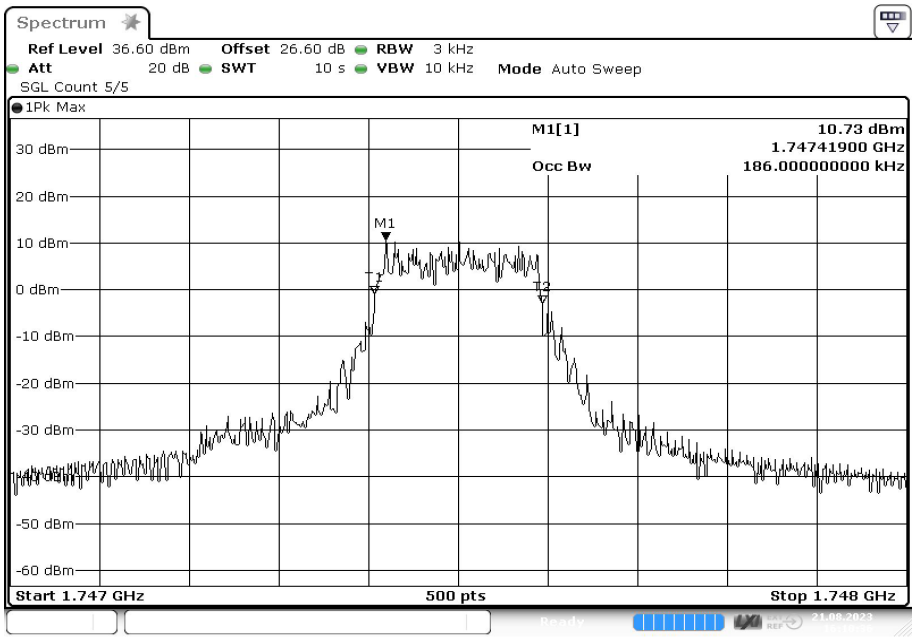
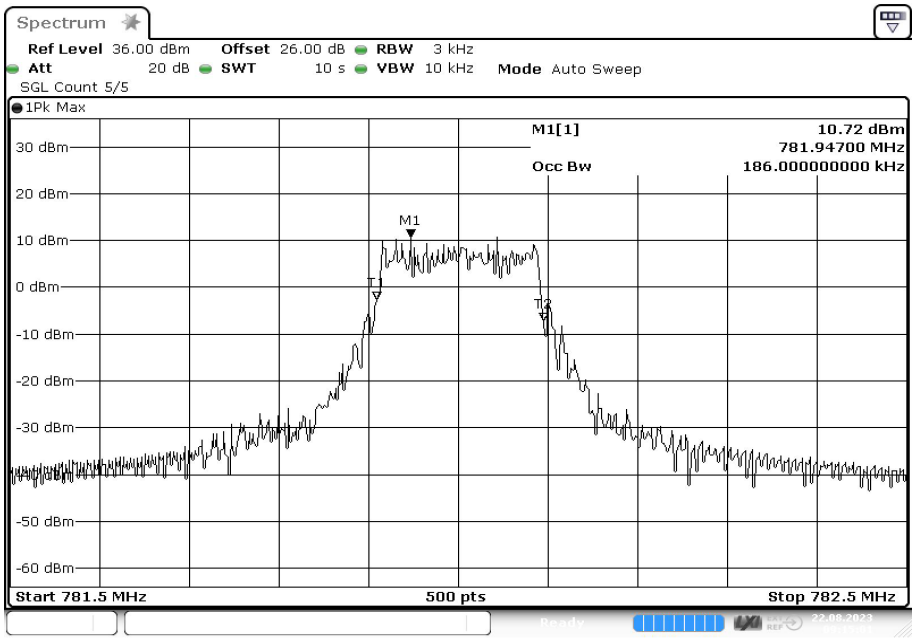
Technology = NB-IoT, Radio Technology = eFDD 4, Operating Frequency = mid channel (S01_AB01)



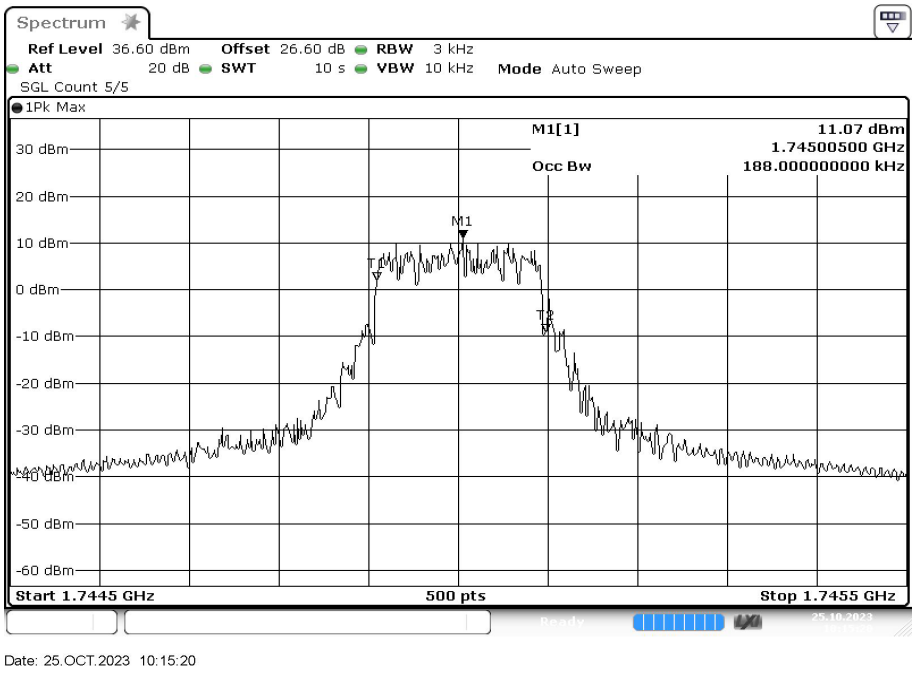
Date: 21.AUG.2023 16:10:36

Technology = NB-IoT, Radio Technology = eFDD 13, Operating Frequency = mid channel (S01_AB01)



