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Test report

378317TRFWL

Date of issue: 2019-10-16

Applicant:

CRESSI SUB S.P.A.

Via Gelasio Adamoli, 501 – 16165 Genova (GE) – Italy

Product:

BT interface

Model:

P127ACSP121

FCC ID:

2AUOC-P127ACSP121

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

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

Test location

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	FCC: 682159 (10 m semi anechoic chamber)

Tested by (name, function and signature)	P. Barbieri	(project handler)	
Reviewed by (name, function and signature)	D. Guarnone	(verifier)	
Date	2019-10-16		

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

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	CRESSI SUB S.P.A.
Address	Via Gelasio Adamoli, 501
City	Genova
Province/State	GE
Postal/Zip code	16165
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

1.3 Test methods

558074 D01 DTS Meas Guidance v03r05 (April 8, 2016)	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
378317TRFWL	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass[1]
§15.31(m)	Number of frequencies	Pass
§15.203	Antenna requirement	Pass[2]

Notes: [1] The equipment tests shall be performed using a new battery.

[2] The Antennas are located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(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	2019-09-27
Nemko sample ID number	378317-2/2

3.2 EUT information

Product name	BT Interface
Model	P127ACSP121
Model variant	--
Serial number	378317-2/2 (Number assigned by Nemko Spa)

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	0.44×10^{-3}
RF power Max (W), Conducted	1.55×10^{-3}
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	794.2 kHz
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious, Units @ distance	53.8 dBµV/m @ 3 m
Power requirements	3 V DC from internal CR2032 battery or 5 V DC from USB cable
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

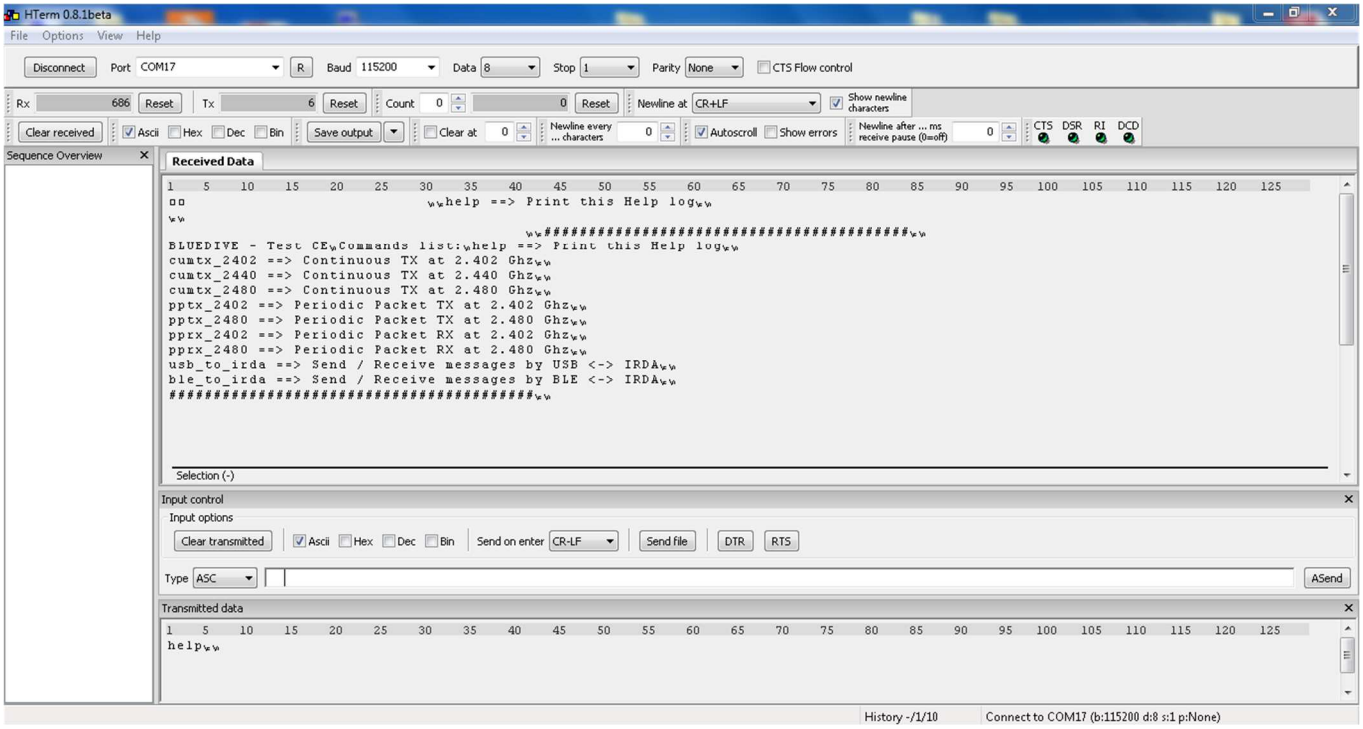
The "BT Interface" device is a communication interface based on BLE 4.1 technology that works with sub watch and a smartphone to allow data exchange, in particular the download of the dives present on the watch. The basic communication scheme is as follows:
- The watch communicates with the interface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

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)
		Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
	Conducted	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	2019-01	2020-01
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	2017-02	2020-02
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 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Table 8.1-1: *Conducted emissions limit*

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

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

8.1.2 Test summary

Test date	2019-10-15	Temperature	22 °C
Test engineer	P. Barbieri	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

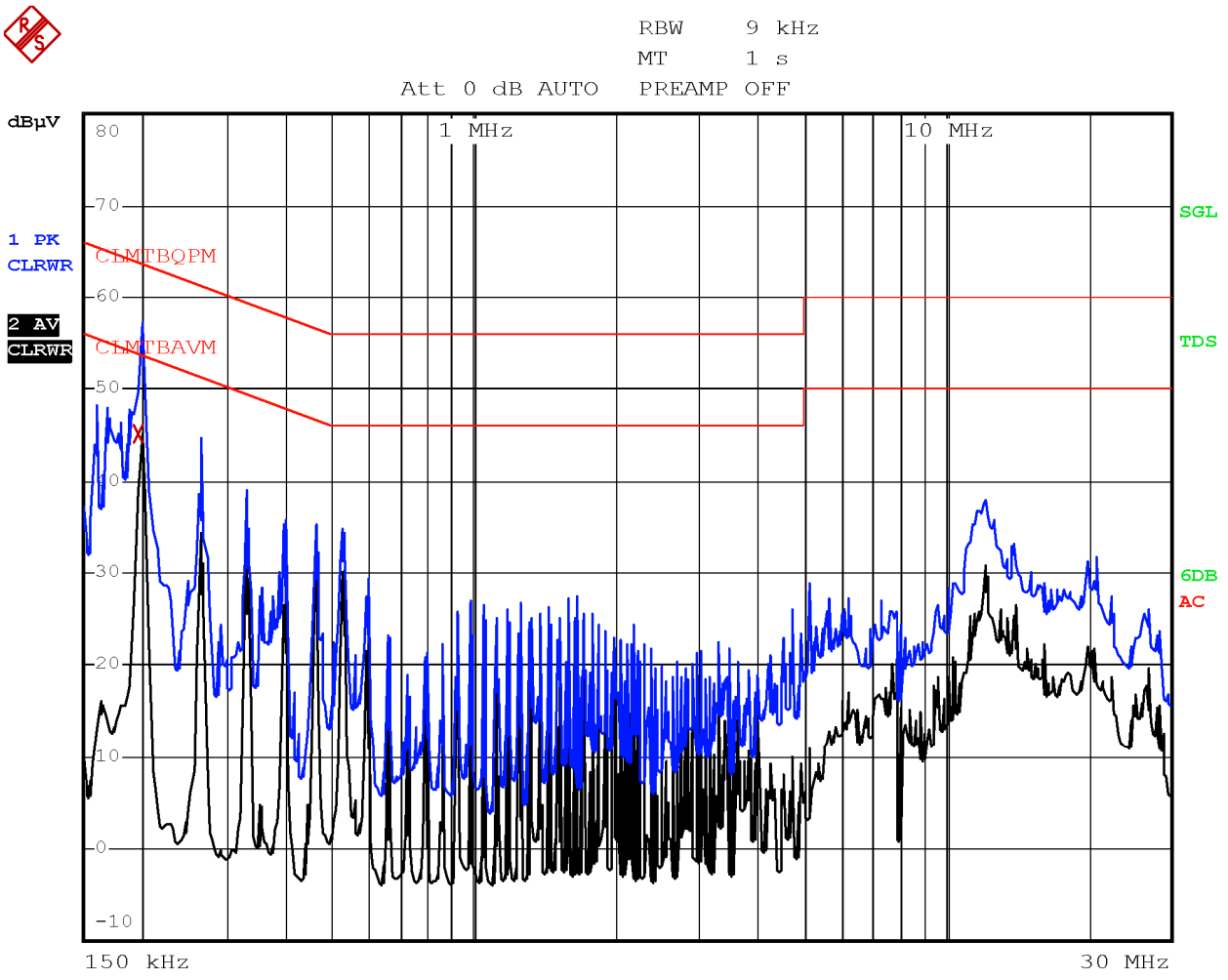


Figure 8.1-1: *Conducted emission on Phase line*

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.1980	45.2	53.7	-8.5	Av

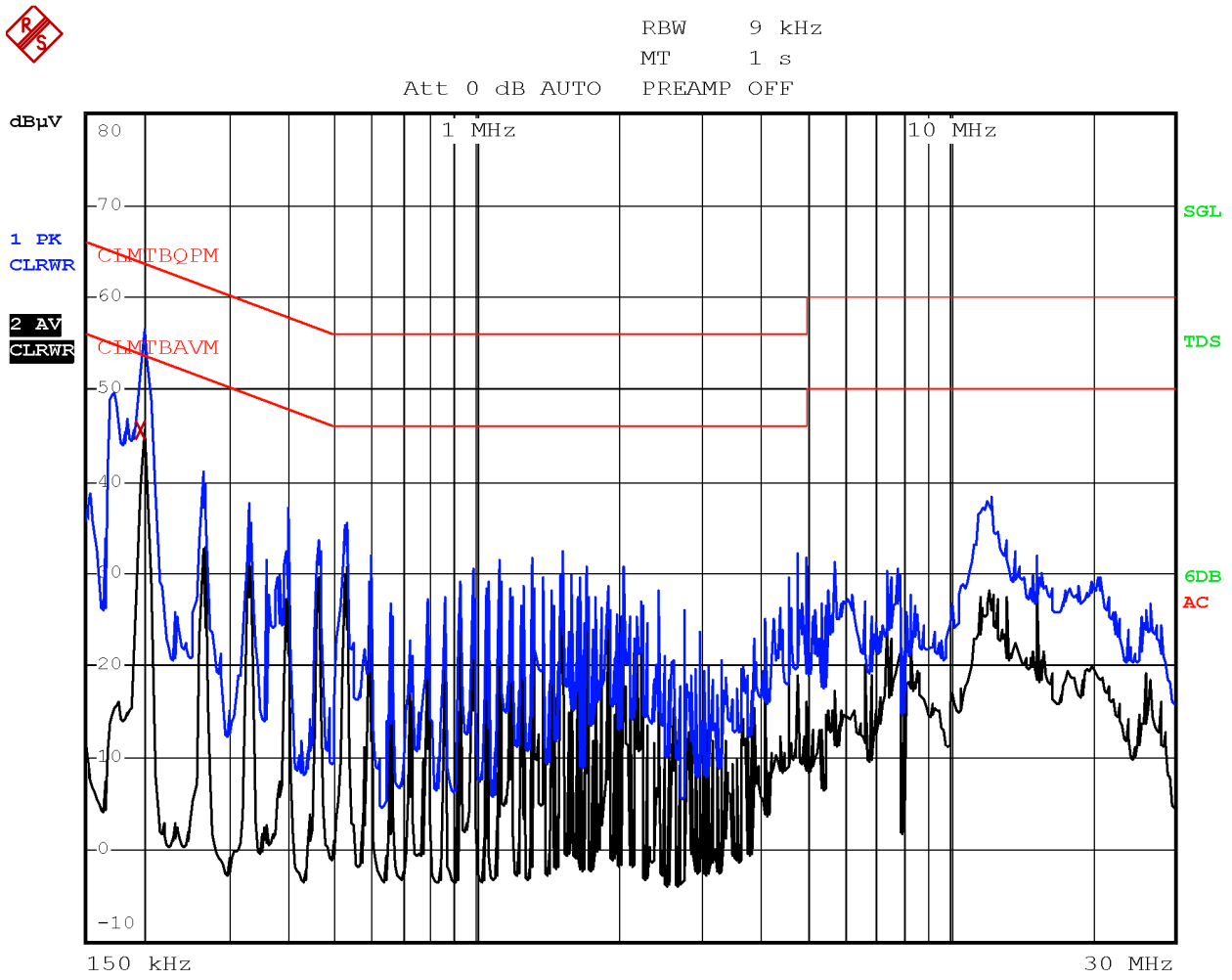


Figure 8.1-2: *Conducted emission on Neutral line*

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.1980	45.7	53.7	-8.0	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	2019-10-11	Temperature	22 °C
Test engineer	P. Barbieri	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	2019-10-14	Temperature	22 °C
Test engineer	P. Barbieri	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	≥3 × 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	0.795	0.50	0.295
	2440	0.775	0.50	0.275
	2480	0.795	0.50	0.295

