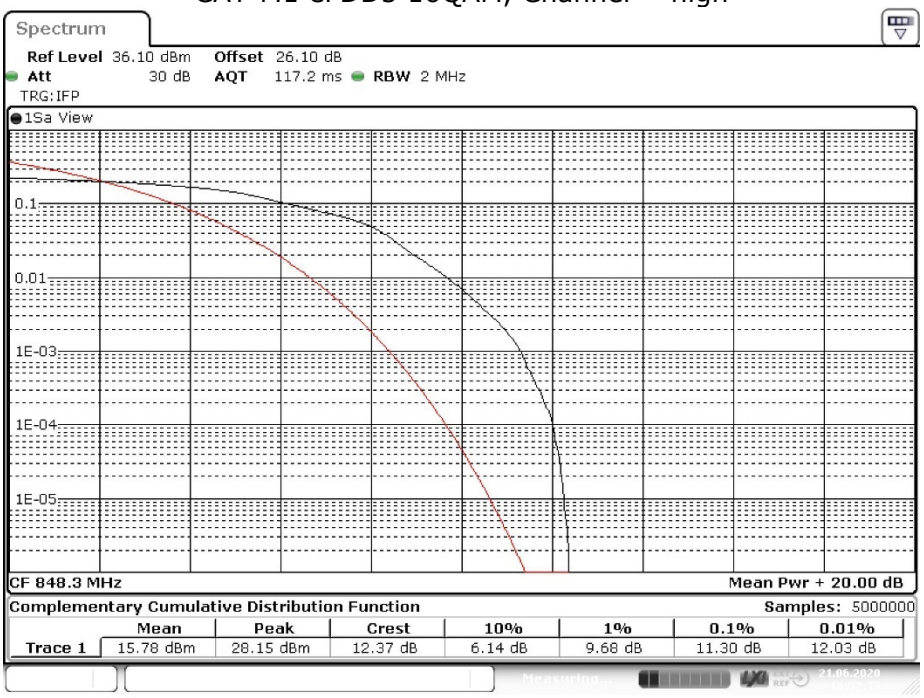
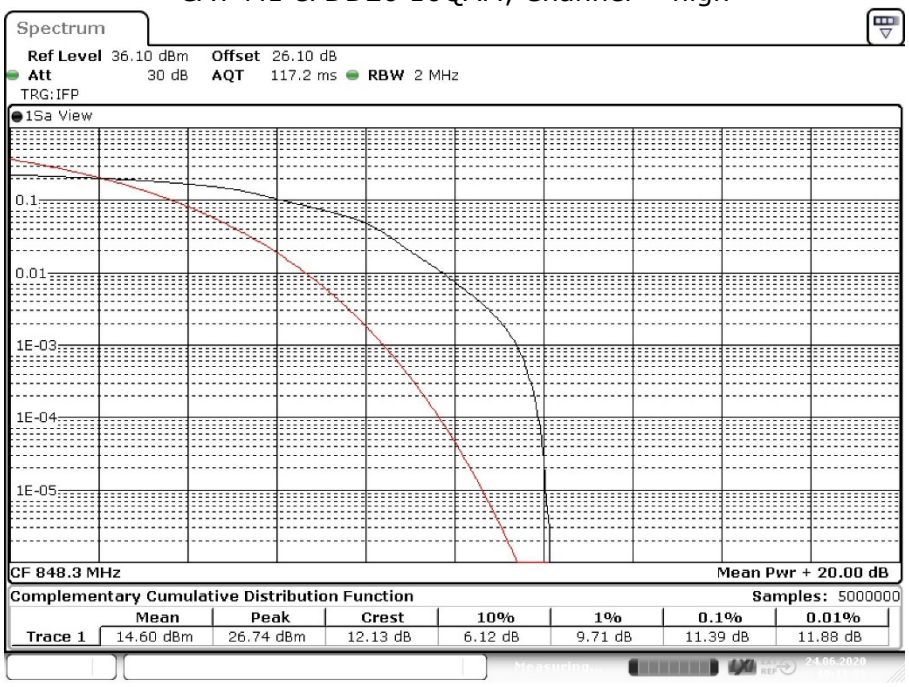
5.7.4 MEASUREMENT PLOT

CAT-M1 eFDD5 16QAM, Channel = high



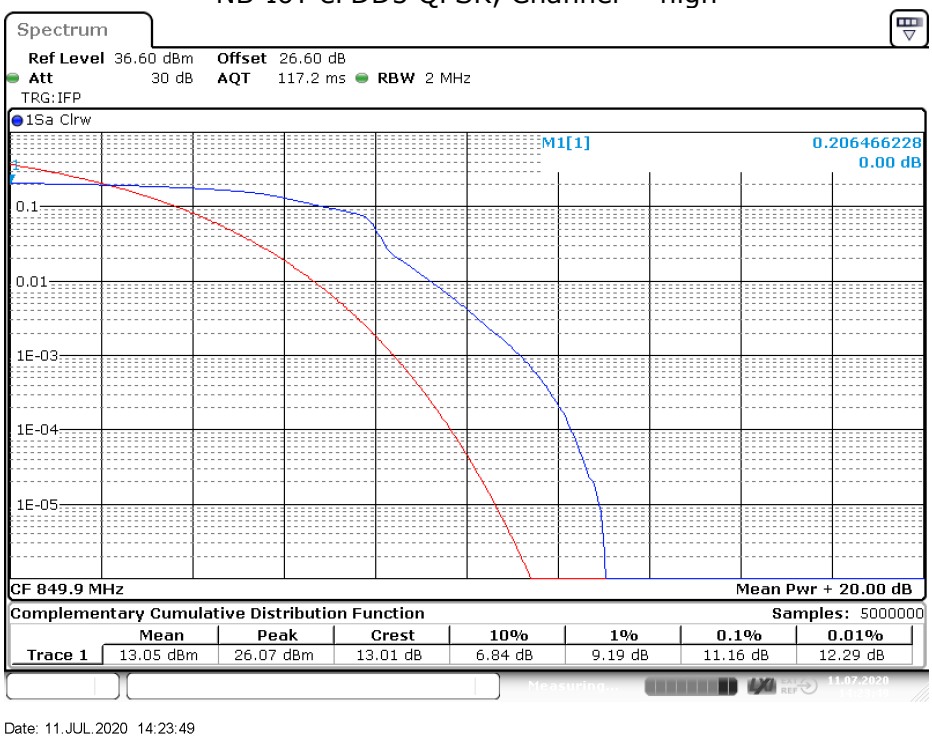
Date: 21.JUN.2020 16:52:19

CAT-M1 eFDD26 16QAM, Channel = high



Date: 24.JUN.2020 10:11:07

NB-IoT eFDD5 QPSK, Channel = high



Date: 11.JUL.2020 14:23:49

5.7.5 TEST EQUIPMENT USED

- Radio Lab

5.8 RF OUTPUT POWER

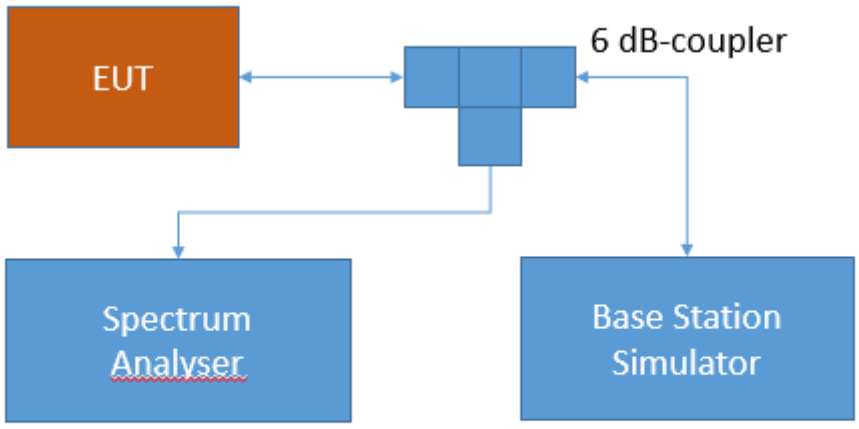
Standard **FCC PART 24 Subpart E**

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

5.8.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable RF Output power test case per § 2.1046 and RSS-GEN 6.12. The limit and the requirements come 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;
RF Output power

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.

5.8.2 TEST REQUIREMENTS / LIMITS

FCC Part 24, § 24.232

(c) Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

RSS-133; 6.4 Transmitter Output Power and Equivalent Isotropically Radiated Power

The equivalent isotropically radiated power (e.i.r.p.) for transmitters shall not exceed the limits given in SRSP-510.

SRSP-510; 5.1.2 Radiated Power and Antenna Height Limits – Mobile Stations

Mobile stations and hand-held portables are limited to 2 watts maximum e.i.r.p. The equipment shall employ means to limit the power to the minimum necessary for successful communication.