Date: 22.AUG.2023 09:15:01

Technology = NB-IoT, Radio Technology = eFDD 66, Operating Frequency = mid channel (S01_AE01)



5.19.5 TEST EQUIPMENT USED

- Radio Lab

5.20 BAND EDGE COMPLIANCE

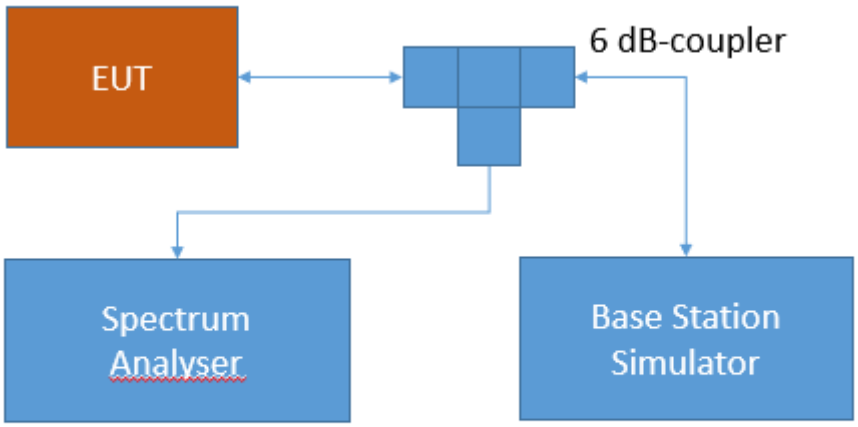
Standard **FCC PART 27 Subpart C**

The test was performed according to:
ANSI C63.26: 2015; 5.7.3

5.20.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable conducted spurious emission test case per § 2. 1051 and RSS-GEN 6.13. The limit comes from the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

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



Test Setup FCC Part 22/24/27/90 Cellular;
Band edge compliance

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.

5.20.2 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.

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 - Emission limits

Band 13

(c) For operations in the 746-758 MHz band and the 776-788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On any frequency outside the 746-758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;

(3) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations;

(4) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations;

(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;

(f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

RSS-130; 4.7.1 General unwanted emissions limits

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

RSS-130; 4.7.2 Additional unwanted emissions limits

In addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:

   i. 76 + 10 $\log_{10}$ p (watts), dB, for base and fixed equipment and

   ii. 65 + 10 $\log_{10}$ p (watts), dB, for mobile and portable equipment

b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed −70 dBW/MHz for wideband signal and −80 dBW for discrete emission with bandwidth less than 700 Hz.

Band 12:

(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

RSS-130; 4.7.1 General unwanted emissions limits

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

RSS-130; 4.7.2 Additional unwanted emissions limits

In addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:

   i. 76 + 10 $\log_{10}$ p (watts), dB, for base and fixed equipment and

   ii. 65 + 10 $\log_{10}$ p (watts), dB, for mobile and portable equipment

b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed −70 dBW/MHz for wideband signal and −80 dBW for discrete emission with bandwidth less than 700 Hz.

Band 4/66:

(h) *AWS emission limits*— (1) *General protection levels.* Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 $\log_{10}$ (P) dB.

RSS-139; 5.6 Transmitter Unwanted Emissions

Unwanted emissions shall be measured in terms of average values.

For all equipment, the TRP or total conducted power (sum of conducted power across all antenna connectors) of the unwanted emissions outside the frequency block or frequency block group shall not exceed the limits shown in table 6.

Table 6: Unwanted emission limits	
Offset from the edge of the frequency	Unwanted emission limits
1 MHz	-13 dBm / (1% of occupied bandwidth)
> 1 MHz	-13 dBm / MHz

5.20.3 TEST PROTOCOL

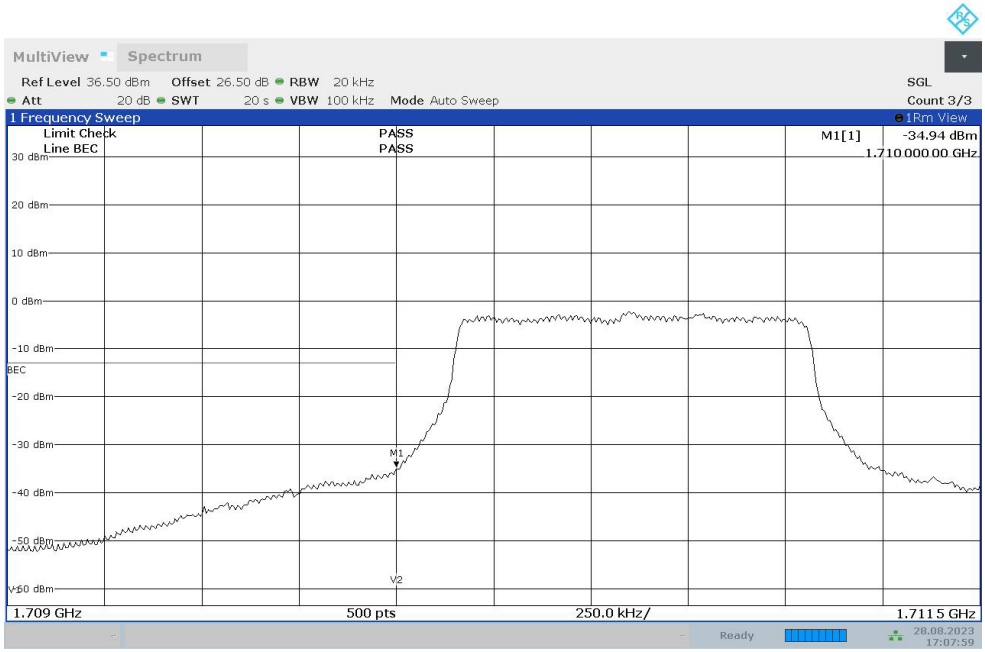
Ambient temperature: 20 - 28 °C
Relative humidity: 30 - 40 %