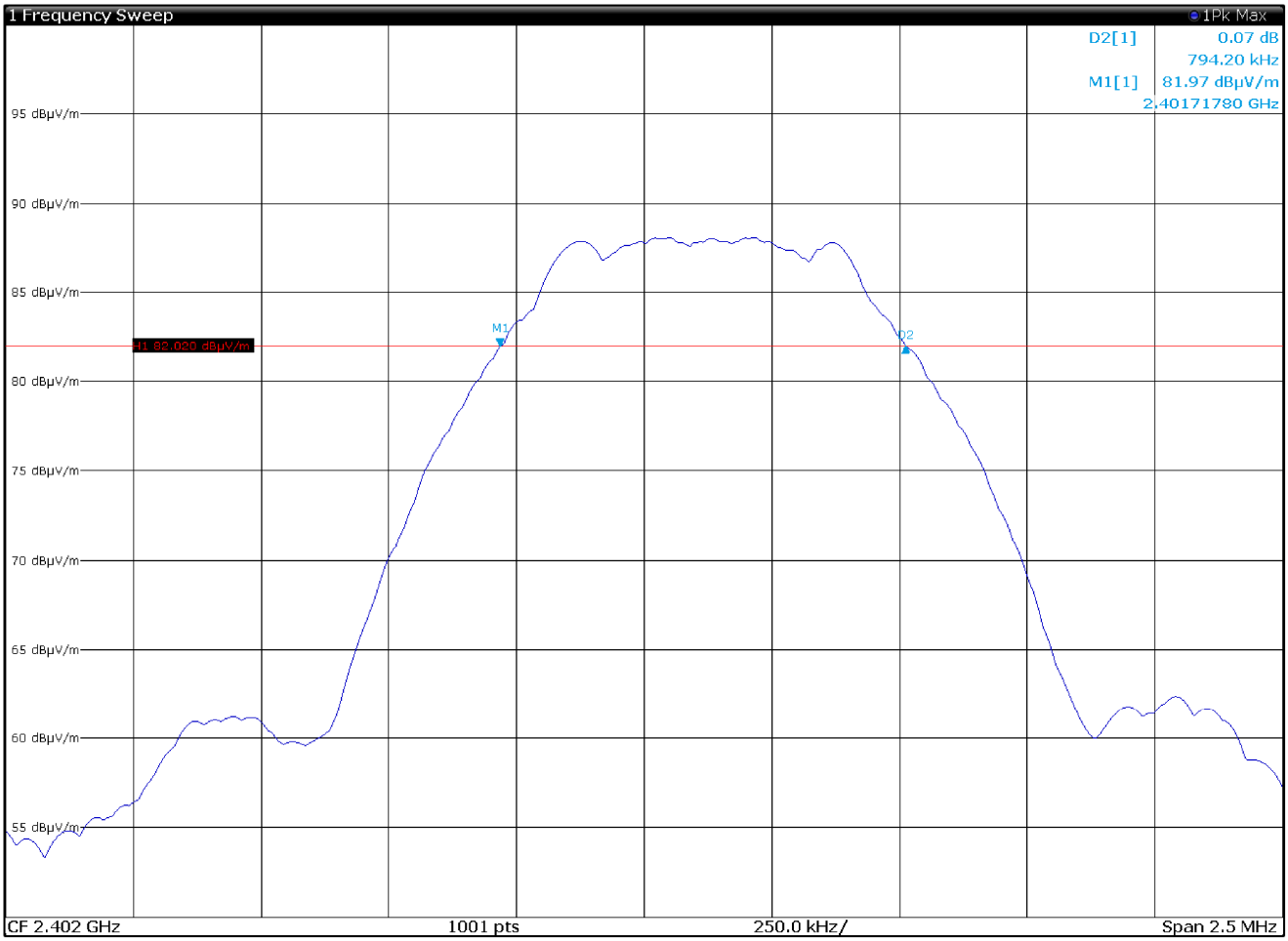


Figure 8.3-1: *6 dB bandwidth on low channel, sample plot*

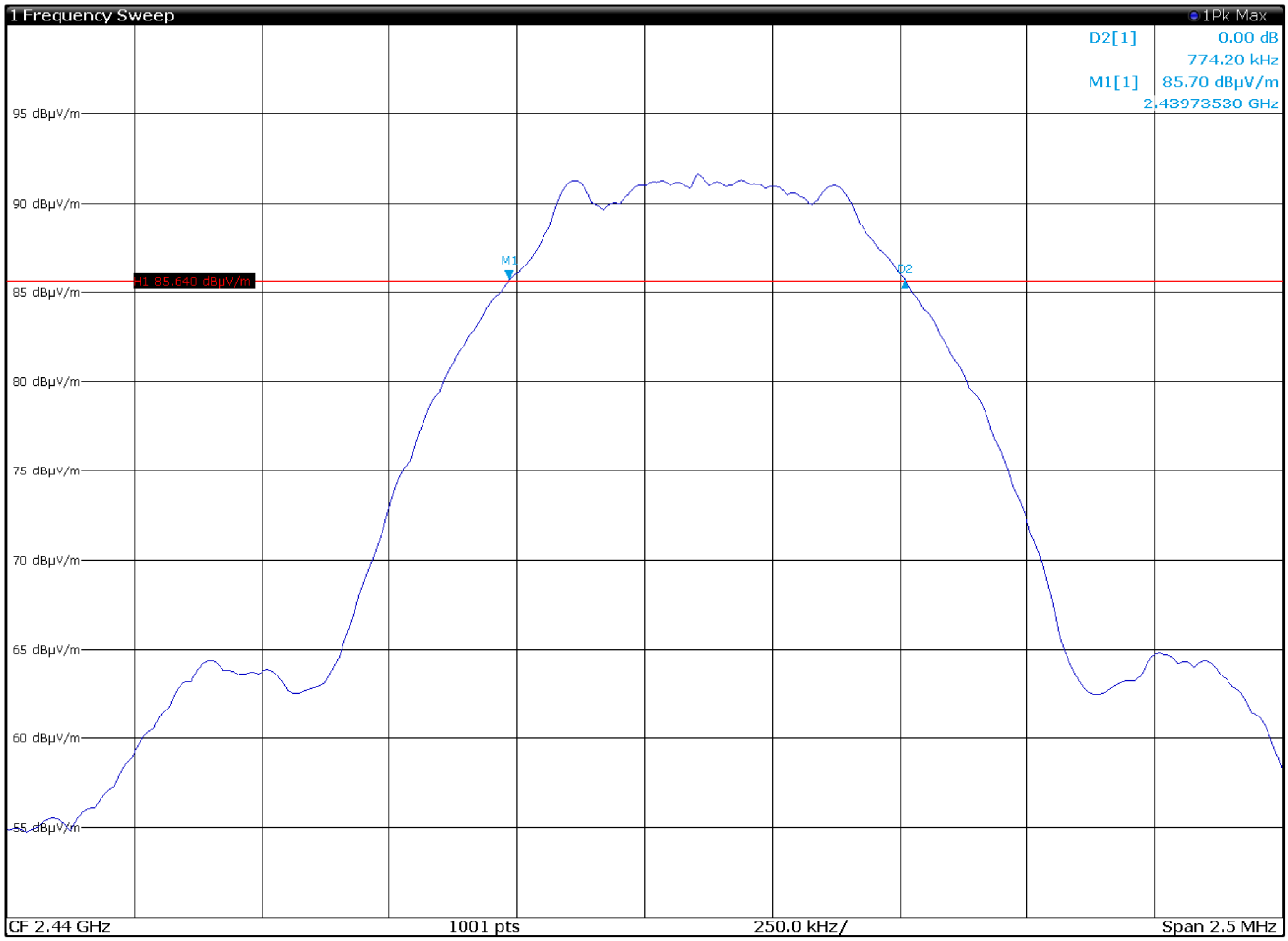


Figure 8.3-2: *6 dB bandwidth on mid channel, sample plot*

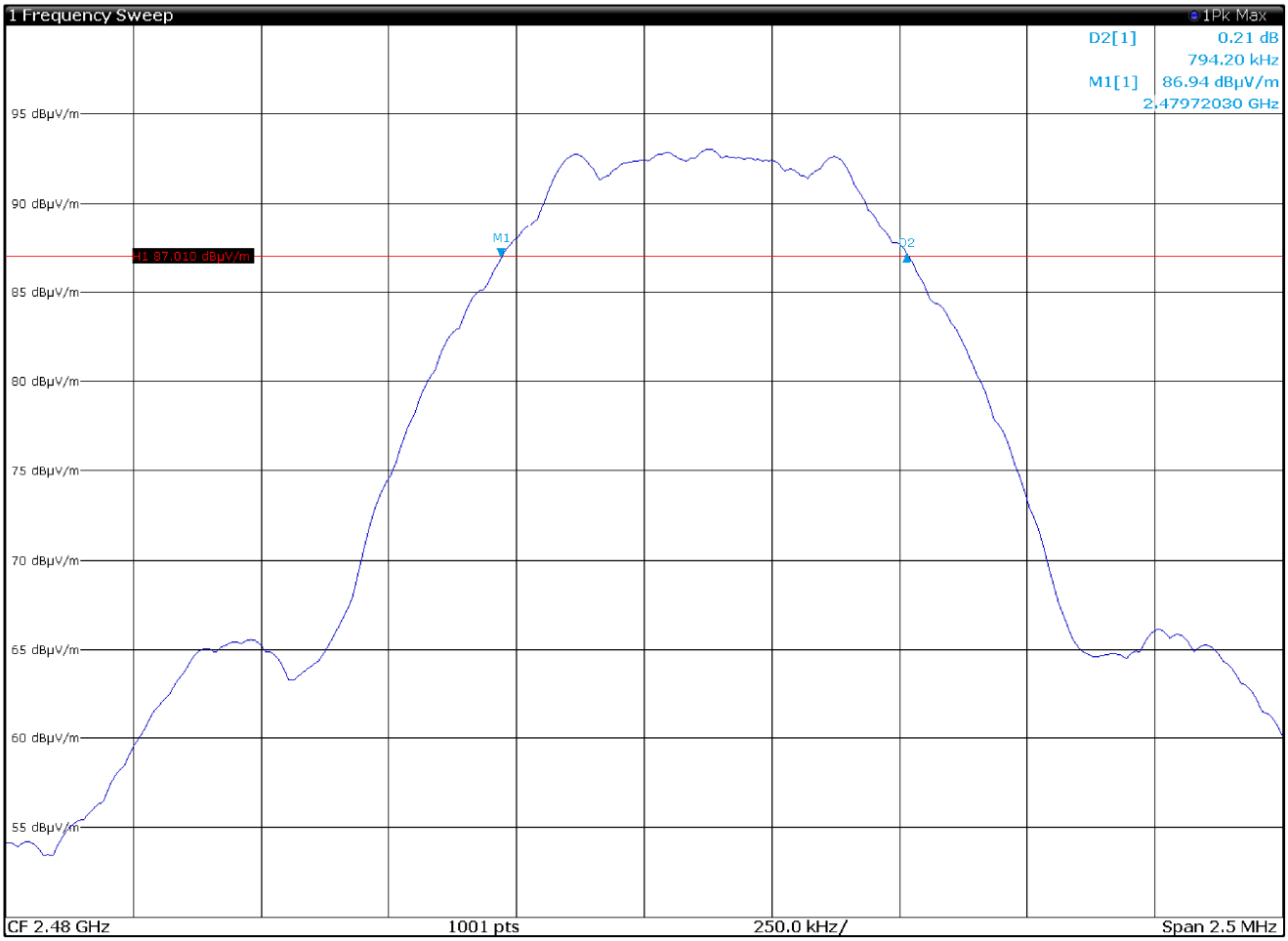


Figure 8.3-3: *6 dB bandwidth on high channel, sample plot*

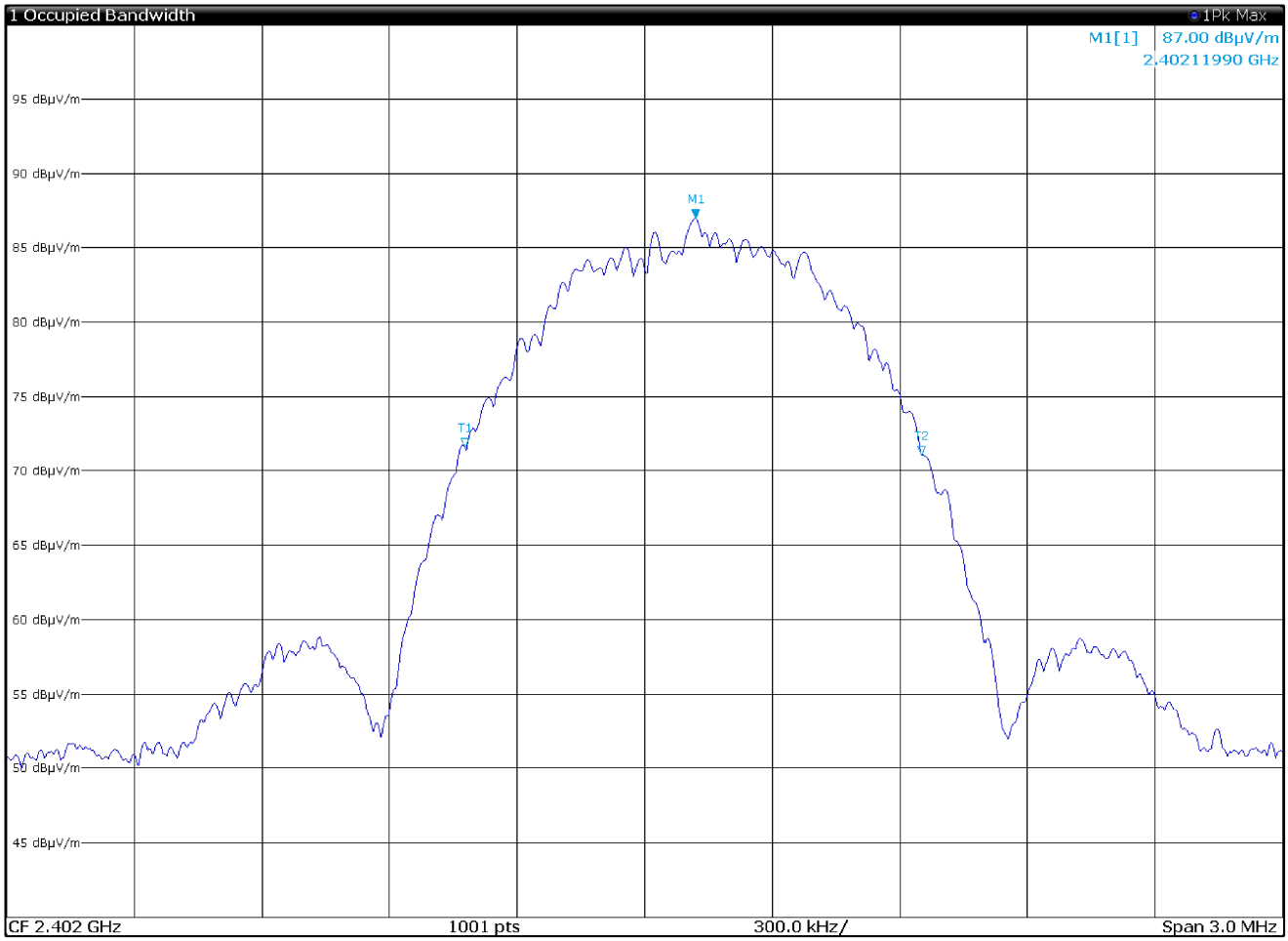


Figure 8.3-4: *99% bandwidth on low channel, sample plot*

2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.4021199 GHz**	**87.00 dBµV/m**	Occ Bw	**1.072800673 MHz**
T1		1	2.40157703 GHz	71.59 dBµV/m	Occ Bw Centroid	2.402113433 GHz
T2		1	2.40264983 GHz	71.08 dBµV/m	Occ Bw Freq Offset	113.432740694 kHz

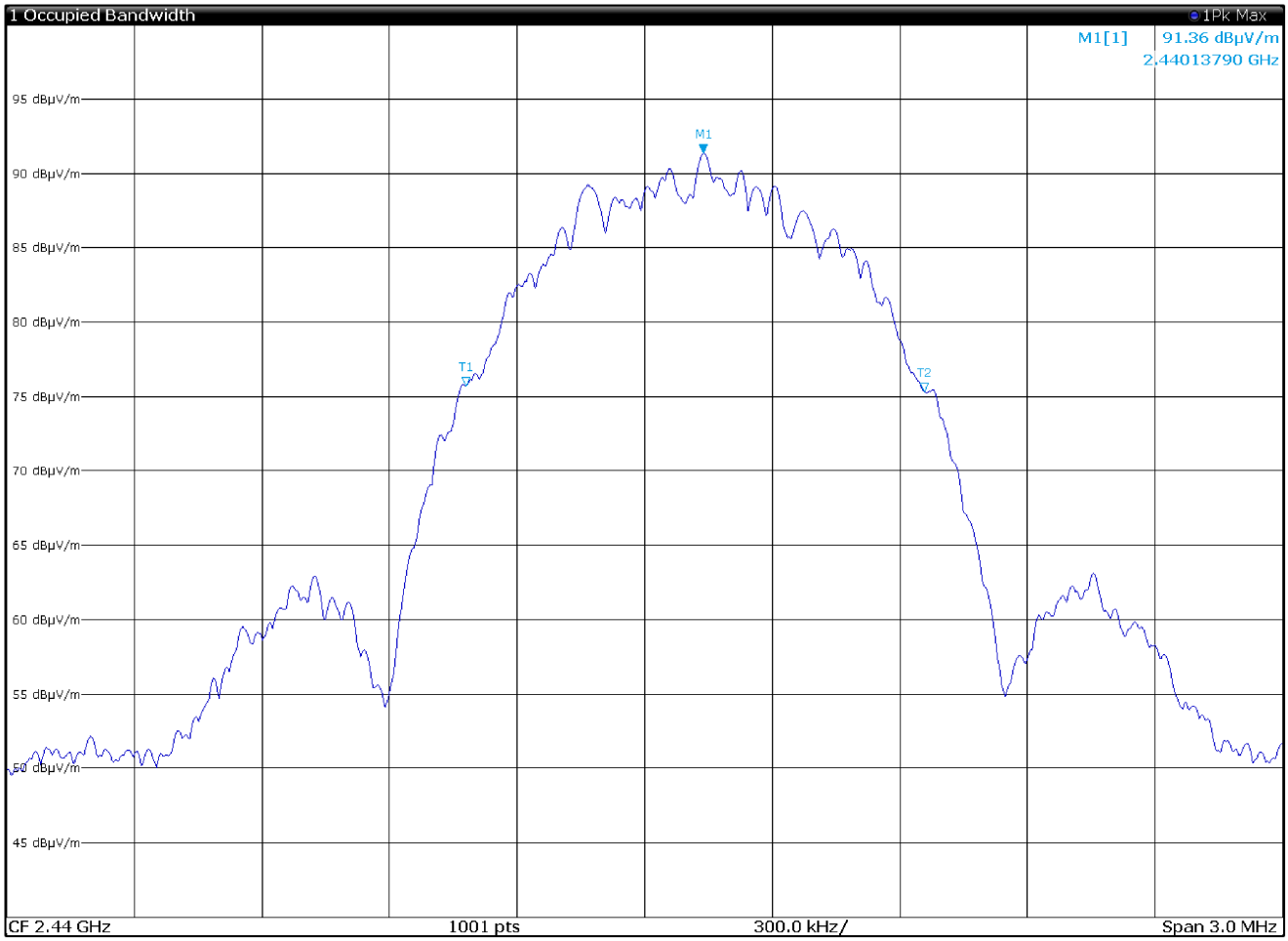


Figure 8.3-5: *99% bandwidth on mid channel, sample plot*

2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.4401379 GHz**	**91.36 dBµV/m**	Occ Bw	**1.078304767 MHz**
T1		1	2.4395801 GHz	75.72 dBµV/m	Occ Bw Centroid	2.440119256 GHz
T2		1	2.44065841 GHz	75.30 dBµV/m	Occ Bw Freq Offset	119.256110042 kHz

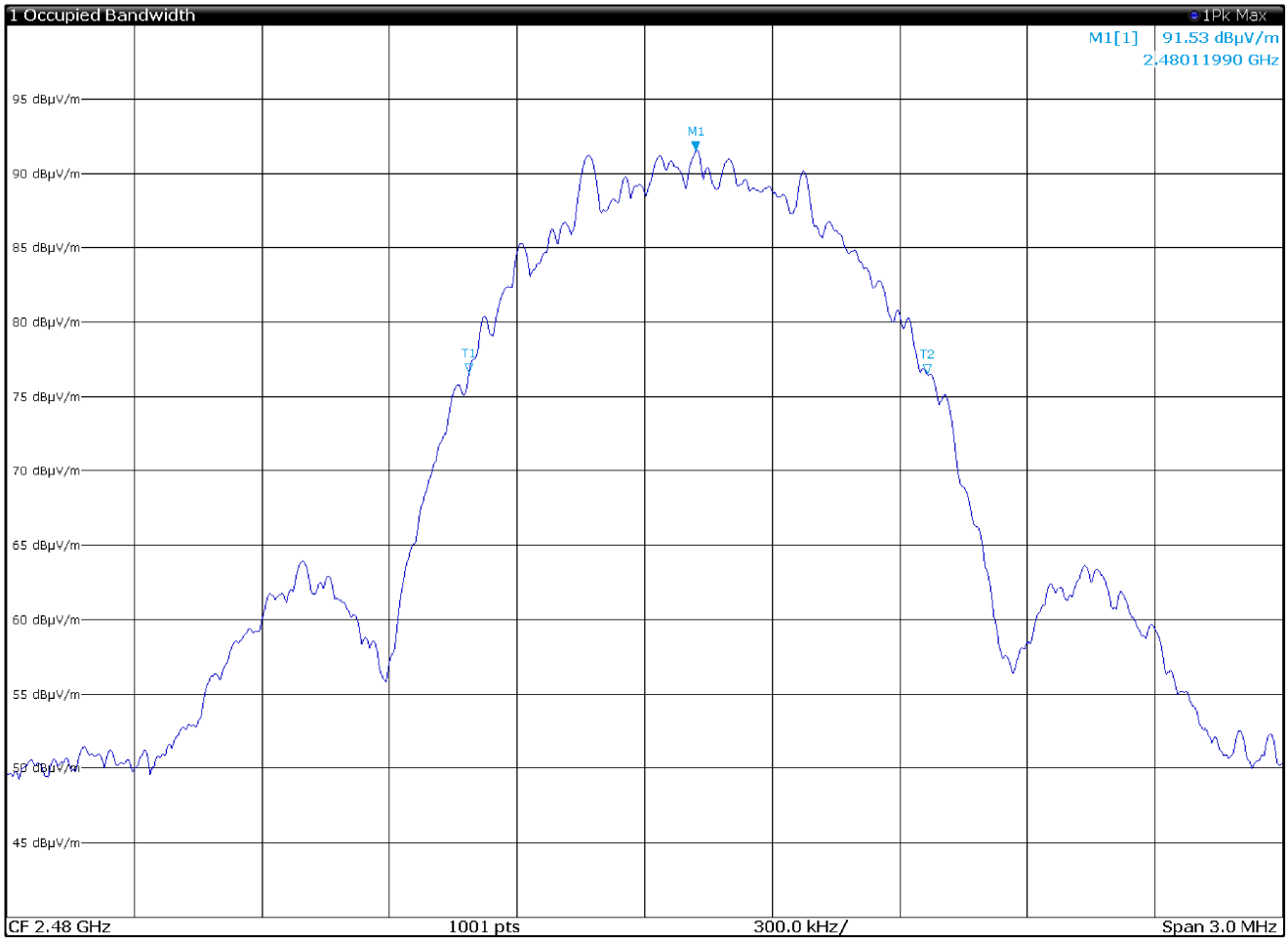


Figure 8.3-6: *99% bandwidth on high channel, sample plot*

2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.4801199 GHz**	**91.53 dBµV/m**	Occ Bw	**1.076486871 MHz**
T1		1	2.47958691 GHz	76.61 dBµV/m	Occ Bw Centroid	2.480125152 GHz
T2		1	2.4806634 GHz	76.54 dBµV/m	Occ Bw Freq Offset	125.151806597 kHz

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.

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(c) Operation with directional antenna gains greater than 6 dBi.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

8.4.2 Test summary

Test date	2019-10-14	Temperature	22 °C
Test engineer	P. Barbieri	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	-3.6	30.00	33.6	0.5	-3.1	36.00	39.1
	2440	-1.1	30.00	31.1	0.5	-0.6	36.00	36.6
	2480	1.9	30.00	28.1	0.5	2.4	36.00	33.6

E[dBµV/m] = EIRP[dBm] + 95.2, for d = 3 m

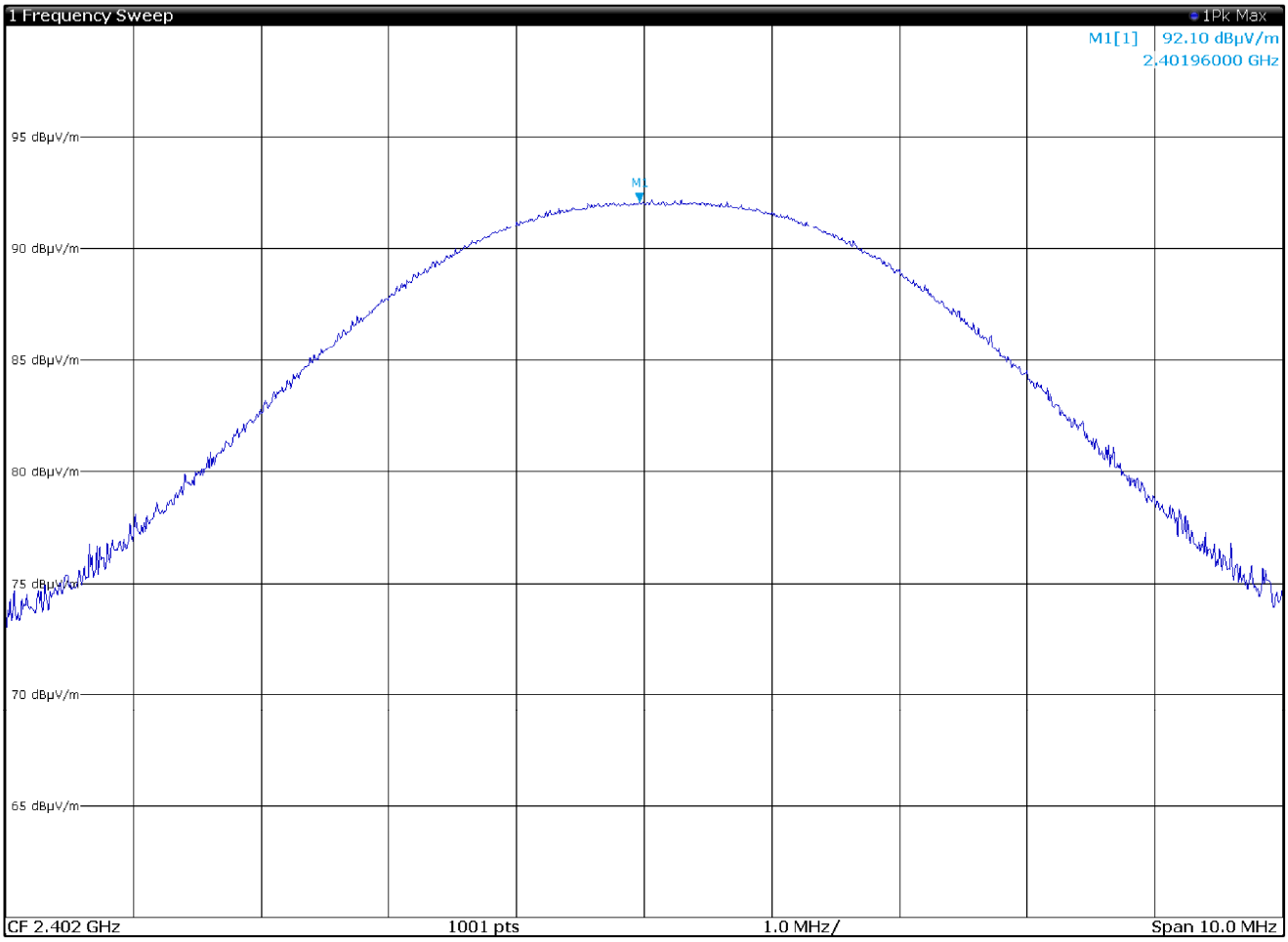


Figure 8.4-1: *radiated power on low channel, sample plot*

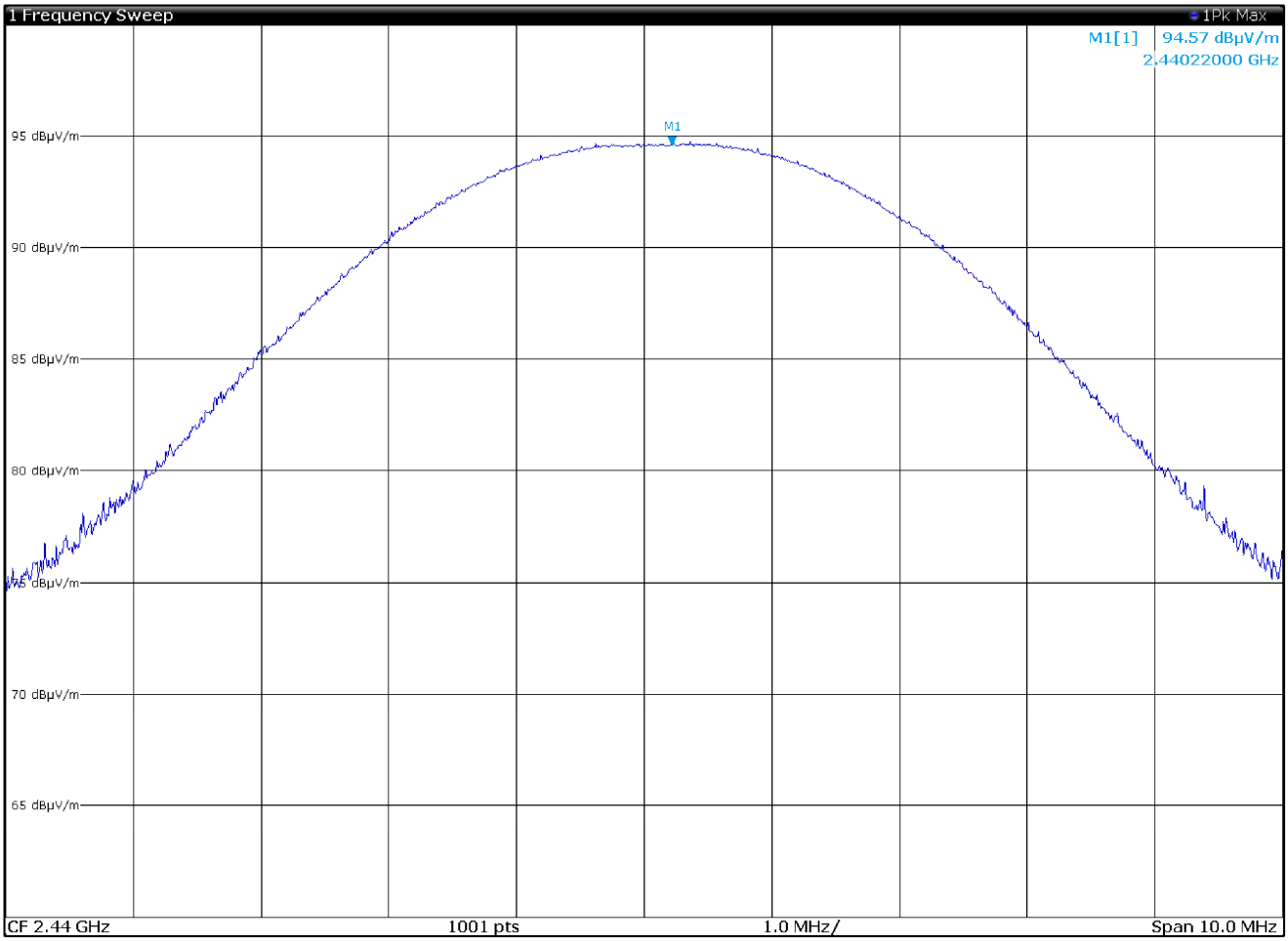


Figure 8.4-2: *radiated power on mid channel, sample plot*

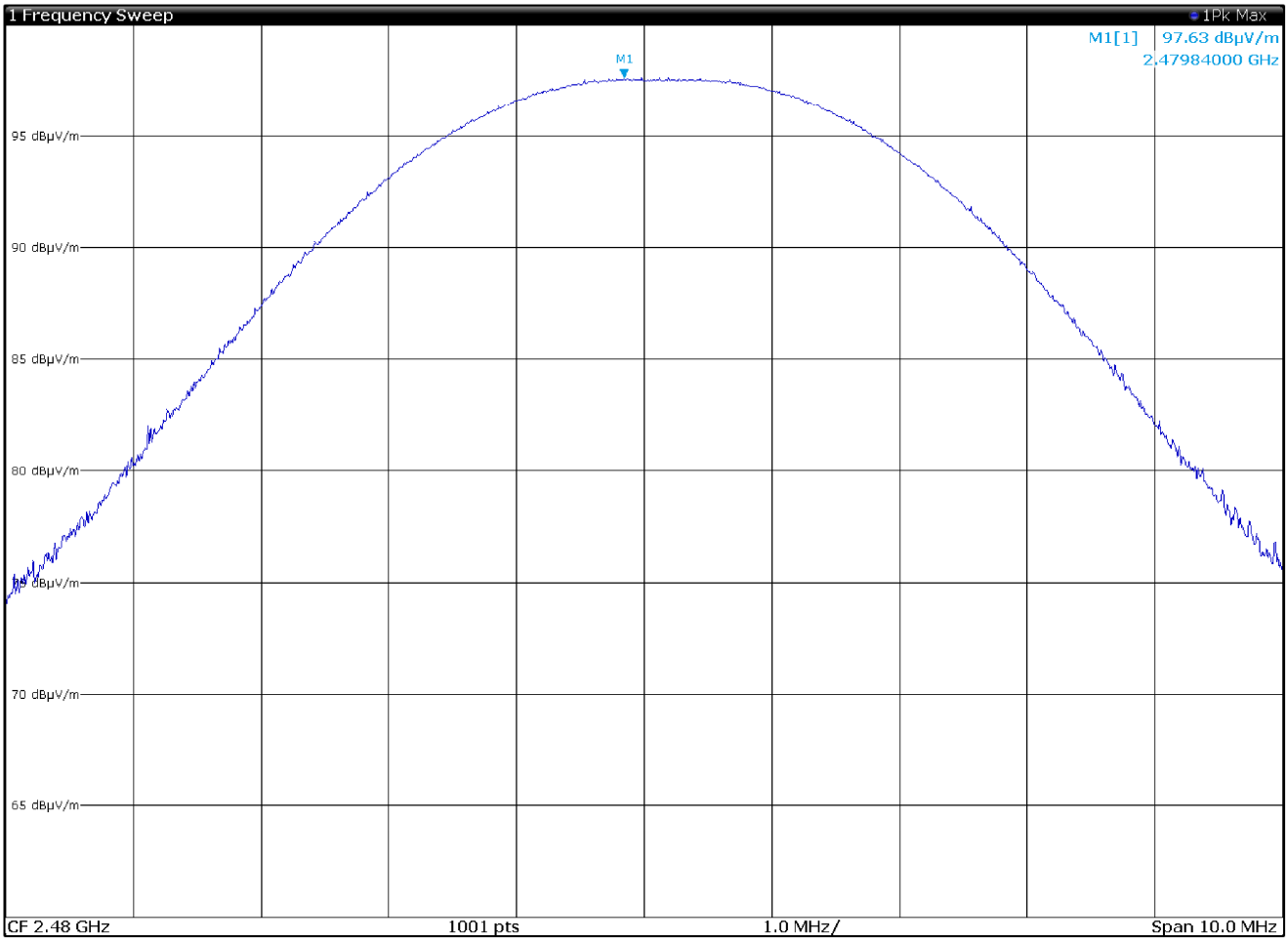


Figure 8.4-3: *radiated power on high channel, sample plot*

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 µV/m	Field strength of emissions dBµV/m	Measurement distance, 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	2019-10-11	Temperature	22 °C
Test engineer	P. Barbieri	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

