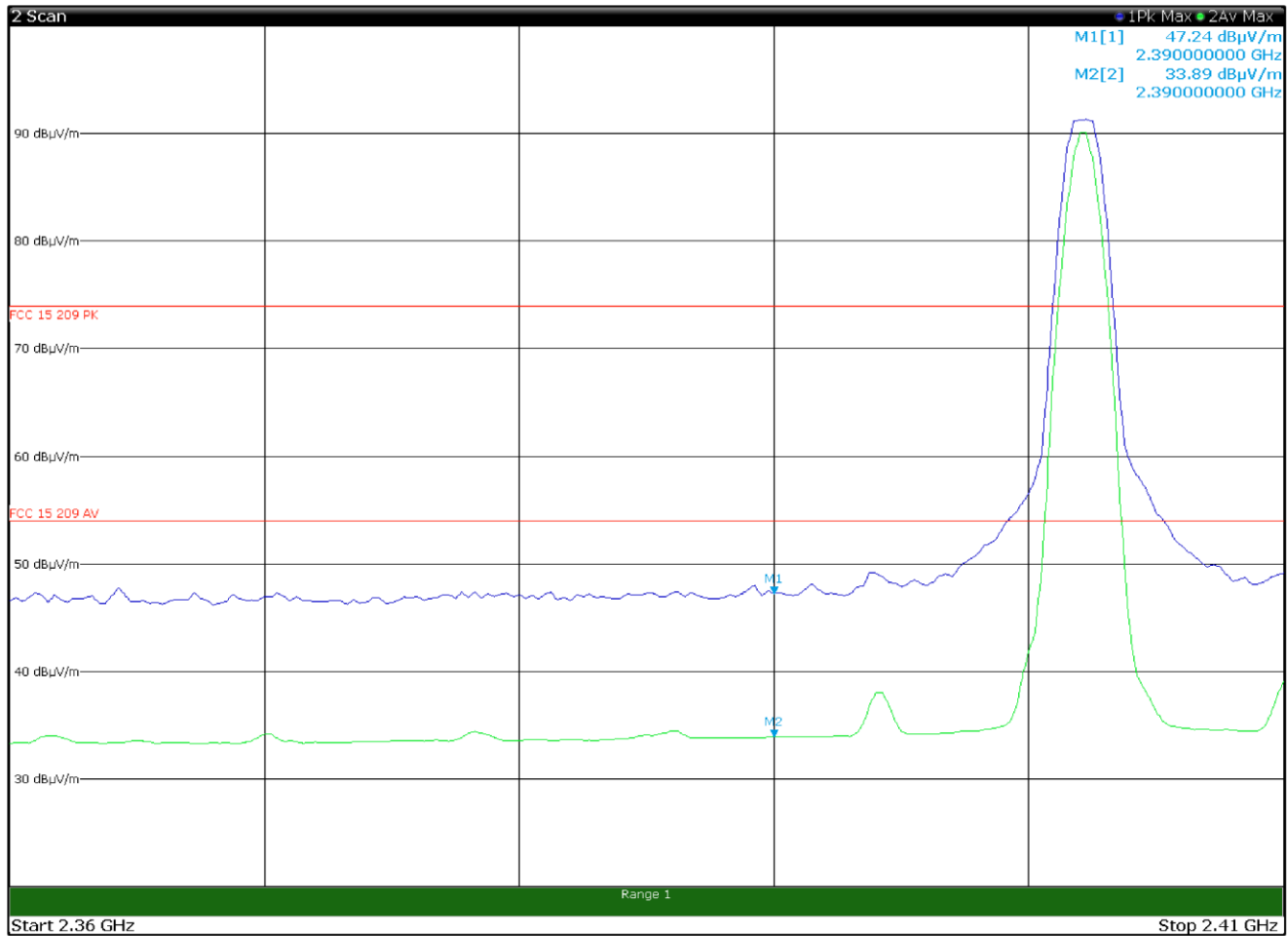


Figure 8.5-25: Band edge with antenna in horizontal polarization, low channel (RBW 1 MHz)

Marker-delta procedure not required because the edge of the occupied bandwidth of the emission don't falls within two "standard bandwidths" of the restricted-band band-edge frequency, where "standard bandwidth" is the RBW required by the measurement procedure. All the peaks are below the general limits specified in §15.209(a).

