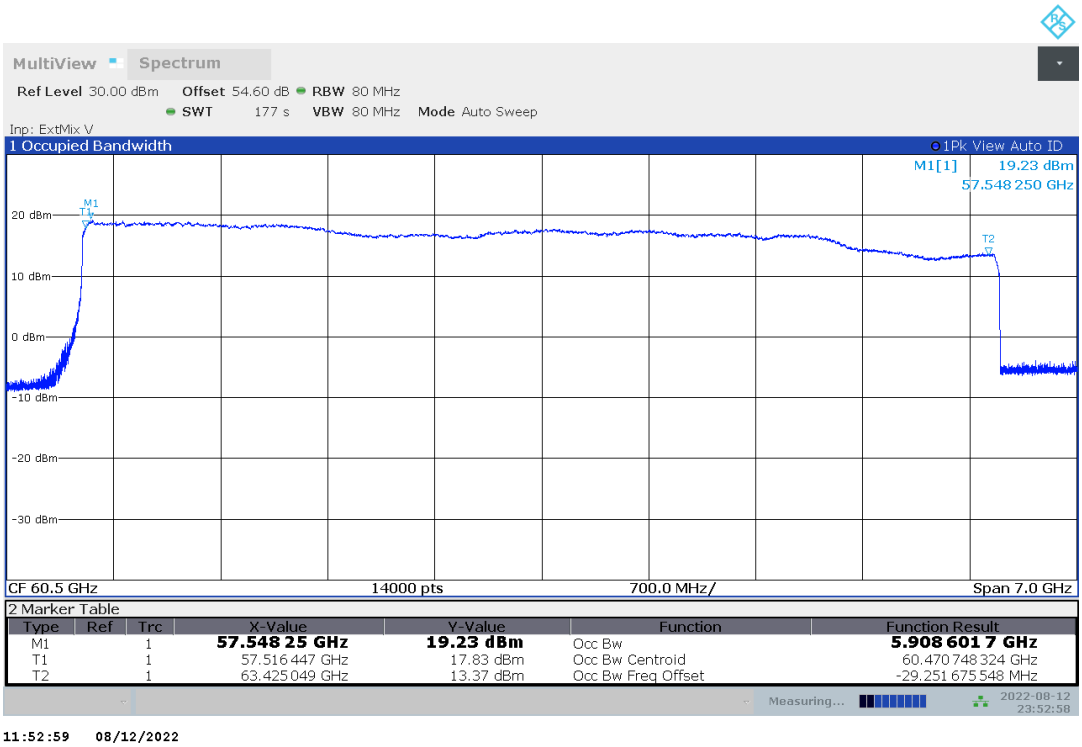
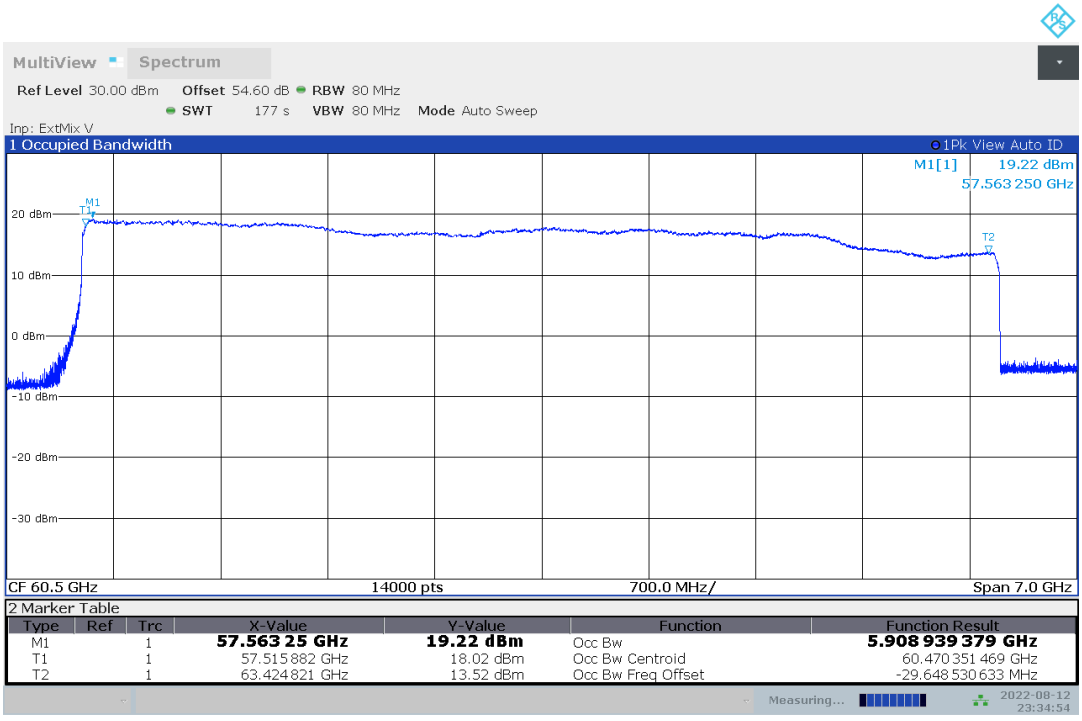
Plot no. 56: 99% OBW, Peak detector, +20 °C, $V_{min,}$ 6 GHz bandwidth, channel 28



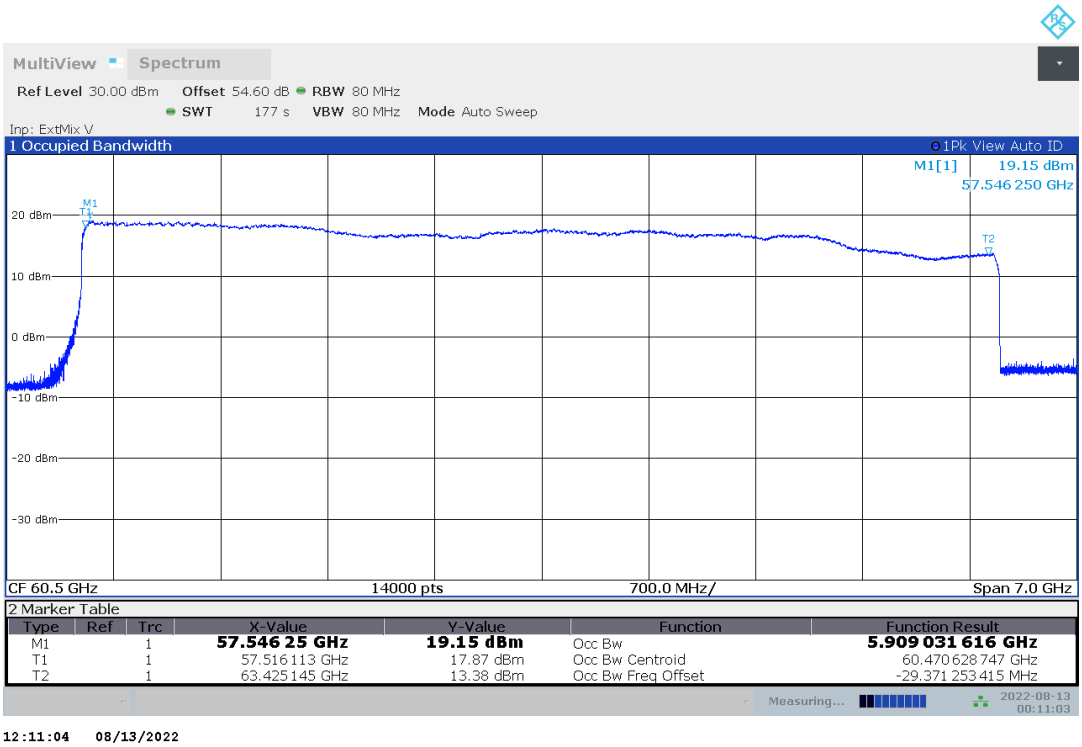
11:52:59 08/12/2022

Plot no. 57: 99% OBW, Peak detector, +20 °C, $V_{nom,}$ 6 GHz bandwidth, channel 28



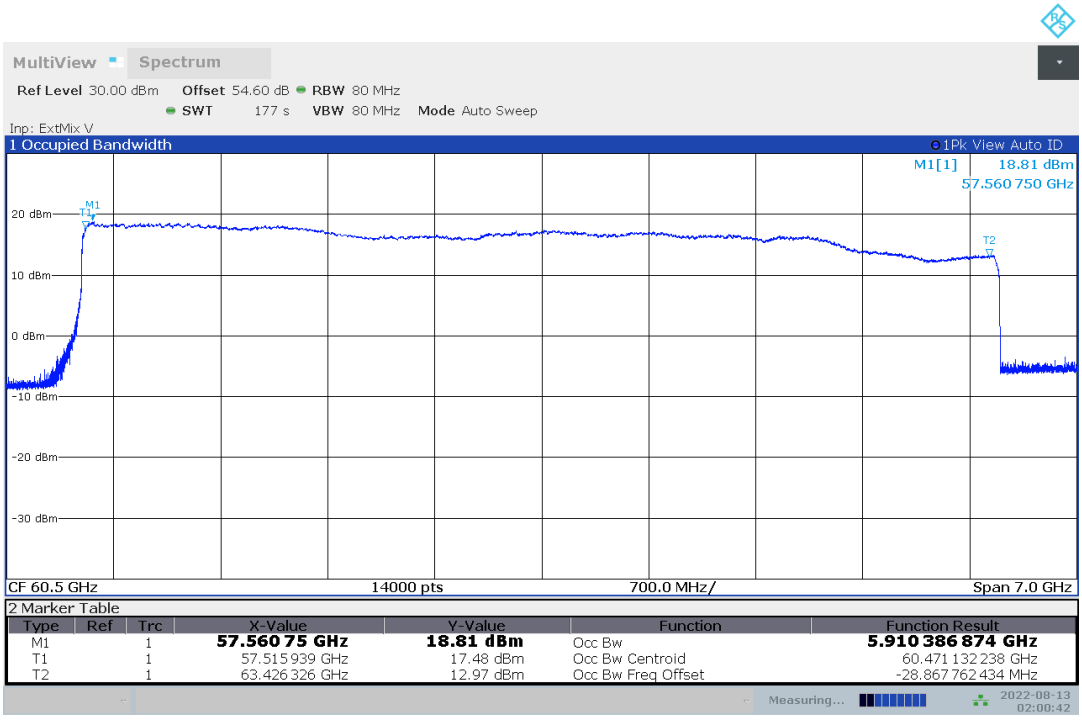
11:34:55 08/12/2022

Plot no. 58: 99% OBW, Peak detector, +20 °C, V_{max}, 6 GHz bandwidth, channel 28



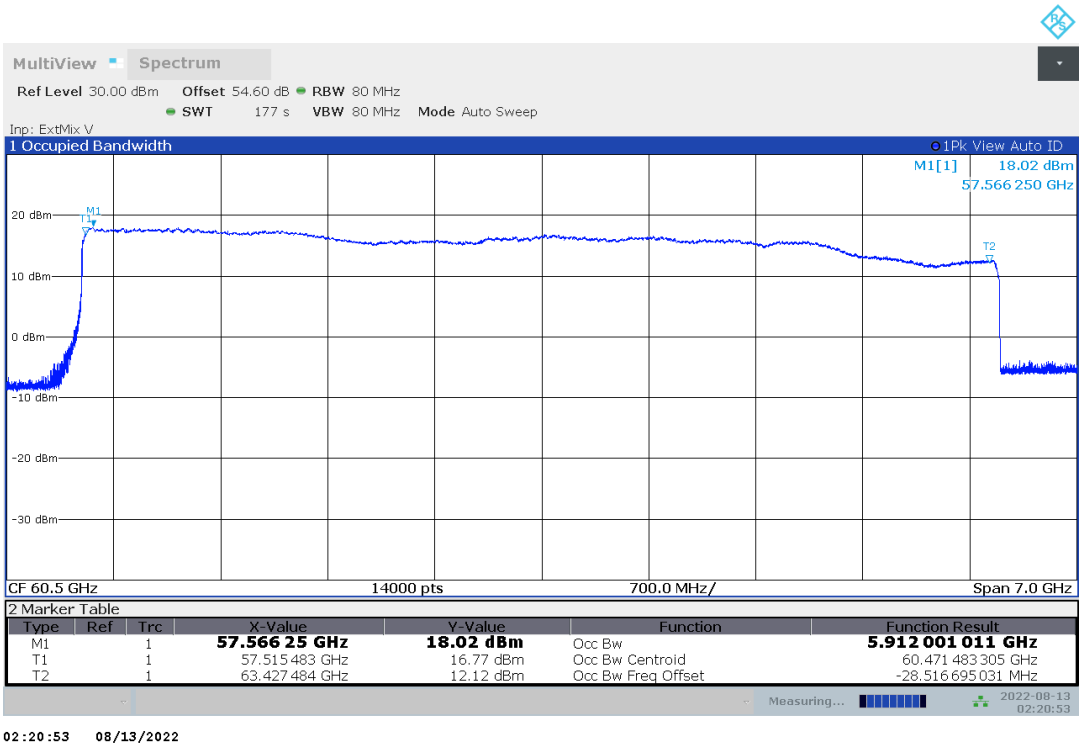
12:11:04 08/13/2022

Plot no. 59: 99% OBW, Peak detector, +30 °C, 6 GHz bandwidth, channel 28

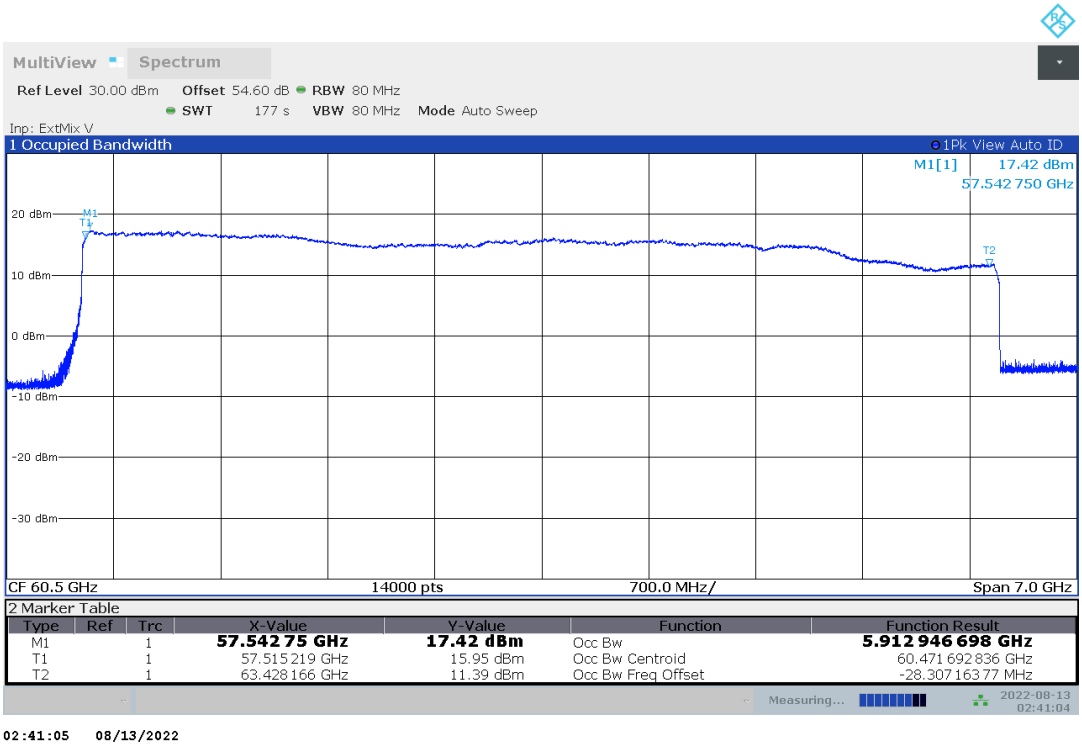


02:00:42 08/13/2022

Plot no. 60: 99% OBW, Peak detector, +40 °C, 6 GHz bandwidth, channel 28



Plot no. 61: 99% OBW, Peak detector, +50 °C, 6 GHz bandwidth, channel 28



7.4 Field strength of emissions (spurious and harmonics)

Description / Limits

RSS-210, J.3

§15.255 (d) (1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.

§15.255 (d) (2)

Radiated emissions below 40 GHz shall not exceed the general limits in § 15.209.:

Frequency	Field Strength	Measurement distance
0.009 – 0.490 MHz	2400/F[kHz] µV/m	300 m
0.490 – 1.705 MHz	24000/F[kHz] µV/m	30 m
1.705 – 30.0 MHz	30.0 µV/m / 29.5 dBµV/m	30 m
30 – 88 MHz	100 µV/m / 40.0 dBµV/m	3 m
88 – 216 MHz	150 µV/m / 43.5 dBµV/m	3 m
216 – 960 MHz	200 µV/m / 46.0 dBµV/m	3 m
960 – 100 000 MHz	500 µV/m / 54.0 dBµV/m	3 m

§15.255 (d) (3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 at a distance of 3 meters.

§15.255 (d) (4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

Limit of Waiver:

30 MHz – 200 GHz: -51.3 dBm

Test procedure

§15.31 (c) Except as otherwise indicated in §15.256, for swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

§15.31 (m) Measurements on intentional radiators or receivers, other than TV broadcast 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:

Frequency range	Number of frequencies	Location
< 1MHz bandwidth	1	middle
1 – 10 MHz bandwidth	2	1 near bottom and 1 near top
> 10 MHz bandwidth	3	1 near bottom / middle / top

§15.35 (b) Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g.,see §§15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, e.g., the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

§15.35 (c) Unless otherwise specified, e.g., §§15.255(b), and 15.256(l)(5), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its

maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to Supplier's Declaration of Conformity.

Calculation of the far field distance (Rayleigh distance):
The aperture dimensions of these horn antennas shall be small enough so that the measurement distance in meters is equal to or greater than the Rayleigh distance (i.e. $R_m = 2D^2 / \lambda$), where D is the largest linear dimension (i.e. width or height) of the antenna aperture in m and λ is the free-space wavelength in meters at the frequency of measurement.