5.8.3 TEST PROTOCOL

Ambient temperature: 20 - 25 °C
Relative humidity: 30 - 40 %

Radio Technology	CH	Re-source Blocks / Sub-carrier	Band-width [MHz]	Peak Cond. Power [dBm]	Average Cond. Power [dBm]	RMS Cond. Power [dBm]	FCC EIRP Limit [W]	IC EIRP Limit [W]	Max. Antenna Gain FCC [dBi]	Max. Antenna Gain IC [dBi]
GSM 1900	low	-	0.2	29.57	29.05	29.05	2	2	3.43	3.43
GSM 1900	mid	-	0.2	29.54	29.04	29.05	2	2	3.46	3.46
GSM 1900	high	-	0.2	29.19	28.73	28.75	2	2	3.81	3.81
GSM 1900 EDGE	low	-	0.2	29.13	26.52	26.48	2	2	3.87	3.87
GSM 1900 EDGE	mid	-	0.2	29.39	26.71	27	2	2	3.61	3.61
GSM 1900 EDGE	high	-	0.2	29.38	26.46	26.89	2	2	3.62	3.62
CAT-M1 eFDD 2 QPSK	low	1	1.4	-	-	22.80	2	2	10.20	10.20
CAT-M1 eFDD 2 QPSK	low	3	1.4	-	-	21.81	2	2	11.19	11.19
CAT-M1 eFDD 2 QPSK	low	6	1.4	-	-	20.83	2	2	12.17	12.17
CAT-M1 eFDD 2 QPSK	mid	1	1.4	-	-	22.82	2	2	10.18	10.18
CAT-M1 eFDD 2 QPSK	mid	3	1.4	-	-	21.86	2	2	11.14	11.14
CAT-M1 eFDD 2 QPSK	mid	6	1.4	-	-	20.85	2	2	12.15	12.15
CAT-M1 eFDD 2 QPSK	high	1	1.4	-	-	22.61	2	2	10.39	10.39
CAT-M1 eFDD 2 QPSK	high	3	1.4	-	-	21.91	2	2	11.09	11.09
CAT-M1 eFDD 2 QPSK	high	6	1.4	-	-	20.82	2	2	12.18	12.18
CAT-M1 eFDD 2 16QAM	low	1	1.4	-	-	22.26	2	2	10.74	10.74
CAT-M1 eFDD 2 16QAM	low	5	1.4	-	-	20.22	2	2	12.78	12.78
CAT-M1 eFDD 2 16QAM	mid	1	1.4	-	-	21.93	2	2	11.07	11.07
CAT-M1 eFDD 2 16QAM	mid	5	1.4	-	-	20.75	2	2	12.25	12.25
CAT-M1 eFDD 2 16QAM	high	1	1.4	-	-	21.58	2	2	11.42	11.42
CAT-M1 eFDD 2 16QAM	high	5	1.4	-	-	20.59	2	2	12.41	12.41
CAT-M1 eFDD 2 QPSK	low	1	3	-	-	22.82	2	2	10.18	10.18
CAT-M1 eFDD 2 QPSK	low	3	3	-	-	21.84	2	2	11.16	11.16
CAT-M1 eFDD 2 QPSK	low	6	3	-	-	20.83	2	2	12.17	12.17
CAT-M1 eFDD 2 QPSK	mid	1	3	-	-	22.75	2	2	10.25	10.25
CAT-M1 eFDD 2 QPSK	mid	3	3	-	-	21.89	2	2	11.11	11.11
CAT-M1 eFDD 2 QPSK	mid	6	3	-	-	20.85	2	2	12.15	12.15
CAT-M1 eFDD 2 QPSK	high	1	3	-	-	22.67	2	2	10.33	10.33
CAT-M1 eFDD 2 QPSK	high	3	3	-	-	21.84	2	2	11.16	11.16
CAT-M1 eFDD 2 QPSK	high	6	3	-	-	20.69	2	2	12.31	12.31
CAT-M1 eFDD 2 16QAM	low	1	3	-	-	22.15	2	2	10.85	10.85
CAT-M1 eFDD 2 16QAM	low	5	3	-	-	20.81	2	2	12.19	12.19
CAT-M1 eFDD 2 16QAM	mid	1	3	-	-	22.07	2	2	10.93	10.93
CAT-M1 eFDD 2 16QAM	mid	5	3	-	-	20.89	2	2	12.11	12.11
CAT-M1 eFDD 2 16QAM	high	1	3	-	-	22.12	2	2	10.88	10.88
CAT-M1 eFDD 2 16QAM	high	5	3	-	-	20.70	2	2	12.30	12.30
CAT-M1 eFDD 2 QPSK	low	1	5	-	-	22.77	2	2	10.23	10.23
CAT-M1 eFDD 2 QPSK	low	3	5	-	-	21.89	2	2	11.11	11.11
CAT-M1 eFDD 2 QPSK	low	6	5	-	-	21.79	2	2	11.21	11.21
CAT-M1 eFDD 2 QPSK	mid	1	5	-	-	22.71	2	2	10.29	10.29
CAT-M1 eFDD 2 QPSK	mid	3	5	-	-	21.96	2	2	11.04	11.04
CAT-M1 eFDD 2 QPSK	mid	6	5	-	-	21.86	2	2	11.14	11.14
CAT-M1 eFDD 2 QPSK	high	1	5	-	-	22.68	2	2	10.32	10.32
CAT-M1 eFDD 2 QPSK	high	3	5	-	-	21.87	2	2	11.13	11.13
CAT-M1 eFDD 2 QPSK	high	6	5	-	-	21.80	2	2	11.20	11.20
CAT-M1 eFDD 2 16QAM	low	1	5	-	-	23.09	2	2	9.91	9.91
CAT-M1 eFDD 2 16QAM	low	5	5	-	-	21.79	2	2	11.21	11.21
CAT-M1 eFDD 2 16QAM	mid	1	5	-	-	23.11	2	2	9.89	9.89

CAT-M1 eFDD 2 16QAM	mid	5	5	-	-	20.92	2	2	12.08	12.08
CAT-M1 eFDD 2 16QAM	high	1	5	-	-	22.69	2	2	10.31	10.31
CAT-M1 eFDD 2 16QAM	high	5	5	-	-	21.79	2	2	11.21	11.21
CAT-M1 eFDD 2 QPSK	low	1	10	-	-	22.73	2	2	10.27	10.27
CAT-M1 eFDD 2 QPSK	low	3	10	-	-	22.86	2	2	10.14	10.14
CAT-M1 eFDD 2 QPSK	low	6	10	-	-	21.87	2	2	11.13	11.13
CAT-M1 eFDD 2 QPSK	mid	1	10	-	-	22.71	2	2	10.29	10.29
CAT-M1 eFDD 2 QPSK	mid	3	10	-	-	21.85	2	2	11.15	11.15
CAT-M1 eFDD 2 QPSK	mid	6	10	-	-	20.77	2	2	12.23	12.23
CAT-M1 eFDD 2 QPSK	high	1	10	-	-	22.66	2	2	10.34	10.34
CAT-M1 eFDD 2 QPSK	high	3	10	-	-	22.73	2	2	10.27	10.27
CAT-M1 eFDD 2 QPSK	high	6	10	-	-	21.76	2	2	11.24	11.24
CAT-M1 eFDD 2 16QAM	low	1	10	-	-	22.81	2	2	10.19	10.19
CAT-M1 eFDD 2 16QAM	low	5	10	-	-	21.90	2	2	11.10	11.10
CAT-M1 eFDD 2 16QAM	mid	1	10	-	-	21.92	2	2	11.08	11.08
CAT-M1 eFDD 2 16QAM	mid	5	10	-	-	20.78	2	2	12.22	12.22
CAT-M1 eFDD 2 16QAM	high	1	10	-	-	23.01	2	2	9.99	9.99
CAT-M1 eFDD 2 16QAM	high	5	10	-	-	21.75	2	2	11.25	11.25
CAT-M1 eFDD 25 QPSK	low	1	1.4	-	-	22.30	2	2	10.70	10.70
CAT-M1 eFDD 25 QPSK	low	3	1.4	-	-	21.95	2	2	11.05	11.05
CAT-M1 eFDD 25 QPSK	low	6	1.4	-	-	20.93	2	2	12.07	12.07
CAT-M1 eFDD 25 QPSK	mid	1	1.4	-	-	22.80	2	2	10.20	10.20
CAT-M1 eFDD 25 QPSK	mid	3	1.4	-	-	21.95	2	2	11.05	11.05
CAT-M1 eFDD 25 QPSK	mid	6	1.4	-	-	20.84	2	2	12.16	12.16
CAT-M1 eFDD 25 QPSK	high	1	1.4	-	-	22.98	2	2	10.02	10.02
CAT-M1 eFDD 25 QPSK	high	3	1.4	-	-	22.09	2	2	10.91	10.91
CAT-M1 eFDD 25 QPSK	high	6	1.4	-	-	21.03	2	2	11.97	11.97
CAT-M1 eFDD 25 16QAM	low	1	1.4	-	-	22.22	2	2	10.78	10.78
CAT-M1 eFDD 25 16QAM	low	5	1.4	-	-	20.78	2	2	12.22	12.22
CAT-M1 eFDD 25 16QAM	mid	1	1.4	-	-	21.89	2	2	11.11	11.11
CAT-M1 eFDD 25 16QAM	mid	5	1.4	-	-	20.78	2	2	12.22	12.22
CAT-M1 eFDD 25 16QAM	high	1	1.4	-	-	22.35	2	2	10.65	10.65
CAT-M1 eFDD 25 16QAM	high	5	1.4	-	-	20.99	2	2	12.01	12.01
CAT-M1 eFDD 25 QPSK	low	1	3	-	-	23.02	2	2	9.98	9.98
CAT-M1 eFDD 25 QPSK	low	3	3	-	-	22.04	2	2	10.96	10.96
CAT-M1 eFDD 25 QPSK	low	6	3	-	-	20.95	2	2	12.05	12.05
CAT-M1 eFDD 25 QPSK	mid	1	3	-	-	22.91	2	2	10.09	10.09
CAT-M1 eFDD 25 QPSK	mid	3	3	-	-	21.92	2	2	11.08	11.08
CAT-M1 eFDD 25 QPSK	mid	6	3	-	-	20.85	2	2	12.15	12.15
CAT-M1 eFDD 25 QPSK	high	1	3	-	-	23.11	2	2	9.89	9.89
CAT-M1 eFDD 25 QPSK	high	3	3	-	-	22.09	2	2	10.91	10.91
CAT-M1 eFDD 25 QPSK	high	6	3	-	-	20.97	2	2	12.03	12.03
CAT-M1 eFDD 25 16QAM	low	1	3	-	-	22.21	2	2	10.79	10.79
CAT-M1 eFDD 25 16QAM	low	5	3	-	-	20.97	2	2	12.03	12.03
CAT-M1 eFDD 25 16QAM	mid	1	3	-	-	22.01	2	2	10.99	10.99
CAT-M1 eFDD 25 16QAM	mid	5	3	-	-	20.77	2	2	12.23	12.23
CAT-M1 eFDD 25 16QAM	high	1	3	-	-	22.10	2	2	10.90	10.90
CAT-M1 eFDD 25 16QAM	high	5	3	-	-	21.01	2	2	11.99	11.99
CAT-M1 eFDD 25 QPSK	low	1	5	-	-	23.06	2	2	9.94	9.94
CAT-M1 eFDD 25 QPSK	low	3	5	-	-	21.98	2	2	11.02	11.02
CAT-M1 eFDD 25 QPSK	low	6	5	-	-	21.87	2	2	11.13	11.13
CAT-M1 eFDD 25 QPSK	mid	1	5	-	-	22.93	2	2	10.07	10.07
CAT-M1 eFDD 25 QPSK	mid	3	5	-	-	21.92	2	2	11.08	11.08
CAT-M1 eFDD 25 QPSK	mid	6	5	-	-	21.81	2	2	11.19	11.19
CAT-M1 eFDD 25 QPSK	high	1	5	-	-	23.09	2	2	9.91	9.91
CAT-M1 eFDD 25 QPSK	high	3	5	-	-	22.11	2	2	10.89	10.89
CAT-M1 eFDD 25 QPSK	high	6	5	-	-	21.98	2	2	11.02	11.02
CAT-M1 eFDD 25 16QAM	low	1	5	-	-	23.31	2	2	9.69	9.69
CAT-M1 eFDD 25 16QAM	low	5	5	-	-	20.90	2	2	12.10	12.10
CAT-M1 eFDD 25 16QAM	mid	1	5	-	-	23.03	2	2	9.97	9.97
CAT-M1 eFDD 25 16QAM	mid	5	5	-	-	20.78	2	2	12.22	12.22
CAT-M1 eFDD 25 16QAM	high	1	5	-	-	22.95	2	2	10.05	10.05
CAT-M1 eFDD 25 16QAM	high	5	5	-	-	20.88	2	2	12.12	12.12
CAT-M1 eFDD 25 QPSK	low	1	10	-	-	22.98	2	2	10.02	10.02
CAT-M1 eFDD 25 QPSK	low	3	10	-	-	23.06	2	2	9.94	9.94
CAT-M1 eFDD 25 QPSK	low	6	10	-	-	21.87	2	2	11.13	11.13
CAT-M1 eFDD 25 QPSK	mid	1	10	-	-	22.82	2	2	10.18	10.18
CAT-M1 eFDD 25 QPSK	mid	3	10	-	-	22.85	2	2	10.15	10.15
CAT-M1 eFDD 25 QPSK	mid	6	10	-	-	21.80	2	2	11.20	11.20
CAT-M1 eFDD 25 QPSK	high	1	10	-	-	23.13	2	2	9.87	9.87
CAT-M1 eFDD 25 QPSK	high	3	10	-	-	23.01	2	2	9.99	9.99
CAT-M1 eFDD 25 QPSK	high	6	10	-	-	21.94	2	2	11.06	11.06
CAT-M1 eFDD 25 16QAM	low	1	10	-	-	23.26	2	2	9.74	9.74