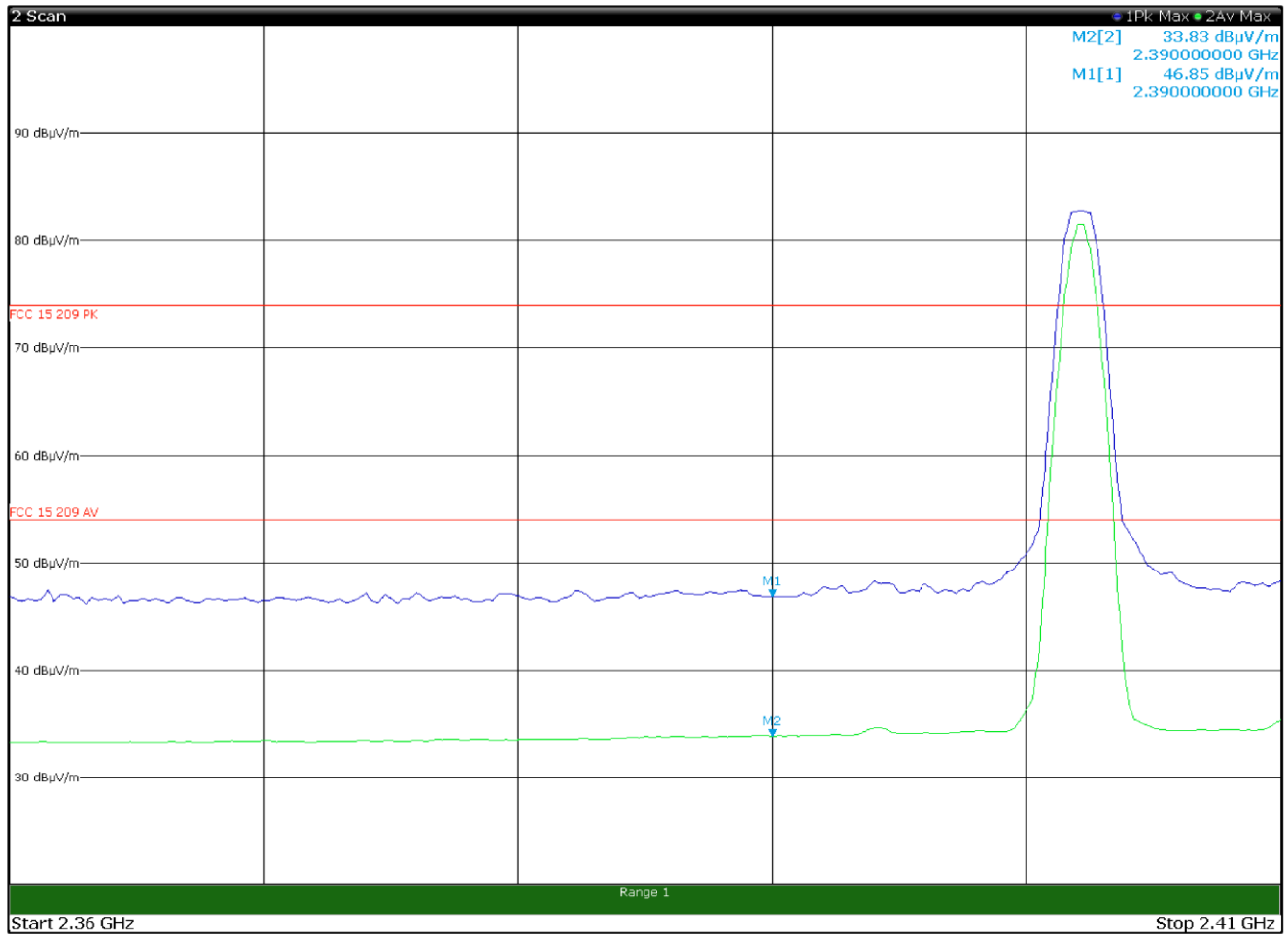


Figure 8.5-26: Band edge with antenna in vertical polarization, low channel (RBW 1 MHz)

Marker-delta procedure not required because the edge of the occupied bandwidth of the emission don't falls within two "standard bandwidths" of the restricted-band band-edge frequency, where "standard bandwidth" is the RBW required by the measurement procedure. All the peaks are below the general limits specified in §15.209(a).

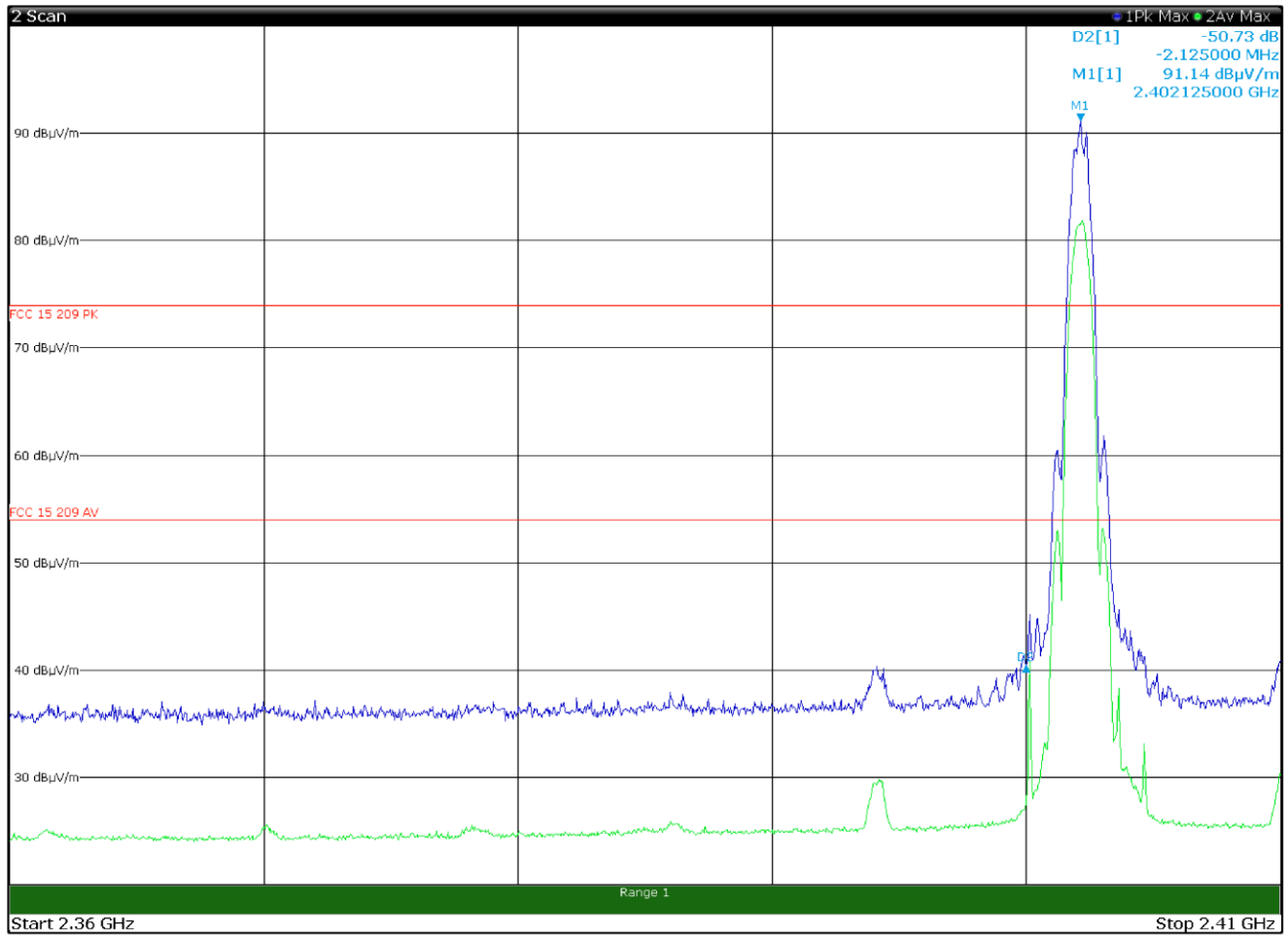


Figure 8.5-27: Band edge with antenna in horizontal polarization, low channel (RBW 100 kHz and limit -20 dBc)

