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Wireless test report – 407189-1TRFWL

Applicant:

Eurotech Spa

Via Fratelli Solari, 3/A – 33020 Amaro (UD) – Italy

Product name:

PCIE 802.11a/b/g/n 2.4GHz/5GHz + USB BT 4.0 card

Model:

SYS-04240-23

FCC ID:

UKM-SYS04240

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

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

Date of issue: November 12, 2020

Tested by
(name, function and signature) P. Barbieri (project handler) Signature:

Reviewed by
(name, function and signature) D. Guarnone (verifier) Signature:

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(s)

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)

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	Eurotech SpA
Address	Via Fratelli Solari 3/a 33020 Amaro, UD, 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 15.247 Meas Guidance v05r02	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the fcc rules
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 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
407189-1TRFWL	November 12, 2020	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Table 2.1-1: *FCC general requirements results*

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not tested
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes:

2.2 FCC Part 15 Subpart C, intentional radiators test results for frequency hopping spread spectrum systems

Table 2.2-1: *FCC 15.247 results for FHSS*

Part	Test description	Verdict
§15.247(a)(1)(i)	Requirements for operation in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Requirements for operation in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Requirements for operation in the 2400–2483.5 MHz band	Not applicable
§15.247(b)(1)	Maximum peak output power in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power in the 902–928 MHz band	Not applicable
§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	Not applicable
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

2.3 FCC Part 15 Subpart C, intentional radiators test results for digital transmission systems (DTS)

Table 2.3-1: *FCC 15.247 results for DTS*

Part	Test description	Verdict
§15.247(a)(2)	Minimum 6 dB bandwidth	Not tested
§15.247(b)(3)	Maximum peak output power 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	Not tested
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	October 22, 2020
Nemko sample ID number	4071890010

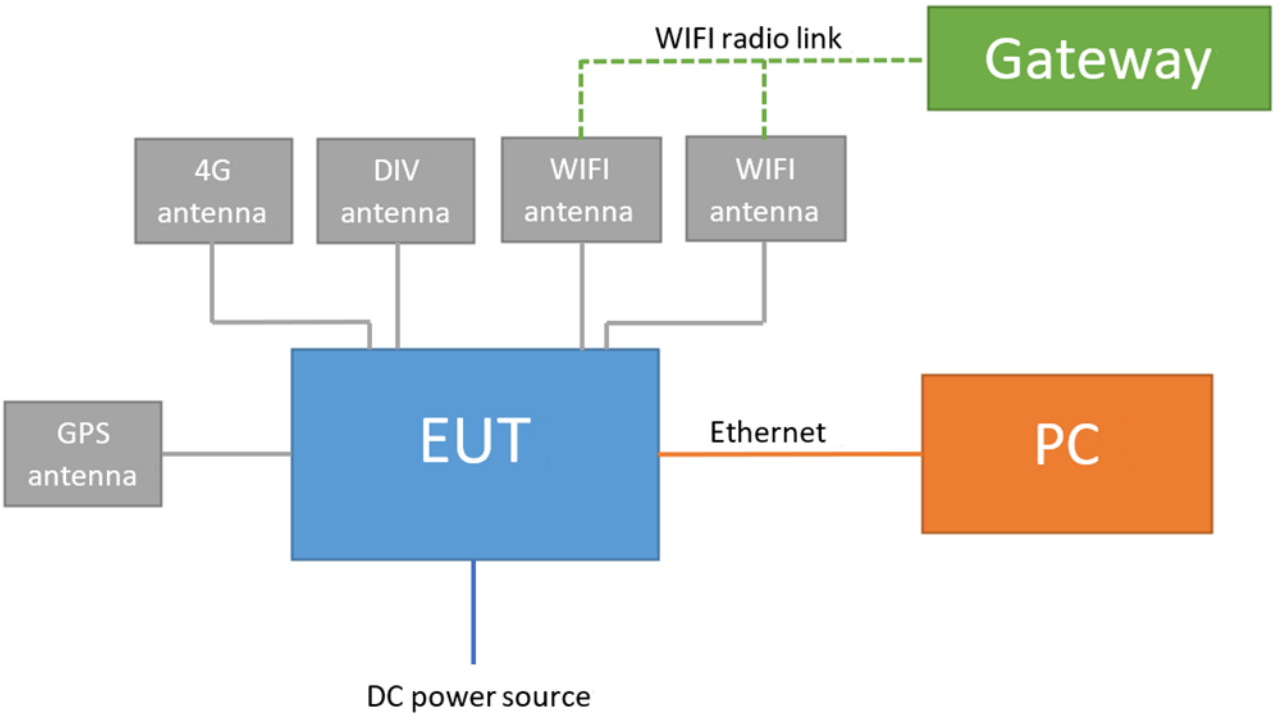
3.2 EUT information

Product name	PCIE 802.11a/b/g/n 2.4GHz/5GHz + USB BT 4.0 card
Model	SYS-04240-23
Model variant	--
Serial number	A119GKA0020

3.3 Technical information

Frequency band	2400 to 2483.5 MHz
Frequency Min (MHz)	2412
Frequency Max (MHz)	2462
RF power Min (W), Conducted	0.0277
RF power Max (W), Conducted	0.0694
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	--
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	802.11b/g/n
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, dBµV/m @3 m	43.5
Power requirements	24 V_{DC}
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. The following antennas are provided with the EUT. Product Type — Manufacturer — Model WIFI antenna — 2J-ANTENNA — 2J630 2MP GNSS antenna — TAOGLAS — GSA.8827.A.101111 Cellular antenna — TAOGLAS — AA.107.301111-1508816

3.4 EUT setup diagram



3.5 Product description and theory of operation

The EUT is intended to be used as Railway Automotive Logger Unit. It is provided with the following separately approved radio module:

- Telit model LE910C1-NF

3.6 EUT sub assemblies

Table 3.6-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Railway Automotive Logger Unit	Eurotech	SYS-04240-23	A119GKA0020
WIFI antenna	2J-ANTENNA	2J630 2MP	None
GNSS antenna	TAOGLAS	GSA.8827.A.1011111	None
Cellular antenna	TAOGLAS	AA.107.301111-1508816	None

3.7 EUT exercise details

EUT was set to continuously transmit mode during tests, by test software provided by client.
The EUT runs a Linux operating system which allows for the testing to be performed using engineering test tools and scripts. Communication with the EUT is via a serial console or Ethernet connection which provides a Linux command line interface for execution of the test tools/scripts. These tools/scripts configure the radio modules to enable continuous transmission with the ability to adjust modulation, frequency and output power as required.

Linux operating system version: Linux 4.1.46-fslc+gf134d1b armv7l

The following script has been used to force the EUT in TX mode:

```
Test_Results     :  Mon Aug 17 10:52:57 UTC 2020
Current_cpu_usage:  13%
Ethernet1_eth0   :  OK [197/197/0], Ping 172.16.0.2
Wireless_wlan0   :  OK [183/182/1], Ping 192.168.10.10
GPS_receiver     :  OK [41/41/0],
disk: mmcblk1p1  :  OK [185/185/0]
```

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

The EUT has three WIFI 2.4 GHz standard; IEEE 802.11g 6 Mb/s standard and IEEE 802.11b 1 Mb/s standard are chosen to be the representative worst-case.

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	01/2019	01/2021
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703	01/2019	01/2021
Barometer	Castle	GPB 3300	072015	12/2019	12/2020

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002.

The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:

P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.

F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.

Hereafter Nemko's measurement uncertainties are reported:

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	0.009 MHz ÷ 30 MHz	1.1 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
		Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter– Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
		Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
		Occupied Channel Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Receiver	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
	Conducted	Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)

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

Section 7. Testing data

7.1 FCC 15.31(e) Variation of power source

7.1.1 Definitions and limits

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.

7.1.2 Test date

Start date	November 11, 2020

7.1.3 Observations, settings and special notes

None

7.1.4 Test data

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

7.2 FCC 15.31(m) Number of frequencies

7.2.1 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 7.2-1: *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.

7.2.2 Test date

Start date	November 9, 2020

7.2.3 Observations, settings and special notes

None

7.2.4 Test data

Table 7.2-2: *Test channels selection*

Modulation	Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
802.11b	2400	2483.5	83.5	2412	2437	2462
802.11g	2400	2483.5	83.5	2412	2437	2462

7.3 FCC 15.203 Antenna requirement

7.3.1 Definitions and limits

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.

7.3.2 Test date

Start date	November 12, 2020

7.3.3 Observations, settings and special notes

None

7.3.4 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

7.4 FCC 15.247(b) Transmitter output power and e.i.r.p. requirements for DTS in 2.4 GHz

7.4.1 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 2400–2483.5 MHz band: 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.

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

(1) Fixed point-to-point operation:

(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 conducted 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.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(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 or digitally modulated 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.

(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.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

7.4.1 Test date

Start date	November 11, 2020

7.4.2 Observations, settings and special notes

The test was performed using Integrated band power method.

7.4.3 Test equipment list

Table 7.4-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767	07/2020	07/2021
Directional Coupler	Amplifier Research	DC7144	301249	04/2020	04/2021
Shielded room	Siemens	Conducted emission test room	1862	NCR	NCR

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

7.4.4 Test data

Table 7.4-2: *Output power measurements results*

Modulation	Frequency, MHz	Conducted output power, dBm		Total peak power mW	Total peak power dBm	Limit dBm	Margin dB
		Chain 0	Chain 1				
802.11b	2412	10.3	12.3	27.7	14.5	30	-15.5
	2437	14.7	16.0	69.4	18.5	30	-11.5
	2462	14.0	14.5	53.3	17.3	30	-12.7

Modulation	Frequency, MHz	Total peak power dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
802.11b	2412	14.5	1.7	16.2	36	-19.8
	2437	18.5	1.7	20.2	36	-15.8
	2462	17.3	1.7	19.0	36	-17.0