Antenna type	Frequency range [GHz]	D [m]	Highest frequency in use [GHz]	Far field distance R_m [m]
20240-20	18.0 – 26.5	0.0520	26.5	0.478
22240-20	26.5 – 40.0	0.0342	40	0.312
23240-20	33.0 – 50.0	0.0280	50	0.261
24240-20	40.0 – 60.0	0.0230	60	0.212
25240-20	50.0 – 75.0	0.0185	75	0.171
26240-20	60.0 – 90.0	0.0150	90	0.135
27240-20	75.0 – 110	0.0124	110	0.113
28240-20	90.0 – 140	0.0100	140	0.093
29240-20	110 – 170	0.0085	170	0.082
30240-20	140 – 220	0.0068	220	0.068

Used test distances

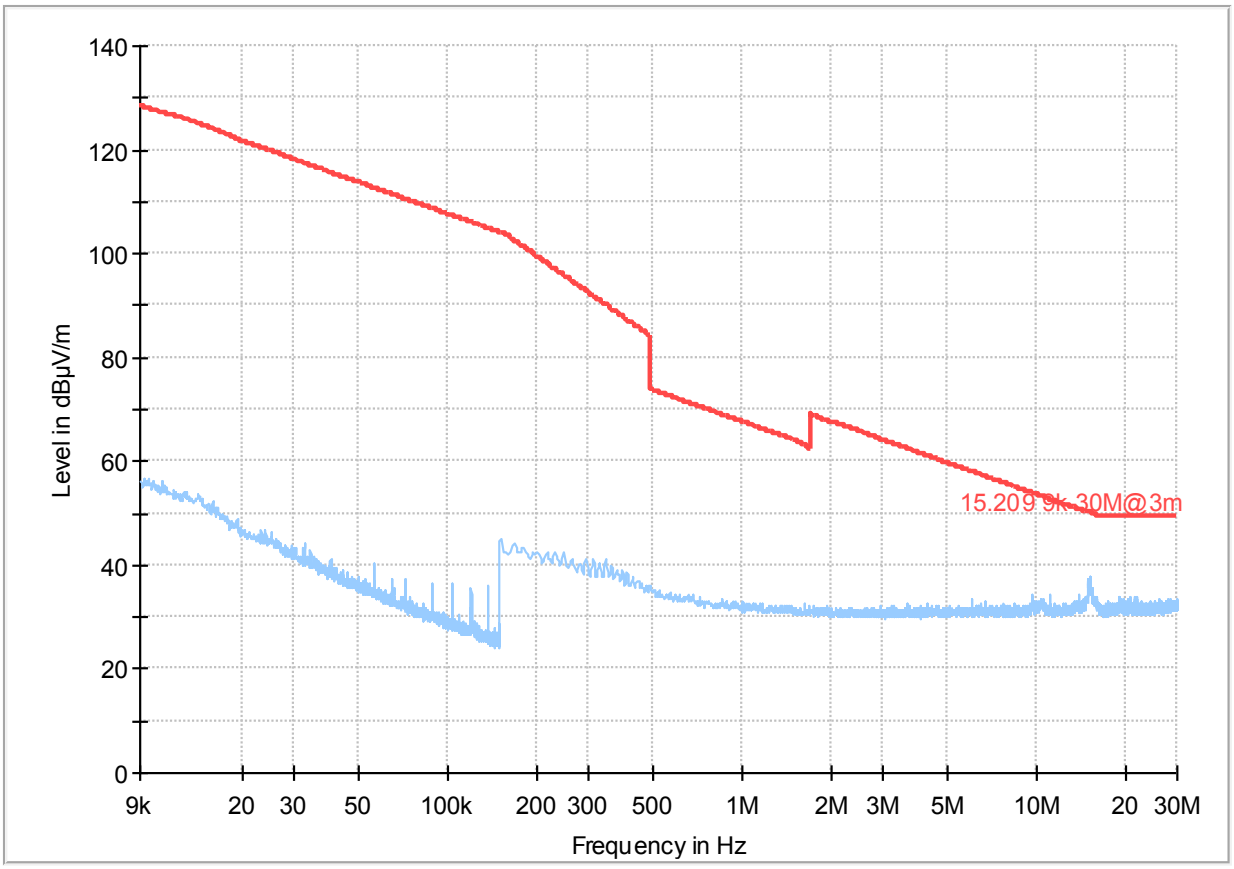
Up to 18 GHz: 3.00 m
18 – 40 GHz: 1.00 m
40 – 50 GHz: 0.35 m
50 – 60 GHz: 0.25 m
50 – 75 GHz: 0.5 m
75 – 90 GHz: 0.2 m
90 – 140 GHz: 0.5 m
140 – 200 GHz: 0.1 m

Test setup: 8.1 – 8.4

Test results:

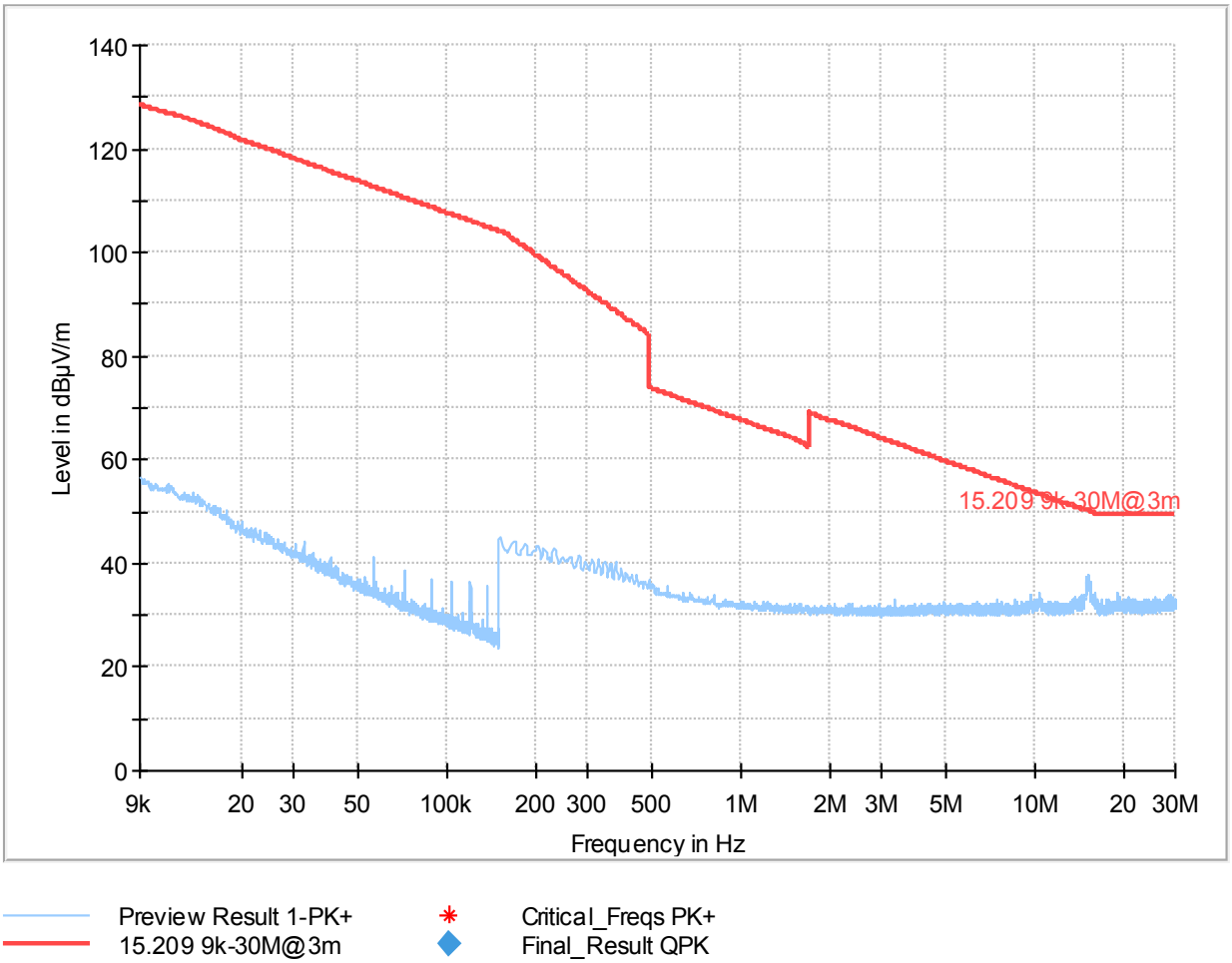
Channel / Mode	Frequency [GHz]	Detector	Test distance [m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
No critical emissions found, please refer to plots.						

Plot no. 62: radiated emissions 9 kHz – 30 MHz, loop antenna, cw low



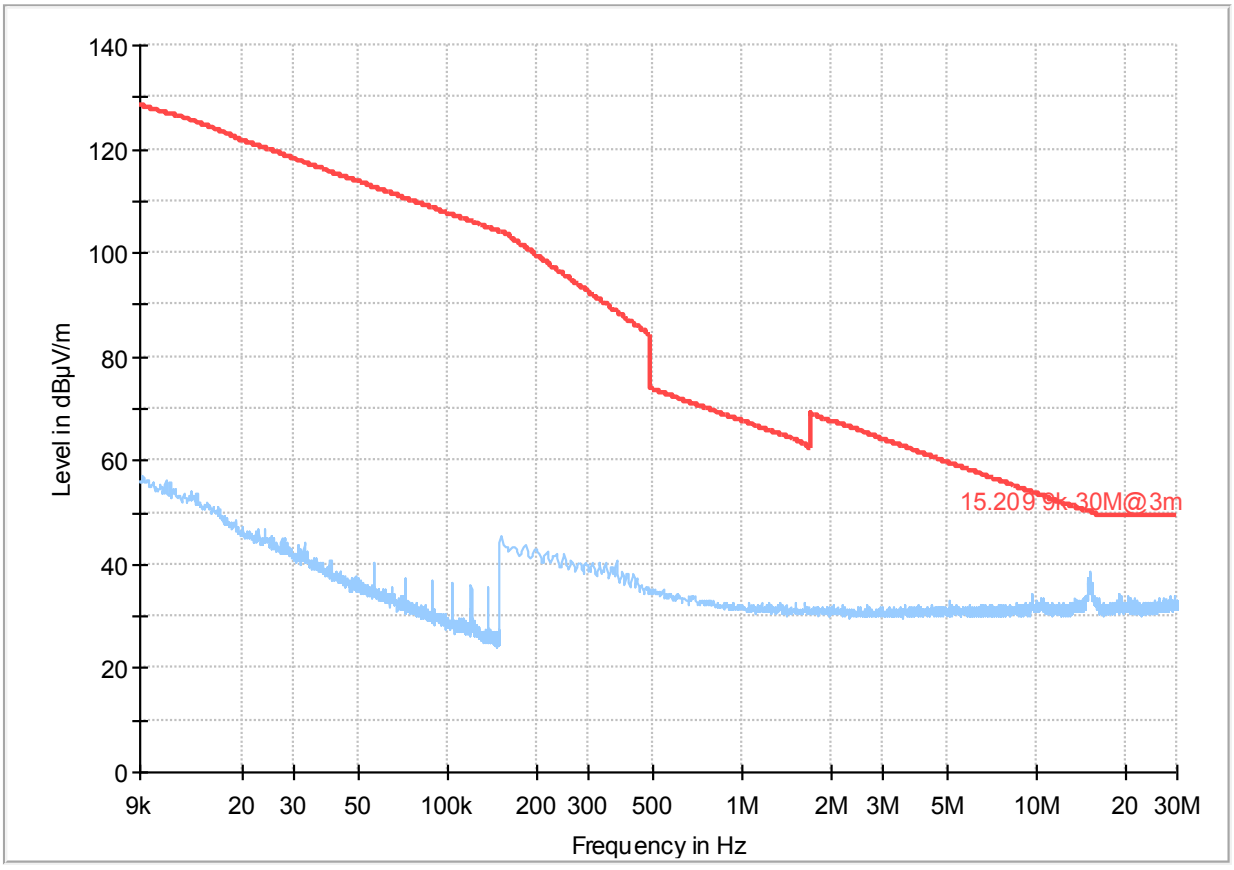
Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X KHz resulted in a level of Y dBuV/m, which is equivalent to Y - 51.5 = Z dBuA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.

Plot no. 63: radiated emissions 9 kHz – 30 MHz, loop antenna, cw mid



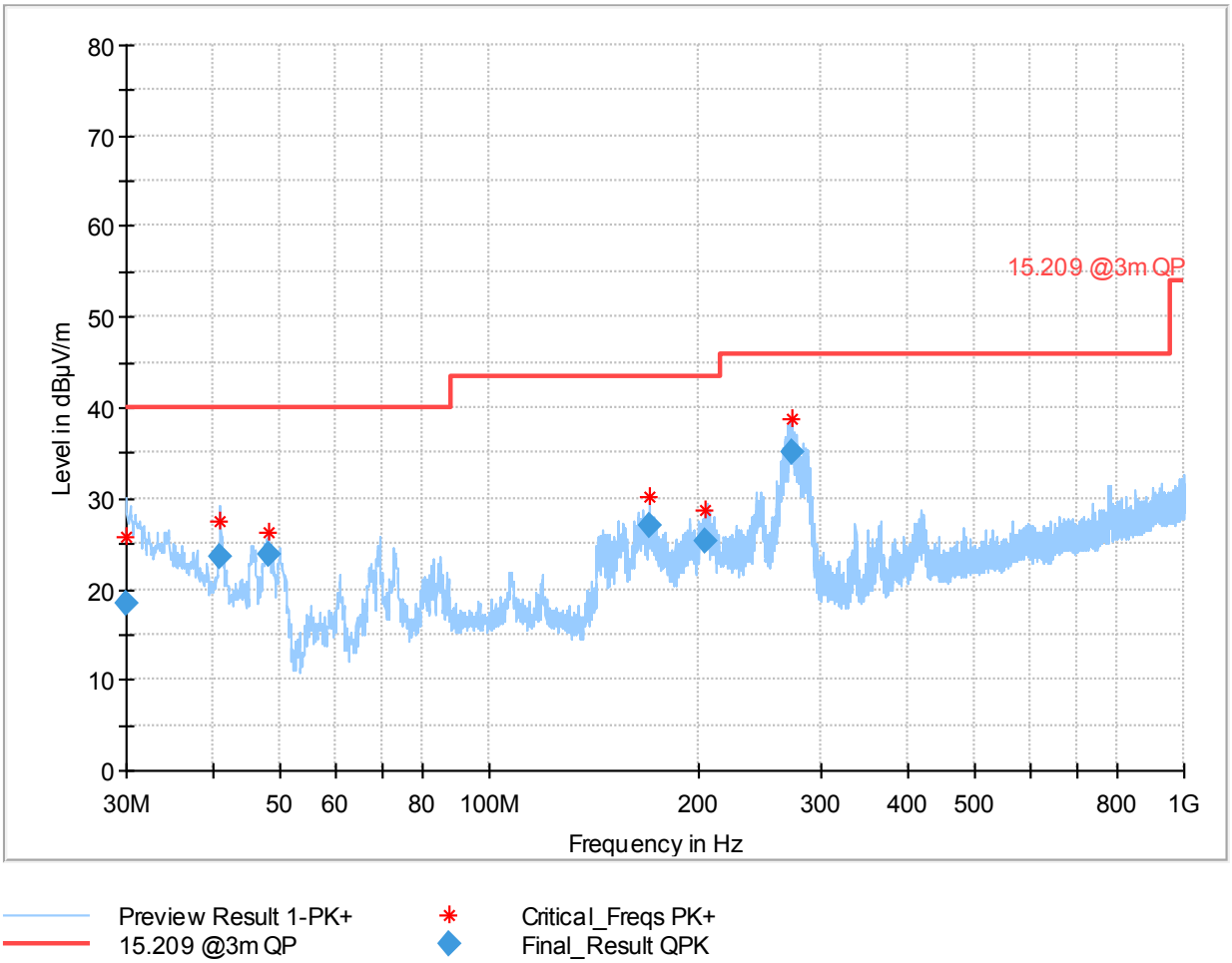
Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X KHz resulted in a level of Y dBuV/m, which is equivalent to Y - 51.5 = Z dBuA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.

Plot no. 64: radiated emissions 9 kHz – 30 MHz, loop antenna, cw high



Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X KHz resulted in a level of Y dBuV/m, which is equivalent to Y - 51.5 = Z dBuA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.

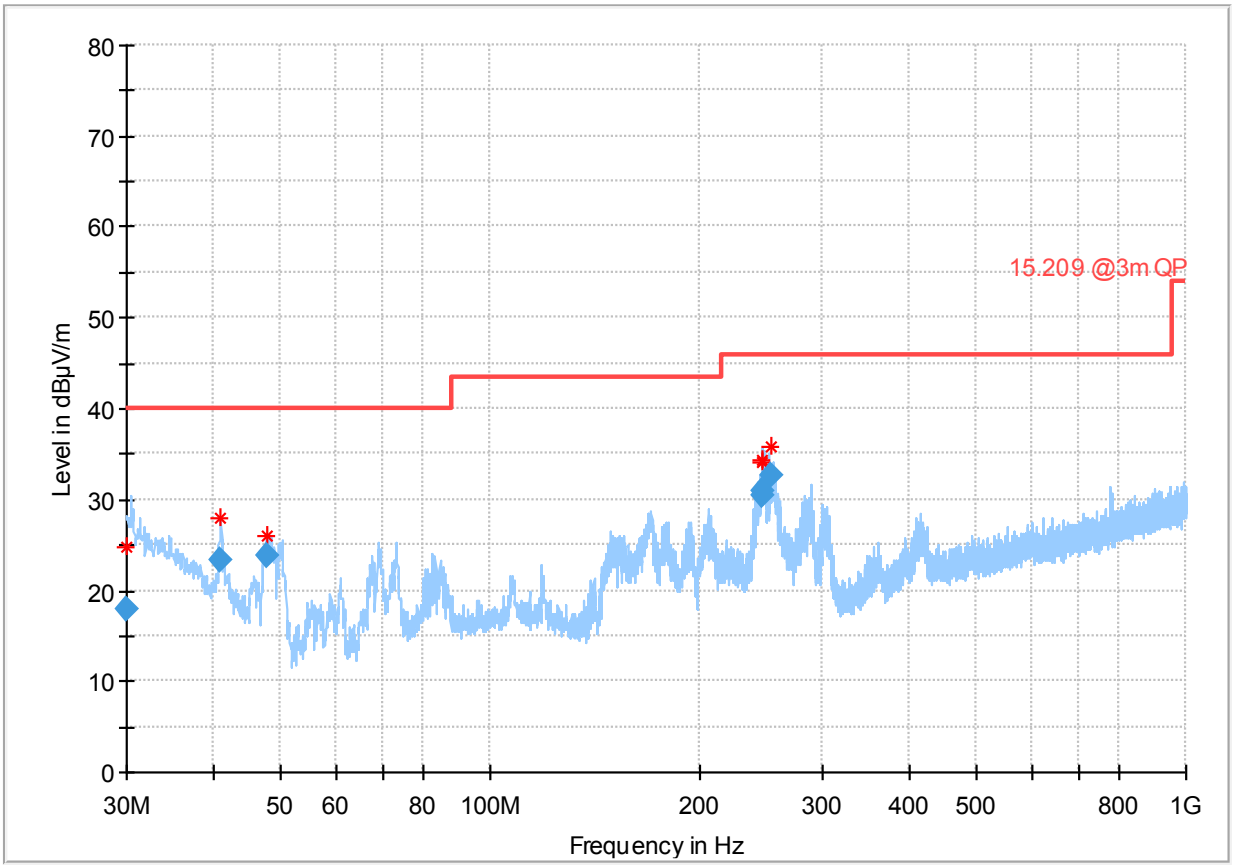
Plot no. 65: radiated emissions 30 MHz – 1 GHz, hor./vert. polarization, cw low



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.100000	18.32	40.00	21.68	100.0	120.000	146.0	V	278.0
40.987500	23.63	40.00	16.37	100.0	120.000	150.0	V	21.0
47.970000	23.77	40.00	16.23	100.0	120.000	100.0	V	23.0
170.075500	26.90	43.50	16.60	100.0	120.000	184.0	H	16.0
205.001000	25.27	43.50	18.23	100.0	120.000	100.0	V	-3.0
271.988500	35.18	46.00	10.82	100.0	120.000	103.0	H	196.0