Radio Technology	Channel	Resource Blocks	Band-width [MHz]	Peak [dBm]	Average [dBm]	RMS [dBm]	Limit /dBm	Margin to Limit /dB
CAT-M1 eFDD 4 QPSK	low	6	1.4	-15.21	-44.22	-35.91	-13	22.91
CAT-M1 eFDD 4 QPSK	high	6	1.4	-17.52	-46.10	-38.27	-13	25.27
CAT-M1 eFDD 4 16QAM	low	5	1.4	-17.89	-45.02	-34.94	-13	21.94
CAT-M1 eFDD 4 16QAM	high	5	1.4	-17.99	-47.12	-38.09	-13	25.09
CAT-M1 eFDD 12 QPSK	low	6	1.4	-13.01	-40.82	-32.12	-13	19.12
CAT-M1 eFDD 12 QPSK	high	6	1.4	-16.26	-41.99	-32.70	-13	19.70
CAT-M1 eFDD 12 16QAM	low	5	1.4	-7.79	-40.41	-31.72	-13	18.72
CAT-M1 eFDD 12 16QAM	high	5	1.4	-14.49	-43.27	-33.81	-13	20.81
CAT-M1 eFDD 13 QPSK	low	6	1.4	-16.29	-41.10	-32.39	-13	19.39
CAT-M1 eFDD 13 QPSK	high	6	1.4	-14.46	-40.12	-32.04	-13	19.04
CAT-M1 eFDD 13 16QAM	low	5	1.4	-19.54	-44.23	-35.88	-13	22.88
CAT-M1 eFDD 13 16QAM	high	5	1.4	-15.79	-43.66	-35.70	-13	22.70
CAT-M1 eFDD 66 QPSK	low	6	1.4	-14.61	-44.03	-35.76	-13	22.76
CAT-M1 eFDD 66 QPSK	high	6	1.4	-16.27	-47.13	-37.41	-13	24.41
CAT-M1 eFDD 66 16QAM	low	5	1.4	-17.33	-44.93	-34.77	-13	21.77
CAT-M1 eFDD 66 16QAM	high	5	1.4	-19.69	-48.61	-38.85	-13	25.85
NB-IoT eFDD 4 QPSK	low	12	0.2	-8.09	-34.19	-24.38	-13	11.38
NB-IoT eFDD 4 QPSK	high	12	0.2	-5.54	-29.54	-23.95	-13	10.95
NB-IoT eFDD 4 BPSK	low	1	0.2	-13.86	-20.22	-18.90	-13	5.90
NB-IoT eFDD 4 BPSK	high	1	0.2	-17.07	-27.19	-24.34	-13	11.34
NB-IoT eFDD 12 QPSK	low	12	0.2	-51.04	-60.78	-59.58	-13	46.58
NB-IoT eFDD 12 QPSK	high	12	0.2	-12.84	-47.97	-37.26	-13	24.26
NB-IoT eFDD 12 BPSK	low	1	0.2	-20.99	-58.96	-56.42	-13	43.42
NB-IoT eFDD 12 BPSK	high	1	0.2	-10.77	-41.59	-36.12	-13	23.12
NB-IoT eFDD 13 QPSK	low	12	0.2	-9.59	-45.88	-35.20	-13	22.20
NB-IoT eFDD 13 QPSK	high	12	0.2	-13.36	-48.26	-36.72	-13	23.72
NB-IoT eFDD 13 BPSK	low	1	0.2	-9.95	-32.04	-31.89	-13	18.89
NB-IoT eFDD 13 BPSK	high	1	0.2	-10.55	-42.52	-36.83	-13	23.83
NB-IoT eFDD 66 QPSK	low	12	0.2	-8.34	-30.22	-20.76	-13	7.76
NB-IoT eFDD 66 QPSK	high	12	0.2	-7.74	-34.77	-21.07	-13	8.07
NB-IoT eFDD 66 BPSK	low	1	0.2	-62.45	-20.47	-19.32	-13	6.32
NB-IoT eFDD 66 BPSK	high	1	0.2	-62.79	-27.34	-25.49	-13	12.49
NB-IoT eFDD 85 QPSK	low	12	0.2	-18.23	-46.80	-36.00	-13	23.00
NB-IoT eFDD 85 QPSK	high	12	0.2	-51.29	-47.78	-36.79	-13	23.79
NB-IoT eFDD 85 BPSK	low	1	0.2	-30.17	-33.77	-31.36	-13	18.36
NB-IoT eFDD 85 BPSK	high	1	0.2	-10.78	-45.90	-36.60	-13	23.60

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

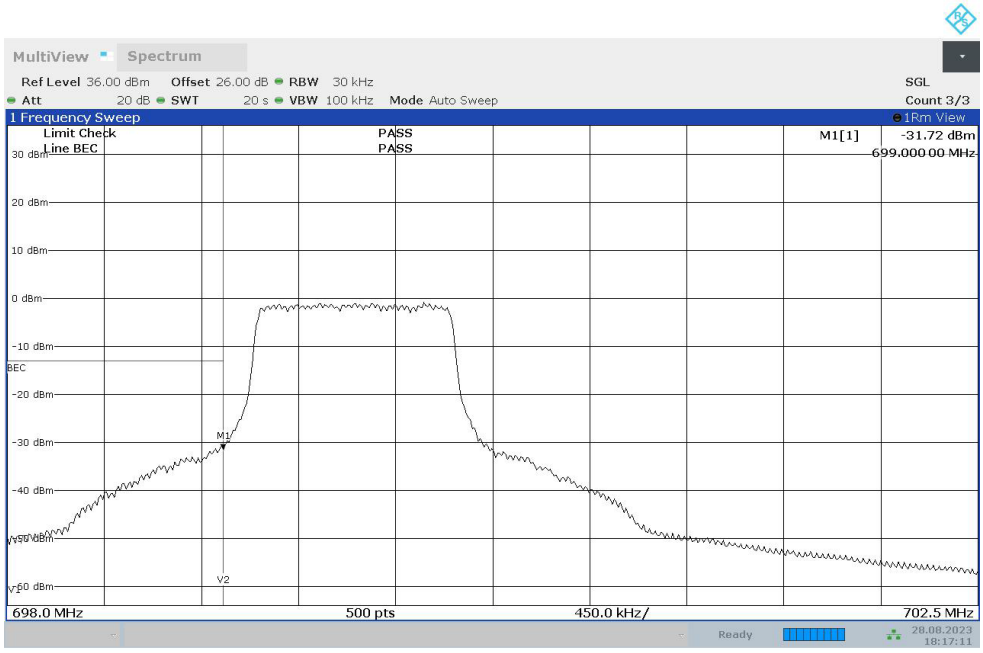
5.20.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