CAT-M1 eFDD 25 16QAM	low	5	10	-	-	21.91	2	2	11.09	11.09
CAT-M1 eFDD 25 16QAM	mid	1	10	-	-	22.95	2	2	10.05	10.05
CAT-M1 eFDD 25 16QAM	mid	5	10	-	-	21.78	2	2	11.22	11.22
CAT-M1 eFDD 25 16QAM	high	1	10	-	-	23.03	2	2	9.97	9.97
CAT-M1 eFDD 25 16QAM	high	5	10	-	-	21.80	2	2	11.20	11.20
NB-IoT eFDD 2 QPSK	low	1	0.2	-	-	23.98	2	2	9.02	9.02
NB-IoT eFDD 2 QPSK	low	3	0.2	-	-	24.06	2	2	8.94	8.94
NB-IoT eFDD 2 QPSK	low	6	0.2	-	-	22.37	2	2	10.63	10.63
NB-IoT eFDD 2 QPSK	low	12	0.2	-	-	21.13	2	2	11.87	11.87
NB-IoT eFDD 2 QPSK	mid	1	0.2	-	-	23.98	2	2	9.02	9.02
NB-IoT eFDD 2 QPSK	mid	3	0.2	-	-	23.71	2	2	9.29	9.29
NB-IoT eFDD 2 QPSK	mid	6	0.2	-	-	22.51	2	2	10.49	10.49
NB-IoT eFDD 2 QPSK	mid	12	0.2	-	-	21.11	2	2	11.89	11.89
NB-IoT eFDD 2 QPSK	high	1	0.2	-	-	24.27	2	2	8.73	8.73
NB-IoT eFDD 2 QPSK	high	3	0.2	-	-	23.81	2	2	9.19	9.19
NB-IoT eFDD 2 QPSK	high	6	0.2	-	-	22.41	2	2	10.59	10.59
NB-IoT eFDD 2 QPSK	high	12	0.2	-	-	20.97	2	2	12.03	12.03
NB-IoT eFDD 2 BPSK	low	1	0.2	-	-	23.99	2	2	9.01	9.01
NB-IoT eFDD 2 BPSK	mid	1	0.2	-	-	23.87	2	2	9.13	9.13
NB-IoT eFDD 2 BPSK	high	1	0.2	-	-	23.69	2	2	9.31	9.31

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

SPOTCHECKS FOR CHILD PRODUCT (S01_AC01 = SARA-R422)

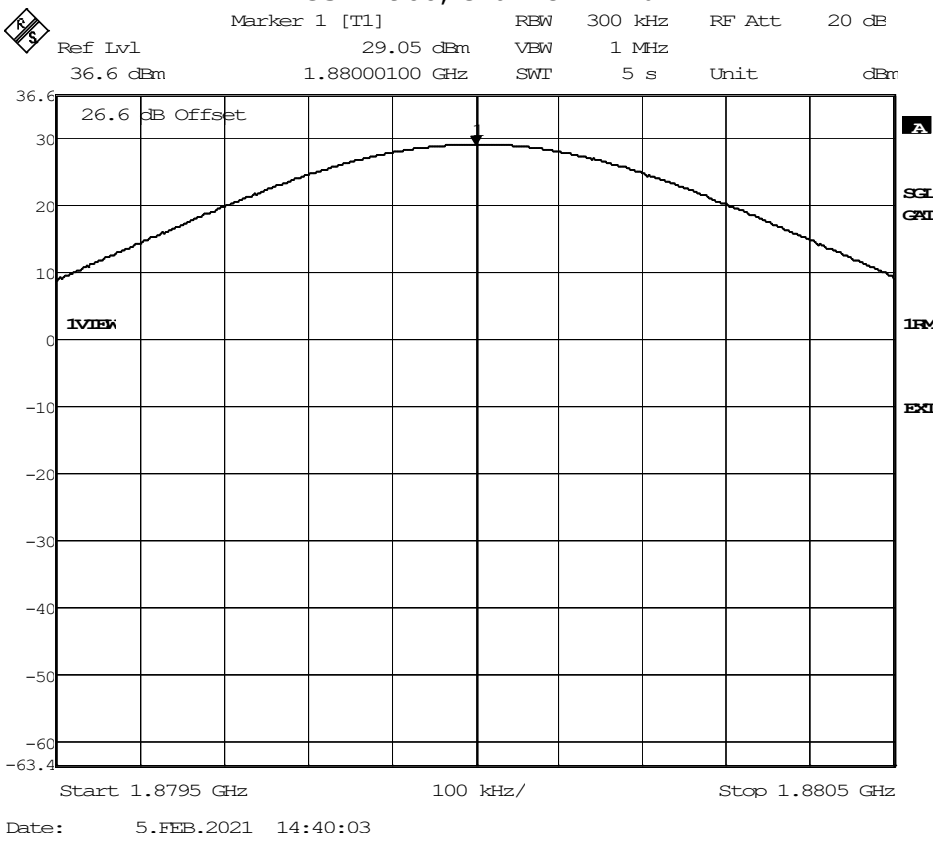
Radio Technology	**Ch**	**Re-source Blocks / Sub-carrier**	**Band-width [MHz]**	**Peak Cond. Power [dBm]**	**Average Cond. Power [dBm]**	**RMS Cond. Power [dBm]**	**FCC EIRP Limit [W]**	**IC EIRP Limit [W]**	**Max. Antenna Gain FCC [dBi]**	**Max. Antenna Gain IC [dBi]**
CAT-M1 eFDD 2 QPSK	mid	1	1.4	-	-	22.84	2	2	10.16	10.16
CAT-M1 eFDD 2 QPSK	mid	3	1.4	-	-	22.08	2	2	10.92	10.92
CAT-M1 eFDD 2 QPSK	mid	6	1.4	-	-	20.93	2	2	12.07	12.07
CAT-M1 eFDD 2 16QAM	mid	1	1.4	-	-	21.58	2	2	11.42	11.42
CAT-M1 eFDD 2 16QAM	mid	5	1.4	-	-	20.77	2	2	12.23	12.23
NB-IoT eFDD 2 QPSK	mid	1	0.2	-	-	23.87	2	2	9.13	9.13
NB-IoT eFDD 2 QPSK	mid	3	0.2	-	-	22.24	2	2	10.76	10.76
NB-IoT eFDD 2 QPSK	mid	6	0.2	-	-	22.14	2	2	10.86	10.86
NB-IoT eFDD 2 QPSK	mid	12	0.2	-	-	21.67	2	2	11.33	11.33
NB-IoT eFDD 2 BPSK	mid	1	0.2	-	-	23.89	2	2	9.11	9.11

