4.4 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Standard FCC Part §2.1051. §27.53

The test was performed according to:
ANSI C63.26

Test date: 2023-12-12

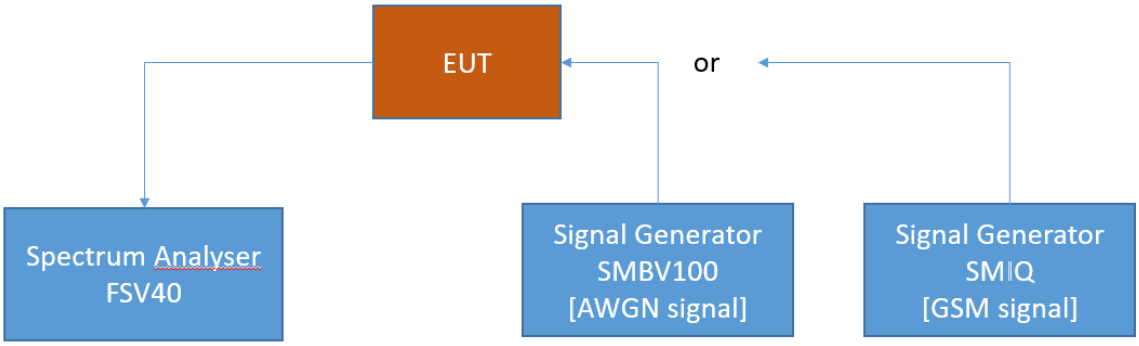
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.4.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the signal booster power and gain limits and requirements for industrial signal boosters.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; RF Output Power / Gain

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.4.2 TEST REQUIREMENTS/LIMITS

FCC Part 2.1051; Measurement required: Spurious emissions at antenna terminal:

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Band 41BRS (LBS/UBS):

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(1) Prior to the transition, and thereafter, solely within the MBS, for analog operations with an EIRP in excess of −9 dBW, the signal shall be attenuated at the channel edges by at least 38 dB relative to the peak visual carrier, then linearly sloping from that level to at least 60 dB of attenuation at 1 MHz below the lower band edge and 0.5 MHz above the upper band edge, and attenuated at least 60 dB at all other frequencies.

(2) For digital base stations, the attenuation shall be not less than 43 + 10 log (P) dB, unless a documented interference complaint is received from an adjacent channel licensee with an overlapping Geographic Service Area. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS No. 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

4.4.3 TEST PROTOCOL

General considerations concerning the limits:

The measuring bandwidth of 1 MHz was chosen according the test requirements exept at the band edges: At the band edges reducing of measurement bandwidth was necessary to prevent overlaying the RF-signal over the spurious emissions.
Also outside the Downlink frequency band at lower frequencies the measurement bandwidths were reduced to have the possibility to record the spurious emissions at these lower frequencies.

At frequencies were measuring bandwidths were reduced also the limit lines were reduced acoording the given formula:

$$p\ RBWreduced\ [dBm] = 10 * \log\left(RBWreduced\ [kHz] — 1000\ kHz\right) + pRBW\ 1000\ kHz[dBm]$$

Hereby "p" are the limit lines' values.

Band 41, BRS (UBS), downlink

Test Frequency	Signal Type	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
low	Narrowband	0.00959	-56.9	RMS	1	-43.0	13.9
low	Narrowband	0.05250	-52.0	RMS	10	-33.0	19.0
low	Narrowband	813.6	-37.7	RMS	100	-23.0	14.7
low	Narrowband	2148.9	-26.2	RMS	1000	-13.0	13.2
low	Narrowband	2589.0	-36.8	RMS	100	-23.0	13.8
low	Narrowband	2695.3	-40.7	RMS	100	-23.0	17.7
low	Narrowband	4756.3	-27.7	RMS	1000	-13.0	14.7
low	Narrowband	6965.6	-24.6	RMS	1000	-13.0	11.6
low	Narrowband	19999.8	-30.0	RMS	1000	-13.0	17.0
low	Narrowband	20286.7	-29.6	RMS	1000	-13.0	16.6
low	Narrowband	30711.9	-28.8	RMS	1000	-13.0	15.8
mid	Narrowband	0.01033	-56.1	RMS	1	-43.0	13.1
mid	Narrowband	0.06250	-51.4	RMS	10	-33.0	18.4
mid	Narrowband	950.5	-38.3	RMS	100	-23.0	15.3
mid	Narrowband	2155.4	-26.2	RMS	1000	-13.0	13.2
mid	Narrowband	2583.7	-39.7	RMS	100	-23.0	16.7
mid	Narrowband	2691.7	-40.7	RMS	100	-23.0	17.7
mid	Narrowband	4914.3	-28.1	RMS	1000	-13.0	15.1
mid	Narrowband	6893.6	-24.6	RMS	1000	-13.0	11.6
mid	Narrowband	19989.7	-29.8	RMS	1000	-13.0	16.8
mid	Narrowband	20257.7	-29.8	RMS	1000	-13.0	16.8
mid	Narrowband	30756.4	-29.0	RMS	1000	-13.0	16.0
high	Narrowband	0.01082	-55.9	RMS	1	-43.0	12.9
high	Narrowband	0.06750	-51.2	RMS	10	-33.0	18.2
high	Narrowband	810.4	-38.0	RMS	100	-23.0	15.0
high	Narrowband	2147.9	-25.9	RMS	1000	-13.0	12.9
high	Narrowband	2584.3	-40.2	RMS	100	-23.0	17.2
high	Narrowband	2691.0	-37.7	RMS	100	-23.0	14.7
high	Narrowband	4869.3	-27.9	RMS	1000	-13.0	14.9
high	Narrowband	6991.6	-24.8	RMS	1000	-13.0	11.8
high	Narrowband	19992.3	-29.6	RMS	1000	-13.0	16.6
high	Narrowband	20305.7	-29.1	RMS	1000	-13.0	16.1
high	Narrowband	30660.9	-29.1	RMS	1000	-13.0	16.1

Band 41, BRS (UBS), downlink							
Test Frequency	**Signal Type**	**Spurious Freq. [MHz]**	**Spurious Level [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
low	Wideband	0.00992	-57.7	RMS	1	-43.0	14.7
low	Wideband	0.09749	-52.2	RMS	10	-33.0	19.2
low	Wideband	952.9	-38.4	RMS	100	-23.0	15.4
low	Wideband	2122.9	-25.7	RMS	1000	-13.0	12.7
low	Wideband	2588.8	-28.2	RMS	100	-23.0	5.2
low	Wideband	2696.7	-40.2	RMS	100	-23.0	17.2
low	Wideband	4704.8	-28.2	RMS	1000	-13.0	15.2
low	Wideband	6860.1	-24.5	RMS	1000	-13.0	11.5
low	Wideband	19994.8	-29.7	RMS	1000	-13.0	16.7
low	Wideband	20277.2	-29.5	RMS	1000	-13.0	16.5
low	Wideband	30663.9	-29.1	RMS	1000	-13.0	16.1
mid	Wideband	0.01009	-56.3	RMS	1	-43.0	13.3
mid	Wideband	0.05250	-52.0	RMS	10	-33.0	19.0
mid	Wideband	811.0	-38.0	RMS	100	-23.0	15.0
mid	Wideband	2136.9	-26.2	RMS	1000	-13.0	13.2
mid	Wideband	2587.8	-40.2	RMS	100	-23.0	17.2
mid	Wideband	2698.1	-40.2	RMS	100	-23.0	17.2
mid	Wideband	4863.3	-27.8	RMS	1000	-13.0	14.8
mid	Wideband	6990.6	-24.7	RMS	1000	-13.0	11.7
mid	Wideband	19909.3	-29.9	RMS	1000	-13.0	16.9
mid	Wideband	20109.7	-29.8	RMS	1000	-13.0	16.8
mid	Wideband	30810.4	-28.9	RMS	1000	-13.0	15.9
high	Wideband	0.00902	-56.8	RMS	1	-43.0	13.8
high	Wideband	0.09749	-52.6	RMS	10	-33.0	19.6
high	Wideband	952.4	-38.0	RMS	100	-23.0	15.0
high	Wideband	2155.4	-25.8	RMS	1000	-13.0	12.8
high	Wideband	2581.1	-40.2	RMS	100	-23.0	17.2
high	Wideband	2675.1	-30.1	RMS	100	-23.0	7.1
high	Wideband	4616.8	-28.3	RMS	1000	-13.0	15.3
high	Wideband	6940.1	-24.3	RMS	1000	-13.0	11.3
high	Wideband	19608.8	-30.1	RMS	1000	-13.0	17.1
high	Wideband	20313.7	-29.3	RMS	1000	-13.0	16.3
high	Wideband	30804.4	-29.0	RMS	1000	-13.0	16.0

Band 41, BRS (UBS), downlink

Test Frequency	Signal Type	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
low	Wideband 5G	0.00902	-55.9	RMS	1	-43.0	12.9
low	Wideband 5G	0.07750	-53.0	RMS	10	-33.0	20.0
low	Wideband 5G	949.9	-38.4	RMS	100	-23.0	15.4
low	Wideband 5G	2578.3	-20.0	RMS	1000	-13.0	7.0
low	Wideband 5G	2586.5	-35.7	RMS	100	-23.0	12.7
low	Wideband 5G	2697.0	-34.9	RMS	100	-23.0	11.9
low	Wideband 5G	4568.8	-27.6	RMS	1000	-13.0	14.6
low	Wideband 5G	6982.1	-25.0	RMS	1000	-13.0	12.0
low	Wideband 5G	19923.3	-29.7	RMS	1000	-13.0	16.7
low	Wideband 5G	20272.2	-29.5	RMS	1000	-13.0	16.5
low	Wideband 5G	30821.9	-28.4	RMS	1000	-13.0	15.4
mid	Wideband 5G	0.01570	-57.6	RMS	1	-43.0	14.6
mid	Wideband 5G	0.05250	-51.2	RMS	10	-33.0	18.2
mid	Wideband 5G	950.4	-38.1	RMS	100	-23.0	15.1
mid	Wideband 5G	2566.8	-20.7	RMS	1000	-13.0	7.7
mid	Wideband 5G	2585.3	-33.5	RMS	100	-23.0	10.5
mid	Wideband 5G	2694.8	-34.4	RMS	100	-23.0	11.4
mid	Wideband 5G	2700.7	-27.2	RMS	1000	-13.0	14.2
mid	Wideband 5G	6975.1	-24.8	RMS	1000	-13.0	11.8
mid	Wideband 5G	19539.8	-29.8	RMS	1000	-13.0	16.8
mid	Wideband 5G	20273.7	-29.1	RMS	1000	-13.0	16.1
mid	Wideband 5G	30749.4	-28.6	RMS	1000	-13.0	15.6
high	Wideband 5G	0.01029	-57.0	RMS	1	-43.0	14.0
high	Wideband 5G	0.07750	-52.1	RMS	10	-33.0	19.1
high	Wideband 5G	810.2	-38.5	RMS	100	-23.0	15.5
high	Wideband 5G	2576.3	-24.5	RMS	1000	-13.0	11.5
high	Wideband 5G	2583.6	-34.9	RMS	100	-23.0	11.9
high	Wideband 5G	2697.3	-35.6	RMS	100	-23.0	12.6
high	Wideband 5G	4973.3	-28.0	RMS	1000	-13.0	15.0
high	Wideband 5G	6977.1	-24.6	RMS	1000	-13.0	11.6
high	Wideband 5G	19554.3	-29.7	RMS	1000	-13.0	16.7
high	Wideband 5G	20318.7	-29.3	RMS	1000	-13.0	16.3
high	Wideband 5G	30758.4	-28.7	RMS	1000	-13.0	15.7

Band 41, BRS (LBS), downlink

Test Frequency	Signal Type	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
low	Narrowband	0.01140	-57.6	RMS	1	-43.0	14.6
low	Narrowband	0.14748	-51.7	RMS	10	-33.0	18.7
low	Narrowband	712.8	-38.7	RMS	100	-23.0	15.7
low	Narrowband	2117.4	-26.0	RMS	1000	-13.0	13.0
low	Narrowband	2494.9	-36.3	RMS	100	-23.0	13.3
low	Narrowband	2598.3	-40.2	RMS	100	-23.0	17.2
low	Narrowband	4891.8	-28.2	RMS	1000	-13.0	15.2
low	Narrowband	6891.6	-24.8	RMS	1000	-13.0	11.8
low	Narrowband	19537.8	-29.9	RMS	1000	-13.0	16.9
low	Narrowband	20273.2	-29.6	RMS	1000	-13.0	16.6
low	Narrowband	30746.4	-28.9	RMS	1000	-13.0	15.9
mid	Narrowband	0.02229	-57.4	RMS	1	-43.0	14.4
mid	Narrowband	0.05750	-50.6	RMS	10	-33.0	17.6
mid	Narrowband	948.9	-38.6	RMS	100	-23.0	15.6
mid	Narrowband	2115.9	-26.5	RMS	1000	-13.0	13.5
mid	Narrowband	2491.4	-40.6	RMS	100	-23.0	17.6
mid	Narrowband	2597.6	-40.4	RMS	100	-23.0	17.4
mid	Narrowband	4775.3	-28.2	RMS	1000	-13.0	15.2
mid	Narrowband	6942.1	-25.0	RMS	1000	-13.0	12.0
mid	Narrowband	19569.3	-29.8	RMS	1000	-13.0	16.8
mid	Narrowband	20285.2	-29.6	RMS	1000	-13.0	16.6
mid	Narrowband	30674.9	-29.0	RMS	1000	-13.0	16.0
high	Narrowband	0.00902	-56.4	RMS	1	-43.0	13.4
high	Narrowband	0.14249	-52.2	RMS	10	-33.0	19.2
high	Narrowband	949.2	-38.5	RMS	100	-23.0	15.5
high	Narrowband	2119.9	-25.9	RMS	1000	-13.0	12.9
high	Narrowband	2487.9	-41.4	RMS	100	-23.0	18.4
high	Narrowband	2597.0	-37.9	RMS	100	-23.0	14.9
high	Narrowband	4876.3	-27.8	RMS	1000	-13.0	14.8
high	Narrowband	6859.1	-24.7	RMS	1000	-13.0	11.7
high	Narrowband	19988.3	-29.7	RMS	1000	-13.0	16.7
high	Narrowband	20298.7	-29.6	RMS	1000	-13.0	16.6
high	Narrowband	30084.0	-28.9	RMS	1000	-13.0	15.9

Band 41, BRS (LBS), downlink							
Test Frequency	**Signal Type**	**Spurious Freq. [MHz]**	**Spurious Level [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
low	Wideband	0.01160	-57.1	RMS	1	-43.0	14.1
low	Wideband	0.05250	-51.3	RMS	10	-33.0	18.3
low	Wideband	952.6	-38.3	RMS	100	-23.0	15.3
low	Wideband	2145.4	-25.7	RMS	1000	-13.0	12.7
low	Wideband	2480.8	-32.0	RMS	100	-23.0	9.0
low	Wideband	2597.2	-40.4	RMS	100	-23.0	17.4
low	Wideband	4837.8	-28.0	RMS	1000	-13.0	15.0
low	Wideband	6841.6	-24.7	RMS	1000	-13.0	11.7
low	Wideband	19557.3	-30.1	RMS	1000	-13.0	17.1
low	Wideband	20288.2	-29.5	RMS	1000	-13.0	16.5
low	Wideband	30737.4	-28.8	RMS	1000	-13.0	15.8
mid	Wideband	0.00910	-57.3	RMS	1	-43.0	14.3
mid	Wideband	0.05250	-51.6	RMS	10	-33.0	18.6
mid	Wideband	795.2	-37.7	RMS	100	-23.0	14.7
mid	Wideband	2155.4	-25.6	RMS	1000	-13.0	12.6
mid	Wideband	2487.6	-40.2	RMS	100	-23.0	17.2
mid	Wideband	2603.7	-40.0	RMS	100	-23.0	17.0
mid	Wideband	4389.4	-27.9	RMS	1000	-13.0	14.9
mid	Wideband	6853.6	-24.6	RMS	1000	-13.0	11.6
mid	Wideband	19559.3	-30.1	RMS	1000	-13.0	17.1
mid	Wideband	20317.2	-29.3	RMS	1000	-13.0	16.3
mid	Wideband	30112.0	-29.0	RMS	1000	-13.0	16.0
high	Wideband	0.01045	-55.8	RMS	1	-43.0	12.8
high	Wideband	0.13249	-52.4	RMS	10	-33.0	19.4
high	Wideband	810.2	-38.7	RMS	100	-23.0	15.7
high	Wideband	2155.4	-25.7	RMS	1000	-13.0	12.7
high	Wideband	2488.7	-40.7	RMS	100	-23.0	17.7
high	Wideband	2590.7	-28.7	RMS	100	-23.0	5.7
high	Wideband	4976.3	-28.1	RMS	1000	-13.0	15.1
high	Wideband	6890.6	-24.5	RMS	1000	-13.0	11.5
high	Wideband	19509.3	-30.0	RMS	1000	-13.0	17.0
high	Wideband	20318.2	-29.7	RMS	1000	-13.0	16.7
high	Wideband	31257.9	-28.9	RMS	1000	-13.0	15.9

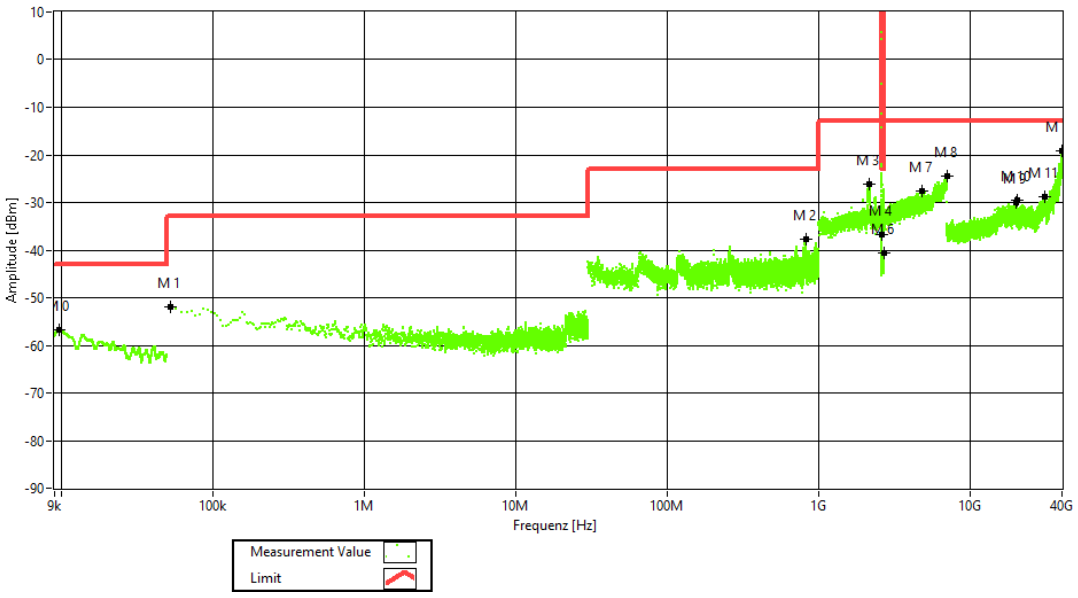
Band 41, BRS (LBS), downlink

Test Frequency	Signal Type	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
low	Wideband 5G	0.01127	-56.6	RMS	1	-43.0	13.6
low	Wideband 5G	0.05750	-51.7	RMS	10	-33.0	18.7
low	Wideband 5G	707.0	-38.8	RMS	100	-23.0	15.8
low	Wideband 5G	2124.4	-25.9	RMS	1000	-13.0	12.9
low	Wideband 5G	2491.4	-38.8	RMS	100	-23.0	15.8
low	Wideband 5G	2597.1	-38.3	RMS	100	-23.0	15.3
low	Wideband 5G	4925.8	-27.9	RMS	1000	-13.0	14.9
low	Wideband 5G	6888.6	-24.7	RMS	1000	-13.0	11.7
low	Wideband 5G	19538.3	-29.8	RMS	1000	-13.0	16.8
low	Wideband 5G	20343.2	-29.4	RMS	1000	-13.0	16.4
low	Wideband 5G	30772.4	-28.8	RMS	1000	-13.0	15.8
mid	Wideband 5G	0.00927	-55.9	RMS	1	-43.0	12.9
mid	Wideband 5G	0.14748	-51.9	RMS	10	-33.0	18.9
mid	Wideband 5G	813.6	-38.2	RMS	100	-23.0	15.2
mid	Wideband 5G	2137.9	-26.5	RMS	1000	-13.0	13.5
mid	Wideband 5G	2493.9	-39.2	RMS	100	-23.0	16.2
mid	Wideband 5G	2604.3	-37.8	RMS	100	-23.0	14.8
mid	Wideband 5G	2609.2	-27.7	RMS	1000	-13.0	14.7
mid	Wideband 5G	6877.1	-24.8	RMS	1000	-13.0	11.8
mid	Wideband 5G	19984.3	-29.2	RMS	1000	-13.0	16.2
mid	Wideband 5G	20302.7	-29.3	RMS	1000	-13.0	16.3
mid	Wideband 5G	30043.0	-28.8	RMS	1000	-13.0	15.8
high	Wideband 5G	0.01590	-57.1	RMS	1	-43.0	14.1
high	Wideband 5G	0.07750	-52.6	RMS	10	-33.0	19.6
high	Wideband 5G	949.8	-38.1	RMS	100	-23.0	15.1
high	Wideband 5G	2154.9	-25.7	RMS	1000	-13.0	12.7
high	Wideband 5G	2494.4	-38.5	RMS	100	-23.0	15.5
high	Wideband 5G	2602.7	-38.0	RMS	100	-23.0	15.0
high	Wideband 5G	4204.4	-28.2	RMS	1000	-13.0	15.2
high	Wideband 5G	6990.6	-24.4	RMS	1000	-13.0	11.4
high	Wideband 5G	19938.8	-30.1	RMS	1000	-13.0	17.1
high	Wideband 5G	20292.2	-29.8	RMS	1000	-13.0	16.8
high	Wideband 5G	30745.4	-28.4	RMS	1000	-13.0	15.4

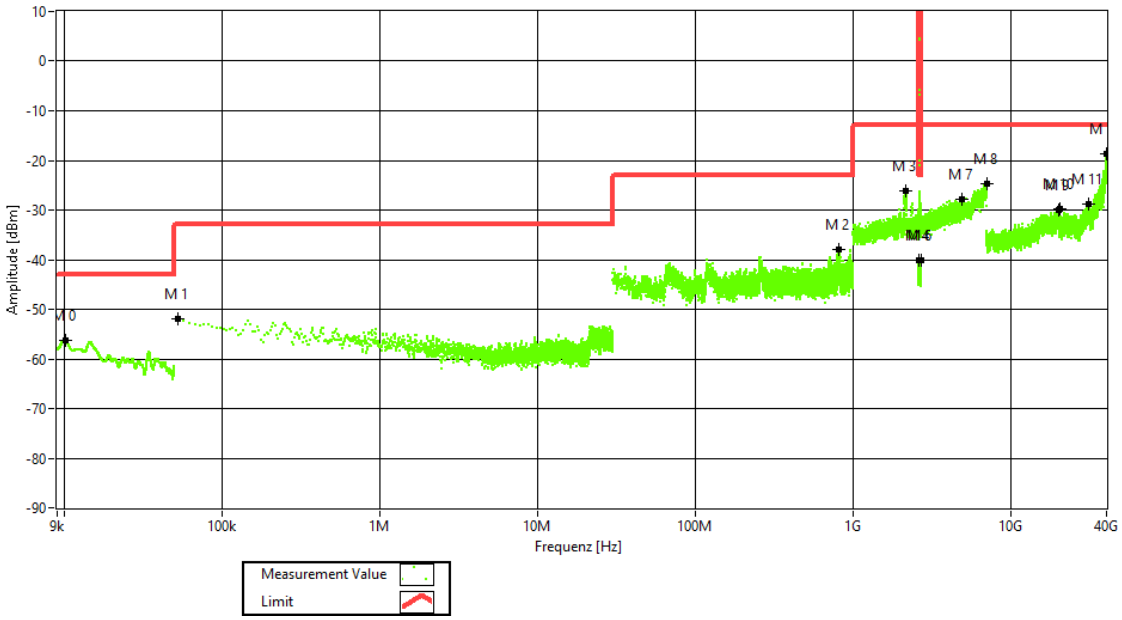
Remark: Please see next sub-clause for the measurement plot.