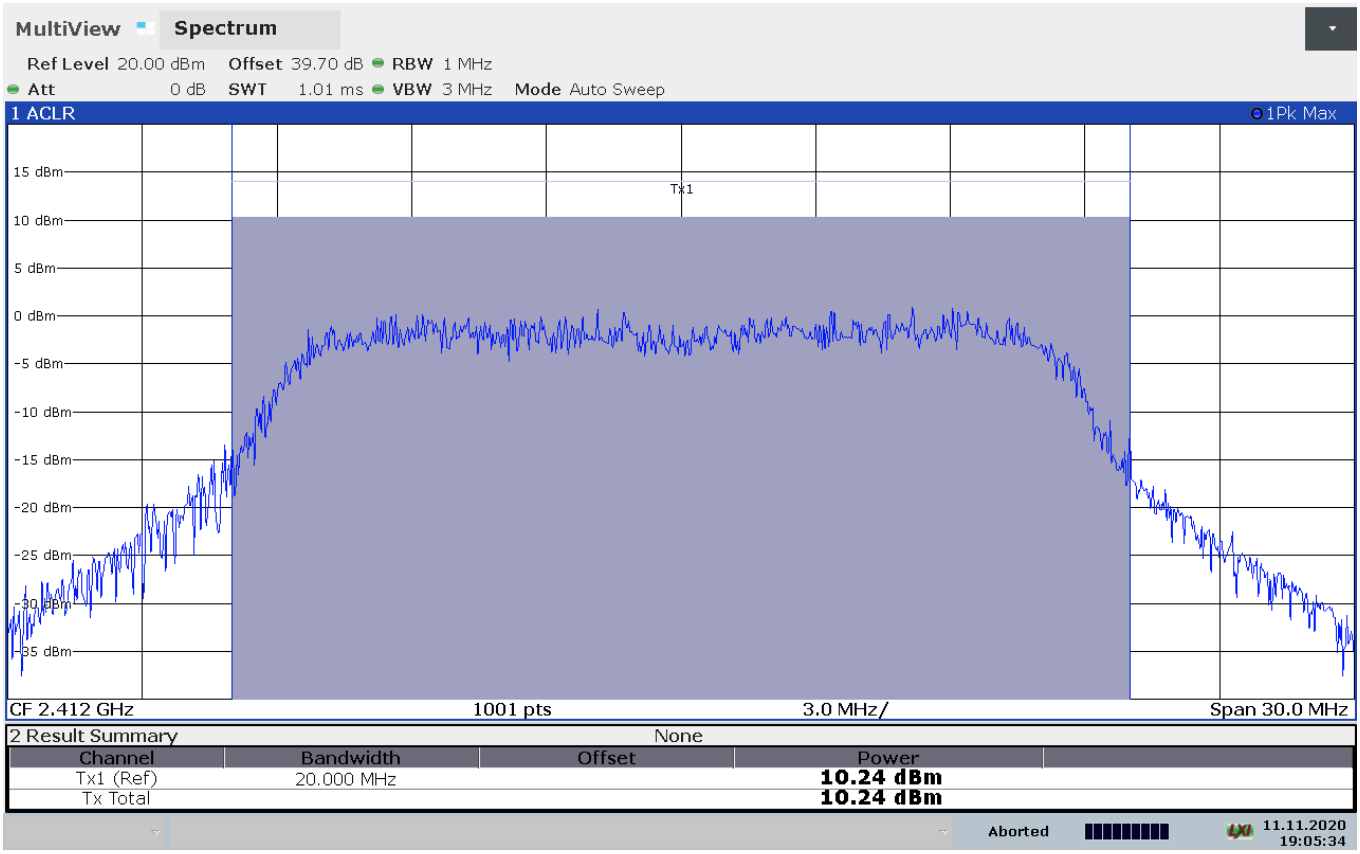


Figure 7.4-1: *Output power of WIFI 802.11b, channel LOW - Chain 0*

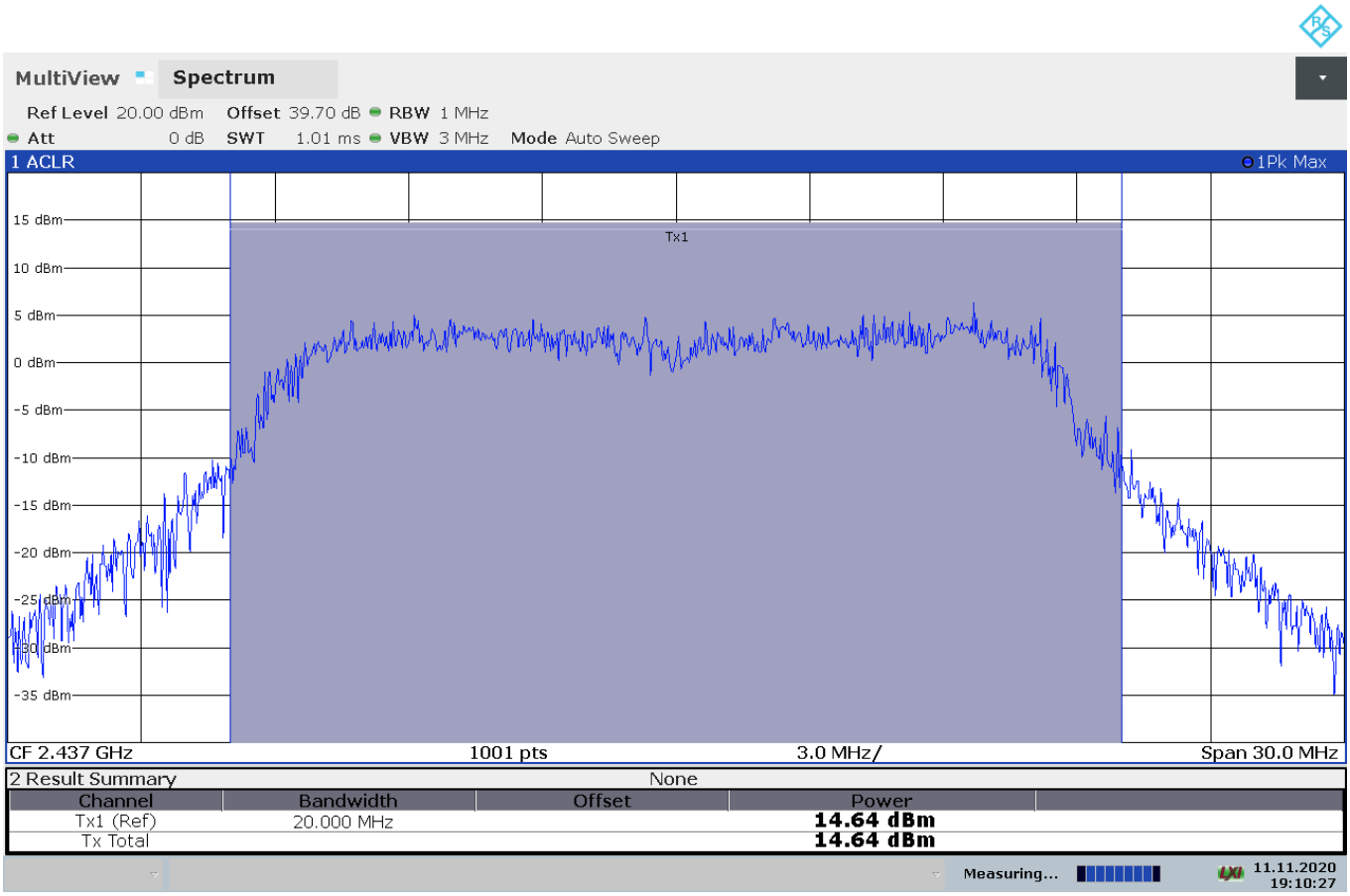


Figure 7.4-2: *Output power of WIFI 802.11b, channel MID - Chain 0*

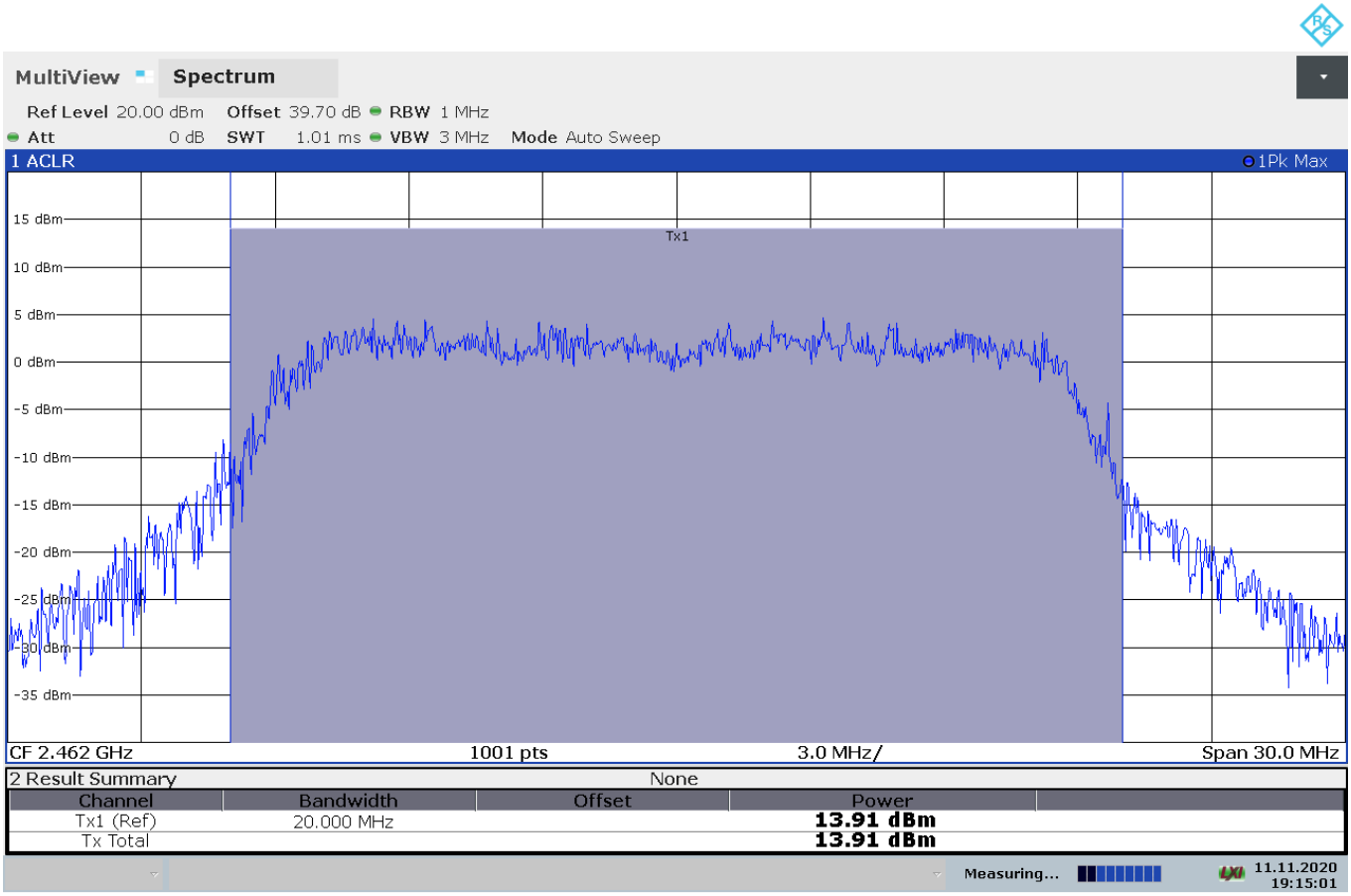


Figure 7.4-3: *Output power of WIFI 802.11b, channel HIGH - Chain 0*

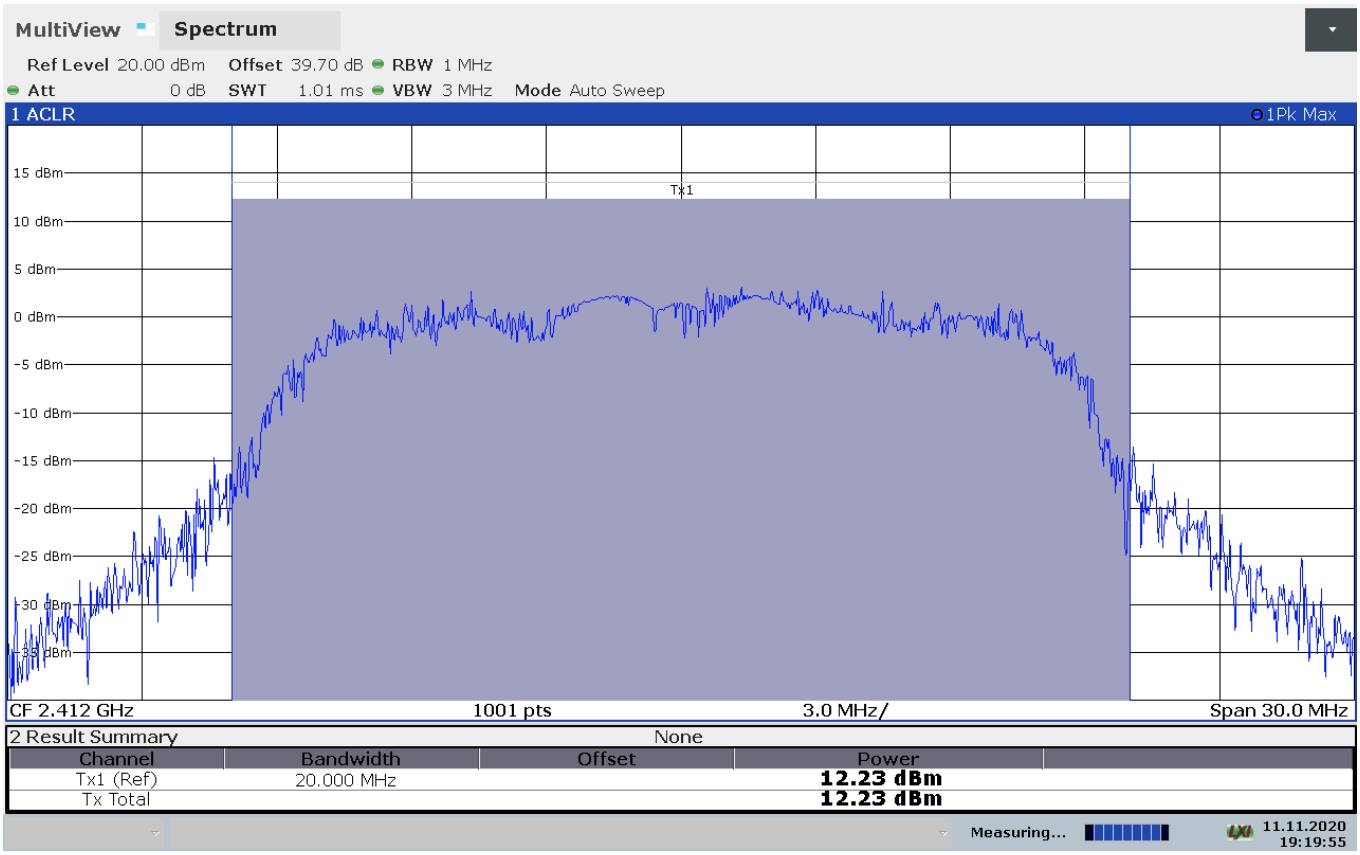


Figure 7.4-4: *Output power of WIFI 802.11b, channel LOW - Chain 1*

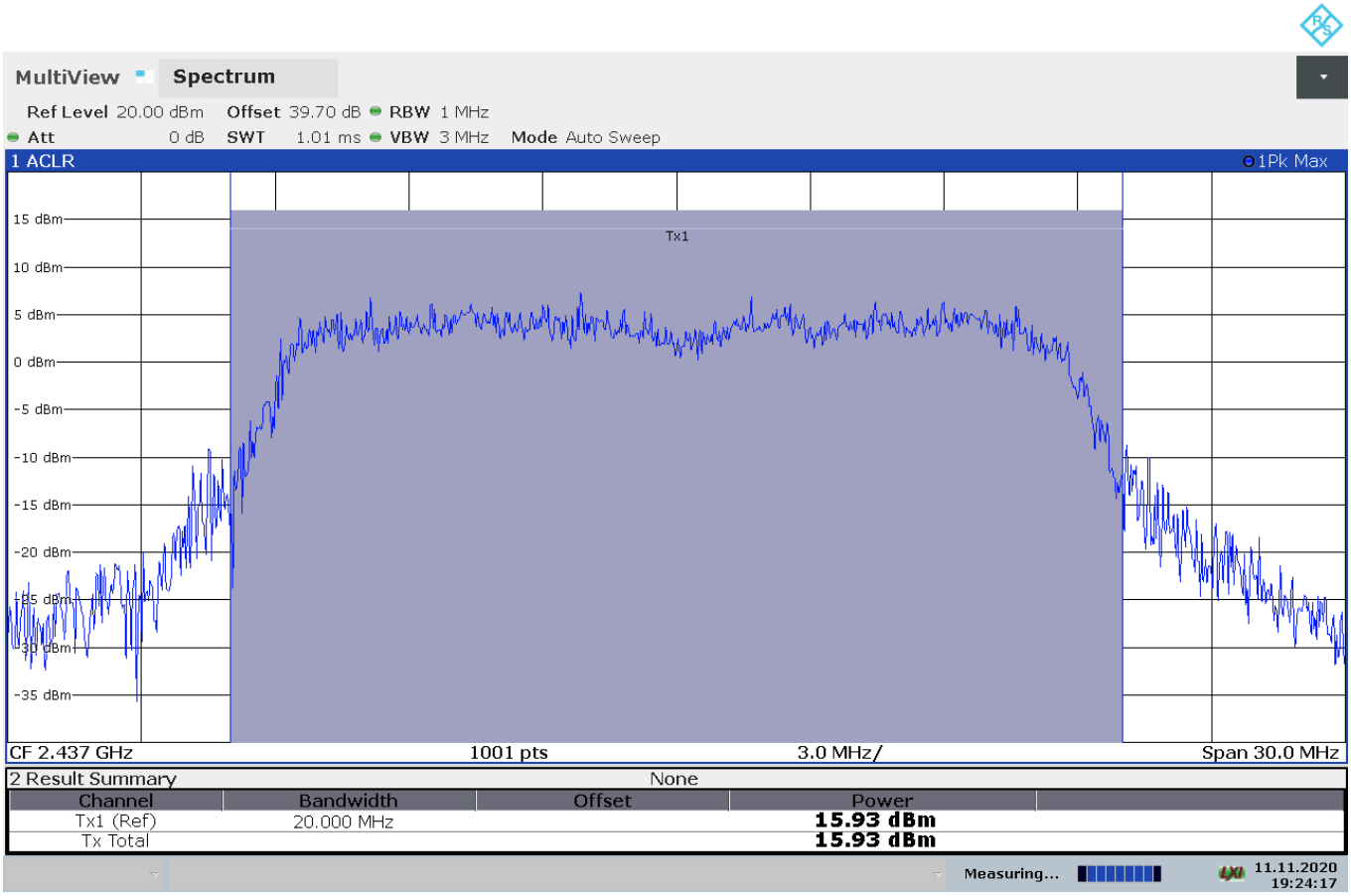


Figure 7.4-5: *Output power of WIFI 802.11b, channel MID - Chain 1*

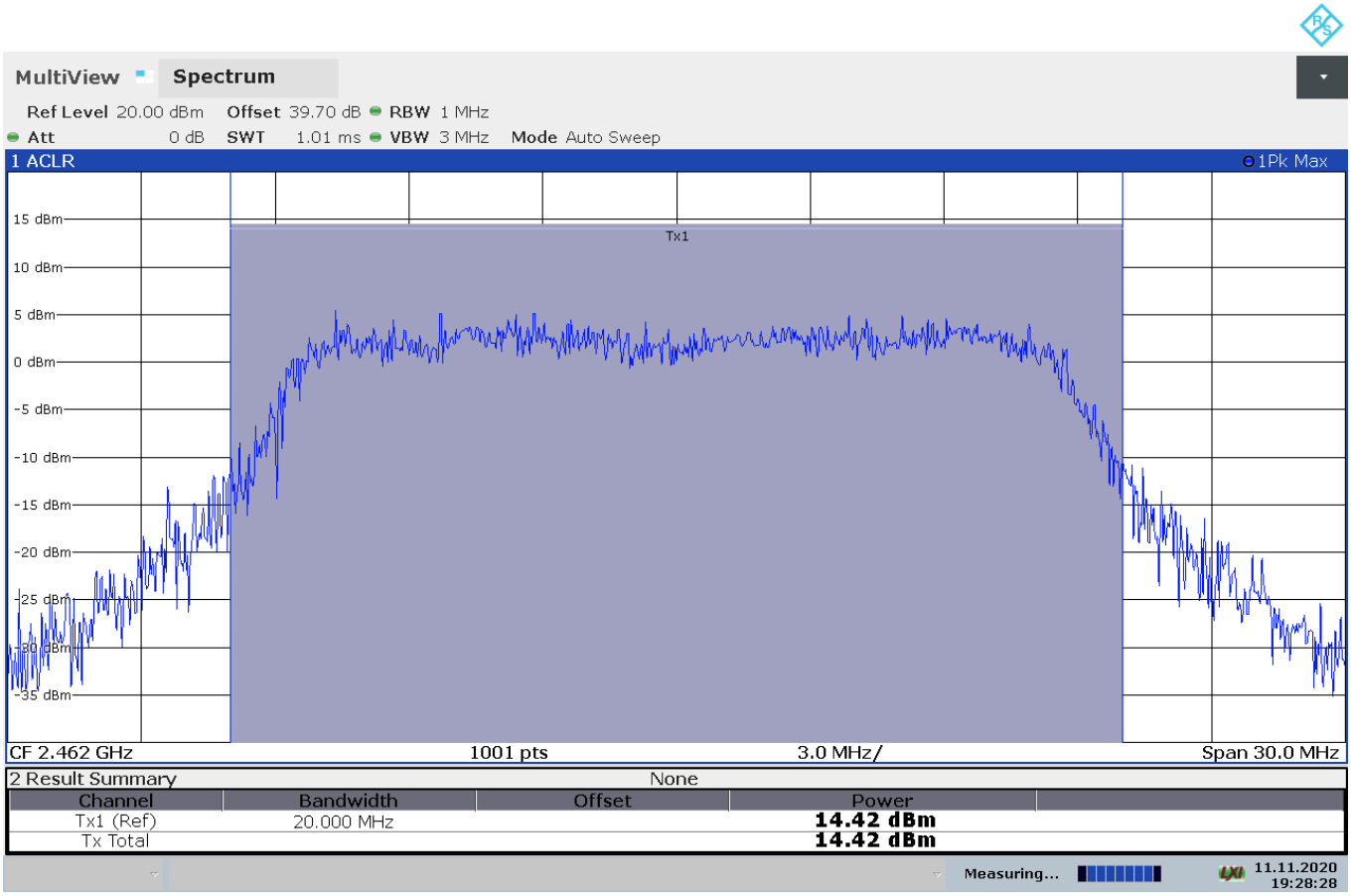


Figure 7.4-6: *Output power of WIFI 802.11b, channel HIGH - Chain 1*

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

7.5.1 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 7.5-1: *FCC §15.209 – 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 7.5-2: *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			

7.5.1 Test date

Start date	November 10, 2020

7.5.2 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit continuously. Radiated measurements were performed at a distance of 3 m. Since fundamental power was tested using the maximum peak conducted output power procedure to demonstrate compliance, the spurious emissions limit is −20 dBc/100 kHz.