Technology = CAT-M1, Radio Technology = eFDD 4, Operating Frequency = low channel (S01_AB01)



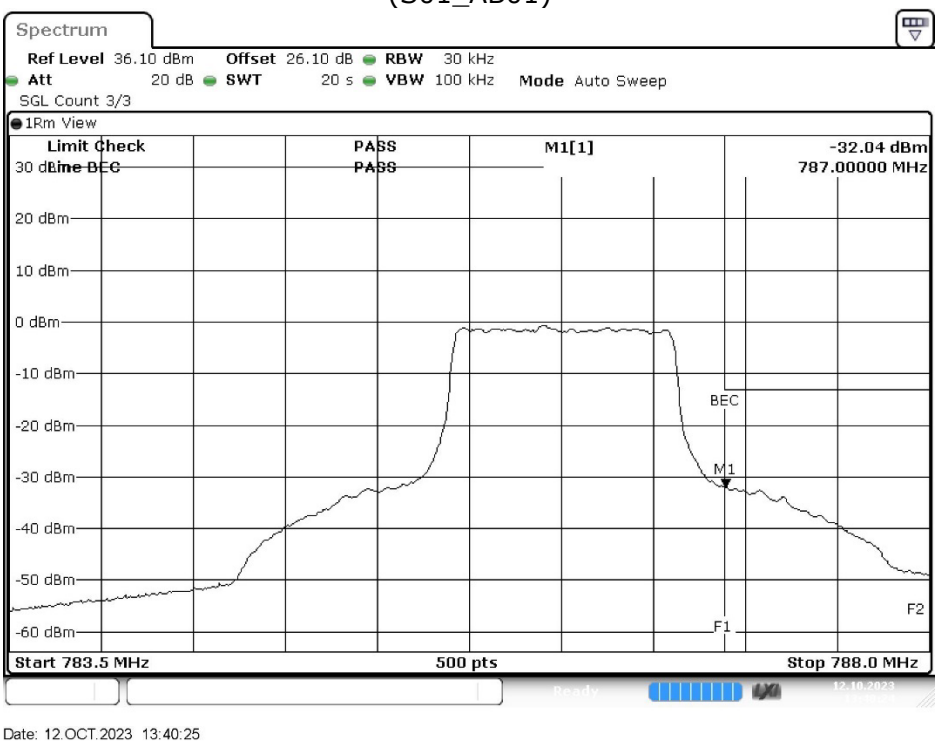
17:07:59 28.08.2023

Technology = CAT-M1, Radio Technology = eFDD 12, Operating Frequency = low channel (S01_AB01)

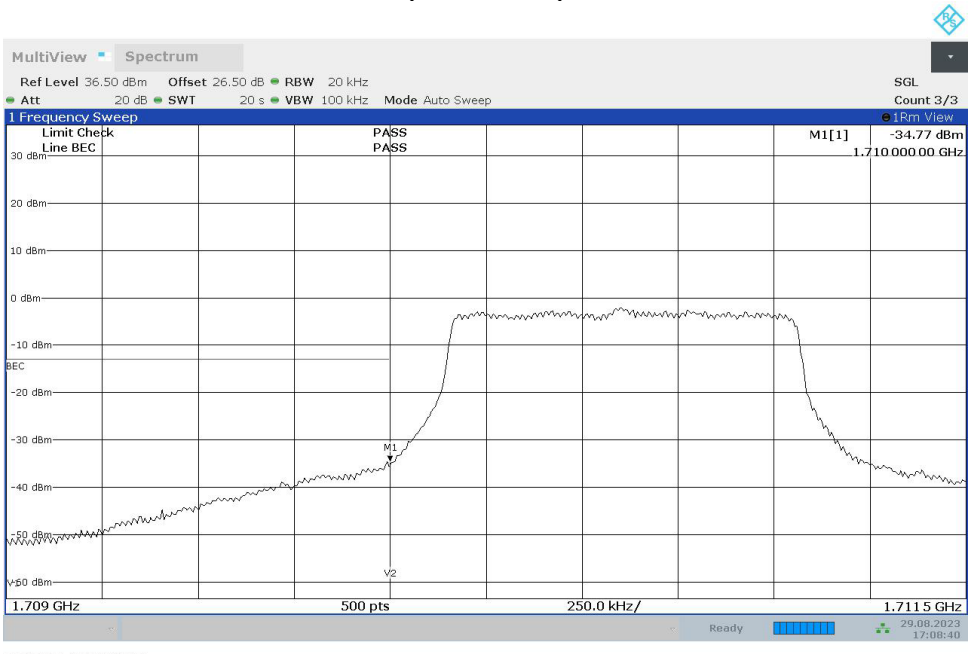


18:17:12 28.08.2023

Technology = CAT-M1, Radio Technology = eFDD 13, Operating Frequency = high channel (S01_AB01)