4.4.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE. "WORST CASE")

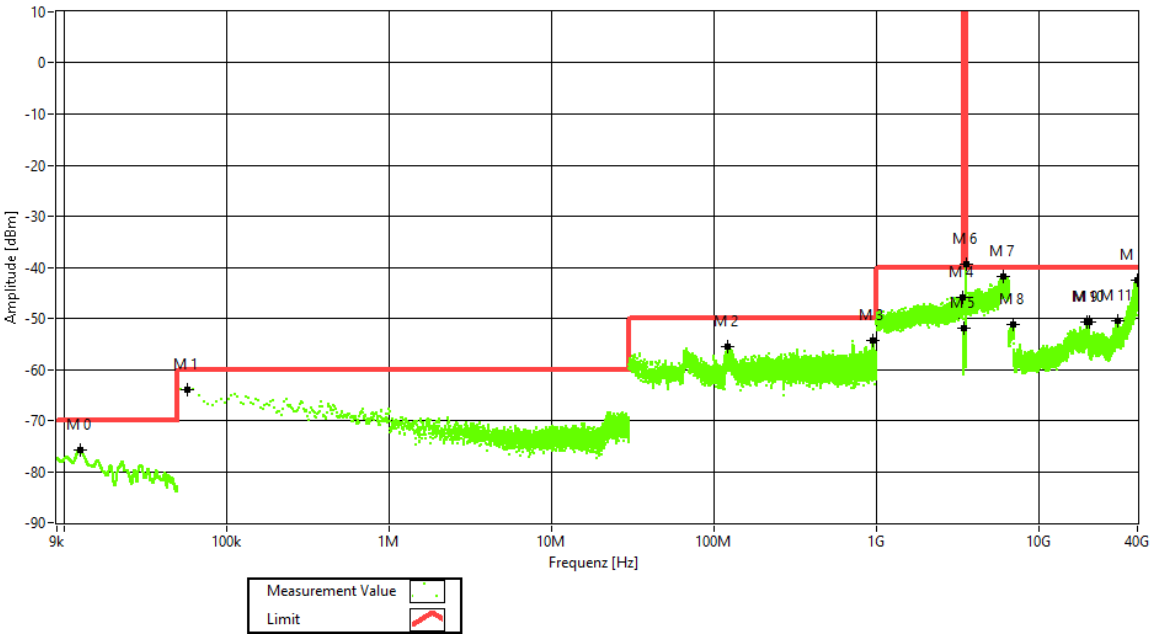
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = Narrowband



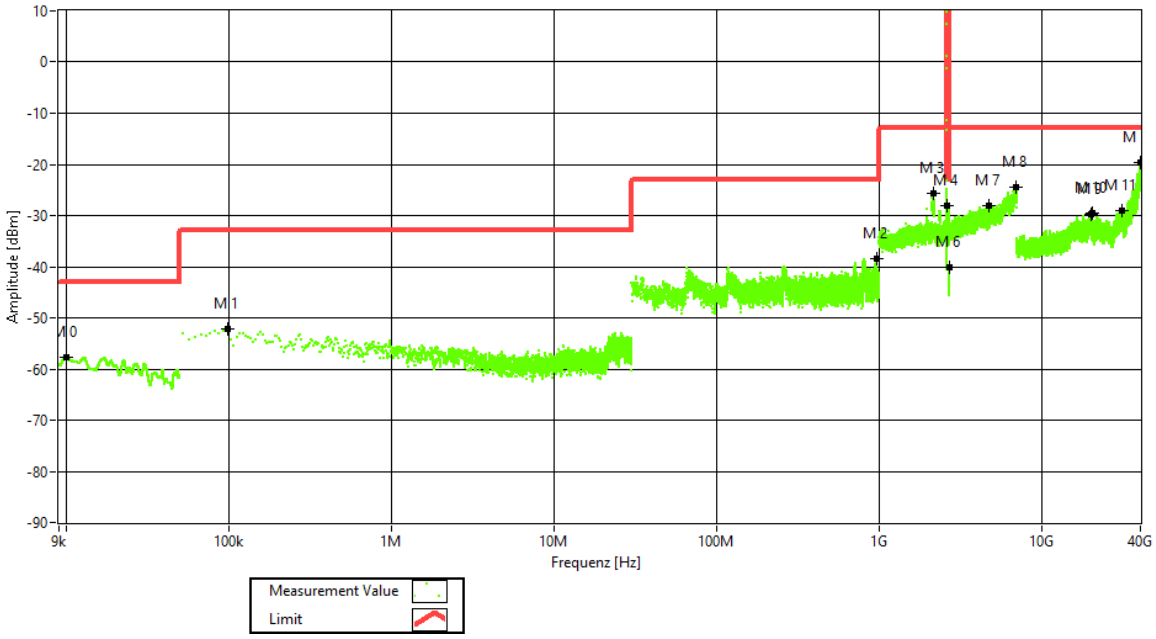
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = mid, Direction = RF downlink,
Signal Type = Narrowband



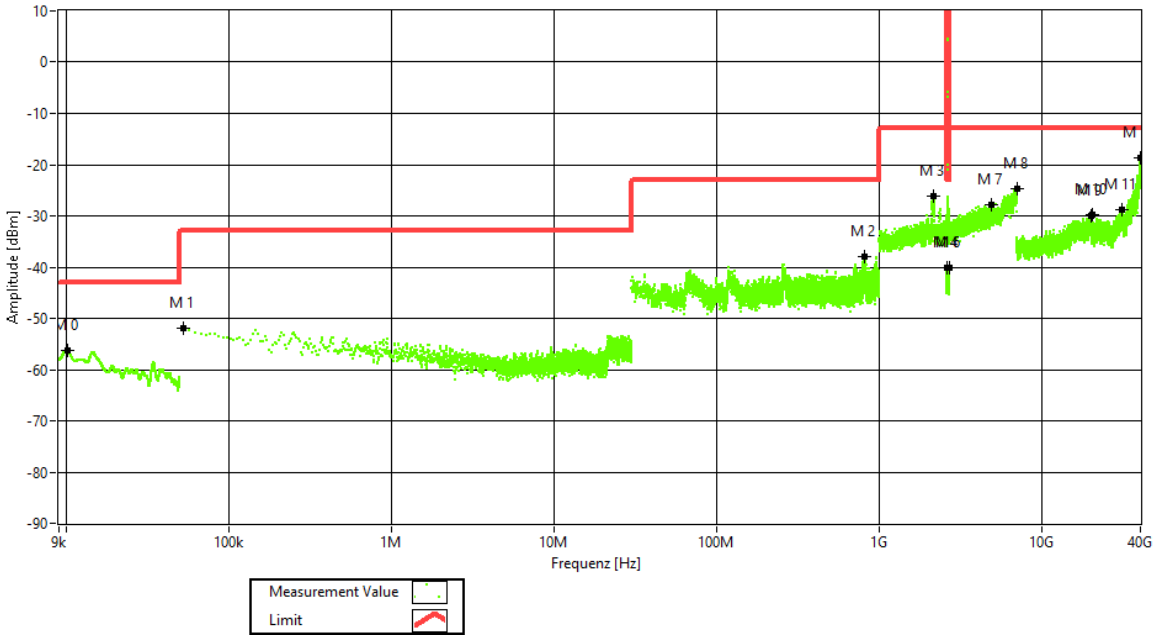
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = Narrowband



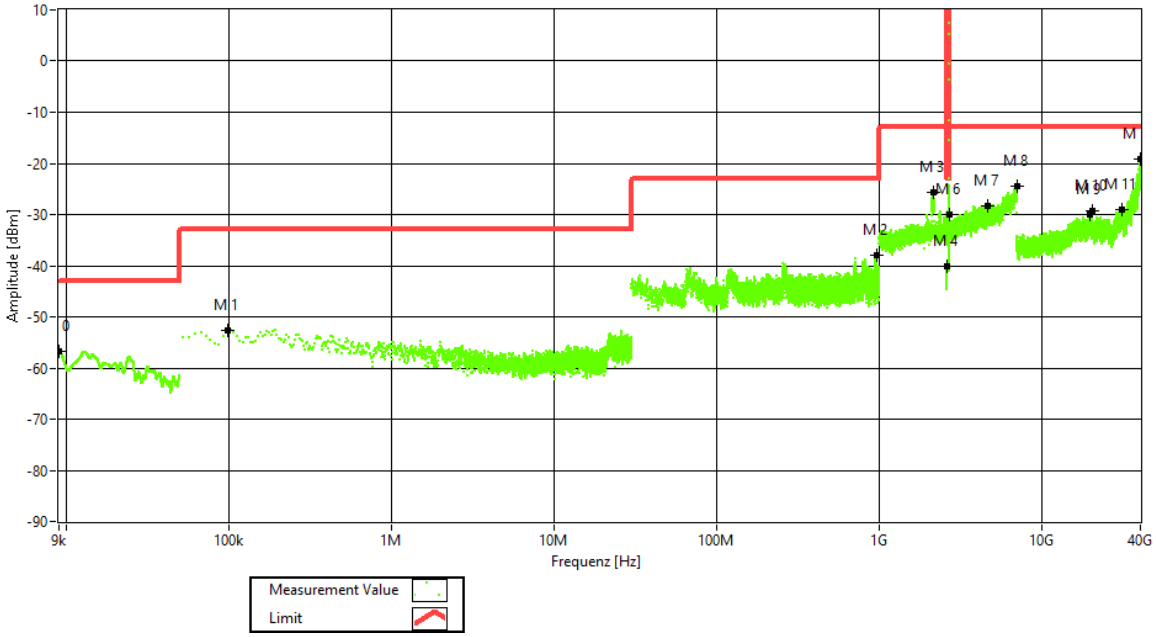
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = AWGN



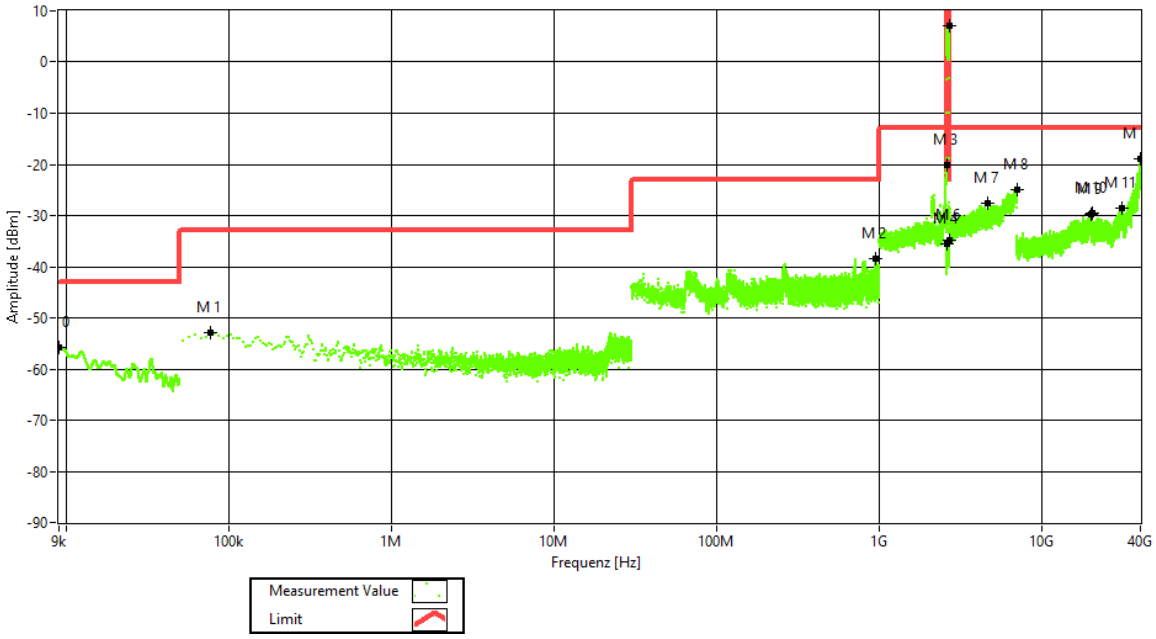
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = mid, Direction = RF downlink,
Signal Type = AWGN



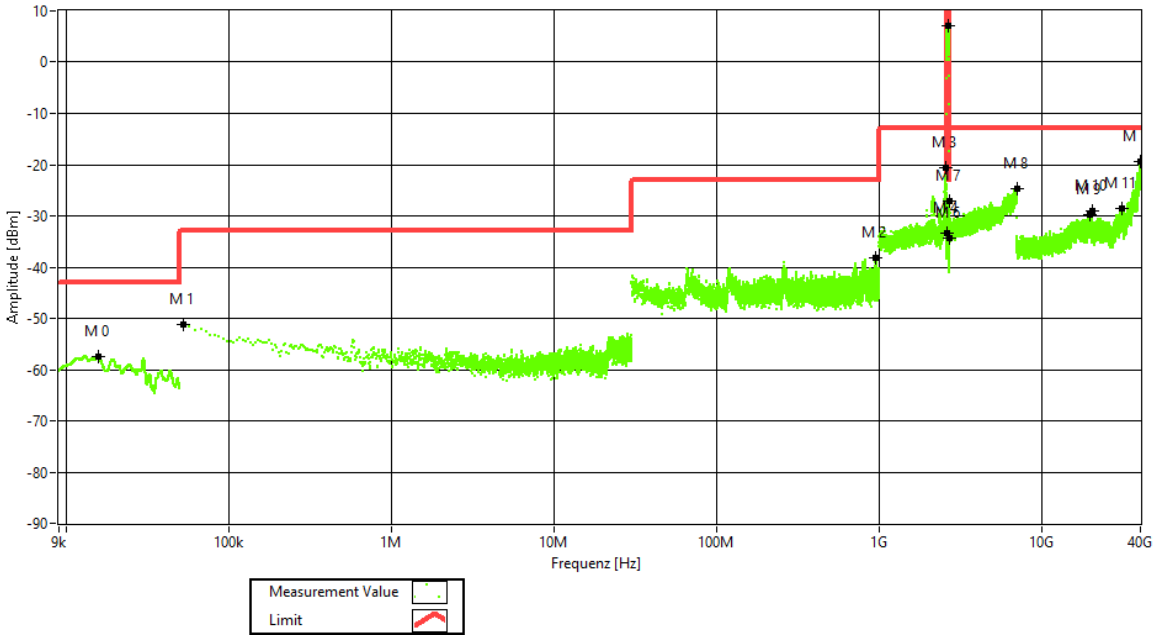
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = AWGN



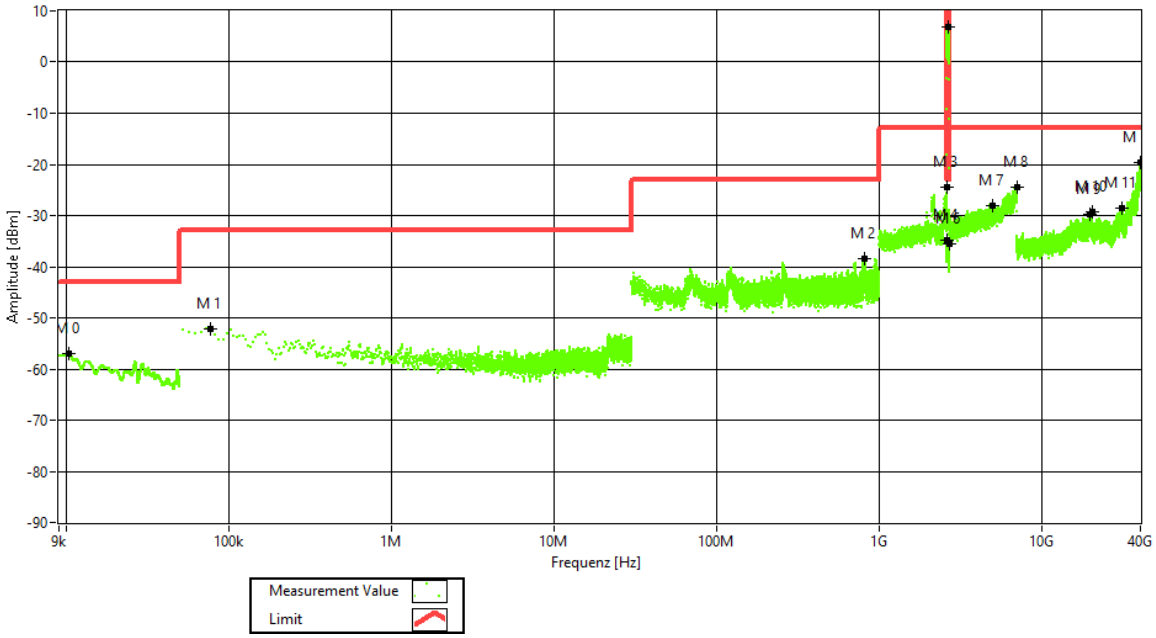
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = low, Direction = RF downlink,
Signal Type = AWGN100



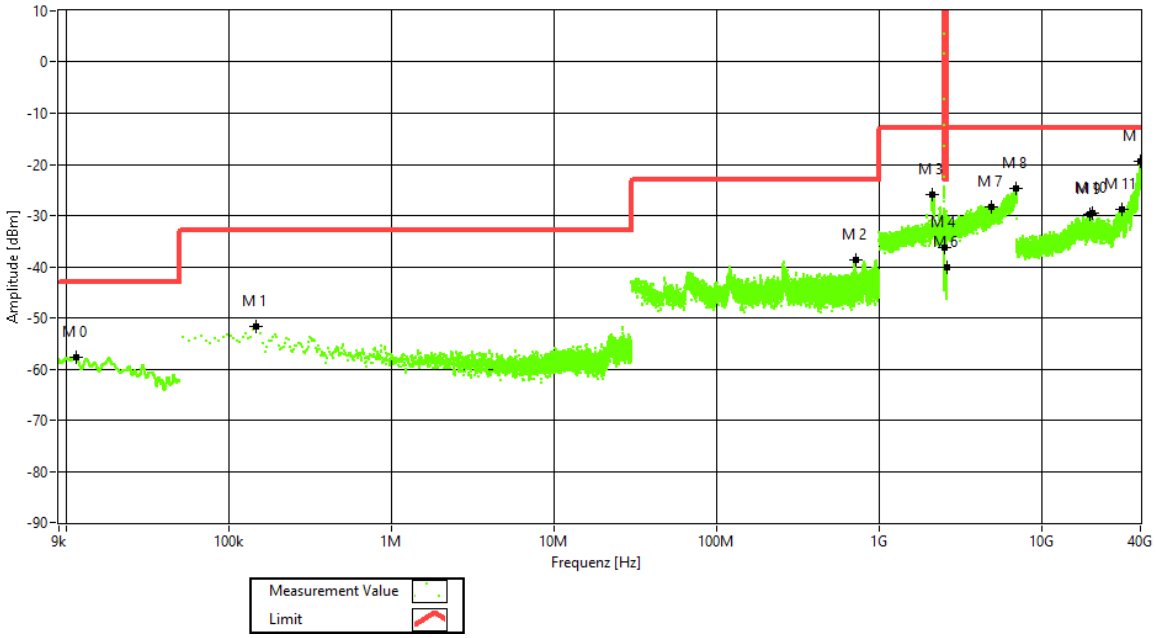
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = mid, Direction = RF downlink,
Signal Type = AWGN100



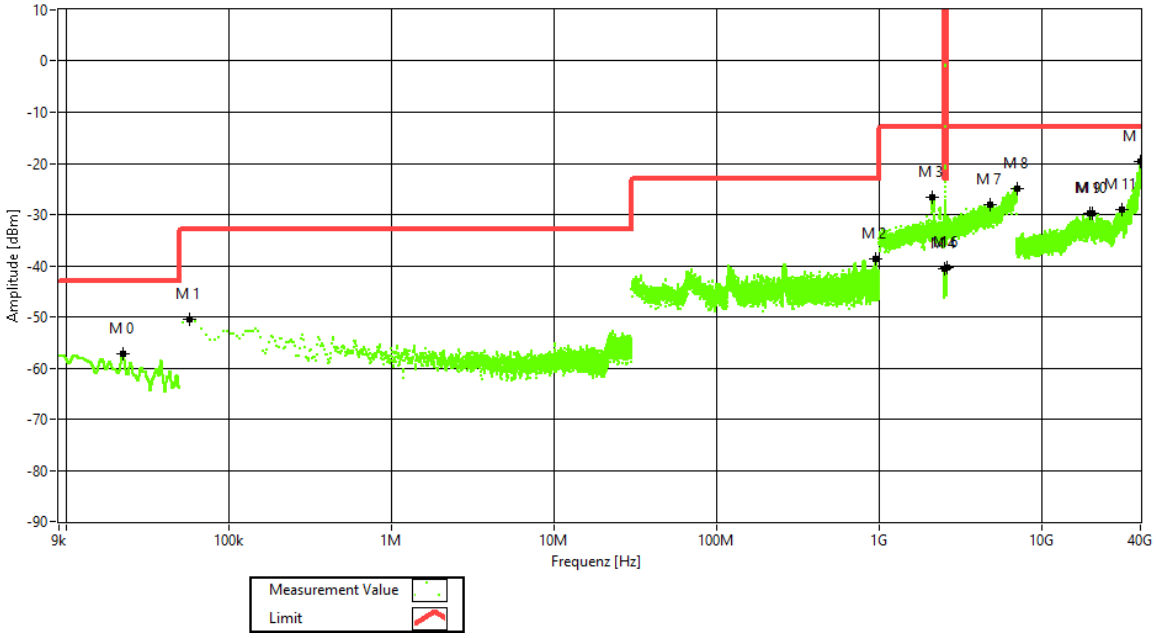
Frequency Band = Band 41 BRS (UBS), ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = AWGN100



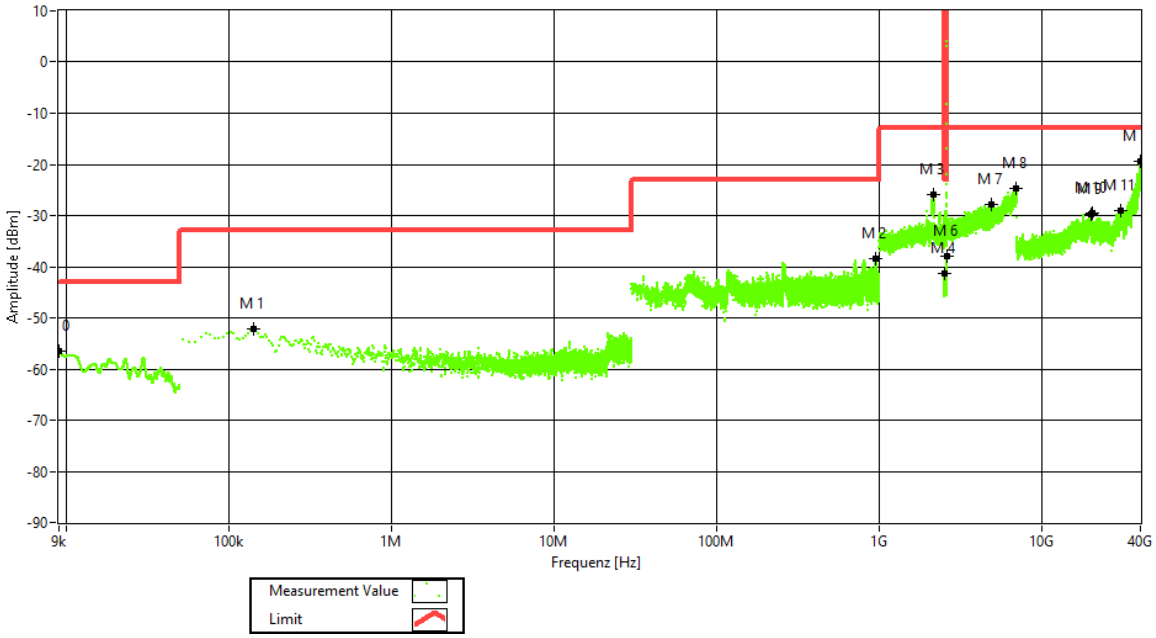
Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = Narrowband



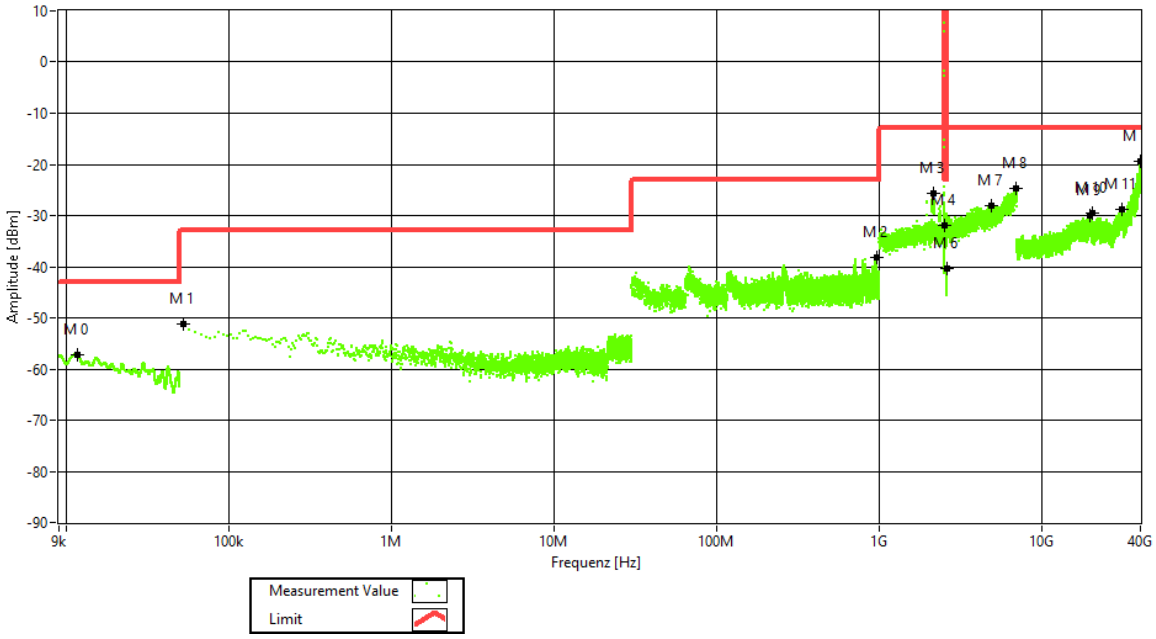
Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = mid, Direction = RF downlink, Signal Type = Narrowband



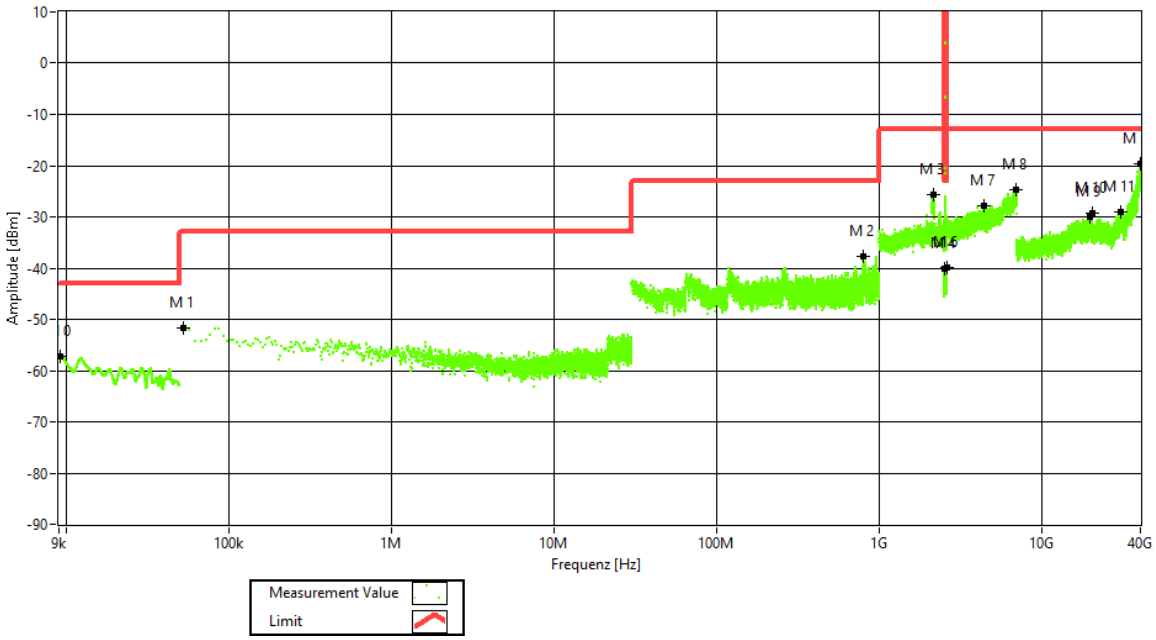
Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = Narrowband



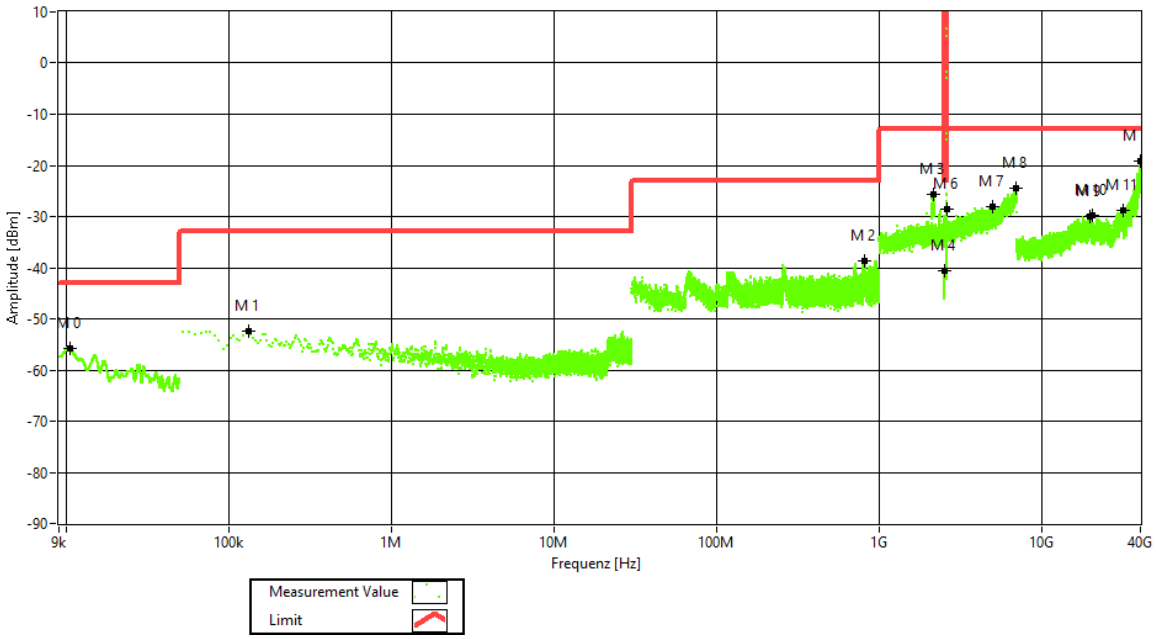
Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = AWGN