EUT tested in IEEE 802.11b 1 Mb/s mode.

Spectrum analyzer settings for radiated measurements below 1 GHz 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 1 GHz 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 1 GHz pre-scan

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

7.5.3 Test equipment list

Table 7.5-3: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI receiver (20 Hz ÷ 8 GHz)	Rohde & Schwarz	ESU8	100202	08/2020	08/2021
EMI receiver (20 Hz ÷ 8 GHz)	Rohde & Schwarz	ESW44	101620	09/2020	09/2021
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767	07/2020	07/2021
Trilog Antenna (30 MHz ÷ 7 GHz)	Schwarzbeck	VULB 9162	9162-025	07/2018	07/2021
Bilog antenna (1 ÷ 18 GHz)	Schwarzbeck	STLP 9148	9148-123	07/2018	07/2021
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV 9718	9718-137	07/2020	07/2021
Horn antenna (3 ÷ 40 GHz)	RFSpin	DRH40	061106A40	04/2020	04/2023
Preamplifier (18 ÷ 40 GHz)	Sage	STB-1834034030-KFKF-L1	18490-01	03/2020	03/2021
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	09/2019	09/2021
Shielded room	Siemens	10m control room	1947	NCR	NCR

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

7.5.4 Test data

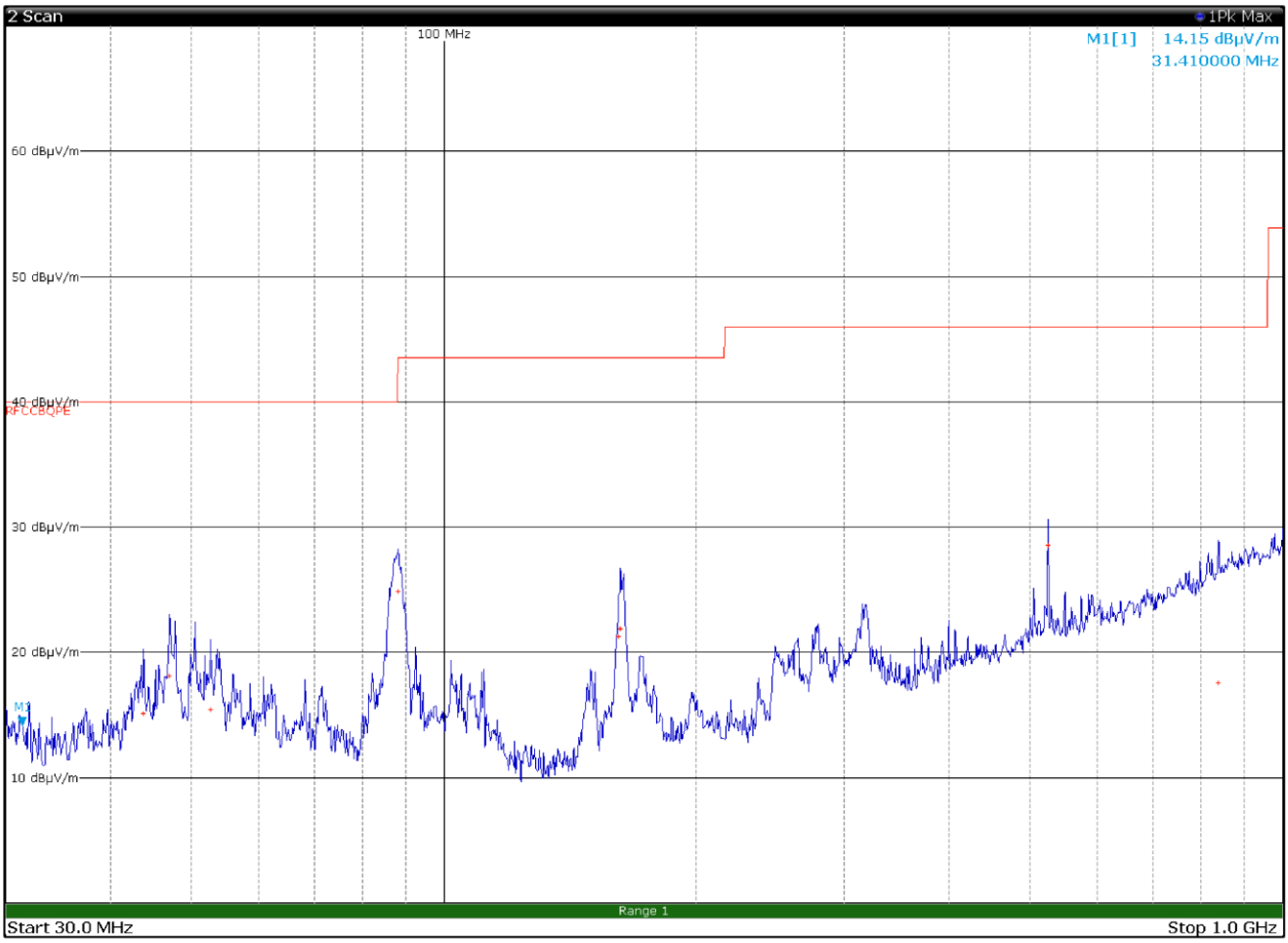


Figure 7.5-1: *Radiated spurious emissions 30 to 1000 MHz, Mid channel with antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
43.8000	15.1	40.0	-24.9	QP
47.0400	18.1	40.0	-21.9	QP
52.6200	15.5	40.0	-24.5	QP
88.1700	24.9	43.5	-18.6	QP
161.4000	21.3	43.5	-22.2	QP
162.3000	21.9	43.5	-21.6	QP
525.0000	28.6	46.0	-17.4	QP
838.8900	17.6	46.0	-28.4	QP

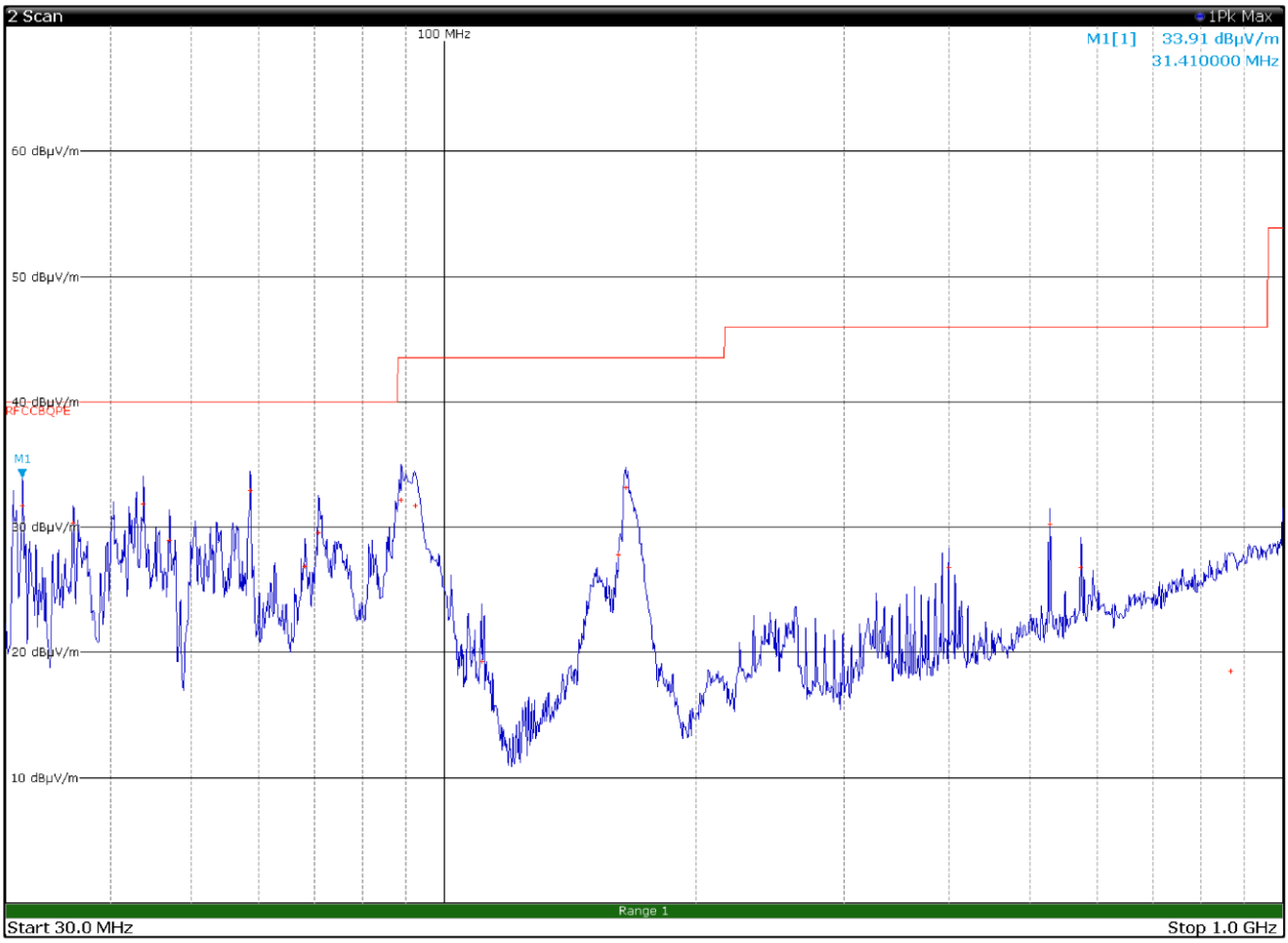


Figure 7.5-2: *Radiated spurious emissions 30 to 1000 MHz, Mid channel with antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
31.4100	31.8	40.0	-8.2	QP
36.1200	30.4	40.0	-9.6	QP
43.8000	31.9	40.0	-8.1	QP
47.0400	29.0	40.0	-11.0	QP
58.7400	33.0	40.0	-7.0	QP
68.2200	26.9	40.0	-13.1	QP
70.8300	29.6	40.0	-10.4	QP
88.8600	32.2	43.5	-11.3	QP
92.4300	31.8	43.5	-11.7	QP
110.7600	19.3	43.5	-24.2	QP
161.4300	27.8	43.5	-15.7	QP
164.5500	33.2	43.5	-10.3	QP
399.6000	26.8	46.0	-19.2	QP
528.0000	30.3	46.0	-15.7	QP

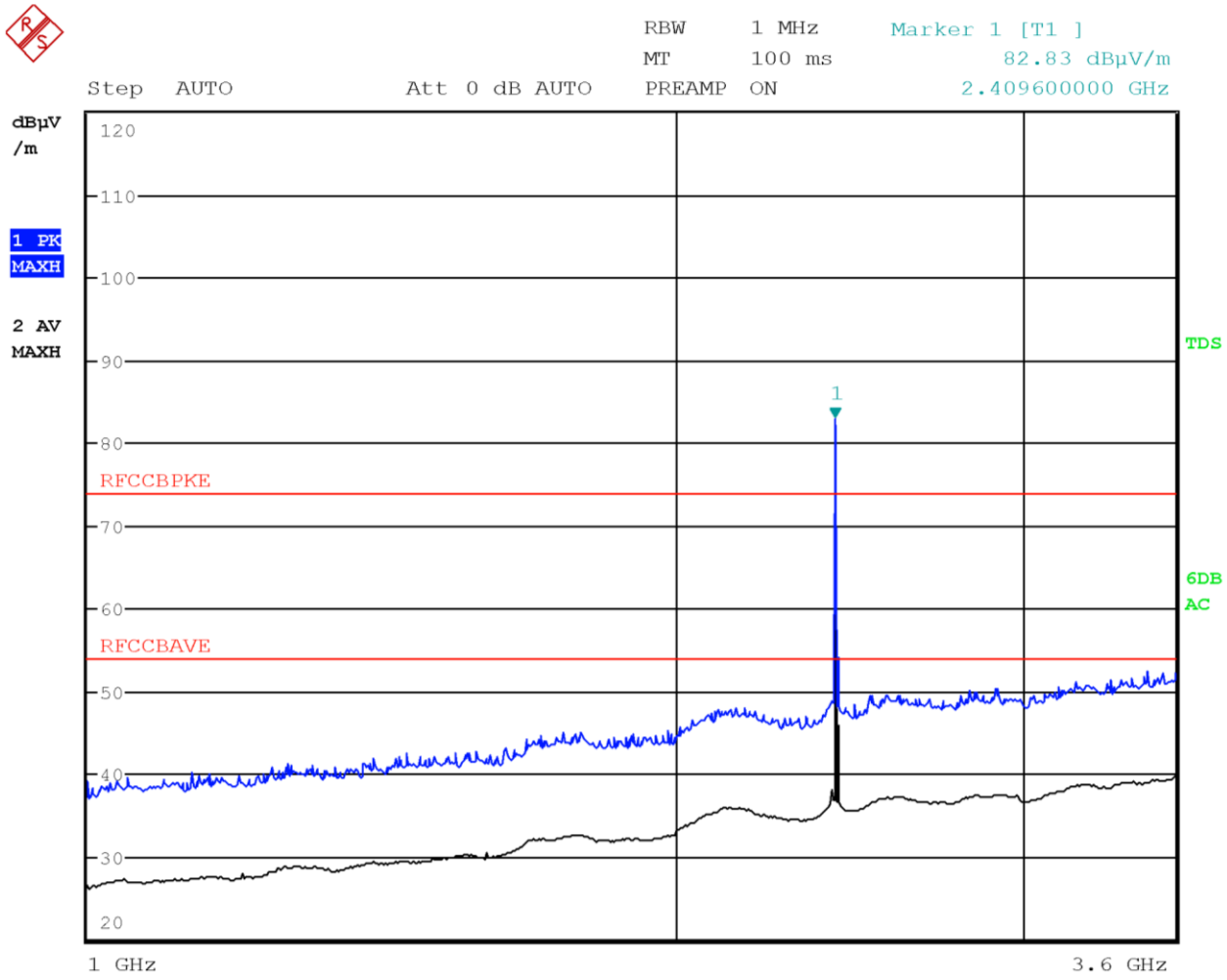


Figure 7.5-3: *Radiated spurious emissions 1 to 3.6 GHz, Low channel with antenna in horizontal polarization*

Limit exceeded by the carrier

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1200.0000	28.2	54.0	-25.8	Av
1400.0000	29.6	54.0	-24.4	Av
1689.2000	32.3	54.0	-21.7	Av
2071.6000	35.3	54.0	-18.7	Av
2947.6000	37.6	54.0	-16.4	Av
3596.0000	39.8	54.0	-14.2	Av