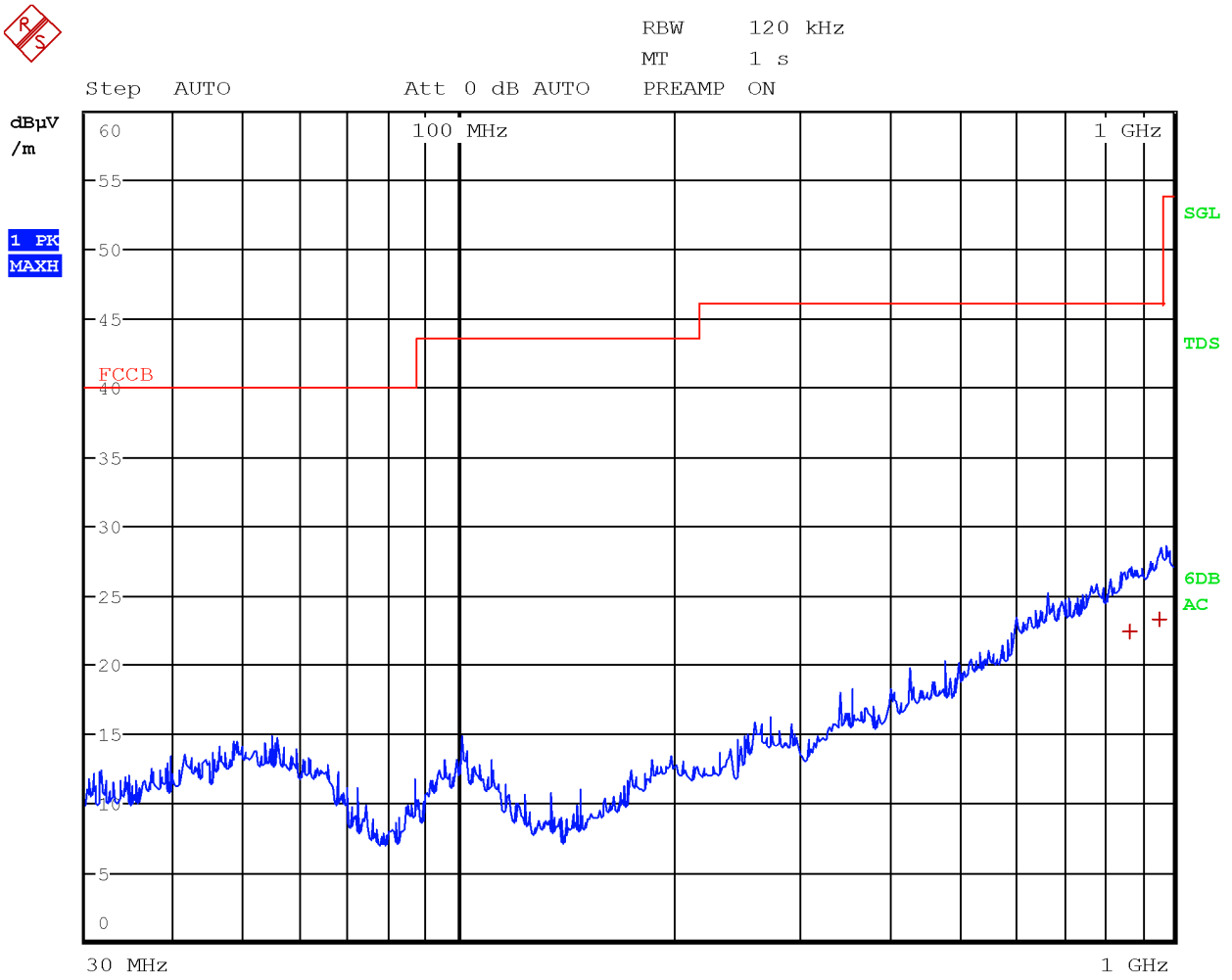


Figure 8.5-1: *Radiated spurious emissions with antenna in horizontal polarization, low channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
867.3900	22.4	46.0	-23.6	QP
958.6500	23.3	46.0	-22.7	QP

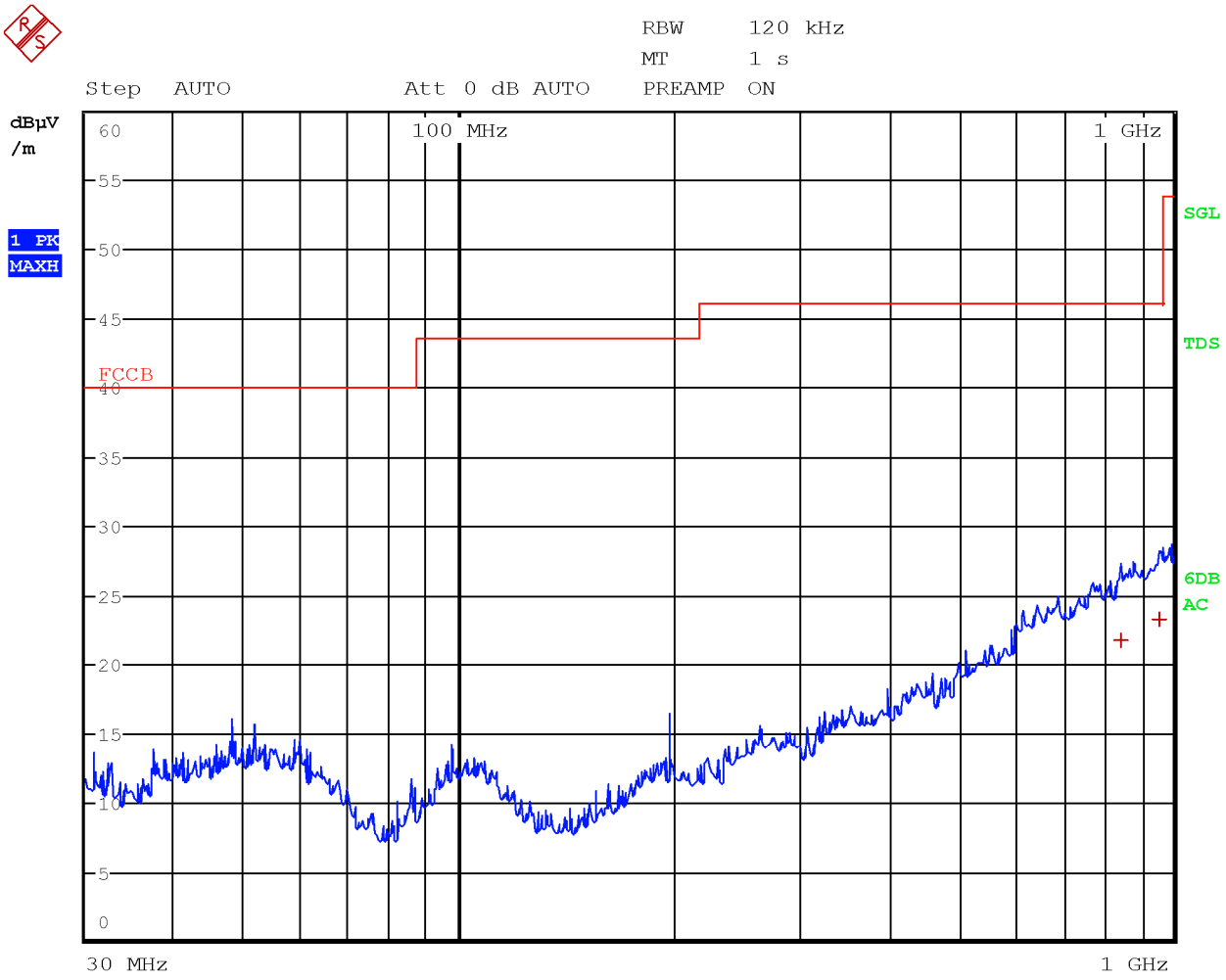


Figure 8.5-2: *Radiated spurious emissions with antenna in vertical polarization, low channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
845.9700	21.8	46.0	-24.2	QP
958.2900	23.3	46.0	-22.7	QP

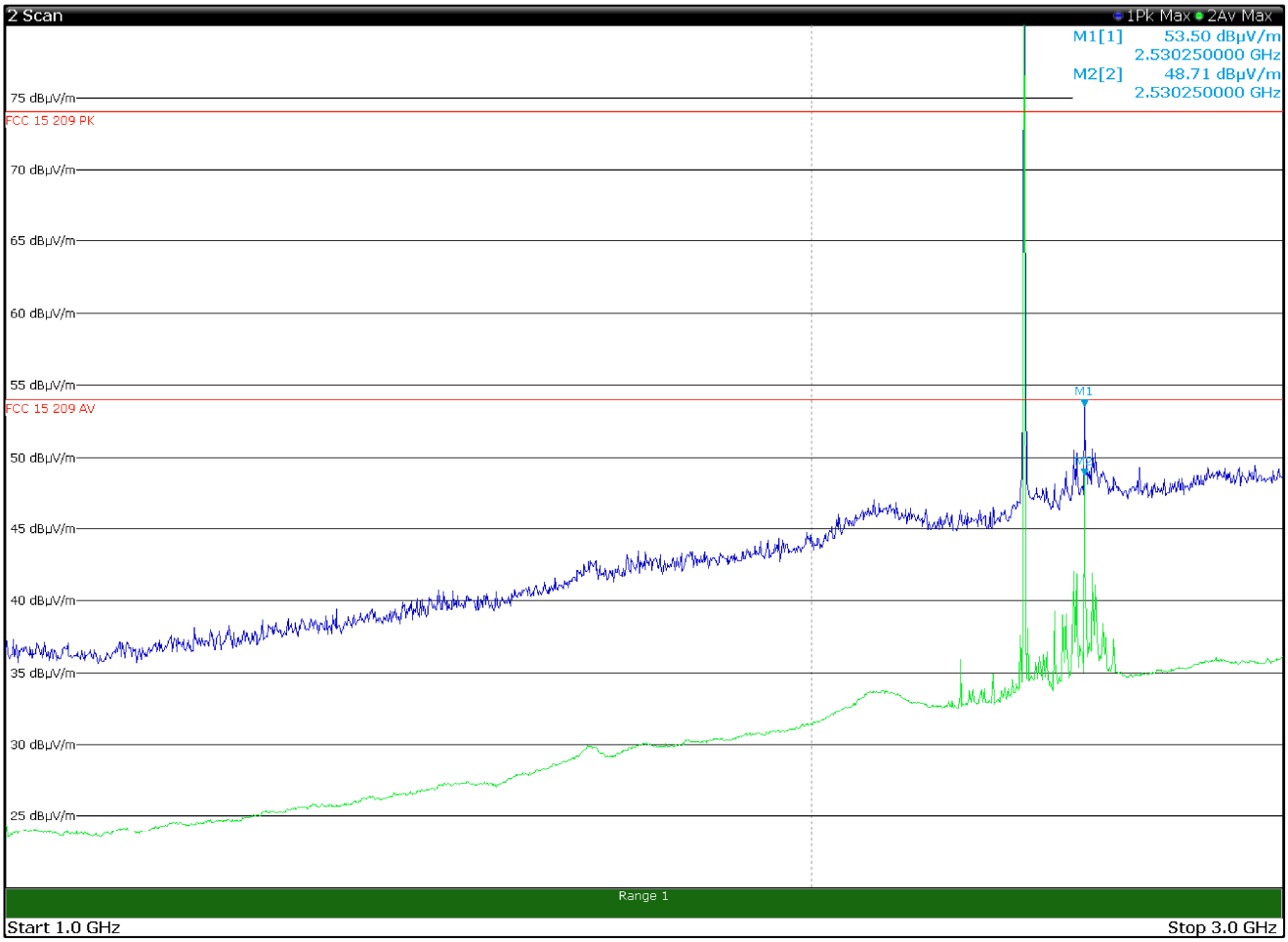


Figure 8.5-3: *Radiated spurious emissions with antenna in horizontal polarization, low channel*

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

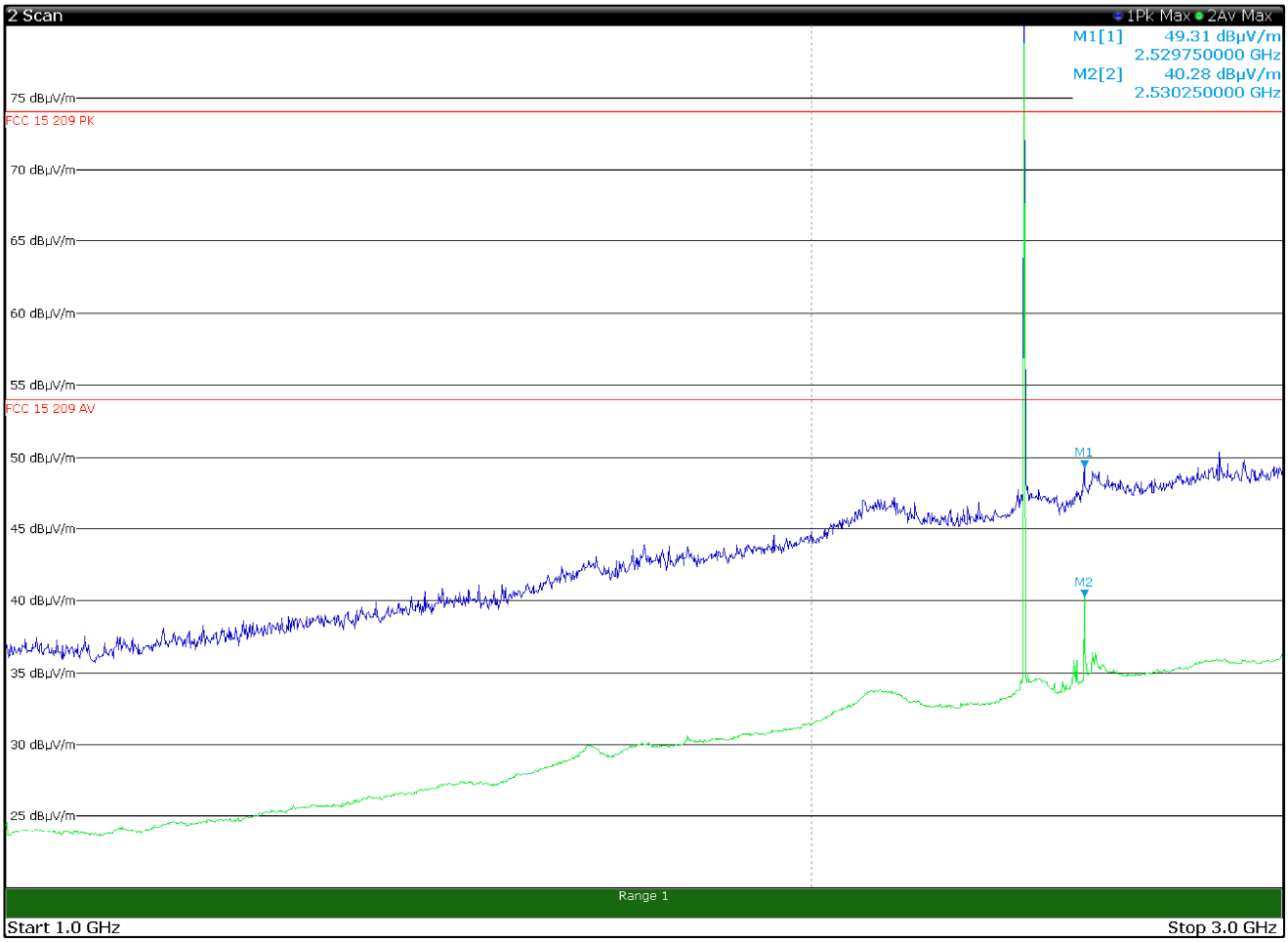


Figure 8.5-4: *Radiated spurious emissions with antenna in vertical polarization, low channel*

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

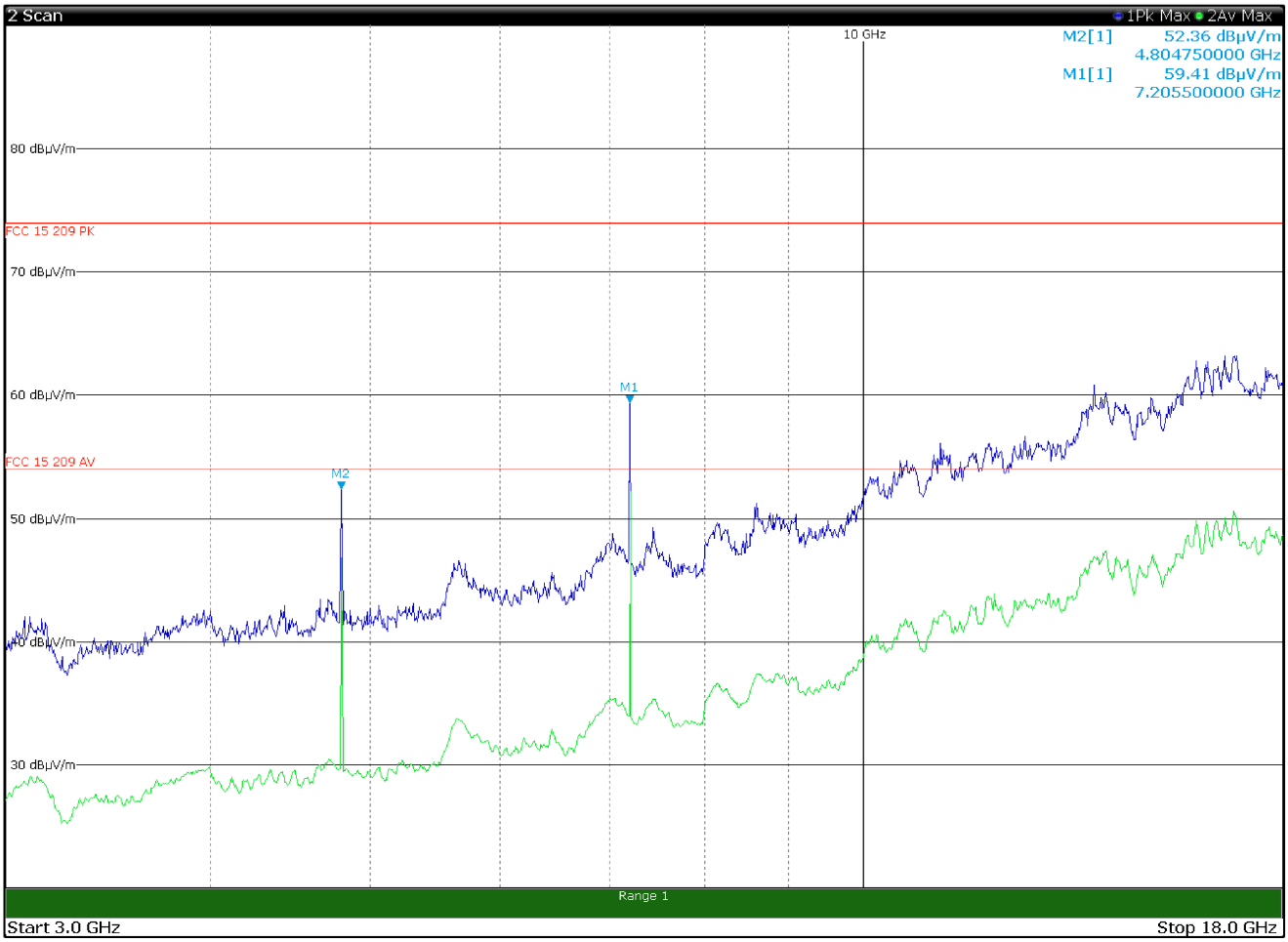


Figure 8.5-5: *Radiated spurious emissions with antenna in horizontal polarization, low channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4804.7500	52.4	74.0	-21.6	Pk
4804.7500	46.9	54.0	-7.1	Av
7205.5000	59.4	74.0	-14.6	Pk
7205.5000	53.7	54.0	-0.3	Av

Av detector measured as state in clause 8.5.3

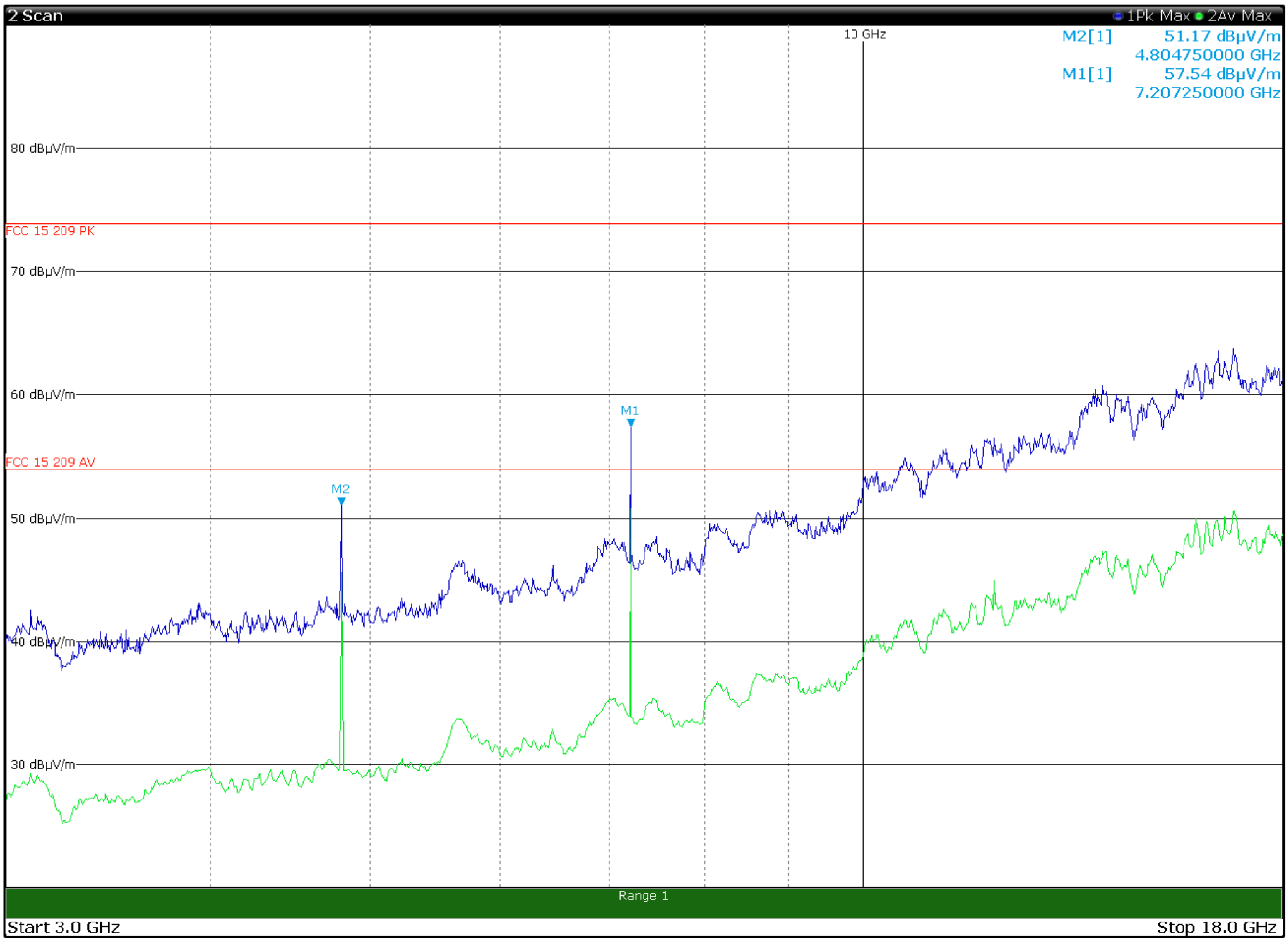


Figure 8.5-6: *Radiated spurious emissions with antenna in vertical polarization, low channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4804.7500	51.2	74.0	-22.8	Pk
4804.7500	45.9	54.0	-8.1	Av
7207.2500	57.6	74.0	-16.4	Pk
7207.2500	52.2	54.0	-1.8	Av