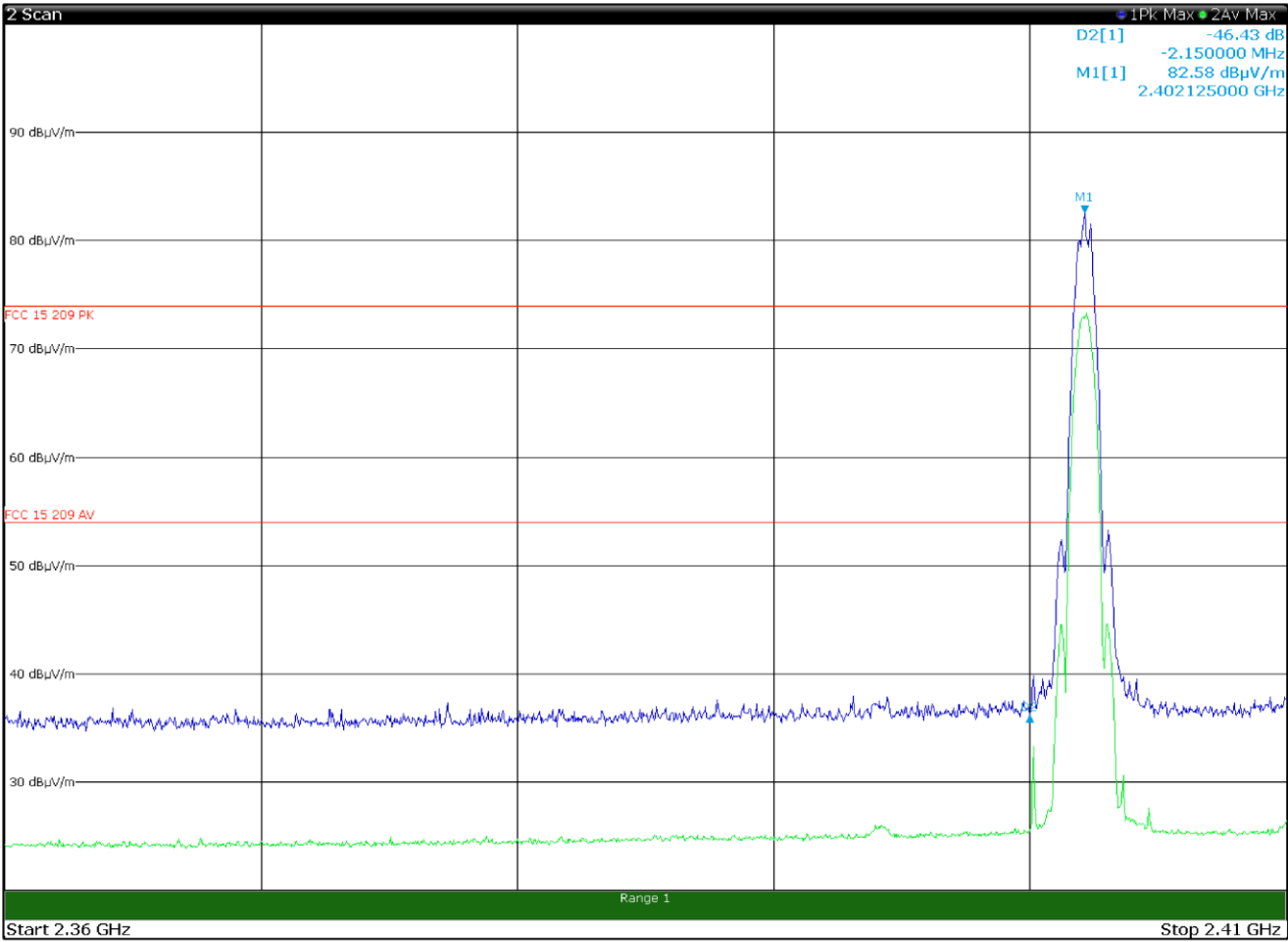


Figure 8.5-28: Band edge with antenna in vertical polarization, low channel (RBW 100 kHz and limit -20 dBc)

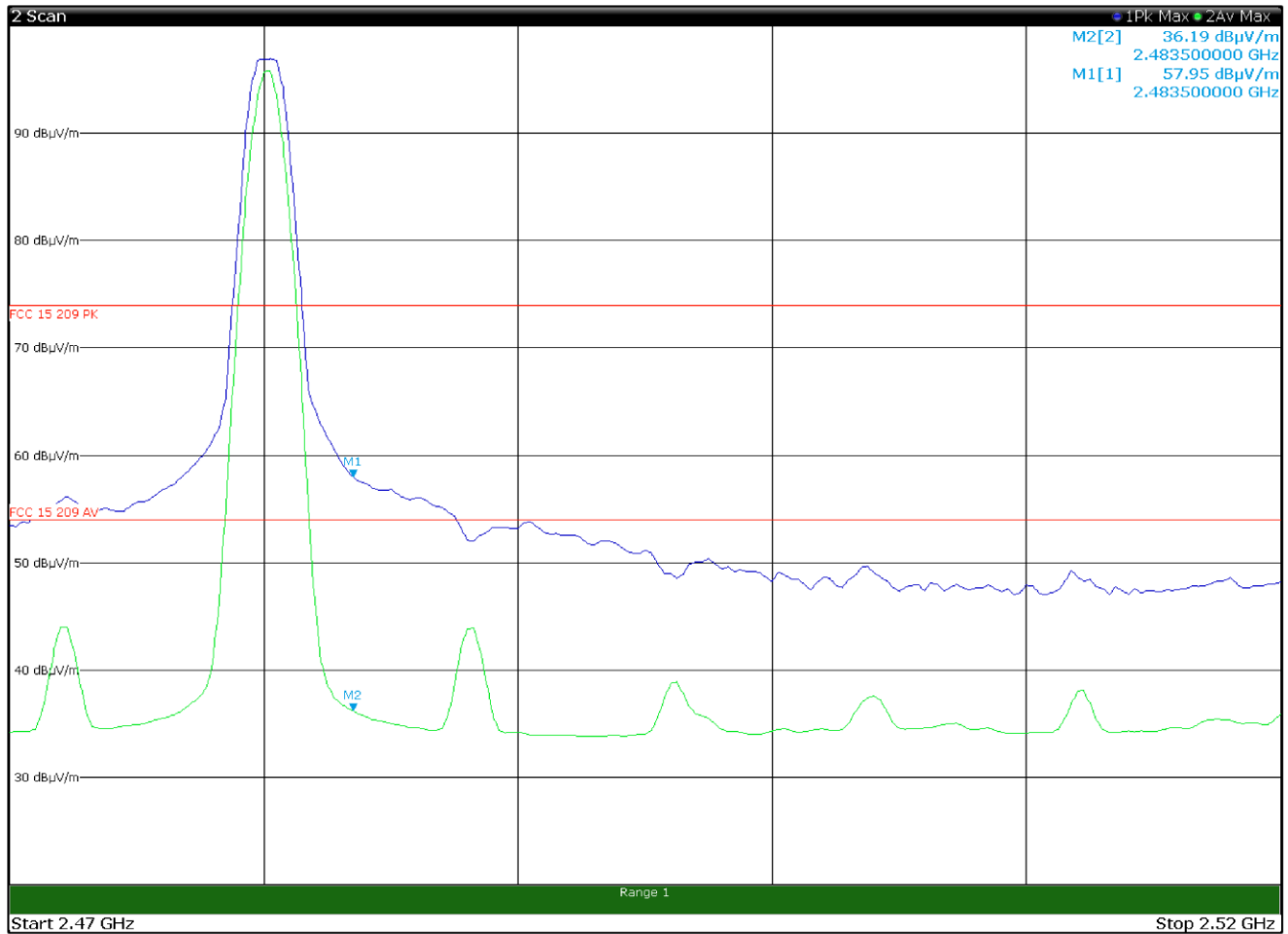


Figure 8.5-29: Band edge with antenna in horizontal polarization, high channel (peak kimit)

Marker-delta procedure not required because the edge of the occupied bandwidth of the emission don't falls within two "standard bandwidths" of the restricted-band band-edge frequency, where "standard bandwidth" is the RBW required by the measurement procedure. For the average evaluation see the following graphics.