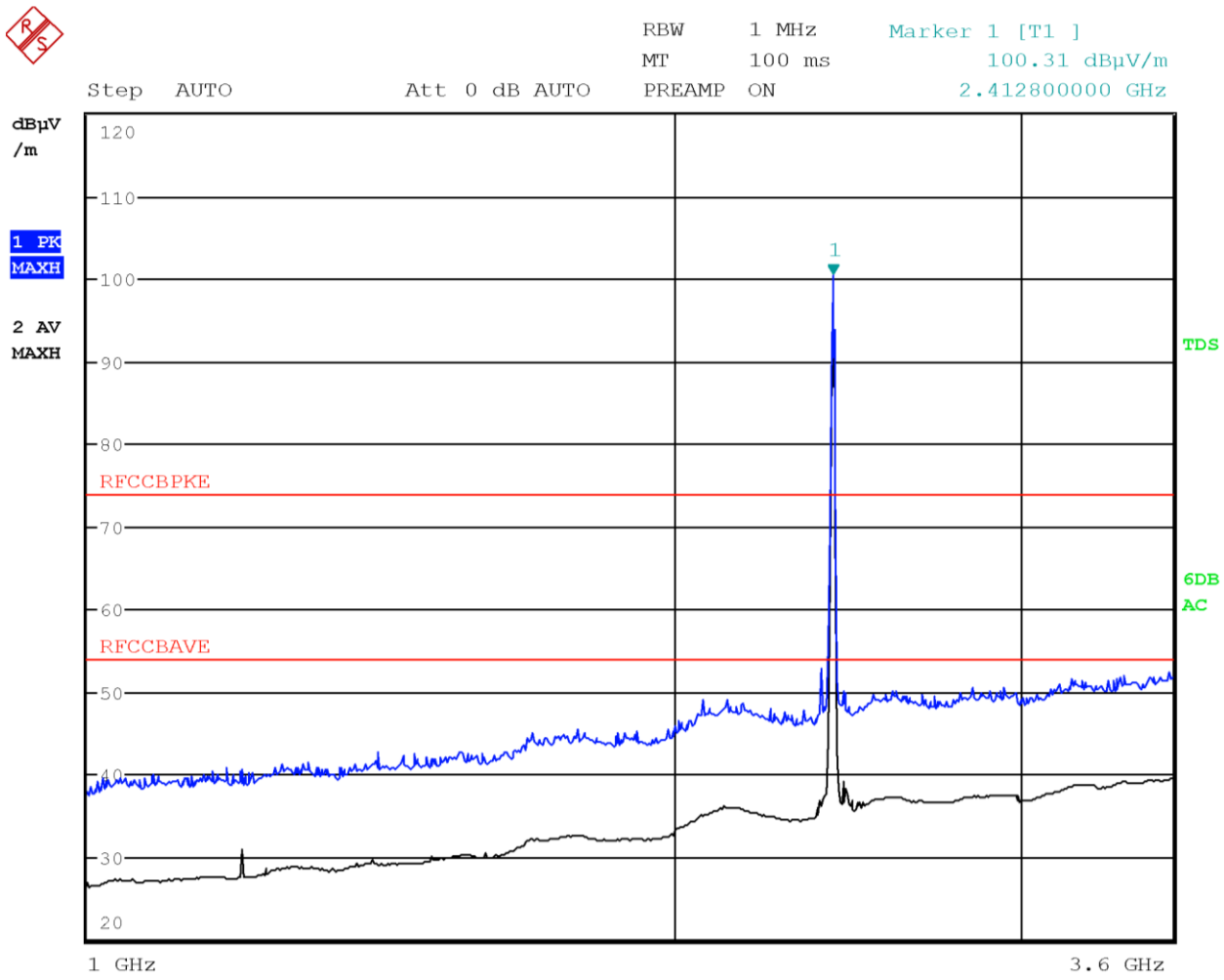


Figure 7.5-4: *Radiated spurious emissions 1 to 3.6 GHz, Low channel with antenna in vertical polarization*

Limit exceeded by the carrier

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1200.0000	28.5	54.0	-25.5	Av
1400.0000	30.2	54.0	-23.8	Av
1693.6000	32.4	54.0	-21.6	Av
2076.8000	35.2	54.0	-18.8	Av
2987.6000	37.6	54.0	-16.4	Av
3596.0000	39.8	54.0	-14.2	Av

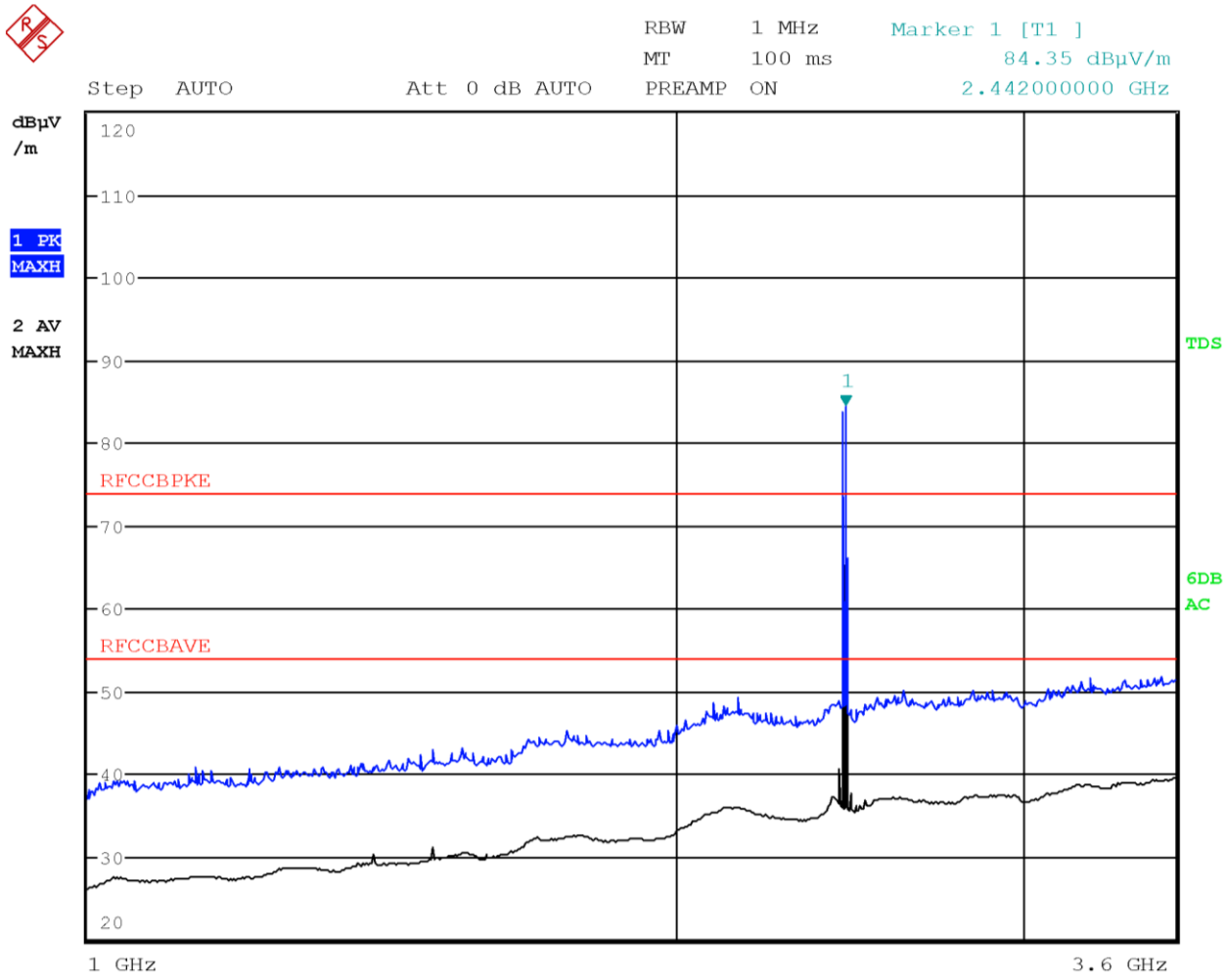


Figure 7.5-5: *Radiated spurious emissions 1 to 3.6 GHz, Mid channel with antenna in horizontal polarization*

Limit exceeded by the carrier

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1200.0000	27.8	54.0	-26.2	Av
1400.0000	30.5	54.0	-23.5	Av
1698.8000	32.6	54.0	-21.4	Av
2071.2000	35.3	54.0	-18.7	Av
2916.8000	37.7	54.0	-16.3	Av
3594.8000	39.7	54.0	-14.3	Av

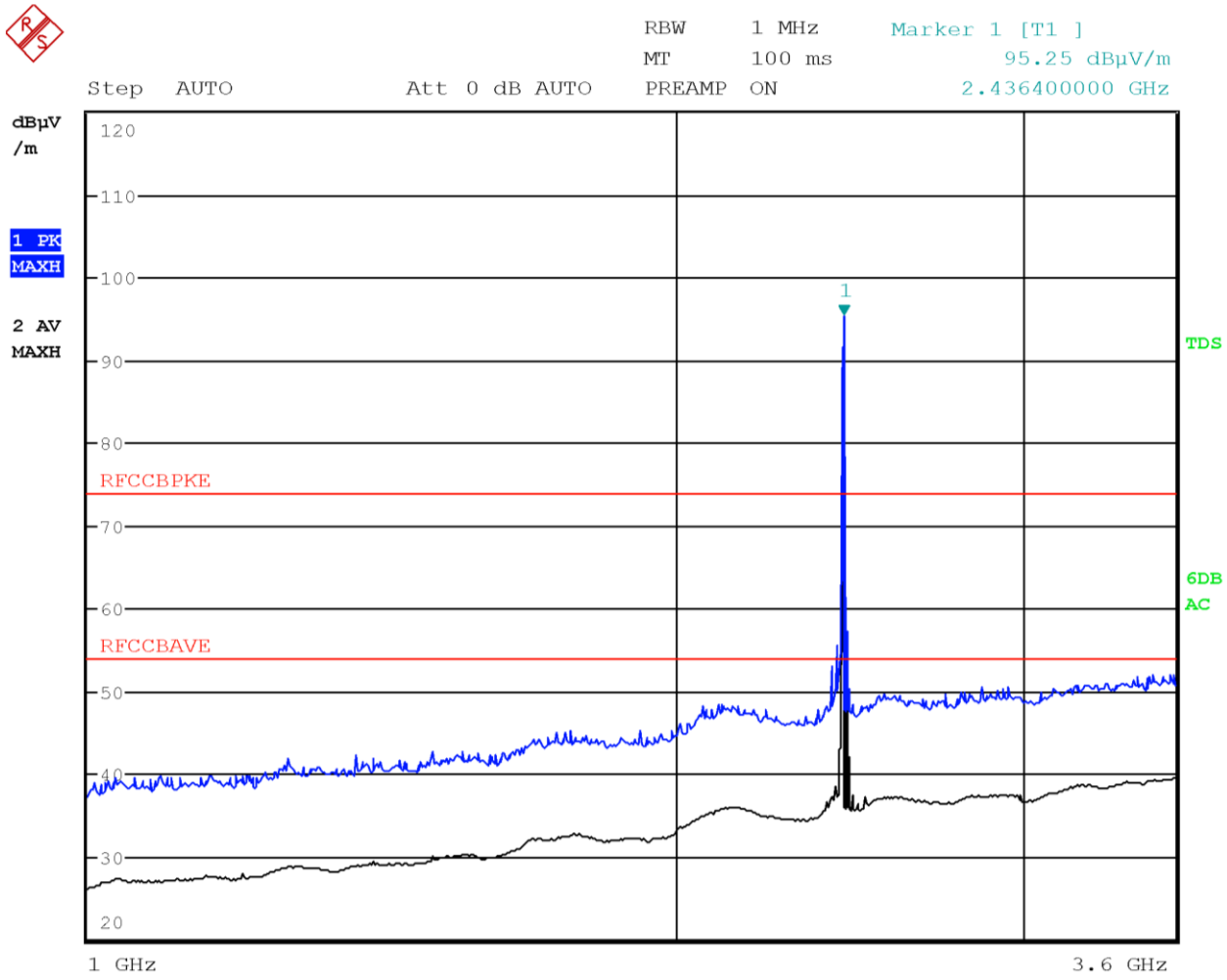


Figure 7.5-6: *Radiated spurious emissions 1 to 3.6 GHz, Mid channel with antenna in vertical polarization*

Limit exceeded by the carrier

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1200.0000	28.2	54.0	-25.8	Av
1400.0000	29.7	54.0	-24.3	Av
1705.2000	32.3	54.0	-21.7	Av
2072.0000	35.3	54.0	-18.7	Av
2988.4000	37.6	54.0	-16.4	Av
3598.8000	39.7	54.0	-14.3	Av

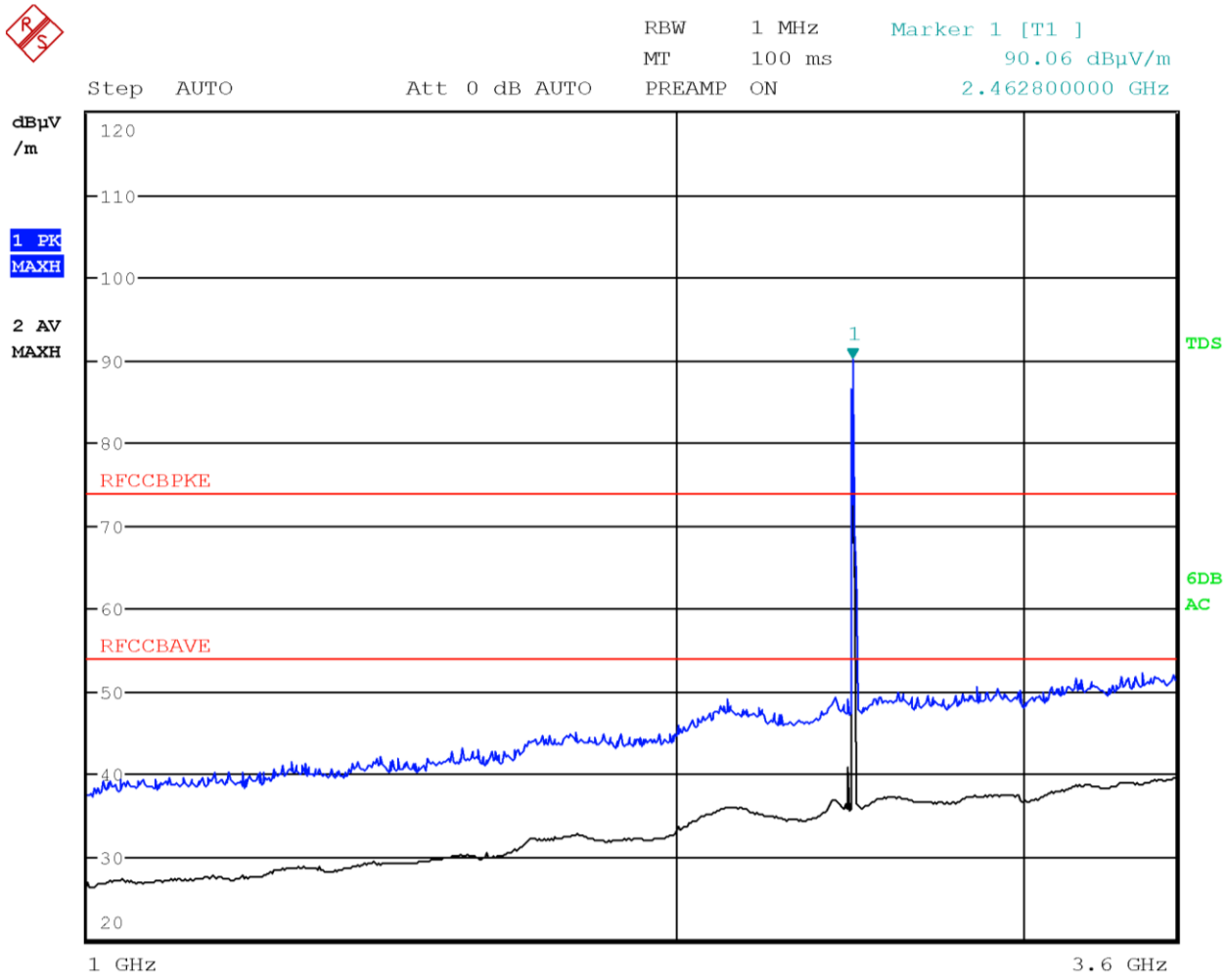


Figure 7.5-7: *Radiated spurious emissions 1 to 3.6 GHz, High channel with antenna in horizontal polarization*

Limit exceeded by the carrier

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1200.0000	27.9	54.0	-26.1	Av
1400.0000	29.5	54.0	-24.5	Av
1691.6000	32.4	54.0	-21.6	Av
2072.8000	35.3	54.0	-18.7	Av
2948.8000	37.7	54.0	-16.3	Av
3598.8000	39.7	54.0	-14.3	Av