SPOTCHECKS FOR CHILD PRODUCT (S01_AE01 = SARA-R422S)

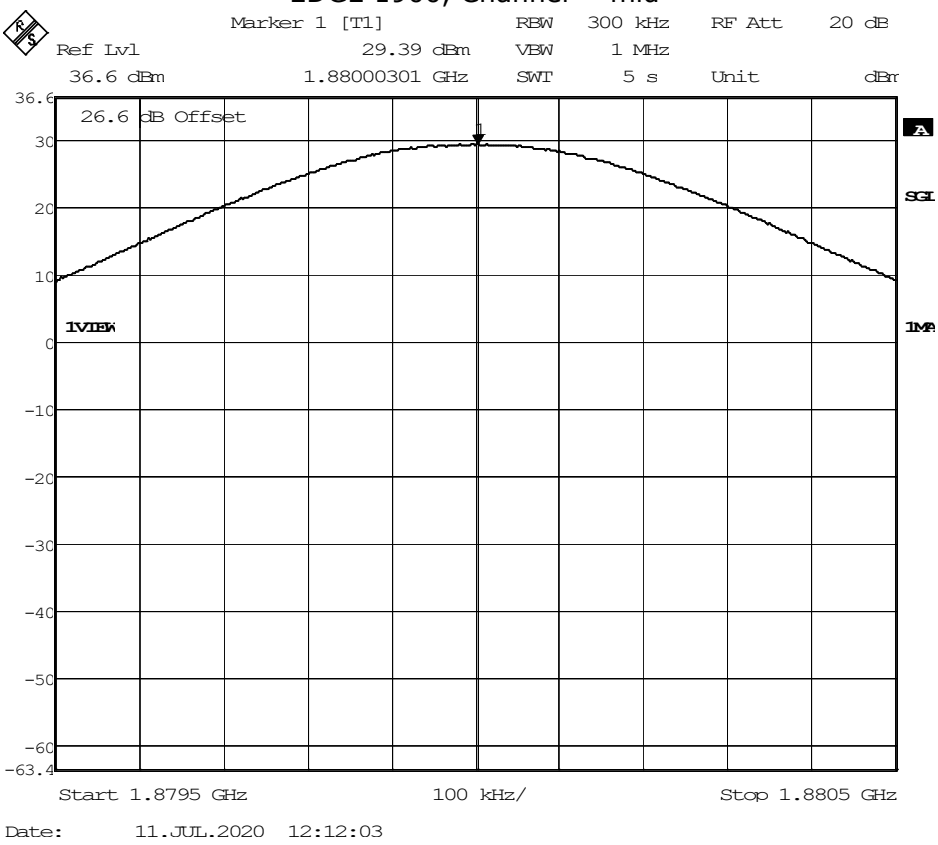
Radio Technology	**Ch**	**Re-source Blocks / Sub-carrier**	**Band-width [MHz]**	**Peak Cond. Power [dBm]**	**Average Cond. Power [dBm]**	**RMS Cond. Power [dBm]**	**FCC EIRP Limit [W]**	**IC EIRP Limit [W]**	**Max. Antenna Gain FCC [dBi]**	**Max. Antenna Gain IC [dBi]**
CAT-M1 eFDD 2 QPSK	mid	1	1.4	-	-	22.51	2	2	10.49	10.49
CAT-M1 eFDD 2 QPSK	mid	3	1.4	-	-	21.55	2	2	11.45	11.45
CAT-M1 eFDD 2 QPSK	mid	6	1.4	-	-	20.41	2	2	12.59	12.59
CAT-M1 eFDD 2 16QAM	mid	1	1.4	-	-	21.39	2	2	11.61	11.61
CAT-M1 eFDD 2 16QAM	mid	5	1.4	-	-	20.39	2	2	12.61	12.61
NB-IoT eFDD 2 QPSK	mid	1	0.2	-	-	23.43	2	2	9.57	9.57
NB-IoT eFDD 2 QPSK	mid	3	0.2	-	-	21.87	2	2	11.13	11.13
NB-IoT eFDD 2 QPSK	mid	6	0.2	-	-	21.93	2	2	11.07	11.07
NB-IoT eFDD 2 QPSK	mid	12	0.2	-	-	21.48	2	2	11.52	11.52
NB-IoT eFDD 2 BPSK	mid	1	0.2	-	-	23.5	2	2	9.5	9.5