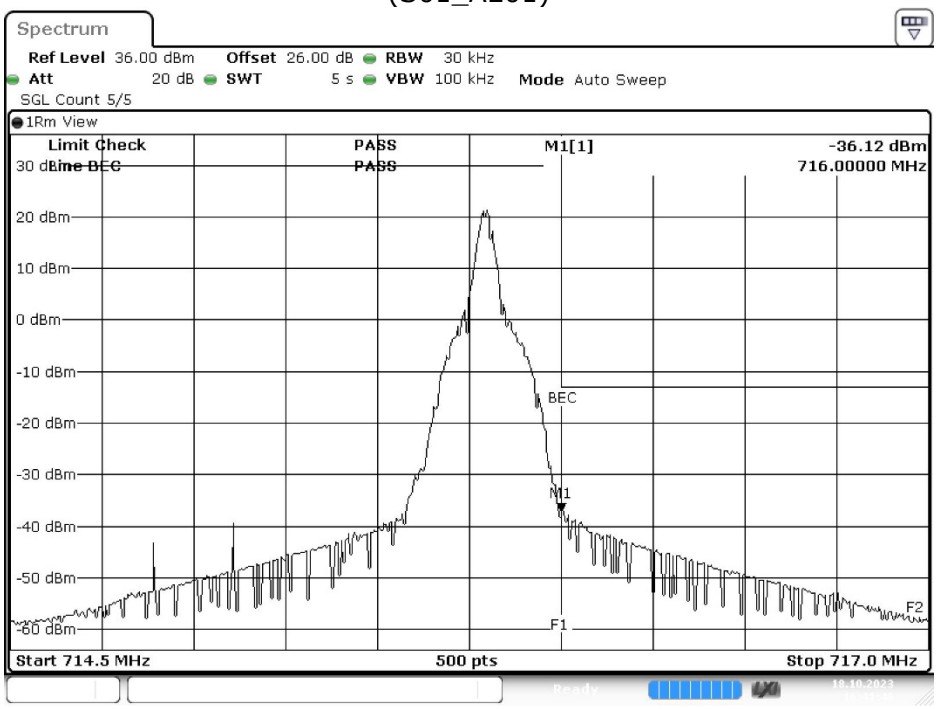
Technology = CAT-M1, Radio Technology = eFDD 66, Operating Frequency = low channel (S01_AB01)



Technology = NB-IoT, Radio Technology = eFDD 4, Operating Frequency = low channel (S01_AE01)

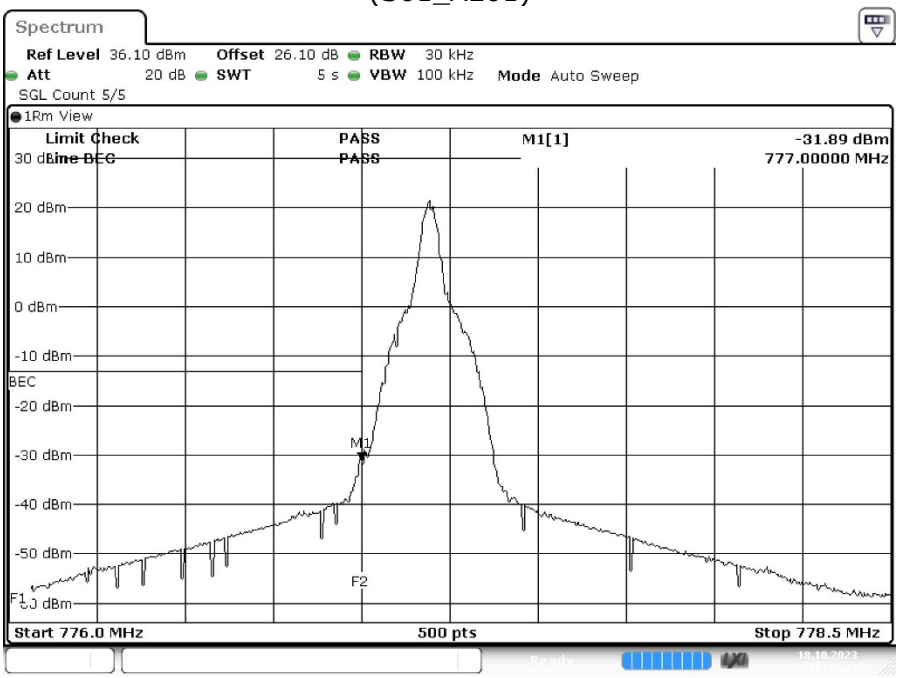
Date: 18.OCT.2023 16:17:42

Technology = NB-IoT, Radio Technology = eFDD 12, Operating Frequency = high channel (S01_AE01)



Date: 18.OCT.2023 16:41:49

Technology = NB-IoT, Radio Technology = eFDD 13, Operating Frequency = low channel (S01_AE01)

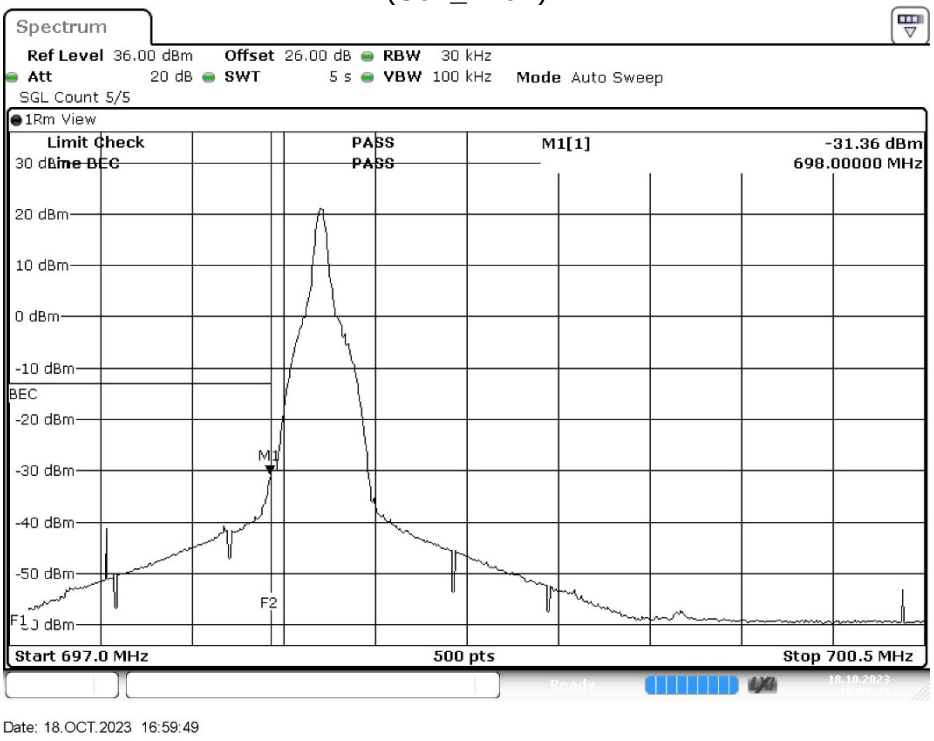


Date: 18.OCT.2023 16:47:25

Technology = NB-IoT, Radio Technology = eFDD 66, Operating Frequency = low channel (S01_AE01)