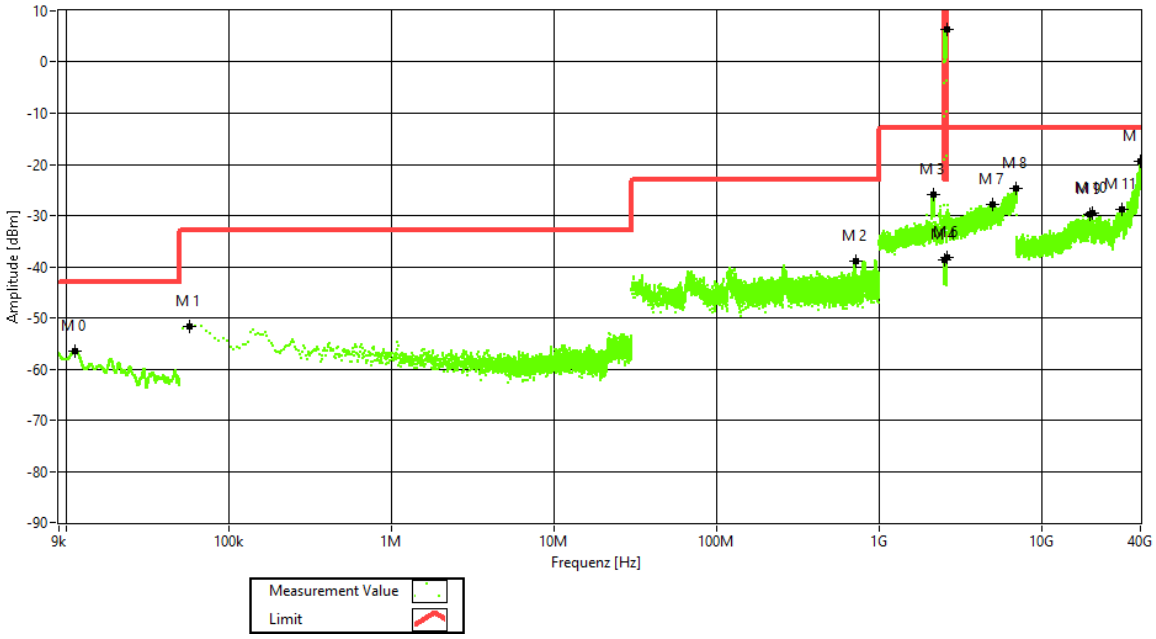
Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = mid, Direction = RF downlink, Signal Type = AWGN



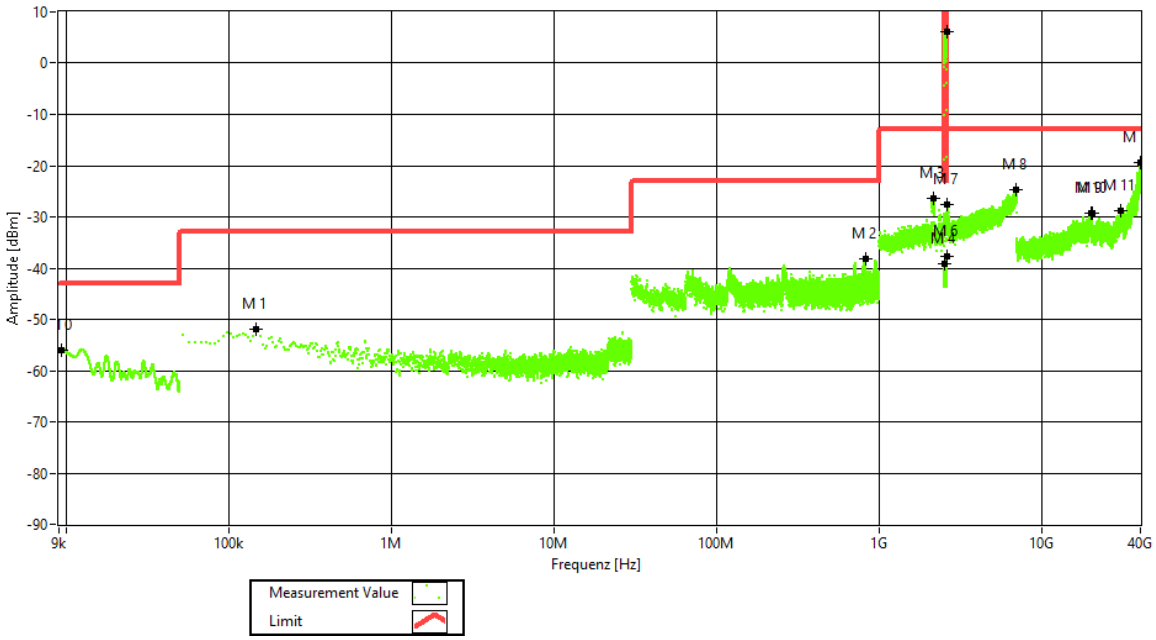
Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = AWGN



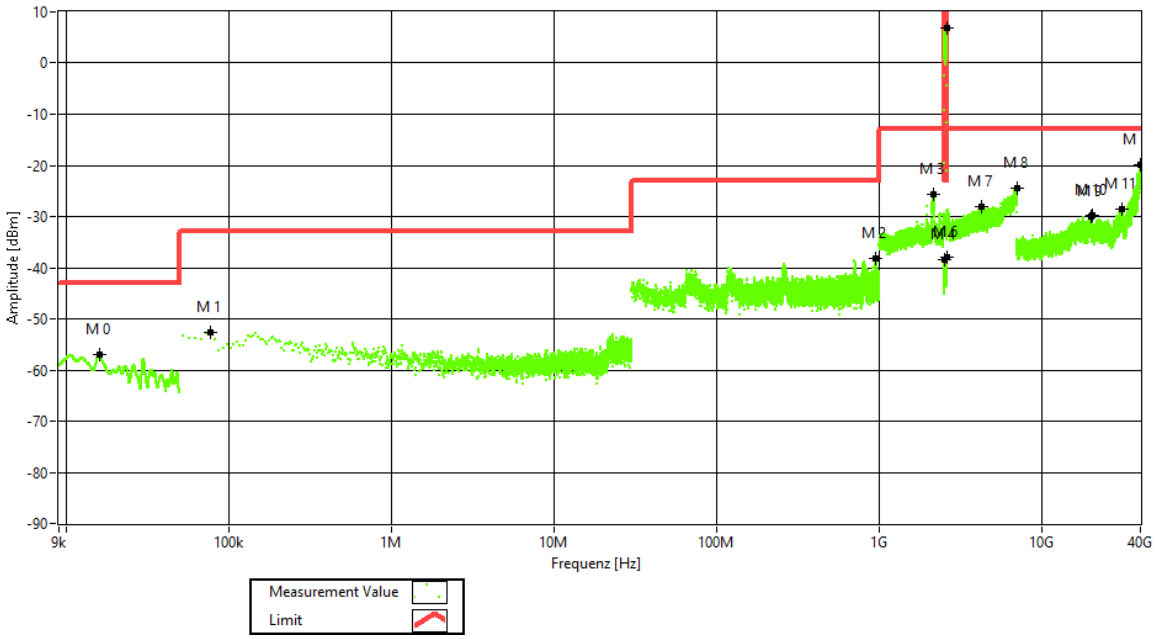
Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = AWGN100



Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = mid, Direction = RF downlink, Signal Type = AWGN100



Frequency Band = Band 41 BRS (LBS), ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = AWGN100



4.4.5 TEST EQUIPMENT USED

- Conducted

4.5 OUT-OF-BAND EMISSION LIMITS

Standard FCC Part §2.1051. §27.53

The test was performed according to:
ANSI C63.26. KDB KDB 935210 D05 v01r04: 3.6

Test date: 2023-10-27

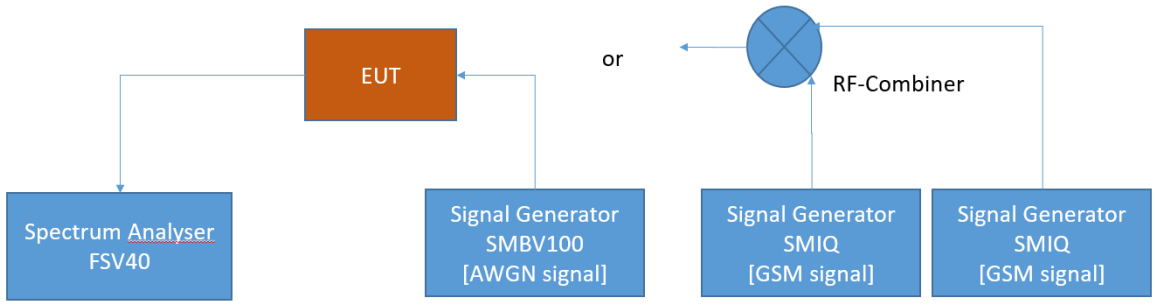
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.5.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the out-of-band emission limit for industrial signal boosters. The limits itself come from the applicable rule part for each operating band.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; Out-of-band emissions

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.5.2 TEST REQUIREMENTS/LIMITS

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Band 41 BRS (LBS/UBS)

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(1) Prior to the transition, and thereafter, solely within the MBS, for analog operations with an EIRP in excess of −9 dBW, the signal shall be attenuated at the channel edges by at least 38 dB relative to the peak visual carrier, then linearly sloping from that level to at least 60 dB of attenuation at 1 MHz below the lower band edge and 0.5 MHz above the upper band edge, and attenuated at least 60 dB at all other frequencies.

(2) For digital base stations, the attenuation shall be not less than 43 + 10 log (P) dB, unless a documented interference complaint is received from an adjacent channel licensee with an overlapping Geographic Service Area. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS No. 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

4.5.3 TEST PROTOCOL

Band 41 BRS (UBS), downlink, Number of input signals = 1							
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
Narrowband	0.3 dB < AGC	lower	2590.2	-3.5	-27.6	-13.0	14.6
Narrowband	3 dB > AGC	lower	2590.2	-0.2	-27.9	-13.0	14.9
Wideband	0.3 dB < AGC	lower	2592.5	-5.1	-30.1	-13.0	17.1
Wideband	3 dB > AGC	lower	2592.5	-1.8	-30.3	-13.0	17.3
Wideband 5G	0.3 dB < AGC	lower	2640.00	-5.4	-28.6	-13.0	15.6
Wideband 5G	3 dB > AGC	lower	2640.00	-2.4	-28.2	-13.0	15.2
Narrowband	0.3 dB < AGC	upper	2689.8	-4.7	-27.4	-13.0	14.4
Narrowband	3 dB > AGC	upper	2689.8	-1.4	-27.9	-13.0	14.9
Wideband	0.3 dB < AGC	upper	2687.5	-5.5	-30.8	-13.0	17.8
Wideband	3 dB > AGC	upper	2687.5	-2.2	-30.6	-13.0	17.6
Wideband 5G	0.3 dB < AGC	upper	2640.00	-5.8	-28.4	-13.0	15.4
Wideband 5G	3 dB > AGC	upper	2640.00	-2.8	-28.3	-13.0	15.3

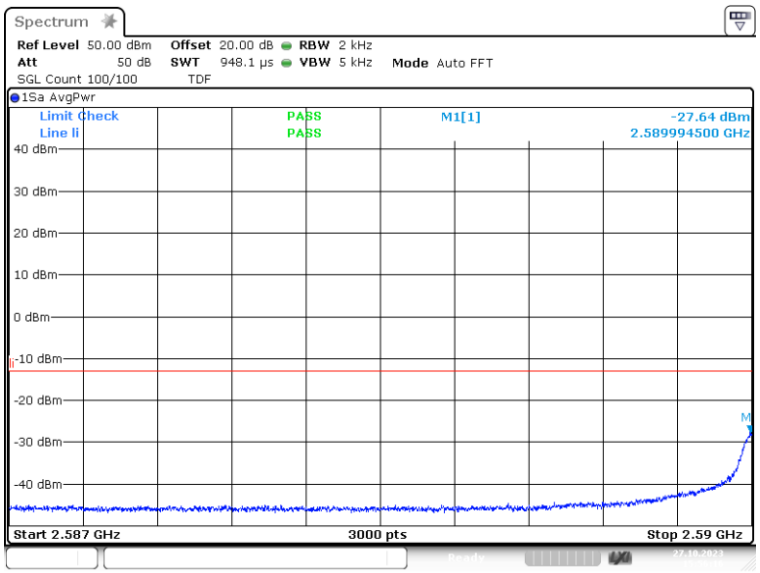
Band 41 BRS (UBS), downlink, Number of input signals = 2								
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency f1 [MHz]**	**Signal Frequency f2 [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
Narrowband	0.3 dB < AGC	lower	2590.2	2592.4	-3.5	-30.2	-13.0	17.2
Narrowband	3 dB > AGC	lower	2590.2	2592.4	-0.2	-30.8	-13.0	17.8
Wideband	0.3 dB < AGC	lower	2592.5	2595.0	-5.1	-30.9	-13.0	17.9
Wideband	3 dB > AGC	lower	2592.5	2595.0	-1.8	-31.1	-13.0	18.1
Narrowband	0.3 dB < AGC	upper	2689.8	2689.6	-4.7	-29.8	-13.0	16.8
Narrowband	3 dB > AGC	upper	2689.8	2689.6	-1.4	-29.9	-13.0	16.9
Wideband	0.3 dB < AGC	upper	2687.5	2685.0	-5.5	-31.0	-13.0	18.0
Wideband	3 dB > AGC	upper	2687.5	2685.0	-2.2	-31.2	-13.0	18.2

Band 41 BRS (LBS), downlink, Number of input signals = 1							
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
Narrowband	0.3 dB < AGC	lower	2496.2	-3.7	-28.4	-13.0	15.4
Narrowband	3 dB > AGC	lower	2496.2	-0.4	-27.4	-13.0	14.4
Wideband	0.3 dB < AGC	lower	2498.5	-4.1	-30.2	-13.0	17.2
Wideband	3 dB > AGC	lower	2498.5	-0.8	-29.8	-13.0	16.8
Wideband 5G	0.3 dB < AGC	lower	2546.00	-4.4	-28.6	-13.0	15.6
Wideband 5G	3 dB > AGC	lower	2546.00	-1.4	-28.3	-13.0	15.3
Narrowband	0.3 dB < AGC	upper	2595.8	-3.5	-27.9	-13.0	14.9
Narrowband	3 dB > AGC	upper	2595.8	-0.2	-28.1	-13.0	15.1
Wideband	0.3 dB < AGC	upper	2593.5	-4.3	-30.5	-13.0	17.5
Wideband	3 dB > AGC	upper	2593.5	-1.0	-30.3	-13.0	17.3
Wideband 5G	0.3 dB < AGC	upper	2546.00	-4.6	-28.4	-13.0	15.4
Wideband 5G	3 dB > AGC	upper	2546.00	-1.6	-28.2	-13.0	15.2

Band 41 BRS (LBS), downlink, Number of input signals = 2								
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency f1 [MHz]**	**Signal Frequency f2 [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
Narrowband	0.3 dB < AGC	lower	2496.2	2496.4	-3.7	-30.7	-13.0	17.7
Narrowband	3 dB > AGC	lower	2496.2	2496.4	-0.4	-30.2	-13.0	17.2
Wideband	0.3 dB < AGC	lower	2498.5	2501.0	-4.1	-30.8	-13.0	17.8
Wideband	3 dB > AGC	lower	2498.5	2501.0	-0.8	-31.1	-13.0	18.1
Narrowband	0.3 dB < AGC	upper	2595.8	2595.6	-3.5	-30.6	-13.0	17.6
Narrowband	3 dB > AGC	upper	2595.8	2595.6	-0.2	-30.2	-13.0	17.2
Wideband	0.3 dB < AGC	upper	2593.5	2591.0	-4.3	-30.7	-13.0	17.7
Wideband	3 dB > AGC	upper	2593.5	2591.0	-1.0	-30.8	-13.0	17.8

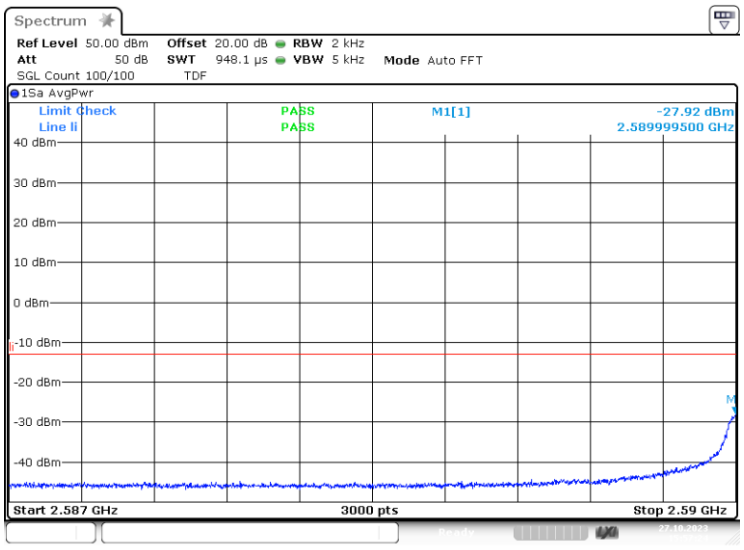
4.5.4 MEASUREMENT PLOT

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



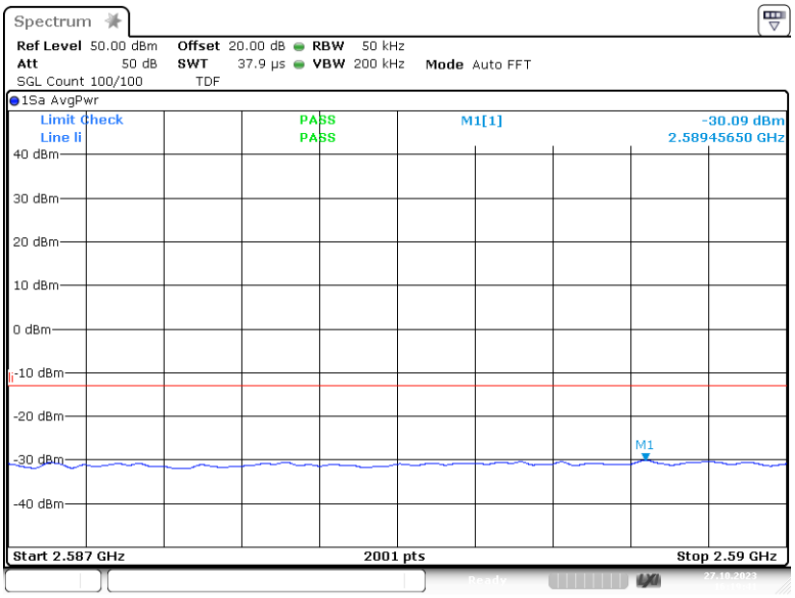
3.6.2 out of band emi BRS high R GSM lower 1carrier -0.3 dB
2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



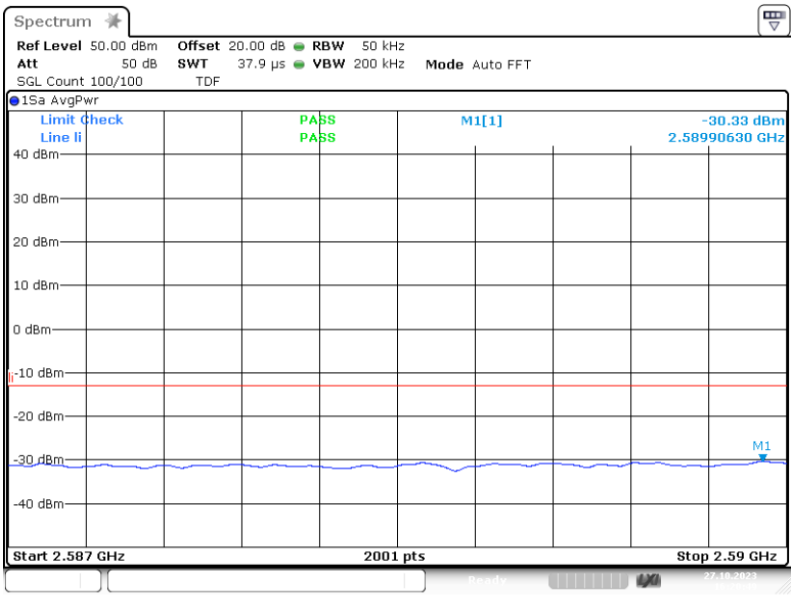
3.6.2 out of band emi BRS high R GSM lower 1carrier +3.0 dB
2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



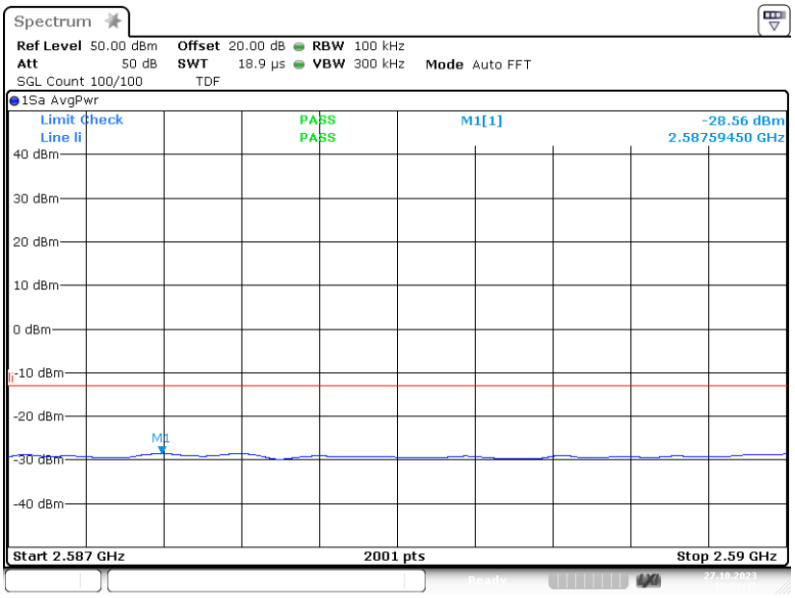
3.6.2 out of band emi BRS high R AWGN lower 1carrier -0.3 dB
2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



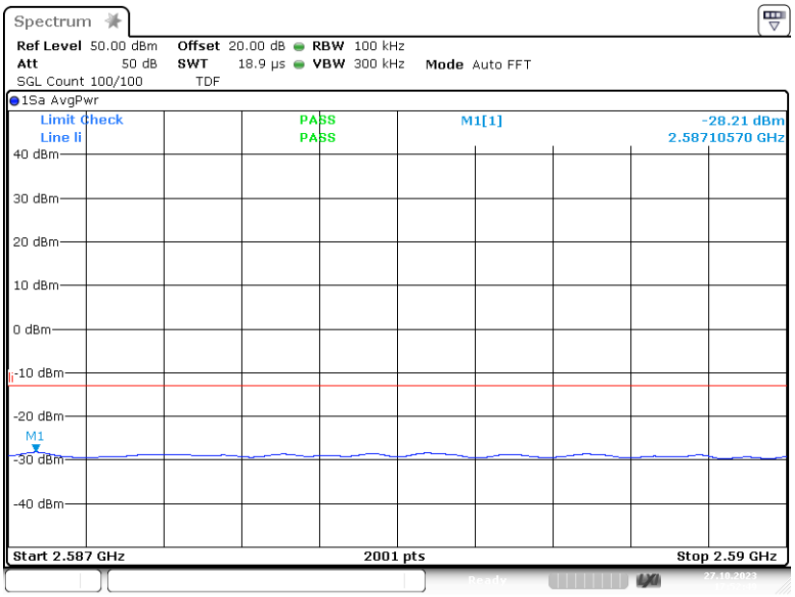
3.6.2 out of band emi BRS high R AWGN lower 1carrier +3.0 dB
2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: AWGN100; Input Power = 0.3 dB < AGC; Number of signals 1



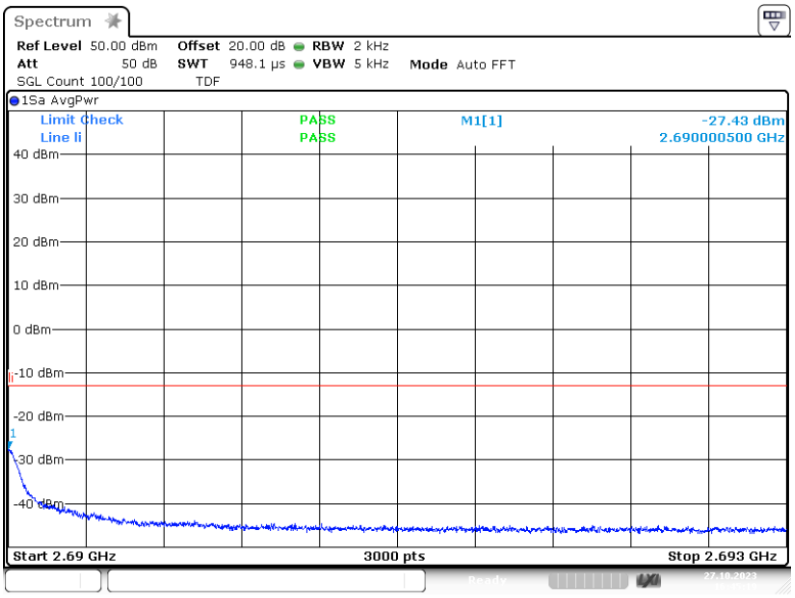
3.6.2 out of band emi BRS high R AWGN100 lower 1carrier -0.3 dB 2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: AWGN100; Input Power = 3 dB > AGC; Number of signals 1



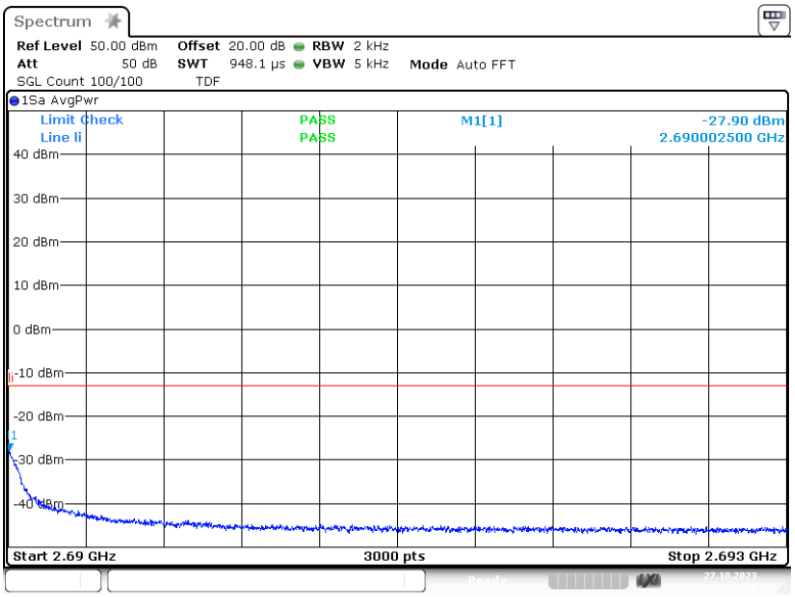
3.6.2 out of band emi BRS high R AWGN100 lower 1carrier +3.0 dB 2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



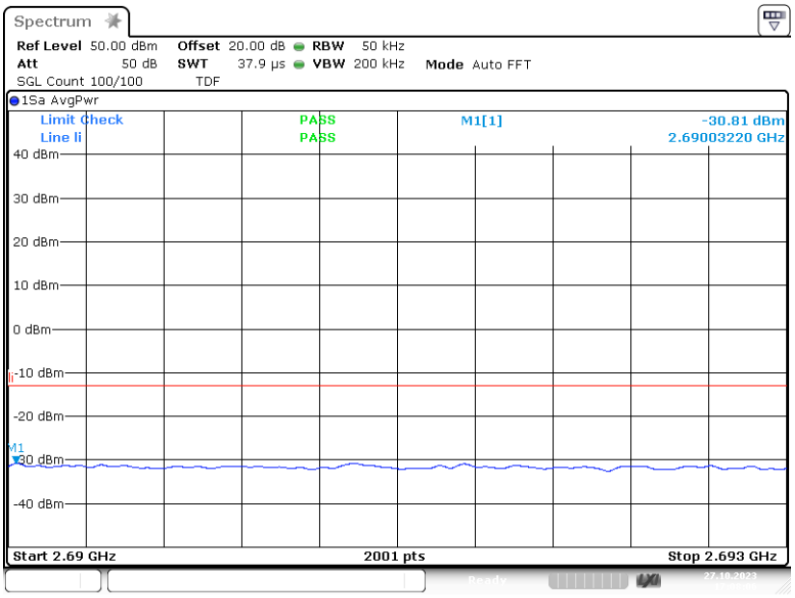
3.6.2 out of band emi BRS high R GSM upper 1carrier -0.3 dB
2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