Av detector measured as state in clause 8.5.3

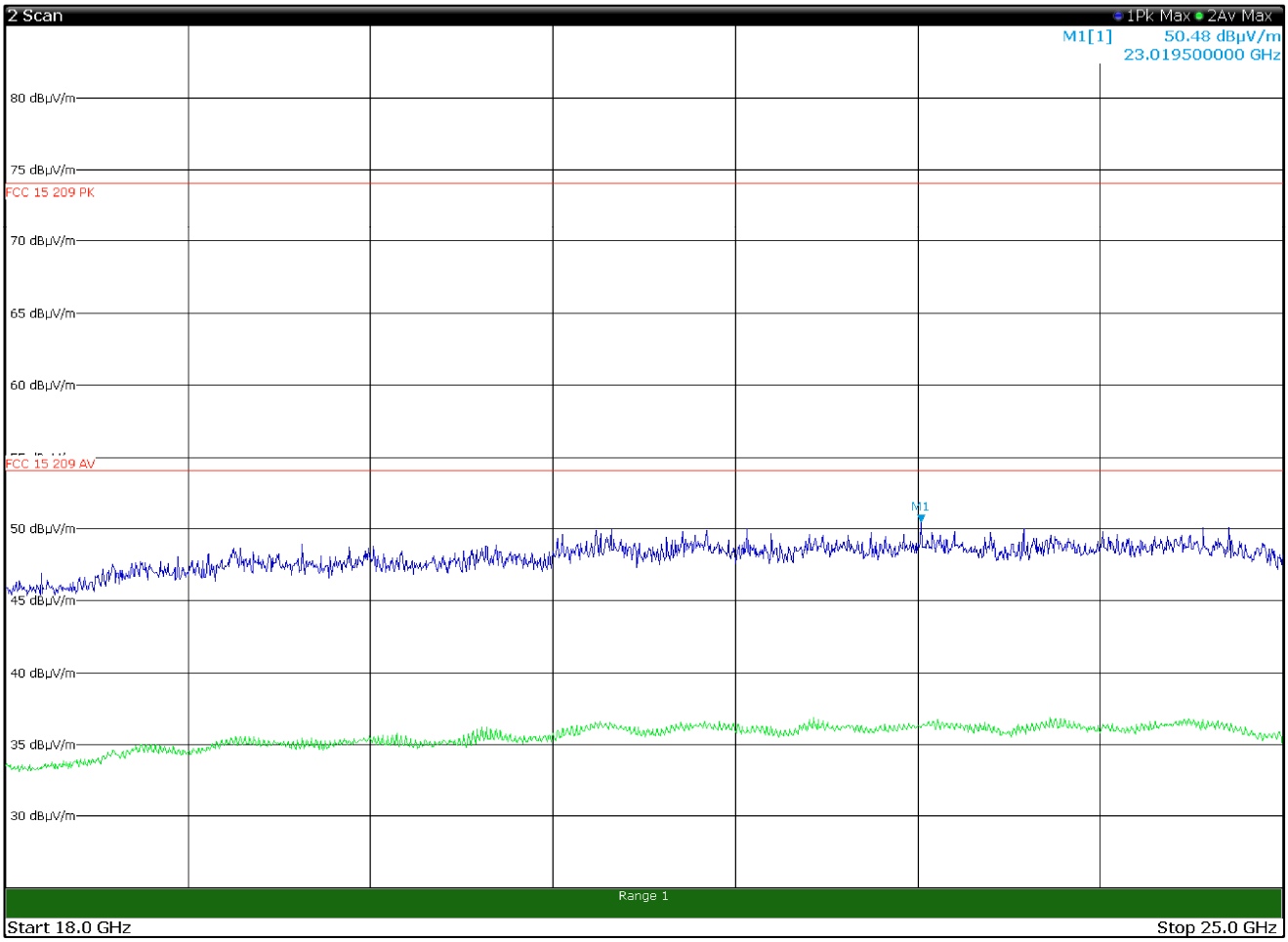


Figure 8.5-7: *Radiated spurious emissions with antenna in horizontal polarization, low channel*

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

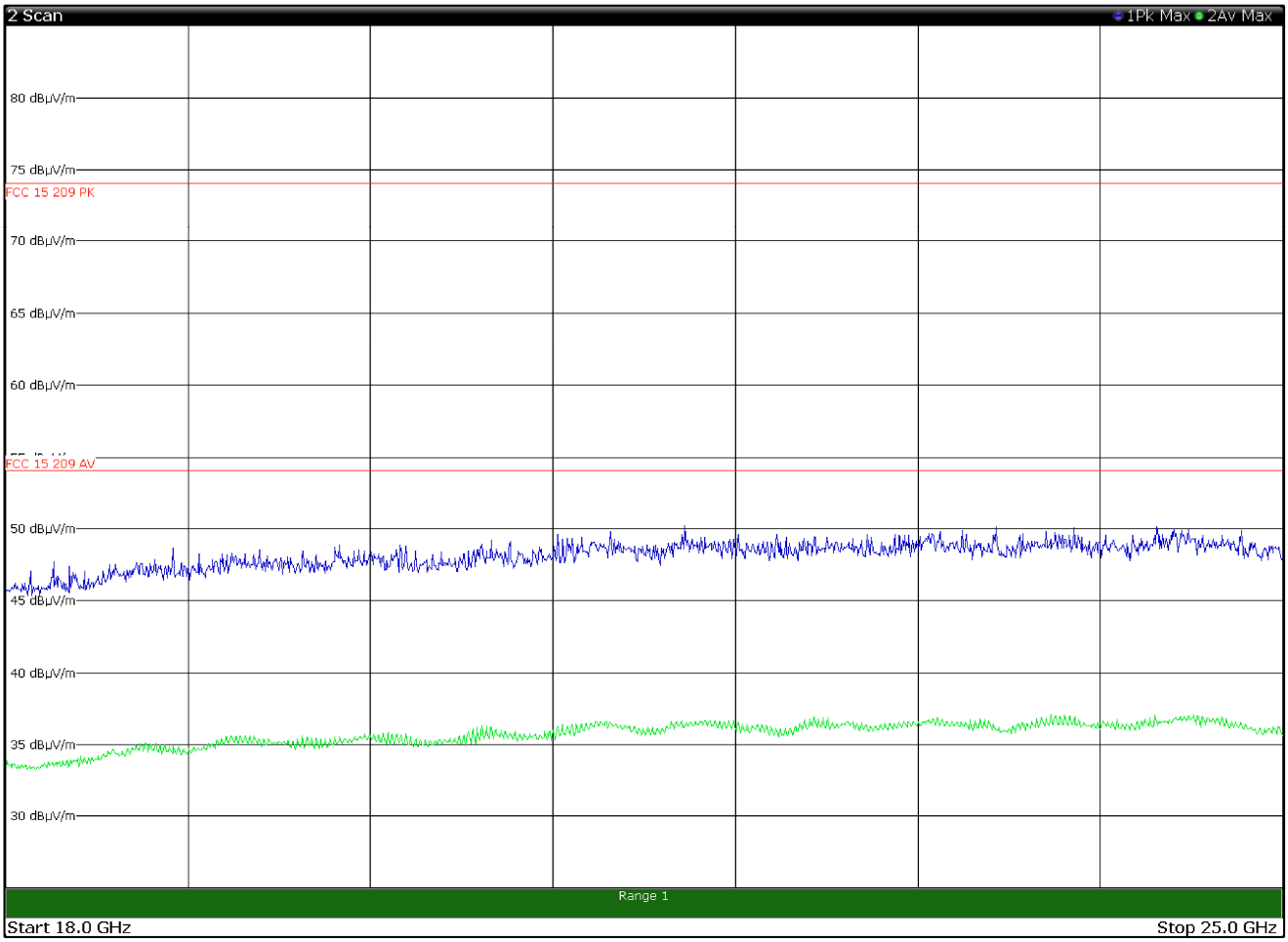


Figure 8.5-8: *Radiated spurious emissions with antenna in vertical polarization, low channel*

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

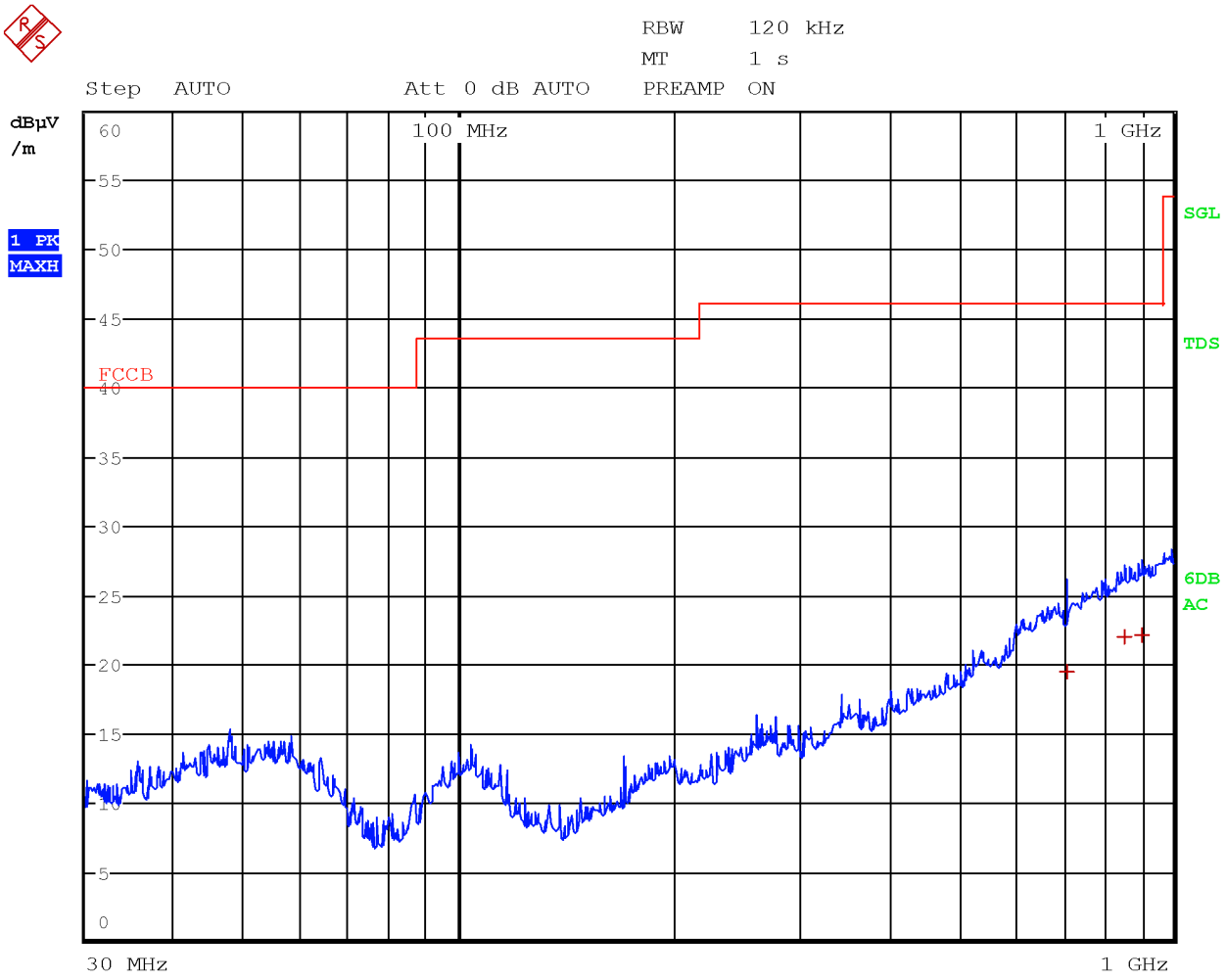


Figure 8.5-9: *Radiated spurious emissions with antenna in horizontal polarization, mid channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
711.5400	19.6	46.0	-26.4	QP
855.1500	22.1	46.0	-23.9	QP
904.0200	22.2	46.0	-23.8	QP

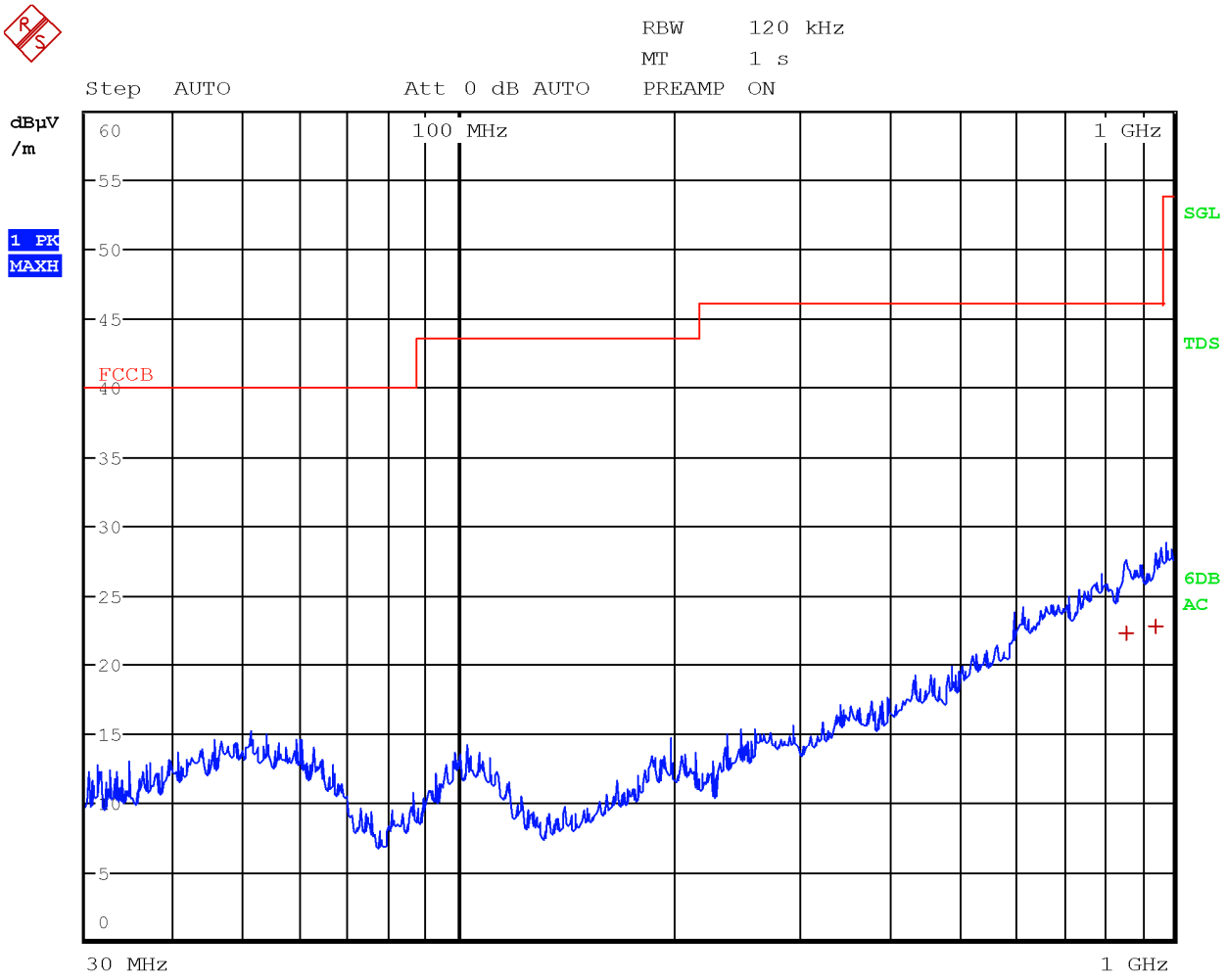


Figure 8.5-10: *Radiated spurious emissions with antenna in vertical polarization, mid channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
858.7800	22.2	46.0	-23.8	QP
947.6700	22.8	46.0	-23.2	QP

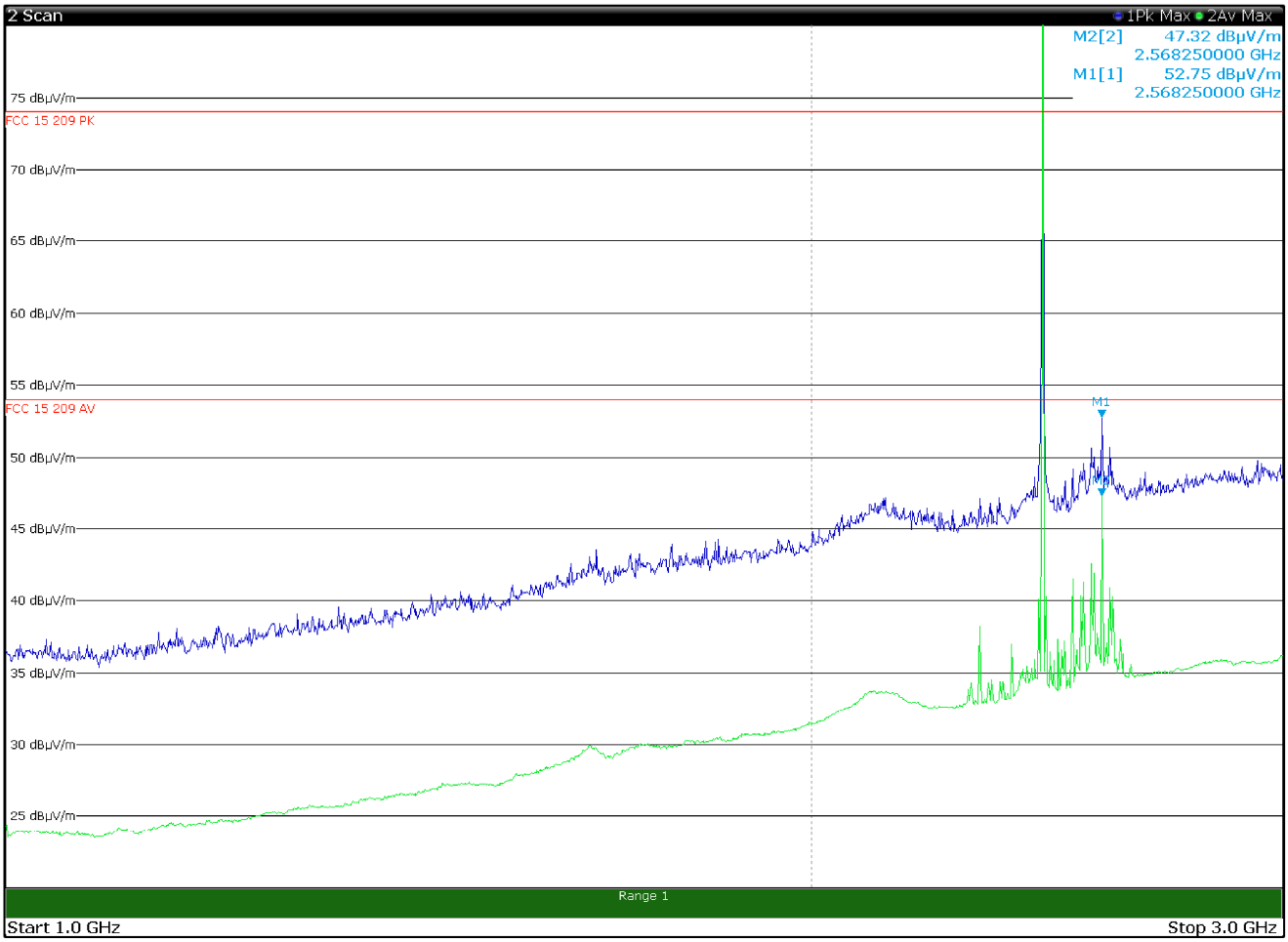


Figure 8.5-11: *Radiated spurious emissions with antenna in horizontal polarization, mid channel*

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

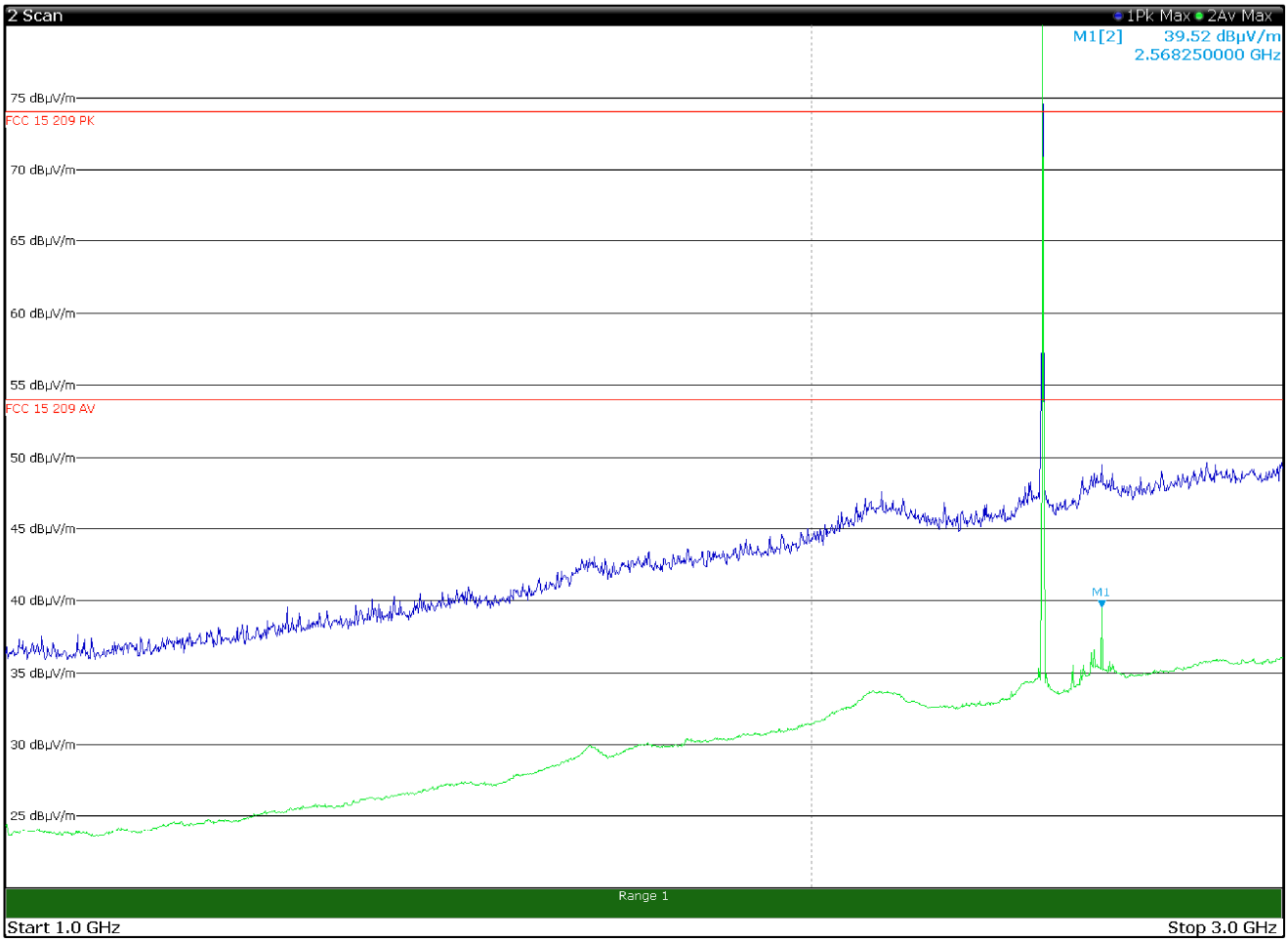


Figure 8.5-12: *Radiated spurious emissions with antenna in vertical polarization, mid channel*

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

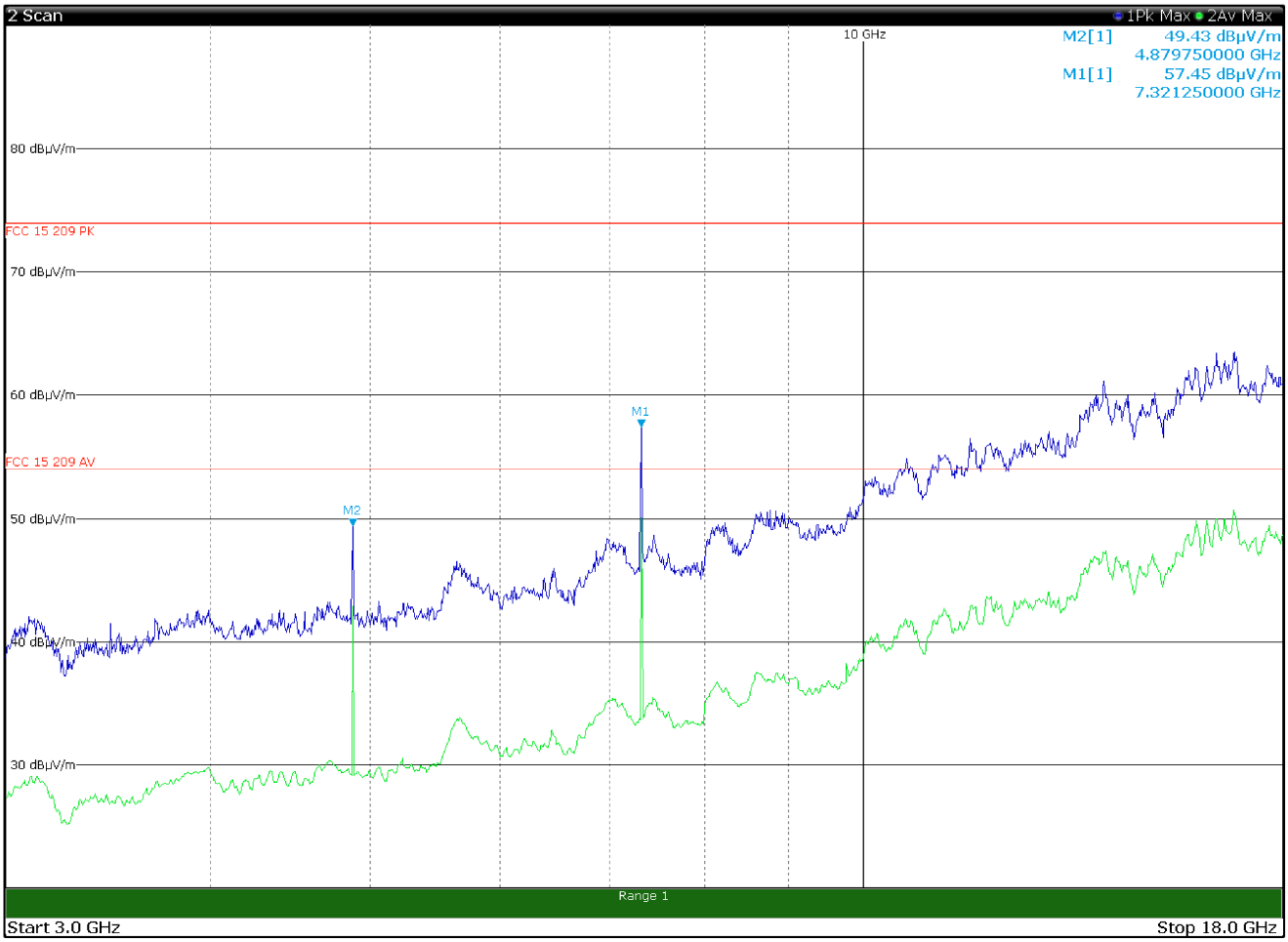


Figure 8.5-13: *Radiated spurious emissions with antenna in horizontal polarization, mid channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4879.7500	49.5	74.0	-24.5	Pk
4879.7500	44.1	54.0	-9.9	Av
7321.2500	57.5	74.0	-16.5	Pk
7321.2500	51.9	54.0	-2.1	Av