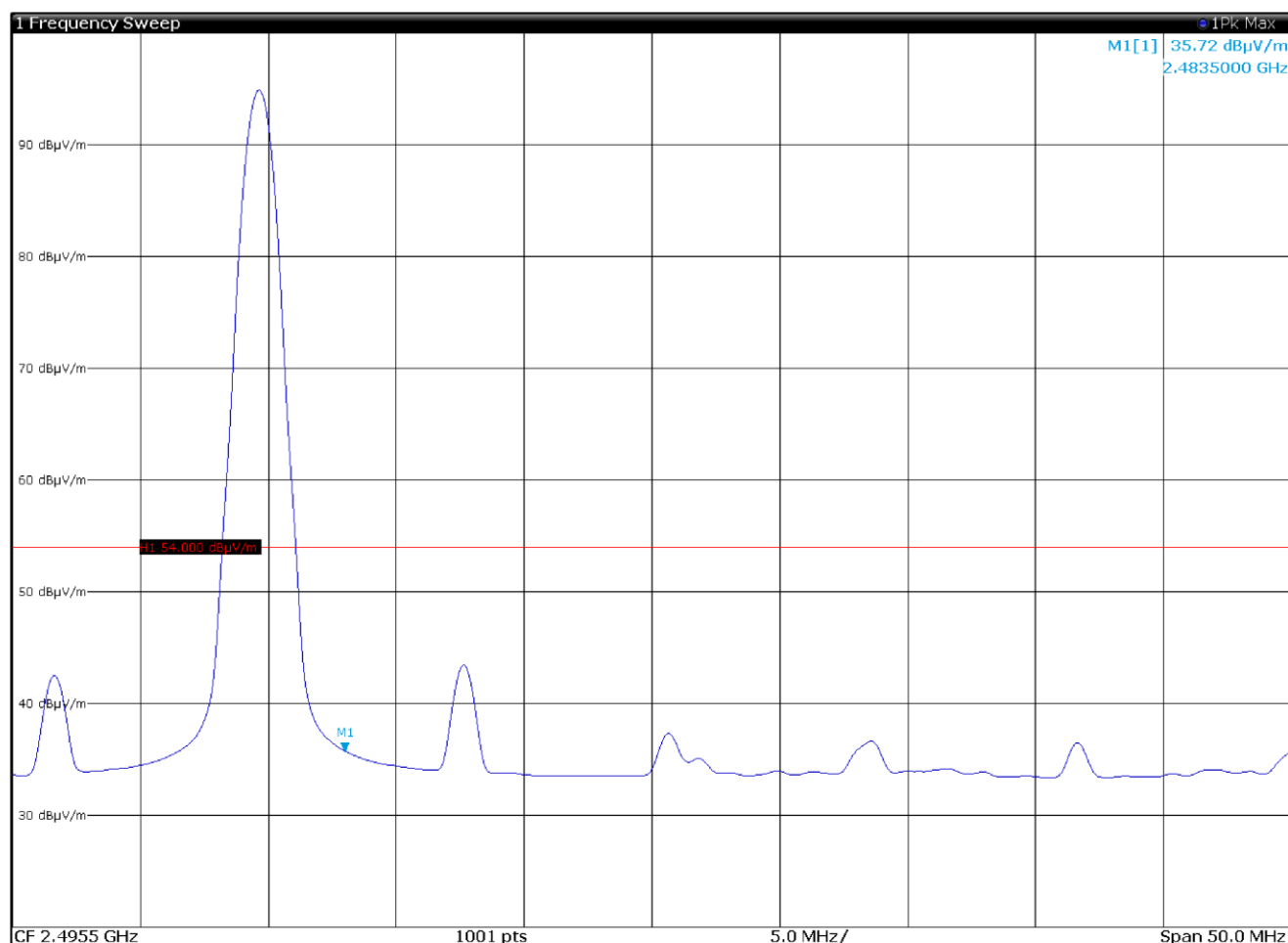


Figure 8.5-30: Band edge with antenna in horizontal polarization, high channel (average limit)