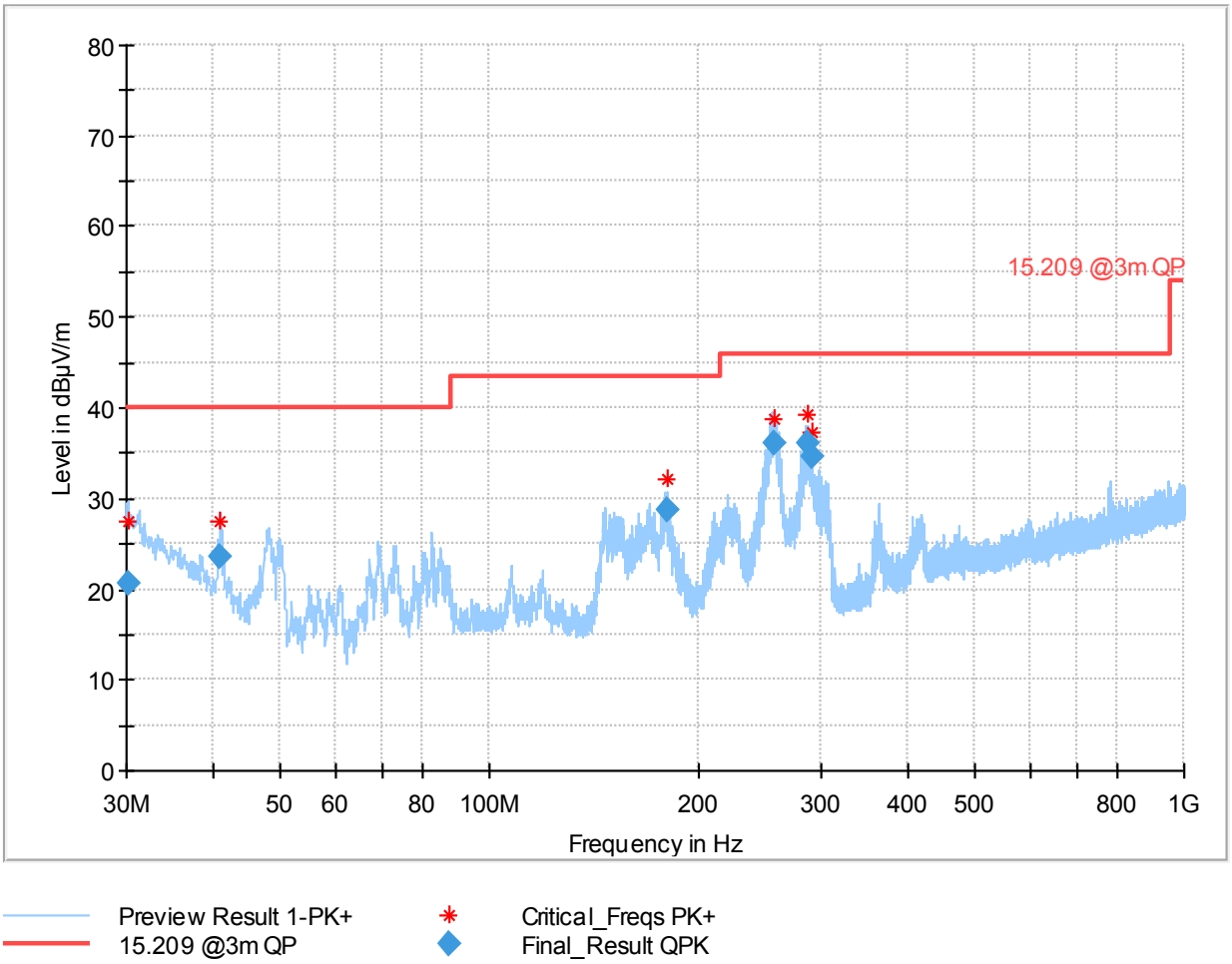
Plot no. 66: radiated emissions 30 MHz – 1 GHz, hor./vert. polarization, cw mid



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.050000	17.84	40.00	22.16	100.0	120.000	150.0	V	23.0
40.961000	23.40	40.00	16.60	100.0	120.000	350.0	H	219.0
47.871500	23.90	40.00	16.10	100.0	120.000	103.0	V	191.0
245.863500	30.33	46.00	15.67	100.0	120.000	150.0	H	185.0
246.699500	30.92	46.00	15.08	100.0	120.000	100.0	H	203.0
252.578500	32.73	46.00	13.27	100.0	120.000	116.0	H	184.0

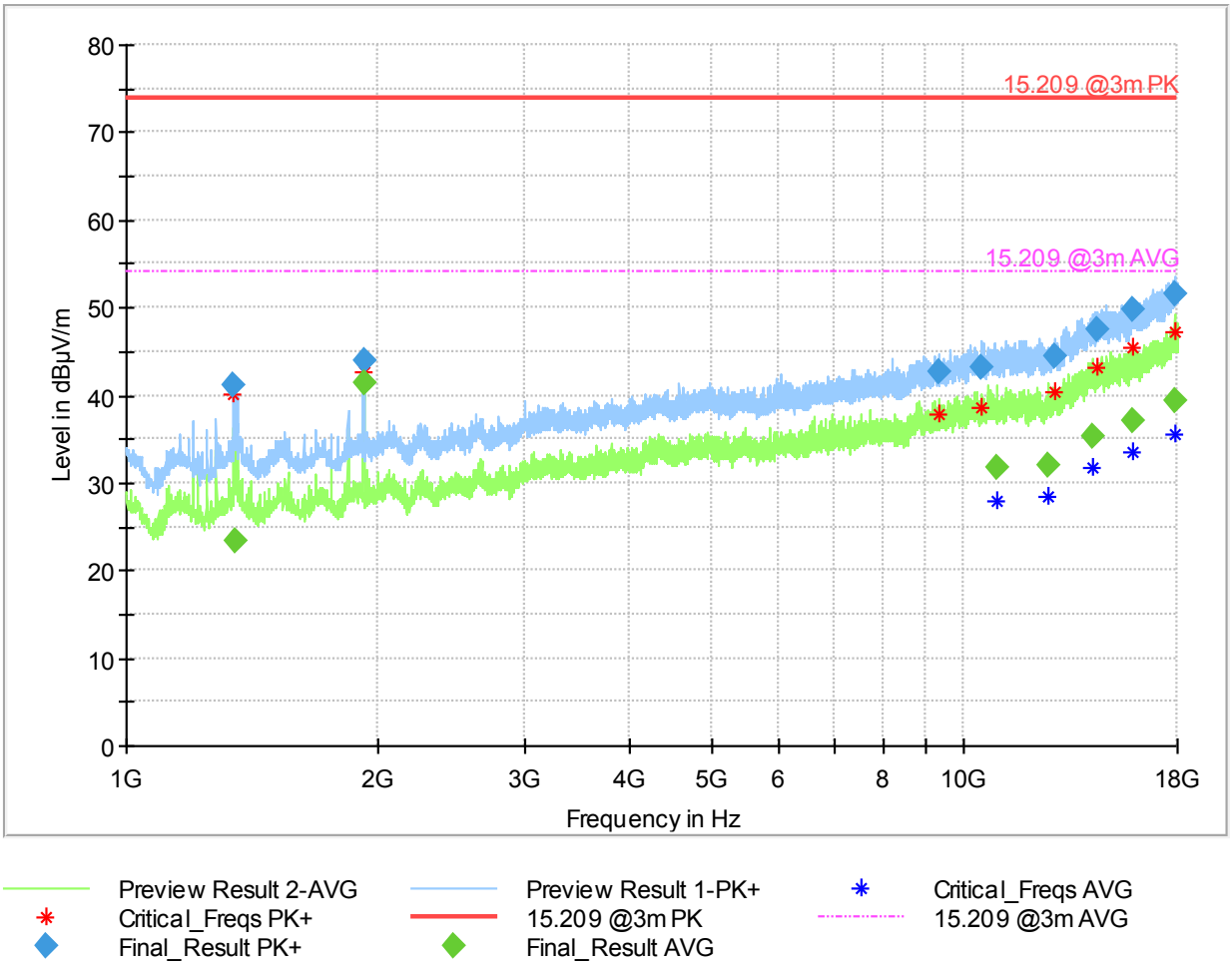
Plot no. 67: radiated emissions 30 MHz – 1 GHz, hor./vert. polarization, cw high



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.325000	20.64	40.00	19.36	100.0	120.000	104.0	V	179.0
40.961000	23.51	40.00	16.49	100.0	120.000	116.0	H	181.0
180.147000	28.77	43.50	14.73	100.0	120.000	150.0	H	8.0
256.291000	36.16	46.00	9.84	100.0	120.000	119.0	H	172.0
286.997000	36.03	46.00	9.97	100.0	120.000	103.0	H	208.0
290.521500	34.56	46.00	11.44	100.0	120.000	104.0	H	215.0

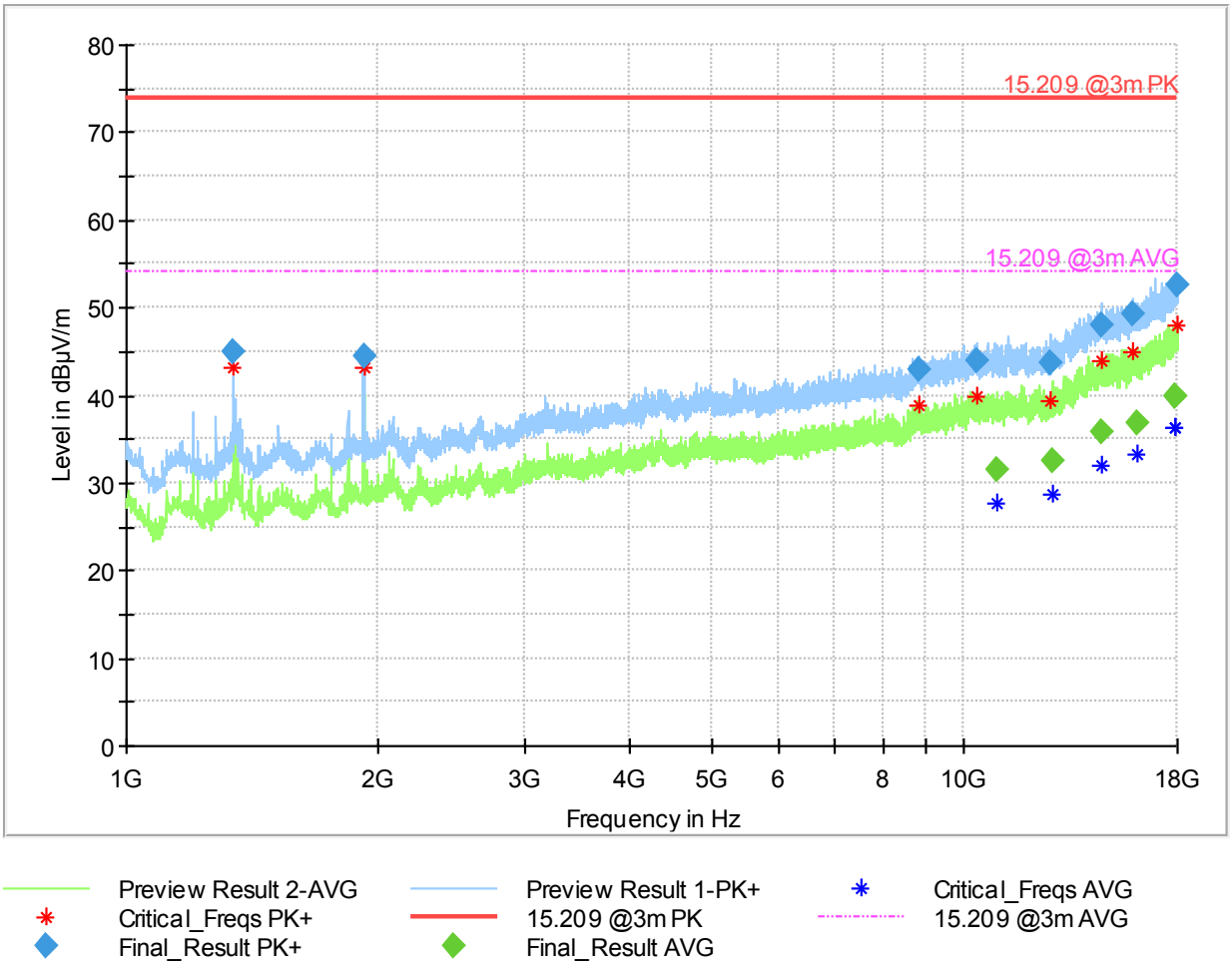
Plot no. 68: radiated emissions 1 GHz – 18 GHz, hor./vert. polarization, cw low



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1342.533333	41.16	---	74.00	32.84	100.0	1000.000	150.0	V
1349.969444	---	23.42	54.00	30.58	100.0	1000.000	150.0	V
1919.963889	43.99	---	74.00	30.01	100.0	1000.000	150.0	V
1919.963889	---	41.52	54.00	12.48	100.0	1000.000	150.0	V
9354.900000	42.59	---	74.00	31.41	100.0	1000.000	150.0	H
10512.444444	43.10	---	74.00	30.90	100.0	1000.000	150.0	V
10933.277778	---	31.69	54.00	22.31	100.0	1000.000	150.0	H
12616.097222	---	32.09	54.00	21.91	100.0	1000.000	150.0	H
12889.880556	44.32	---	74.00	29.68	100.0	1000.000	150.0	V
14281.377778	---	35.42	54.00	18.58	100.0	1000.000	150.0	V
14463.444444	47.54	---	74.00	26.46	100.0	1000.000	150.0	V
15958.861111	---	37.06	54.00	16.94	100.0	1000.000	150.0	H
15963.822222	49.87	---	74.00	24.13	100.0	1000.000	150.0	H
17835.666667	---	39.39	54.00	14.61	100.0	1000.000	150.0	V
17836.866667	51.60	---	74.00	22.40	100.0	1000.000	150.0	V

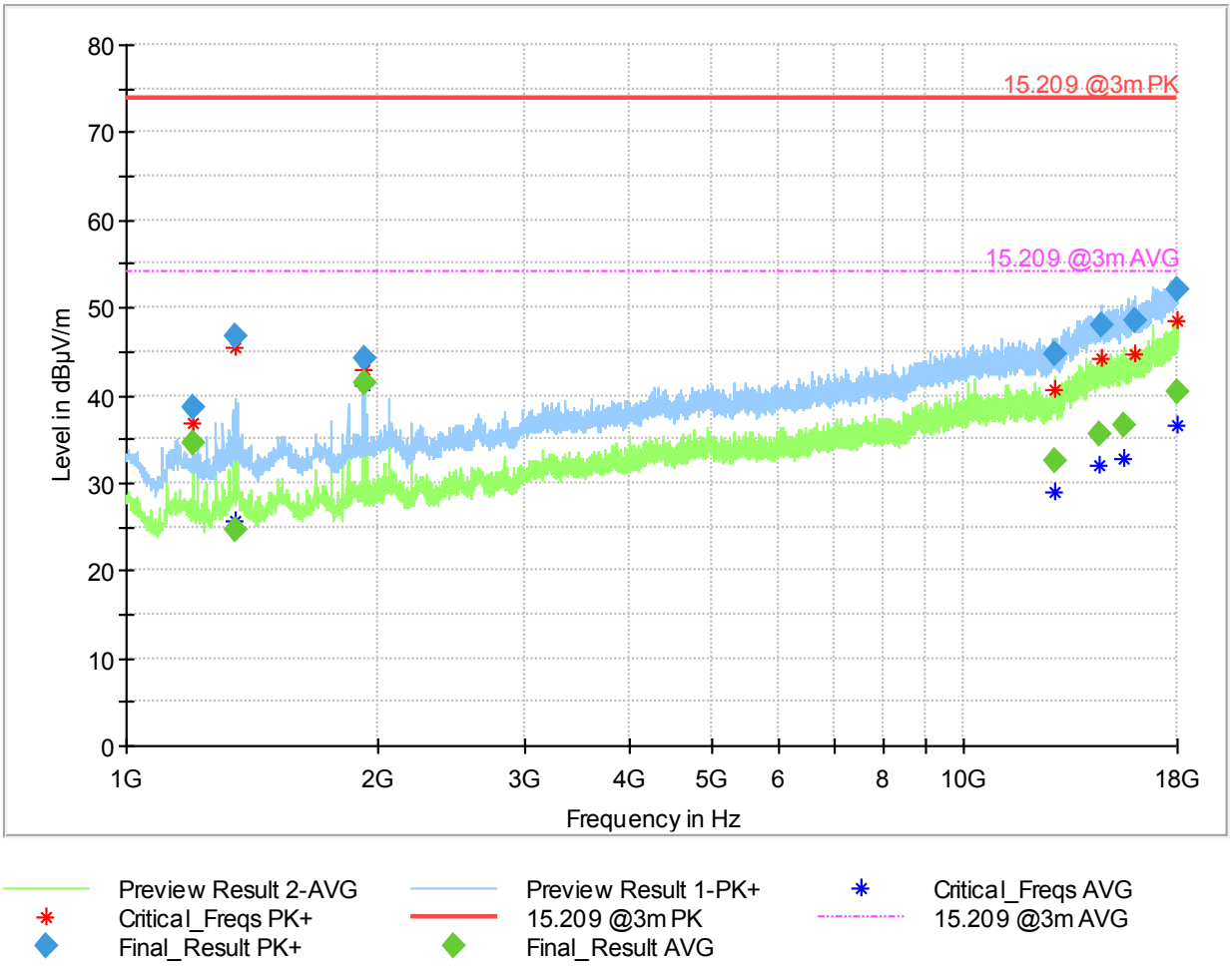
Plot no. 69: radiated emissions 1 GHz – 18 GHz, hor./vert. polarization, cw mid



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1342.533333	44.96	---	74.00	29.04	100.0	1000.000	150.0	H
1919.994444	44.55	---	74.00	29.45	100.0	1000.000	150.0	V
8851.422222	42.92	---	74.00	31.08	100.0	1000.000	150.0	V
10368.350000	43.90	---	74.00	30.10	100.0	1000.000	150.0	V
10962.555556	---	31.41	54.00	22.59	100.0	1000.000	150.0	V
12676.391667	43.74	---	74.00	30.26	100.0	1000.000	150.0	H
12809.663889	---	32.39	54.00	21.61	100.0	1000.000	150.0	V
14585.158333	47.93	---	74.00	26.07	100.0	1000.000	150.0	V
14587.108333	---	35.72	54.00	18.28	100.0	1000.000	150.0	V
15966.116667	49.25	---	74.00	24.75	100.0	1000.000	150.0	H
16077.305556	---	36.80	54.00	17.20	100.0	1000.000	150.0	V
17937.997222	---	39.91	54.00	14.09	100.0	1000.000	150.0	H
17938.072222	---	39.91	54.00	14.09	100.0	1000.000	150.0	H
17981.066667	52.64	---	74.00	21.36	100.0	1000.000	150.0	H

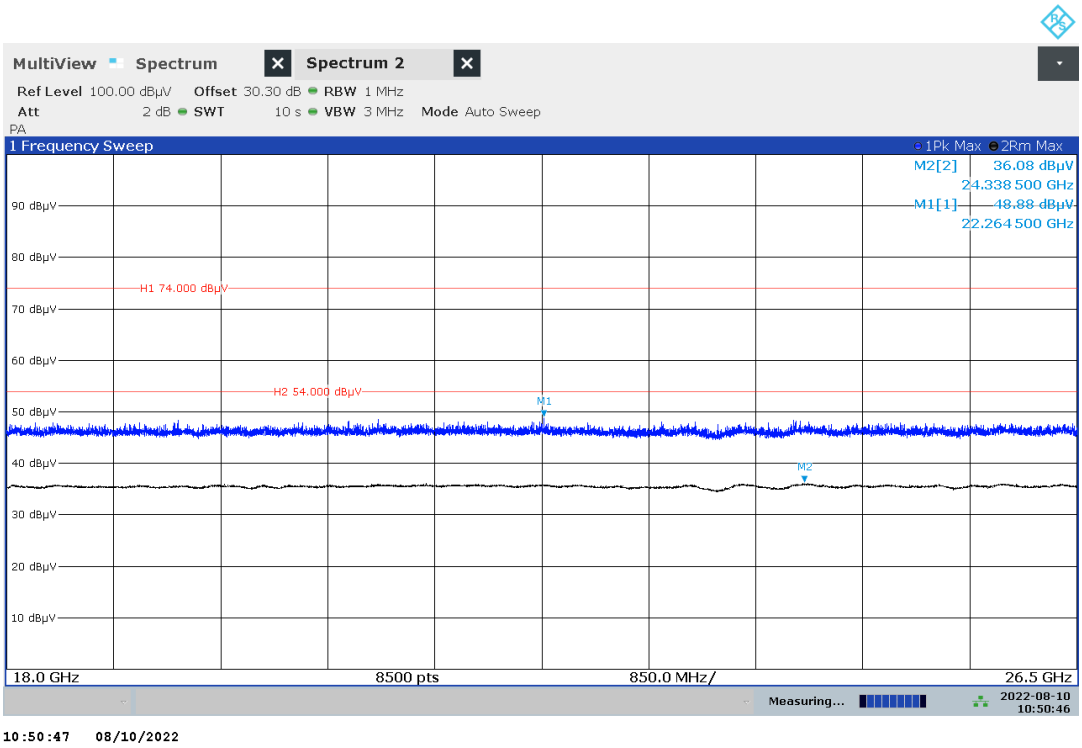
Plot no. 70: radiated emissions 1 GHz – 18 GHz, hor./vert. polarization, cw high