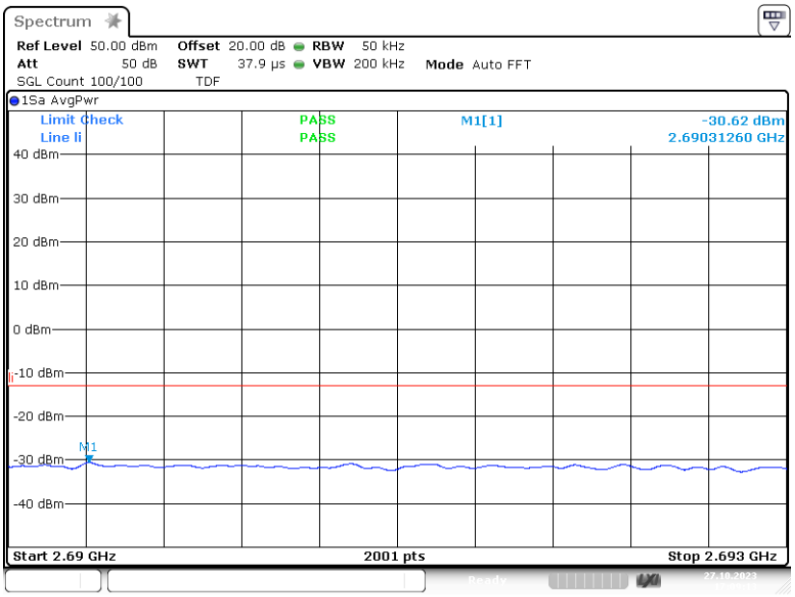
3.6.2 out of band emi BRS high R GSM upper 1carrier +3.0 dB
2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



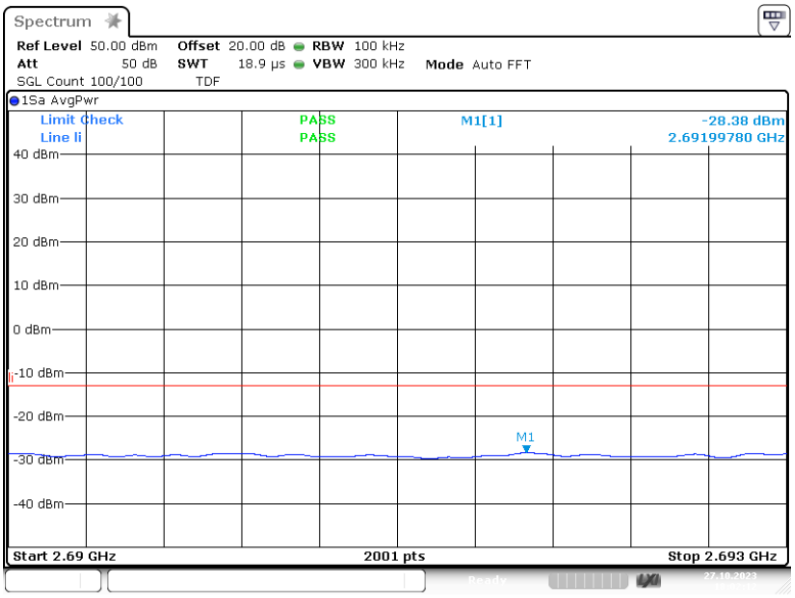
3.6.2 out of band emi BRS high R AWGN upper 1carrier -0.3 dB
2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



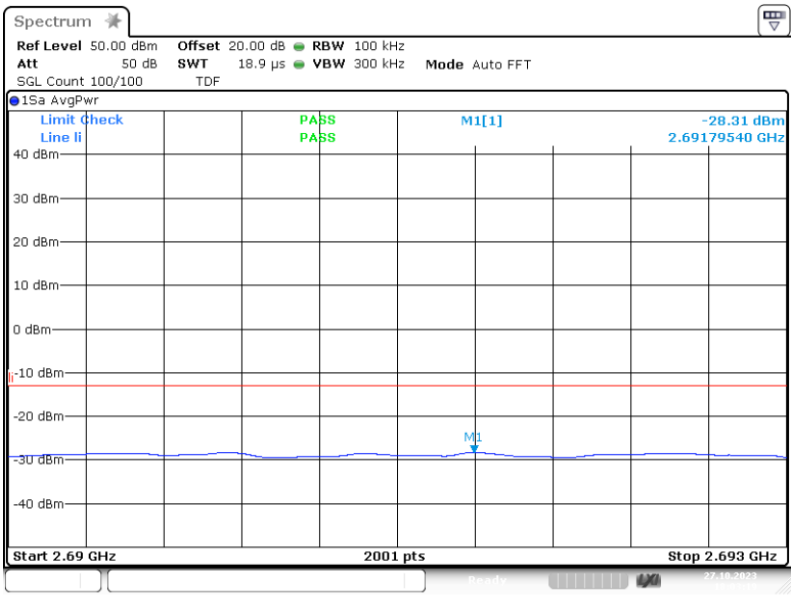
3.6.2 out of band emi BRS high R AWGN upper 1carrier +3.0 dB
2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: AWGN100; Input Power = 0.3 dB < AGC; Number of signals 1



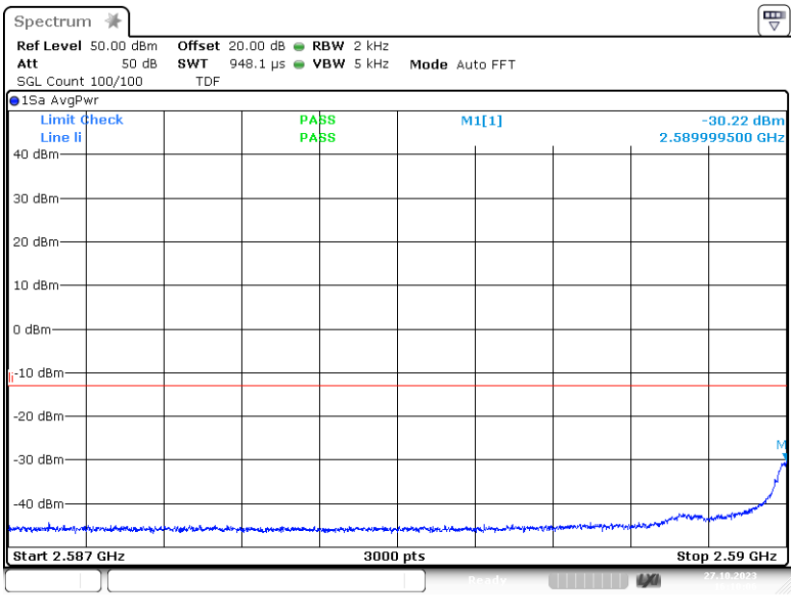
3.6.2 out of band emi BRS high R AWGN100 upper 1carrier -0.3 dB 2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: AWGN100; Input Power = 3 dB > AGC; Number of signals 1



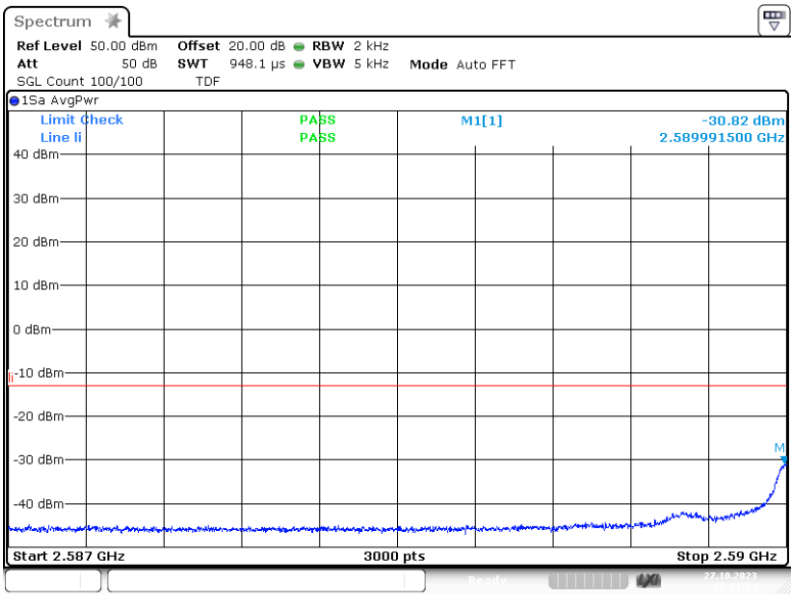
3.6.2 out of band emi BRS high R AWGN100 upper 1carrier +3.0 dB 2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



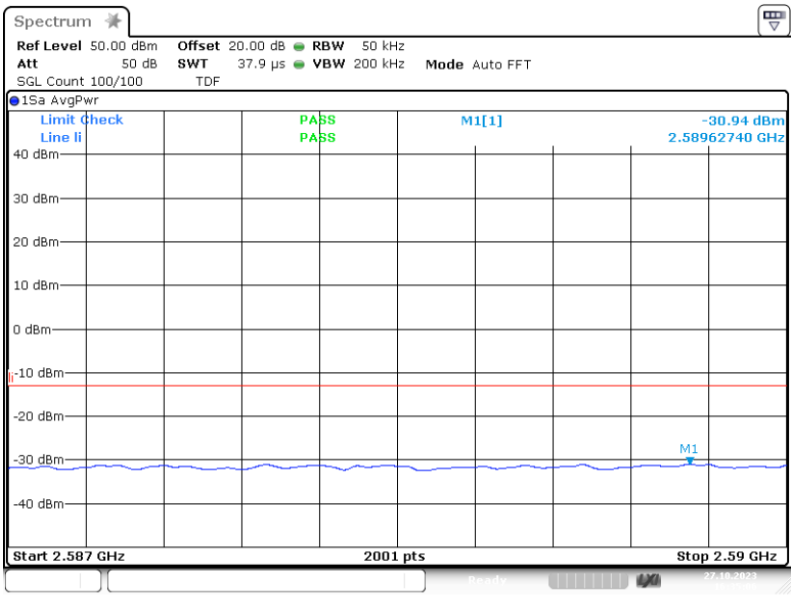
3.6.2 out of band emi BRS high R GSM lower 2carriers -0.3 dB
2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



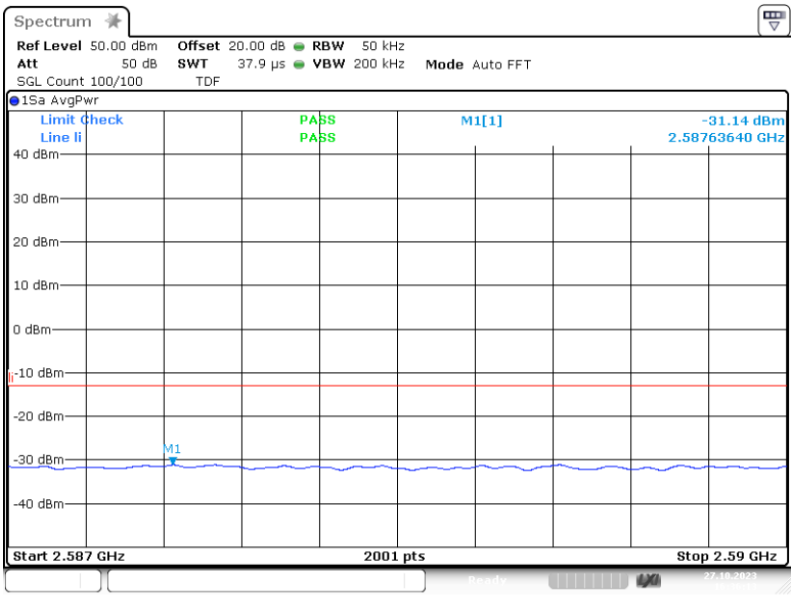
3.6.2 out of band emi BRS high R GSM lower 2carriers +3.0 dB
2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



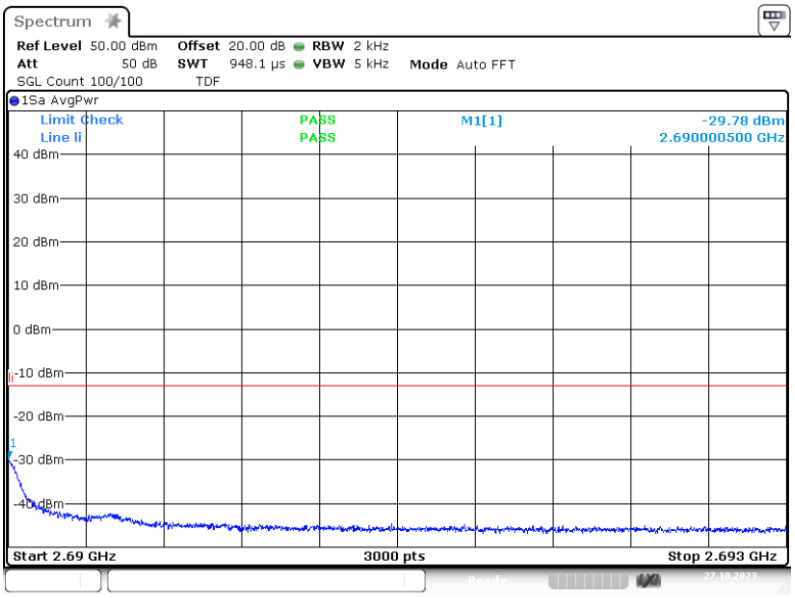
3.6.2 out of band emi BRS high R AWGN lower 2carriers -0.3 d
B 2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



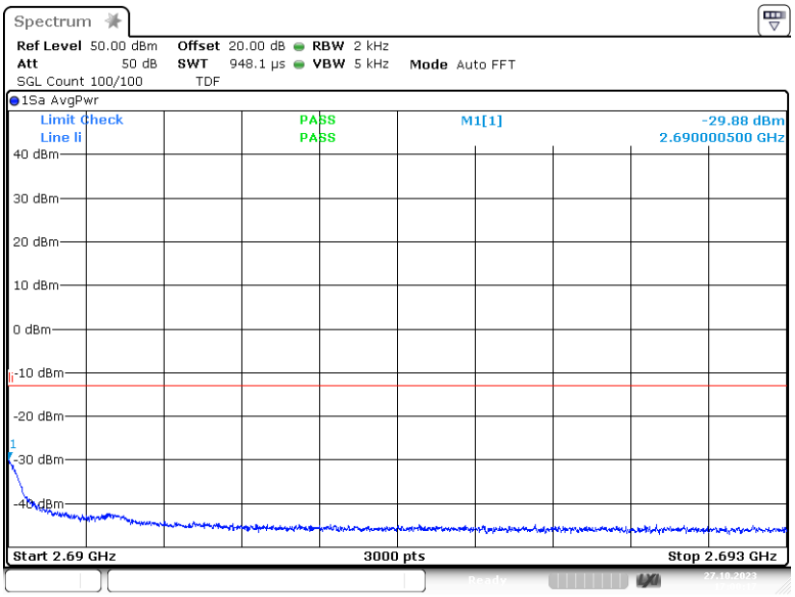
3.6.2 out of band emi BRS high R AWGN lower 2carriers +3.0 d
B 2.587G 2.590G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



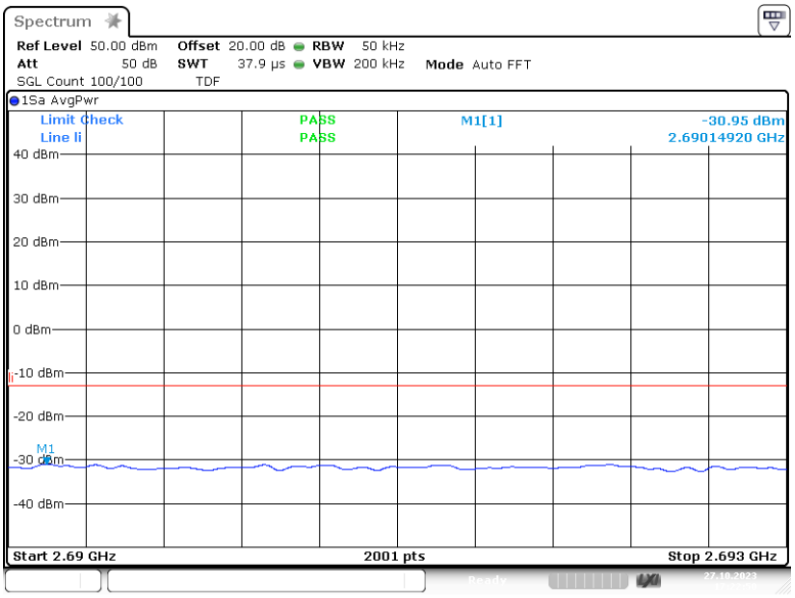
3.6.2 out of band emi BRS high R GSM upper 2carriers -0.3 dB
2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



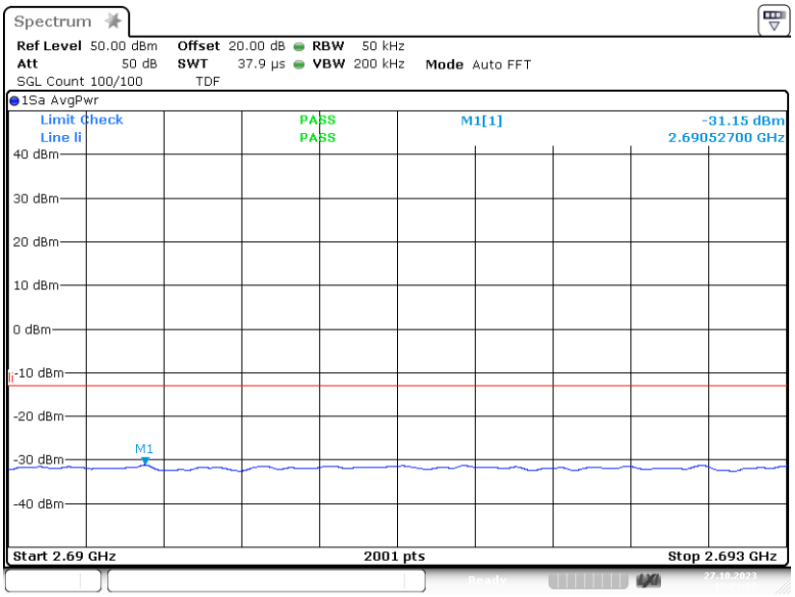
3.6.2 out of band emi BRS high R GSM upper 2carriers +3.0 dB
2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



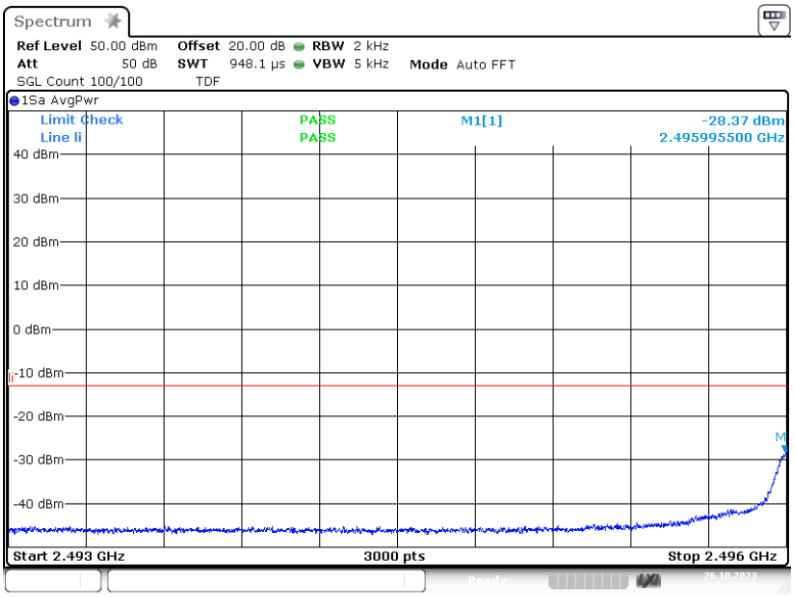
3.6.2 out of band emi BRS high R AWGN upper 2carriers -0.3 d
B 2.690G 2.693G

Band: BRS (UBS); ANT 2; Frequency: 2.5900 GHz to 2.6900 GHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



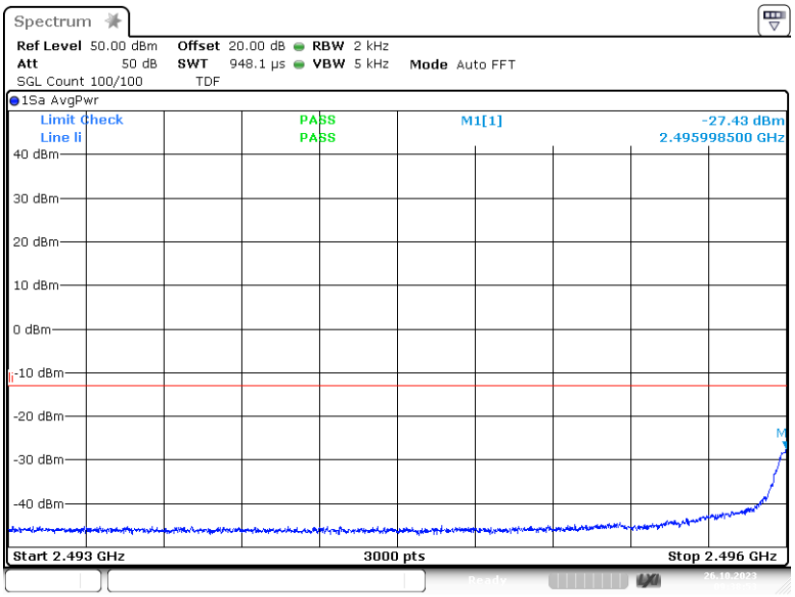
3.6.2 out of band emi BRS high R AWGN upper 2carriers +3.0 d
B 2.690G 2.693G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



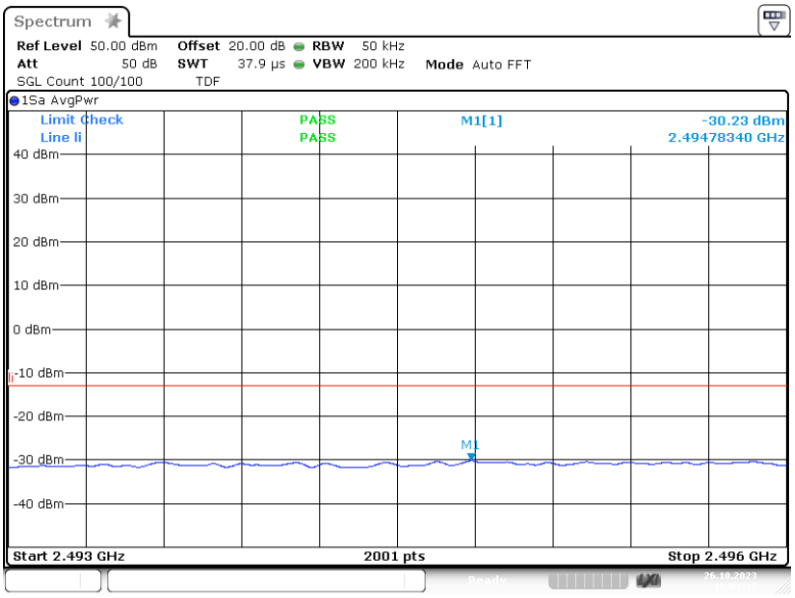
3.6.2 out of band emi BRS low R GSM lower 1carrier -0.3 dB 2
.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



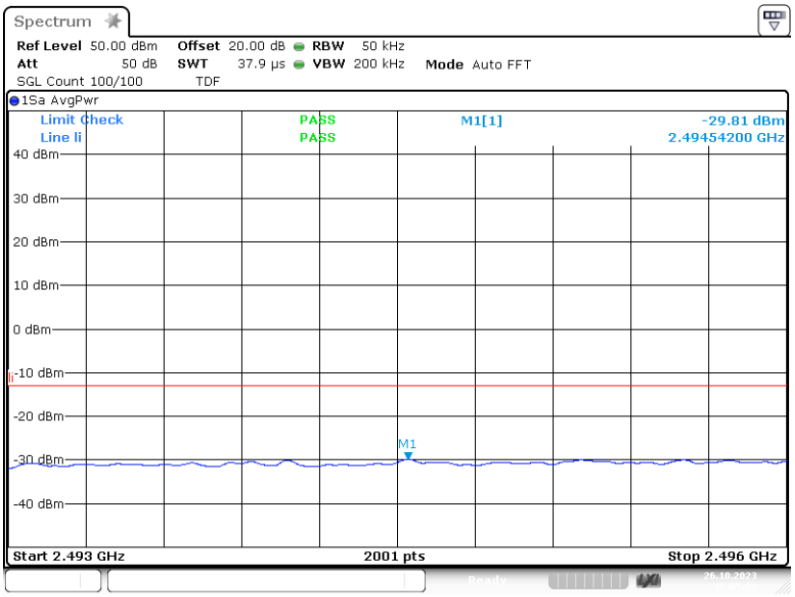
3.6.2 out of band emi BRS low R GSM lower 1carrier +3.0 dB 2
.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



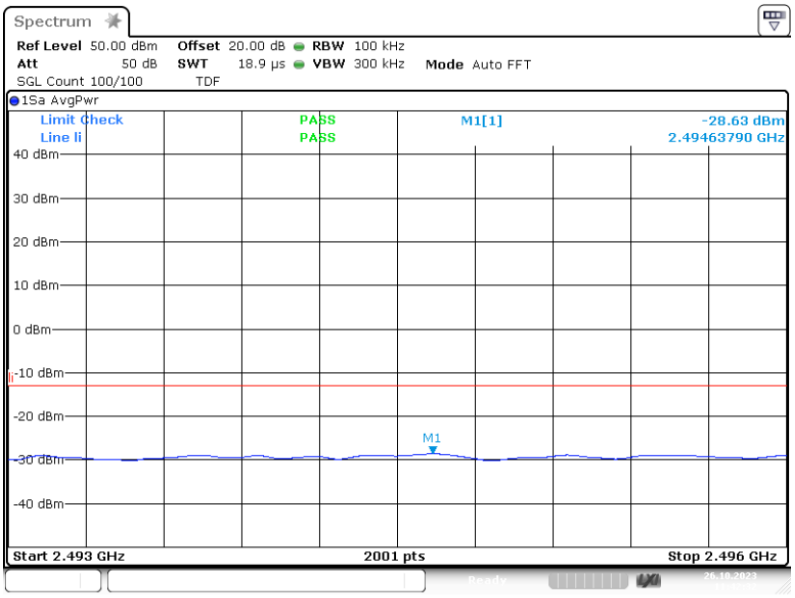
3.6.2 out of band emi BRS low R AWGN lower 1carrier -0.3 dB
2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



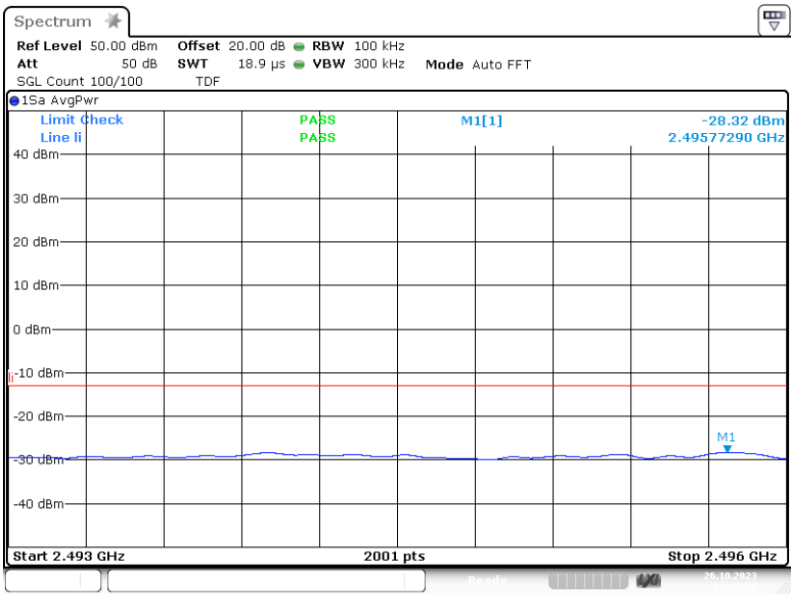
3.6.2 out of band emi BRS low R AWGN lower 1carrier +3.0 dB
2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: AWGN100; Input Power = 0.3 dB < AGC; Number of signals 1