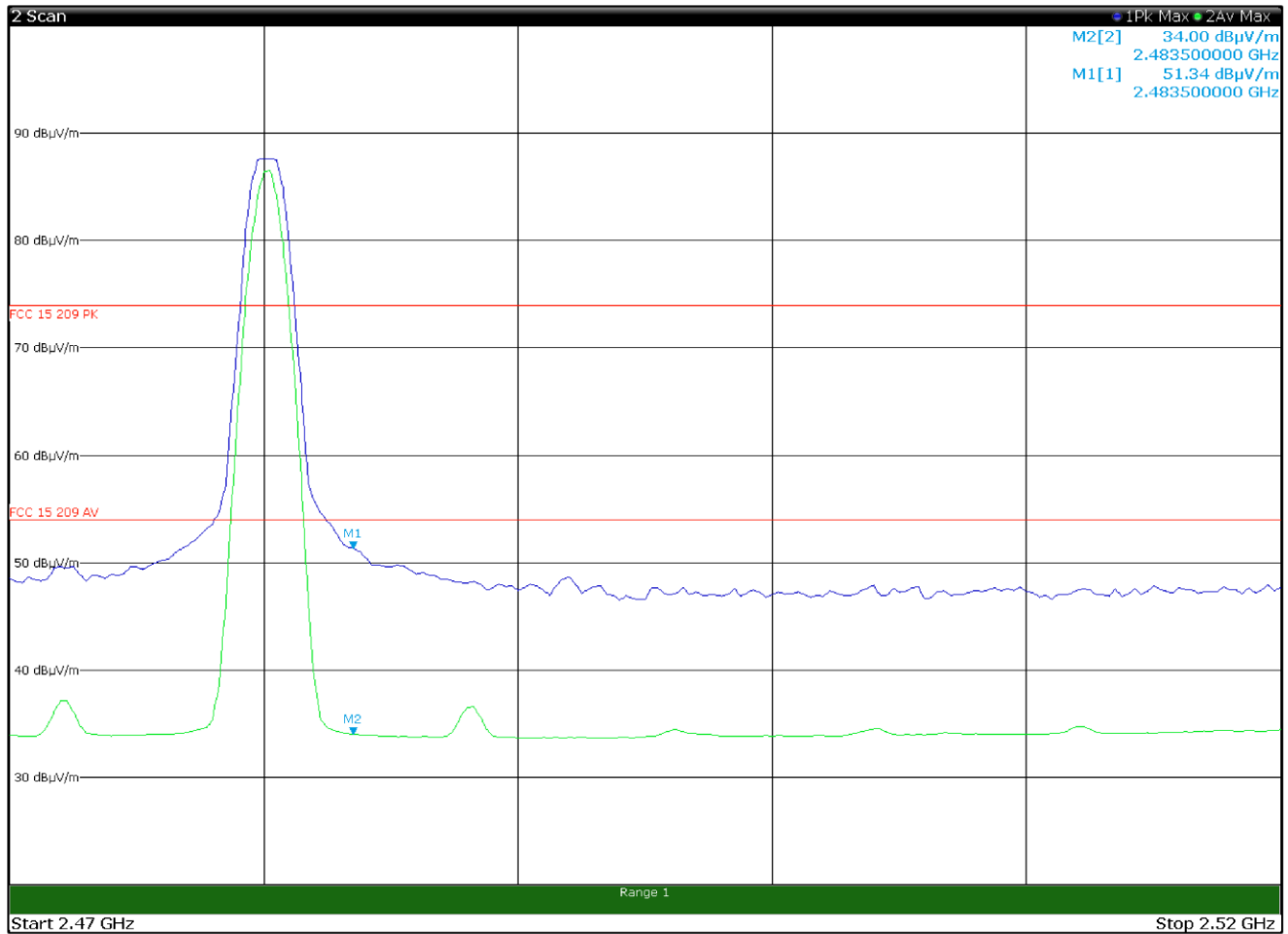


Figure 8.5-31: Band edge with antenna in vertical polarization, high channel

Marker-delta procedure not required because the edge of the occupied bandwidth of the emission don't falls within two "standard bandwidths" of the restricted-band band-edge frequency, where "standard bandwidth" is the RBW required by the measurement procedure. . All the peaks are below the general limits specified in §15.209(a).

8.6 FCC 15.247(e) Power spectral density for digitally modulated devices

8.6.1 Definitions and limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

8.6.2 Test summary

Test date	2020-04-21	Temperature	21 °C
Test engineer	G. Tepelena	Air pressure	1020 mbar
Verdict	Pass	Relative humidity	45 %

8.6.3 Observations, settings and special notes

The test was performed using method described in section 11.10.2 Method PKPSD (peak PSD). Spectrum analyser settings:

Resolution bandwidth:	$3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$
Video bandwidth:	$\geq 3 \times \text{RBW}$
Frequency span:	1.5 times the OBW
Detector mode:	Peak
Trace mode:	Max hold

8.6.4 Test data

Table 8.6-1: PSD measurements results

Modulation	Frequency, MHz	PSD, dBm/100 kHz	PSD limit, dBm/3 kHz	Margin, dB
GFSK	2402	-4.7	8.00	12.7
	2440	-1.3	8.00	9.3
	2480	-0.2	8.00	8.2