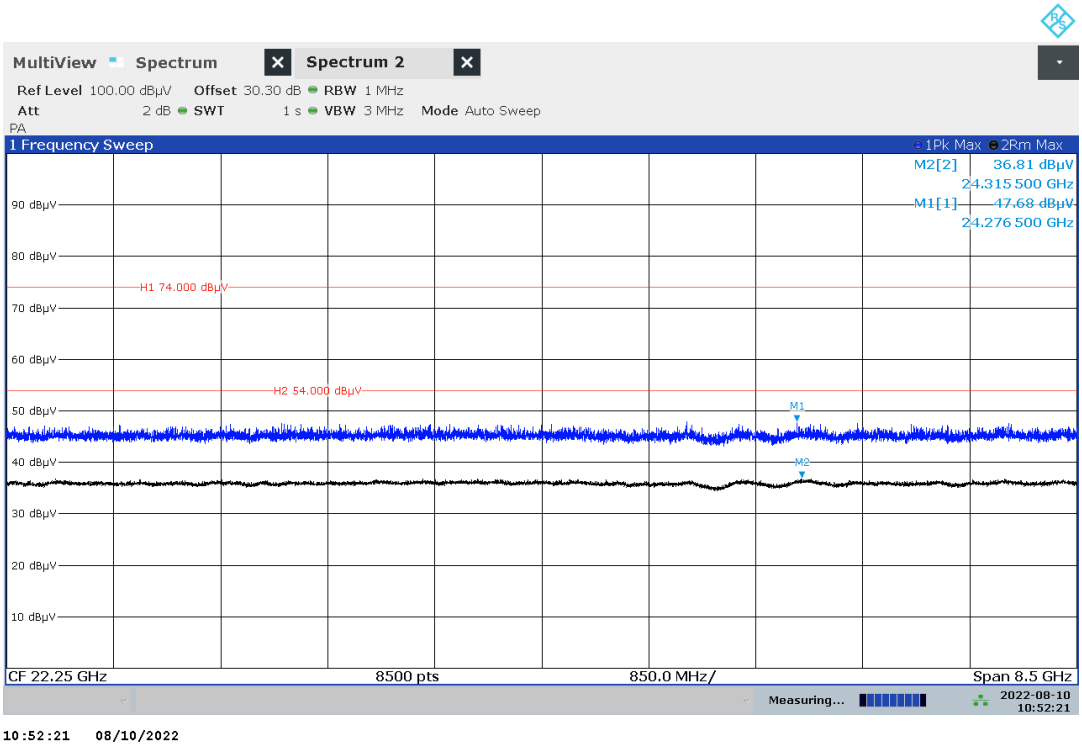
Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1200.027778	38.57	---	74.00	35.43	100.0	1000.000	150.0	V
1200.027778	---	34.60	54.00	19.40	100.0	1000.000	150.0	H
1349.969444	---	24.68	54.00	29.32	100.0	1000.000	150.0	H
1349.969444	46.81	---	74.00	27.19	100.0	1000.000	150.0	H
1919.963889	44.07	---	74.00	29.93	100.0	1000.000	150.0	V
1919.963889	---	41.36	54.00	12.64	100.0	1000.000	150.0	V
12828.702778	---	32.52	54.00	21.48	100.0	1000.000	150.0	H
12844.233333	44.82	---	74.00	29.18	100.0	1000.000	150.0	V
14537.127778	---	35.53	54.00	18.47	100.0	1000.000	150.0	V
14585.188889	48.12	---	74.00	25.88	100.0	1000.000	150.0	V
15552.375000	---	36.50	54.00	17.50	100.0	1000.000	150.0	V
16016.322222	48.60	---	74.00	25.40	100.0	1000.000	150.0	V
17978.683333	---	40.31	54.00	13.69	100.0	1000.000	150.0	H
17984.319444	52.14	---	74.00	21.86	100.0	1000.000	150.0	V

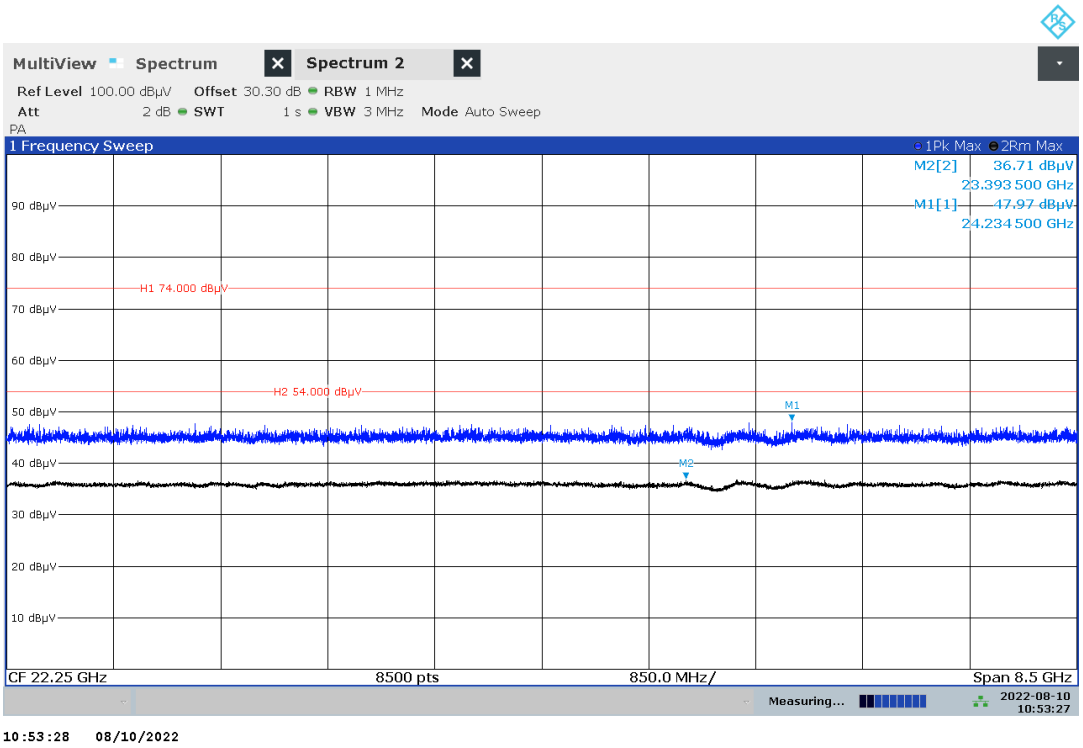
Plot no. 71: radiated emissions 18 GHz – 26.5 GHz, hor./vert. polarization, cw low



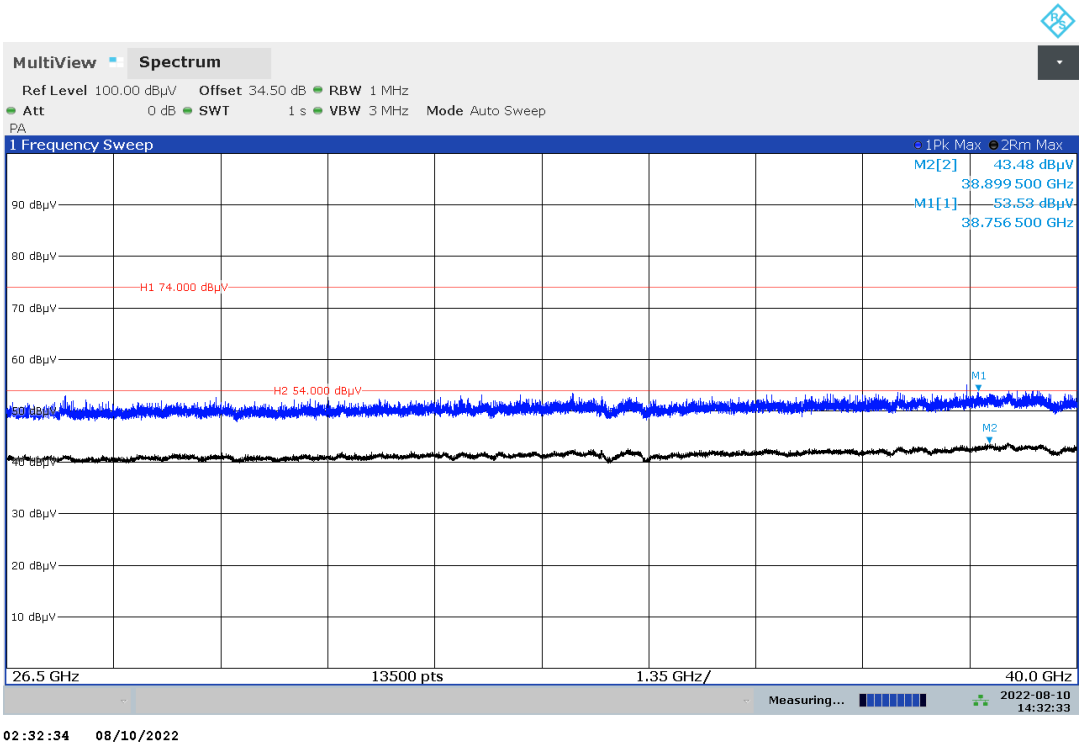
Plot no. 72: radiated emissions 18 GHz – 26.5 GHz, hor./vert. polarization, cw mid



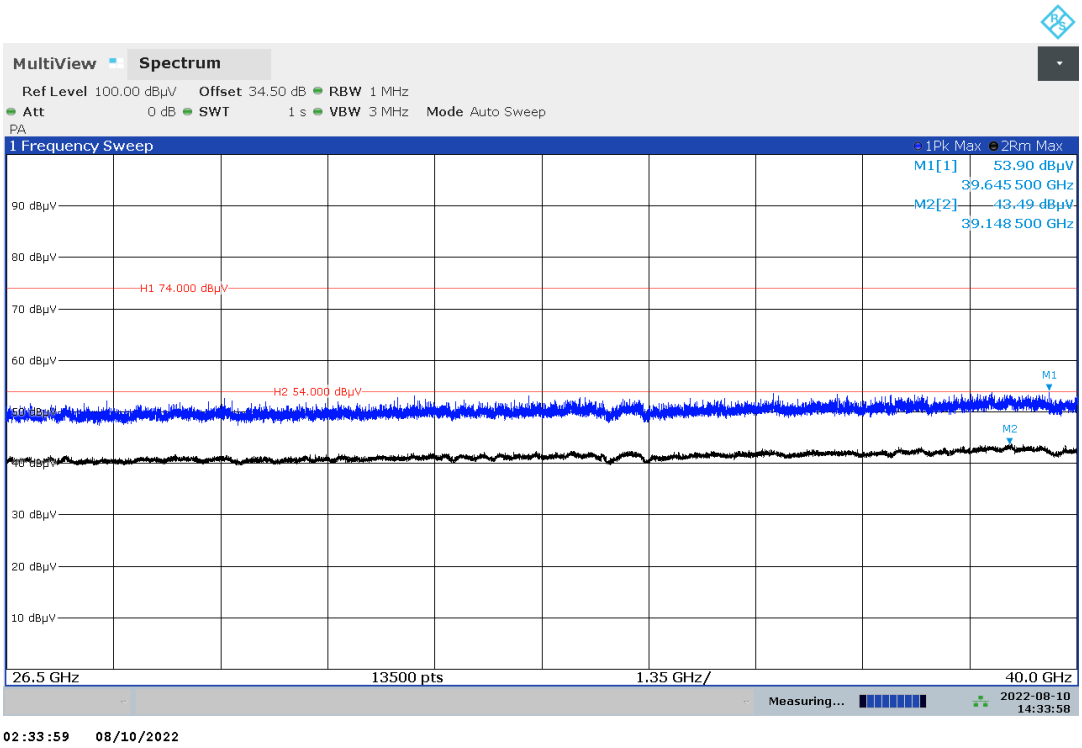
Plot no. 73: radiated emissions 18 GHz – 26.5 GHz, hor./vert. polarization, cw high



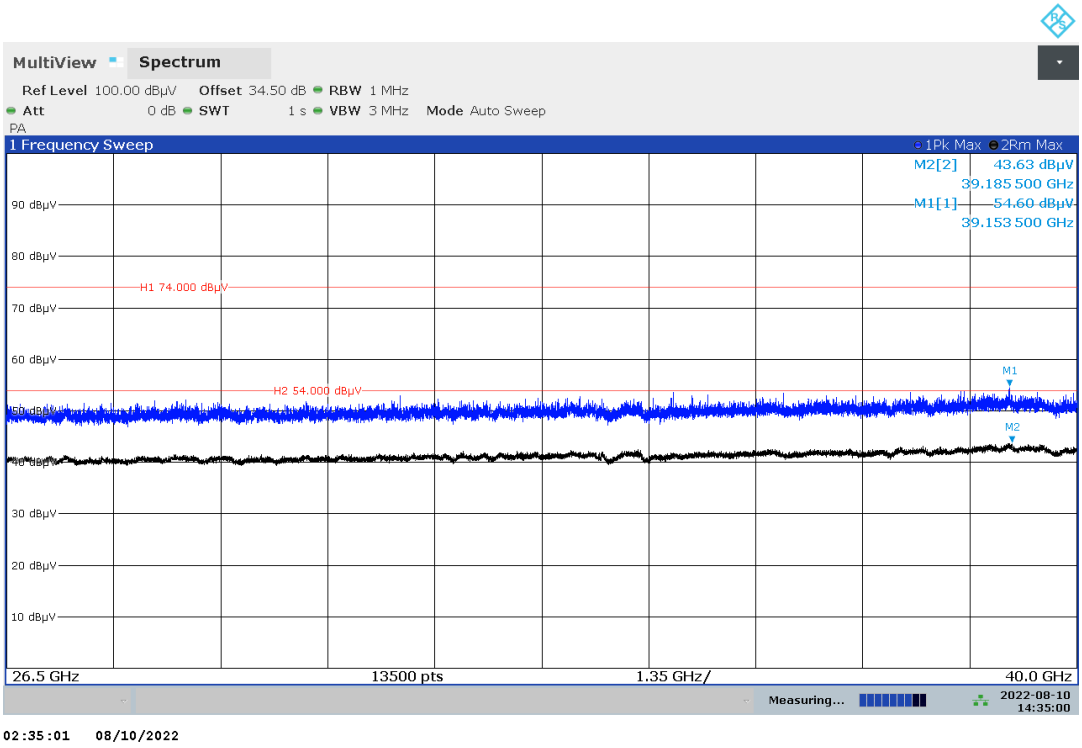
Plot no. 74: radiated emissions 26.5 GHz – 40 GHz, hor./vert. polarization, cw low



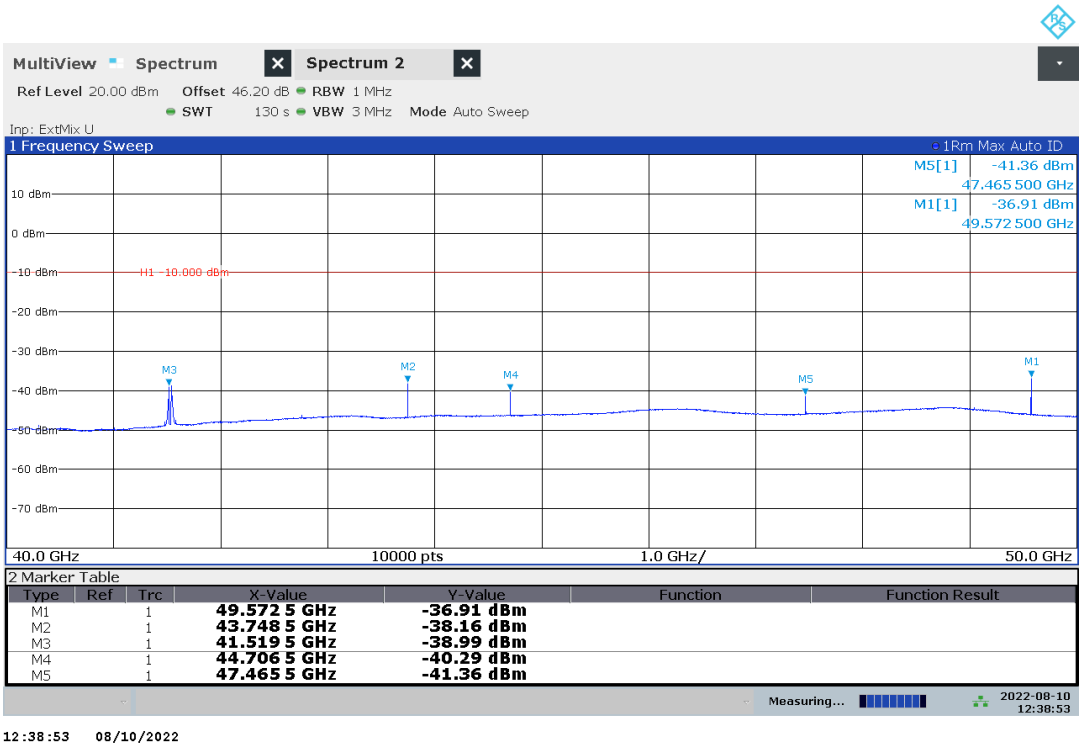
Plot no. 75: radiated emissions 26.5 GHz – 40 GHz, hor./vert. polarization, cw mid



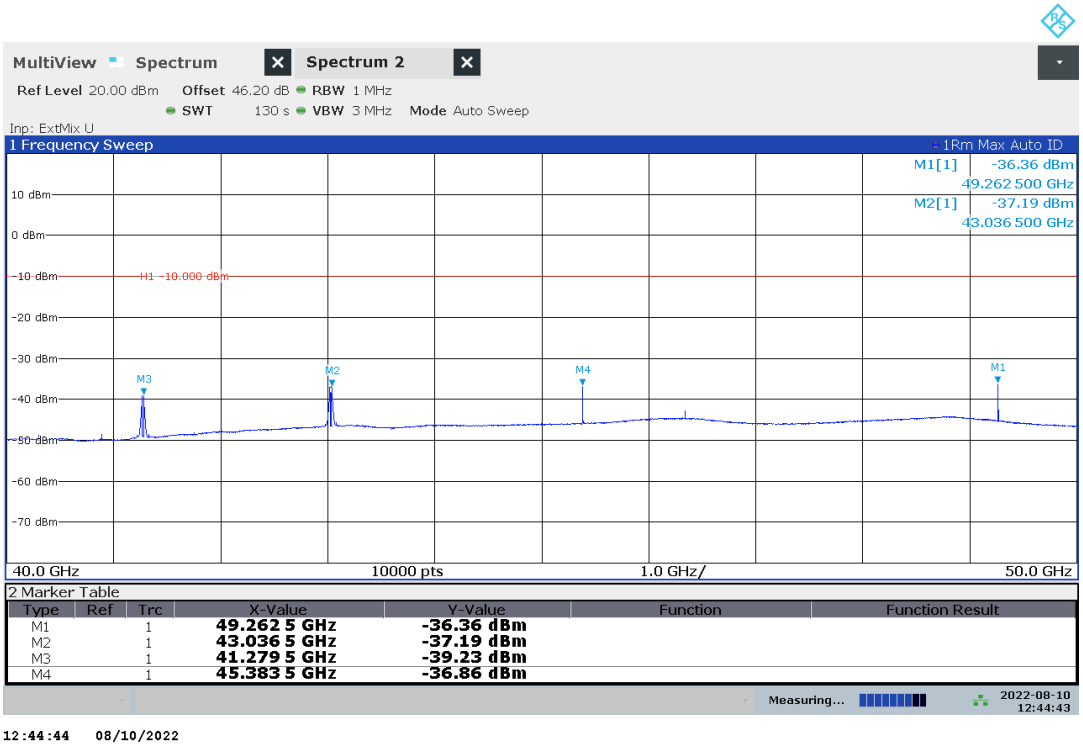
Plot no. 76: radiated emissions 26.5 GHz – 40 GHz, hor./vert. polarization, cw high