Av detector measured as state in clause 8.5.3

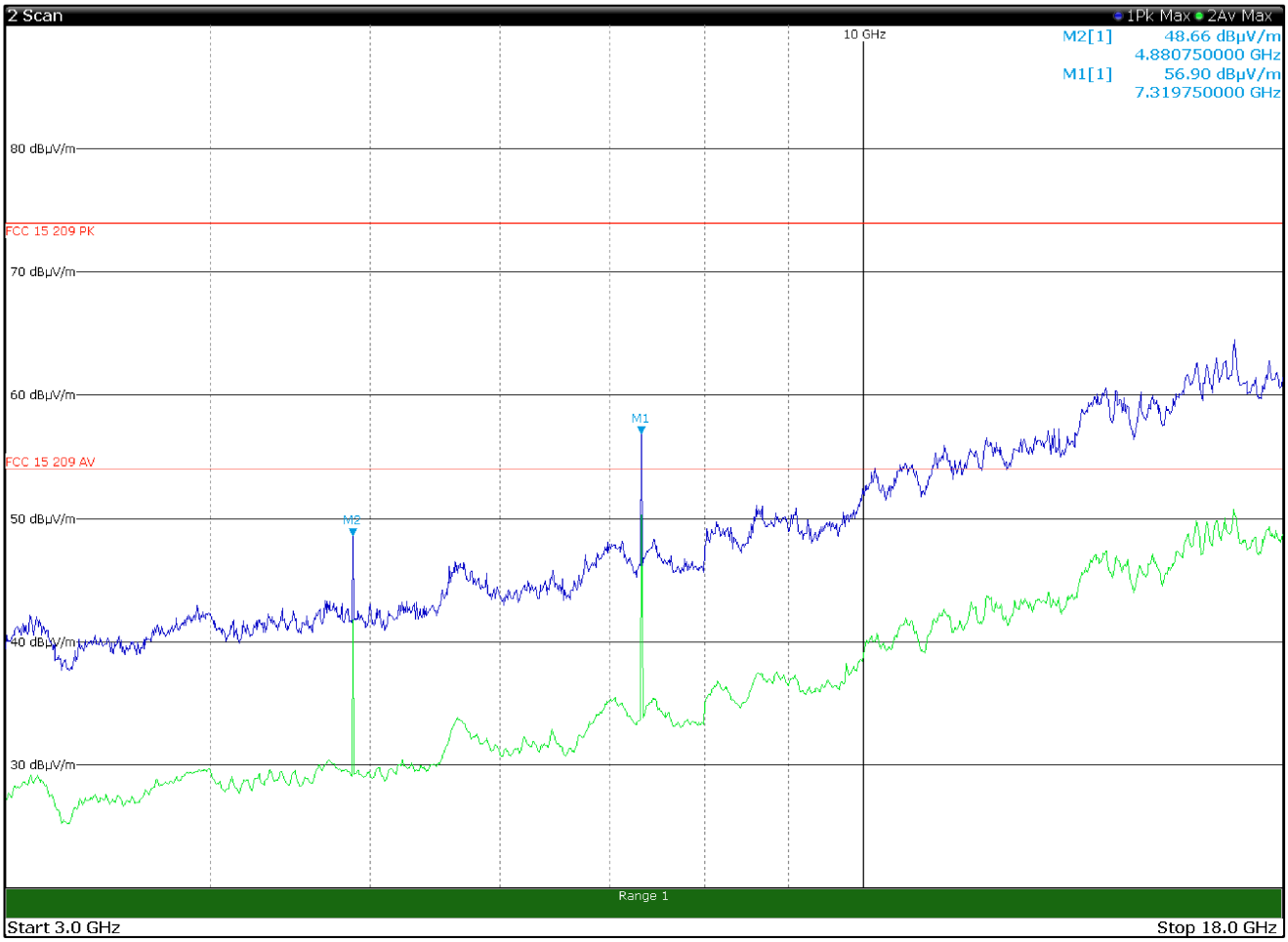


Figure 8.5-14: *Radiated spurious emissions with antenna in vertical polarization, mid channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4804.2500	46.9	74.0	-27.1	Pk
4804.2500	41.8	54.0	-12.2	Av
7207.2500	59.5	74.0	-14.5	Pk
7207.2500	53.8	54.0	-0.2	Av

Av detector measured as state in clause 8.5.3

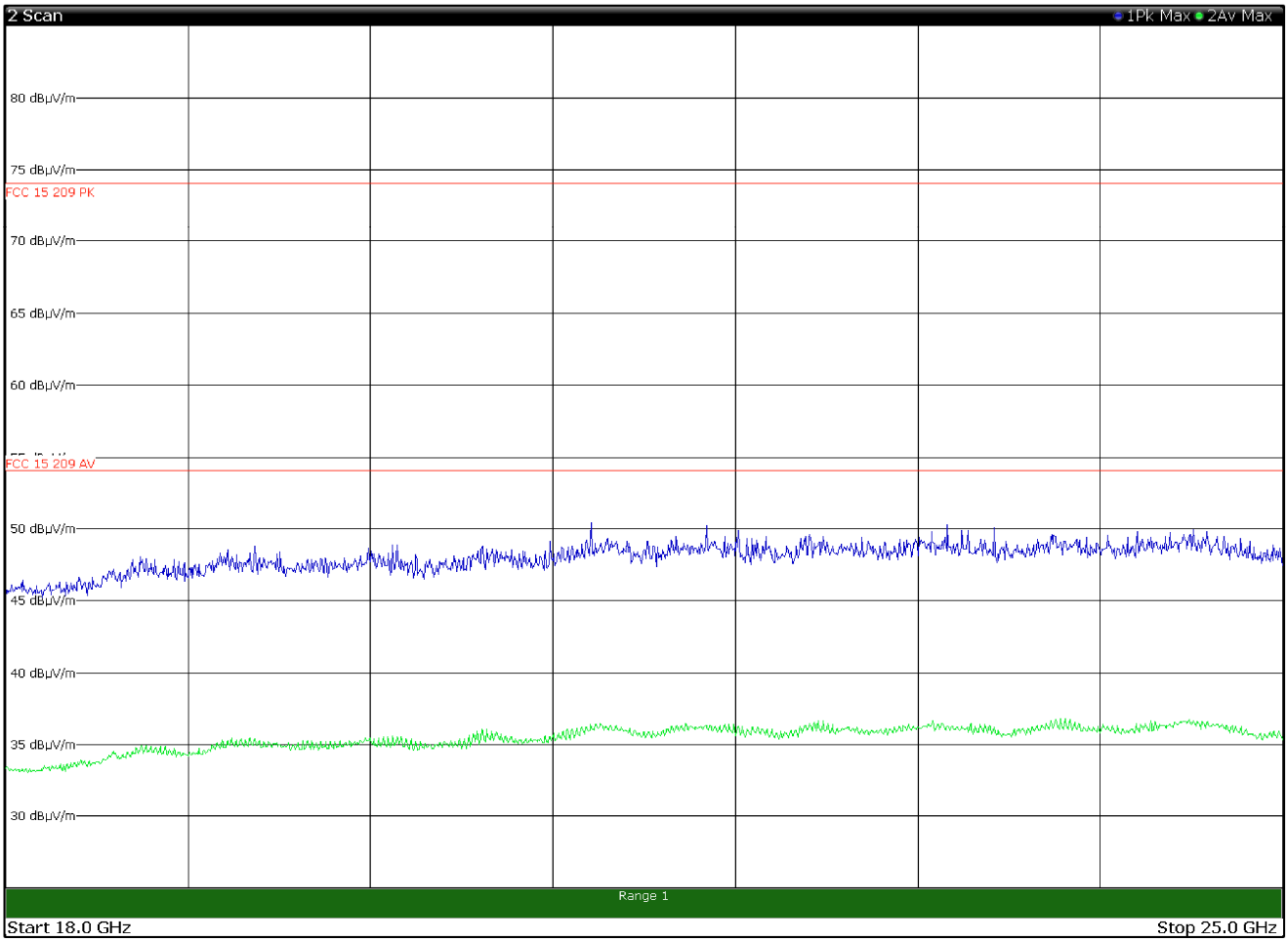


Figure 8.5-15: *Radiated spurious emissions with antenna in horizontal polarization, mid channel*

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

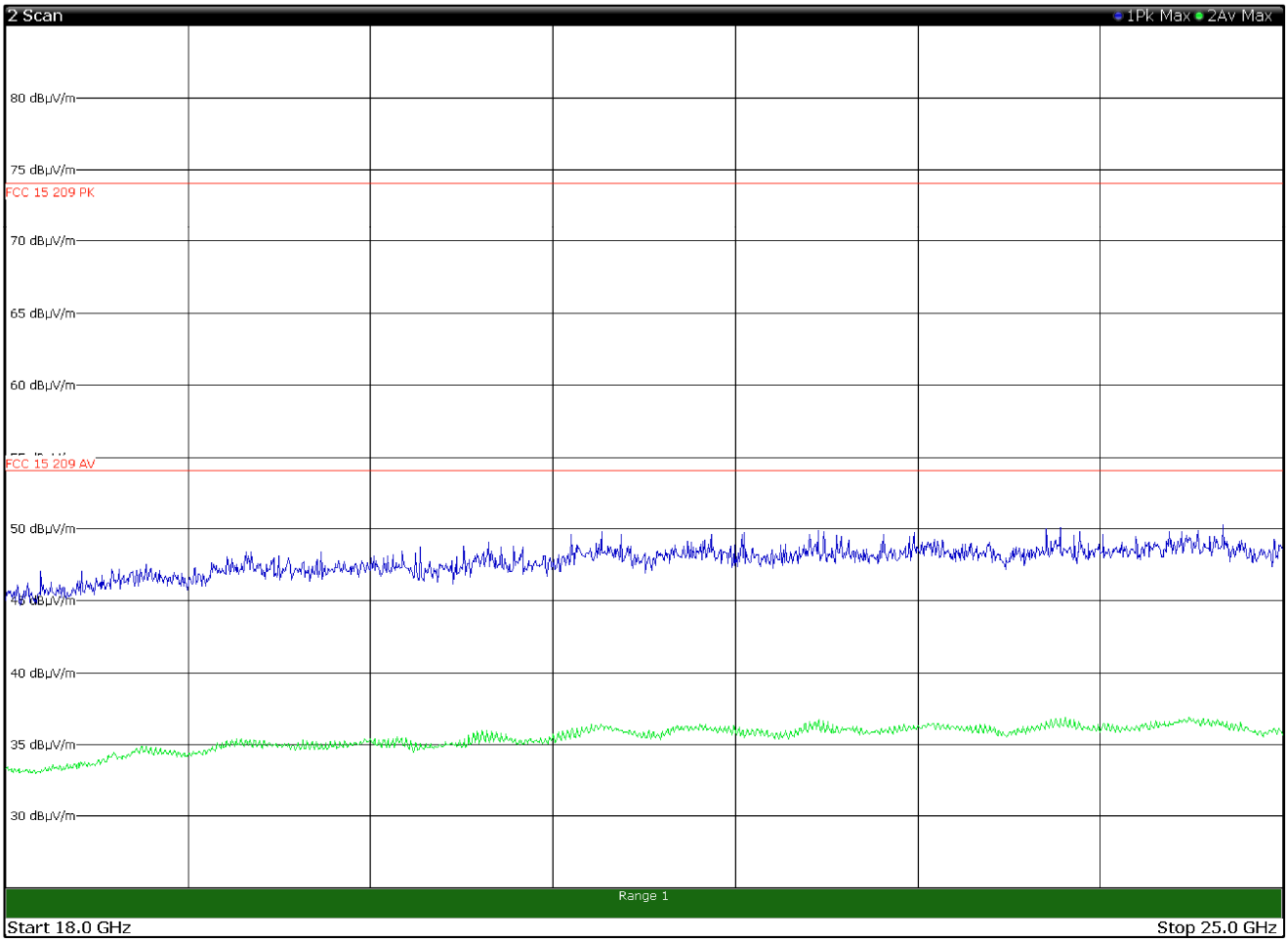


Figure 8.5-16: *Radiated spurious emissions with antenna in vertical polarization, mid channel*

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

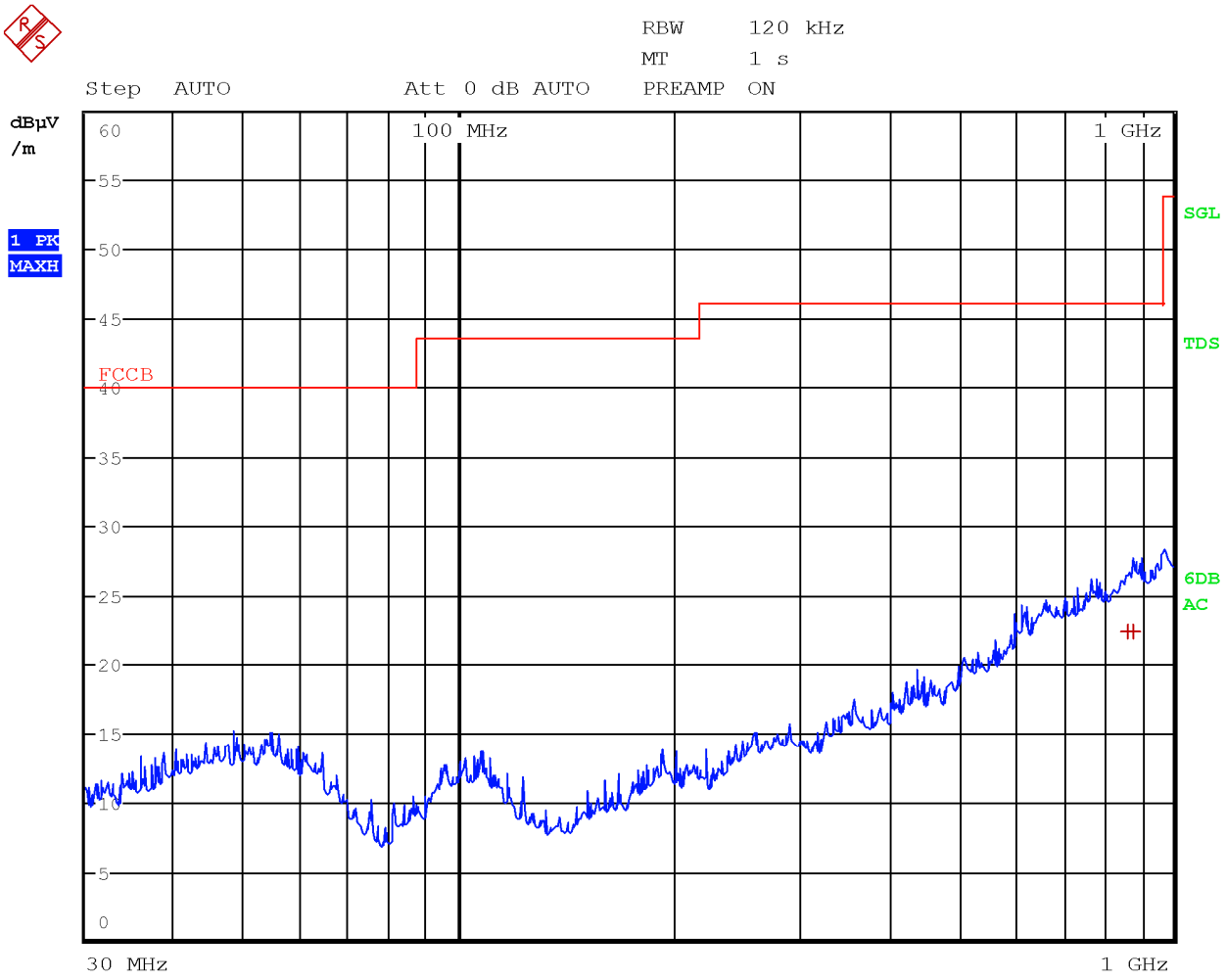


Figure 8.5-17: *Radiated spurious emissions with antenna in horizontal polarization, high channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
866.0400	22.4	46.0	-23.6	QP
879.3000	22.5	46.0	-23.5	QP

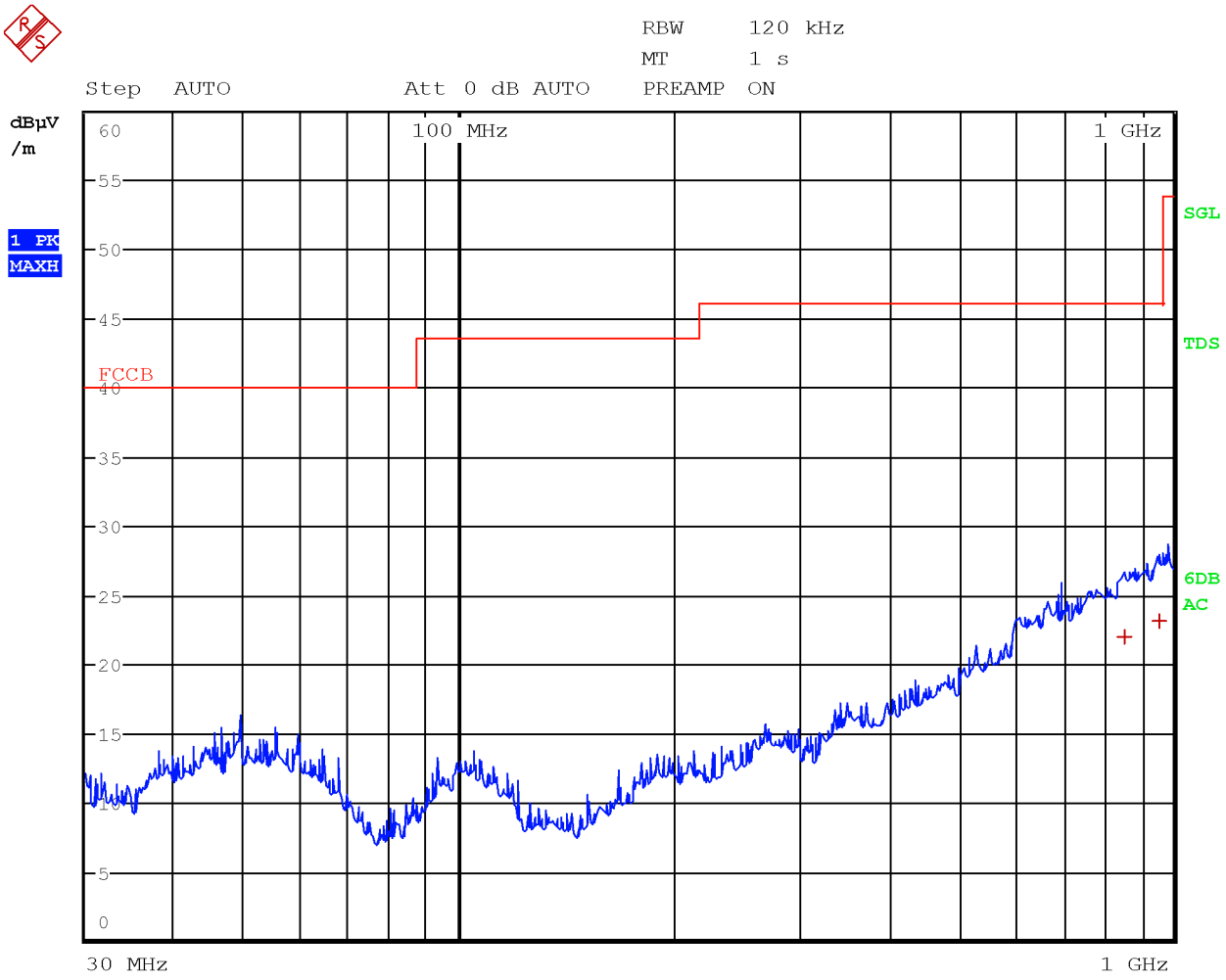


Figure 8.5-18: *Radiated spurious emissions with antenna in vertical polarization, high channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
852.9300	22.0	46.0	-24.0	QP
954.5100	23.2	46.0	-22.8	QP

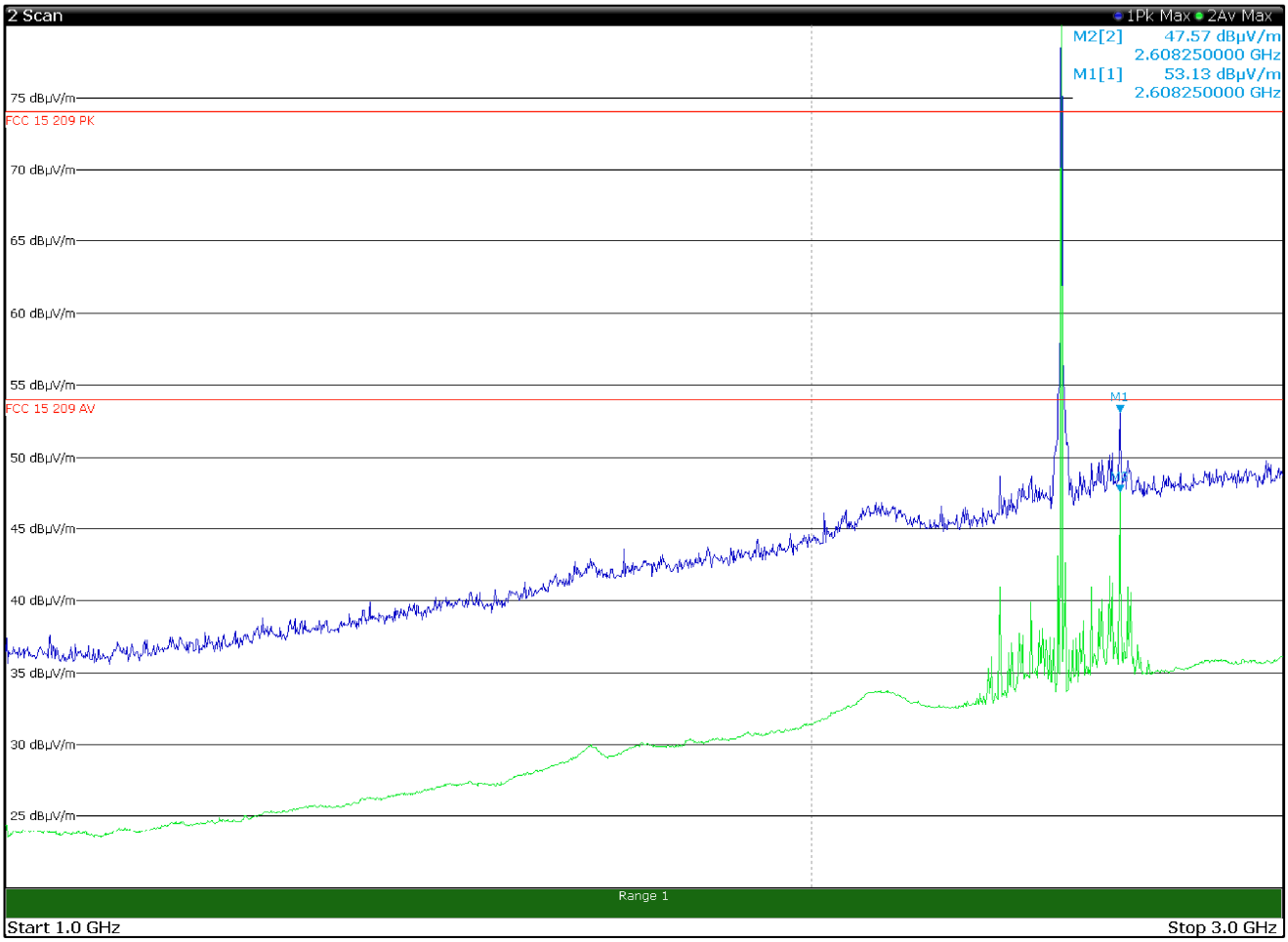


Figure 8.5-19: *Radiated spurious emissions with antenna in horizontal polarization, high channel*