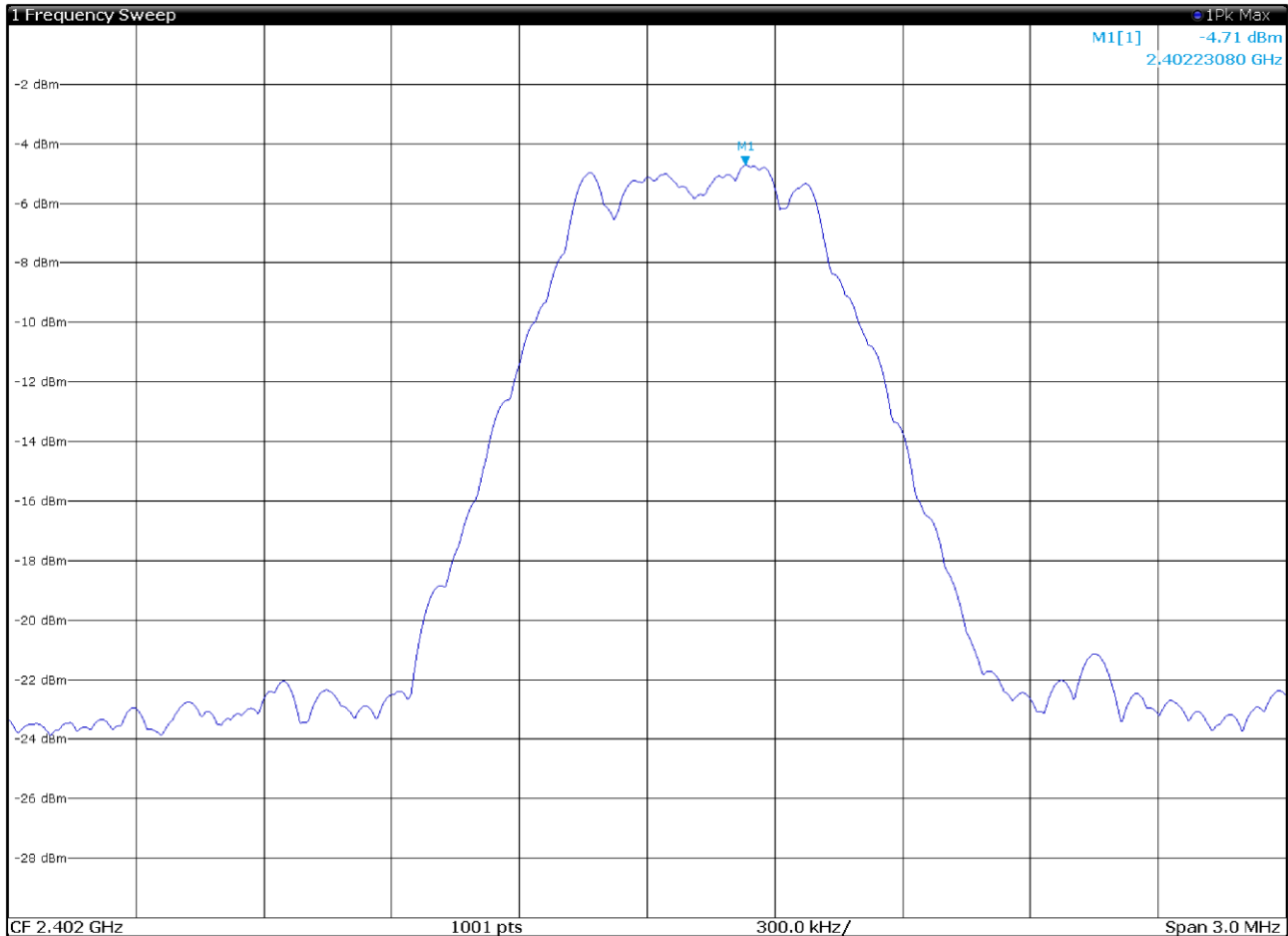


Figure 8.6-1: PSD sample plot on low channel

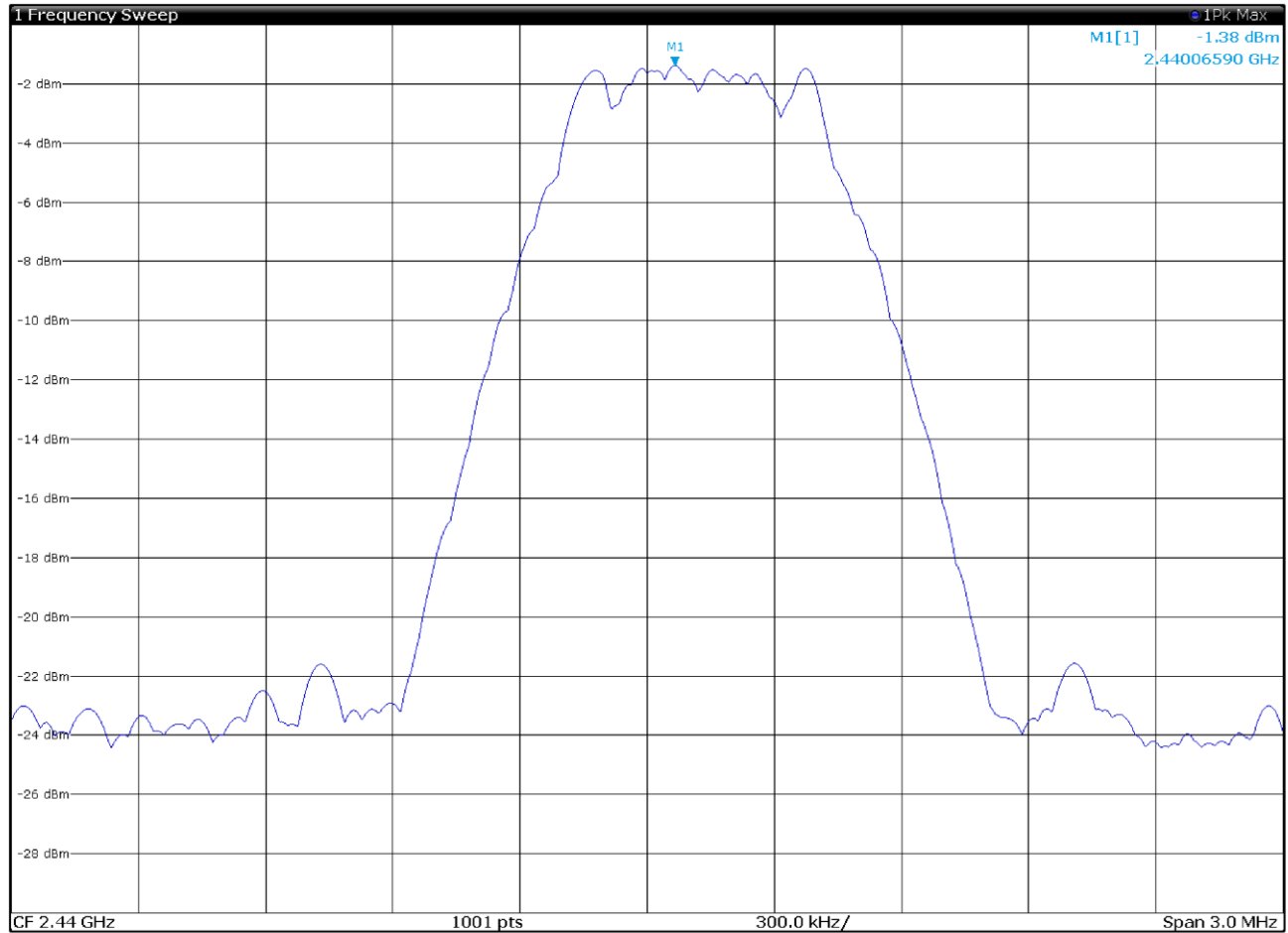