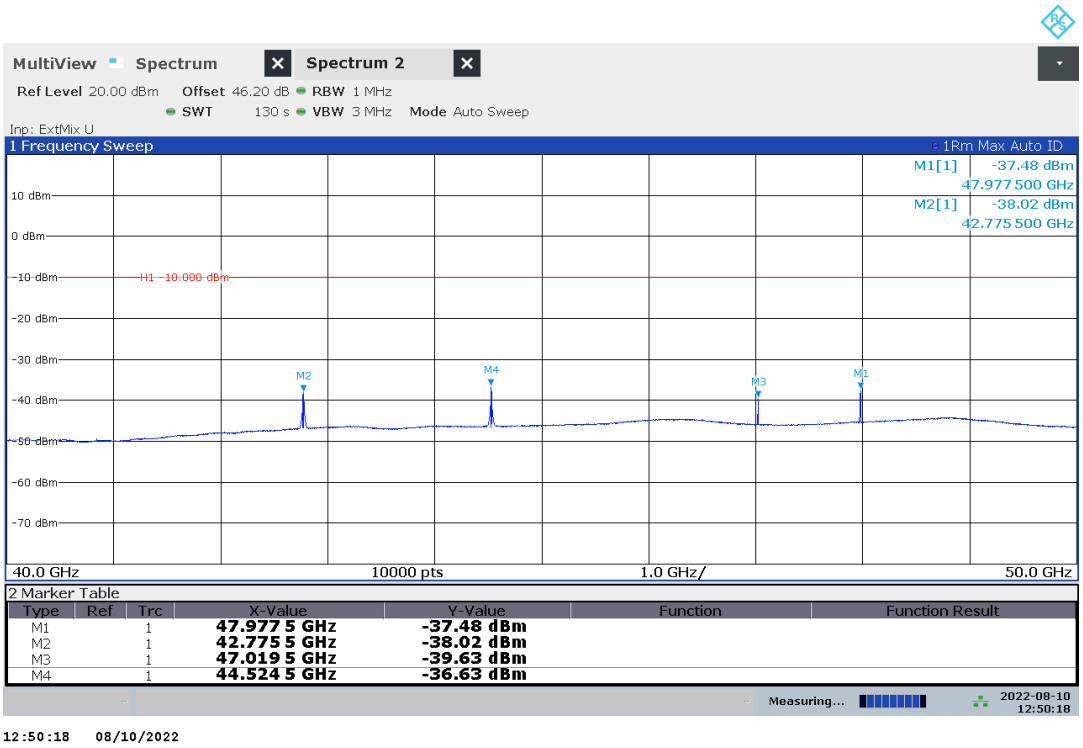
Plot no. 77: radiated emissions 40 GHz – 50 GHz, hor./vert. polarization, cw low



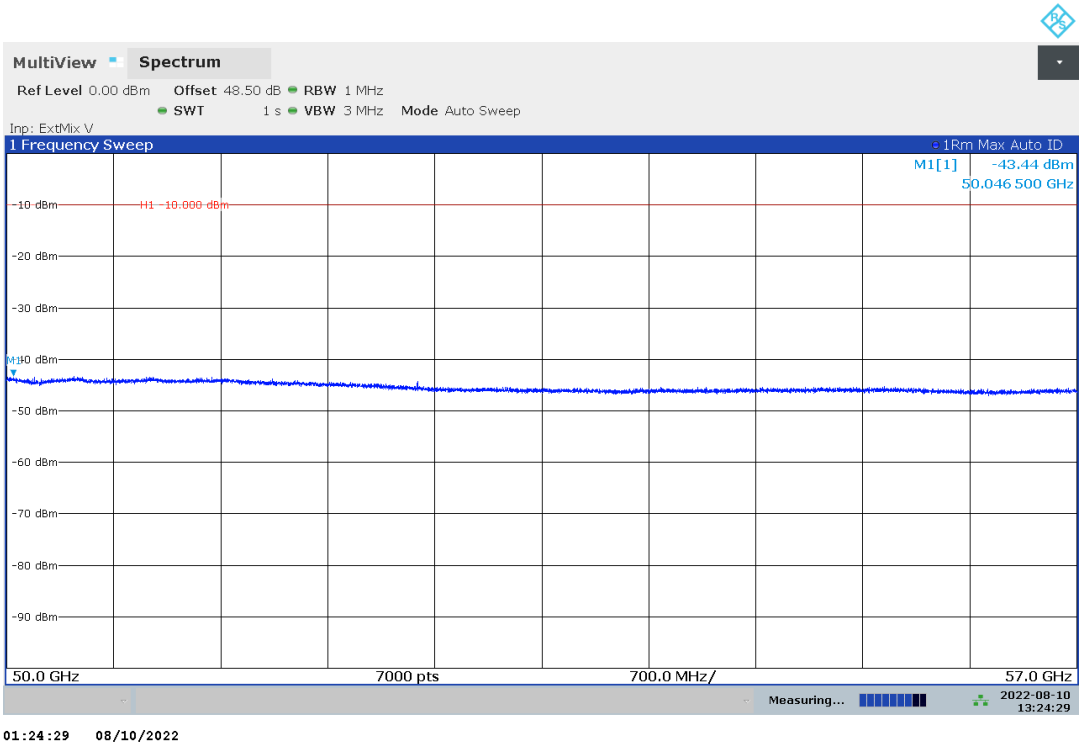
Plot no. 78: radiated emissions 40 GHz – 50 GHz, hor./vert. polarization, cw mid



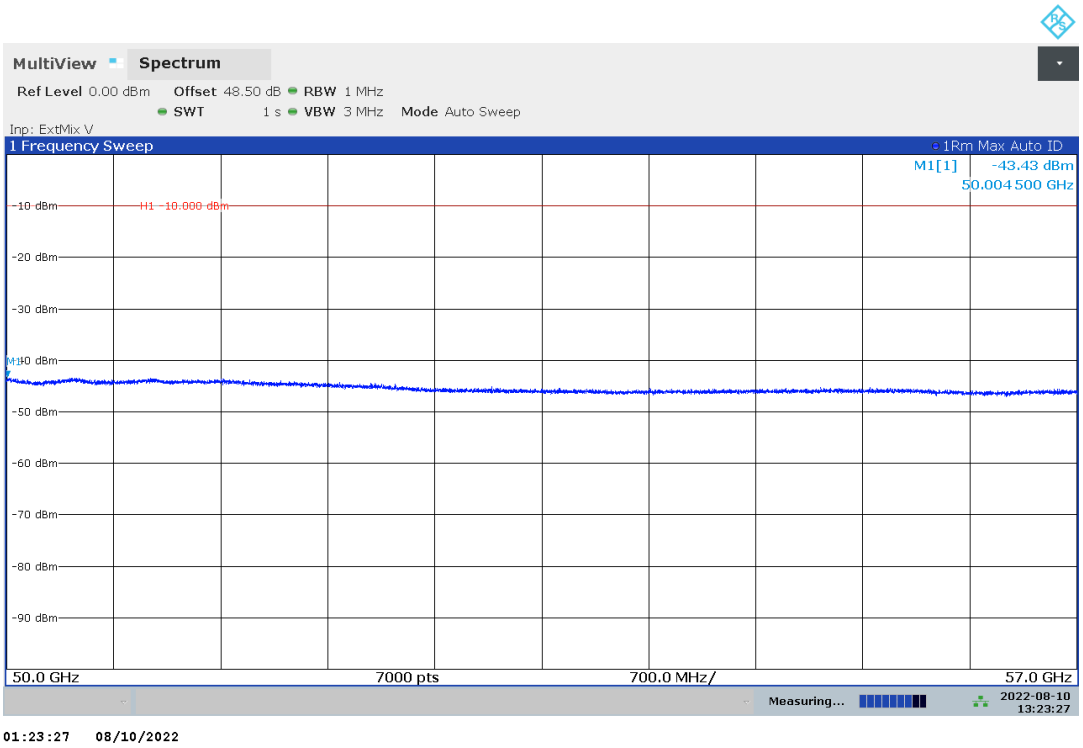
Plot no. 79: radiated emissions 40 GHz – 50 GHz, hor./vert. polarization, cw high



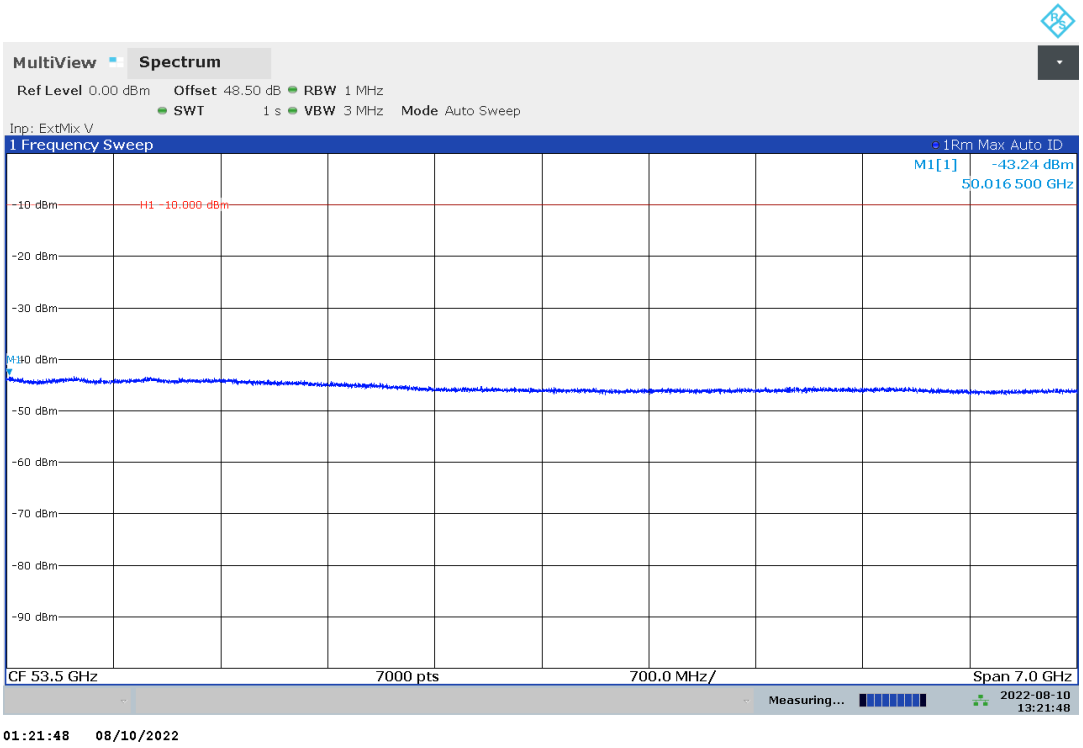
Plot no. 80: radiated emissions 50 GHz – 57 GHz, hor./vert. polarization, cw low



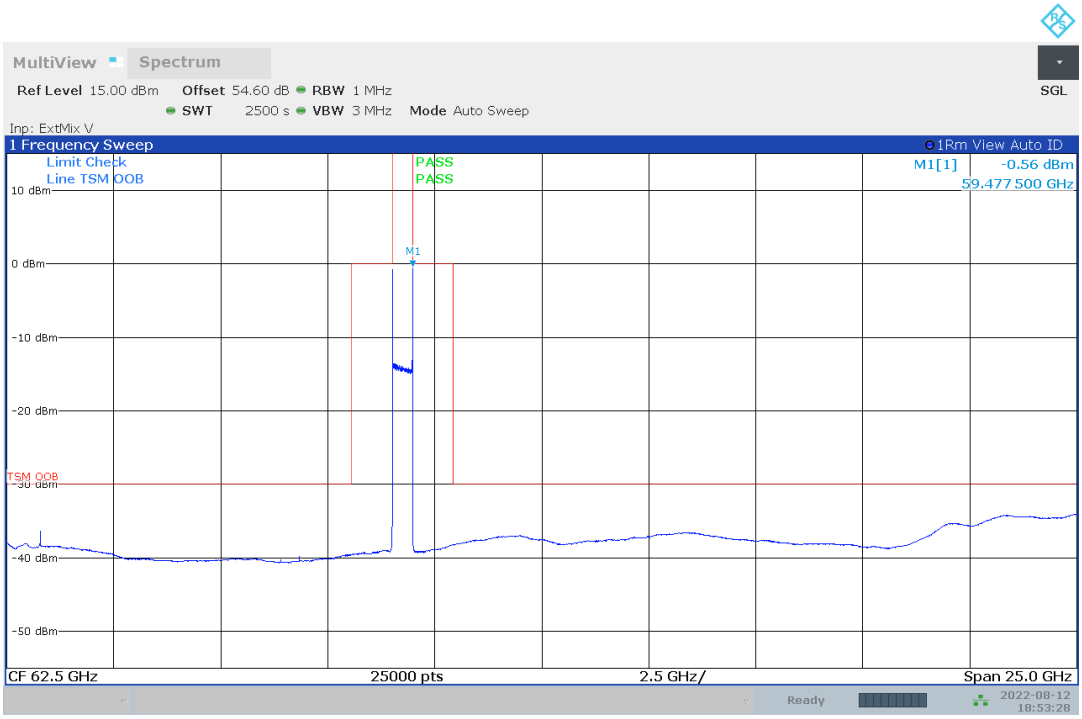
Plot no. 81: radiated emissions 50 GHz – 57 GHz, hor./vert. polarization, cw mid



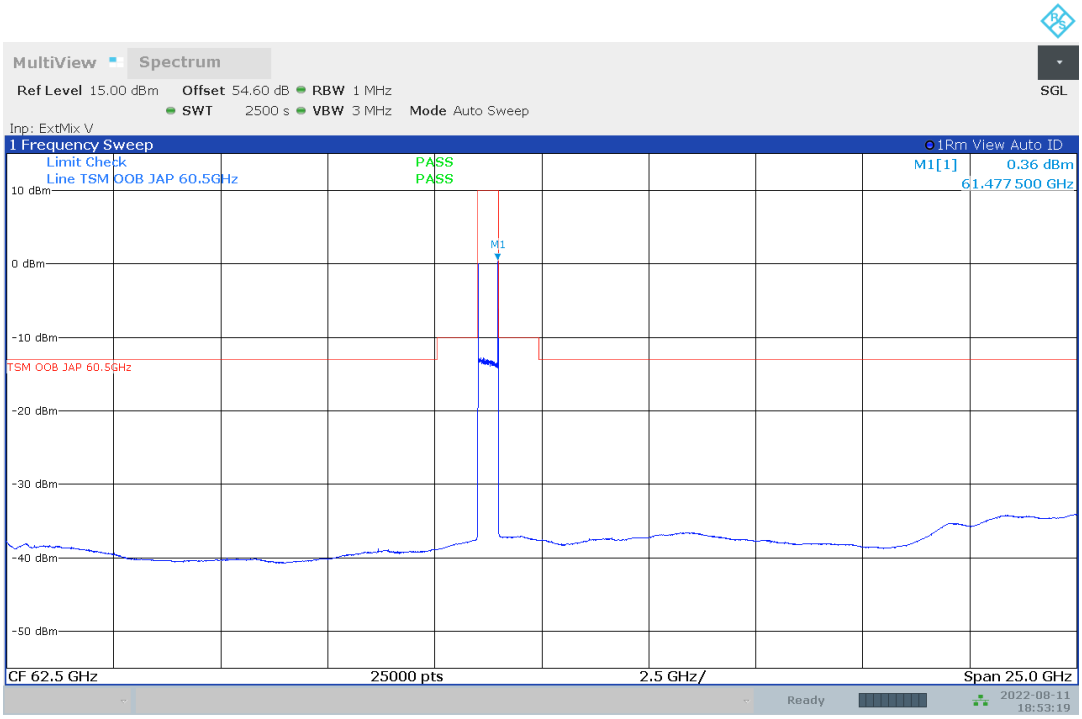
Plot no. 82: radiated emissions 50 GHz – 57 GHz, hor./vert. polarization, cw high



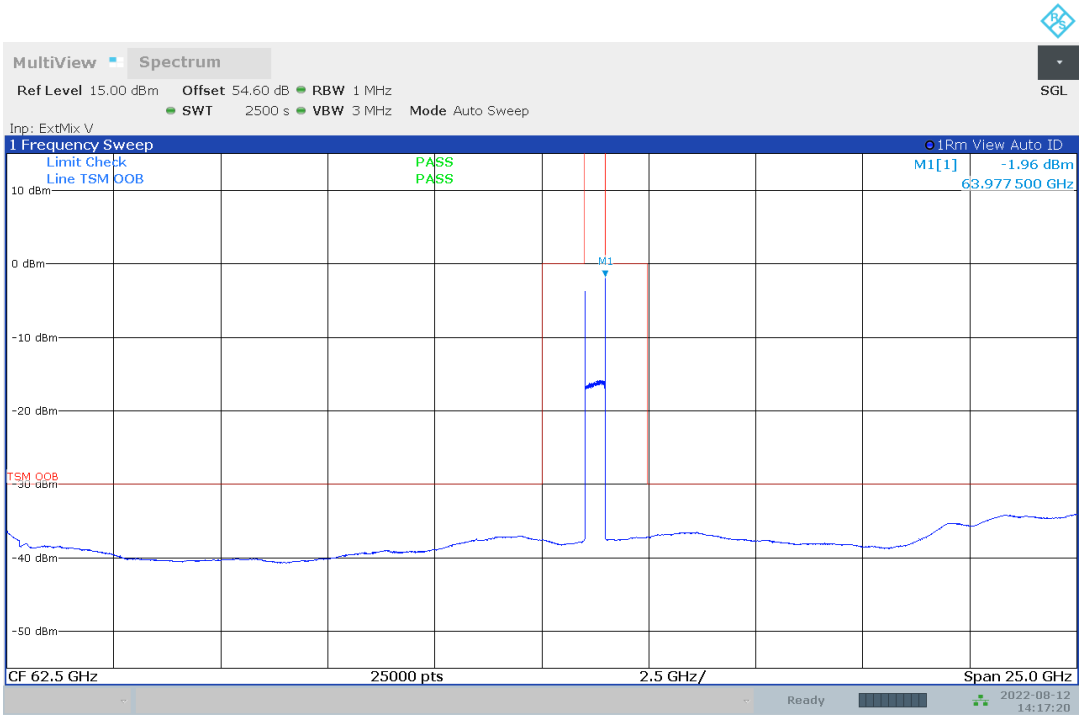
Plot no. 83: radiated emissions 50 GHz – 75 GHz, OOB hor./vert. polarization, band edge considerations Ch05



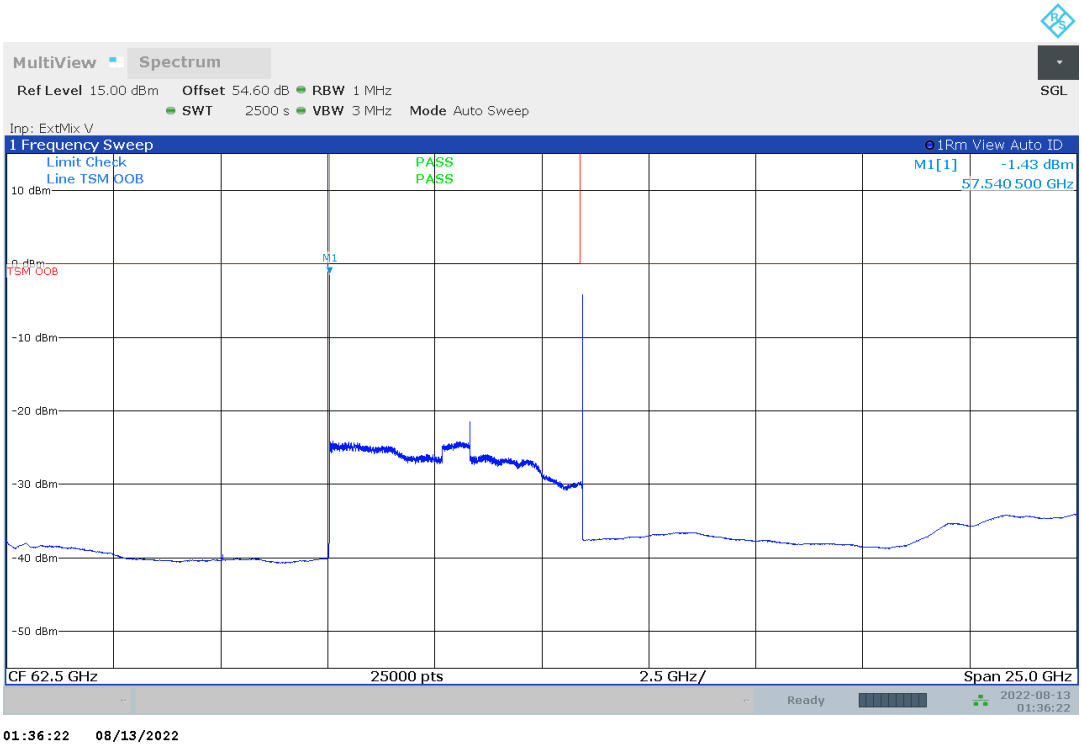
Plot no. 84: radiated emissions 50 GHz – 75 GHz, OOB hor./vert. polarization, band edge considerations Ch09