5.8.4 MEASUREMENT PLOT

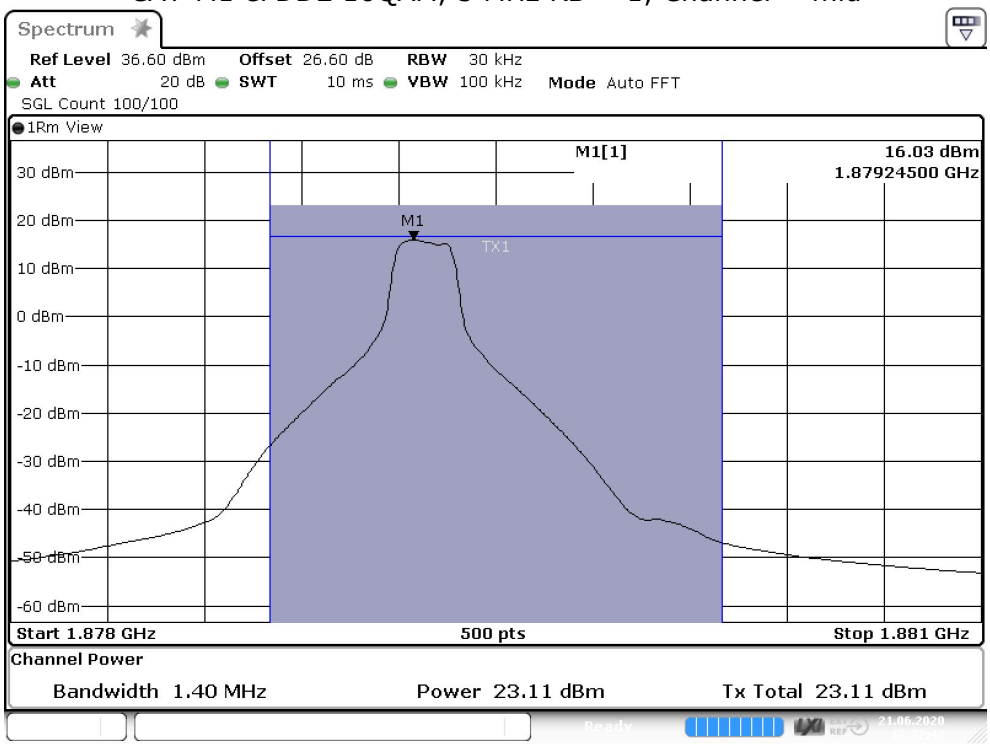
GSM 1900, Channel = mid



EDGE 1900, Channel = mid

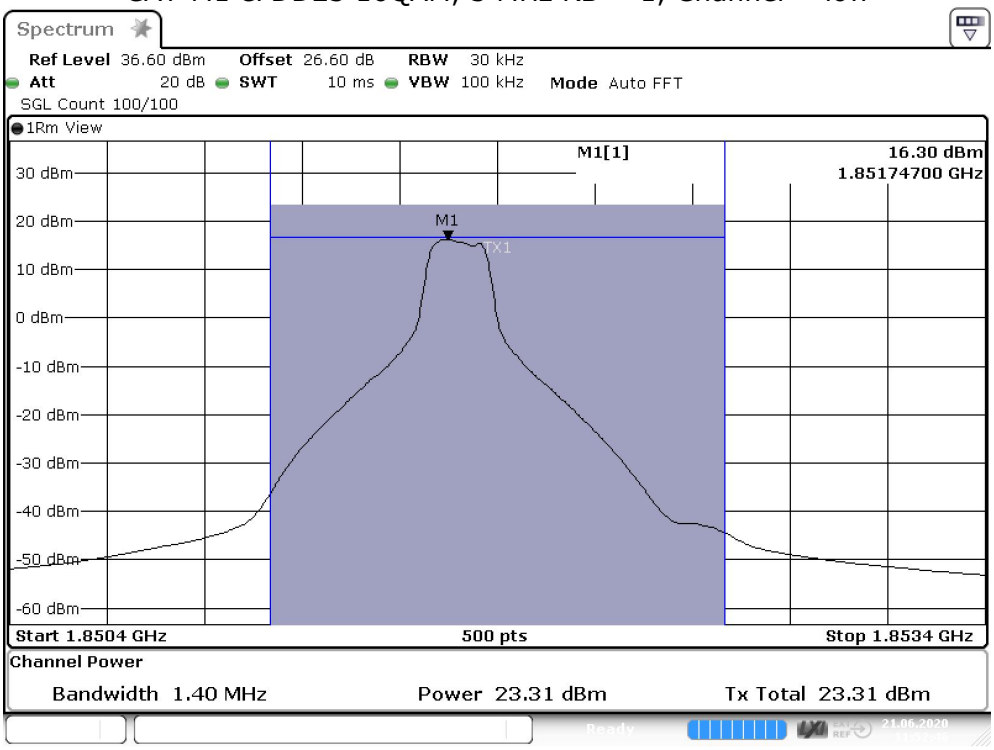


CAT-M1 eFDD2 16QAM, 5 MHz RB = 1, Channel = mid



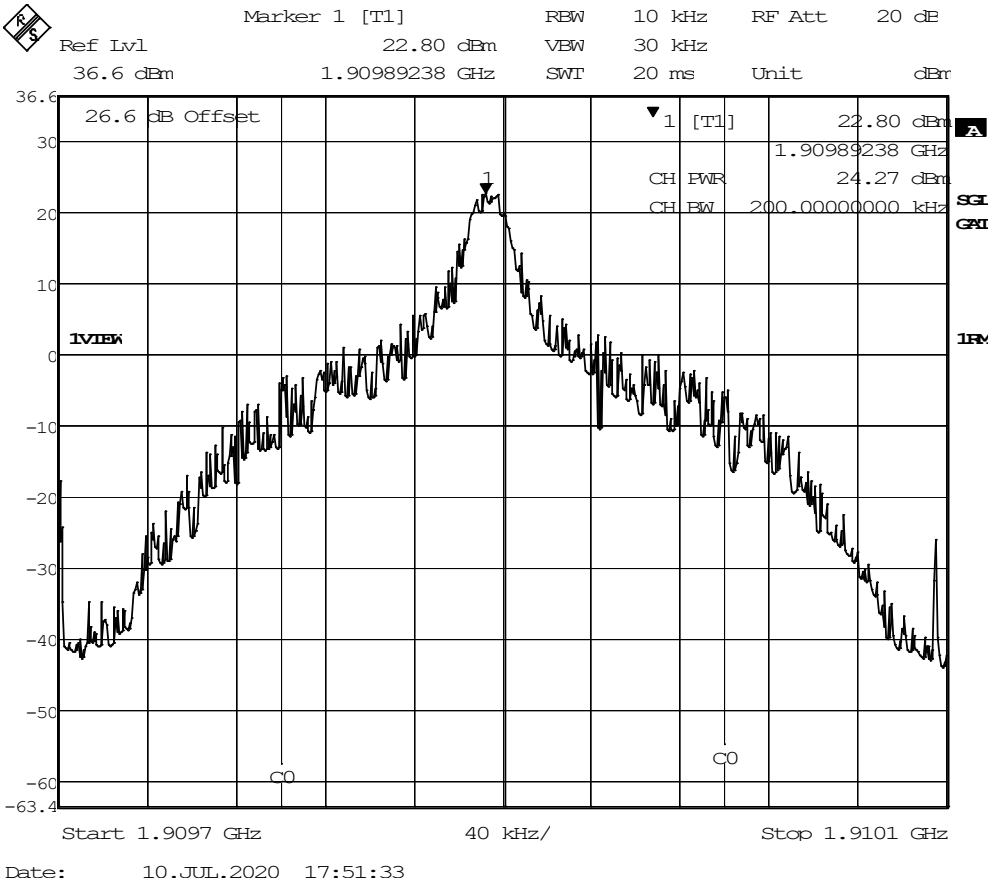
Date: 21.JUN.2020 13:32:47

CAT-M1 eFDD25 16QAM, 5 MHz RB = 1, Channel = low



Date: 21.JUN.2020 11:52:46

NB-IoT eFDD2 QPSK, SC = 1, Channel = high



5.8.5 TEST EQUIPMENT USED

- Radio Lab

5.9 FREQUENCY STABILITY

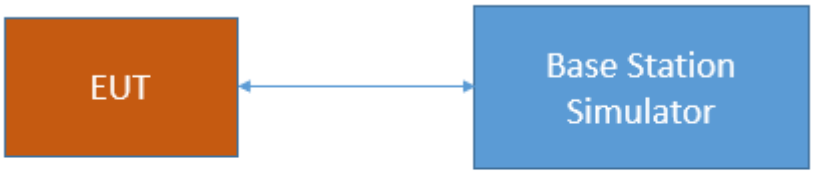
Standard **FCC PART 24 Subpart E**

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

5.9.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable frequency stability test case per § 2.1055 and RSS-GEN 6.11. The limit and the requirements come 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;
Frequency stability

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

5.9.2 TEST REQUIREMENTS / LIMITS

FCC Part 24, § 24.235

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

RSS-133; 6.3 Frequency Stability

The carrier frequency shall not depart from the reference frequency, in excess of ±2.5 ppm for mobile stations.

In lieu of meeting the above stability values, the test report may show that the frequency stability is sufficient to ensure that the emission bandwidth stays within the operating frequency block when tested to the temperature and supply voltage variations specified in RSS-Gen.

5.9.3 TEST PROTOCOL

GSM 1900

Temp. °C	Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
-30	0	normal	2095.5	3	9	passed
-30	5			5	11	passed
-30	10			2	8	passed
-20	0	normal	2095.5	4	12	passed
-20	5			4	13	passed
-20	10			3	10	passed
-10	0	normal	2095.5	5	8	passed
-10	5			4	10	passed
-10	10			2	11	passed
0	0	normal	2095.5	2	13	passed
0	5			3	12	passed
0	10			5	12	passed
10	0	normal	2095.5	3	9	passed
10	5			3	10	passed
10	10			4	10	passed
20	0	low	2095.5	4	12	passed
20	5			2	9	passed
20	10			2	9	passed
20	0	normal	2095.5	5	10	passed
20	5			3	11	passed
20	10			4	13	passed
20	0	high	2095.5	5	13	passed
20	5			3	12	passed
20	10			3	9	passed
30	0	normal	2095.5	4	8	passed
30	5			2	10	passed
30	10			5	13	passed
40	0	normal	2095.5	3	10	passed
40	5			4	12	passed
40	10			3	9	passed
50	0	normal	2095.5	2	11	passed
50	5			2	13	passed
50	10			3	10	passed

EDGE 1900

Temp. °C	Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
-30	0	normal	2095.5	14	22	passed
-30	5			13	23	passed
-30	10			8	16	passed
-20	0	normal	2095.5	6	16	passed
-20	5			1	12	passed
-20	10			11	20	passed
-10	0	normal	2095.5	13	22	passed
-10	5			11	18	passed
-10	10			11	19	passed
0	0	normal	2095.5	7	14	passed
0	5			11	18	passed
0	10			8	19	passed
10	0	normal	2095.5	5	13	passed
10	5			2	9	passed
10	10			11	16	passed
20	0	low	2095.5	3	13	passed
20	5			8	15	passed
20	10			10	17	passed
20	0	normal	2095.5	10	18	passed
20	5			7	15	passed
20	10			7	14	passed
20	0	high	2095.5	4	14	passed
20	5			8	17	passed
20	10			10	18	passed
30	0	normal	2095.5	16	25	passed
30	5			0	12	passed
30	10			16	28	passed
40	0	normal	2095.5	18	26	passed
40	5			7	16	passed
40	10			13	21	passed
50	0	normal	2095.5	22	34	passed
50	5			11	21	passed
50	10			12	24	passed

CAT-M1 eFDD2

Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
0	normal	4700	-1	5	passed
5			2	7	passed
10			1	3	passed
0	normal	4700	-2	5	passed
5			2	6	passed
10			2	8	passed
0	normal	4700	0	4	passed
5			-1	5	passed
10			0	4	passed
0	normal	4700	2	8	passed
5			-1	5	passed
10			-1	6	passed
0	normal	4700	2	7	passed
5			2	6	passed
10			1	7	passed
0	low	4700	0	8	passed
5			2	5	passed
10			1	7	passed
0	normal	4700	1	7	passed
5			2	6	passed
10			1	8	passed
0	high	4700	1	7	passed
5			1	4	passed
10			1	3	passed
0	normal	4700	2	6	passed
5			2	4	passed
10			-1	7	passed
0	normal	4700	-1	6	passed
5			2	7	passed
10			1	4	passed
0	normal	4700	2	8	passed
5			1	6	passed
10			2	7	passed

CAT-M1 eFDD25

Temp. °C	Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
-30	0	normal	4706.25	1	3	passed
-30	5			0	4	passed
-30	10			0	1	passed
-20	0	normal	4706.25	1	6	passed
-20	5			0	5	passed
-20	10			0	2	passed
-10	0	normal	4706.25	0	4	passed
-10	5			1	6	passed
-10	10			1	3	passed
0	0	normal	4706.25	1	1	passed
0	5			0	4	passed
0	10			0	4	passed
10	0	normal	4706.25	0	3	passed
10	5			1	6	passed
10	10			1	1	passed
20	0	low	4706.25	1	5	passed
20	5			0	2	passed
20	10			1	4	passed
20	0	normal	4706.25	0	6	passed
20	5			0	1	passed
20	10			1	1	passed
20	0	high	4706.25	1	4	passed
20	5			2	4	passed
20	10			1	5	passed
30	0	normal	4706.25	0	3	passed
30	5			1	5	passed
30	10			0	5	passed
40	0	normal	4706.25	0	4	passed
40	5			0	3	passed
40	10			1	3	passed
50	0	normal	4706.25	1	4	passed
50	5			1	5	passed
50	10			0	2	passed

NB-IoT eFDD2

Temp. °C	Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
-30	0	normal	4700	-2	-12	passed
-30	5			-3	-13	passed
-30	10			-1	-9	passed
-20	0	normal	4700	-5	-15	passed
-20	5			-2	-14	passed
-20	10			-8	-18	passed
-10	0	normal	4700	7	15	passed
-10	5			9	18	passed
-10	10			9	20	passed
0	0	normal	4700	8	16	passed
0	5			9	20	passed
0	10			7	16	passed
10	0	normal	4700	9	17	passed
10	5			8	15	passed
10	10			4	16	passed
20	0	low	4700	-12	-22	passed
20	5			-11	-21	passed
20	10			-9	-17	passed
20	0	normal	4700	-8	-18	passed
20	5			-7	-18	passed
20	10			-6	-16	passed
20	0	high	4700	-5	-13	passed
20	5			-8	-18	passed
20	10			-5	-17	passed
30	0	normal	4700	-11	-19	passed
30	5			-9	-18	passed
30	10			-11	-21	passed
40	0	normal	4700	-13	-27	passed
40	5			-13	-24	passed
40	10			-10	-21	passed
50	0	normal	4700	-18	-36	passed
50	5			-15	-40	passed
50	10			-15	-42	passed

5.9.4 TEST EQUIPMENT USED

- Radio Lab

5.10 SPURIOUS EMISSIONS AT ANTENNA TERMINAL

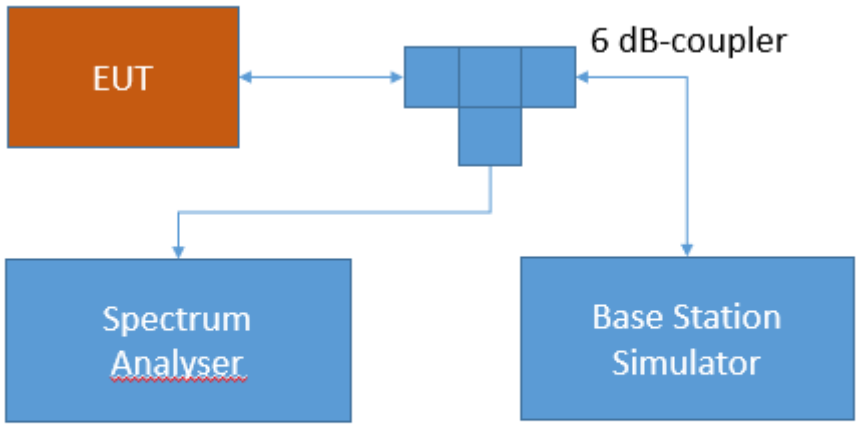
Standard **FCC PART 24 Subpart E**

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

5.10.1 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;
Spurious Emissions at antenna terminal

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.