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

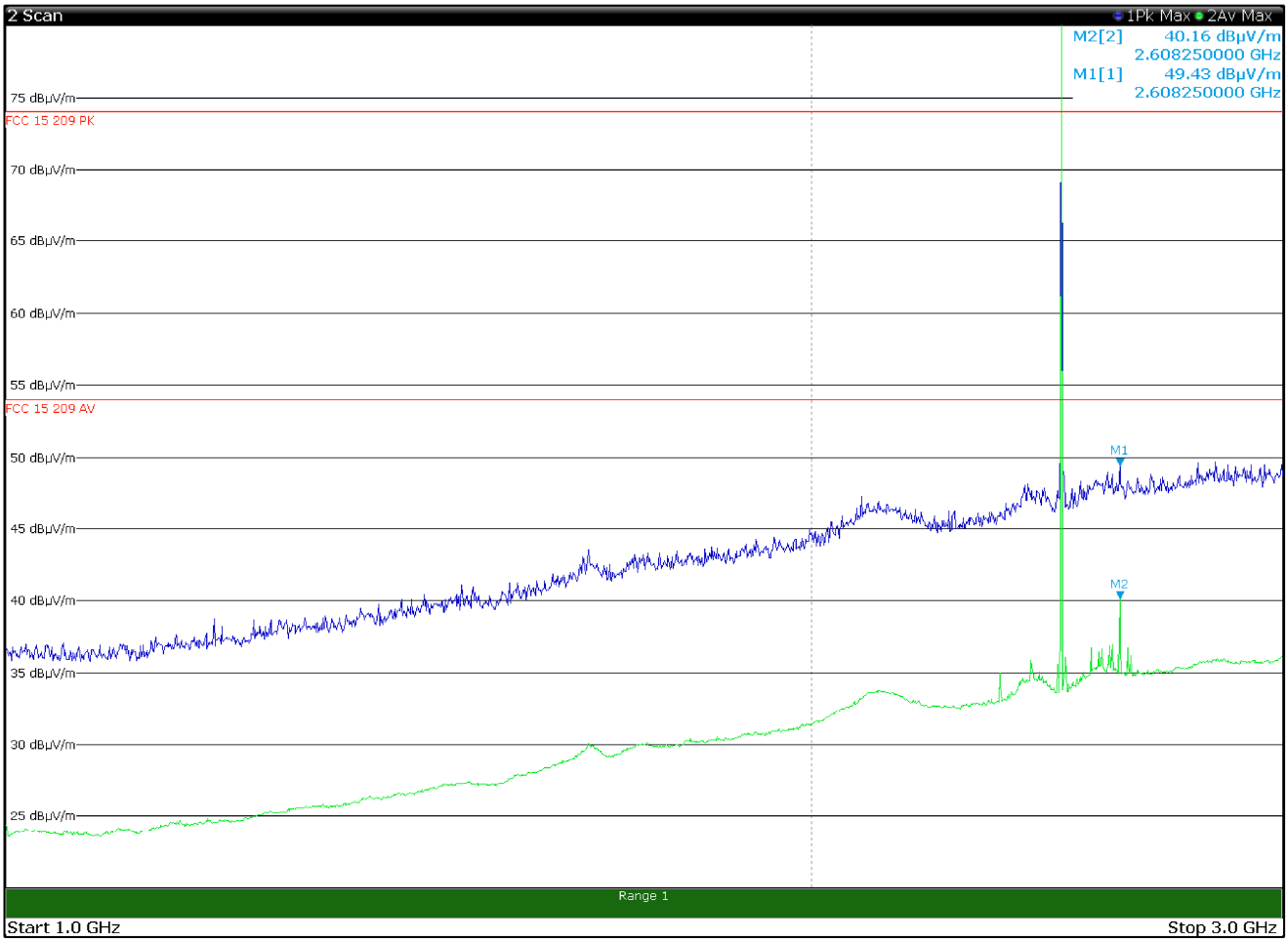


Figure 8.5-20: *Radiated spurious emissions with antenna in vertical polarization, high channel*

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

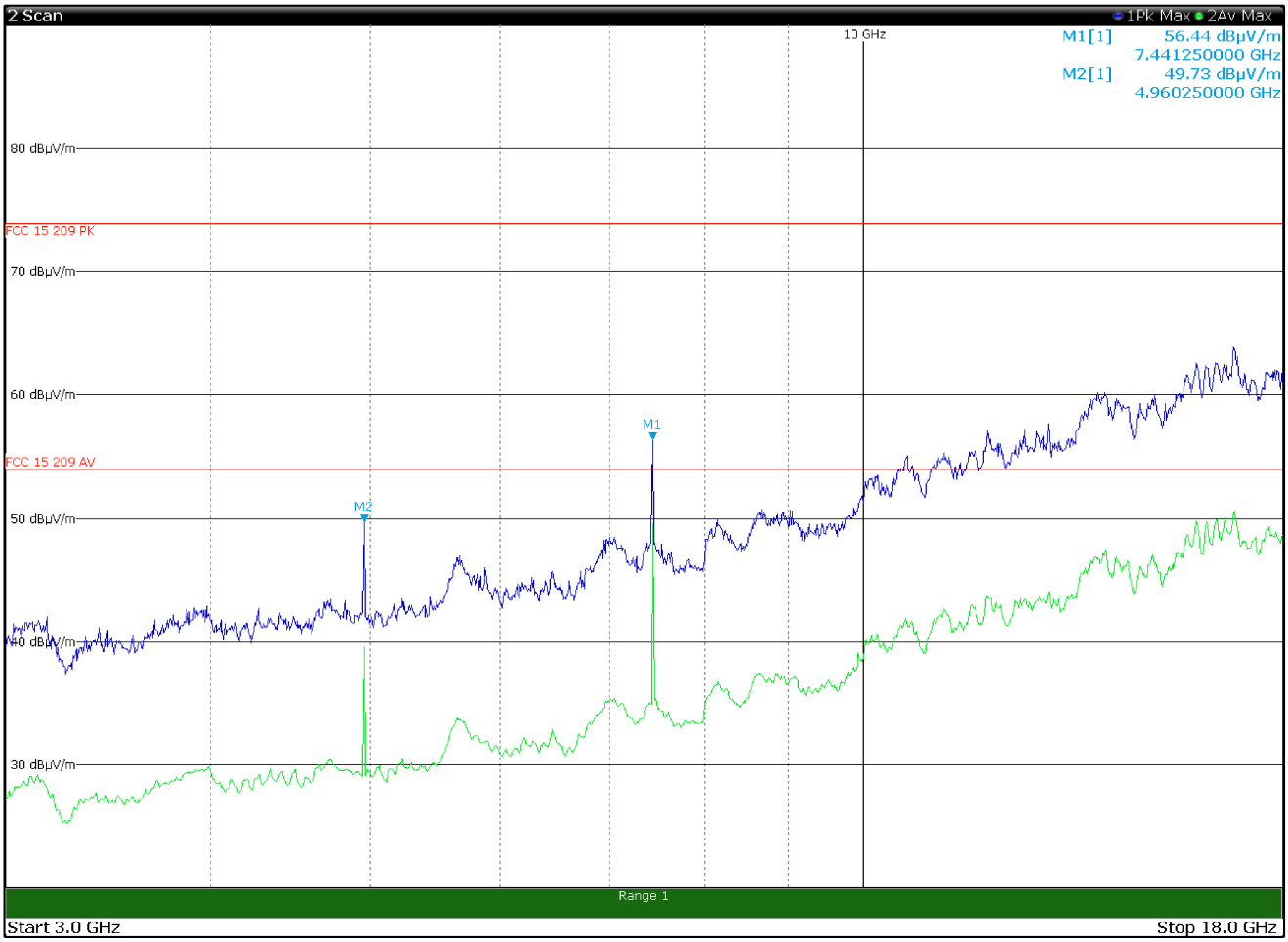


Figure 8.5-21: *Radiated spurious emissions with antenna in horizontal polarization, high channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4960.2500	49.8	74.0	-24.2	Pk
4960.2500	44.4	54.0	-9.6	Av
7439.5000	56.6	74.0	-17.4	Pk
7439.5000	51.1	54.0	-2.9	Av

Av detector measured as state in clause 8.5.3

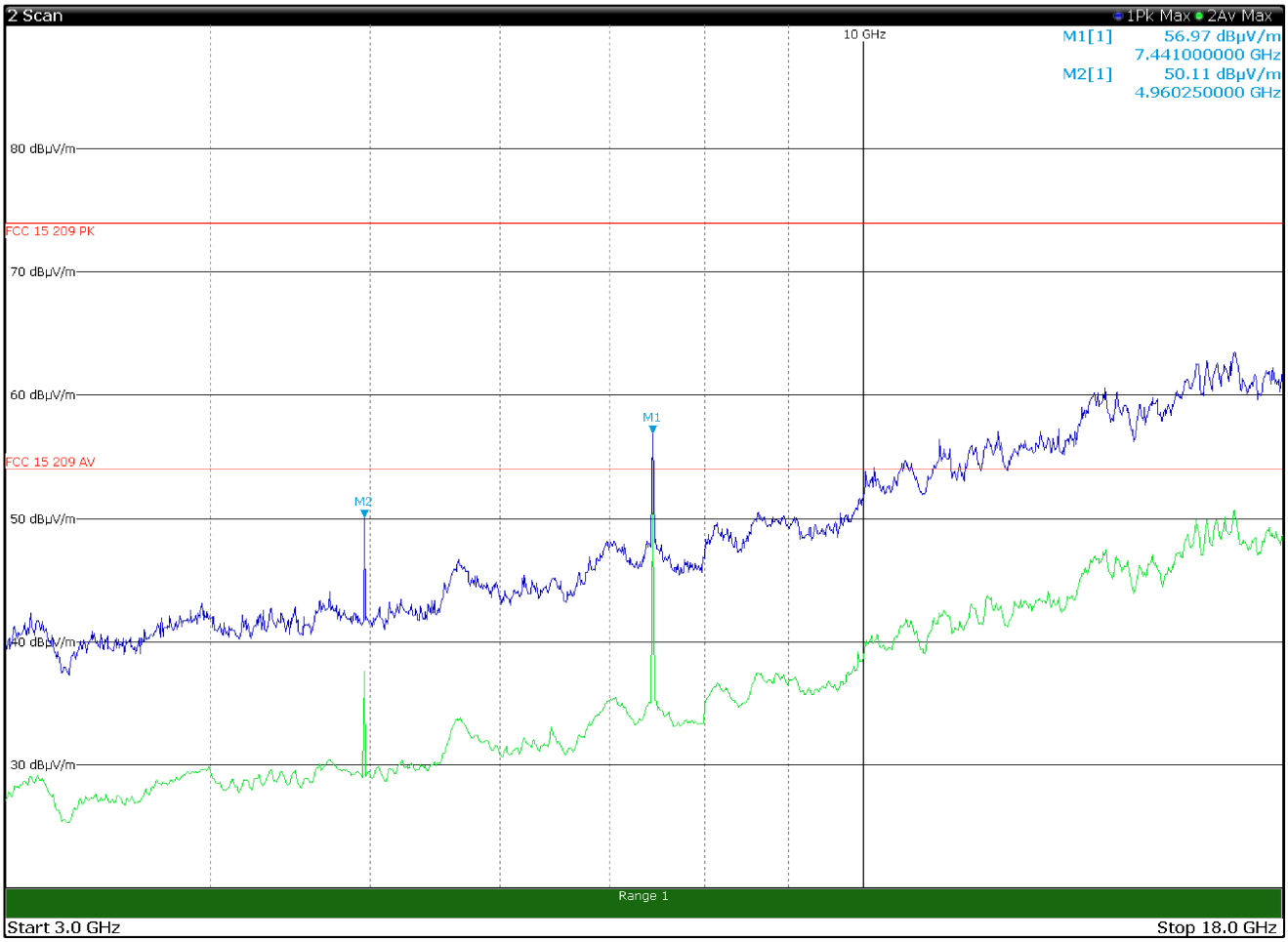


Figure 8.5-22: *Radiated spurious emissions with antenna in vertical polarization, high channel*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4960.2500	50.2	74.0	-23.8	Pk
4960.2500	45.0	54.0	-9.0	Av
7439.5000	57.3	74.0	-16.7	Pk
7439.5000	51.7	54.0	-2.3	Av

Av detector measured as state in clause 8.5.3

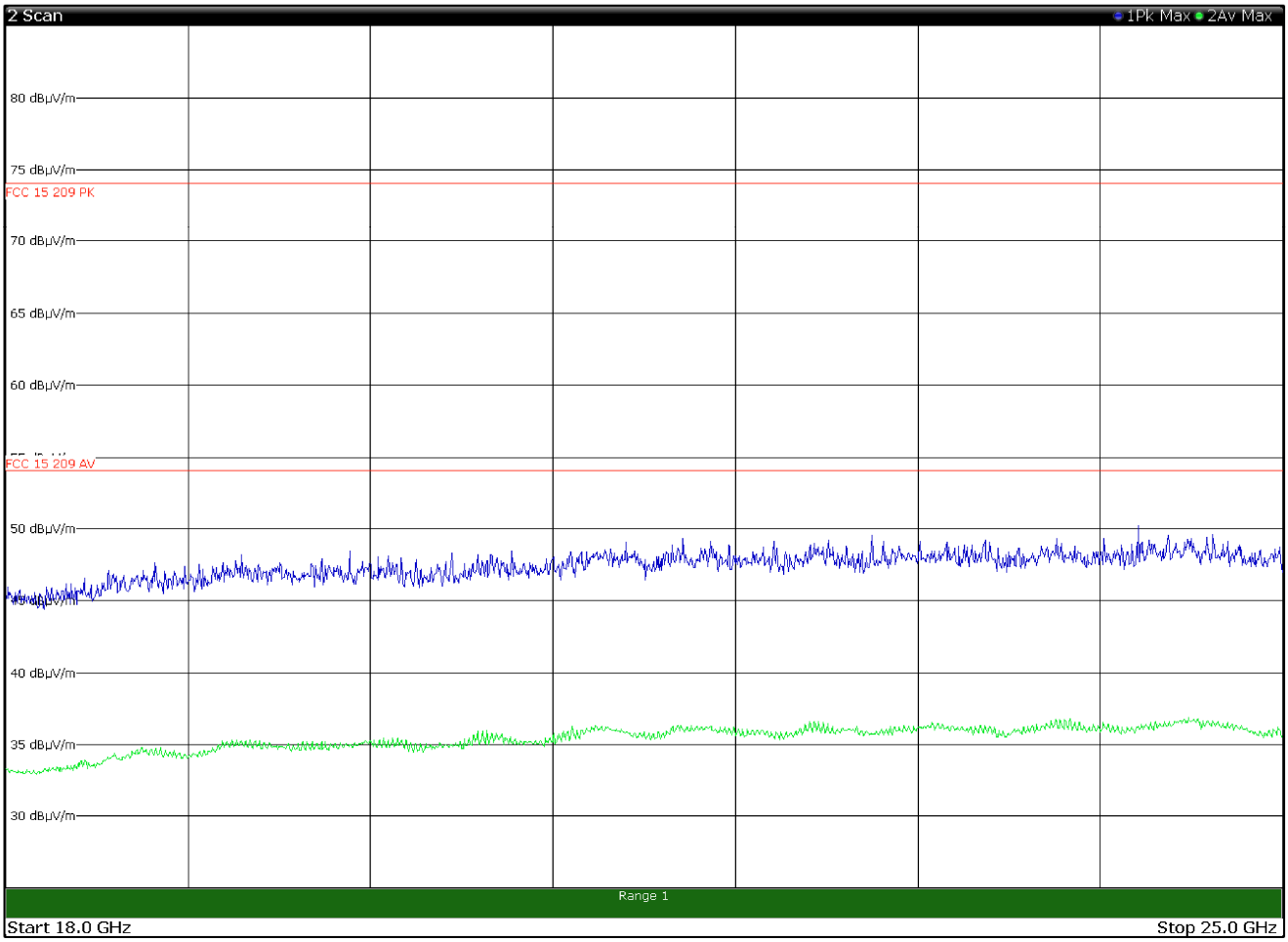


Figure 8.5-23: *Radiated spurious emissions with antenna in horizontal polarization, high channel*

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

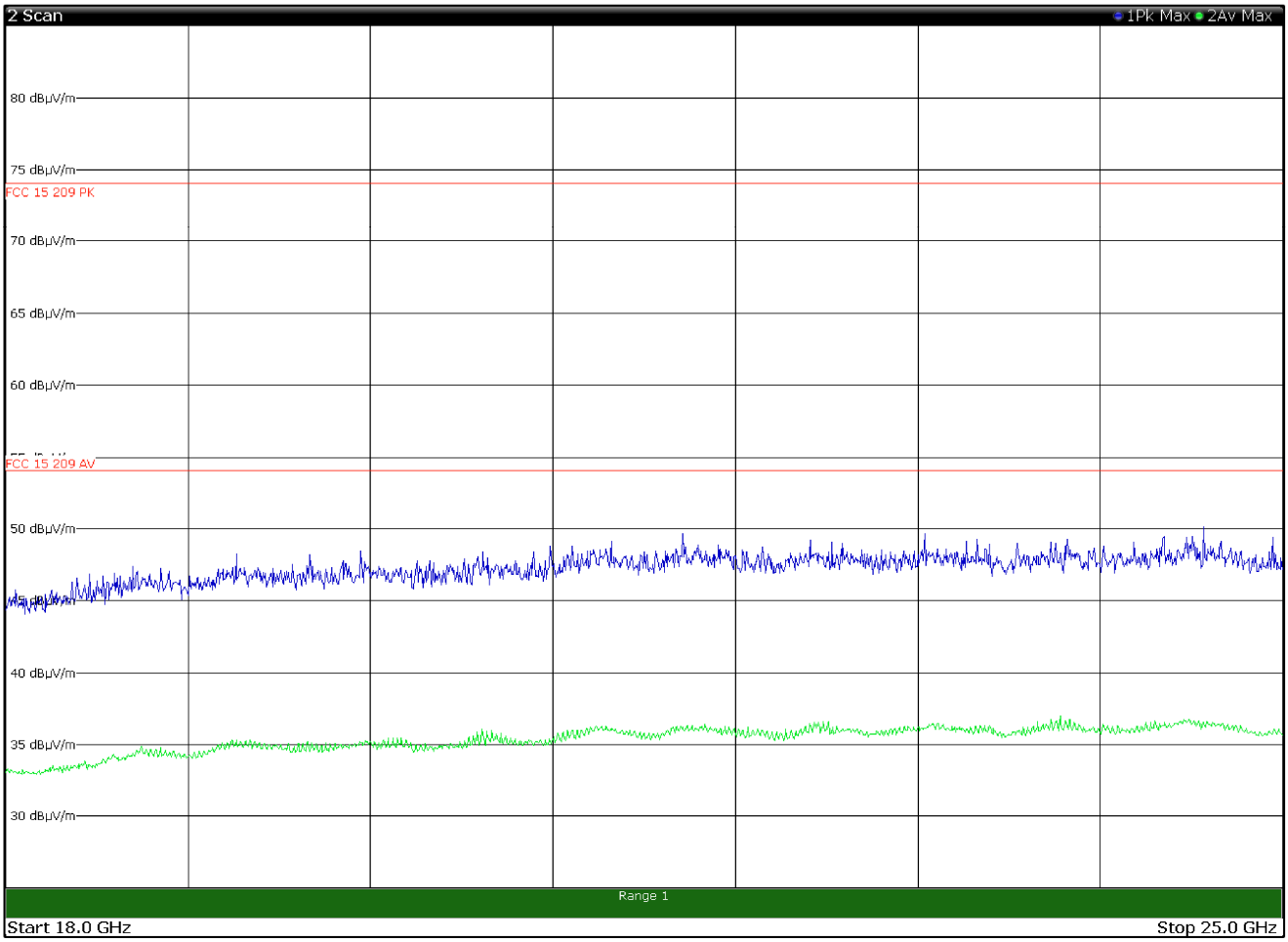


Figure 8.5-24: *Radiated spurious emissions with antenna in vertical polarization, high channel*

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

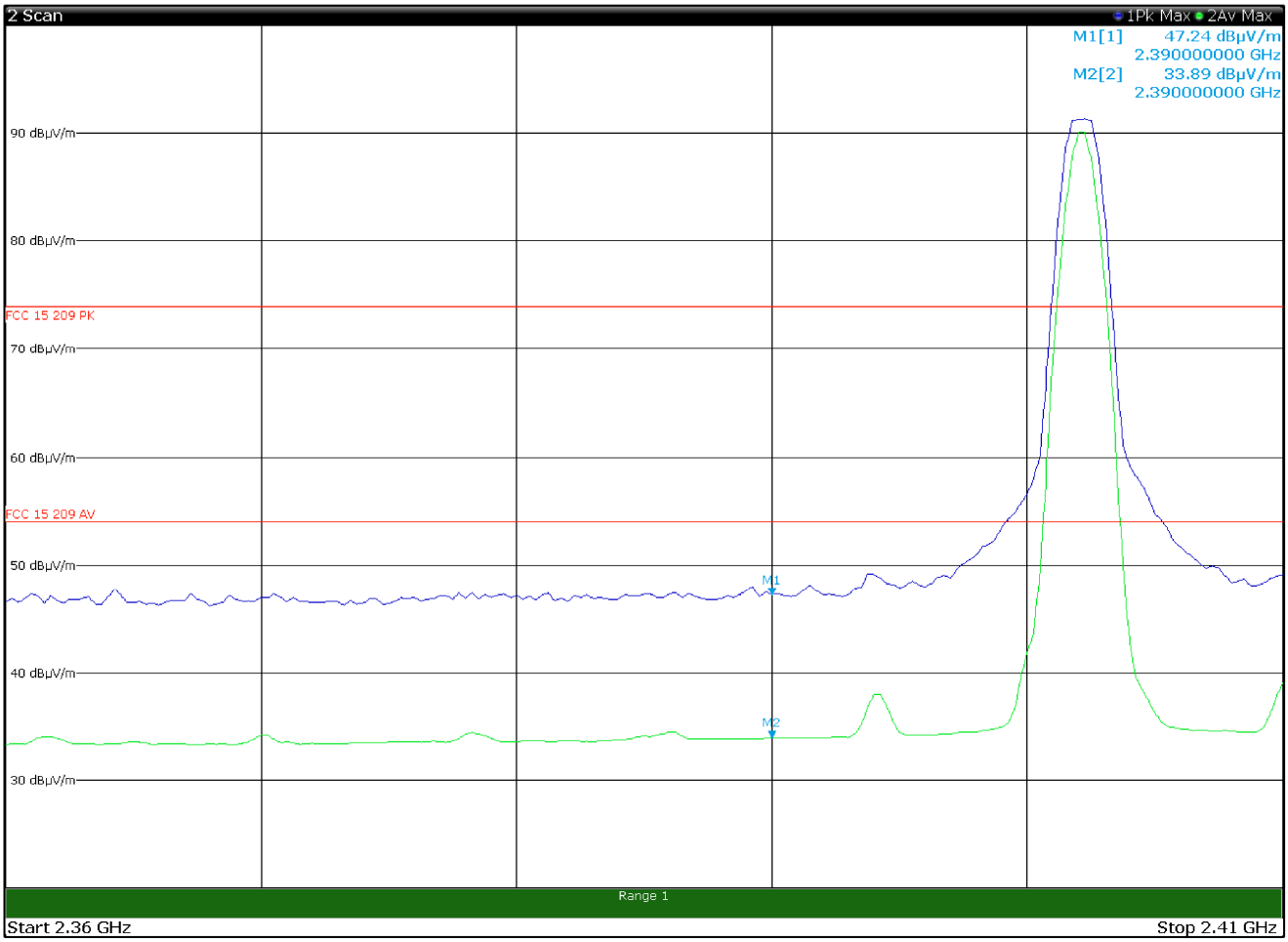


Figure 8.5-25: *Band edge with antenna in horizontal polarization, low channel (RBW 1 MHz)*

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).