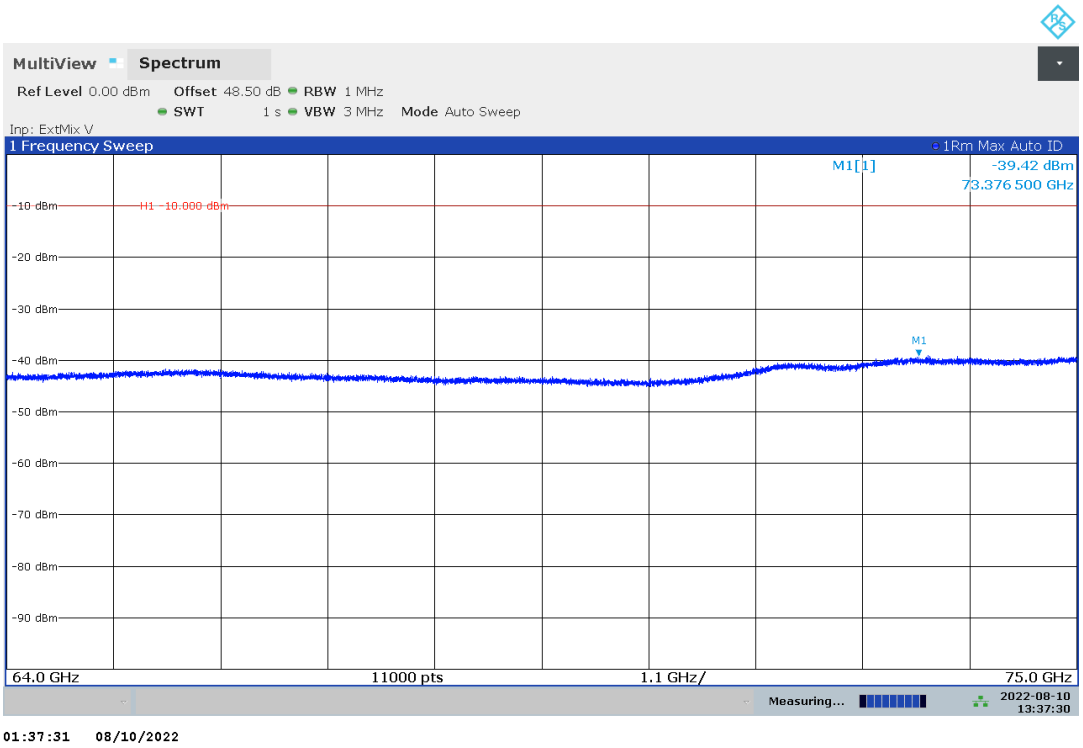
Plot no. 85: radiated emissions 50 GHz – 75 GHz, OOB hor./vert. polarization, band edge considerations Ch14



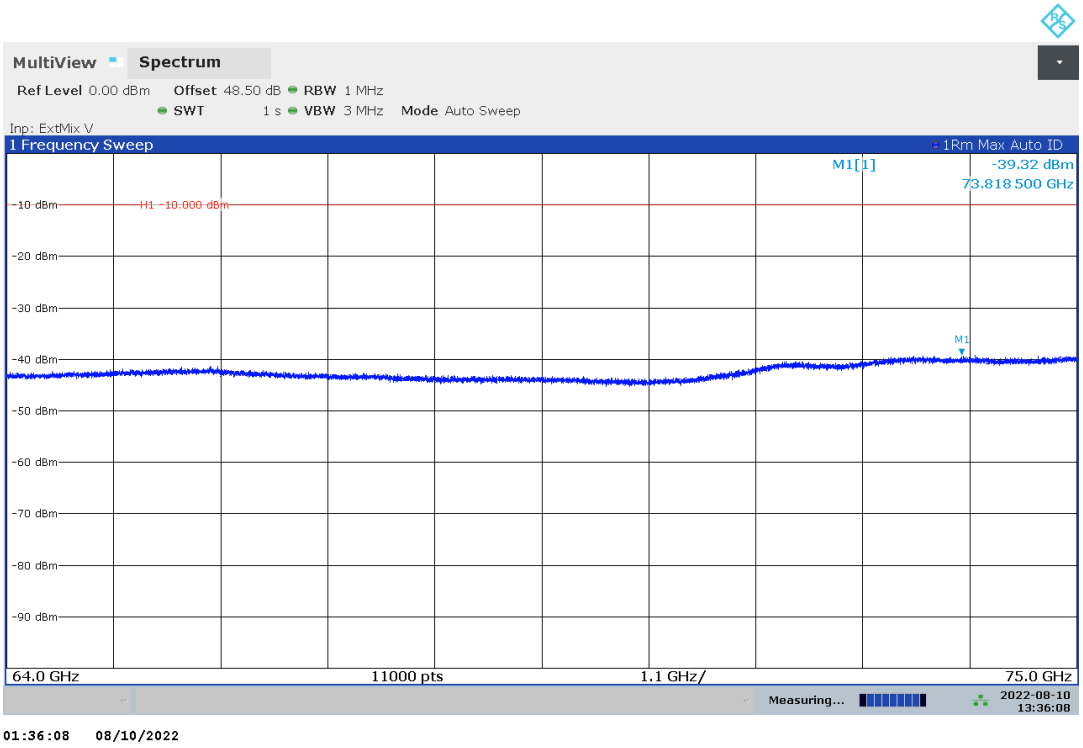
Plot no. 86: radiated emissions 50 GHz – 75 GHz, OOB hor./vert. polarization, band edge considerations Ch28



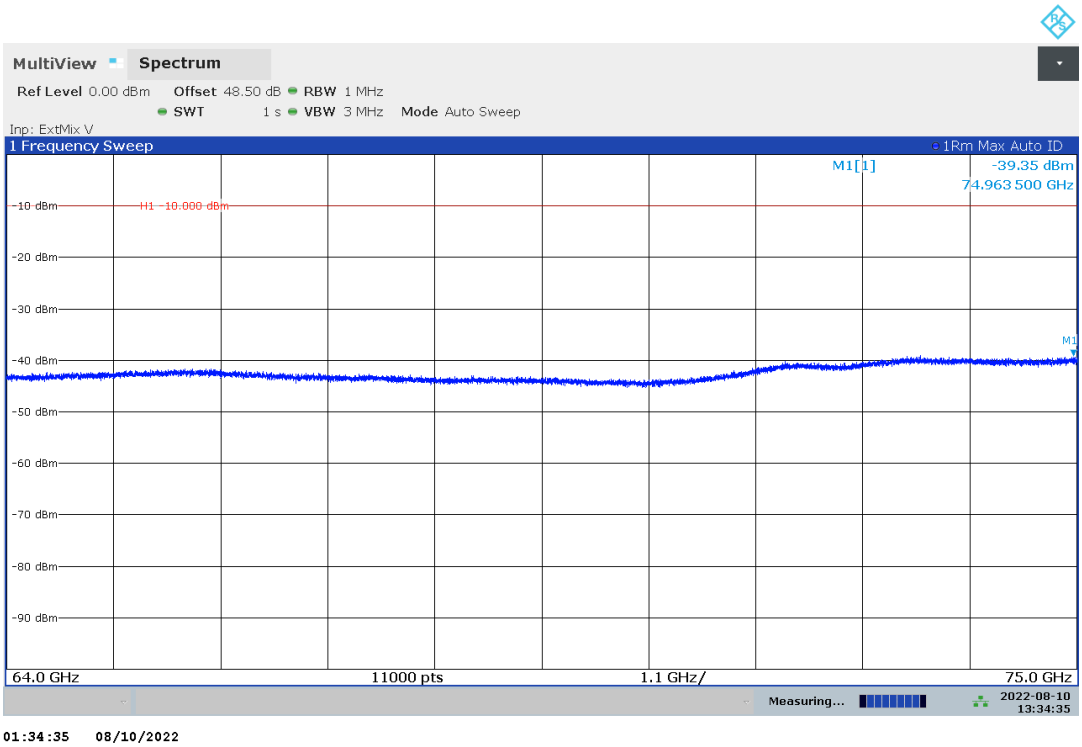
Plot no. 87: radiated emissions 64 GHz – 75 GHz, hor./vert. polarization, cw low



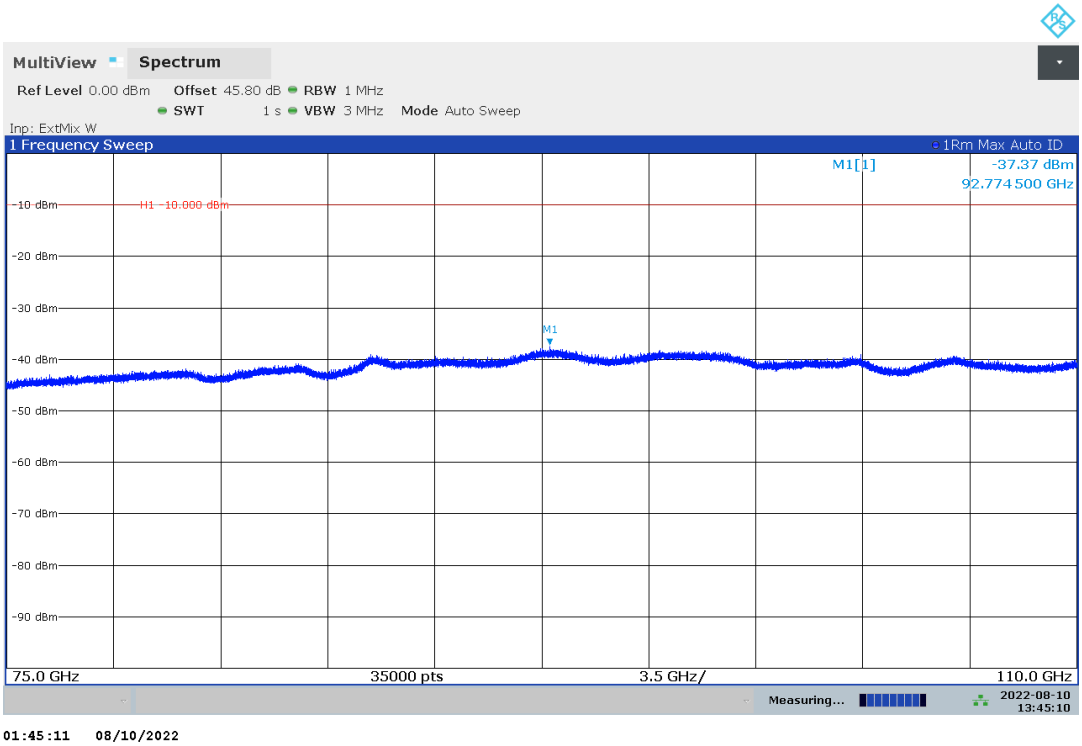
Plot no. 88: radiated emissions 64 GHz – 75 GHz, hor./vert. polarization, cw mid



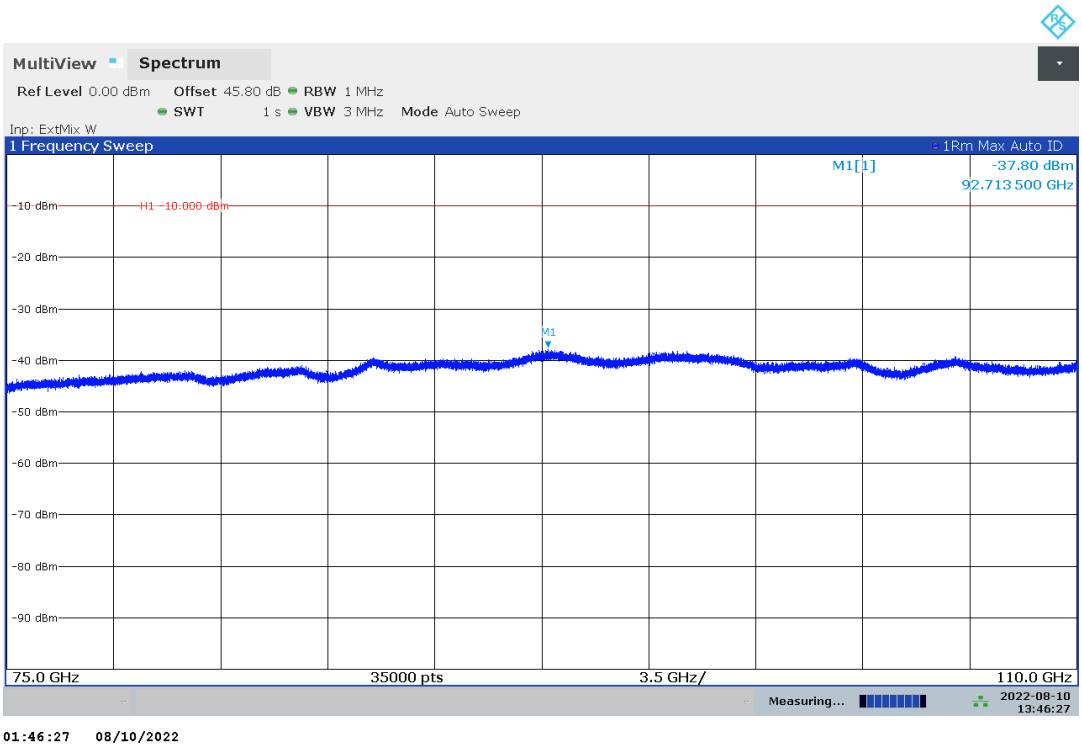
Plot no. 89: radiated emissions 64 GHz – 75 GHz, hor./vert. polarization, cw high



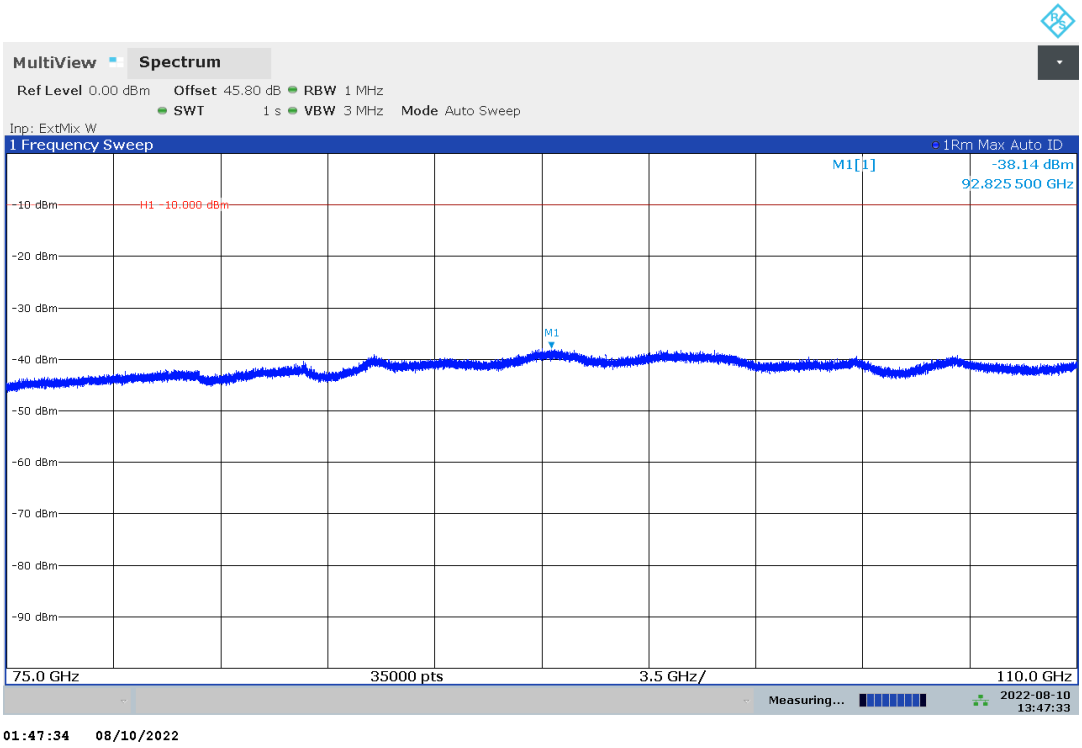
Plot no. 90: radiated emissions 75 GHz – 110 GHz, hor./vert. polarization, cw low



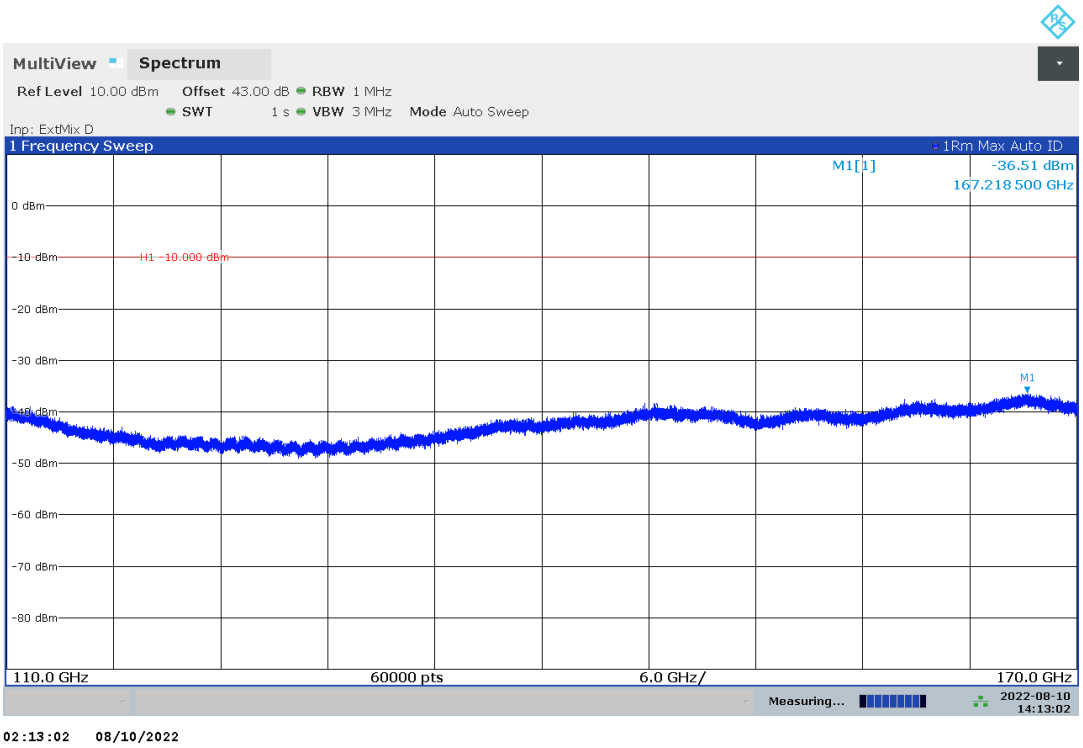
Plot no. 91: radiated emissions 75 GHz – 110 GHz, hor./vert. polarization, cw mid