Figure 8.6-2: PSD sample plot on mid channel

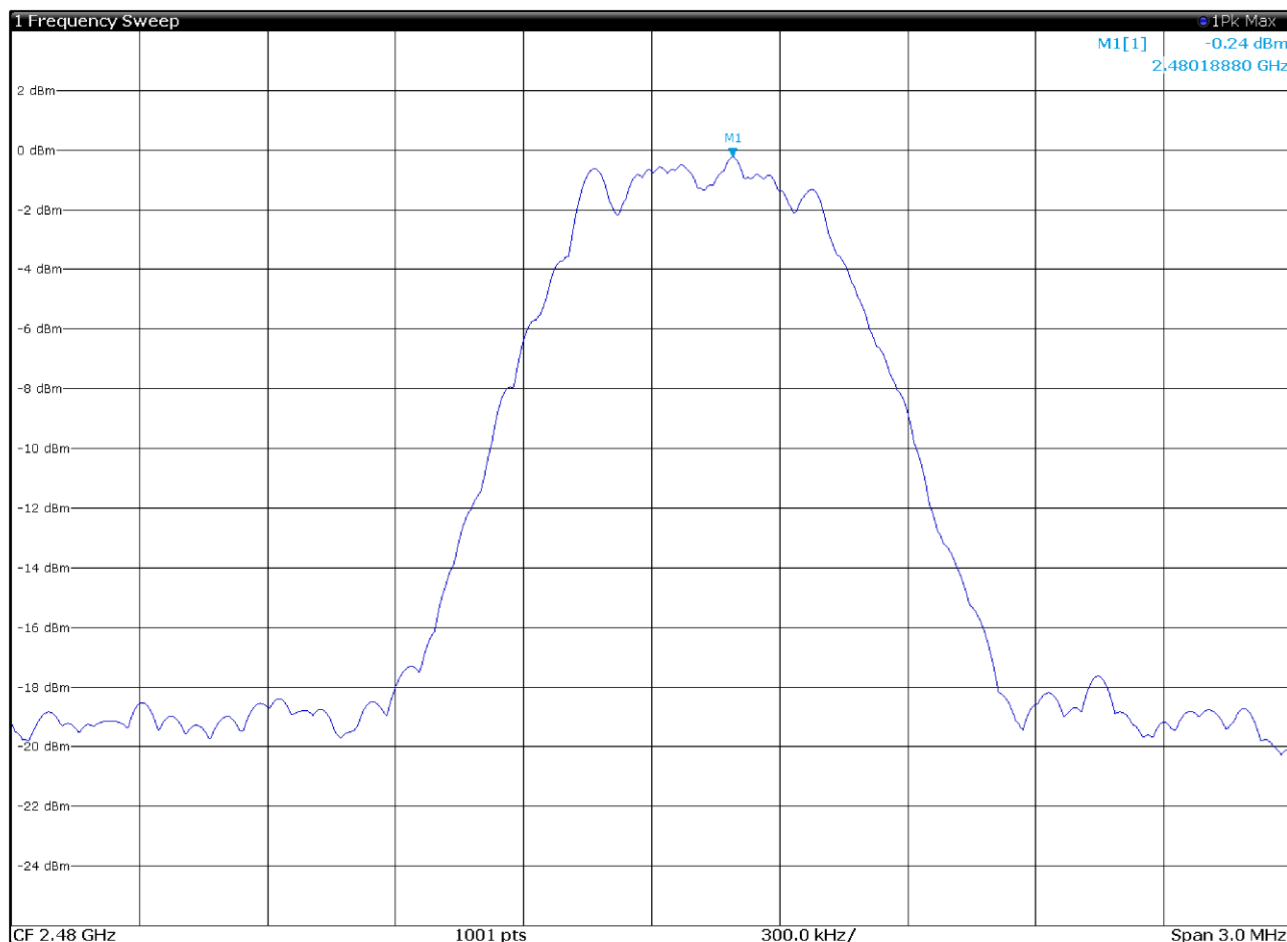
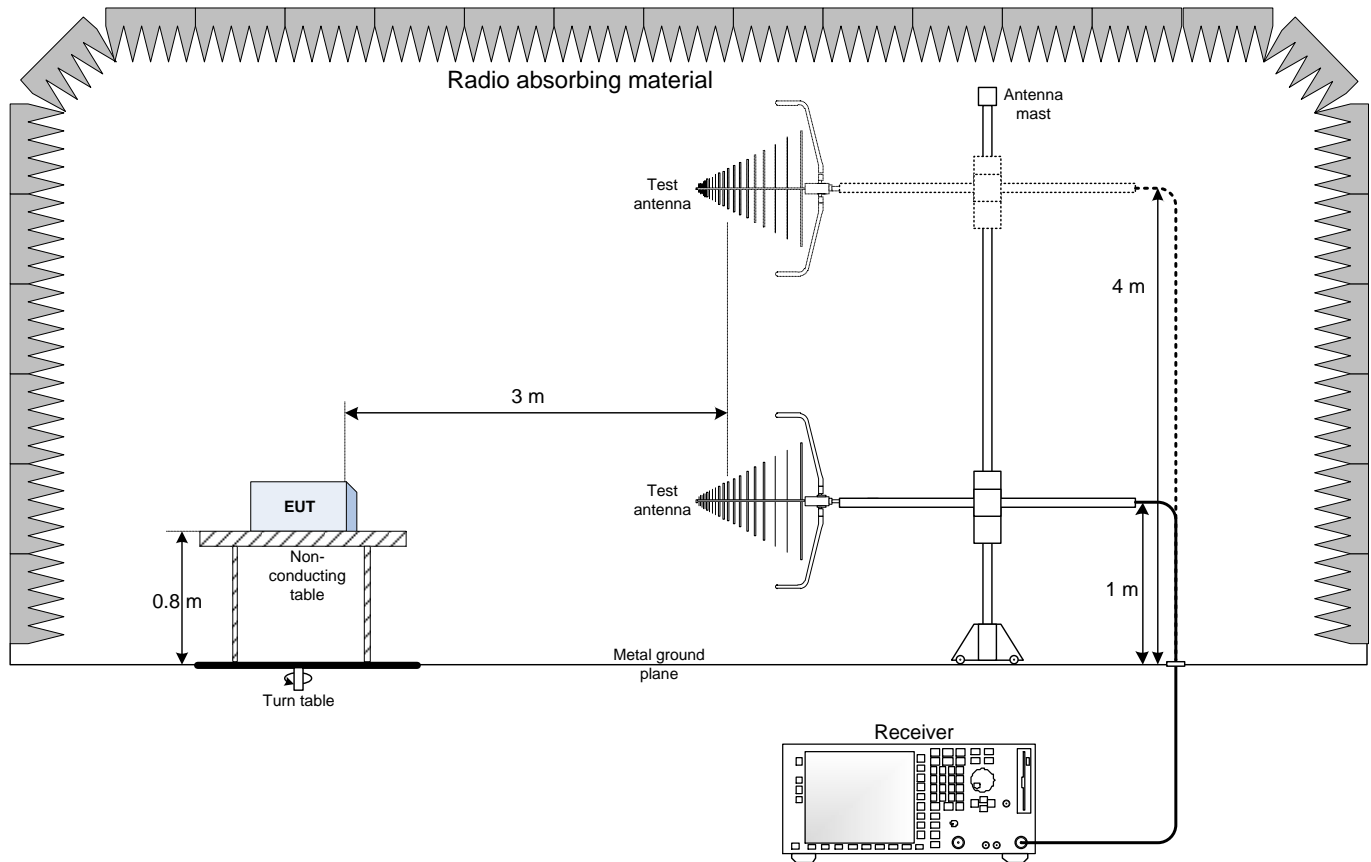