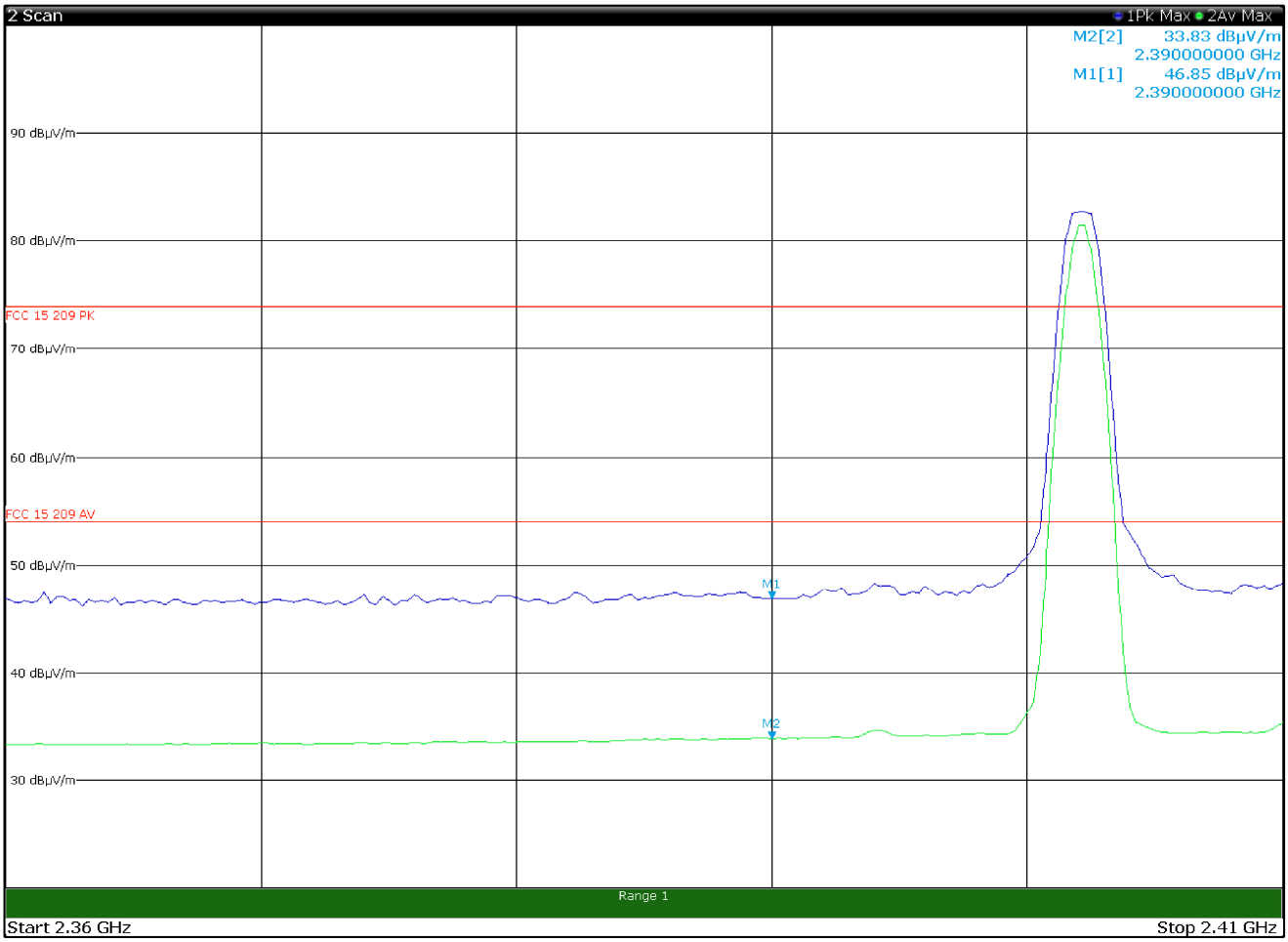


Figure 8.5-26: *Band edge with antenna in vertical polarization, low channel (RBW 1 MHz)*

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).

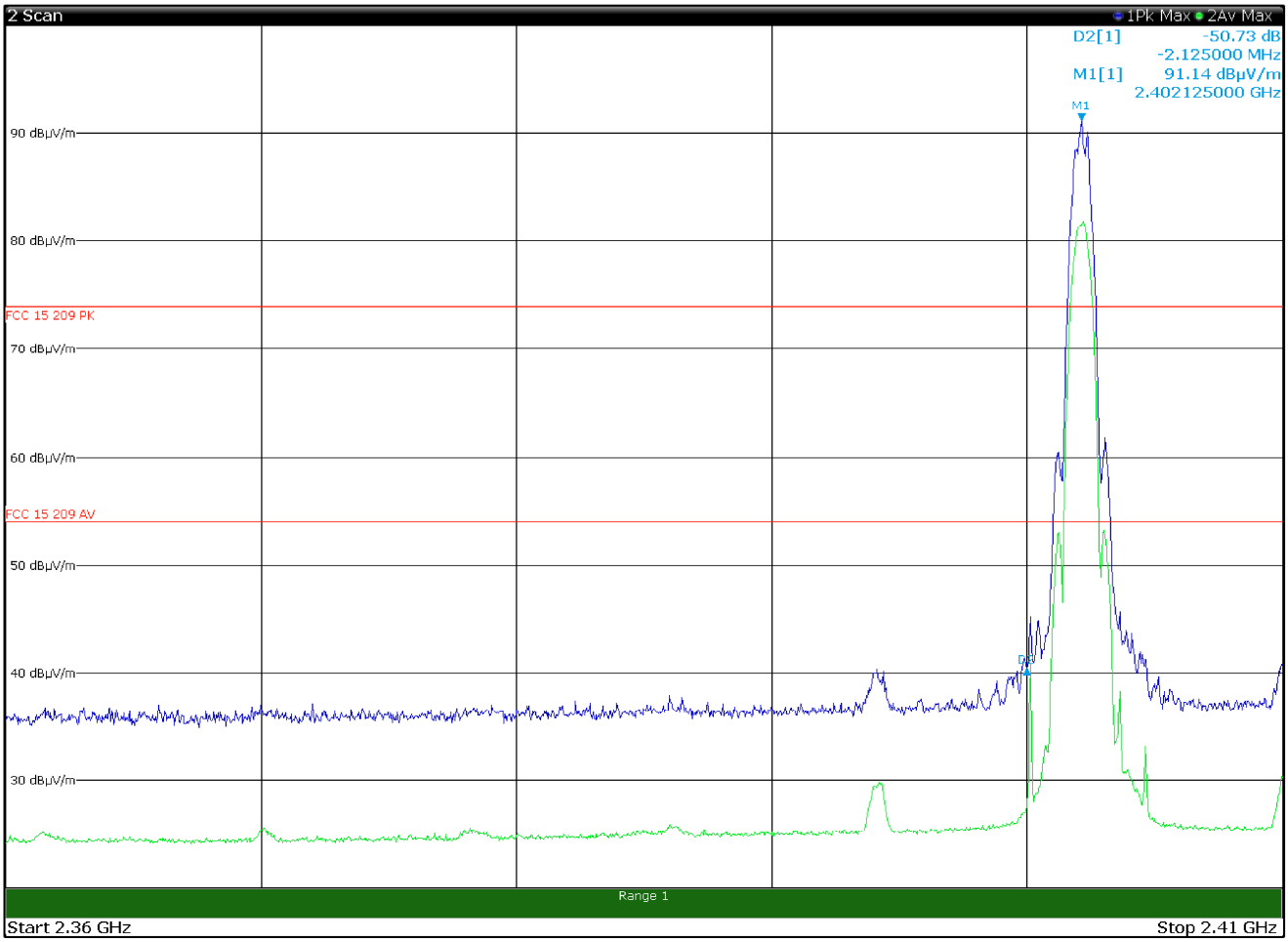


Figure 8.5-27: *Band edge with antenna in horizontal polarization, low channel (RBW 100 kHz and limit -20 dBc)*

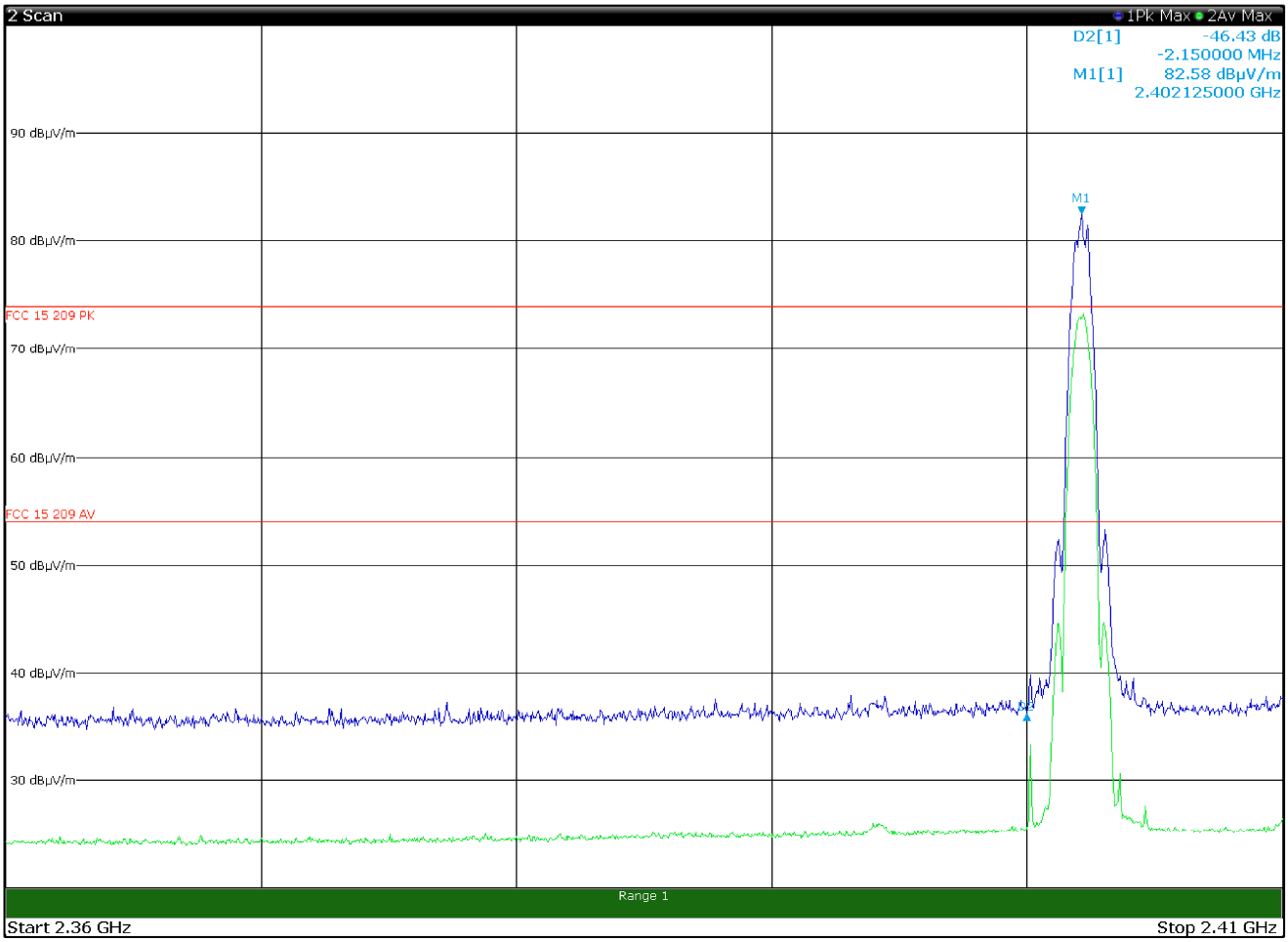


Figure 8.5-28: *Band edge with antenna in vertical polarization, low channel (RBW 100 kHz and limit -20 dBc)*

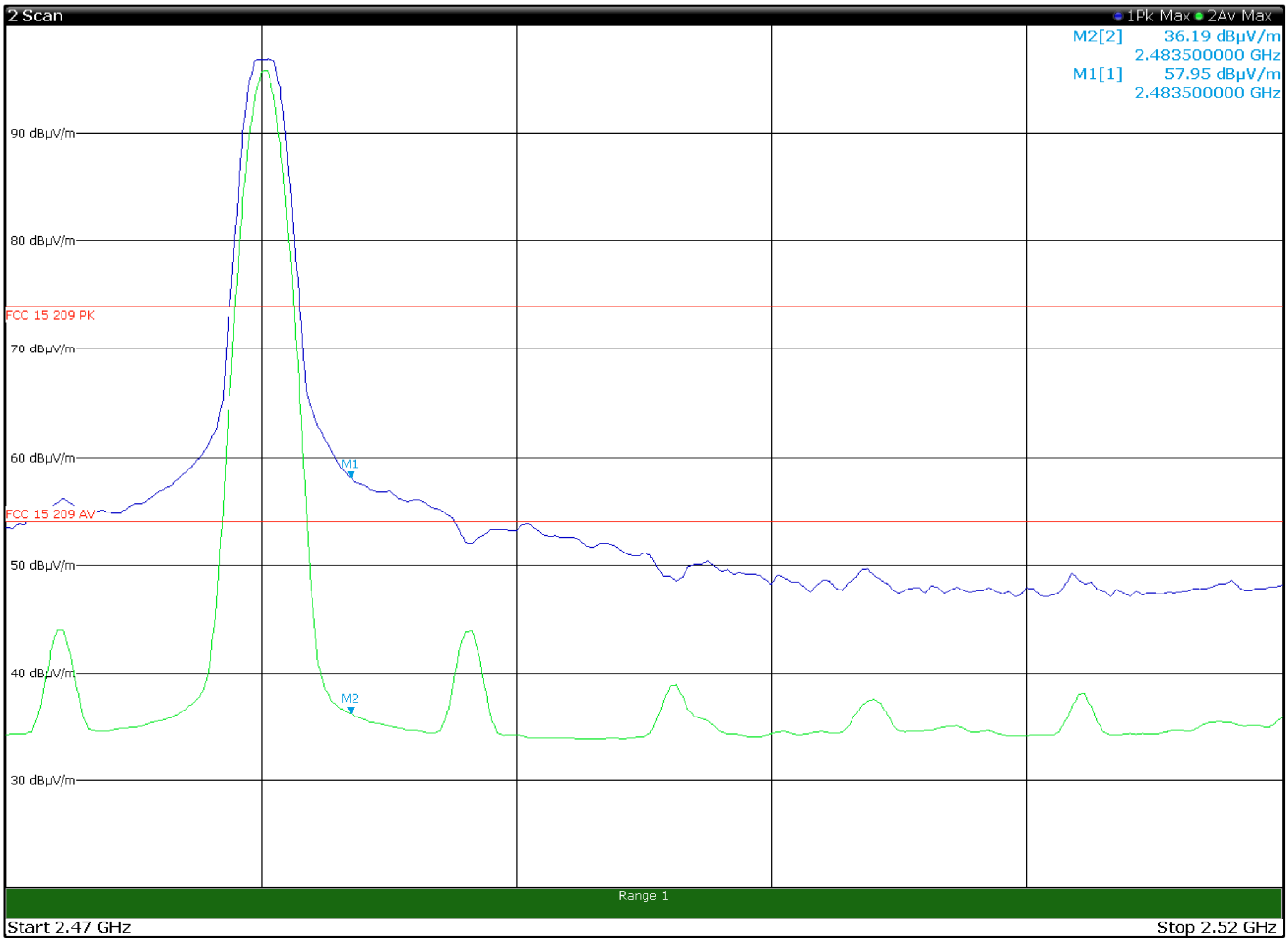


Figure 8.5-29: *Band edge with antenna in horizontal polarization, high channel (peak kimit)*

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 evalutation see the following graphics.

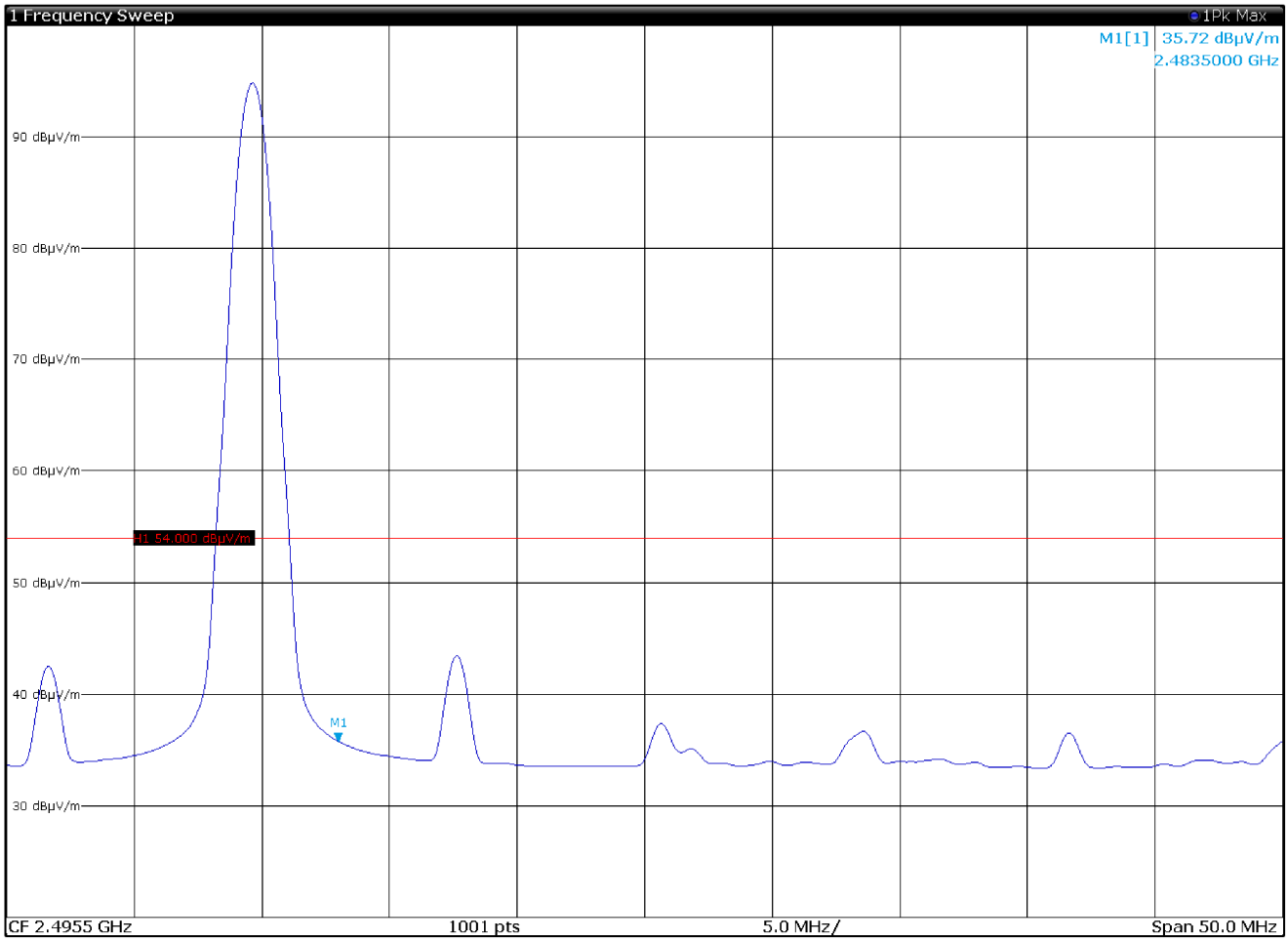


Figure 8.5-30: *Band edge with antenna in horizontal polarization, high channel (average limit)*

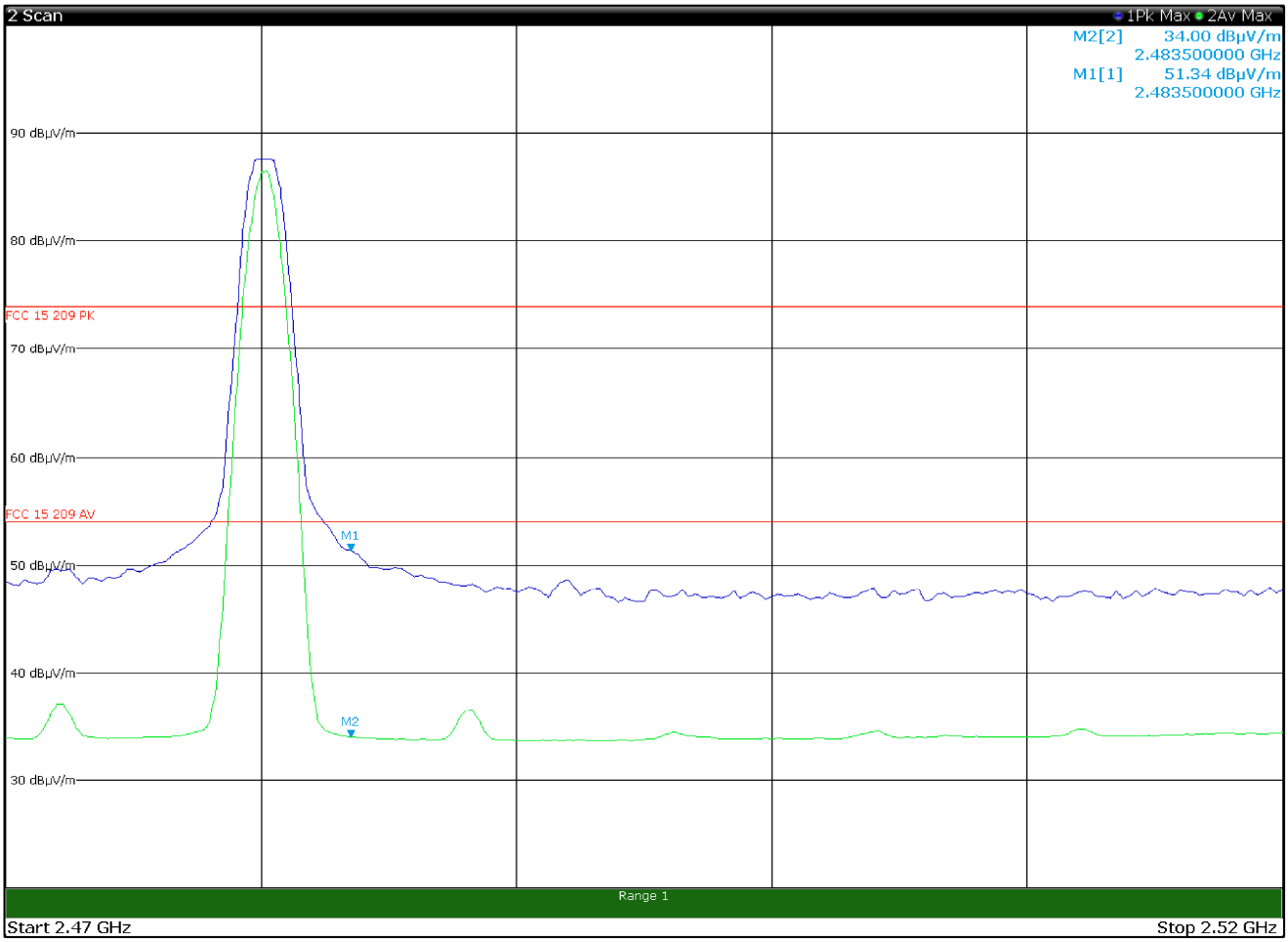


Figure 8.5-31: *Band edge with antenna in vertical polarization, high channel*

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	2019-10-14	Temperature	22 °C
Test engineer	P. Barbieri	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 10.3 Method AVGPSD-1 (trace averaging with EUT transmitting at full power throughout each sweep). Spectrum analyser settings:

Resolution bandwidth:	3 kHz ≤ RBW ≤ 100 kHz
Video bandwidth:	≥3 × 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