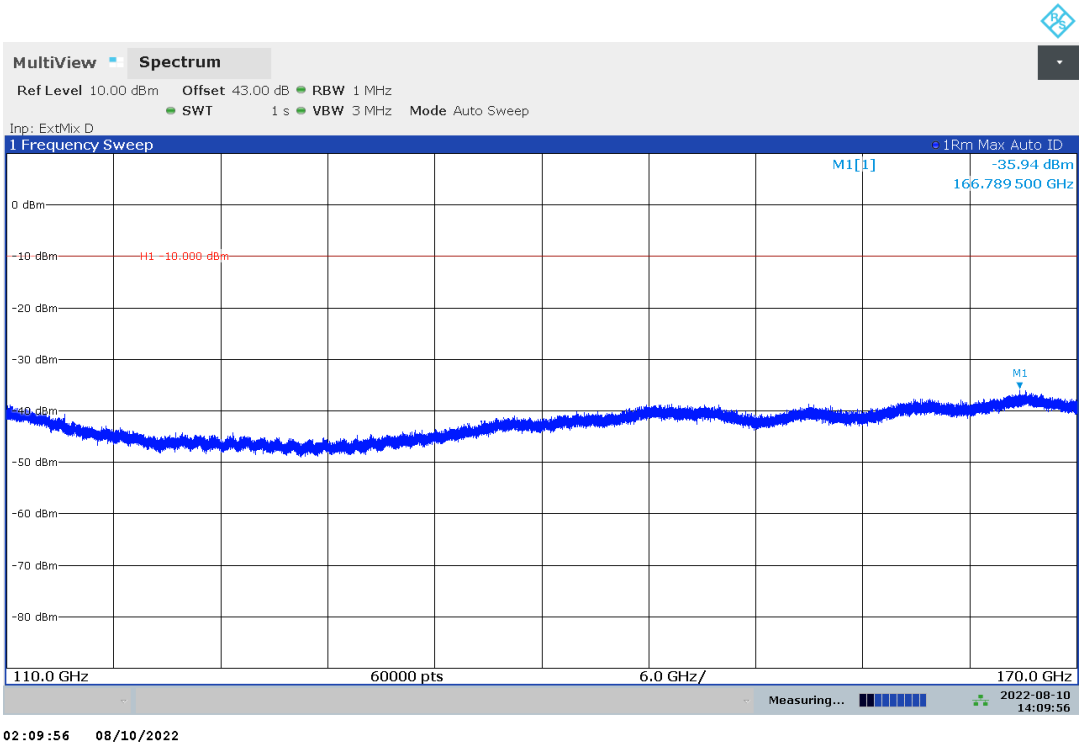
Plot no. 92: radiated emissions 75 GHz – 110 GHz, hor./vert. polarization, cw high



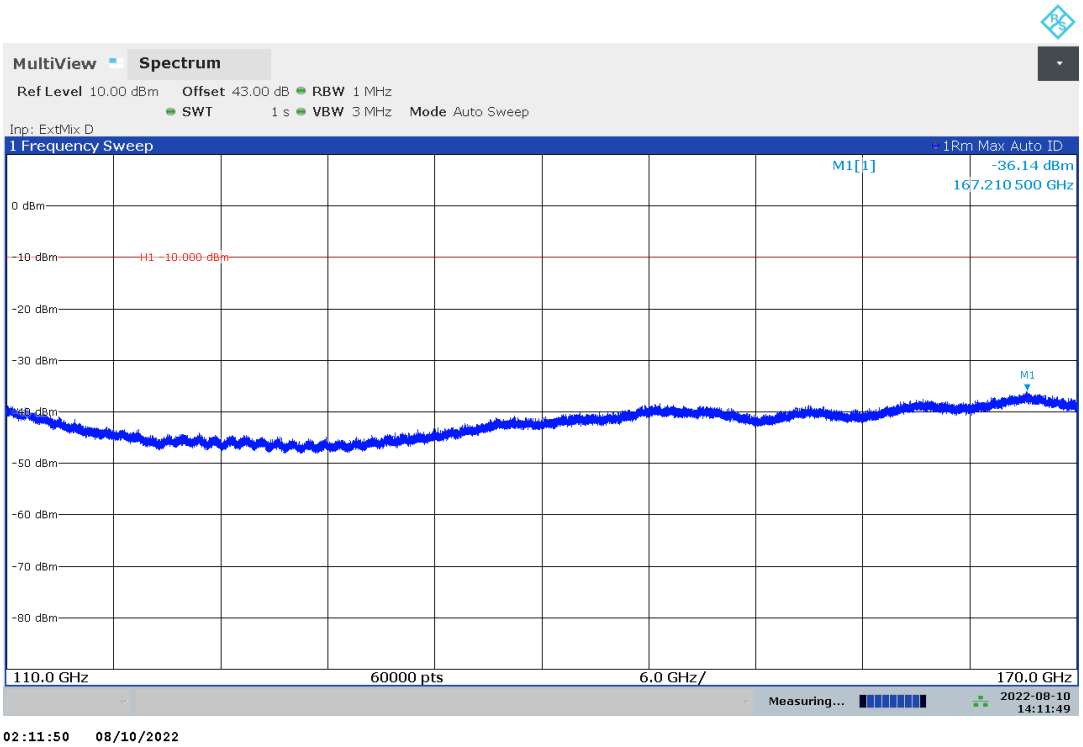
Plot no. 93: radiated emissions 110 GHz – 170 GHz, hor./vert. polarization, cw low



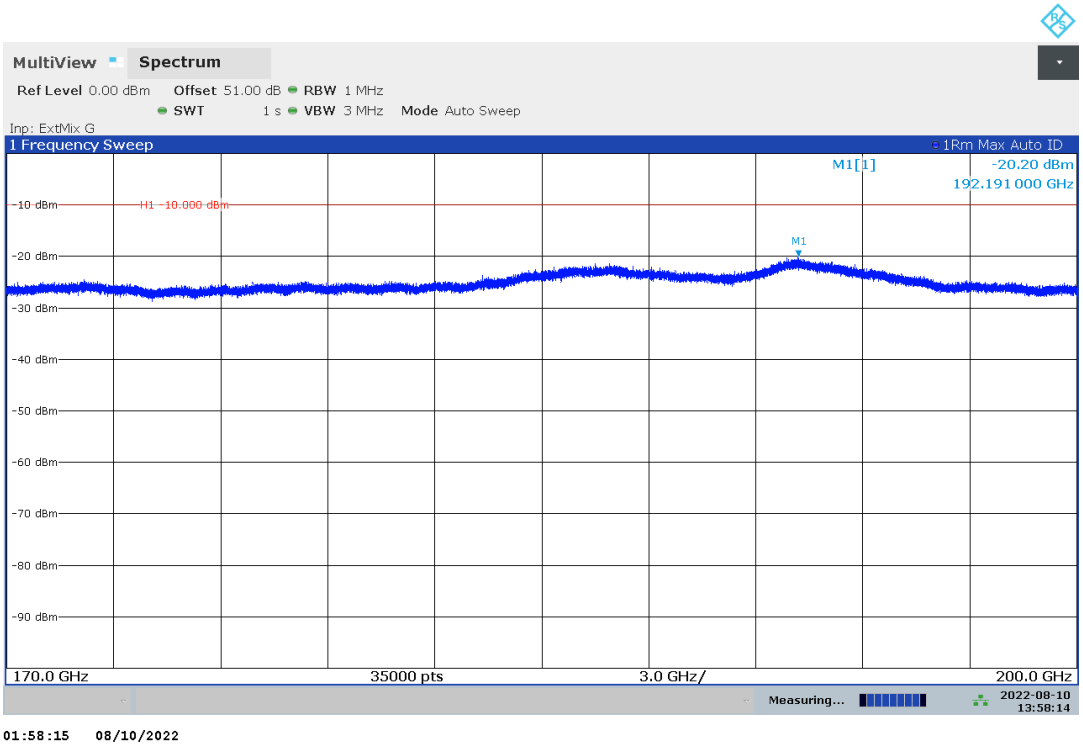
Plot no. 94: radiated emissions 110 GHz – 170 GHz, hor./vert. polarization, cw mid



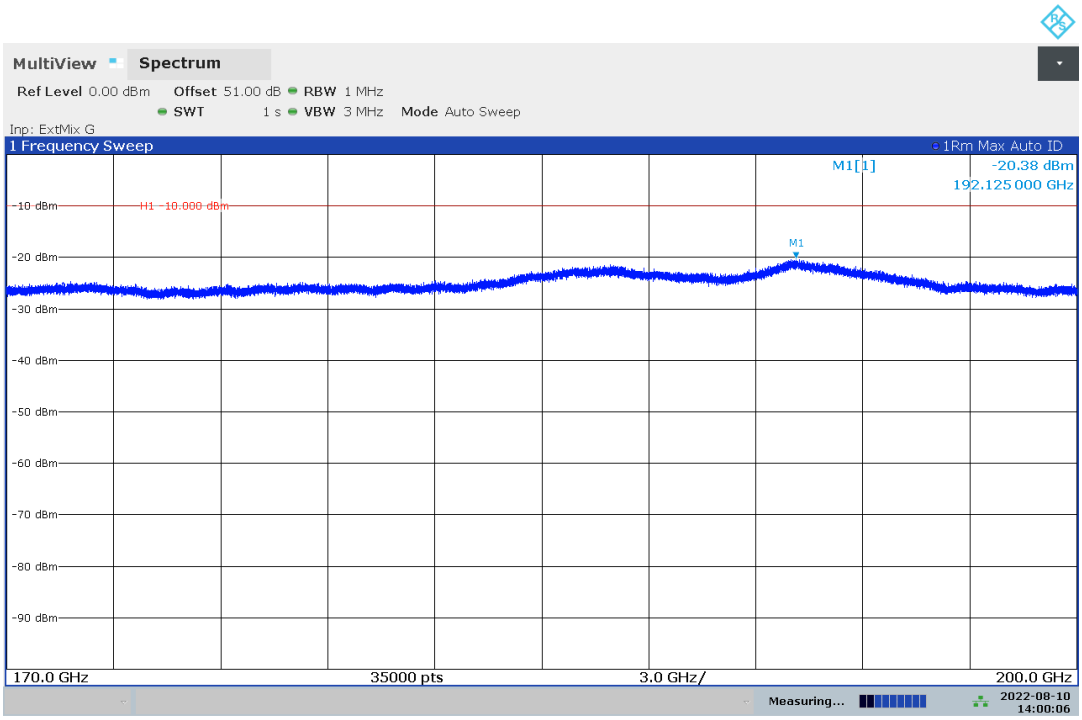
Plot no. 95: radiated emissions 110 GHz – 170 GHz, hor./vert. polarization, cw high



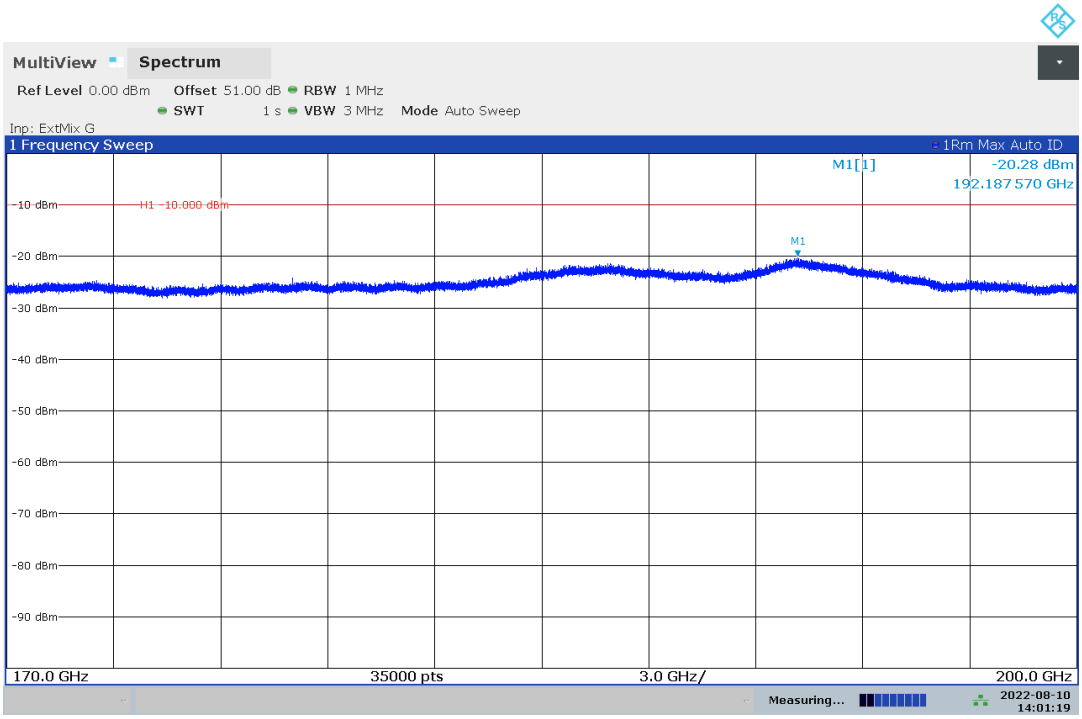
Plot no. 96: radiated emissions 170 GHz – 200 GHz, hor./vert. polarization, cw low



Plot no. 97: radiated emissions 170 GHz – 200 GHz, hor./vert. polarization, cw mid



Plot no. 98: radiated emissions 170 GHz – 200 GHz, hor./vert. polarization, cw high



8 Test Setup Description

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Cyclic chamber inspections and range calibrations are performed. Where possible, RF generating and signalling equipment as well as measuring receivers and analysers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

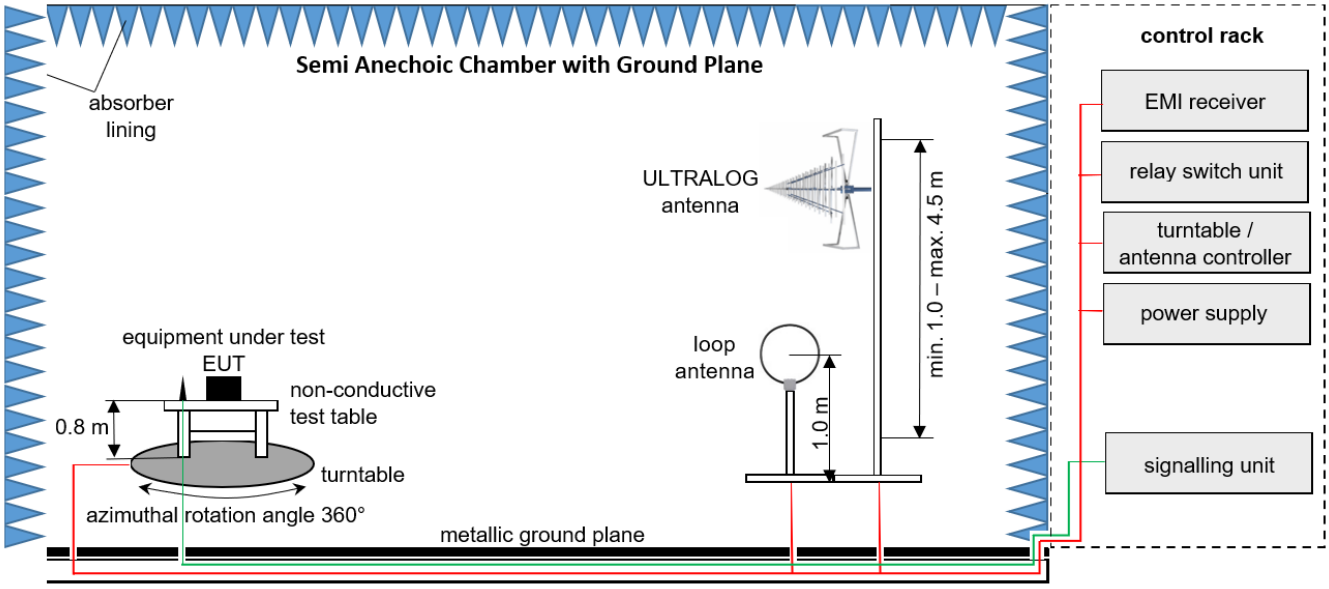
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Kind of calibration (abbreviations):

C = calibrated
CM = cyclic maintenance
NR = not required
L = locked

8.1 Semi Anechoic Chamber with Ground Plane

Radiated measurements are performed in vertical and horizontal plane in the frequency range 30 MHz to 1 GHz in a Semi Anechoic Chamber with a metallic ground plane. The EUT is positioned on a non-conductive test table with a height of 0.80 m above the metallic ground plane that covers the whole chamber. The receiving antennas conform to specification ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices. These antennas can be moved over the height range between 1.0 m and 4.5 m in order to search for maximum field strength emitted from the EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by a spectrum analyzer where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: ULTRALOG antenna at 3 m; loop antenna at 3 m
EMC32 software version: 11.20.00

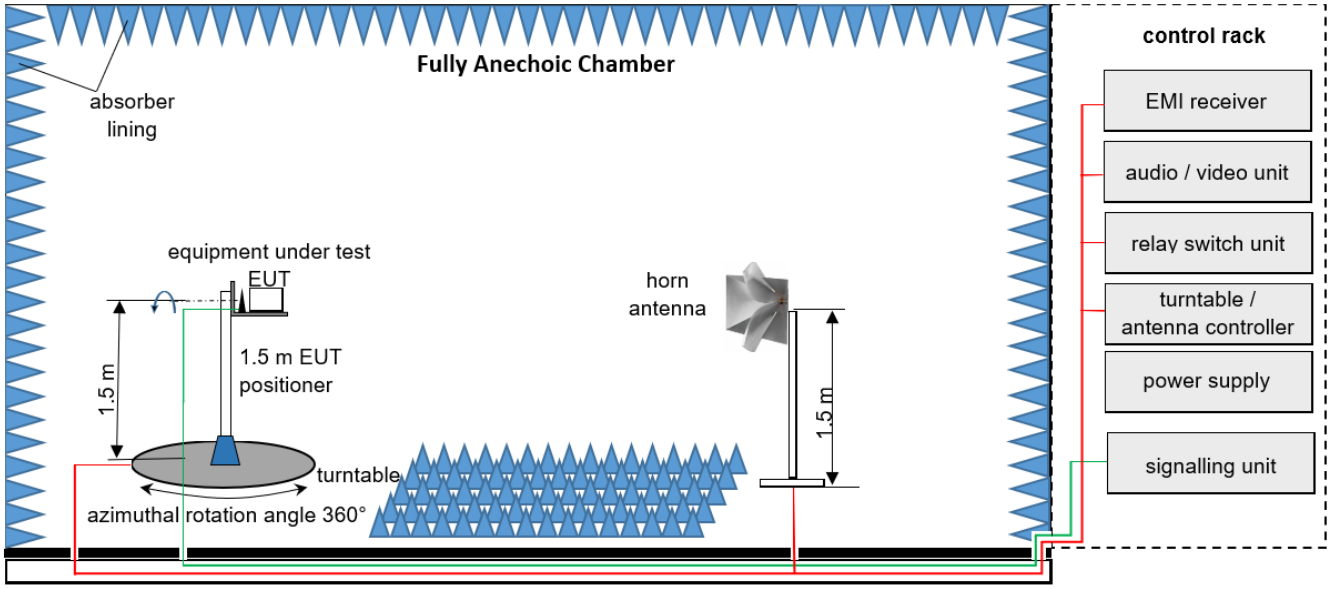
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	NR	–
2	Test table	innco systems GmbH	PT1208-080-RH	-	LAB000306	NR	–
3	Power Supply	Chroma	61604	616040005416	LAB000285	NR	–
4	Positioner	maturo GmbH	TD 1.5-10KG		LAB000258	NR	–
5	Compressed Air	Implotex	1-850-30	-	LAB000256	NR	–
6	EMI Test Receiver	Rohde & Schwarz	ESW26	101481	LAB000236	C	2022-07-07 → 12M → 2023-07-07
7	Semi/Fully Anechoic Chamber (SFAC)	Albatross Projects GmbH	Babylon 5 (SAC 5)	20168.PRB	LAB000235	NR	–
8	Measurement Software	Rohde & Schwarz	EMC32 V11.20		LAB000226	NR	–
9	Turntable	maturo GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	NR	–
10	Antenna Mast	maturo GmbH	CAM4.0-P	CAM4.0-P/316	LAB000224	NR	–
11	Antenna Mast	maturo GmbH	BAM4.5-P	BAM4.5-P/272	LAB000223	NR	–
12	Controller	maturo GmbH	FCU 3.0	10082	LAB000222	NR	–
13	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350292	LAB000191	NR	–
14	Pre-Amplifier	Schwarzbeck Mess-Elektronik OHG	BBV 9718 C	84	LAB000169	NR	–
15	Antenna	Rohde & Schwarz	HF907	102899	LAB000151	C	2020-04-23 → 36M → 2023-04-23
16	Antenna	Rohde & Schwarz	HL562E	102005	LAB000150	C	2020-07-05 → 36M → 2023-07-05
17	Open Switch and Control Platform	Rohde & Schwarz	OSP200 Base Unit 2HU	101748	LAB000149	NR	–
18	Antenna	Rohde & Schwarz	HF907	102898	LAB000124	C	2020-04-23 → 36M → 2023-04-23
19	Antenna	Rohde & Schwarz	HL562E	102001	LAB000123	C	2020-07-05 → 36M → 2023-07-05
20	Antenna	Rohde & Schwarz	HFH2-Z2E - Active Loop Antenna	100954	LAB000108	C	2020-03-25 → 36M → 2023-03-25