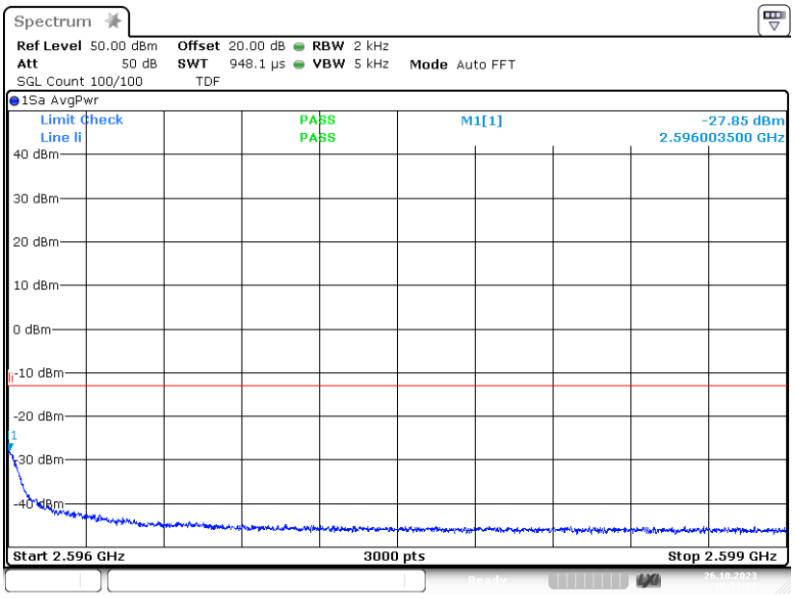
3.6.2 out of band emi BRS low R AWGN100 lower 1carrier -0.3
dB 2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: AWGN100; Input Power = 3 dB > AGC; Number of signals 1



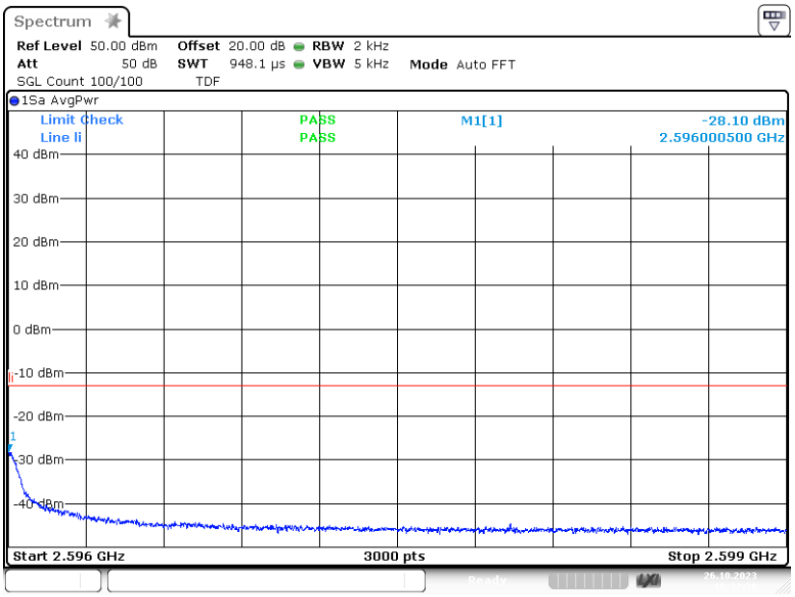
3.6.2 out of band emi BRS low R AWGN100 lower 1carrier +3.0
dB 2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



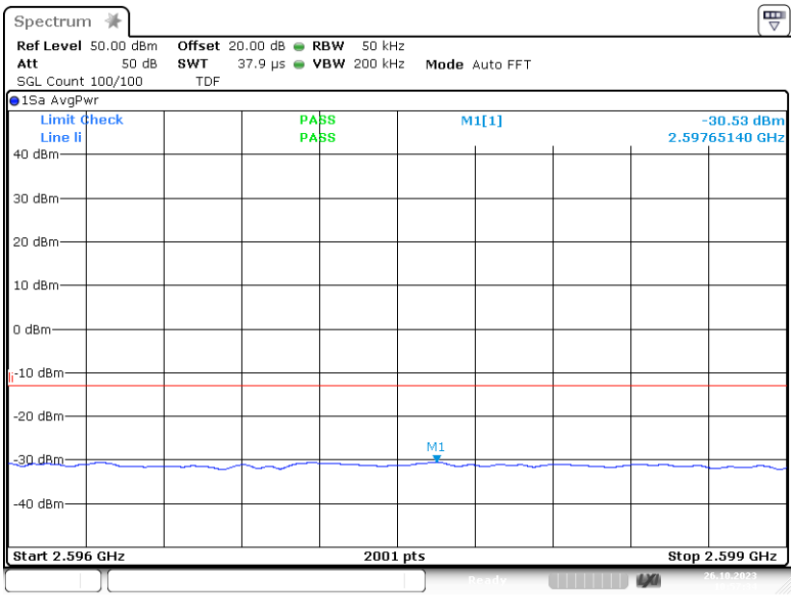
3.6.2 out of band emi BRS low R GSM upper 1carrier -0.3 dB 2
.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



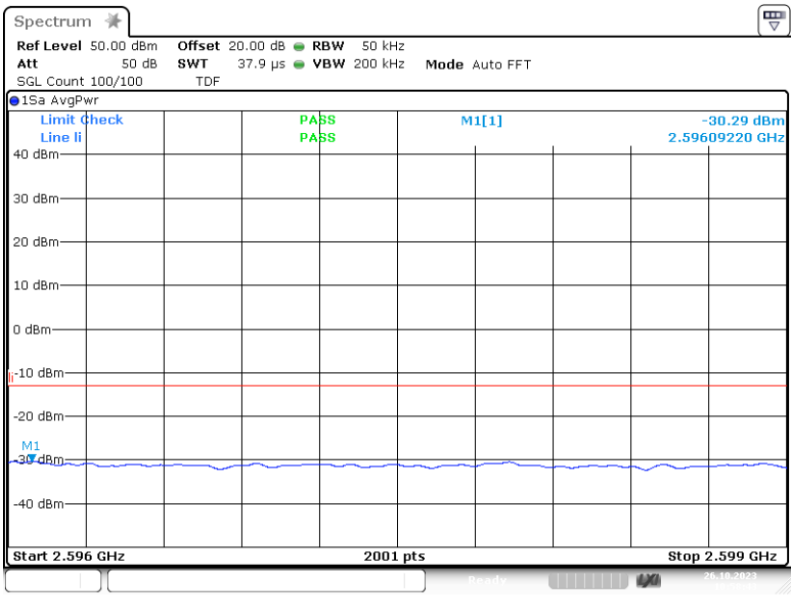
3.6.2 out of band emi BRS low R GSM upper 1carrier +3.0 dB 2
.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



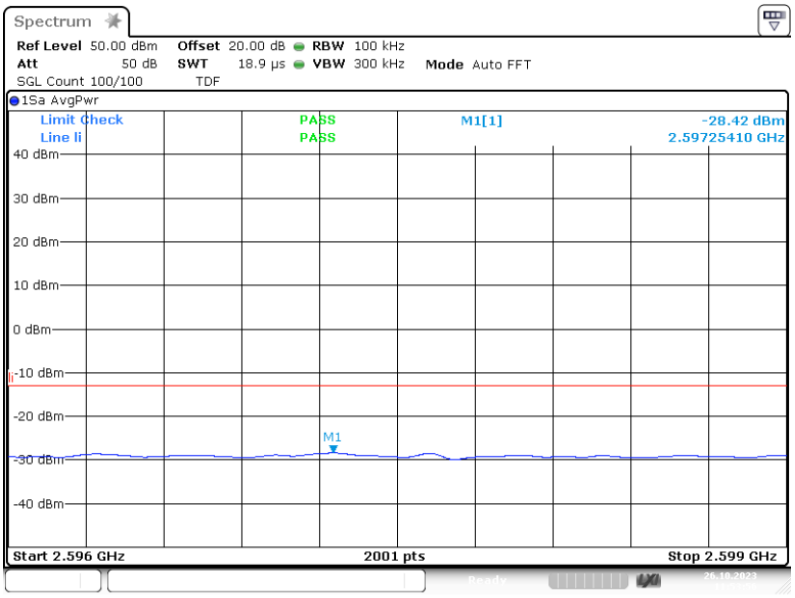
3.6.2 out of band emi BRS low R AWGN upper 1carrier -0.3 dB
2.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



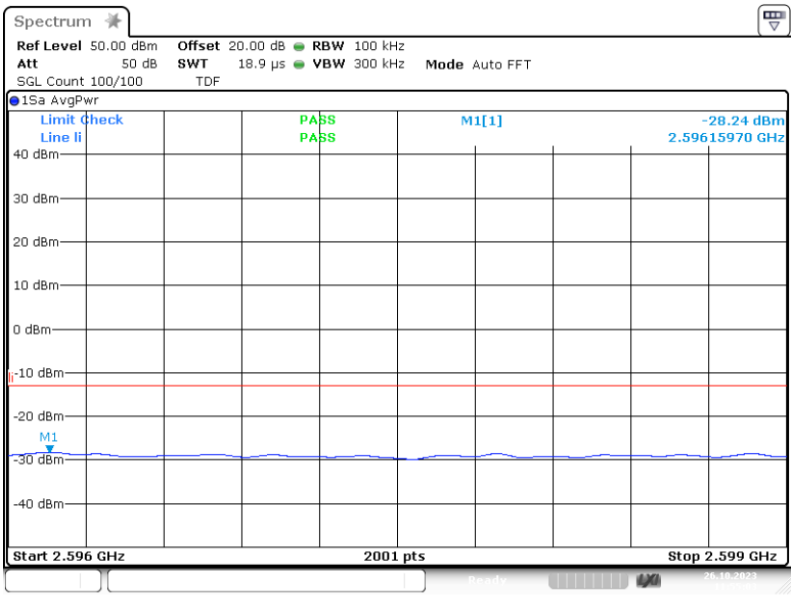
3.6.2 out of band emi BRS low R AWGN upper 1carrier +3.0 dB
2.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: AWGN100; Input Power = 0.3 dB < AGC; Number of signals 1



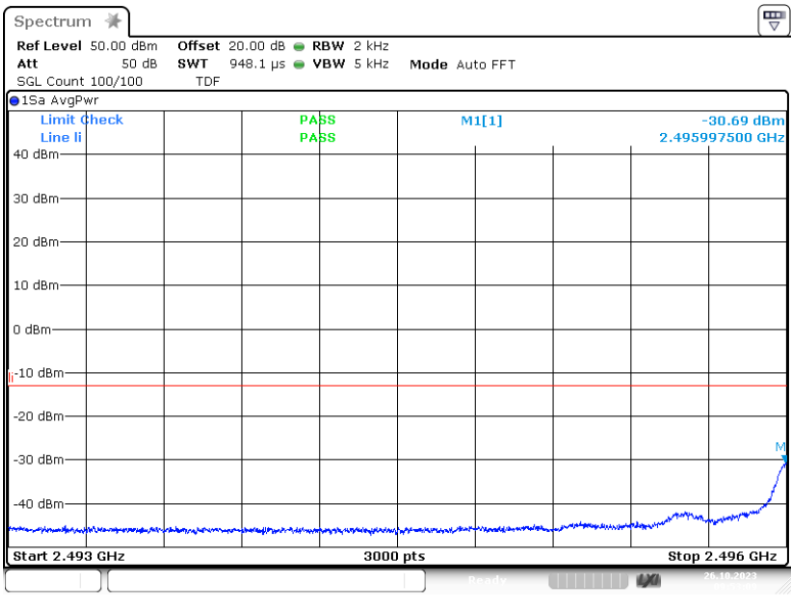
3.6.2 out of band emi BRS low R AWGN100 upper 1carrier -0.3 dB 2.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: AWGN100; Input Power = 3 dB > AGC; Number of signals 1



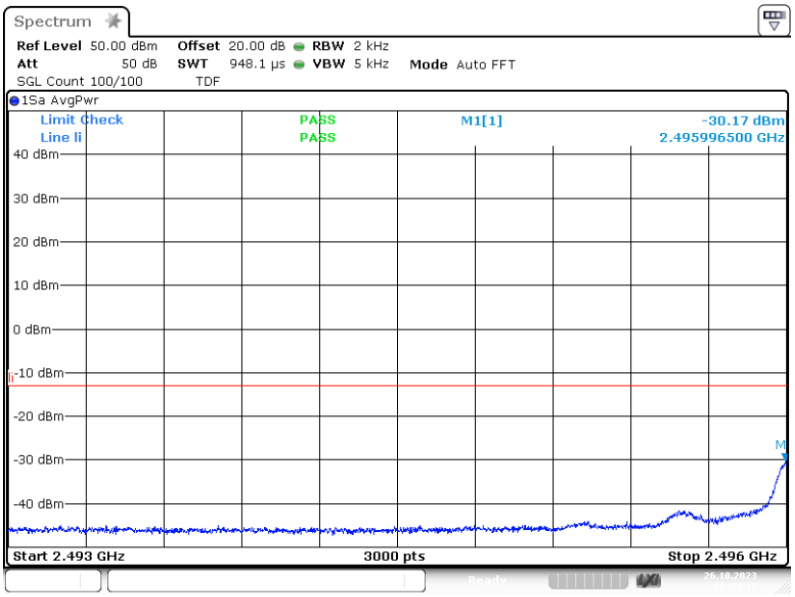
3.6.2 out of band emi BRS low R AWGN100 upper 1carrier +3.0 dB 2.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



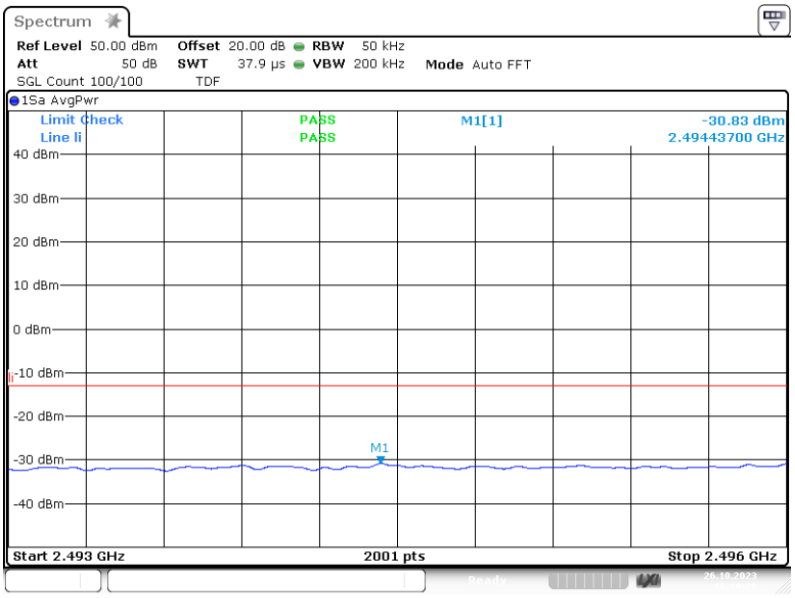
3.6.2 out of band emi BRS low R GSM lower 2carriers -0.3 dB
2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



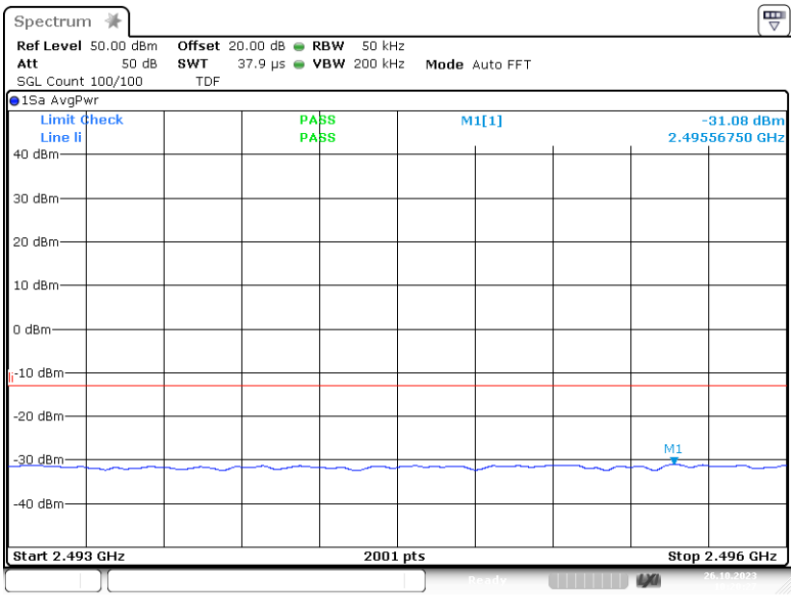
3.6.2 out of band emi BRS low R GSM lower 2carriers +3.0 dB
2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



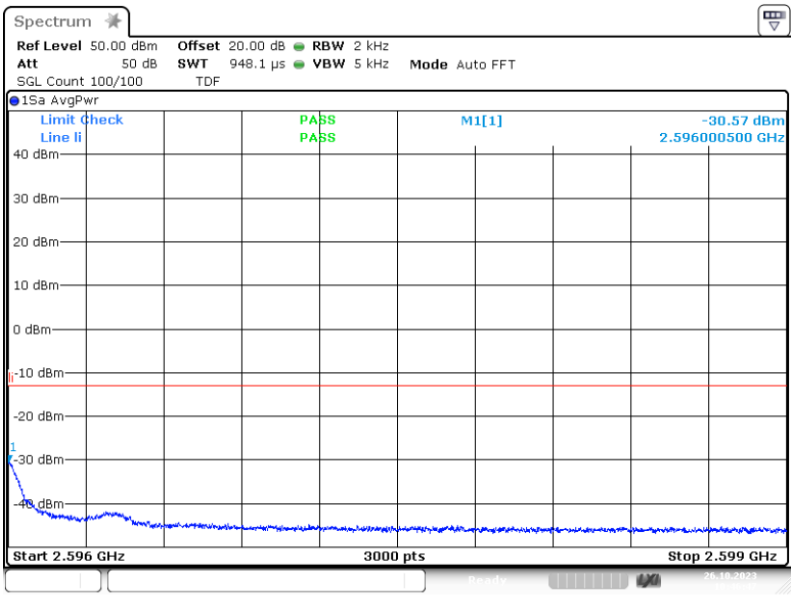
3.6.2 out of band emi BRS low R AWGN lower 2carriers -0.3 dB
2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



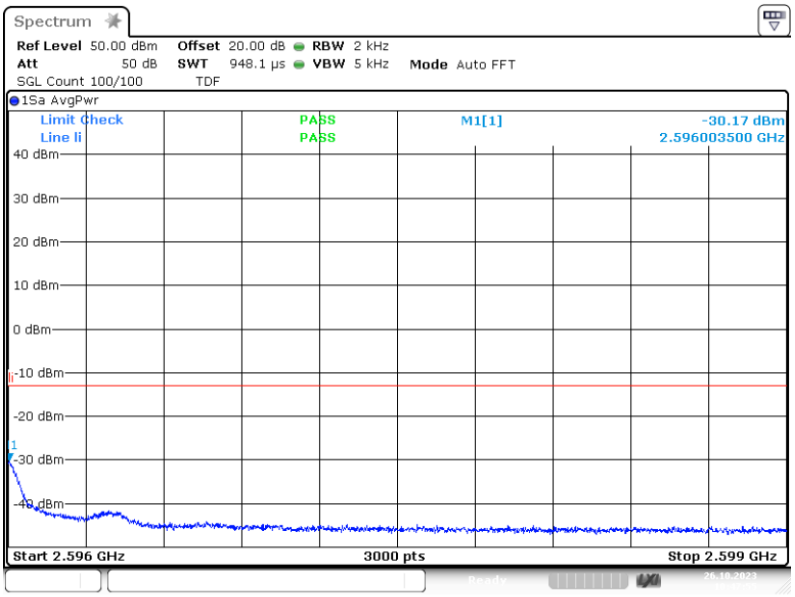
3.6.2 out of band emi BRS low R AWGN lower 2carriers +3.0 dB
2.493G 2.496G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



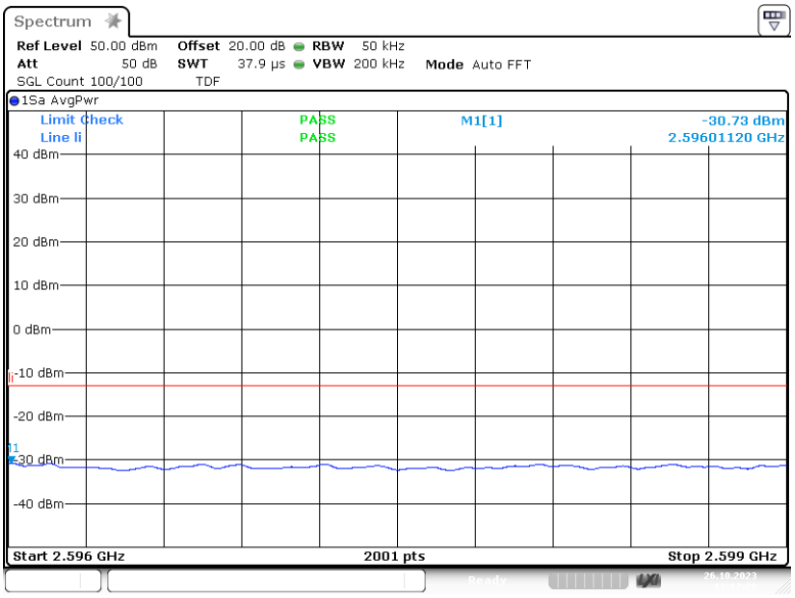
3.6.2 out of band emi BRS low R GSM upper 2carriers -0.3 dB
2.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



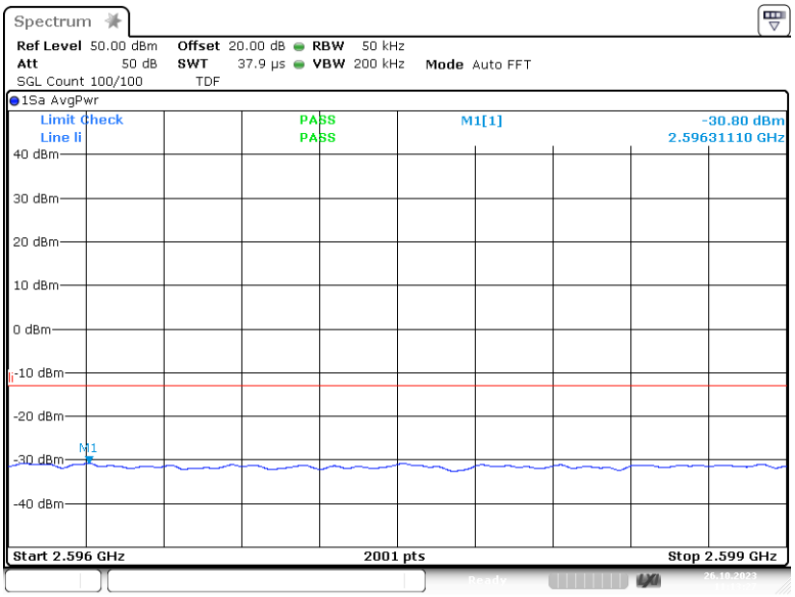
3.6.2 out of band emi BRS low R GSM upper 2carriers +3.0 dB
2.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



3.6.2 out of band emi BRS low R AWGN upper 2carriers -0.3 dB
2.596G 2.599G

Band: BRS (LBS); ANT 2; Frequency: 2.4960 GHz to 2.5960 GHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



3.6.2 out of band emi BRS low R AWGN upper 2carriers +3.0 dB
2.596G 2.599G

4.5.5 TEST EQUIPMENT USED

- Conducted

4.6 OUT-OF-BAND REJECTION

Standard FCC Part 27

The test was performed according to:
ANSI C63.26

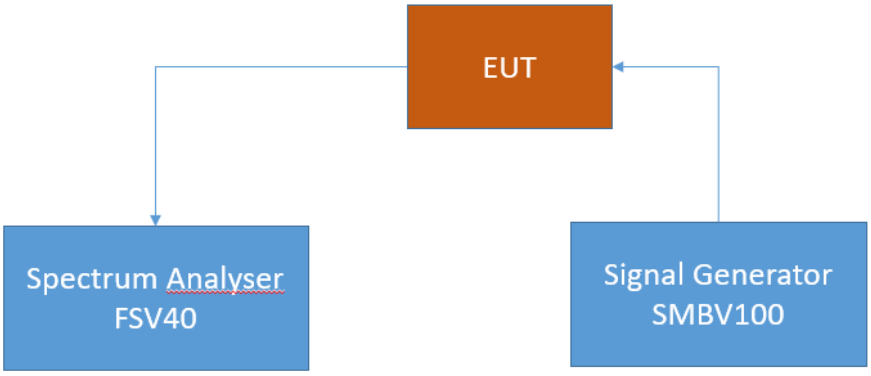
Test date: 2023-10-26 – 2023-10-27; 2023-11-28

Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.6.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the out-of-band rejection test case for industrial signal boosters.
The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; Out-of-band rejection

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.6.2 TEST REQUIREMENTS/LIMITS

For this test case exists no applicable limit

4.6.3 TEST PROTOCOL

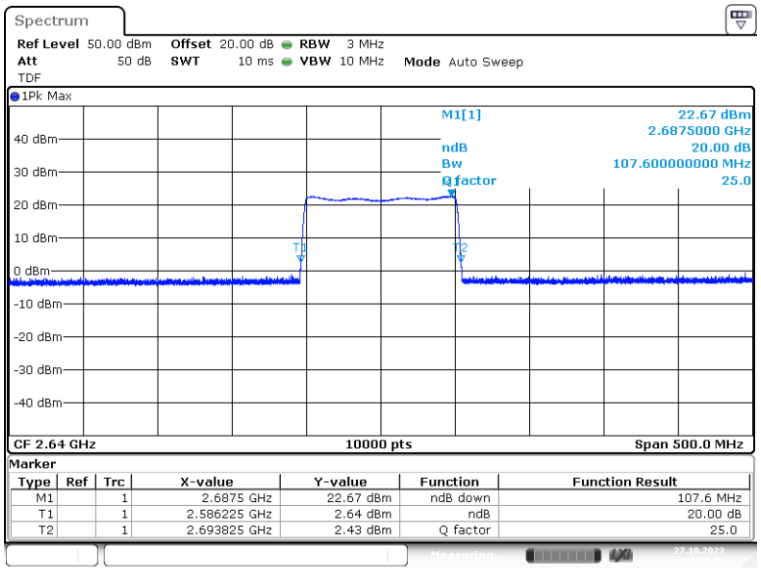
Band 41 BRS (UBS), downlink				
Highest Power Frequency [MHz]	**Output Power [dBm]**	**Lower Highest Power -20 dB Frequency [MHz]**	**Upper Highest Power -20 dB Frequency [MHz]**	**20 dB Bandwidth [MHz]**
2687.5	22.67	2586.225	2693.825	107.60

Band 41 BRS (LBS), downlink				
Highest Power Frequency [MHz]	**Output Power [dBm]**	**Lower Highest Power -20 dB Frequency [MHz]**	**Upper Highest Power -20 dB Frequency [MHz]**	**20 dB Bandwidth [MHz]**
2590.6	21.90	2492.275	2599.875	107.60

Remark: Please see next sub-clause for the measurement plots.

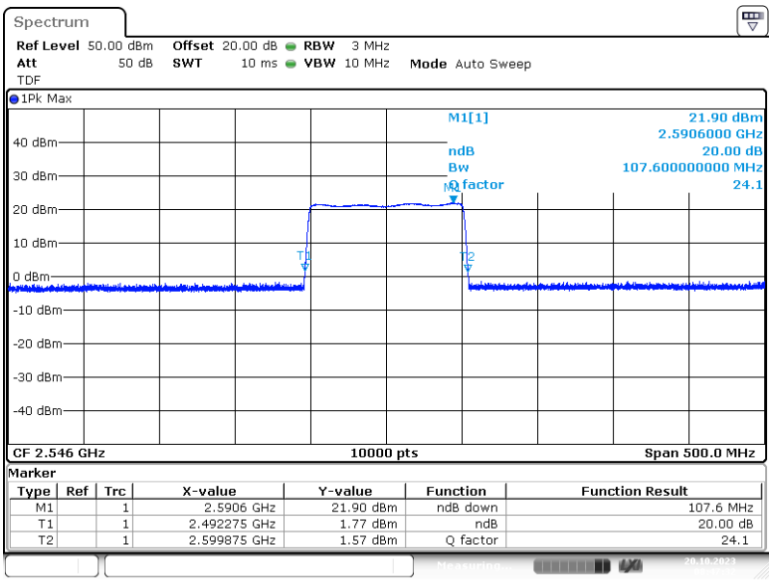
4.6.4 MEASUREMENT PLOTS

Frequency Band = Band 41 BRS (UBS), ANT 2; Direction = RF downlink



3.3 Out of band rejection BRS high R 2.64000G
_20dB

Frequency Band = Band 41 BRS (LBS), ANT 2; Direction = RF downlink



3.3 Out of band rejection BRS low R 2.54600G
_20dB

4.6.5 TEST EQUIPMENT USED

- Conducted

4.7 FREQUENCY STABILITY

The frequency stability test case was not carried out, as any frequency errors are eliminated by the given system architecture. This is achieved by generating the LOs in the head-end station and the LOs in the remote unit with a common reference clock. This reference clock is transmitted from the head-end station to the remote unit and regenerated there. This means that the same reference frequency is used for all signal conversions (up- and down-conversion as well as analog-to-digital and digital-to-analog conversion) and any frequency error in the reference clock is compensated therefore. This is already clear from the measurement markings for the occupied bandwidth (26 dB bandwidth). It can be seen that the DUT has no influence on the frequency (comparison between input and output signal). In addition, it is operationally necessary for the frequency deviation to be significantly smaller than the spectral distance between the transmission bandwidth edge and the channel bandwidth edge in order to meet the signal quality requirement (signal purity) and such ensure that the fundamental emissions remain within the authorized bands of operation.