Date: 18.OCT.2023 16:53:49

Technology = NB-IoT, Radio Technology = eFDD 85, Operating Frequency = low channel (S01_AE01)



5.20.5 TEST EQUIPMENT USED

- Radio Lab

5.21 PEAK TO AVERAGE RATIO

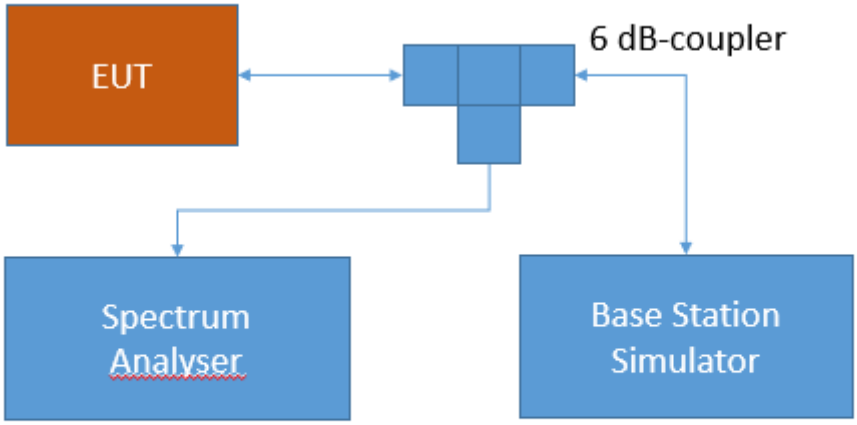
Standard **FCC PART 27 Subpart C**

The test was performed according to:
ANSI C63.26: 2015; 5.2.3.4 (broadband noise-like signal using CCDF [LTE, CAT-M1, NB-IoT])
5.2.6 (alternative procedure for PAPR [GSM, EDGE, WCDMA, HSDPA, HSUPA])

5.21.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance of the EUT to the peak-to-average limits and requirements of the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

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



Test Setup FCC Part 22/24/27/90 Cellular;
Peak-average ratio

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. The internal CCDF (complementary cumulative distribution function) of the spectrum analyser is used for this measurement

5.21.2 TEST REQUIREMENTS / LIMITS

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§ 27.50 - Power limits and duty cycle

Band 13:

No applicable PAPR limit.

RSS-130; 4.6.1 General

The transmitter output power shall be measured in terms of average power. In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the highest PAPR during periods of continuous transmission.

Band 12:

No applicable PAPR limit.

RSS-130; 4.6.1 General

The transmitter output power shall be measured in terms of average power. In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the highest PAPR during periods of continuous transmission.

Band 4/10/66:

d) The following power and antenna height requirements apply to stations transmitting in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz and 2180-2200 MHz bands:

(5) Equipment employed must be authorized in accordance with the provisions of §24.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (d)(6) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

RSS-139; 5.5 Transmitter Output Power

In addition, the peak to average power ratio (PAPR) of the equipment shall not exceed 13 dB for more than 0.1% of the time, using a signal that corresponds to the highest PAPR during periods of continuous transmission.

5.21.3 TEST PROTOCOL

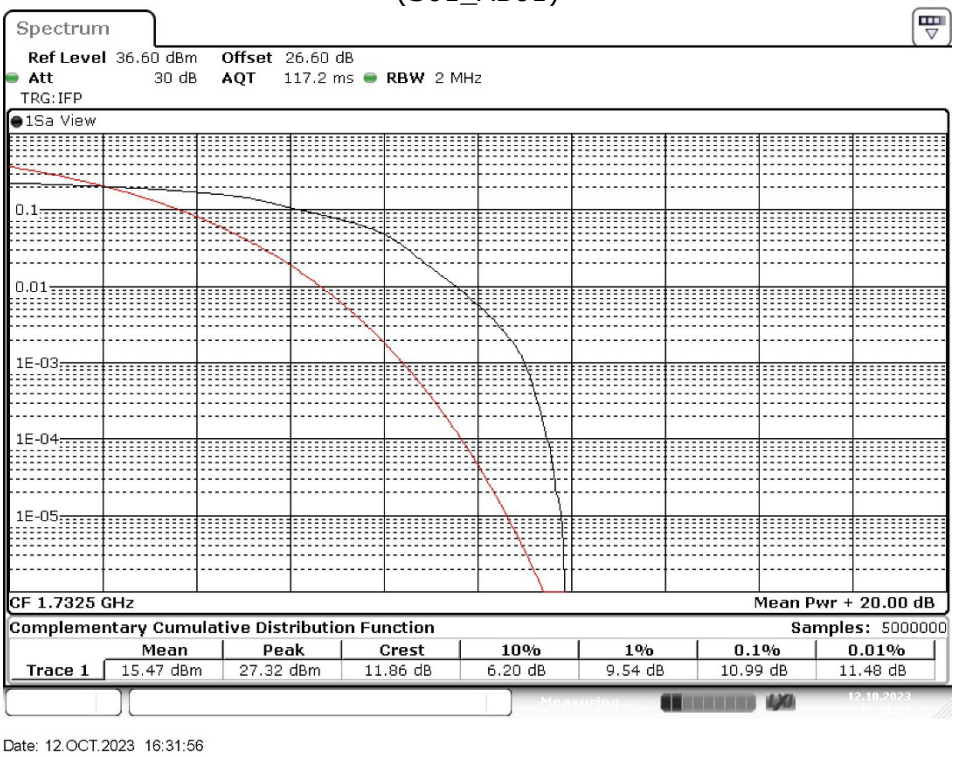
Ambient temperature: 20 - 28 °C
Relative humidity: 30 - 40 %