5.10.2 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 24, Subpart E – Broadband PCS; Band 2

§24.238 – Emission limitations for Broadband PCS equipment

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-133; 6.5 Transmitter Unwanted Emissions

6.5.1 Out-of-Block Emissions

Equipment shall comply with the limits in (i) and (ii) below.

i. In the 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the emission power per any 1% of the emission bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p(watts).
ii. After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p(watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

5.10.3 TEST PROTOCOL

Ambient temperature: 20 - 25 °C
Relative humidity: 30 - 40 %

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
GSM1900	low	rms	maxhold	3	1849.99	-17.94	-13	4.94
GSM1900	mid	rms	maxhold	-	-	-	-13	>20
GSM1900	high	rms	maxhold	3	1910.02	-28.84	-13	15.84

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
EDGE1900	low	rms	maxhold	-	-	-	-13	>20
EDGE1900	mid	rms	maxhold	-	-	-	-13	>20
EDGE1900	high	rms	maxhold	-	-	-	-13	>20

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
CAT-M1 eFDD2	low	rms	maxhold	20	1850	-36.44	-13	23.44
CAT-M1 eFDD2	mid	rms	maxhold	-	-	-	-13	>20
CAT-M1 eFDD2	high	rms	maxhold	20	1910	-29.1	-13	16.1

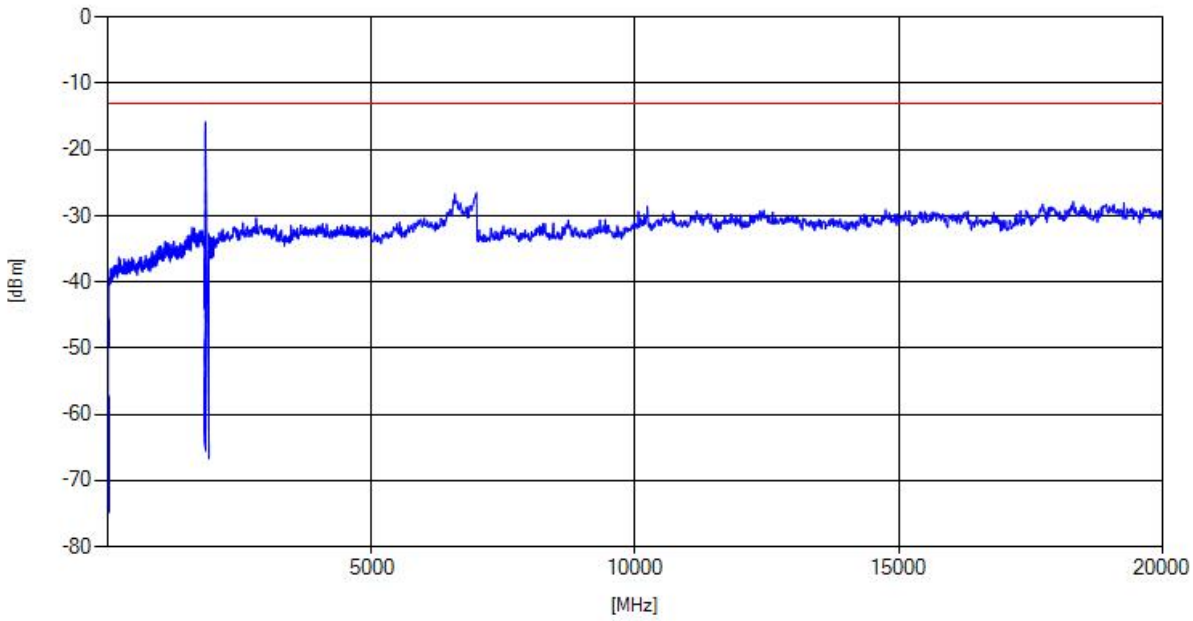
Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
CAT-M1 eFDD25	low	rms	maxhold	1000	1847.98	-17.36	-13	4.36
CAT-M1 eFDD25	low	rms	maxhold	20	1850	-24.88	-13	11.88
CAT-M1 eFDD25	mid	rms	maxhold	-	-	-	-13	>20
CAT-M1 eFDD25	high	rms	maxhold	20	1915	-38,64	-13	25.64

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
NB-IoT eFDD2	low	rms	maxhold	2	1850	-24.25	-13	11.25
NB-IoT eFDD2	mid	rms	maxhold	-	-	-	-13	>20
NB-IoT eFDD2	high	rms	maxhold	2	1910	-23.90	-13	10.90

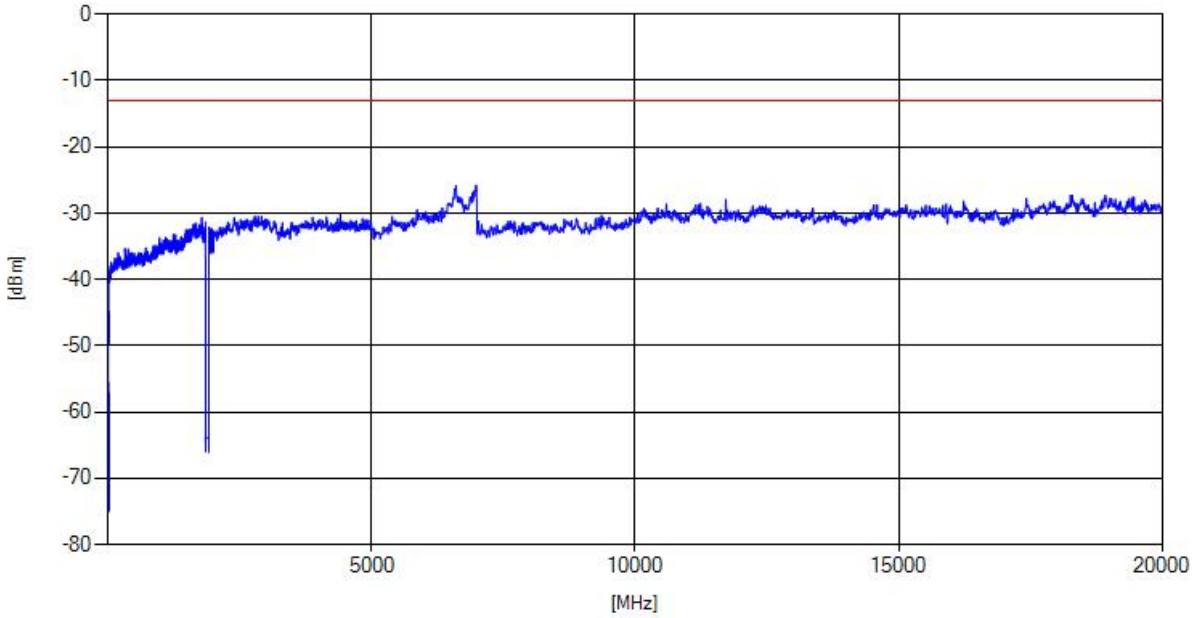
Remark: Please see next sub-clause for the measurement plot.