4.8 FIELD STRENGTH OF SPURIOUS RADIATION

Standard FCC Part § 2.1051, § 27.53

The test was performed according to:
ANSI C63.26

Test date: 2023-11-02 - 2023-11-13

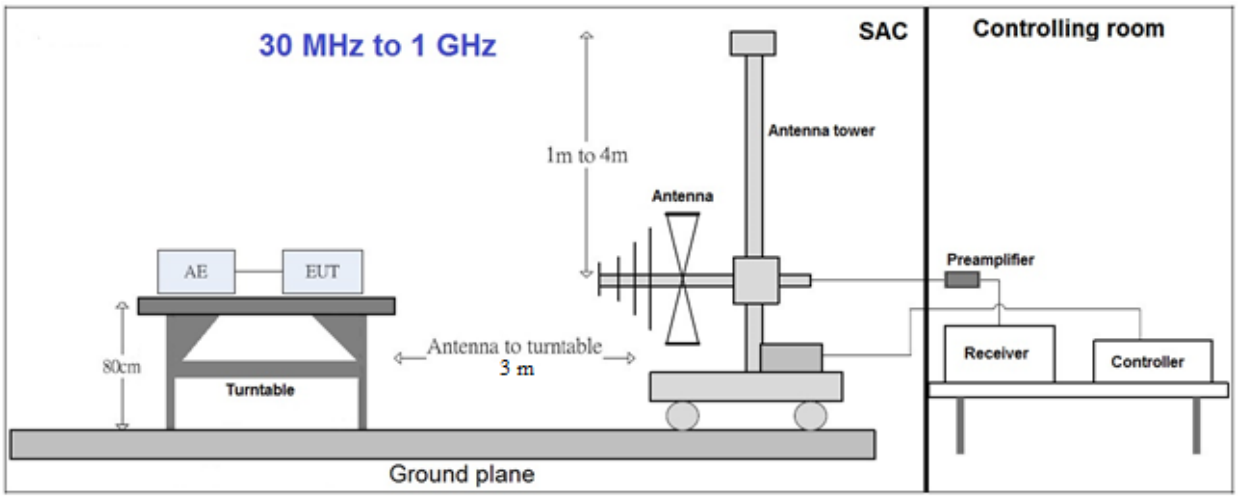
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

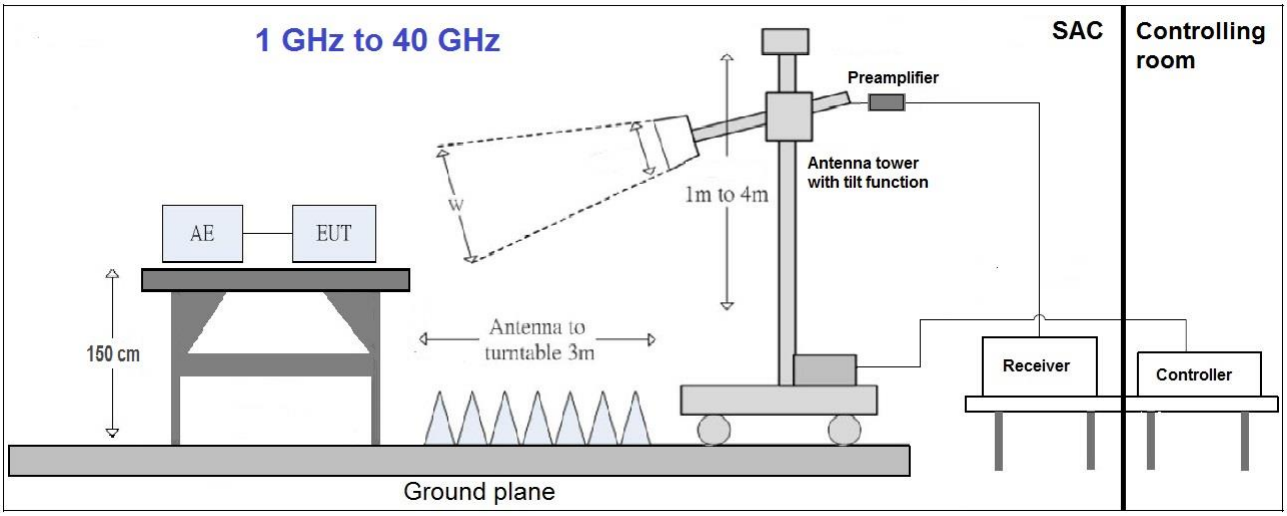
Test engineer: Thomas Hufnagel

4.8.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable radiated spurious emission measurements per § 2.1053

The EUT was connected to the test setup according to the following diagram:





The test set-up was made in accordance to the general provisions of ANSI C63.4 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.5 x 1.5 m² in the semi-anechoic chamber. 0.8 meter above the ground or floor-standing arrangement shall be placed on the horizontal ground reference plane. The influence of the EUT support table that is used between 30–1000 MHz was evaluated. For the initial measurements. the receiving antenna is varied from 1-4 meter height and is changed in the vertical plane from vertical to horizontal polarization at each frequency. The highest emissions between 30 MHz to 1000 MHz were analyzed in details by operating the spectrum analyzer and/or EMI receiver in quasi-peak mode to determine the precise amplitude of the emissions.

The measurement procedure is implemented into the EMI test software BAT EMC from NEXIO. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered by a DC power source.

1. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: PEAK
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 100 kHz
- Turntable angle range: –180° to 180°
- Turntable step size: 15°
- Height variation range: 1 – 4 m
- Height variation step size: 1 m
- Polarisation: Horizontal + Vertical

Intention of this step is. to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency. which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ±15° around this value. During this action. the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position. the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action. the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: PEAK
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 100 kHz
- Turntable angle range: ±15 ° around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with PEAK detector
With the settings determined in step 3. the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: PEAK (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 100 kHz

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

Step 1:

The Equipment Under Test (EUT) was set up on a non-conductive support at 1.5 m height in the semi-anechoic chamber. Absorbers are placed around and between the turn table and the antenna tower.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis. with a step size of 15 °.
The turn table step size (azimuth angle) for the preliminary measurement is 15 °.

Step 2:

The maximum RFI field strength was determined during the measurement by rotating the turntable (±180 degrees) and varying the height of the receive antenna (h = 1 ... 4 m) with a additional tilt function of the antenna.The turn table azimuth will slowly vary by ±15°.
EMI receiver settings (for all steps):
- Detector: PEAK
- IF Bandwidth = 1 MHz

Step 3:

Spectrum analyser settings for step 3:
- Detector: PEAK
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz

4.8.2 TEST REQUIREMENTS/LIMITS

FCC Part 2.1053; Measurement required: Field strength of spurious radiation:

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet. control circuits. power leads. or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test. single sideband. independent sideband. and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049. as appropriate.

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Band 41 BRS (LBS/UBS)

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(1) Prior to the transition, and thereafter, solely within the MBS, for analog operations with an EIRP in excess of −9 dBW, the signal shall be attenuated at the channel edges by at least 38 dB relative to the peak visual carrier, then linearly sloping from that level to at least 60 dB of attenuation at 1 MHz below the lower band edge and 0.5 MHz above the upper band edge, and attenuated at least 60 dB at all other frequencies.

(2) For digital base stations, the attenuation shall be not less than 43 + 10 log (P) dB, unless a documented interference complaint is received from an adjacent channel licensee with an overlapping Geographic Service Area. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS No. 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

4.8.3 TEST PROTOCOL

General considerations concerning the limits:

The measuring bandwidth of 1 MHz was chosen according the test requirements exept at the bands from 30 MHz to 1 GHz: At these bands reducing of measurement bandwidth was done.
Also outside the downlink frequency band at lower frequencies the measurement bandwidths were reduced to have the possibility to record the spurious emissions at these lower frequencies.

At frequencies were measuring bandwidths were reduced also the limit lines were reduced acoording the given formula:

$$p\ RBWreduced\ [dBm] = 10 * \log\left(RBWreduced\ [kHz] — 1000\ kHz\right) + pRBW\ 1000\ kHz[dBm]$$

Hereby "p" are the limit lines' values.

Considerations to MIMO operation:

At this test the two output ports ANT 1 and ANT 2 are together in function according KDB 935210 D02 v04r02 chapter II (o) (2).

Measurement tables (showing the highest value. "worst case") with one antenna

At this tables the highest peak value of spurious radiation per frequency test band is shown.

Band BRS (UBS), downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
47.6/hor..	-45.0	-3.9	RMS	100	-23.0	22.0
47.9/vert.	-40.6	-3.9	RMS	100	-23.0	17.6
17746.1/hor.	-23.4	-3.9	RMS	100	-13.0	10.4
17742.4/ver.	-24.2	-3.9	RMS	1000	-13.0	11.2
26625.6/hor.	-65.9	-3.9	RMS	1000	-13.0	52.9
26643.6/vert.	-65.6	-3.9	RMS	1000	-13.0	52.6

Band BRS (LBS), downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
271.4/hor..	-63.1	-3.9	RMS	100	-23.0	40.1
271.3/vert.	-63.0	-3.9	RMS	100	-23.0	40.0
17783.0/hor.	-24.0	-3.9	RMS	100	-13.0	11.0
16756.2/ver.	-23.2	-3.9	RMS	1000	-13.0	10.2
23191.8/hor.	-65.9	-3.9	RMS	1000	-13.0	52.9
23195.4/vert.	-65.4	-3.9	RMS	1000	-13.0	52.4

Measurement tables (showing the highest value. "worst case") with two antennas (MIMO)

At this tables the highest peak value of spurious radiation per frequency test band is shown.

Band BRS (UBS), downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
47.7/hor..	-45.6	-3.9	RMS	100	-23.0	22.6
47.9/vert.	-40.2	-3.9	RMS	100	-23.0	17.2
17769.4/hor.	-23.1	-3.9	RMS	100	-23.0	10.1
17729.7/ver.	-23.2	-3.9	RMS	1000	-13.0	10.2
23195.1/hor.	-66.2	-3.9	RMS	1000	-13.0	53.2
23198.4/vert.	-65.6	-3.9	RMS	1000	-13.0	52.6

Band BRS (LBS), downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
271.4/hor..	-63.1	-3.5	RMS	100	-23.0	40.1
271.3/vert.	-63.0	-3.5	RMS	100	-23.0	40.0
17211.8/hor.	-23.2	-3.5	RMS	100	-23.0	10.2
16756.2/ver.	-23.2	-3.5	RMS	1000	-13.0	10.2
26655.3/hor.	-65.7	-3.5	RMS	1000	-13.0	52.7
26648.7/vert.	-65.4	-3.5	RMS	1000	-13.0	52.4

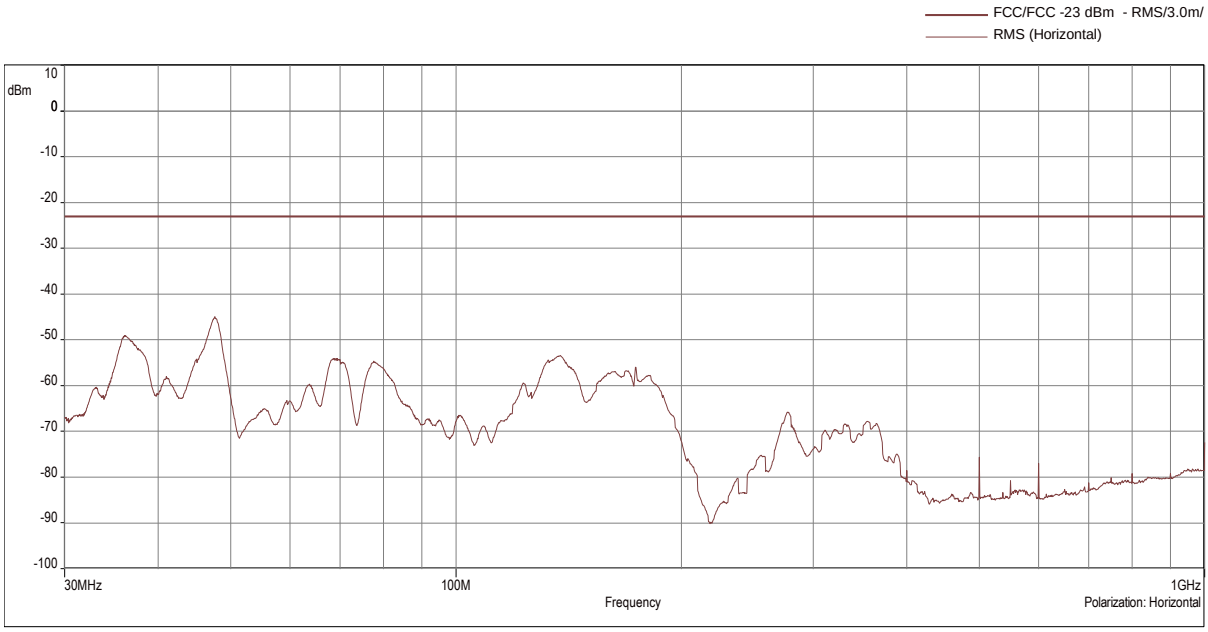
Abbreviations:
Hor.: horizontal position
Vert.: vertical position

Remark: Please see next sub-clause for the measurement plot.

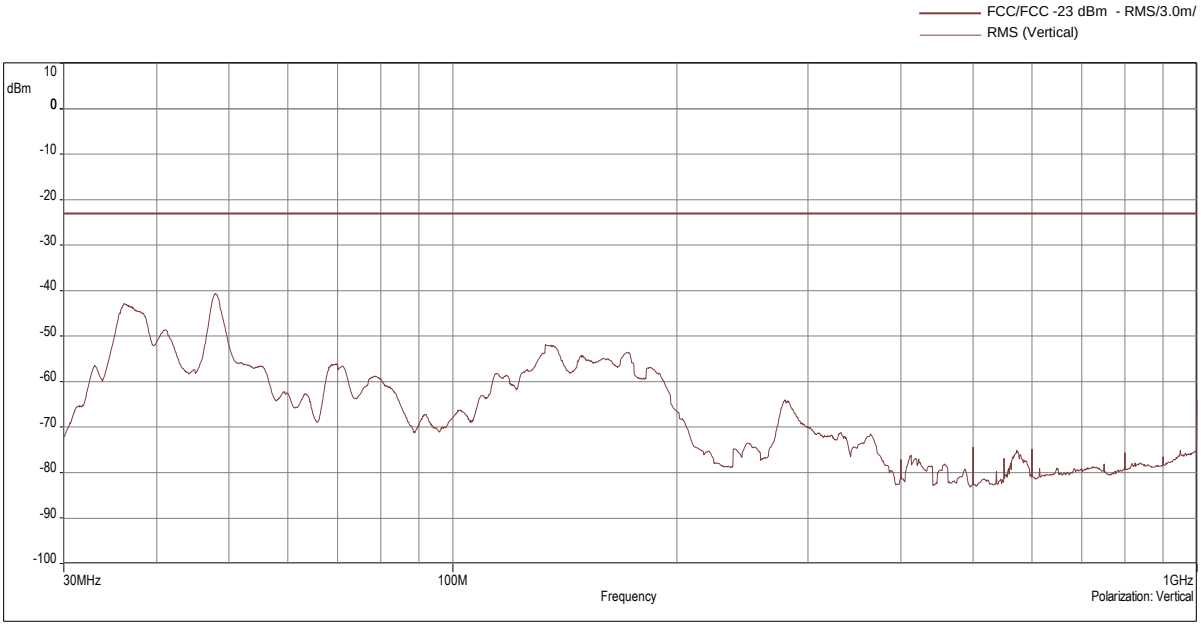
4.8.4 MEASUREMENT PLOTS (SHOWING THE HIGHEST VALUE. "WORST CASE") WITH ONE ANTENNA