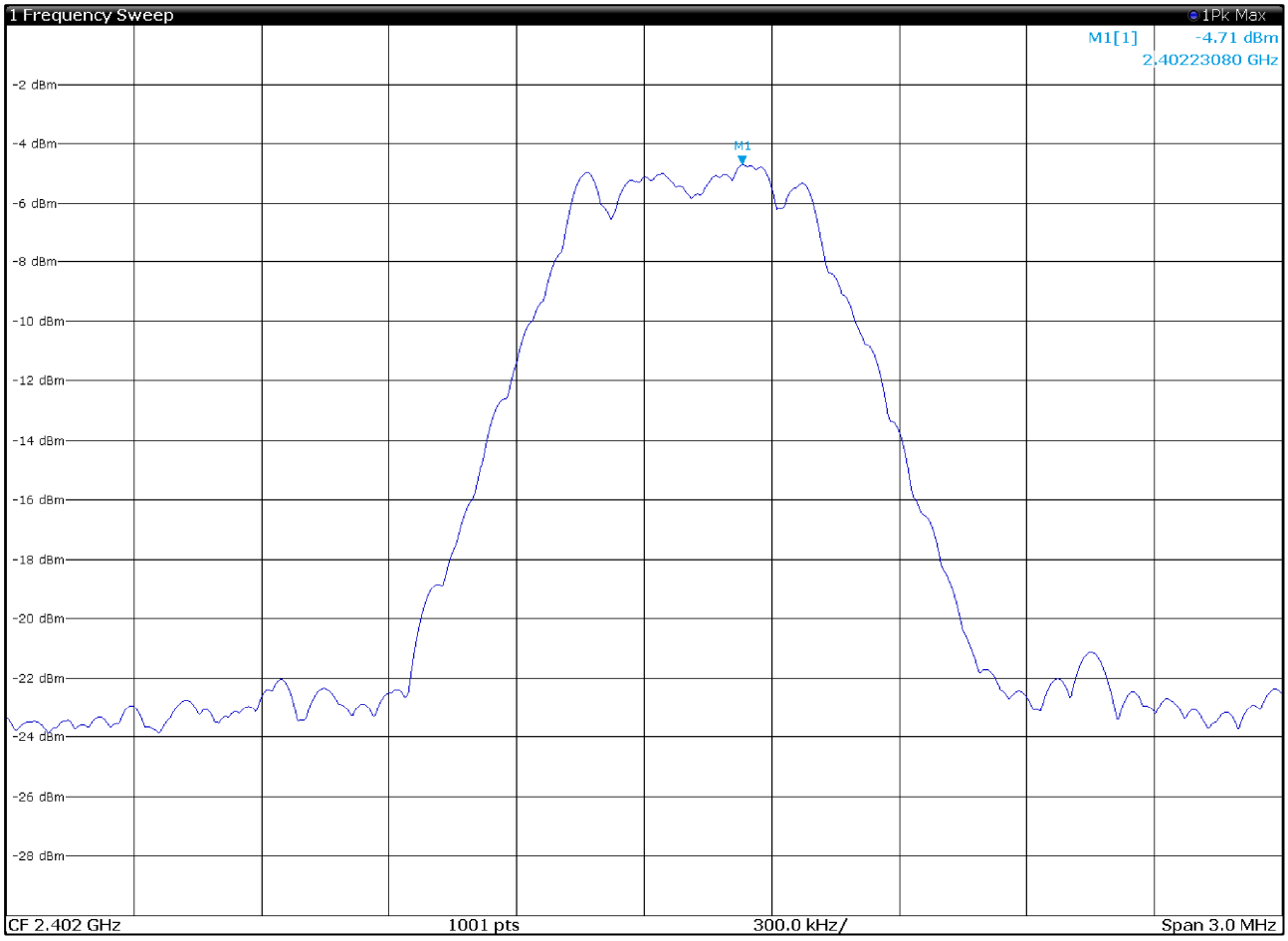


Figure 8.6-1: *PSD sample plot on low channel*

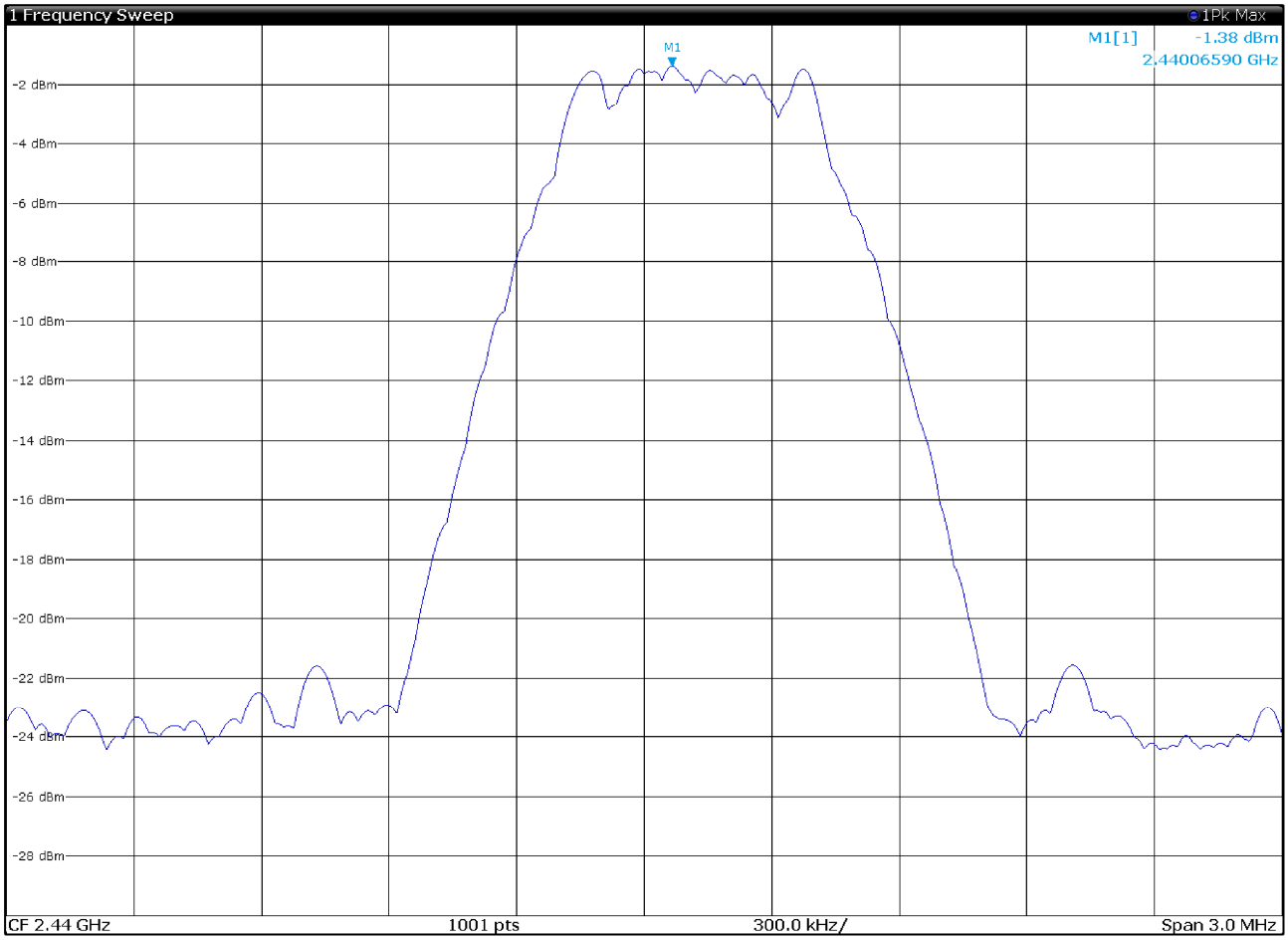


Figure 8.6-2: *PSD sample plot on mid channel*

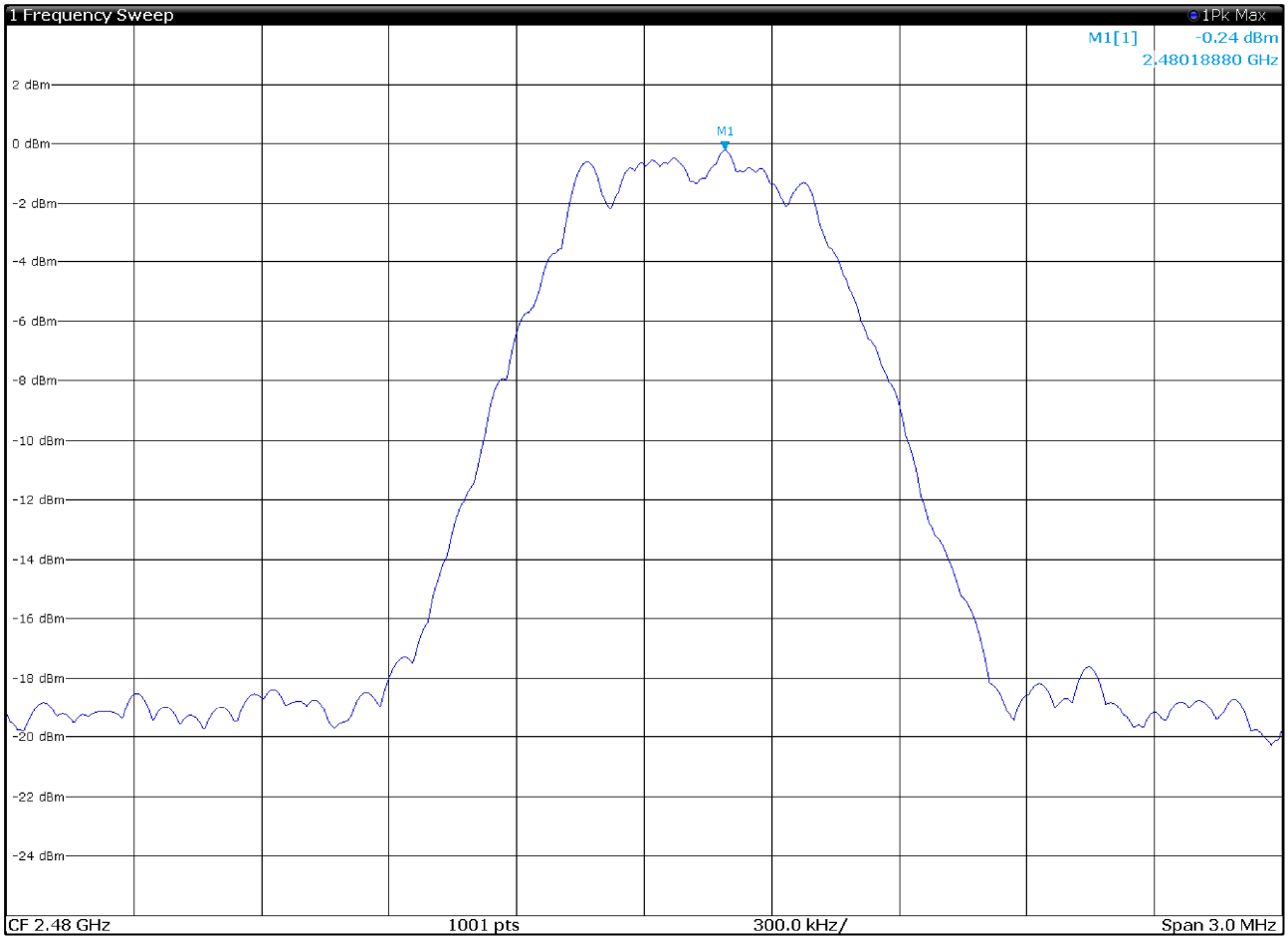
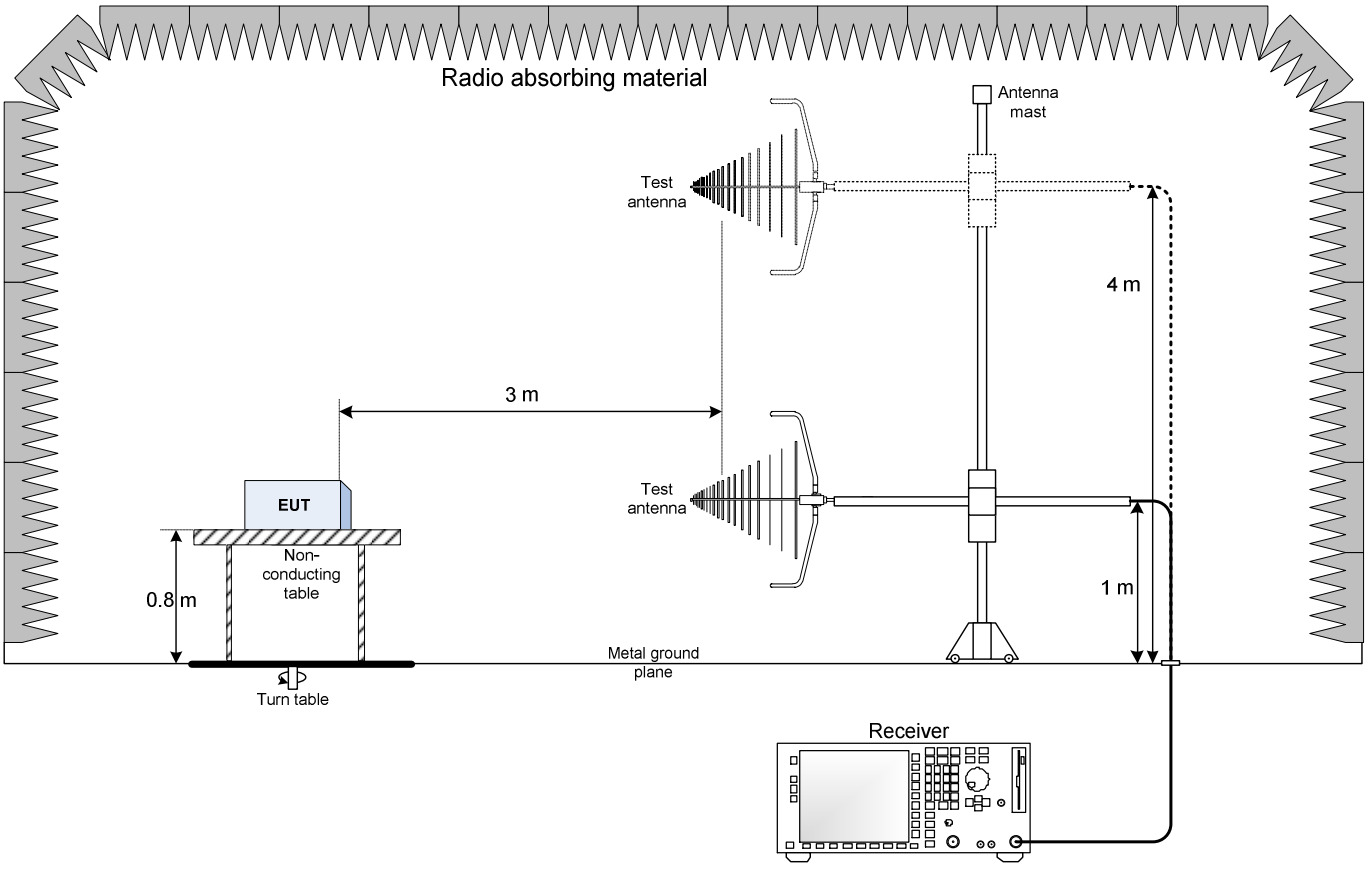


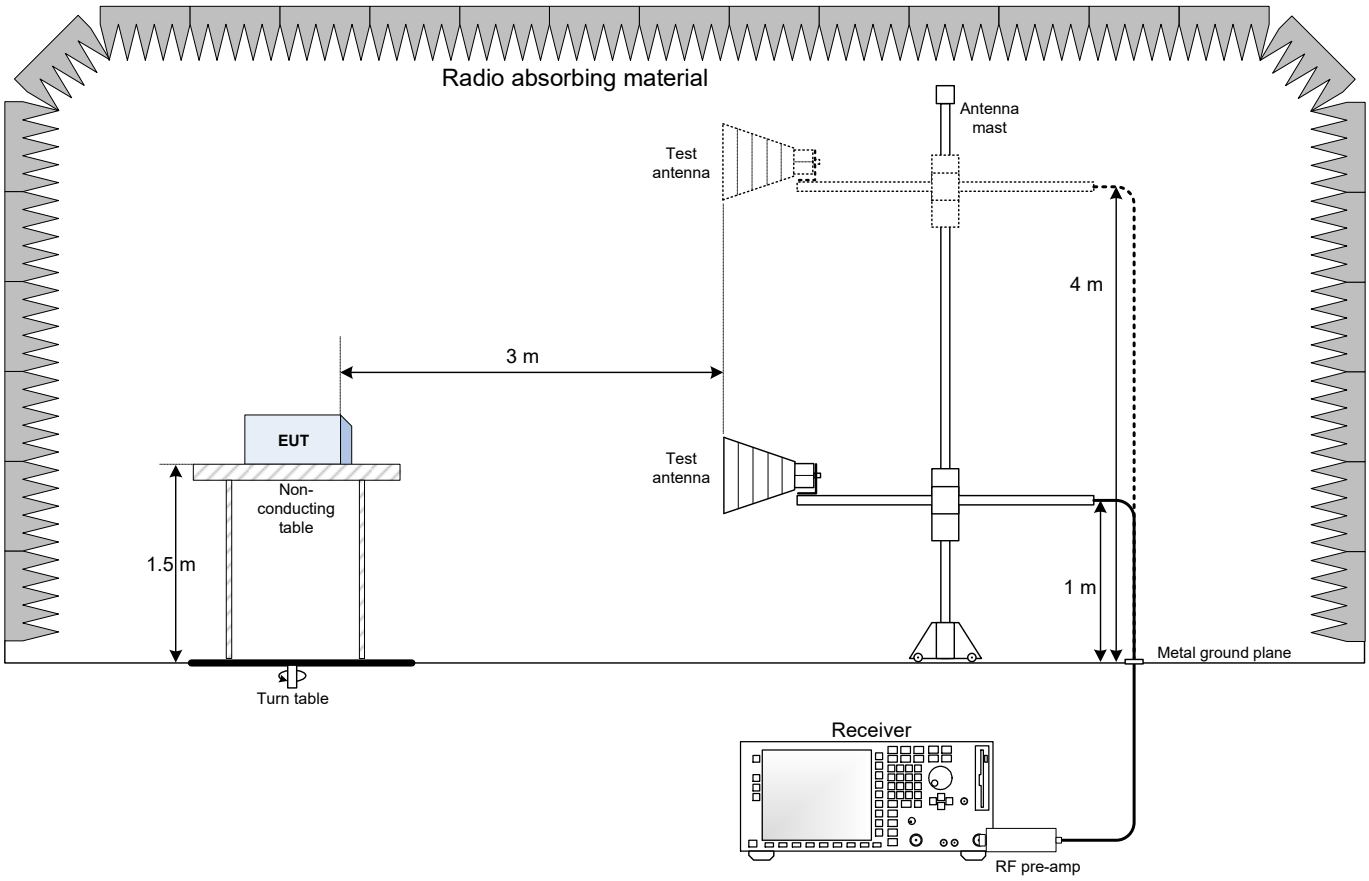
Figure 8.6-3: *PSD sample plot on high channel*

Section 9. Block diagrams of test set-ups

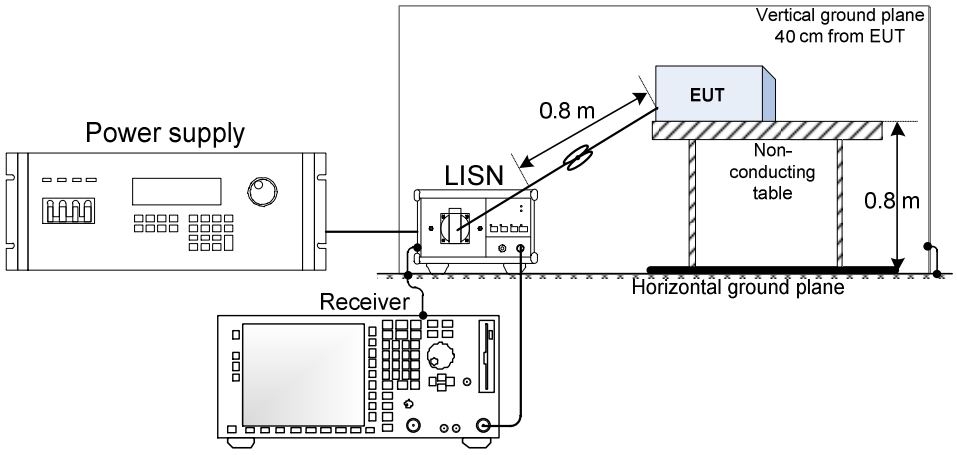
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz

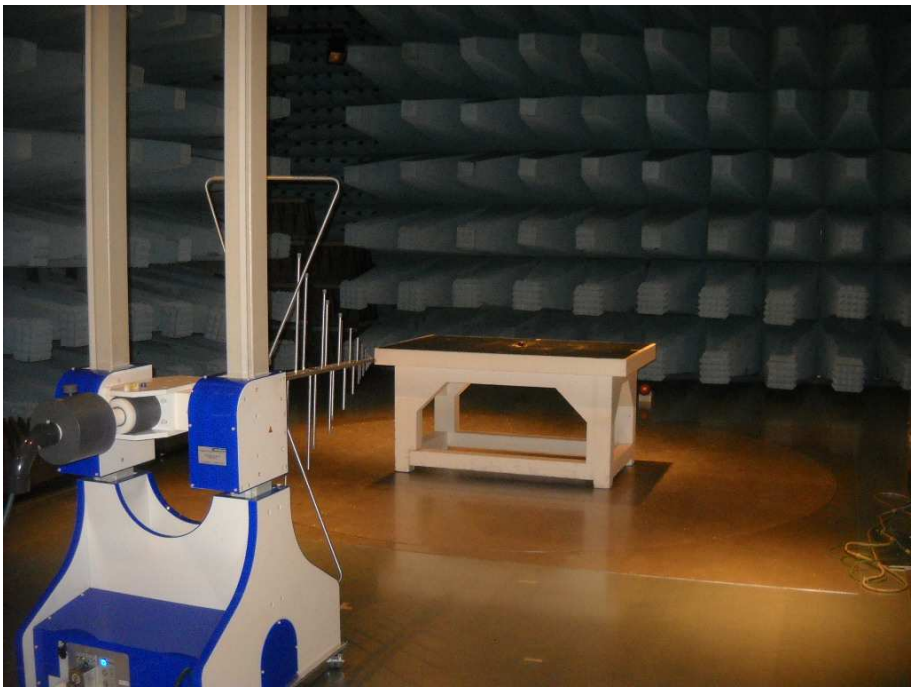


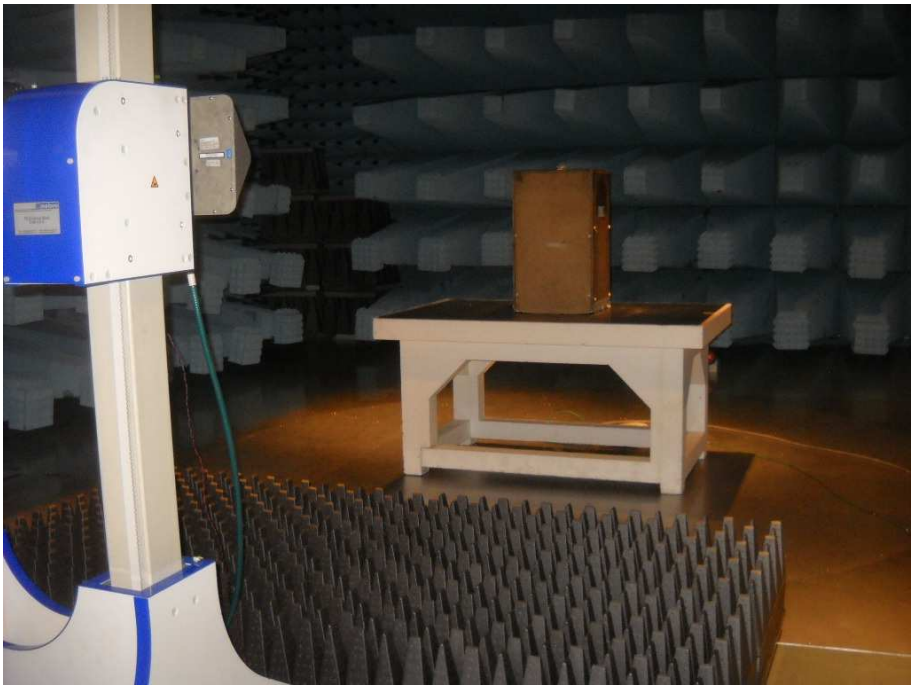
9.3 Conducted emissions set-up



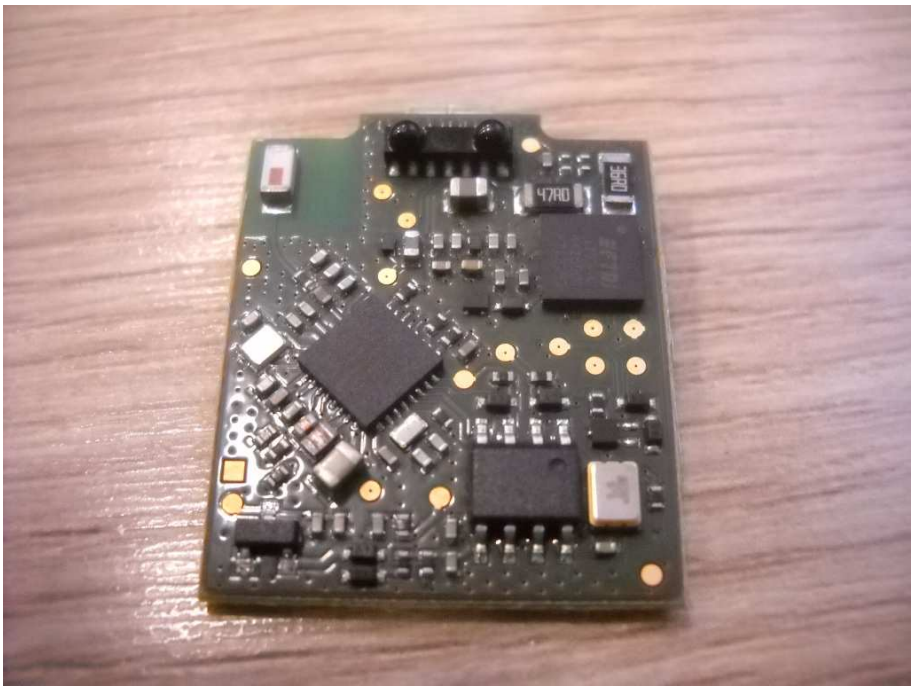
Section 10. Photos

10.1 Photos of the test set-up





10.2 Photos of the EUT



End of report