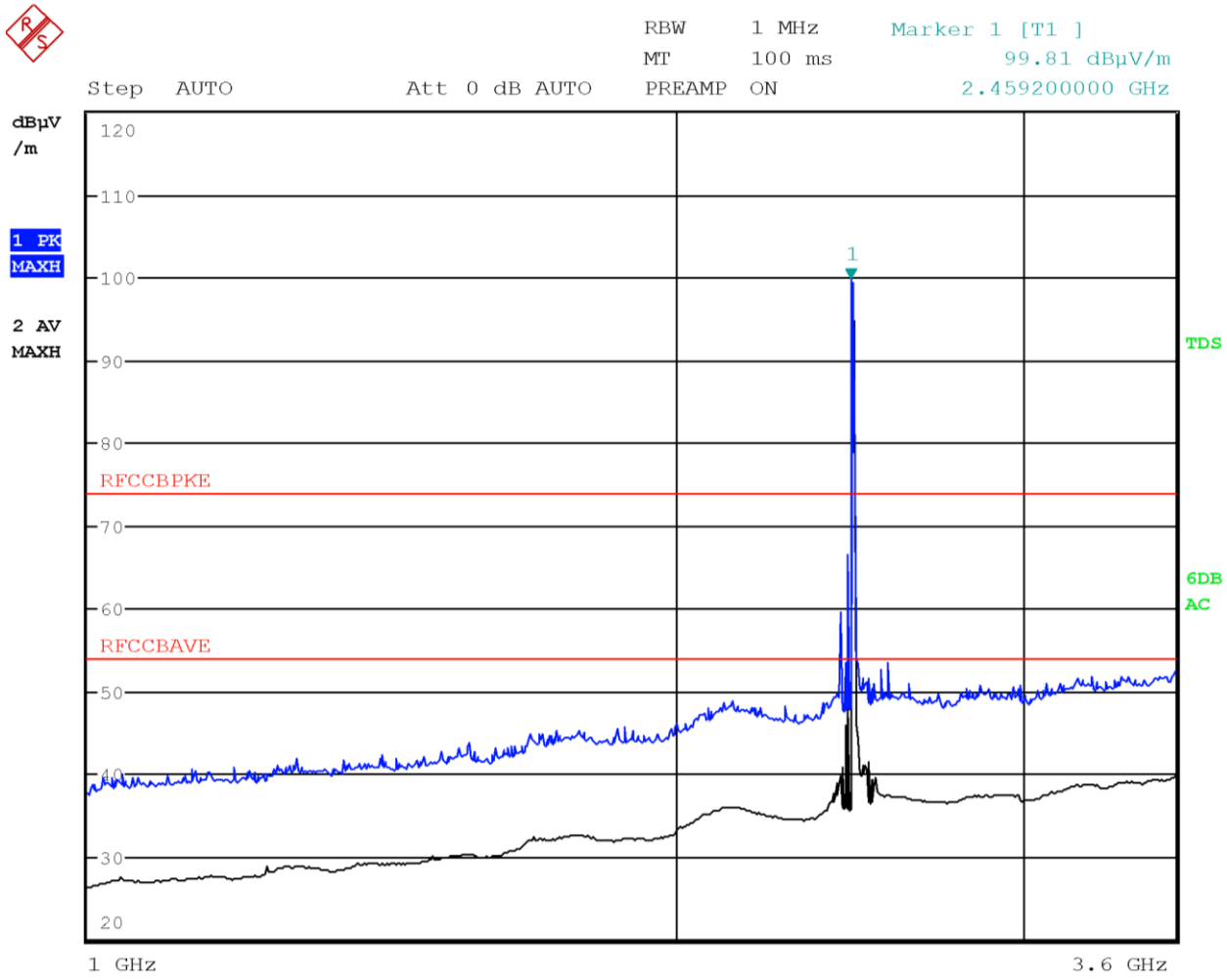


Figure 7.5-8: *Radiated spurious emissions 1 to 3.6 GHz, High channel with antenna in vertical polarization*

Limit exceeded by the carrier

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1156.0000	27.8	54.0	-26.2	Av
1375.2000	29.5	54.0	-24.5	Av
1691.2000	32.5	54.0	-21.5	Av
2073.6000	35.3	54.0	-18.7	Av
2508.0000	41.6	54.0	-12.4	Av
3598.8000	39.8	54.0	-14.2	Av

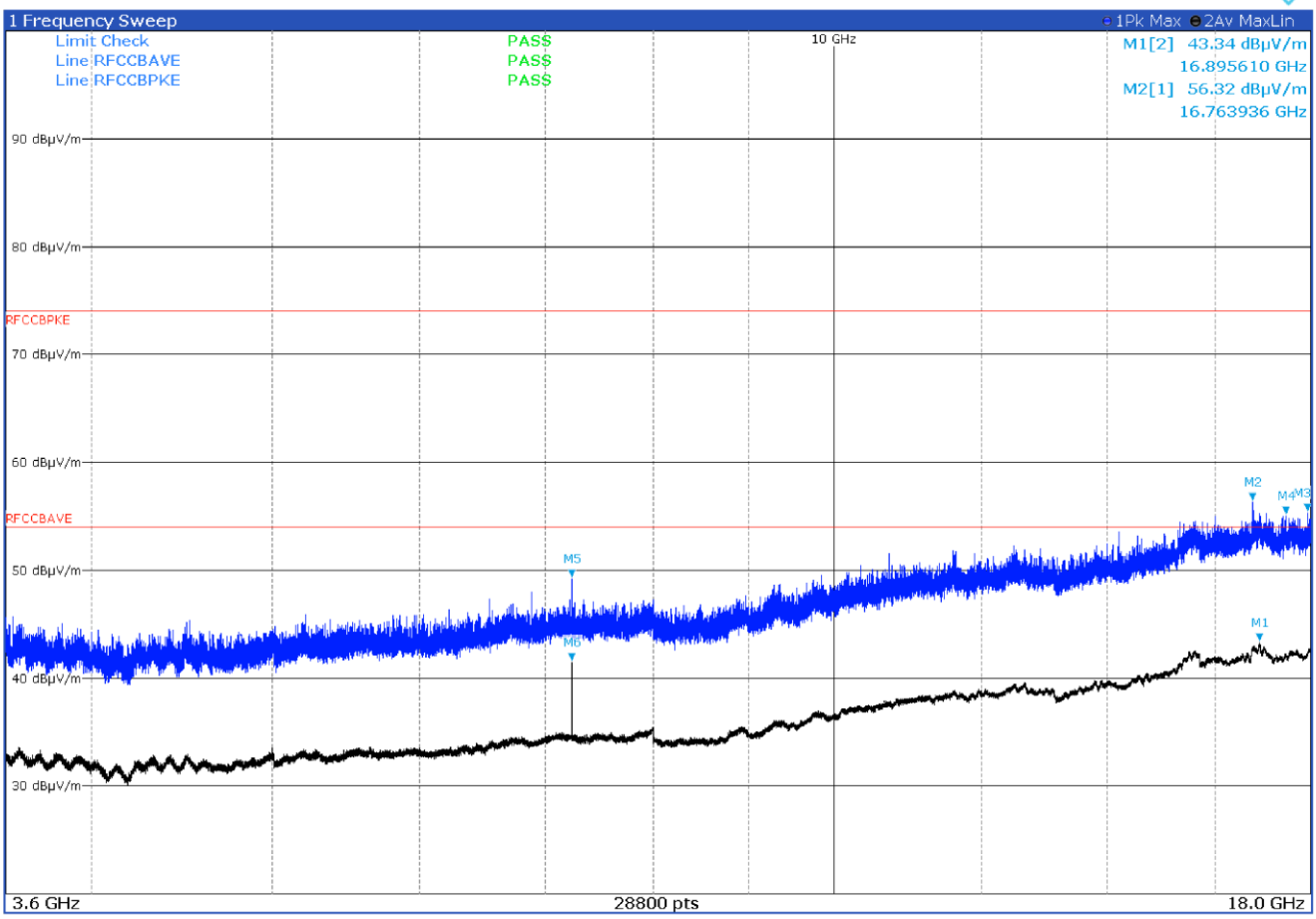


Figure 7.5-9: *Radiated spurious emissions 3.6 to 18 GHz, Low channel with antenna in horizontal polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
16.8956	43.4	54	-10.6	Av
16.7639	56.4	74	-17.6	Pk
17.9297	55.4	74	-18.6	Pk
17.4678	55.2	74	-18.8	Pk
7.2360	49.3	74	-24.7	Pk
7.2360	41.5	54	-12.5	Av

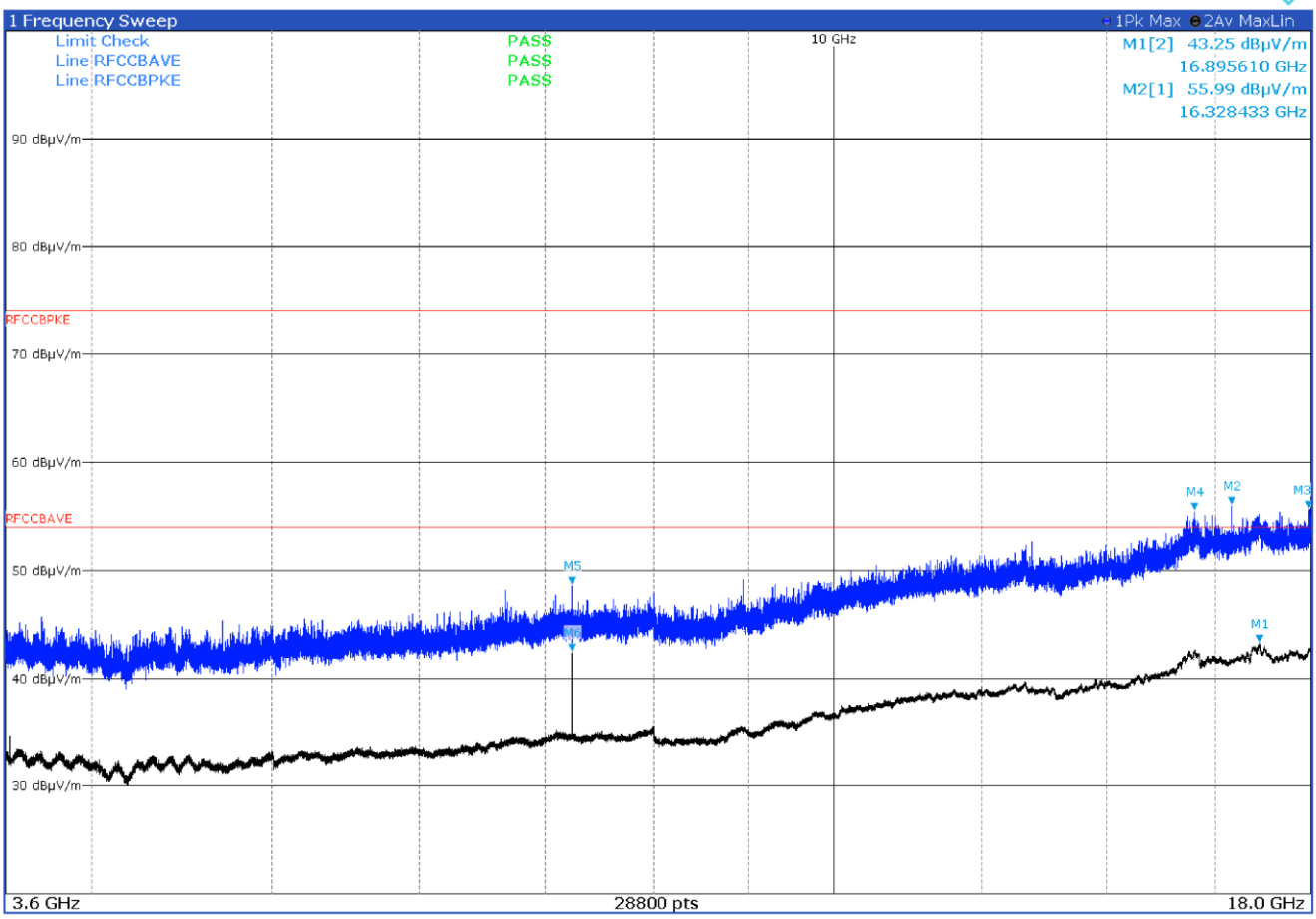


Figure 7.5-10: *Radiated spurious emissions 3.6 to 18 GHz, Low channel with antenna in vertical polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
16.8956	43.3	54	-10.7	Av
16.3284	56.0	74	-18.0	Pk
17.9537	55.7	74	-18.3	Pk
15.6005	55.5	74	-18.5	Pk
7.2360	48.7	74	-25.3	Pk
7.2360	42.5	54	-11.5	Av

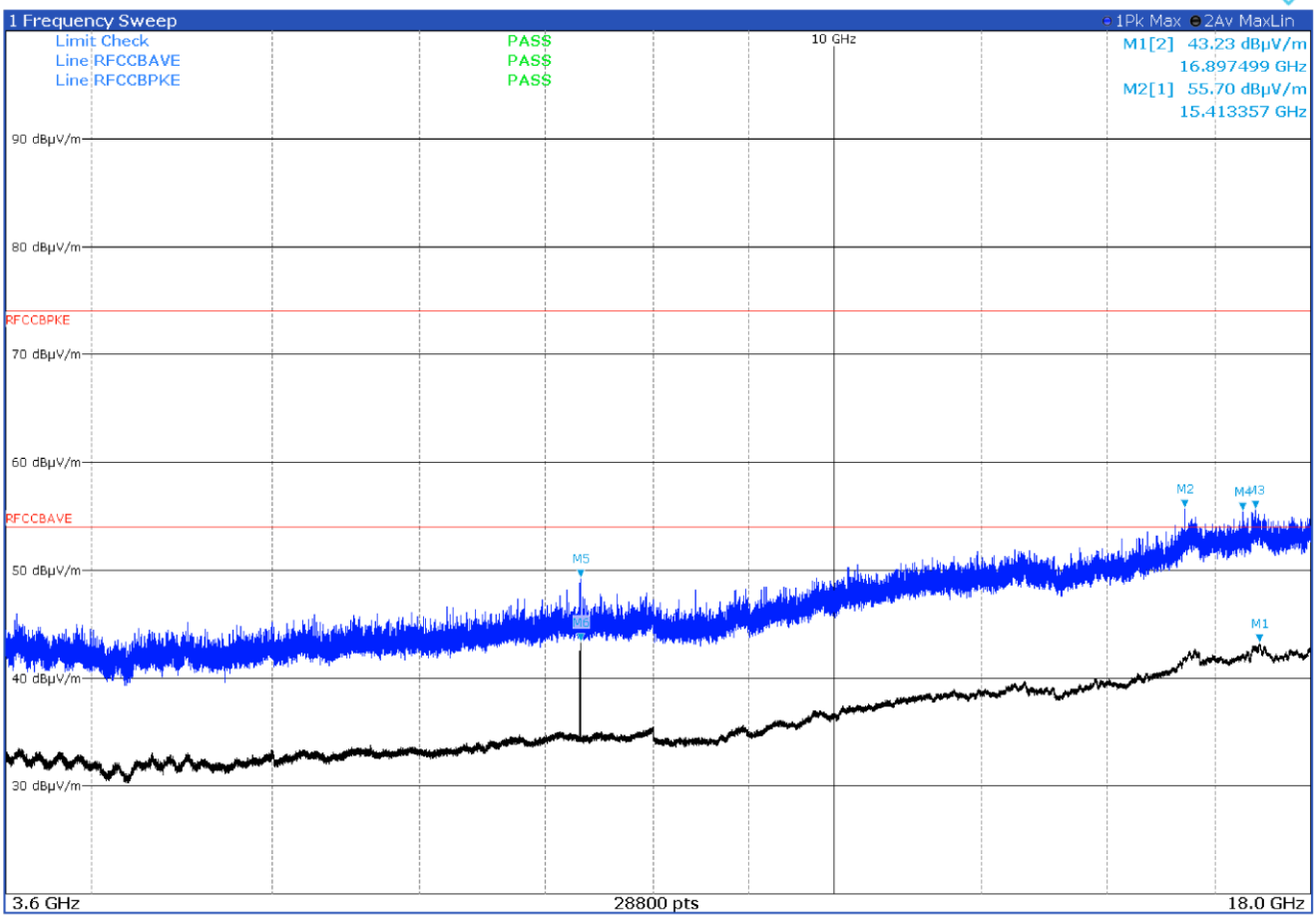


Figure 7.5-11: *Radiated spurious emissions 3.6 to 18 GHz, Mid channel with antenna in horizontal polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
16.8974	43.3	54	-10.7	Av
15.4133	55.7	74	-18.3	Pk
16.8183	55.7	74	-18.3	Pk
16.5563	55.5	74	-18.5	Pk
7.3108	49.3	74	-24.7	Pk
7.3108	43.4	54	-10.6	Av