4.8.4.1 Frequency Band = Band BRS (UBS), ANT 2. Direction = RF Downlink

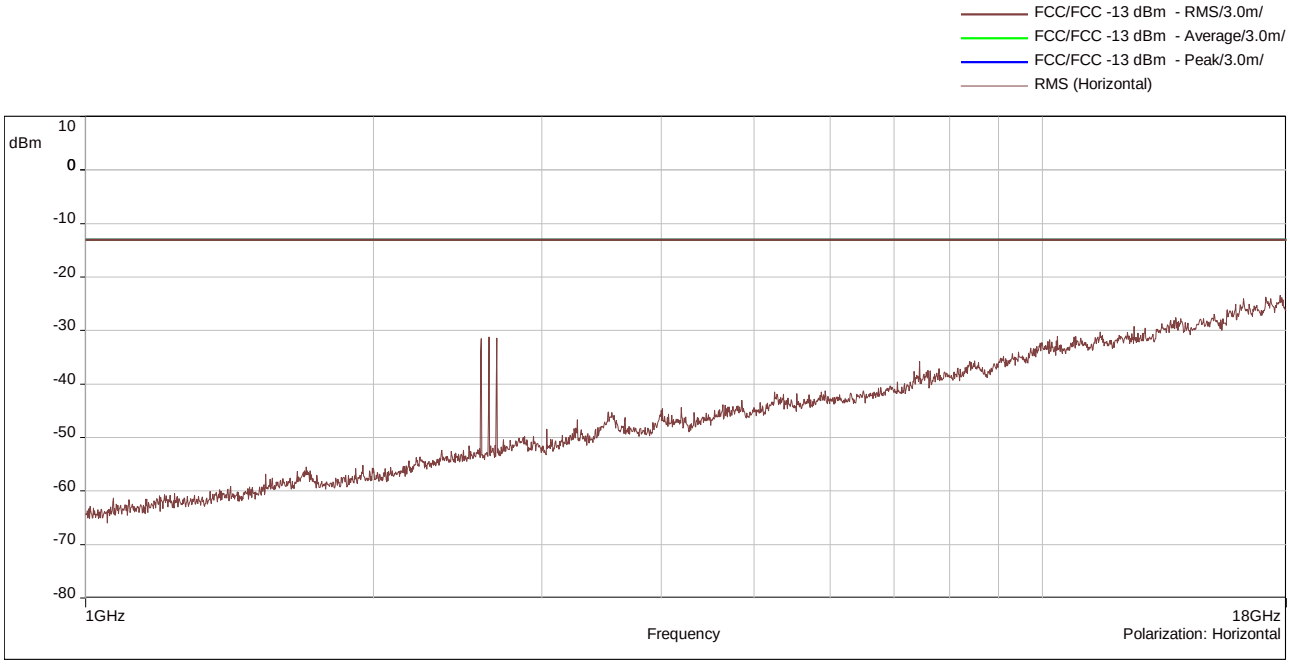
30 MHz - 1 GHz, horizontal



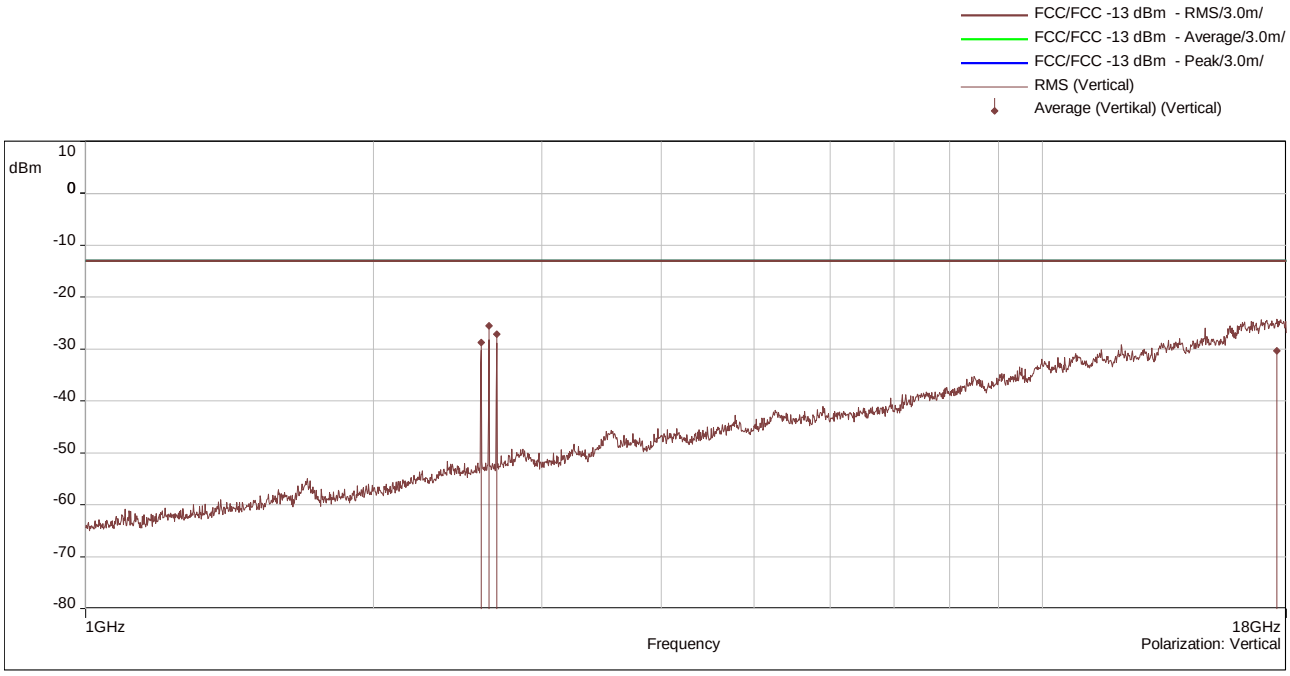
30 MHz - 1 GHz, vertical



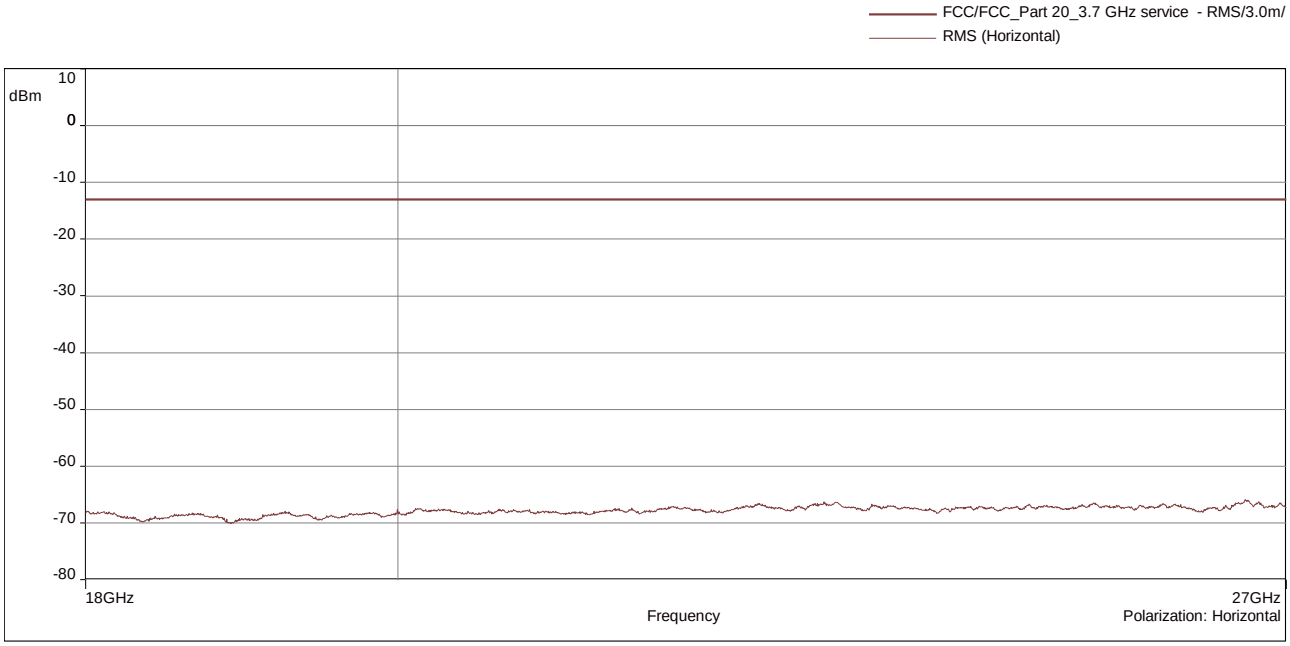
1 GHz - 18 GHz, horizontal



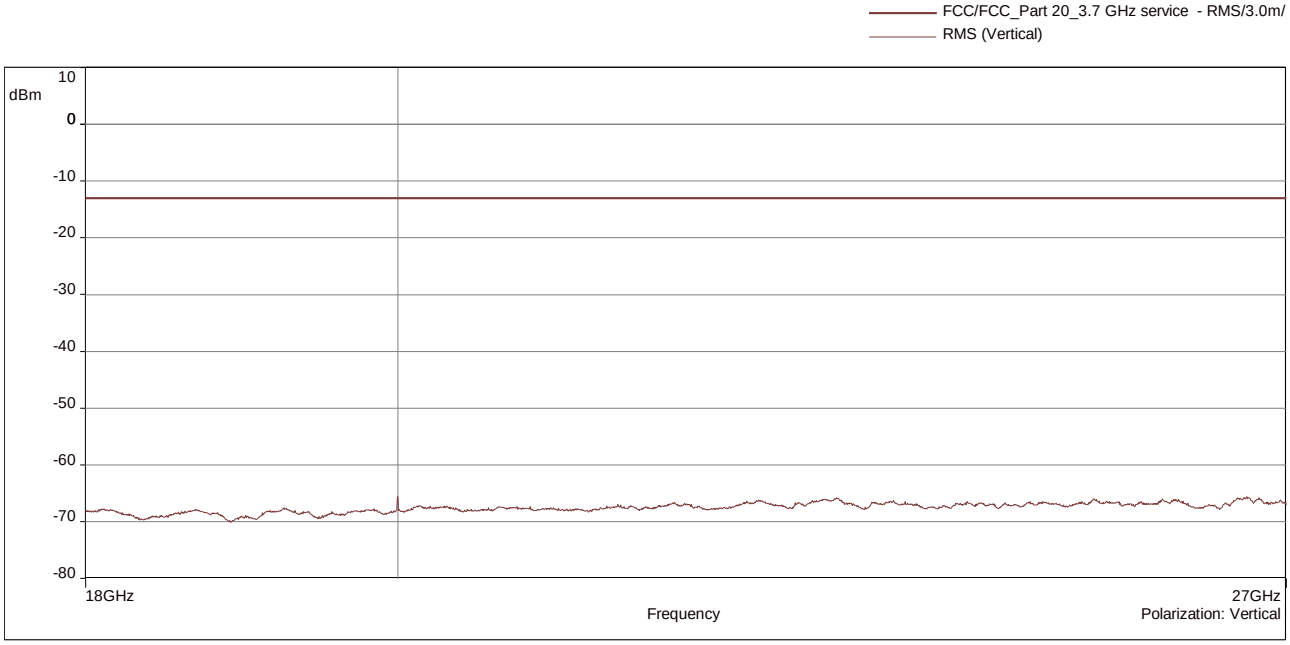
1 GHz - 18 GHz, vertical



18 GHz - 27 GHz, horizontal

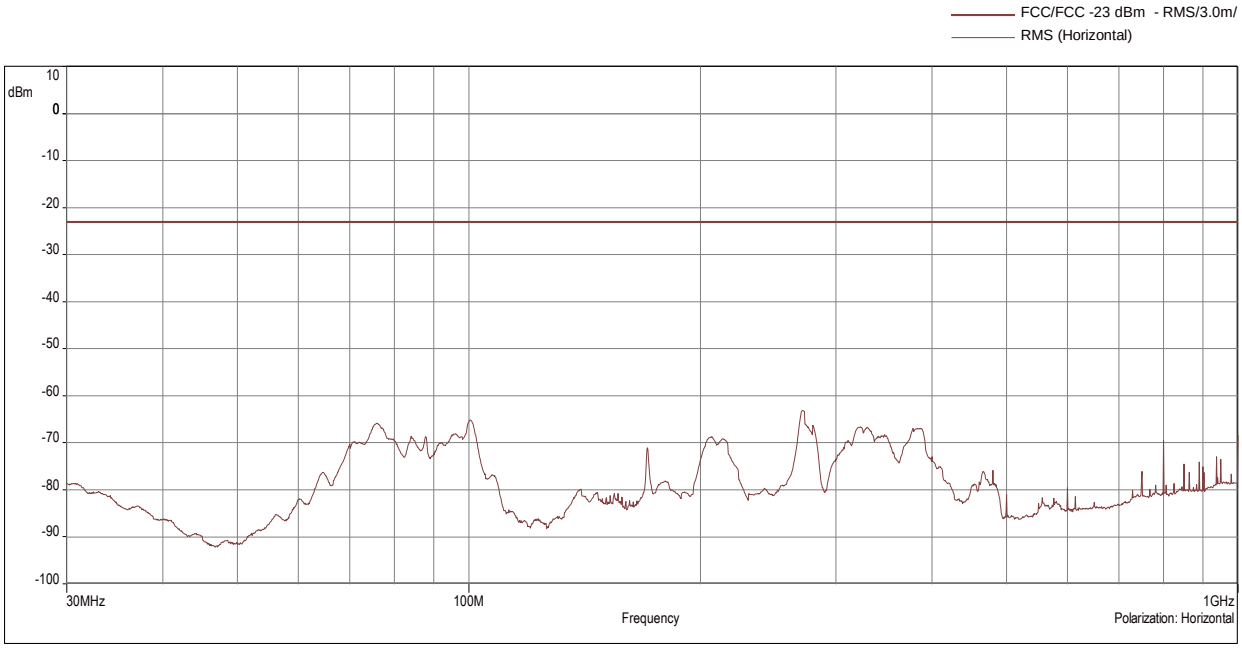


18 GHz - 27 GHz, vertical

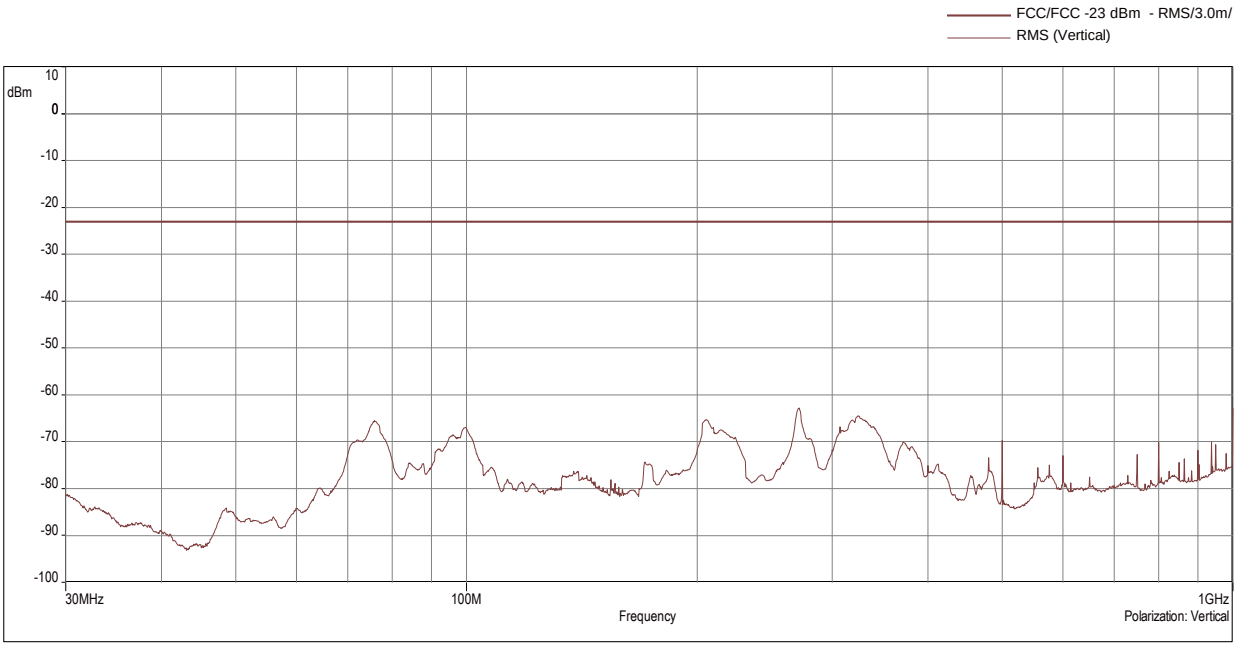


4.8.4.2 Frequency Band = Band BRS (LBS), ANT 2. Direction = RF Downlink

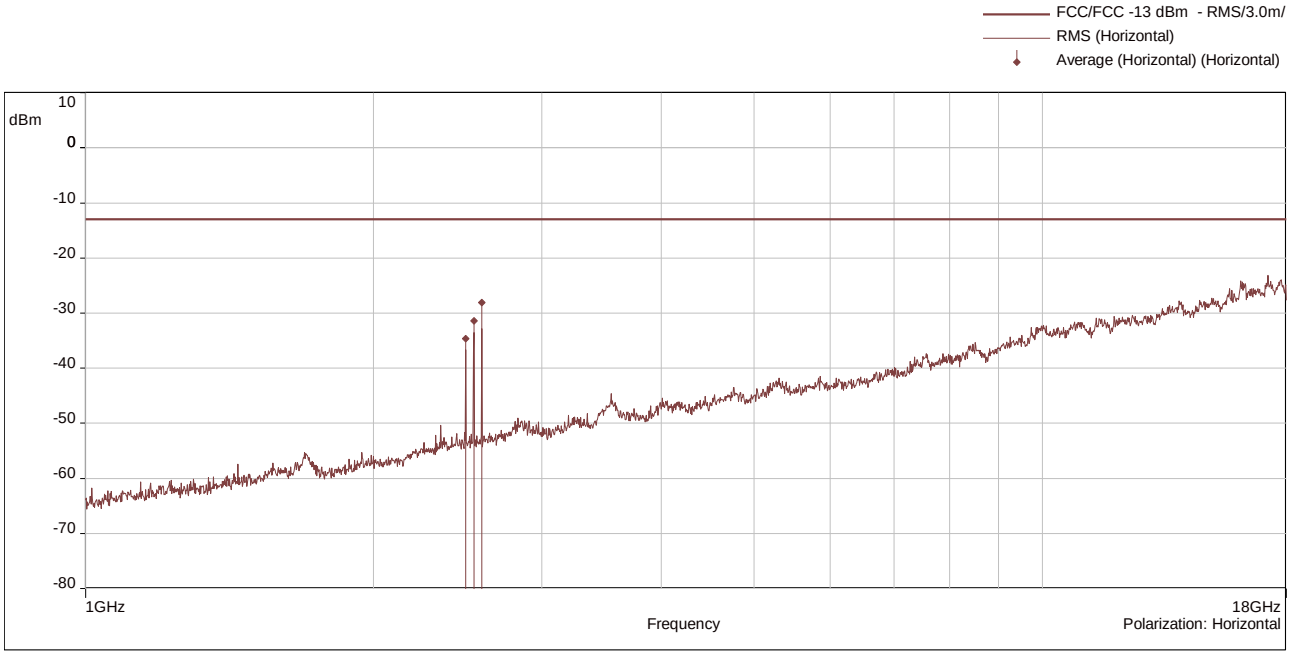
30 MHz - 1 GHz, horizontal



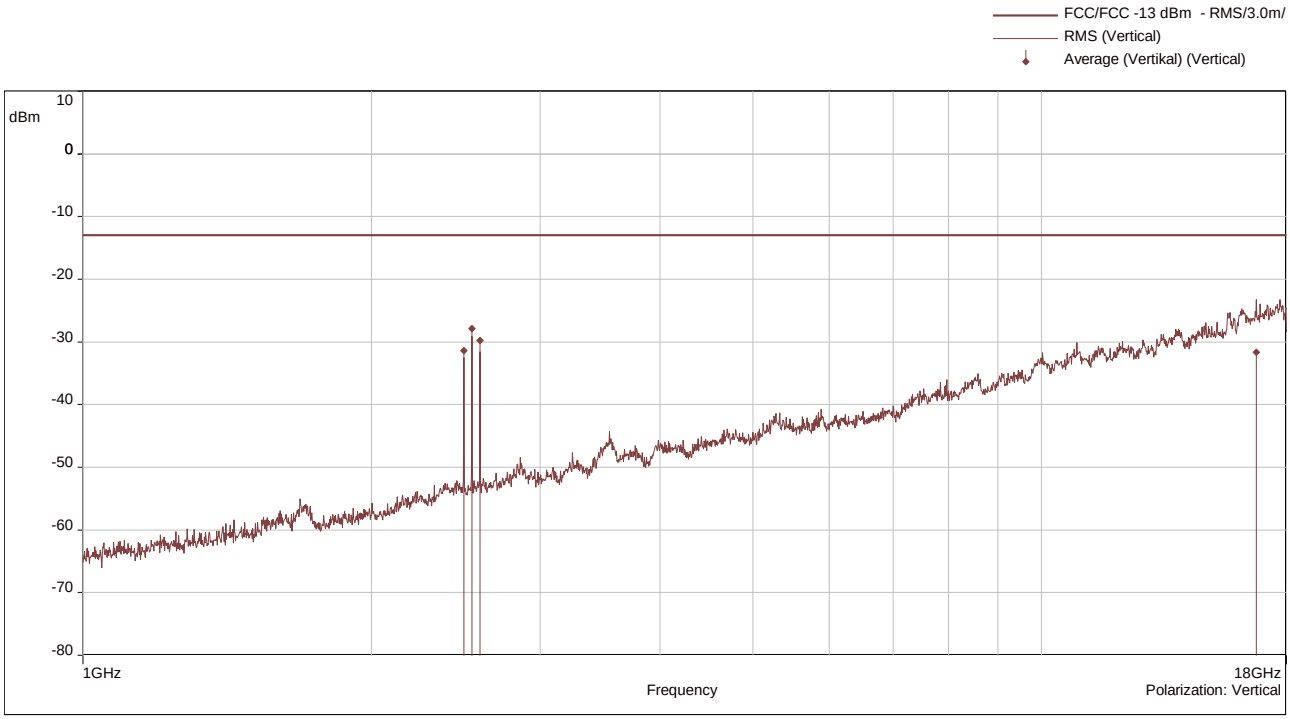
30 MHz - 1 GHz, vertical



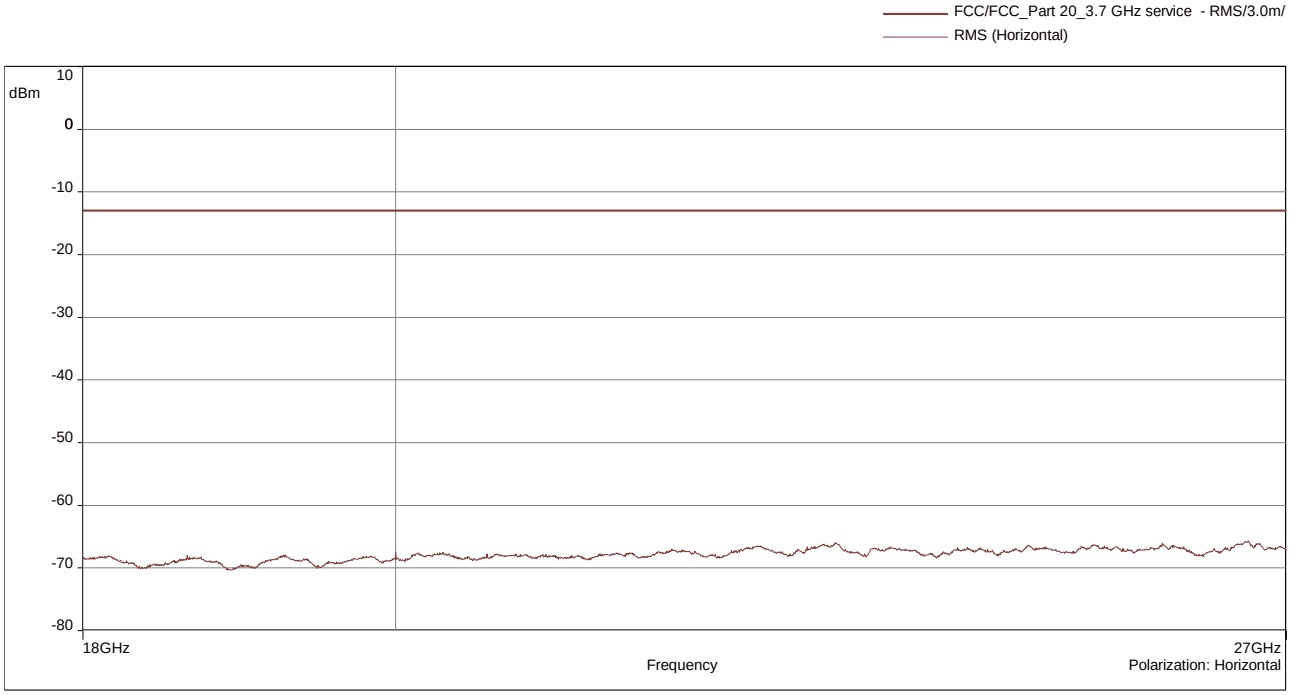
1 GHz - 18 GHz, horizontal



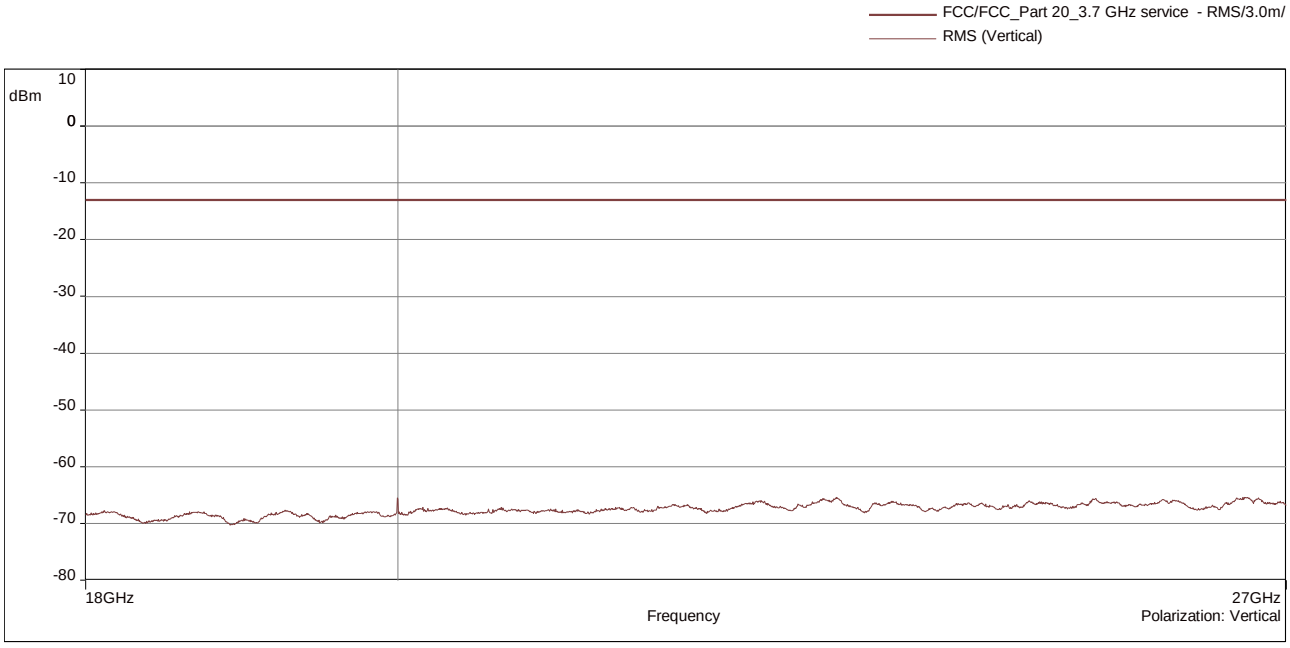
1 GHz - 18 GHz, vertical



18 GHz - 27 GHz, horizontal



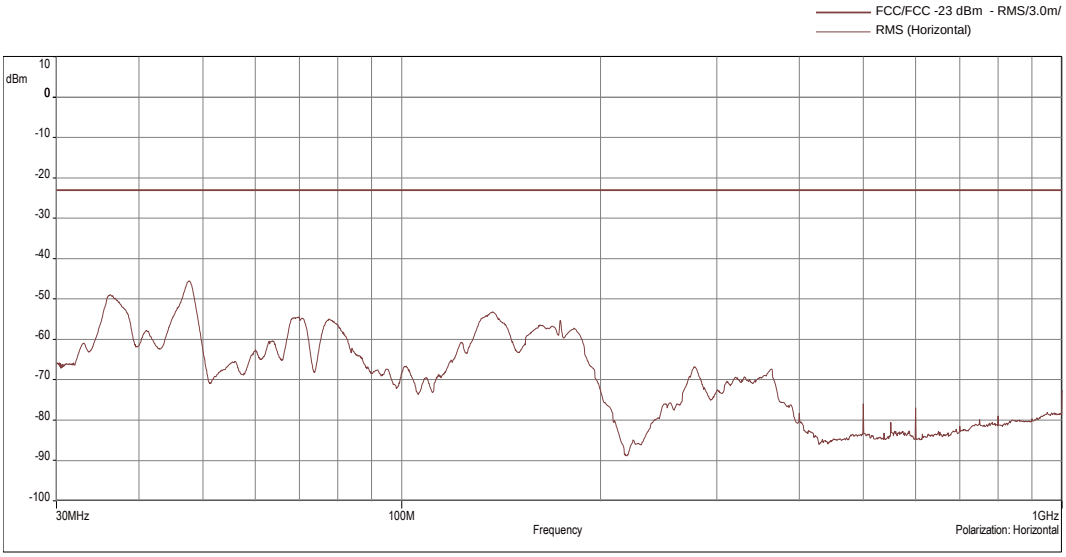
18 GHz - 27 GHz, vertical



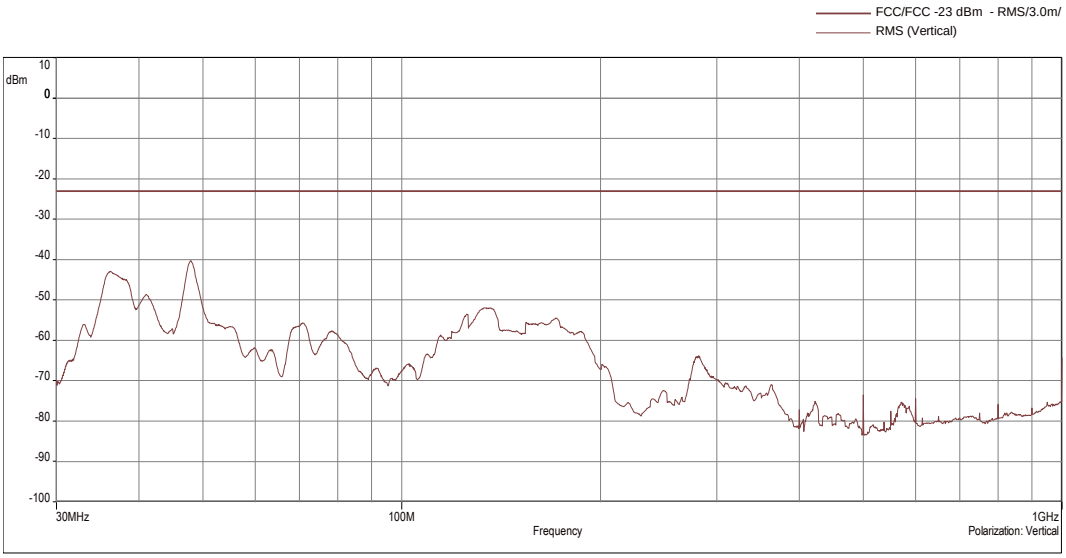
4.8.5 MEASUREMENT PLOTS (SHOWING THE HIGHEST VALUE. "WORST CASE") WITH TWO ANTENNAS (MIMO)