8.2 Fully Anechoic Chamber



Measurement distance: horn antenna at 3 m
EMC32 software version: 11.20.00

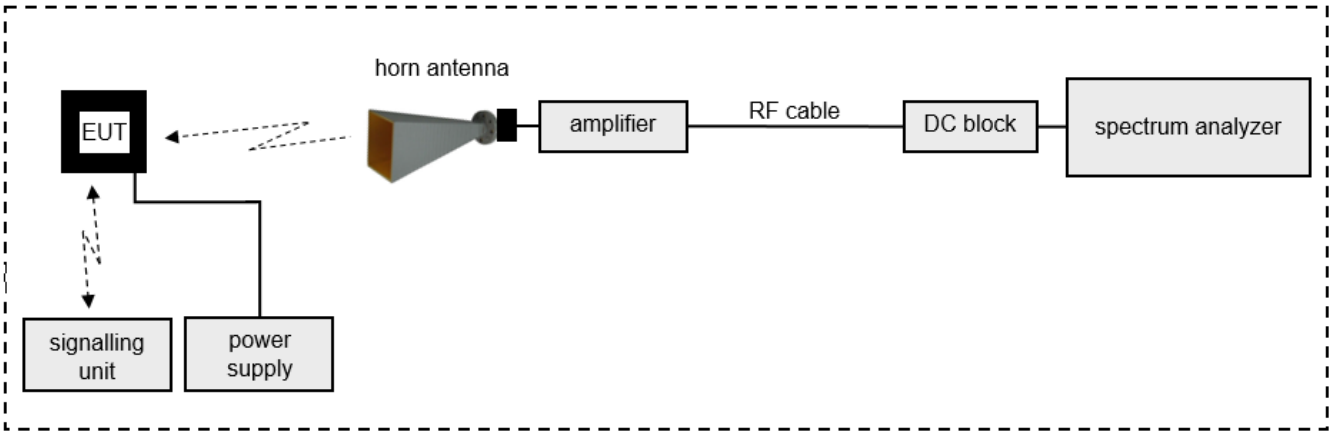
ROP = AV + D - G
(ROP-rad. output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain)

Example calculation:
ROP [dBm] = -54.0 [dBm] + 64.0 [dB] - 20.0 [dBi] = -10 [dBm] (100 µW)

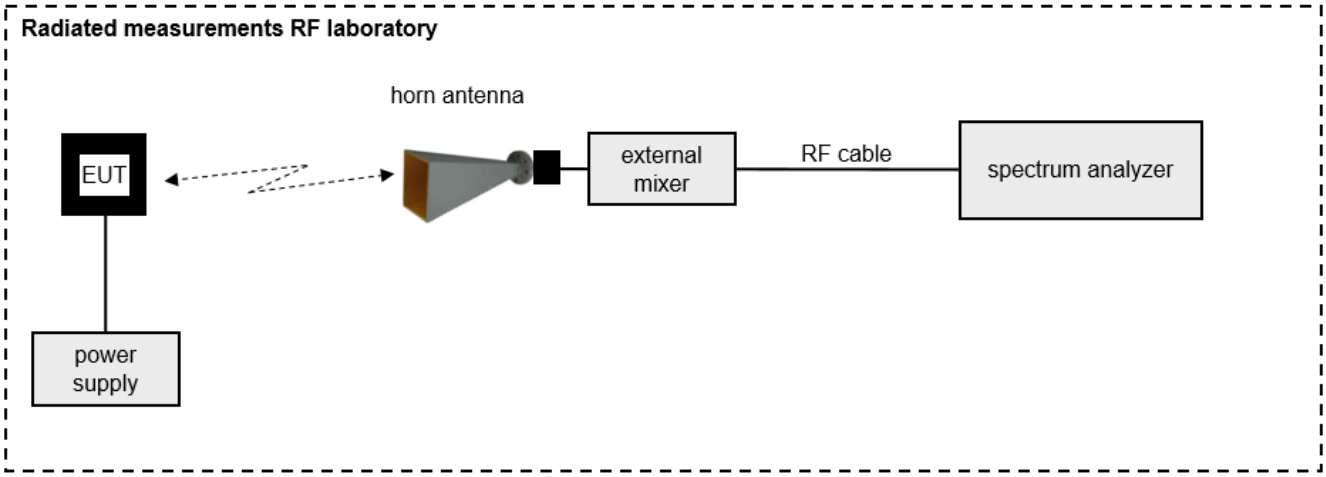
List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	NR	-
2	Test table	innco systems GmbH	PT1208-080-RH	-	LAB000306	NR	-
3	Power Supply	Chroma	61604	616040005416	LAB000285	NR	-
4	Positioner	maturo GmbH	TD 1.5-10KG		LAB000258	NR	-
5	Compressed Air	Implotex	1-850-30	-	LAB000256	NR	-
6	EMI Test Receiver	Rohde & Schwarz	ESW26	101481	LAB000236	C	2022-07-07 → 12M → 2023-07-07
7	Semi/Fully Anechoic Chamber (SFAC)	Albatross Projects GmbH	Babylon 5 (SAC 5)	20168.PRB	LAB000235	NR	-
8	Measurement Software	Rohde & Schwarz	EMC32 V11.20		LAB000226	NR	-
9	Turntable	maturo GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	NR	-
10	Antenna Mast	maturo GmbH	CAM4.0-P	CAM4.0-P/316	LAB000224	NR	-
11	Antenna Mast	maturo GmbH	BAM4.5-P	BAM4.5-P/272	LAB000223	NR	-
12	Controller	maturo GmbH	FCU 3.0	10082	LAB000222	NR	-
13	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350292	LAB000191	NR	-
14	Pre-Amplifier	Schwarzbeck Mess-Elektronik OHG	BBV 9718 C	84	LAB000169	NR	-
15	Antenna	Rohde & Schwarz	HF907	102899	LAB000151	C	2020-04-23 → 36M → 2023-04-23
16	Antenna	Rohde & Schwarz	HL562E	102005	LAB000150	C	2020-07-05 → 36M → 2023-07-05
17	Open Switch and Control Platform	Rohde & Schwarz	OSP200 Base Unit 2HU	101748	LAB000149	NR	-
18	Antenna	Rohde & Schwarz	HF907	102898	LAB000124	C	2020-04-23 → 36M → 2023-04-23
19	Antenna	Rohde & Schwarz	HL562E	102001	LAB000123	C	2020-07-05 → 36M → 2023-07-05
20	Antenna	Rohde & Schwarz	HFH2-Z2E - Active Loop Antenna	100954	LAB000108	C	2020-03-25 → 36M → 2023-03-25

8.3 Radiated measurements > 18 GHz



8.4 Radiated measurements > 50 GHz



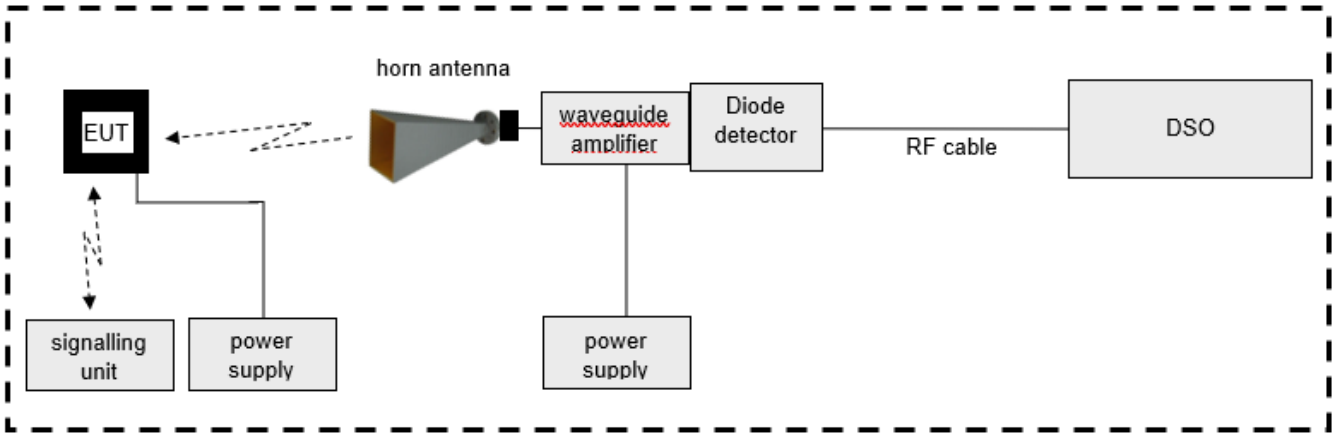
Measurement distance: Horn antenna e.g. 10 cm @ 170 GHz

ROP = AV + D - PA - G
(ROP-rad. output power; AV-analyzer value; PA preamplifier; D-free field attenuation of measurement distance; G-antenna gain)

Example calculation:
ROP [dBm] = -72.63 [dBm] + 57.05 [dB] - 26.4 [dB] - 20.02 [dBi] = -62 [dBm]

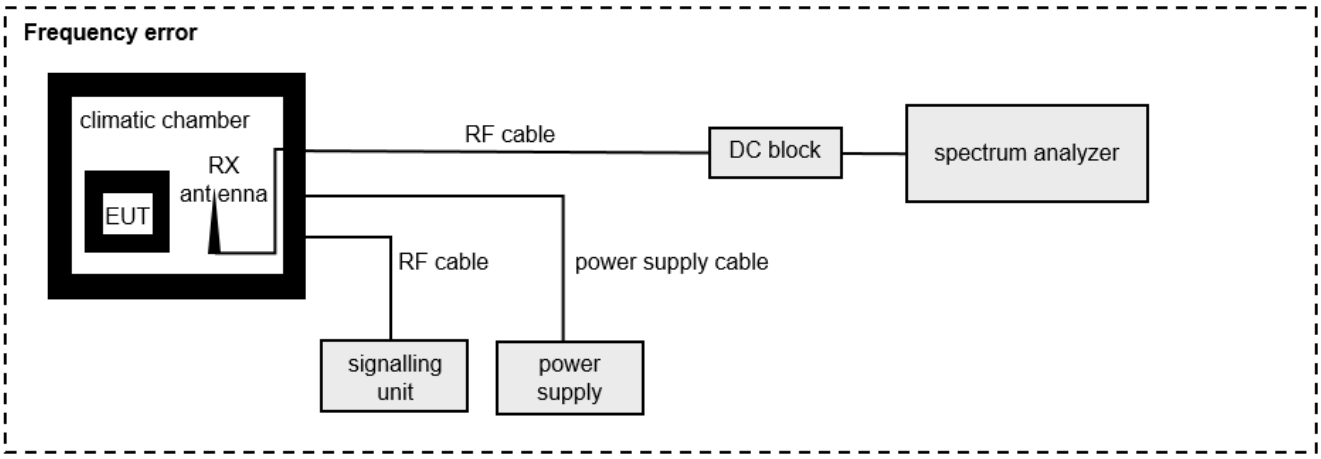
Note: Conversion loss of mixer, as well as above mentioned values (e.g. PA, D, G) are already included in analyzer value, due to corresponding transducer file and given offset.
Values in plots are final measurement values.

8.5 Radiated measurements / substitution method for EIRP



*) waveguide amplifier depends on frequency range and signal-to-noise ratio

8.6 Radiated measurements under extreme conditions



List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Antenna Mast	Schwarzbeck Mess-Elektronik OHG	AM 9104	99	LAB000109	NR	–
2	Climatic Chamber	CTS GmbH	T-65/50	204002	LAB000110	CM	2022-05-11 → 12M → 2023-05-11
3	Spectrum Analyser	Rohde & Schwarz	FSW50	101450	LAB000111	C	2022-07-28 → 12M → 2023-07-28
4	Harmonic Mixer	Rohde & Schwarz	FS-Z075	102015	LAB000112	C	2022-04-20 → 12M → 2023-04-20
5	Harmonic Mixer	Rohde & Schwarz	FS-Z090	102020	LAB000113	C	2022-04-05 → 12M → 2023-04-05
6	Harmonic Mixer	Rohde & Schwarz	FS-Z110	102000	LAB000114	C	2022-04-14 → 12M → 2023-04-14
7	Harmonic Mixer	Rohde & Schwarz	FS-Z140	101144	LAB000115	C	2022-03-28 → 12M → 2023-03-28
8	Harmonic Mixer	Rohde & Schwarz	FS-Z220	101039	LAB000116	C	2022-03-28 → 12M → 2023-03-28
9	Signal Generator	Rohde & Schwarz	SMA100-B-50	103838	LAB000118	C	2021-06-30 → 36M → 2024-06-30
10	Harmonic Mixer	Rohde & Schwarz	FS-Z170	100996	LAB000126	C	2022-04-12 → 12M → 2023-04-12
11	Antenna	Flann Microwave Ltd	20240-20	266403	LAB000128	C	2020-06-29 → 36M → 2023-06-29
12	Antenna	Flann Microwave Ltd	22240-20	270448	LAB000130	C	2020-06-29 → 36M → 2023-06-29
13	Antenna	Flann Microwave Ltd	25240-20	272860	LAB000133	CM	2020-07-01 → 36M → 2023-07-01
14	Antenna	Flann Microwave Ltd	26240-20	273417	LAB000135	CM	2020-08-01 → 36M → 2023-08-01
15	Antenna	Flann Microwave Ltd	27240-20	273367	LAB000137	CM	2020-08-01 → 36M → 2023-08-01
16	Antenna	Flann Microwave Ltd	29240-20	273382	LAB000139	CM	2020-08-01 → 36M → 2023-08-01
17	Antenna	Flann Microwave Ltd	29240-20	273382	LAB000139	CM	2020-08-01 → 36M → 2023-08-01
18	Coaxial Cable	Rosenberger	LU7-022-1000	33	LAB000153	NA	–
19	Coaxial Cable	Rosenberger	LU7-022-1000	34	LAB000154	NA	–
20	Coaxial Cable	Huber & Suhner	ST18/48"	2276454-02	LAB000158	CM	2022-05-31 → 12M → 2023-05-31
21	Coaxial Cable	Huber & Suhner	SF101/1.0m	503990/1	LAB000164	CM	2022-05-31 → 12M → 2023-05-31
22	Digital Oscilloscope	Rohde & Schwarz	RTE1204	300113	LAB000175	C	2021-06-02 → 24M → 2023-06-02
23	Antenna	Flann Microwave Ltd	28240-20	273371	LAB000176	CM	2021-09-01 → 36M → 2024-09-01
24	Antenna	Flann Microwave Ltd	30240-20	273390	LAB000178	CM	2021-09-01 → 36M → 2024-09-01
25	WG-Coax-Adapter	Flann Microwave Ltd	20093-TF30 UBR220	273374	LAB000181	CM	2021-09-01 → 36M → 2024-09-01
26	WG-Coax-Adapter	Flann Microwave Ltd	22093-TF30 UG599/U	273263	LAB000183	CM	2021-09-01 → 36M → 2024-09-01
27	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350255	LAB000189	NA	–
28	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350263	LAB000190	NA	–
29	Multiplier	Rohde & Schwarz	SMZ110	100001	LAB000272	NA	–
30	Spectrum Analyser	Rohde & Schwarz	FSW43	101391	LAB000289	C	2022-06-10 → 12M → 2023-06-10
31	Test table	innco systems GmbH	PT0707-RH light	-	LAB000303	NA	–
32	Harmonic Mixer	Rohde & Schwarz	FS-Z060	101350	LAB000375	C	2022-03-18 → 12M → 2023-03-18
33	Antenna	Flann Microwave Ltd	24240-20	275176	LAB000376	CM	2021-09-01 → 36M → 2024-09-01
34	Detector Diode	Eravant	SFD-903144-08SF-P1	13795-01	LAB000437	NA	–
35	Pre-Amplifier	Eravant	SBL-9531443565-0808-E1	13790-01	LAB000439	CM	2021-10-21 → 12M → 2022-10-21
36	Amplifier	Radiometer Physics GmbH	GLNA 140-220-20-6	200145	LAB000440	CM	2021-12-06 → 12M → 2022-12-06

9 Measurement procedures

9.1 Radiated spurious emissions from 9 kHz to 30 MHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- For each turntable step the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated with special 3D adapter set to find maximum level of emissions.
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade of distance in the region closer than λ in m divided by 2π (i.e., λ/2π), and at 20 dB/decade of distance beyond that, using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the limit line of corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.2 Radiated spurious emissions from 30 MHz to 1 GHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- Antenna polarisation is changed (H-V / V-H) and antenna height is changed from 1 meter to 4 meters.
- For each turntable step / antenna polarisation / antenna height the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan by rotating the turntable and changing antenna height and polarisation.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C6.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position, antenna polarisation and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region λ in m divided by 2π (i.e., λ/2π), using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.3 Radiated spurious emissions from 1 GHz to 18 GHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 315° in 45° steps.
- Antenna polarisation is changed (H-V / V-H) and antenna height is changed from 1 meter to 4 meters.
- For each turntable step / antenna polarisation / antenna height the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan by rotating the turntable and changing antenna height and polarisation.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C6.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position, antenna polarisation and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region λ in m divided by 2π (i.e., λ/2π), using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.4 Radiated spurious emissions above 18 GHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- EUT is powered on and set into operation.
- Test distance depends on EUT size and test antenna size (farfield conditions shall be met).

Pre-scan

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and for different polarizations of the antenna.

Final measurement

- Significant emissions found during the pre-scan will be maximized, i.e. position and antenna orientation causing the highest emissions with Peak and RMS detector
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C63.4 / C63.10).
- Final plot showing measurement data, levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit is recorded.

Note

- In case of measurements with external harmonic mixers (e.g. above 50 GHz) special care is taken to avoid possible overloading of the external mixer's input.
- As external harmonic mixers may generate false images, care is taken to ensure that any emission measured by the spectrum analyzer is indeed radiated from the EUT and not internally generated by the external harmonic mixer. Signal identification feature of spectrum analyzer is used to eliminate/reduce images of the external harmonic mixer.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region λ in m divided by 2π (i.e., λ/2π), using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.5 Radiated measurements of wanted emission using RF detector

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- EUT is powered on and set into operation.
- Test distance depends on EUT size and test antenna size (farfield conditions shall be met).

Measurement

Step #1:

- EUT's wanted signal is measured with RF-detector and oscilloscope:
- The EUT is moved carefully to maximize the wanted emission as shown on oscilloscope.
- Record mean and peak voltages (V_{mean} and V_{peak}) from the oscilloscope (e.g. screen shot).
- Measurement distance to EUT: d_{EUT}
- EUT's duty cycle: DC

Step #2: Substitution measurement at EUT's center frequency with CW-signal generator at d_{EUT}

- Power-off and remove EUT from test scenery.
- Install unmodulated CW-signal generator (with frequency multiplier) at the exact EUT position.
- Set the frequency of the signal generator to the center of the EUT's frequency range.
- Adjust the power of the generator such that the oscilloscope indicates a voltage equal to the peak voltage as measured and recorded for the EUT (V_{peak}).
- Disconnect the test antenna from signal generator and measure the generator's output power without changing any settings with a wideband mm-wave power meter with a thermocouple detector or equivalent. Record the measured value as peak power ($V_{ref\ peak}$). Record antenna gain of test antenna.
- Repeat above substitution measurement for the mean voltage recorded in 2nd step and record the measured value as mean power ($V_{ref\ mean}$).

Step #3: Calculation of Peak EIRP:

- Antenna gain of used test antenna at EUT's center frequency: G_{test}
- Peak EIRP = $P_{ref\ peak} + G_{test}$

Step #4: Calculation of Mean EIRP:

- Mean EIRP = $P_{ref\ mean} + G_{test}$

Detailed requirements can be found in ANSIC63.10, 9.11

10 MEASUREMENT UNCERTAINTIES

Radio frequency	≤ ± 10 ppm
Radiated emission	≤ ± 6 dB
Temperature	≤ ± 1 °C
Humidity	≤ ± 5 %
DC and low frequency voltages	≤ ± 3 %

The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor k = 2. It was determined in accordance with EA-4/02 M:2013. The true value is located in the corresponding interval with a probability of 95 %.