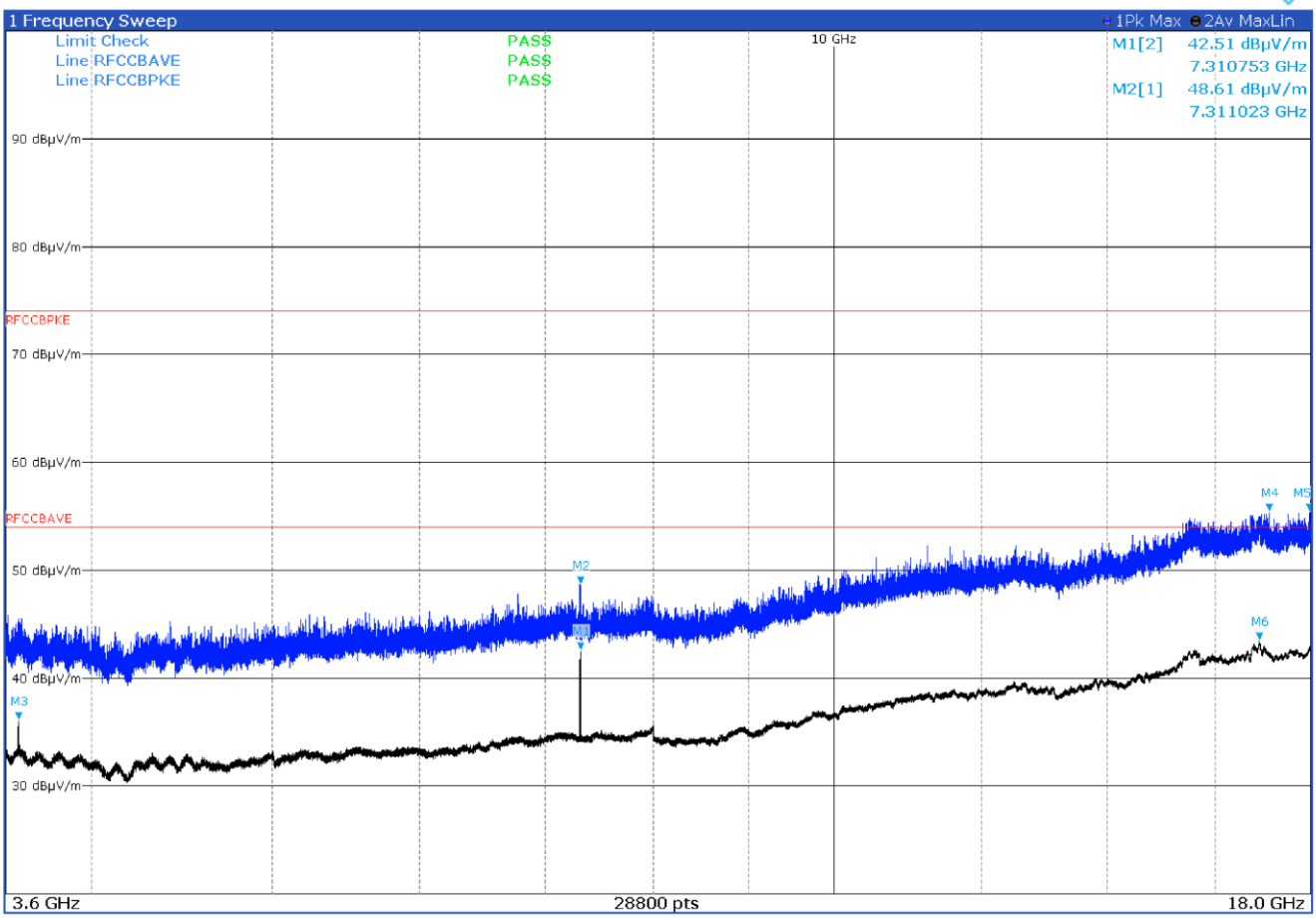


Figure 7.5-12: *Radiated spurious emissions 3.6 to 18 GHz, Mid channel with antenna in vertical polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
7.3107	42.6	54	-11.4	Av
7.3110	48.7	74	-25.3	Pk
3.6552	36.1	54	-17.9	Av
17.1113	55.4	74	-18.6	Pk
17.9748	55.4	74	-18.6	Pk
16.8927	43.4	54	-10.6	Av

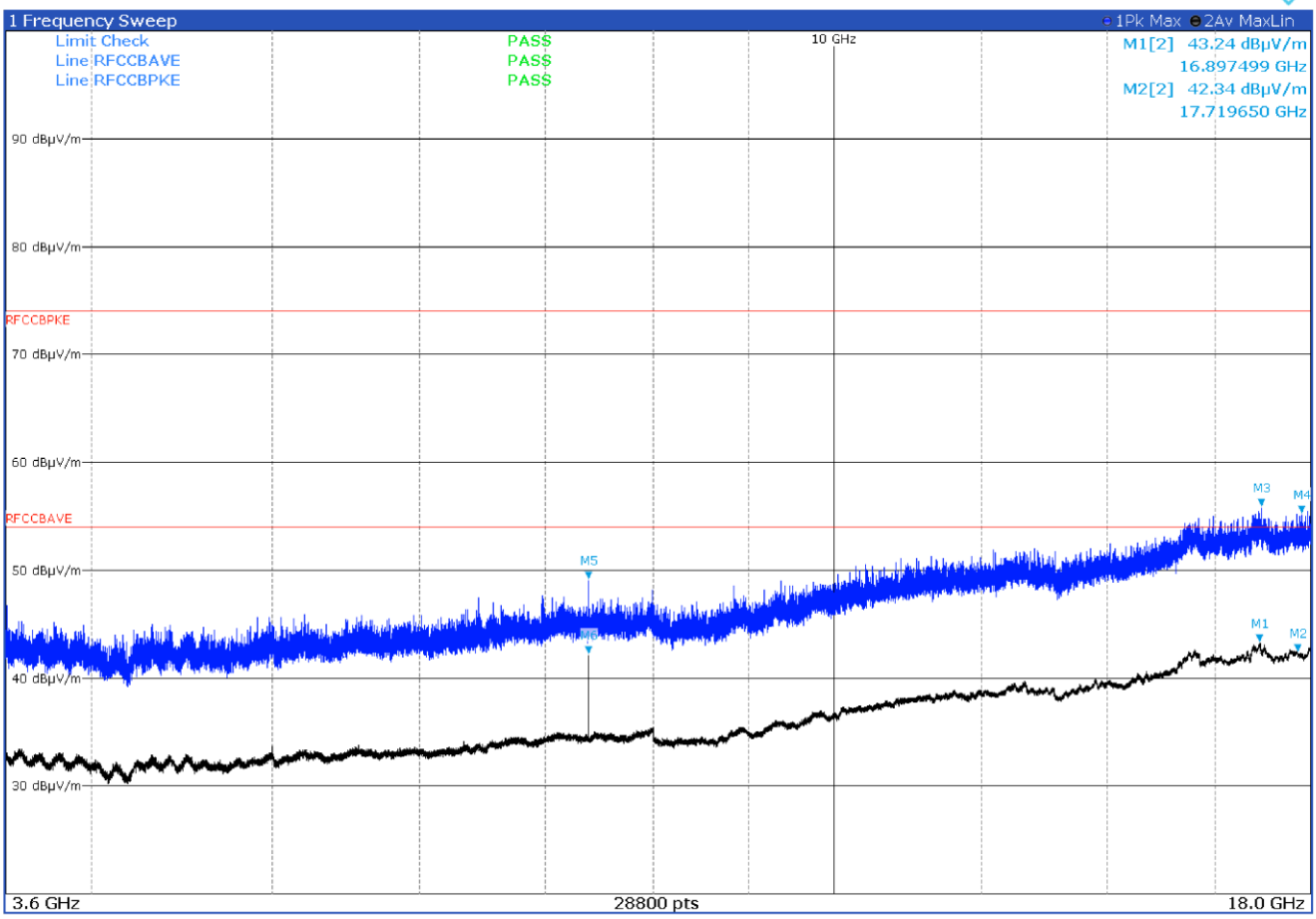


Figure 7.5-13: *Radiated spurious emissions 3.6 to 18 GHz, High channel with antenna in horizontal polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
16.8974	43.3	54	-10.7	Av
17.7195	42.4	54	-11.6	Av
16.9391	55.9	74	-18.1	Pk
17.8088	55.2	74	-18.8	Pk
7.3859	49.2	74	-24.8	Pk
7.3859	42.2	54	-11.8	Av

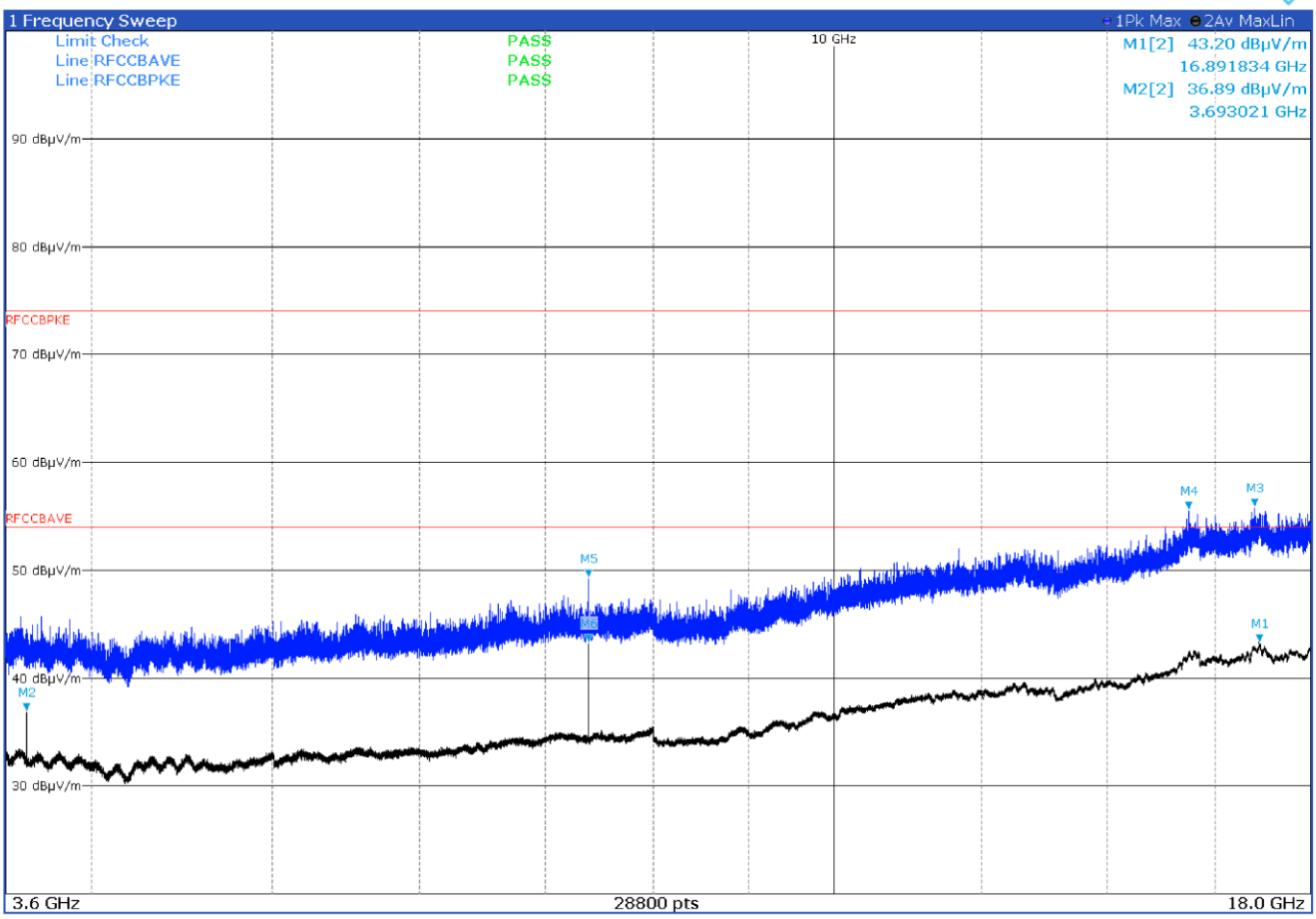


Figure 7.5-14: *Radiated spurious emissions 3.6 to 18 GHz, High channel with antenna in vertical polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
16.8918	43.2	54	-10.8	Av
3.6930	36.9	54	-17.1	Av
16.8042	55.8	74	-18.2	Pk
15.4858	55.6	74	-18.4	Pk
7.3859	49.2	74	-24.8	Pk
7.3859	43.3	54	-10.7	Av

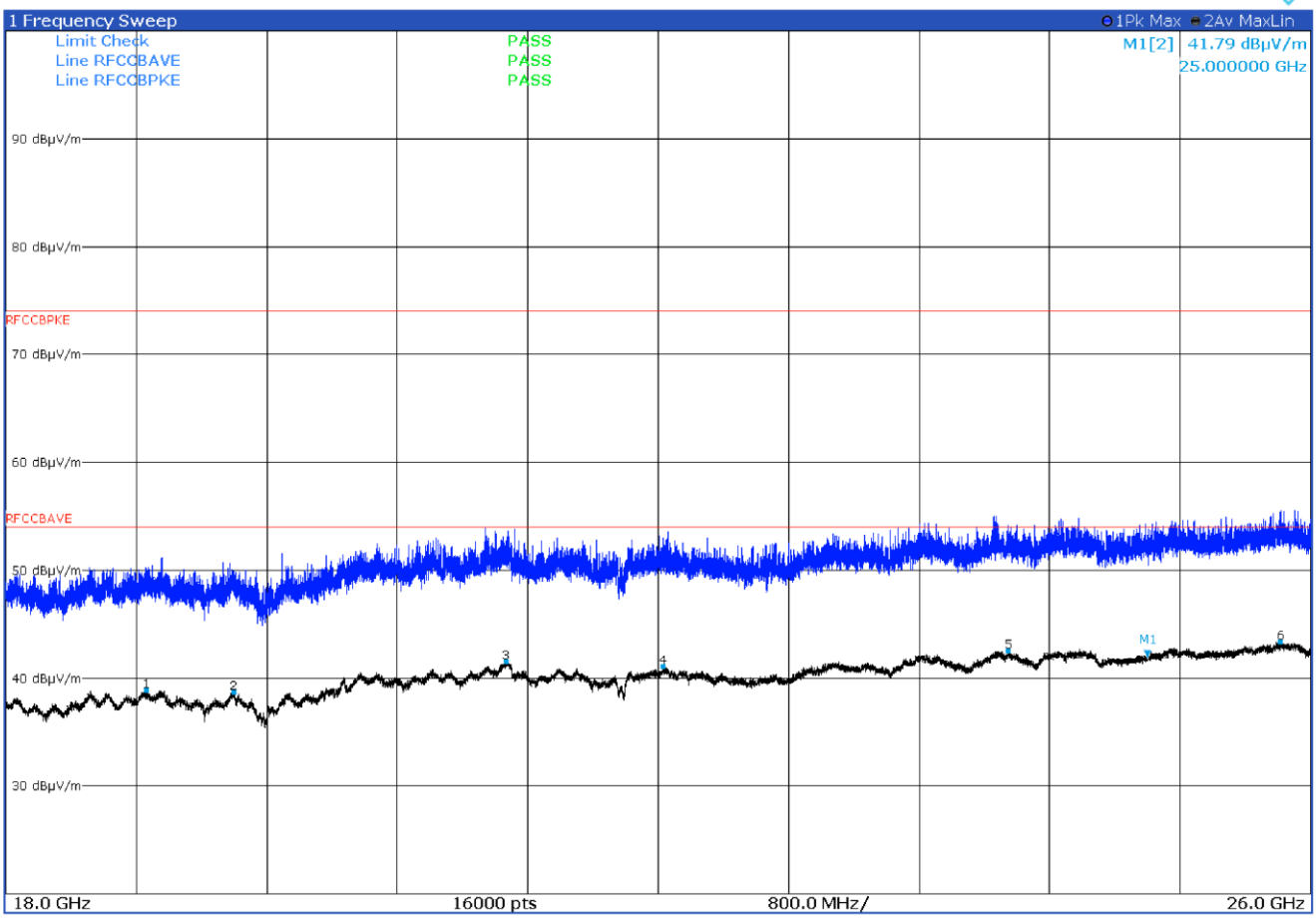


Figure 7.5-15: *Radiated spurious emissions 18 to 26 GHz, Low channel with antenna in horizontal polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
18.8627	38.9	54	-15.1	Av
19.3947	38.7	54	-15.3	Av
21.0657	41.6	54	-12.4	Av
22.0327	41.1	54	-12.9	Av
24.1472	42.6	54	-11.4	Av
25.8162	43.4	54	-10.6	Av