4.8.5.1 Frequency Band = Band BRS (UBS), ANT 1and 2 (MIMO). Direction = RF Downlink

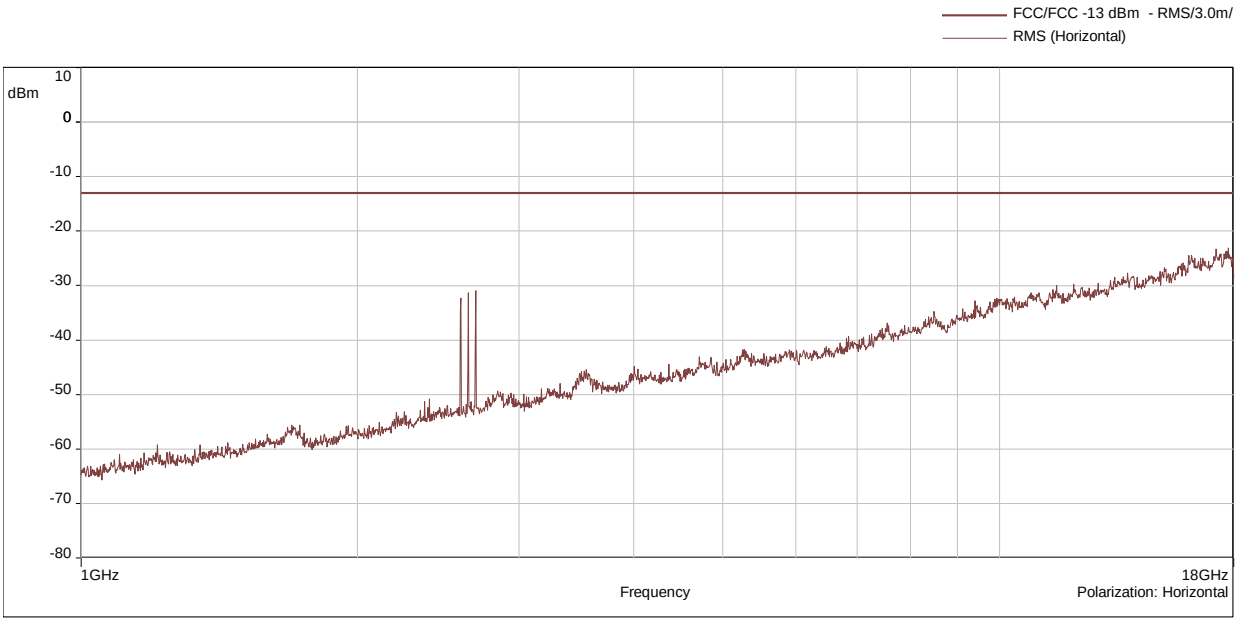
30 MHz - 1 GHz, horizontal



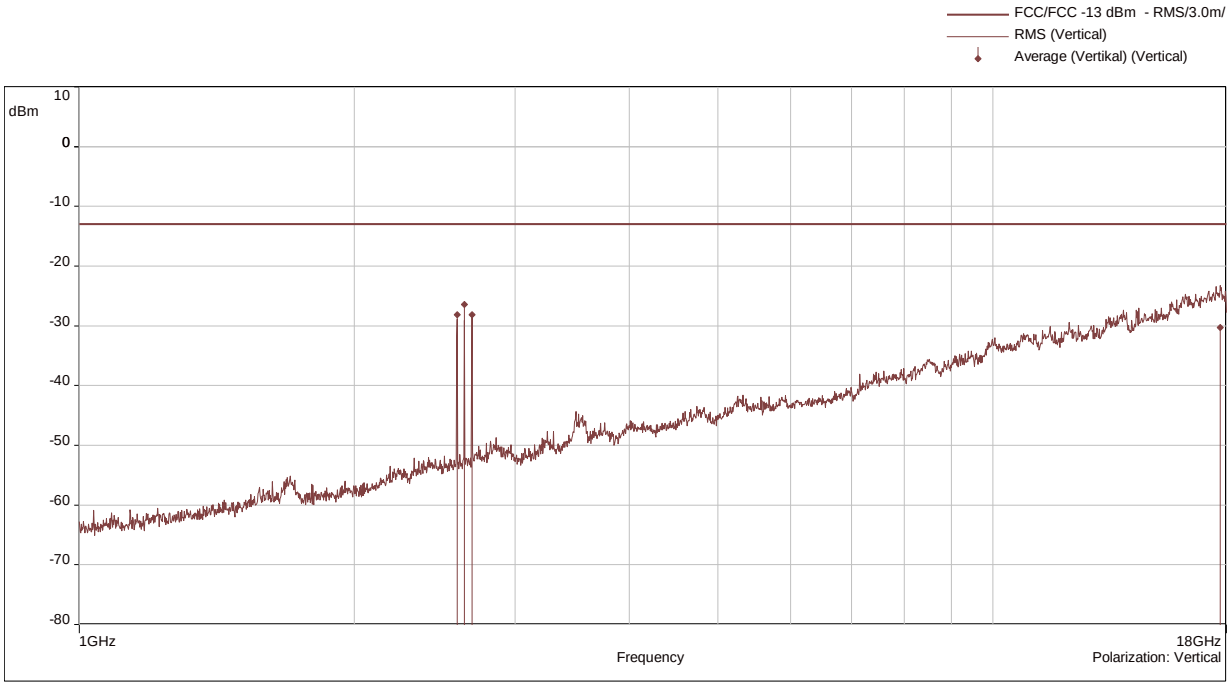
30 MHz - 1 GHz, vertical



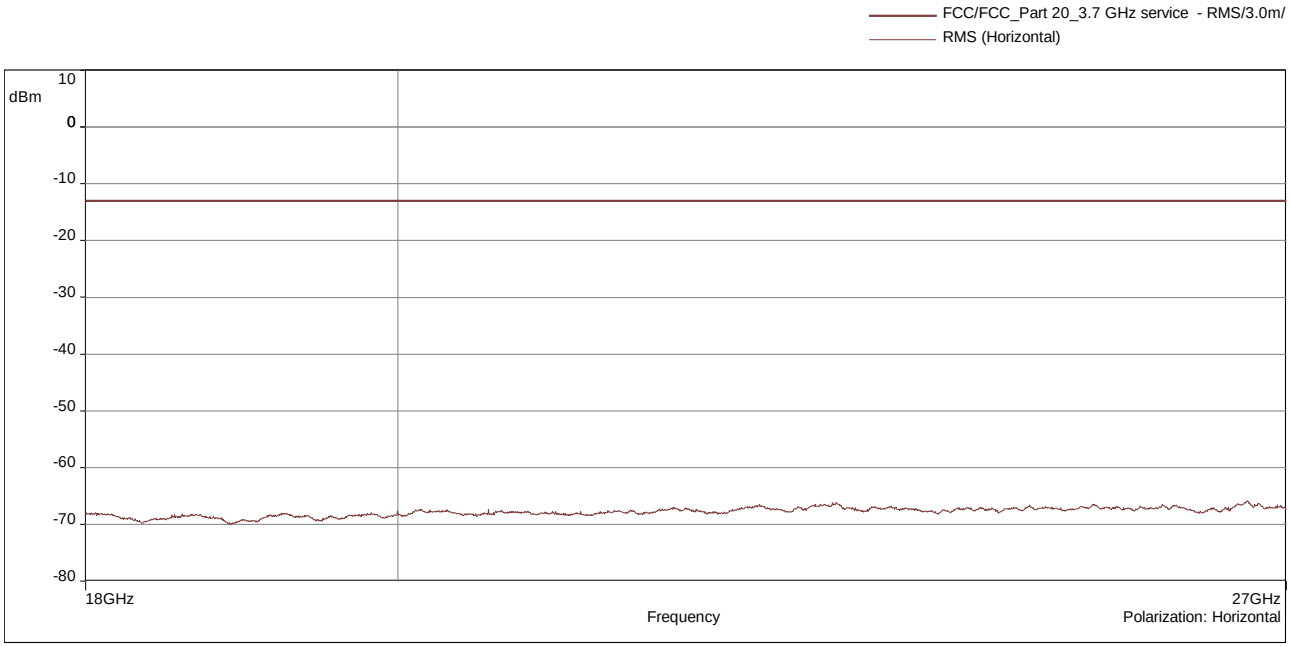
1 GHz - 18 GHz, horizontal



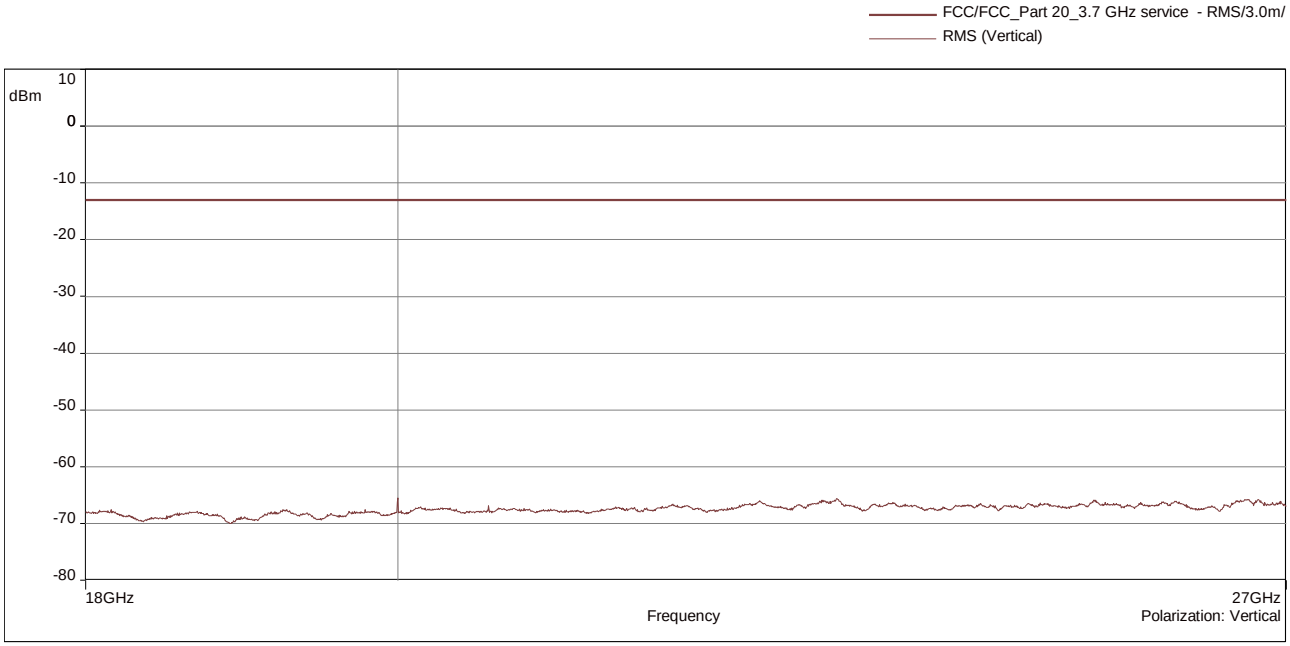
1 GHz - 18 GHz, vertical



18 GHz - 27 GHz, horizontal

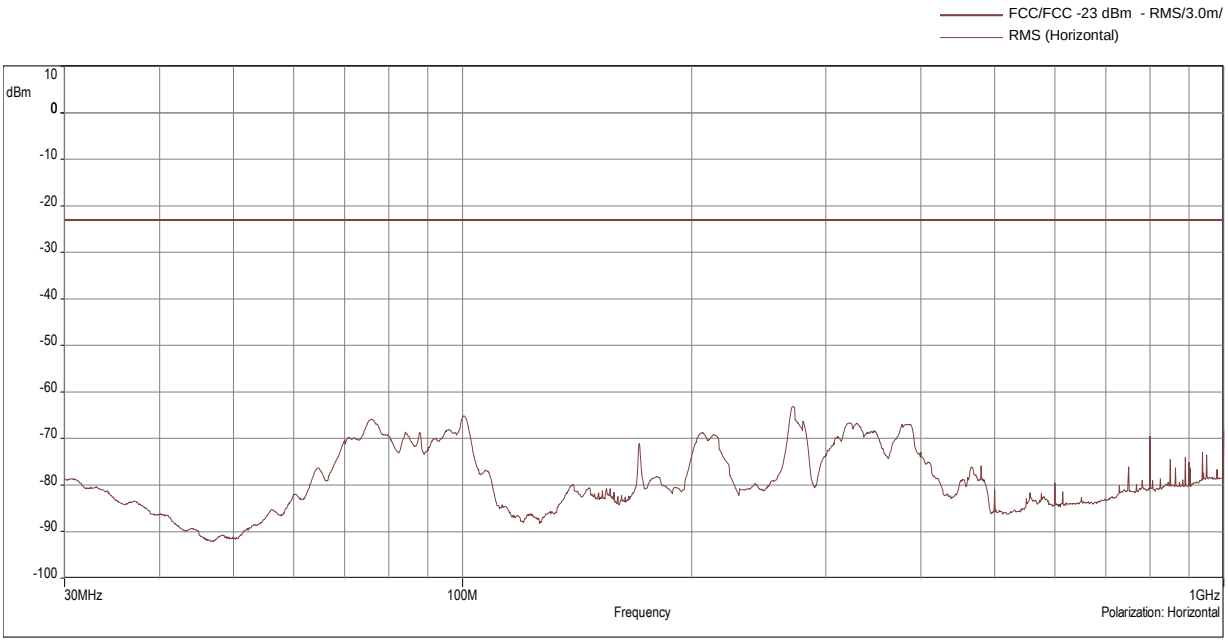


18 GHz - 27 GHz, vertical

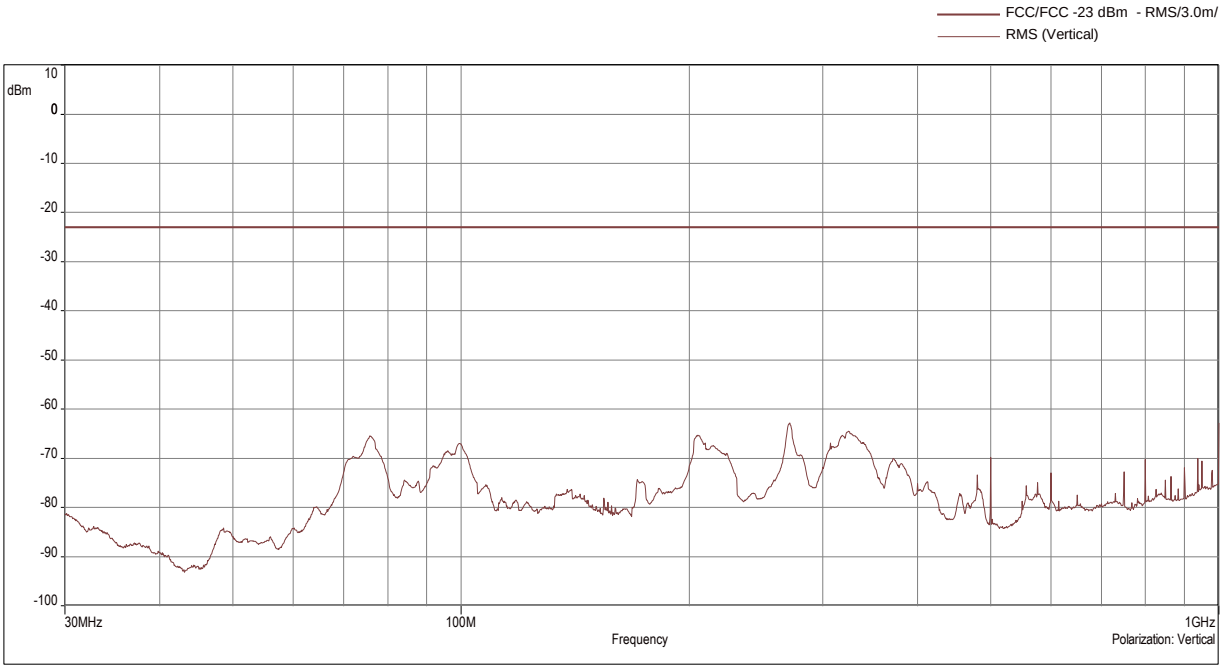


4.8.5.2 Frequency Band = Band BRS (LBS), ANT 1and 2 (MIMO). Direction = RF Downlink

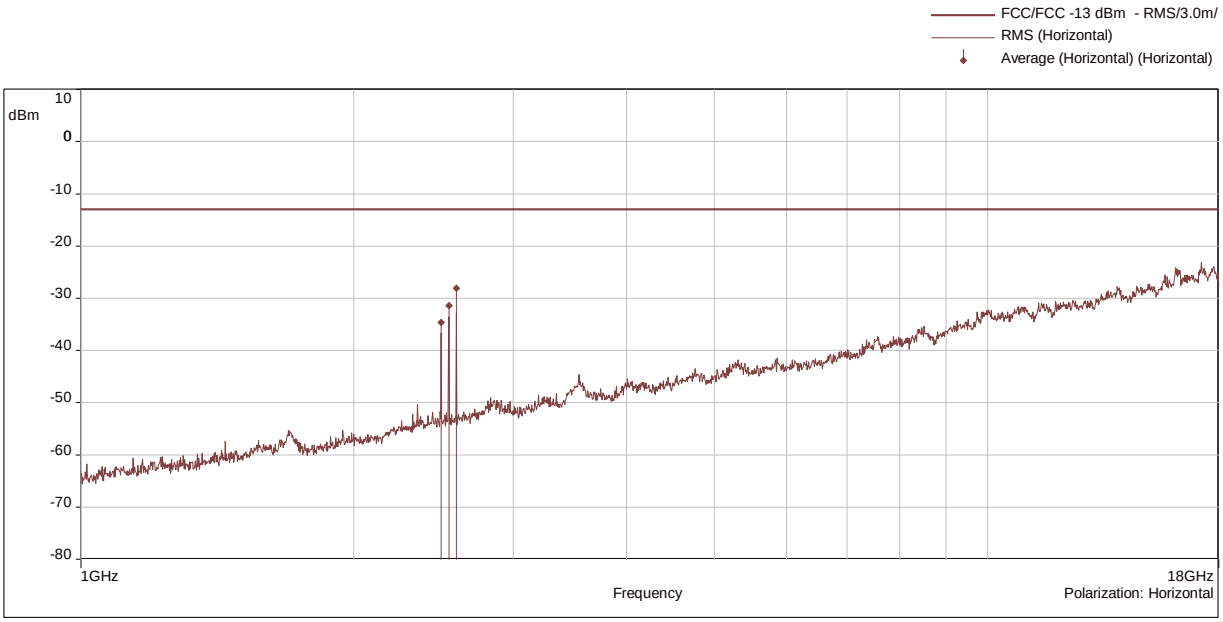
30 MHz - 1 GHz, horizontal



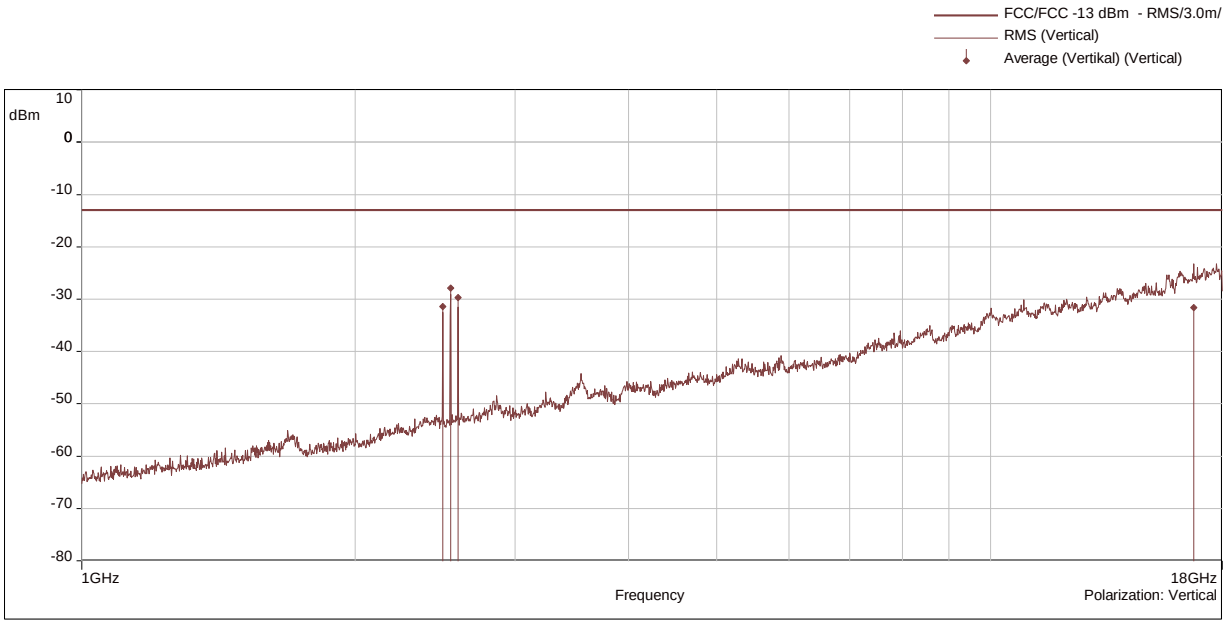
30 MHz - 1 GHz, vertical



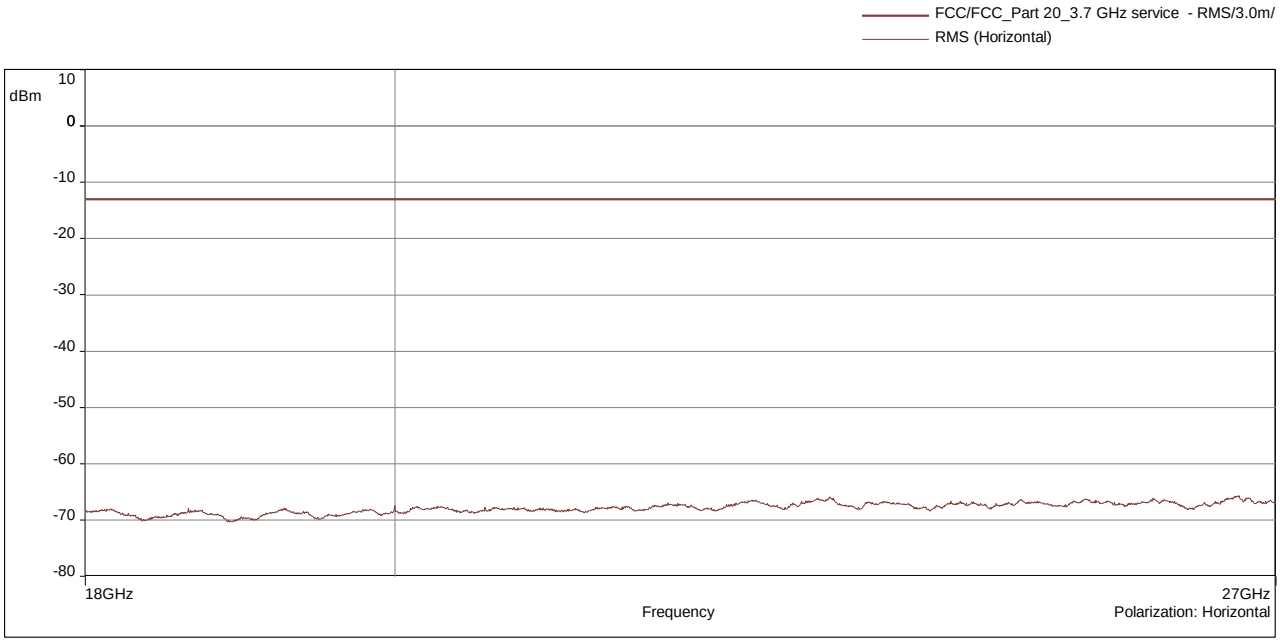
1 GHz - 18 GHz, horizontal



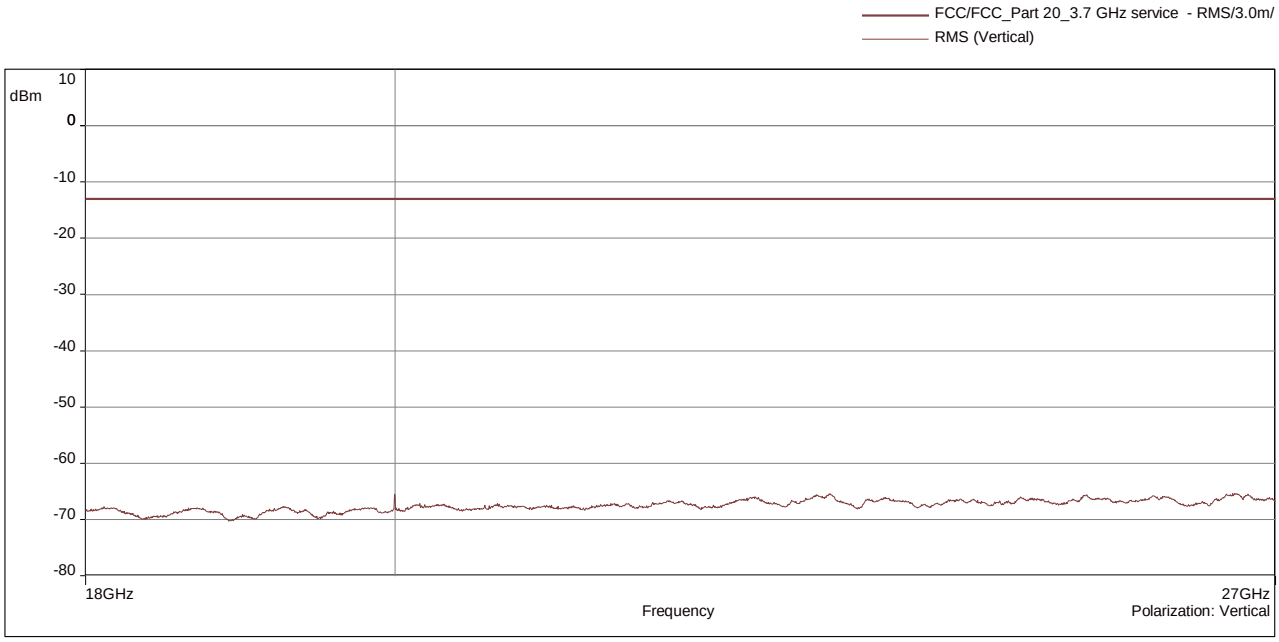
1 GHz - 18 GHz, vertical



18 GHz - 27 GHz, horizontal



18 GHz - 27 GHz, vertical



4.8.6 FIELD STRENGTH CALCULATIONS

FS = SA + AF + CL + PA

Where as:

FS = Field strength
SA = EMC test receiver reading
AF = Antenna factor
CL = Cable loss
PA = Preamplifier

4.8.7 TEST EQUIPMENT USED

- Radiated Emissions

5 TEST EQUIPMENT

5.1 CONDUCTED EMISSIONS

Ref.No.	Type	Description	Manufacturer	Inventory no.	Last Calibration	Calibration Due
1.1	FSV40	Signal Analyzer 10 Hz - 40 GHz	Rohde & Schwarz	E-003139	2023-10	2024-10
1.2	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	E-003206	2023-01	2025-01
1.3	LabView	Software	NI	Auto Messung 1 Channel V8	---	---

5.2 RADIATED EMISSIONS

Ref.No.	Type	Description	Manufacturer	Inventory no.	Last Calibration	Calibration Due
1.4	ESU40	EMI test receiver 10 Hz - 40 GHz	Rohde & Schwarz	E-003138	2023-10	2024-10
1.5	CBL 6111C	Antenna 30 MHz – 1 GHz	Chase	E-003226	2021-10	2024-10
1.6	HL 025	Antenna 1 GHz - 18 GHz	Rohde & Schwarz	E-003259	2022-10	2024-10
1.7	MWH-1826/B	Antenna 18 GHz – 26.5 GHz	ARA Inc.	E-003233	2022-11	2024-11
1.8	AM1431	Pre amplifier 10 kHz – 1 GHz	Miteq	E-003365	2023-10	2024-10
1.9	AFS4-00102000	Preamplifier 100 MHz - 20 GHz	Miteq	E-003633	2023-10	2024-10
1.10	AMP-18000-40000-60-18-2.9-F	Preamplifier 18 GHz - 40 GHz	TTE Europe	E-004003	2023-10	2024-10
1.11	CO3000	Controller SAC	Innco systems GmbH	E-003052 with Software 1.02.62	---	---
1.12	BAT-EMC	Software	Nexio	V 2023.0.3.0	---	---

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”.

6 ANTENNA FACTORS. CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

6.1 ANTENNA CHASE CBL 6111C (30 MHZ – 1 GHZ)

(d_{Limit} = 3 m)

Frequency	AF	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18.6	0.6	0.29	0.04	0.23	0.02	0.0	3	3
50	6.0	0.9	0.39	0.09	0.32	0.08	0.0	3	3
100	9.7	1.2	0.56	0.14	0.47	0.08	0.0	3	3
150	7.9	1.6	0.73	0.20	0.59	0.12	0.0	3	3
200	7.6	1.9	0.84	0.21	0.70	0.11	0.0	3	3
250	9.5	2.1	0.98	0.24	0.80	0.13	0.0	3	3
300	11.0	2.3	1.04	0.26	0.89	0.15	0.0	3	3
350	12.4	2.6	1.18	0.31	0.96	0.13	0.0	3	3
400	13.6	2.9	1.28	0.35	1.03	0.19	0.0	3	3
450	14.7	3.1	1.39	0.38	1.11	0.22	0.0	3	3
500	15.6	3.2	1.44	0.39	1.20	0.19	0.0	3	3
550	16.3	3.5	1.55	0.46	1.24	0.23	0.0	3	3
600	17.2	3.5	1.59	0.43	1.29	0.23	0.0	3	3
650	18.1	3.6	1.67	0.34	1.35	0.22	0.0	3	3
700	18.5	3.6	1.67	0.42	1.41	0.15	0.0	3	3
750	19.1	4.1	1.87	0.54	1.46	0.25	0.0	3	3
800	19.6	4.1	1.90	0.46	1.51	0.25	0.0	3	3
850	20.1	4.4	1.99	0.60	1.56	0.27	0.0	3	3
900	20.8	4.7	2.14	0.60	1.63	0.29	0.0	3	3
950	21.1	4.8	2.22	0.60	1.66	0.33	0.0	3	3
1000	21.6	4.9	2.23	0.61	1.71	0.30	0.0	3	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables. switch unit. distance correction. amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.2 ANTENNA ROHDE & SCHWARZ HL 025 (1 GHZ – 18 GHZ)

Frequency	AF	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit. atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24.4	-19.4	0.99	0.31	-21.51	0.79		
2000	28.5	-17.4	1.44	0.44	-20.63	1.38		
3000	31.0	-16.1	1.87	0.53	-19.85	1.33		
4000	33.1	-14.7	2.41	0.67	-19.13	1.31		
5000	34.4	-13.7	2.78	0.86	-18.71	1.40		
6000	34.7	-12.7	2.74	0.90	-17.83	1.47		
7000	35.6	-11.0	2.82	0.86	-16.19	1.46		

Frequency	AF	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit. atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31.0	-23.4	0.47	1.87	0.53	-27.58	1.33	
4000	33.1	-23.3	0.56	2.41	0.67	-28.23	1.31	
5000	34.4	-21.7	0.61	2.78	0.86	-27.35	1.40	
6000	34.7	-21.2	0.58	2.74	0.90	-26.89	1.47	
7000	35.6	-19.8	0.66	2.82	0.86	-25.58	1.46	

Frequency	AF	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35.6	-57.3	0.56	1.28	-62.72	2.66	0.94	1.46
8000	36.3	-56.3	0.69	0.71	-61.49	2.84	1.00	1.53
9000	37.1	-55.3	0.68	0.65	-60.80	3.06	1.09	1.60
10000	37.5	-56.2	0.70	0.54	-61.91	3.28	1.20	1.67
11000	37.5	-55.3	0.80	0.61	-61.40	3.43	1.27	1.70
12000	37.6	-53.7	0.84	0.42	-59.70	3.53	1.26	1.73
13000	38.2	-53.5	0.83	0.44	-59.81	3.75	1.32	1.83
14000	39.9	-56.3	0.91	0.53	-63.03	3.91	1.40	1.77
15000	40.9	-54.1	0.98	0.54	-61.05	4.02	1.44	1.83
16000	41.3	-54.1	1.23	0.49	-61.51	4.17	1.51	1.85
17000	42.8	-54.4	1.36	0.76	-62.36	4.34	1.53	2.00
18000	44.2	-54.7	1.70	0.53	-62.88	4.41	1.55	1.91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables. switch unit. distance correction. amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.3 ANTENNA ARA INC. MWH-1826-B (18 GHZ – 26.5 GHZ) PARTIALLY IN CONJUNCTION WITH PRE-AMPLIFIER MITEQ JS43-1800-4000: THE USE OF THE PRE-AMPLIFIER IS DEPENDENT FROM THE FIELD STRENGTH

Frequency	AF	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40.2	-23.5	0.72	-35.85	6.20	2.81	2.65
18500	40.2	-23.2	0.69	-35.71	6.46	2.76	2.59
19000	40.2	-22.0	0.76	-35.44	6.69	3.15	2.79
19500	40.3	-21.3	0.74	-35.07	7.04	3.11	2.91
20000	40.3	-20.3	0.72	-34.49	7.30	3.07	3.05
20500	40.3	-19.9	0.78	-34.46	7.48	3.12	3.15
21000	40.3	-19.1	0.87	-34.07	7.61	3.20	3.33
21500	40.3	-19.1	0.90	-33.96	7.47	3.28	3.19
22000	40.3	-18.7	0.89	-33.57	7.34	3.35	3.28
22500	40.4	-19.0	0.87	-33.66	7.06	3.75	2.94
23000	40.4	-19.5	0.88	-33.75	6.92	3.77	2.70
23500	40.4	-19.3	0.90	-33.35	6.99	3.52	2.66
24000	40.4	-19.8	0.88	-33.99	6.88	3.88	2.58
24500	40.4	-19.5	0.91	-33.89	7.01	3.93	2.51
25000	40.4	-19.3	0.88	-33.00	6.72	3.96	2.14
25500	40.5	-20.4	0.89	-34.07	6.90	3.66	2.22
26000	40.5	-21.3	0.86	-35.11	7.02	3.69	2.28
26500	40.5	-21.1	0.90	-35.20	7.15	3.91	2.36

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables. switch unit. distance correction. amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

7 MEASUREMENT UNCERTAINTIES

KDB 935210 D05	**ECL**
Power measurement	0.68 dB
Measuring AGC threshold level	0.90 dB
Out of band rejection	0.90 dB
Input-versus-output signal comparison	0.91 dB
Mean power output	0.90 dB
Measuring out-of-band/out-of-block (including intermodulation) emissions and spurious emissions	0.90 dB
Out-of-band/out-of-block emissions conducted measurements	0.90 dB
Spurious emissions conducted	2.18 dB
Spurious emissions radiated mesurements	5.38 dB
Total frequency uncertainty	2×10^{-7}

Reference : ECL-MU5.4.6.3-EMC-14-001-V03.00 MU Wireless.xlsx

8 PHOTO REPORT

Please see separate photo report.

ANNEX A: ACCREDITATION CERTIFICATE (FOR INFORMATION)

The accreditation relates to competences stated on the accreditation certificate. The current certificate is available on the homepage of the DAkkS and can be downloaded under accredited bodies with the processing number:

https://www.dakks.de/en

ANNEX B: ADDITIONAL INFORMATION PROVIDED BY CLIENT

None.

****** End of test report *****

Thomas Hufnagel
Test Engineer

Digitally signed by Thomas Hufnagel
Date: 2024.01.31 08:31:53 +01'00'