5.10.4 MEASUREMENT PLOT

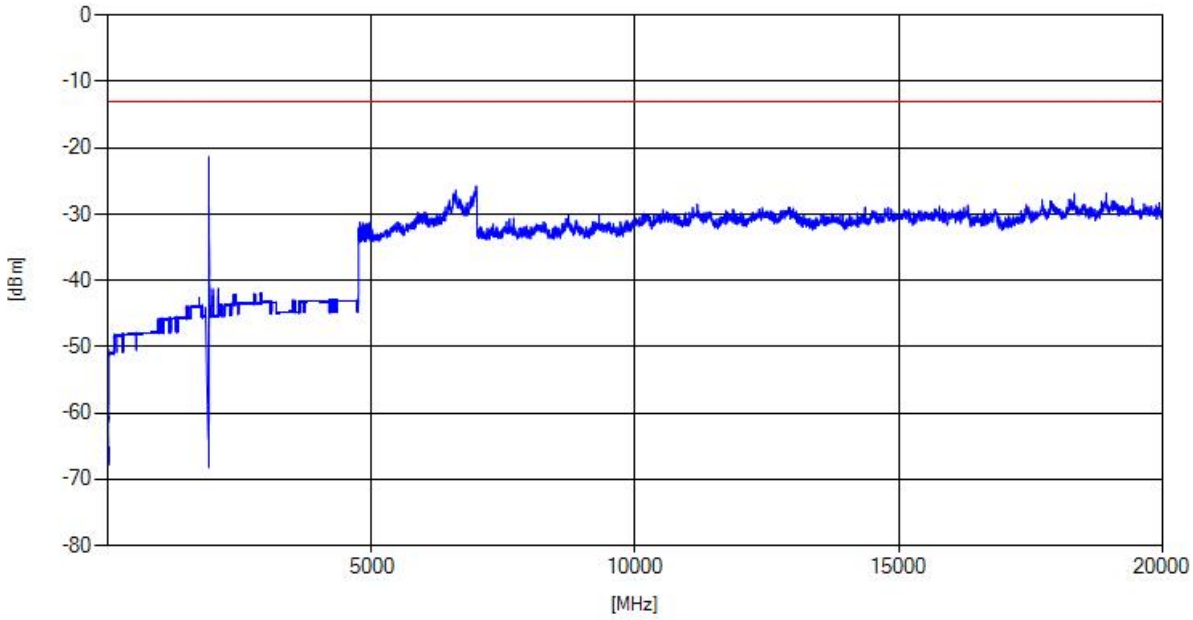
GSM1900, Channel = low



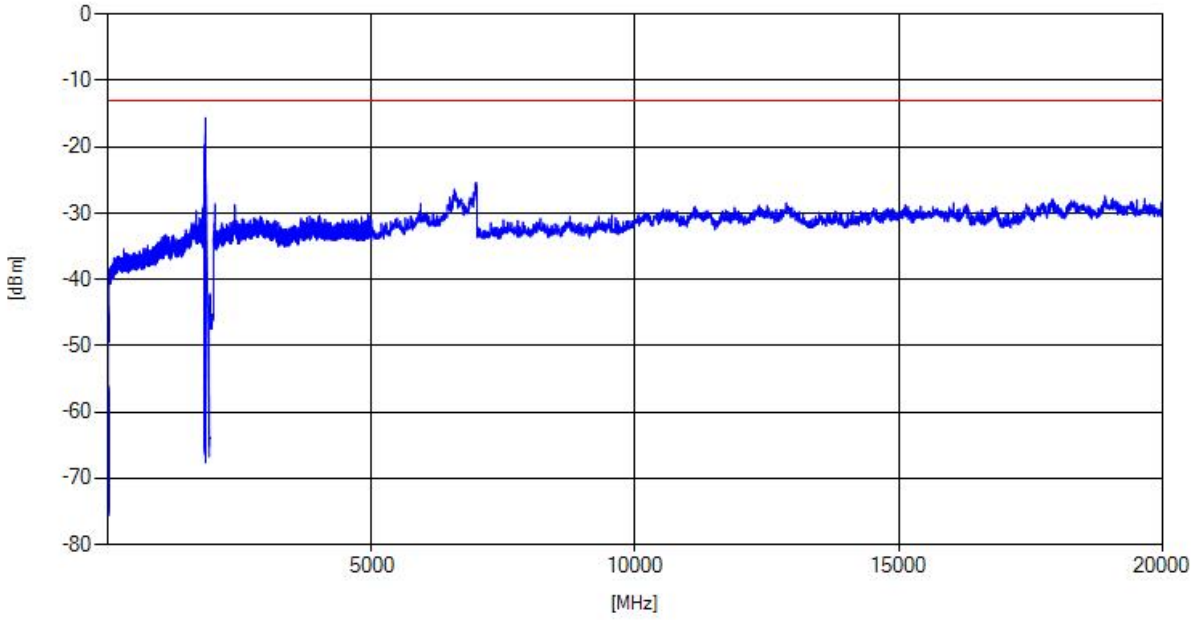
EDGE1900, Channel = mid



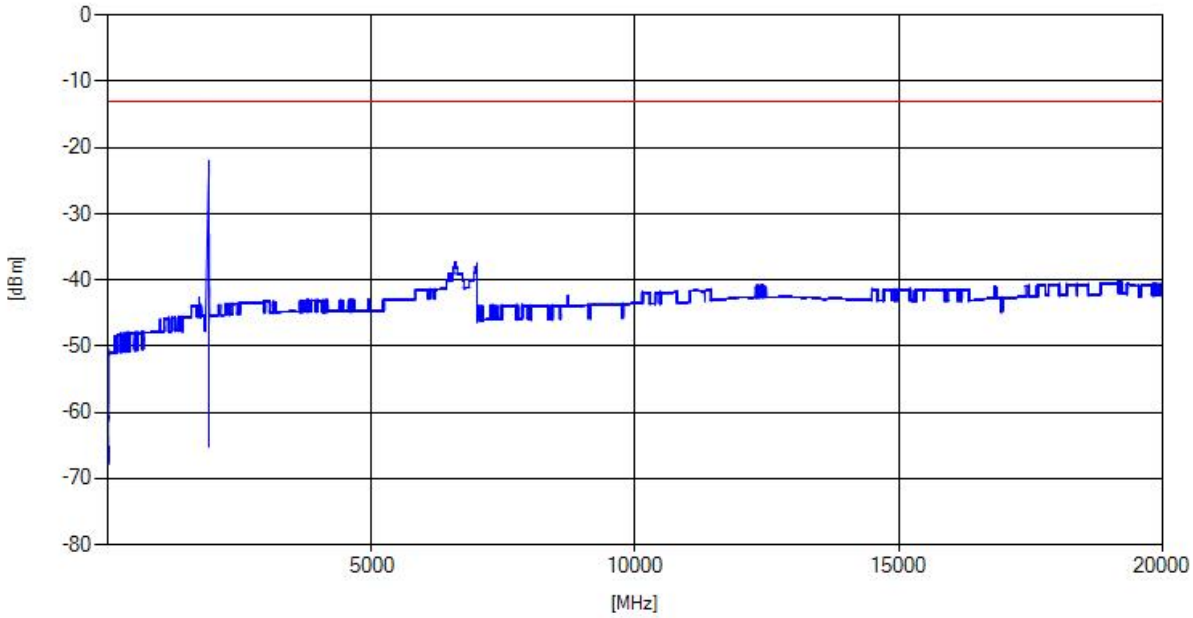
CAT-M1 eFDD2, Channel = high



CAT-M1 eFDD25, Channel = low



NB-IoT eFDD2, Channel = high



5.10.5 TEST EQUIPMENT USED

- Radio Lab

5.11 FIELD STRENGTH OF SPURIOUS RADIATION

Standard **FCC PART 24 Subpart E**

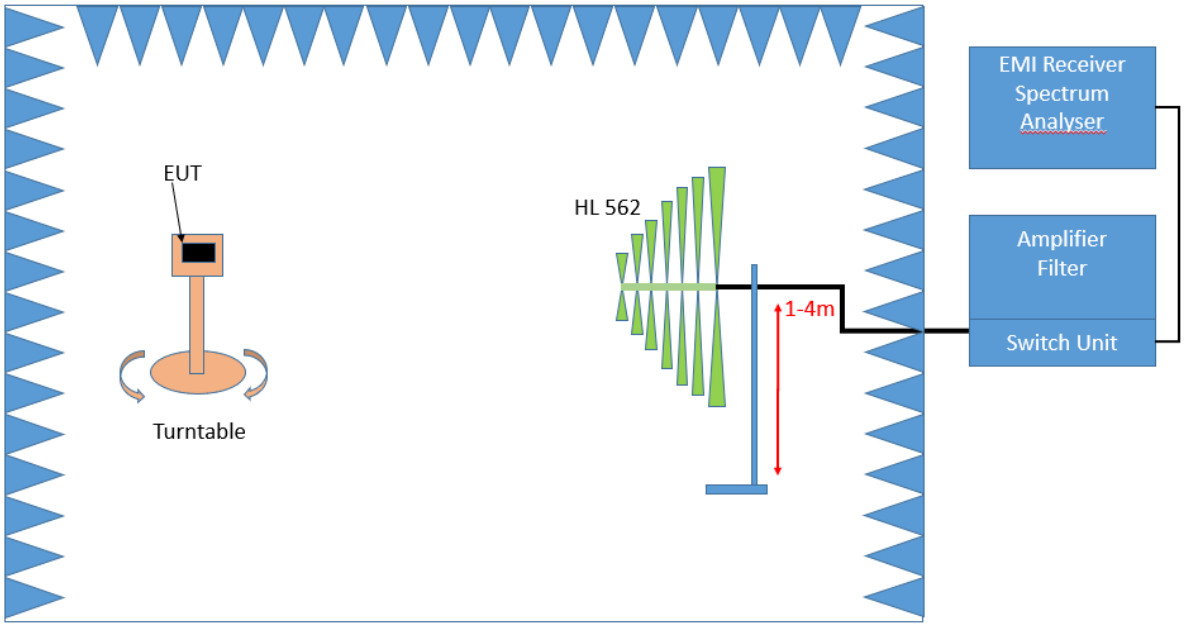
The test was performed according to:
ANSI C63.26: 2015

5.11.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable radiated spurious emission measurements per § 2.1053 and RSS-GEN 6.13. The limit and requirements come from the applicable rule part and ISED RSS-Standard for the operating band of the cellular device.