Radio Technology	Channel	Resource Blocks	Band-width [MHz]	Peak to Average Ratio	Limit (IC) [dB]
CAT-M1 eFDD 4 QPSK	low	6	1.4	10.41	13
CAT-M1 eFDD 4 QPSK	mid	6	1.4	10.35	13
CAT-M1 eFDD 4 QPSK	high	6	1.4	10.87	13
CAT-M1 eFDD 4 16QAM	low	5	1.4	10.99	13
CAT-M1 eFDD 4 16QAM	mid	5	1.4	10.99	13
CAT-M1 eFDD 4 16QAM	high	5	1.4	11.13	13
CAT-M1 eFDD 12 QPSK	low	6	1.4	9.65	13
CAT-M1 eFDD 12 QPSK	mid	6	1.4	9.74	13
CAT-M1 eFDD 12 QPSK	high	6	1.4	9.62	13
CAT-M1 eFDD 12 16QAM	low	5	1.4	10.26	13
CAT-M1 eFDD 12 16QAM	mid	5	1.4	10.41	13
CAT-M1 eFDD 12 16QAM	high	5	1.4	10.32	13
CAT-M1 eFDD 13 QPSK	low	6	1.4	10.00	13
CAT-M1 eFDD 13 QPSK	mid	6	1.4	10.55	13
CAT-M1 eFDD 13 QPSK	high	6	1.4	9.10	13
CAT-M1 eFDD 13 16QAM	low	5	1.4	11.36	13
CAT-M1 eFDD 13 16QAM	mid	5	1.4	11.04	13
CAT-M1 eFDD 13 16QAM	high	5	1.4	11.80	13
CAT-M1 eFDD 66 QPSK	low	6	1.4	10.29	13
CAT-M1 eFDD 66 QPSK	mid	6	1.4	10.35	13
CAT-M1 eFDD 66 QPSK	high	6	1.4	10.38	13
CAT-M1 eFDD 66 16QAM	low	5	1.4	10.96	13
CAT-M1 eFDD 66 16QAM	mid	5	1.4	10.99	13
CAT-M1 eFDD 66 16QAM	high	5	1.4	11.13	13
NB-IoT eFDD 4 QPSK	low	12	0.2	7.91	13
NB-IoT eFDD 4 QPSK	mid	12	0.2	7.94	13
NB-IoT eFDD 4 QPSK	high	12	0.2	7.94	13
NB-IoT eFDD 4 BPSK	low	1	0.2	8.43	13
NB-IoT eFDD 4 BPSK	mid	1	0.2	8.23	13
NB-IoT eFDD 4 BPSK	high	1	0.2	8.23	13
NB-IoT eFDD 12 QPSK	low	12	0.2	7.45	13
NB-IoT eFDD 12 QPSK	mid	12	0.2	7.48	13
NB-IoT eFDD 12 QPSK	high	12	0.2	7.48	13
NB-IoT eFDD 12 BPSK	low	1	0.2	8.09	13
NB-IoT eFDD 12 BPSK	mid	1	0.2	8.09	13
NB-IoT eFDD 12 BPSK	high	1	0.2	8.26	13
NB-IoT eFDD 13 QPSK	low	12	0.2	7.62	13
NB-IoT eFDD 13 QPSK	mid	12	0.2	7.48	13
NB-IoT eFDD 13 QPSK	high	12	0.2	7.65	13
NB-IoT eFDD 13 BPSK	low	1	0.2	8.14	13
NB-IoT eFDD 13 BPSK	mid	1	0.2	8.14	13
NB-IoT eFDD 13 BPSK	high	1	0.2	8.14	13
NB-IoT eFDD 66 QPSK	low	12	0.2	7.91	13
NB-IoT eFDD 66 QPSK	mid	12	0.2	7.94	13
NB-IoT eFDD 66 QPSK	high	12	0.2	7.94	13
NB-IoT eFDD 66 BPSK	low	1	0.2	8.23	13
NB-IoT eFDD 66 BPSK	mid	1	0.2	8.23	13
NB-IoT eFDD 66 BPSK	high	1	0.2	8.41	13
NB-IoT eFDD 85 QPSK	low	12	0.2	7.45	13
NB-IoT eFDD 85 QPSK	mid	12	0.2	7.48	13
NB-IoT eFDD 85 QPSK	high	12	0.2	7.45	13
NB-IoT eFDD 85 BPSK	low	1	0.2	8.09	13
NB-IoT eFDD 85 BPSK	mid	1	0.2	8.12	13
NB-IoT eFDD 85 BPSK	high	1	0.2	8.09	13

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

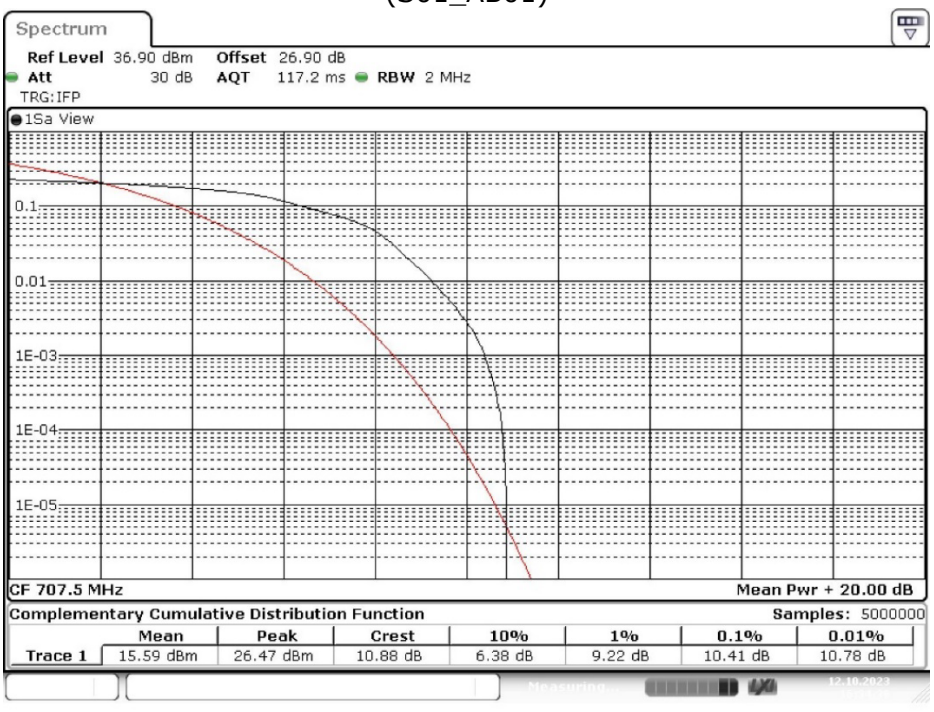
5.21.4 MEASUREMENT PLOT (EXAMPLE PLOT, SHOWING WORST CASE, IF APPLICABLE)