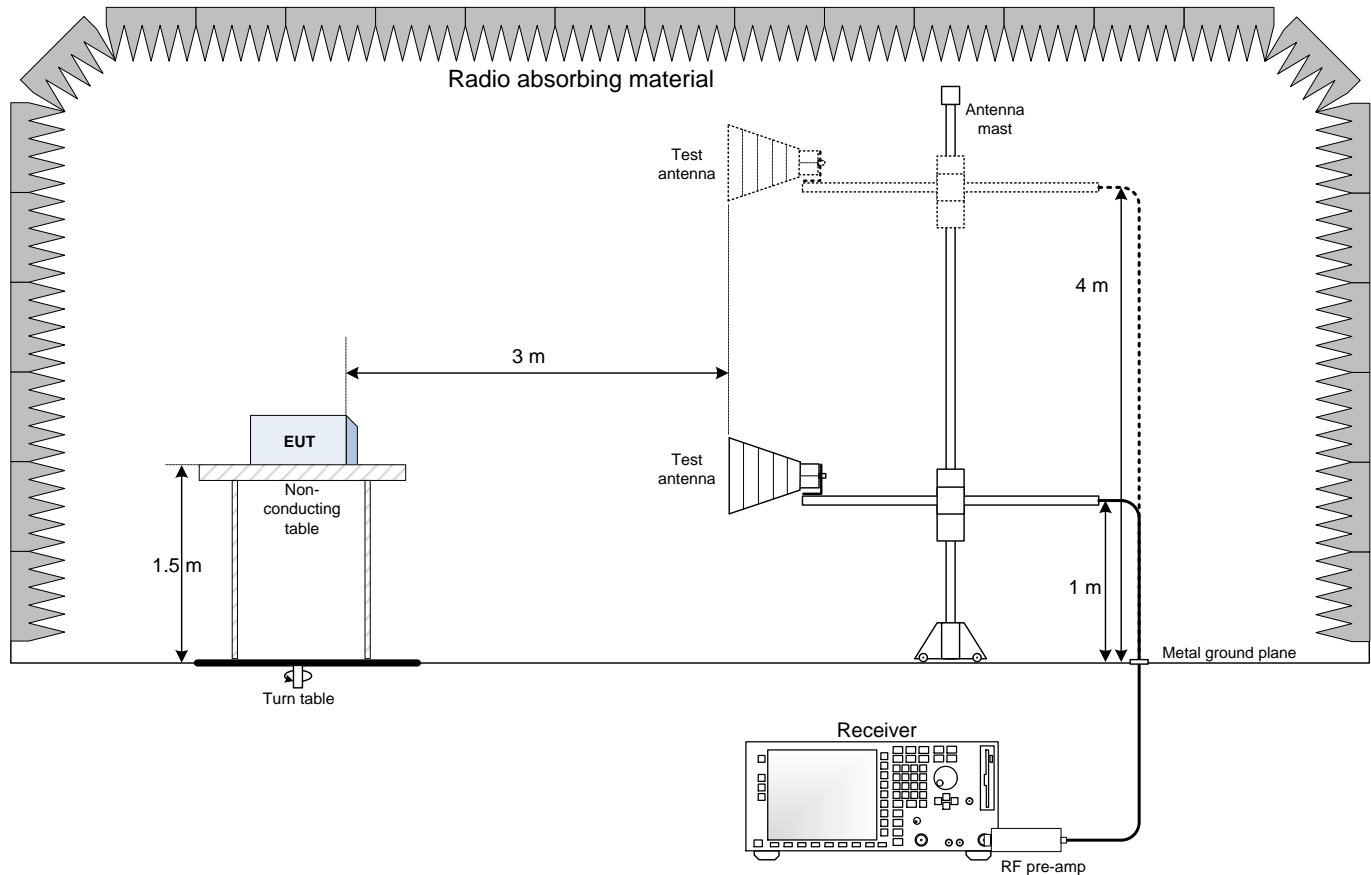
Figure 8.6-3: PSD sample plot on high channel

Section 9. Block diagrams of test set-ups

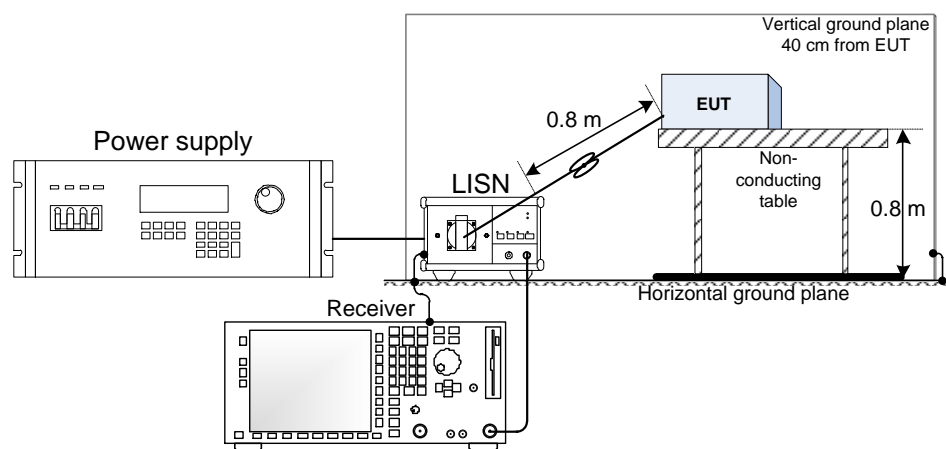
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz

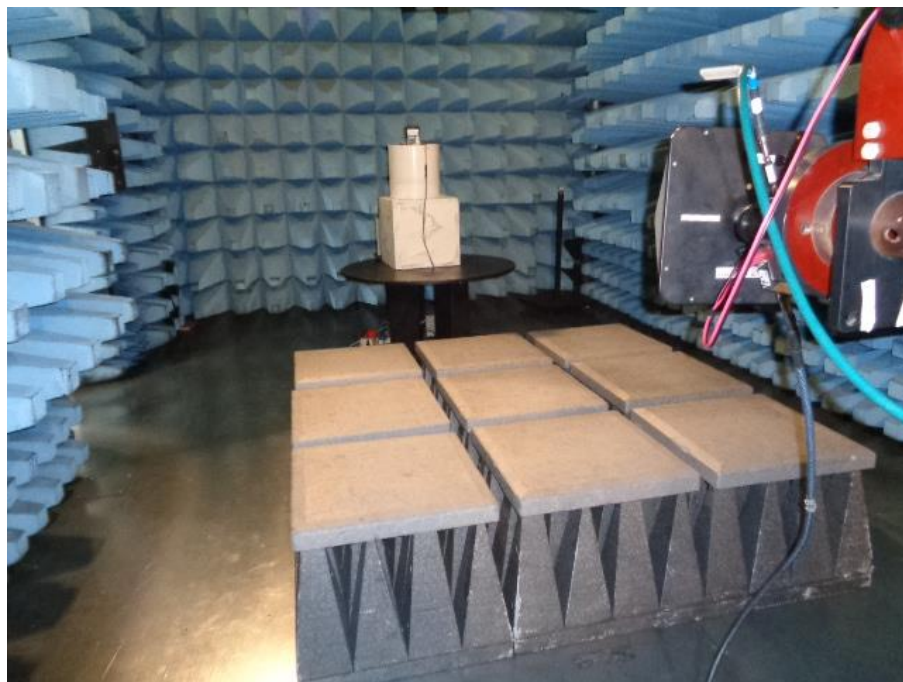


9.3 Conducted emissions set-up



Section 10. Photos

10.1 Photos of the test set-up



10.2 Photos of the EUT





End of report