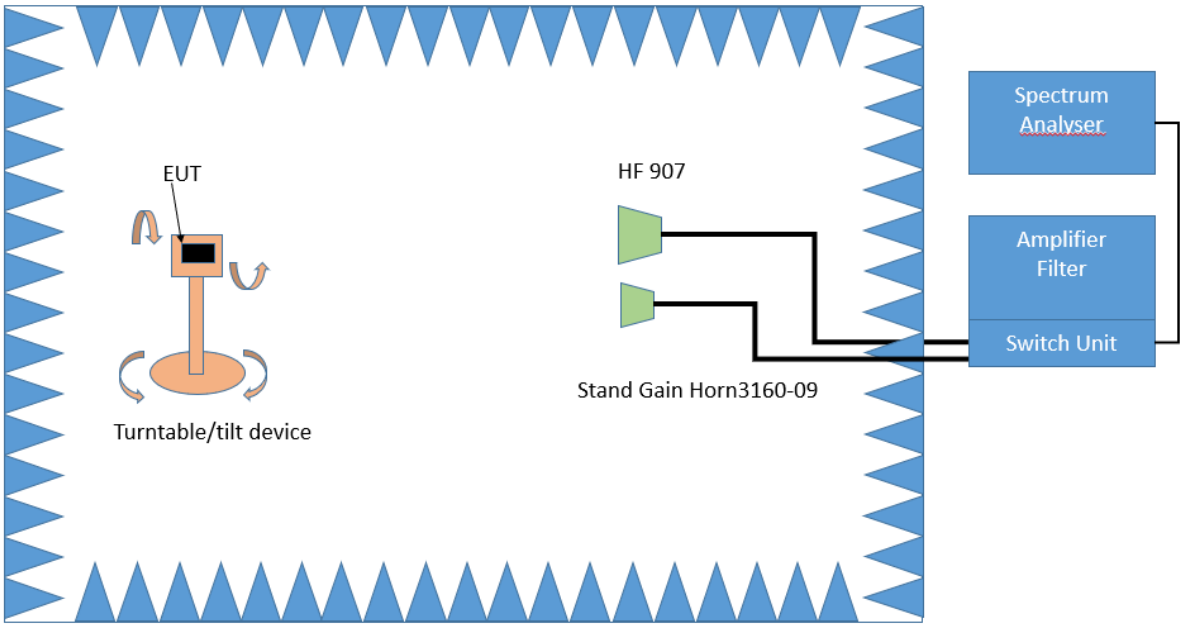
The EUT was connected to the test setup according to the following diagram:

Frequency Range: 30 MHz – 1 GHz:



Test Setup; Spurious Emission Radiated (SAC), 30 MHz- 1GHz

Frequency Range: 1 GHz – 26.5 GHz



Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

The test set-up was made in accordance to the general provisions of ANSI C63.26 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S. 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 from 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
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: coupled
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 4 m
- Height variation step size: 1.5 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 360°. 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 1 – 4 m.

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
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: coupled
- Turntable angle range: 360°
- Height variation range: 1 – 4 m
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with RMS detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: RMQ
- Measured frequencies: in step 1 determined frequencies
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: 1 s

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 (tilt device) at 1.5 m height in the fully-anechoic chamber.
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 45 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
- Antenna distance: 3 m
- Detector: Peak
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep time: coupled
- Turntable angle range: –180° to 135°
- Turntable step size: 45°
- Polarisation: Horizontal + Vertical

Step 2:
Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
EMI receiver settings (for all steps):
- Detector: Peak,
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep time: coupled

Step 3:

Spectrum analyser settings for step 3:
- Detector: RMS
- Measured frequencies: in step 1 determined frequencies
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep Time: 1 s

5.11.2 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 24, Subpart E – Broadband PCS

§ 24 238 – Emission limitations for Broadband PCS equipment

a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

RSS-133; 6.5 Transmitter Unwanted Emissions

Mobile and base station equipment shall comply with the limits in (1) and (2) below.

1. In the 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the emission power per any 1% of the emission bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 $\log_{10}$p (watts).
2. After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 $\log_{10}$p (watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

5.11.3 TEST PROTOCOL

Ambient temperature: 20 - 25 °C
Relative humidity: 30 - 40 %

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
GSM1900	low	rms	maxhold	3	1849.7	-18.4	-13	5.4
GSM1900	low	rms	maxhold	3	1849.99	-15.5	-13	2.5
GSM1900	mid	rms	maxhold	-	-	-	-13	>20
GSM1900	high	rms	maxhold	3	1910.0	-18.8	-13	5.77

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
EDGE1900	low	peak	maxhold	3	1849.7	-25.70	-13	12.7
EDGE1900	mid	rms	maxhold	-	-	-	-13	>20
EDGE1900	high	peak	maxhold	3	1910	-23.77	-13	10.8
EDGE1900	high	peak	maxhold	1000	3819.5	-23.14	-13	10.1

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
CAT-M1 eFDD2	low	rms	maxhold	-	-	-	-13	>20
CAT-M1 eFDD2	mid	rms	maxhold	-	-	-	-13	>20
CAT-M1 eFDD2	high	rms	maxhold	-	-	-	-13	>20

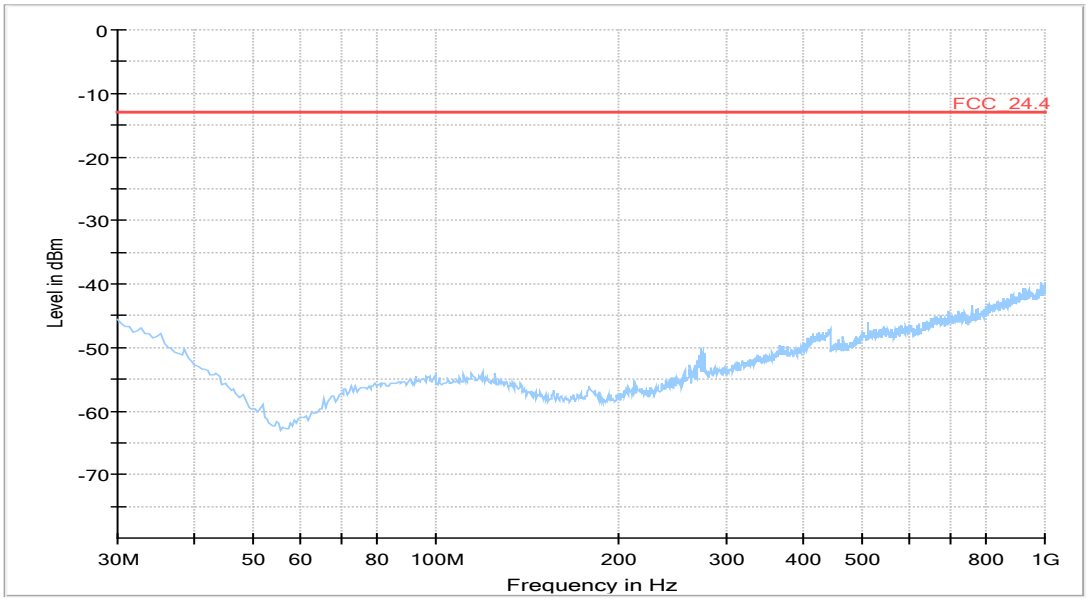
Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
CAT-M1 eFDD25	low	rms	maxhold	-	-	-	-13	>20
CAT-M1 eFDD25	mid	rms	maxhold	-	-	-	-13	>20
CAT-M1 eFDD25	high	rms	maxhold	-	-	-	-13	>20

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
NB-IoT eFDD2	low	rms	maxhold	2	1850	-24.25	-13	11.25
NB-IoT eFDD2	mid	rms	maxhold	-	-	-	-13	>20
NB-IoT eFDD2	high	rms	maxhold	-	-	-	-13	>20

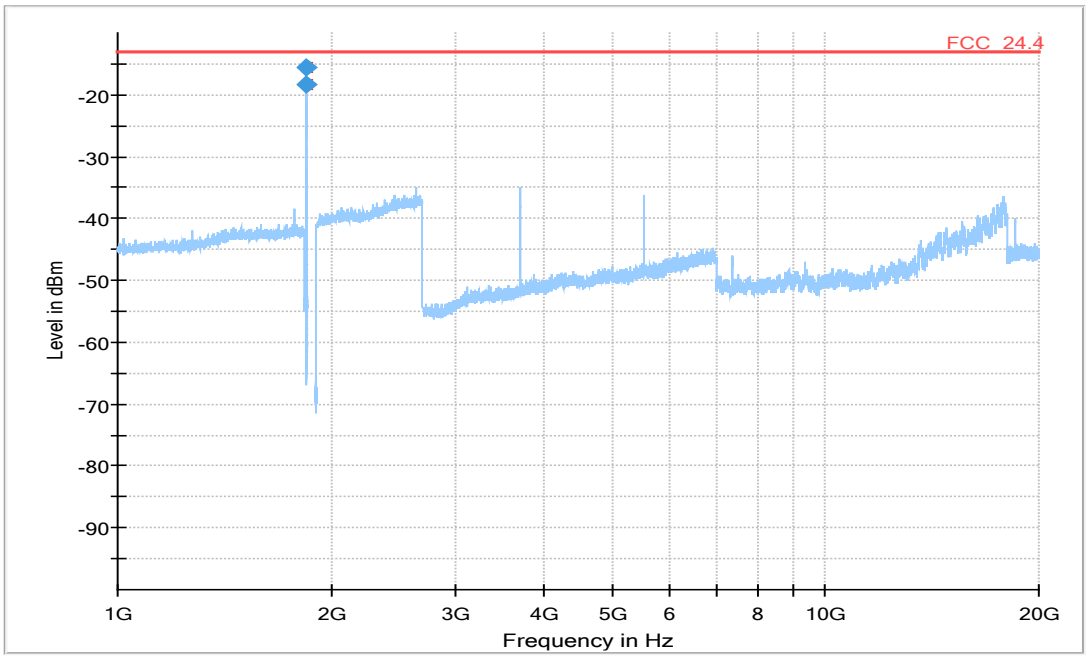
Remark: Please see next sub-clause for the measurement plot.

5.11.4 MEASUREMENT PLOT

GSM 1900, Channel = low
30 MHz – 1 GHz



1 GHz – 20 GHz



Frequency (MHz)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1849.977	-18.4	-13.00	5.42	2000.0	3.000	150.0	V	-135.0	90.0	-65.3
1849.998	-15.5	-13.00	2.49	2000.0	3.000	150.0	V	-135.0	90.0	-65.3