Technology = CAT-M1, Radio Technology = eFDD 4, Operating Frequency = mid channel (S01_AB01)



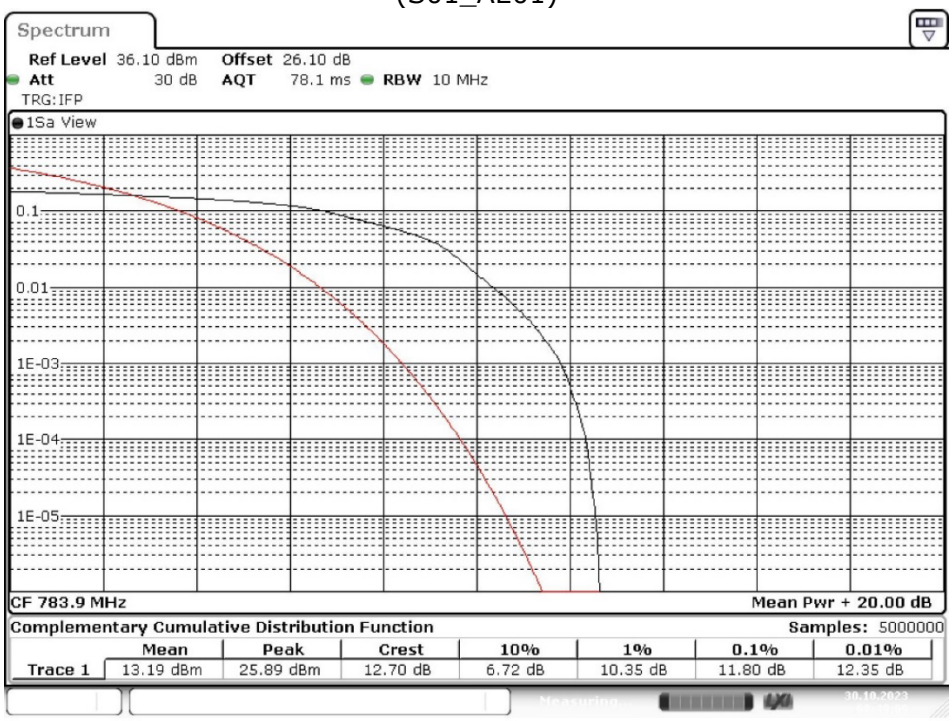
Date: 12.OCT.2023 16:31:56

Technology = CAT-M1, Radio Technology = eFDD 12, Operating Frequency = mid channel (S01_AB01)



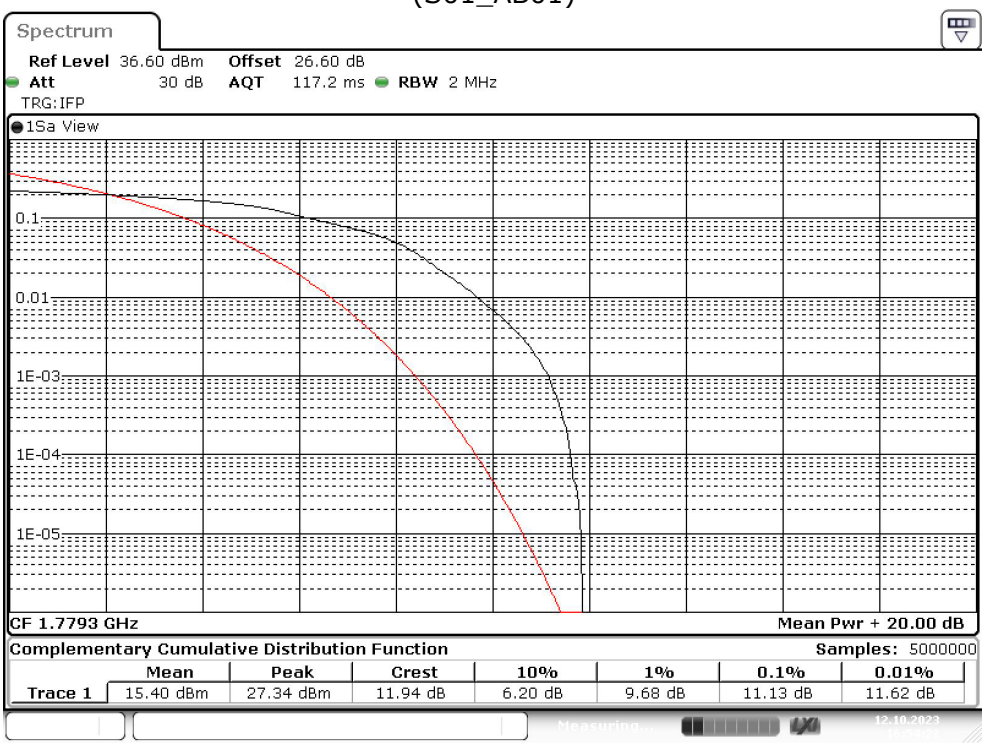
Date: 12.OCT.2023 16:34:30

Technology = CAT-M1, Radio Technology = eFDD 13, Operating Frequency = high channel (S01_AE01)



Date: 30.OCT.2023 08:49:10

Technology = CAT-M1, Radio Technology = eFDD 66, Operating Frequency = high channel (S01_AB01)



Date: 12.OCT.2023 16:54:23