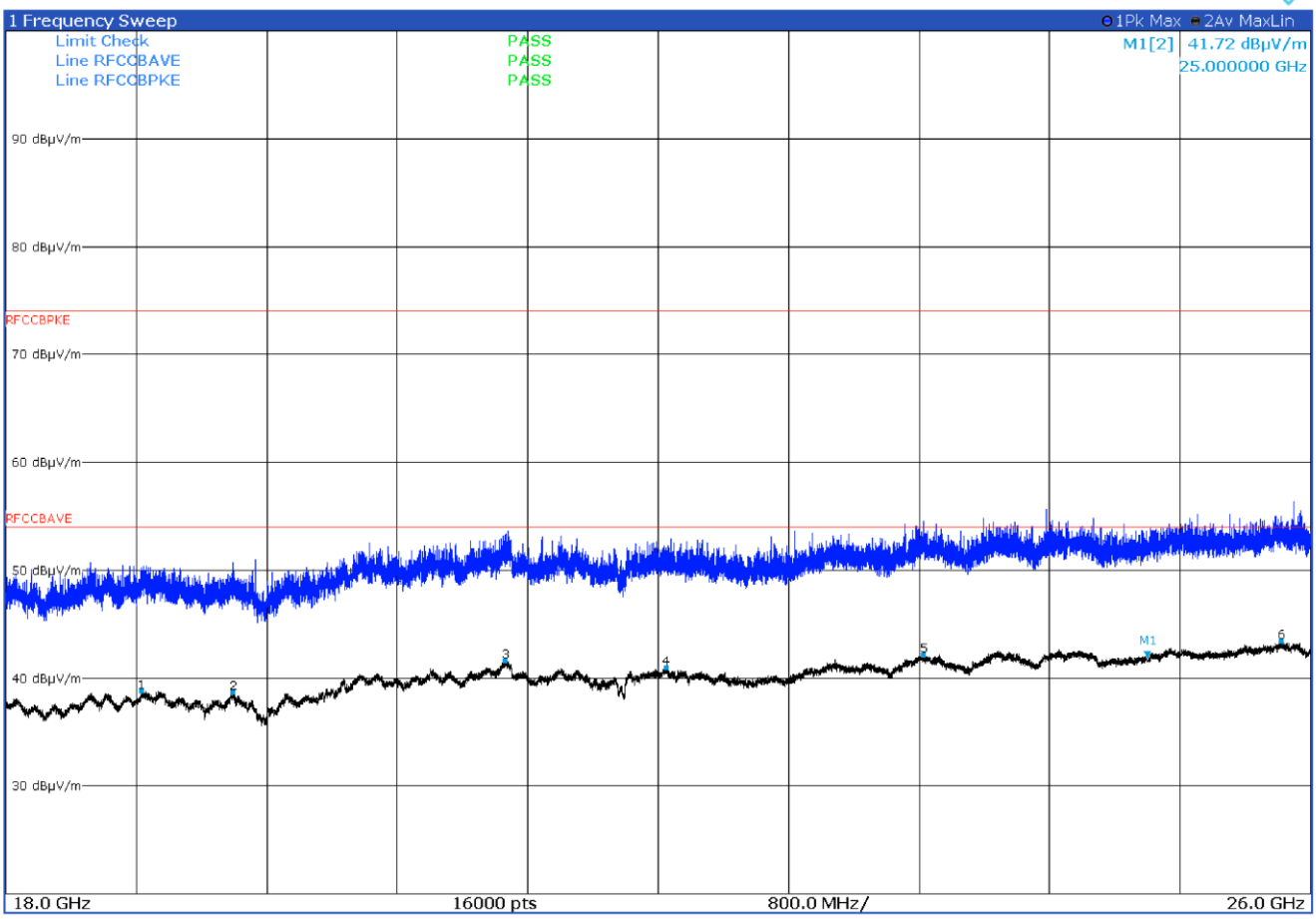


Figure 7.5-16: *Radiated spurious emissions 18 to 26 GHz, Low channel with antenna in vertical polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
18.8302	38.8	54	-15.2	Av
19.3937	38.7	54	-15.3	Av
21.0607	41.7	54	-12.3	Av
22.0477	41.0	54	-13.0	Av
23.6292	42.2	54	-11.8	Av
25.8202	43.5	54	-10.5	Av

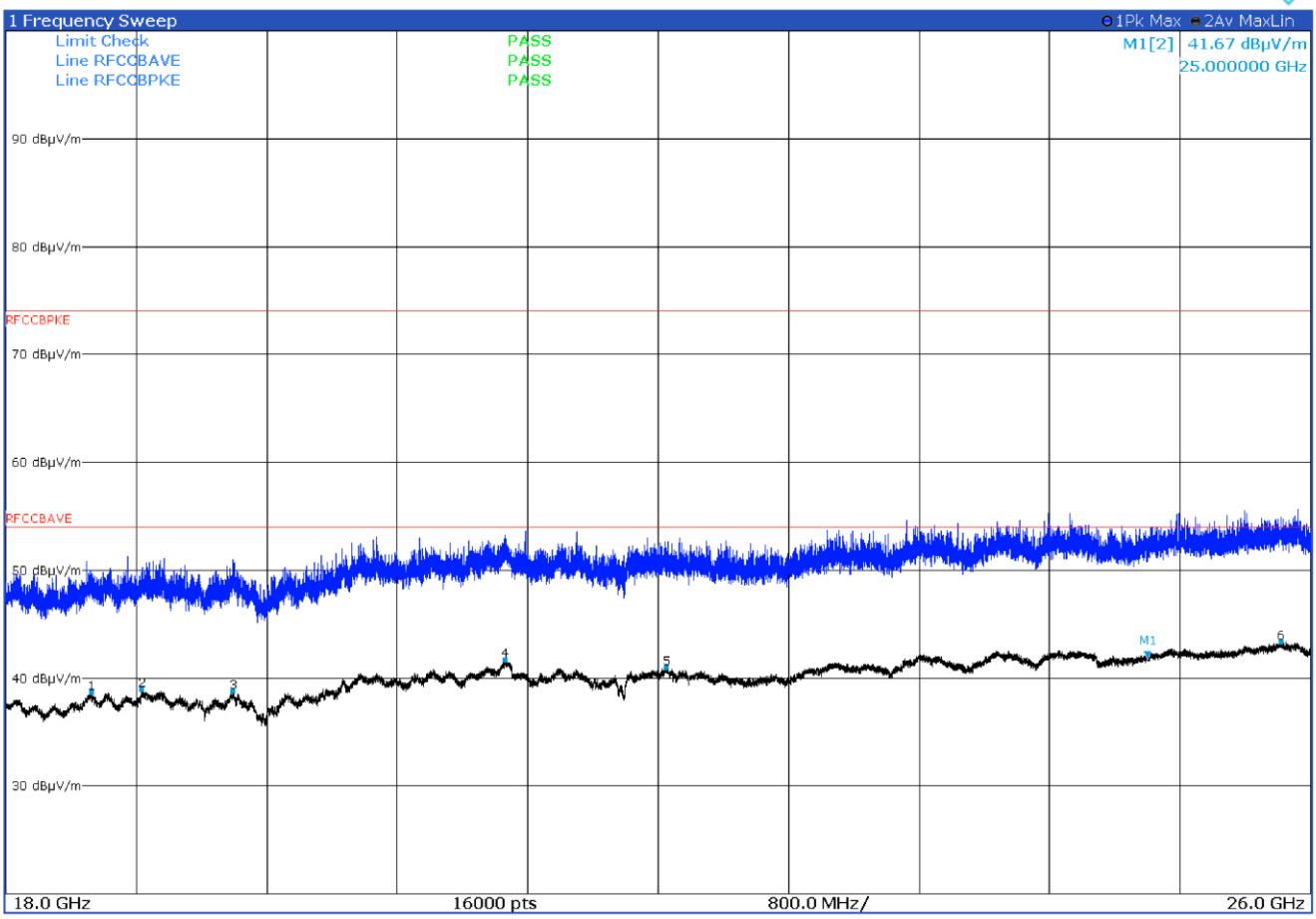


Figure 7.5-17: *Radiated spurious emissions 18 to 26 GHz, Mid channel with antenna in horizontal polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
18.5232	38.8	54	-15.2	Av
18.8332	39.0	54	-15.0	Av
19.3932	38.8	54	-15.2	Av
21.0597	41.7	54	-12.3	Av
22.0492	41.0	54	-13.0	Av
25.8172	43.4	54	-10.6	Av

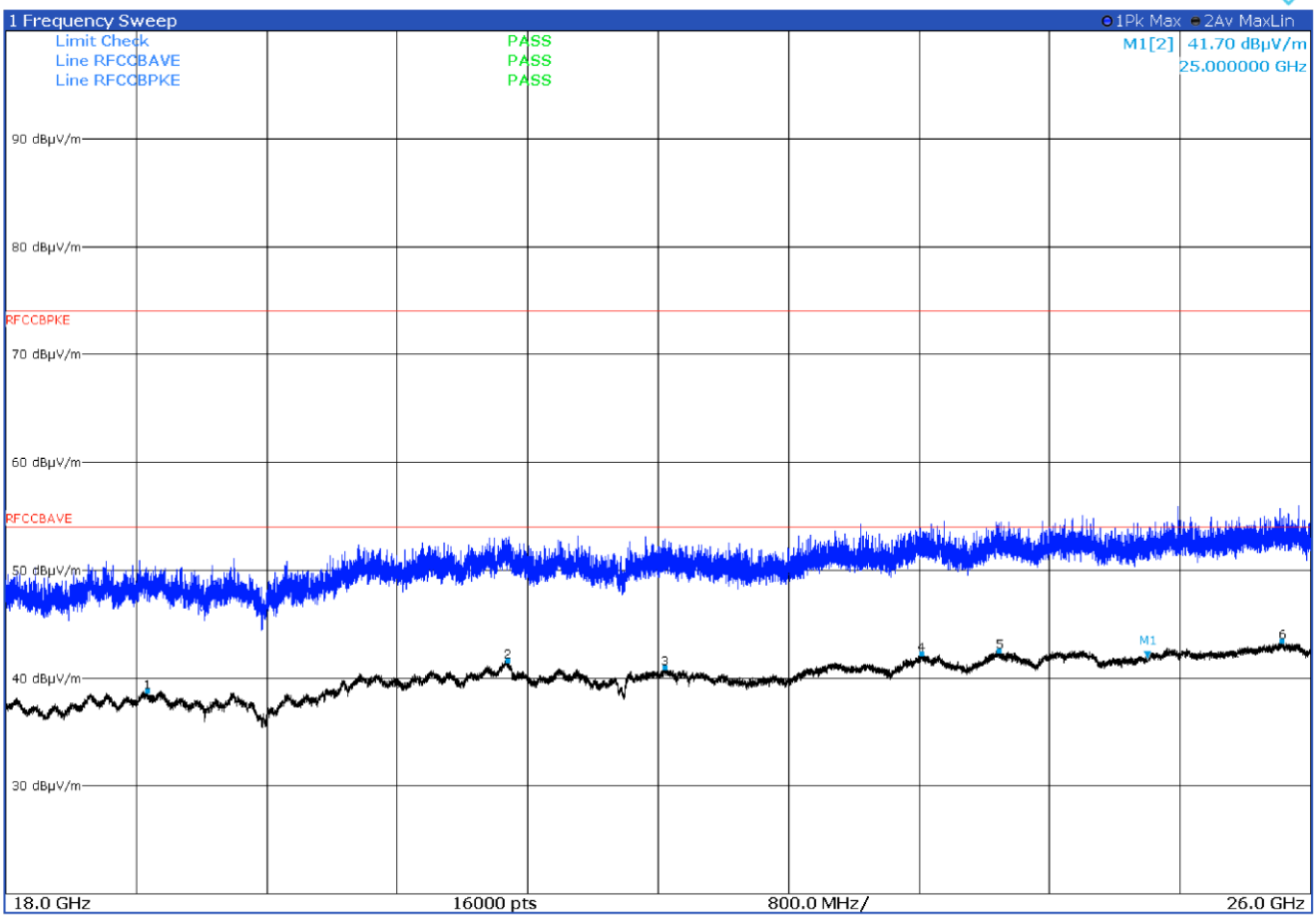


Figure 7.5-18: *Radiated spurious emissions 18 to 26 GHz, Mid channel with antenna in vertical polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
18.8647	38.8	54	-15.2	Av
21.0777	41.7	54	-12.3	Av
22.0397	41.0	54	-13.0	Av
23.6162	42.3	54	-11.7	Av
24.0912	42.6	54	-11.4	Av
25.8267	43.4	54	-10.6	Av

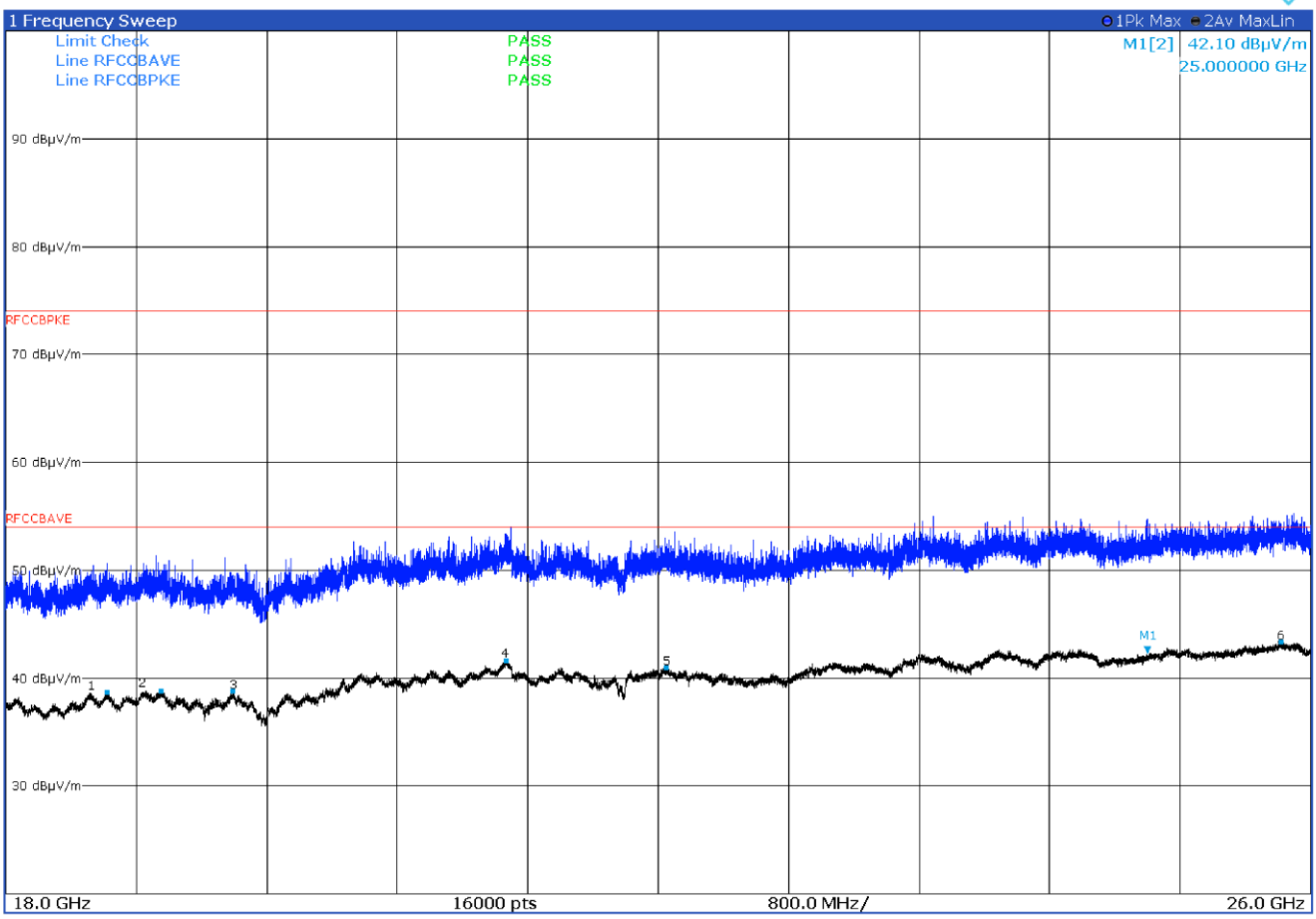


Figure 7.5-19: *Radiated spurious emissions 18 to 26 GHz, High channel with antenna in horizontal polarization*

Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
18.6192	38.7	54	-15.3	Av
18.9522	38.8	54	-15.2	Av
19.3937	38.8	54	-15.2	Av
21.0642	41.7	54	-12.3	Av
22.0467	41.0	54	-13.0	Av
25.8172	43.3	54	-10.7	Av

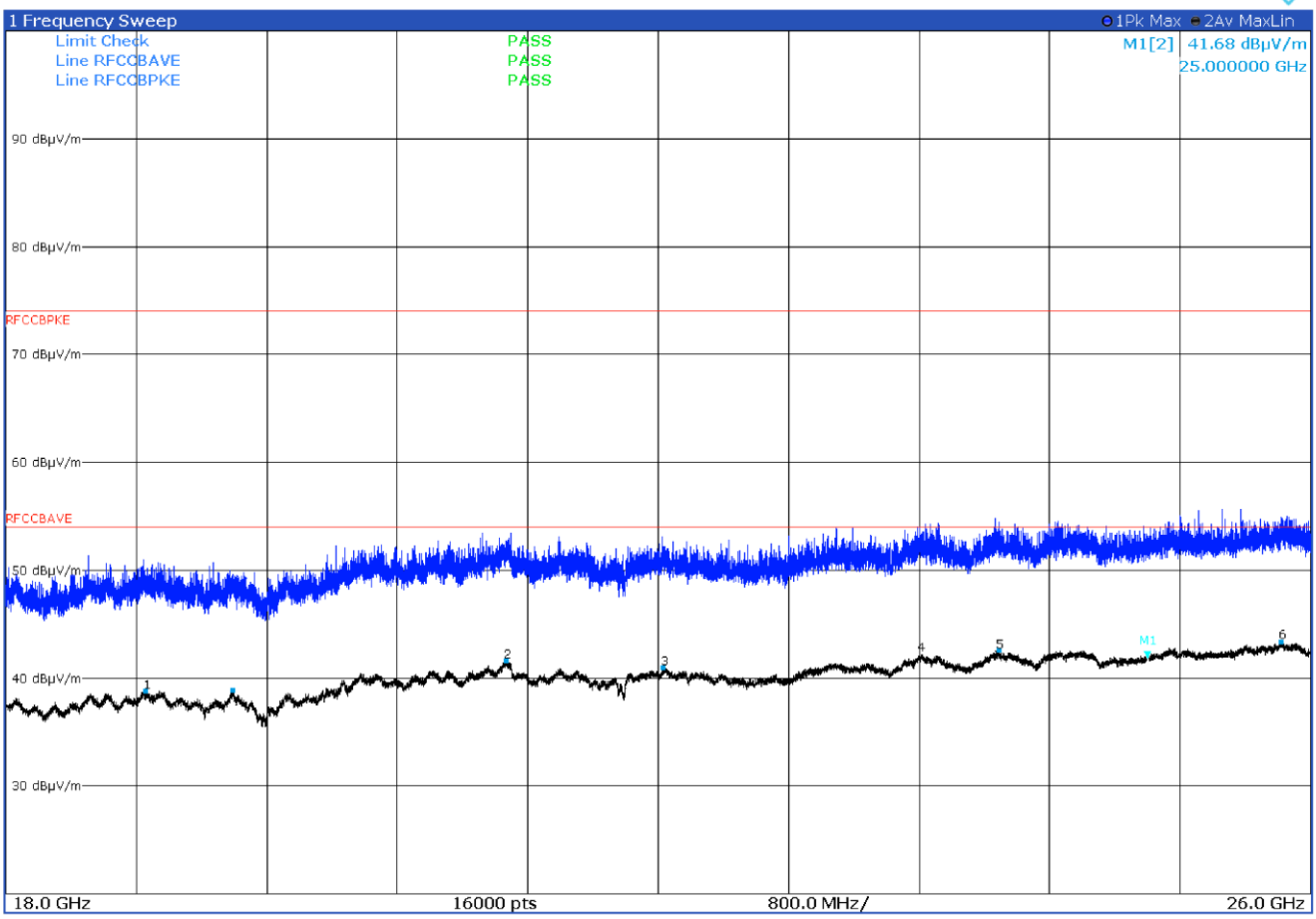
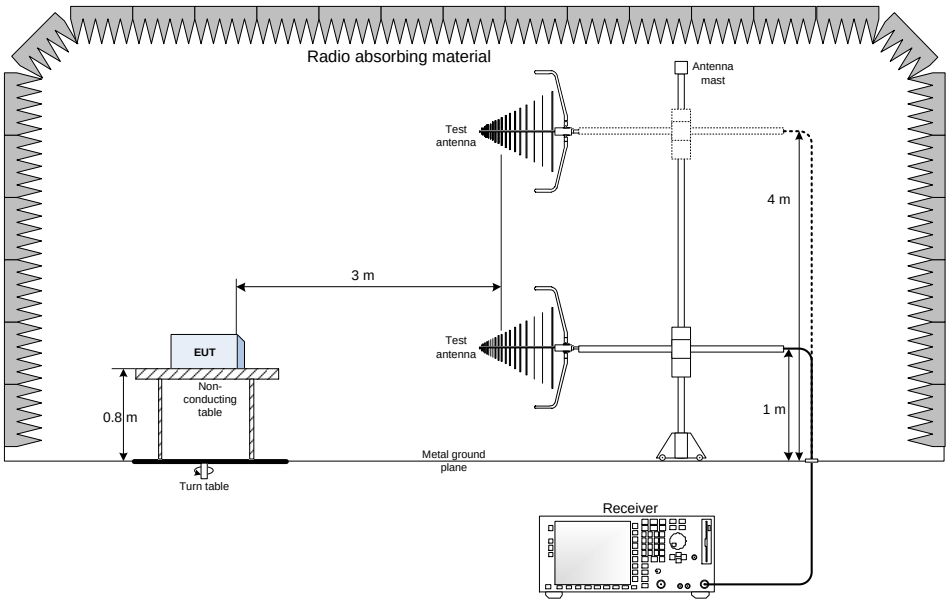


Figure 7.5-20: *Radiated spurious emissions 18 to 26 GHz, High channel with antenna in vertical polarization*

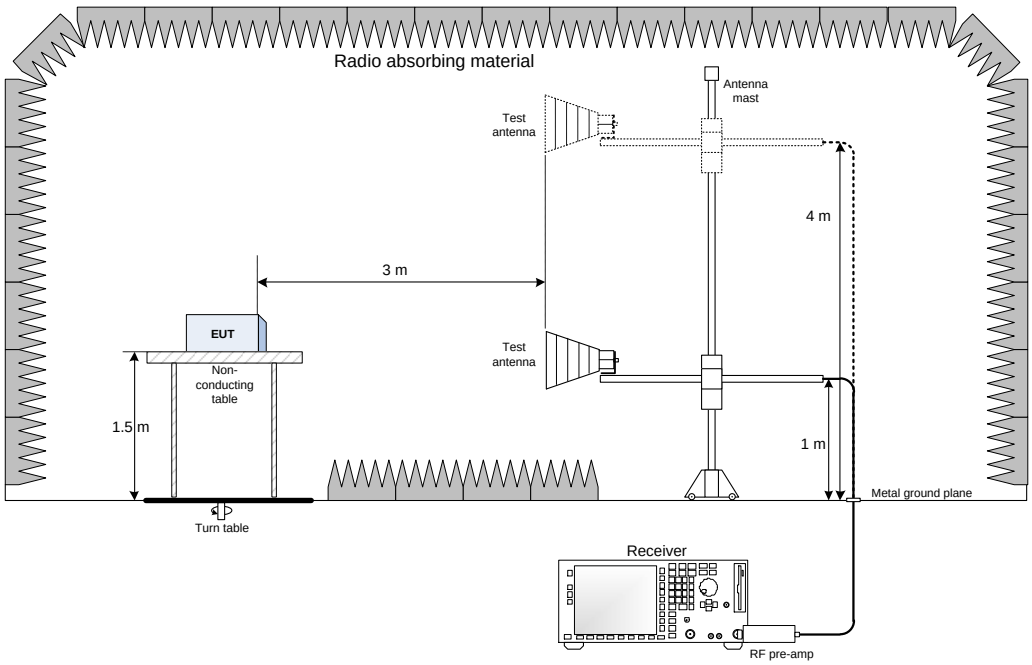
Frequency (GHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
18.8547	38.8	54	-15.2	Av
19.3932	38.9	54	-15.1	Av
21.0662	41.7	54	-12.3	Av
22.0302	41.0	54	-13.0	Av
24.0927	42.7	54	-11.3	Av
25.8167	43.4	54	-10.6	Av

Section 8. Block diagrams of test set-ups

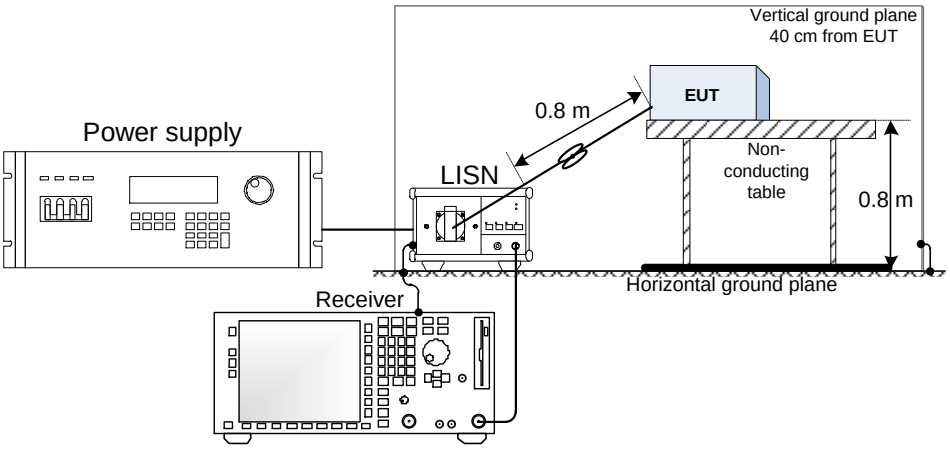
8.1 Radiated emissions set-up for frequencies below 1 GHz



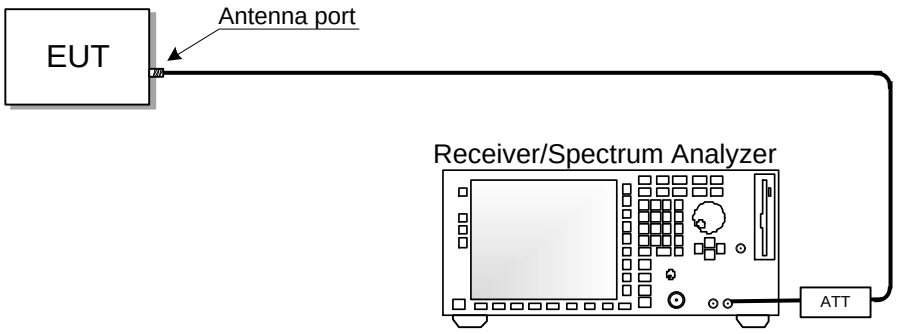
8.2 Radiated emissions set-up for frequencies above 1 GHz



8.3 Conducted emissions set-up

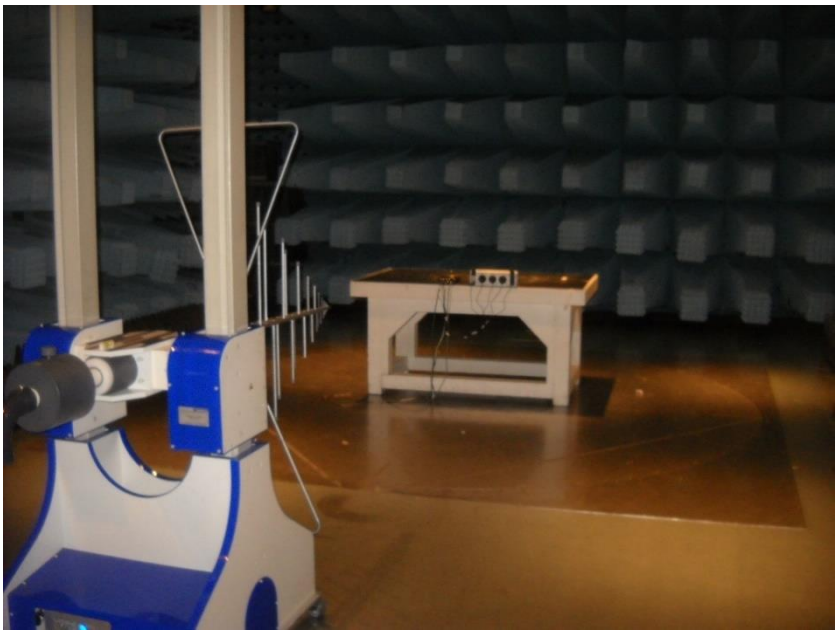


8.4 Antenna port set-up



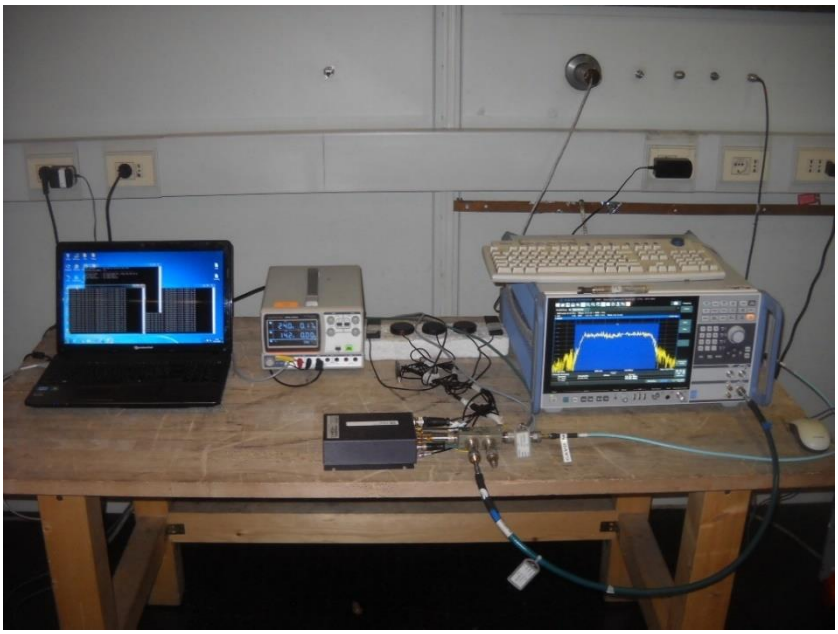
Section 9. Photos

9.1 Photos of the test set-up



Radiated emission below 1 GHz

Radiated emission above 1 GHz



Conducted emission on the antenna port

9.2 Photos of the EUT

(End of report)