

## 5.6 BAND EDGE COMPLIANCE

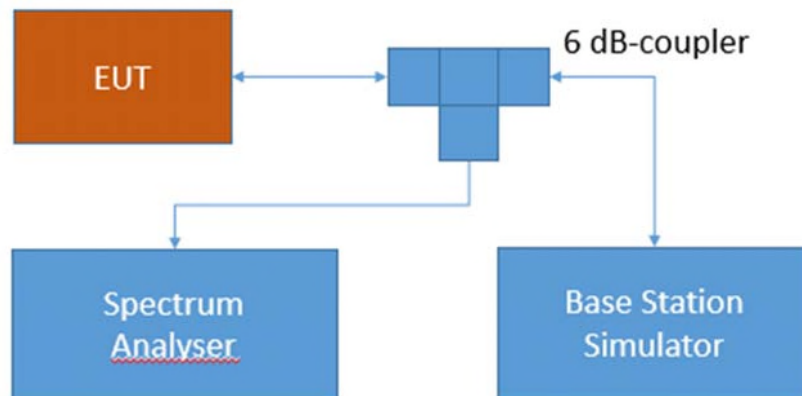
Standard **FCC PART 22 Subpart H**

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

### 5.6.1 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 ISSED 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.

### 5.6.2 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 22, Subpart H – Cellular Radiotelephone Service

### §22 917 – Emission limitations for cellular 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-132; 5.5 Transmitter Unwanted Emissions

Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

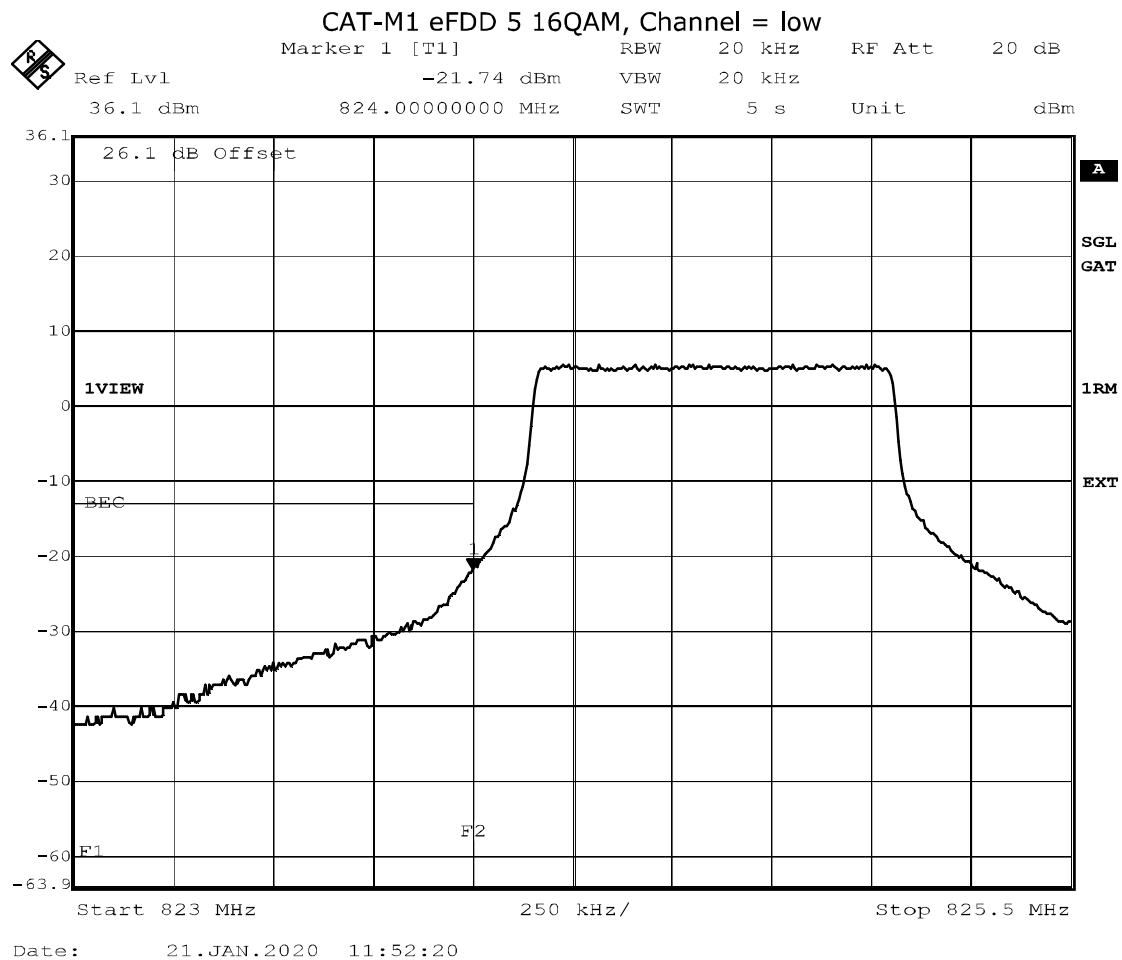
1. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P ( dBW) by at least  $43 + 10 \log_{10} p$  (watts).
2. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz 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 occupied bandwidth, power integration over 100 kHz is required.

### 5.6.3 TEST PROTOCOL

Radio Technology	Channel	Ressource Blocks / Subcarrier	Bandwidth [MHz]	RMS [dBm]	Limit [dBm]	Margin to Limit [dB]
CAT-M1 eFDD 5 QPSK	low	6	1,4	-22,82	-13	9,82
CAT-M1 eFDD 5 QPSK	high	6	1,4	-22,44	-13	9,44
CAT-M1 eFDD 5 16QAM	low	5	1,4	-21,74	-13	8,74
CAT-M1 eFDD 5 16QAM	high	5	1,4	-25,15	-13	12,15
CAT-M1 eFDD 26 QPSK	low	6	1,4	-22,94	-13	9,94
CAT-M1 eFDD 26 QPSK	high	6	1,4	-21,74	-13	8,74
CAT-M1 eFDD 26 16QAM	low	5	1,4	-23,07	-13	10,07
CAT-M1 eFDD 26 16QAM	high	5	1,4	-25,31	-13	12,31

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

#### 5.6.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")



#### 5.6.5 TEST EQUIPMENT USED

- Radio Lab

## 5.7 PEAK-AVERAGE-RATIO

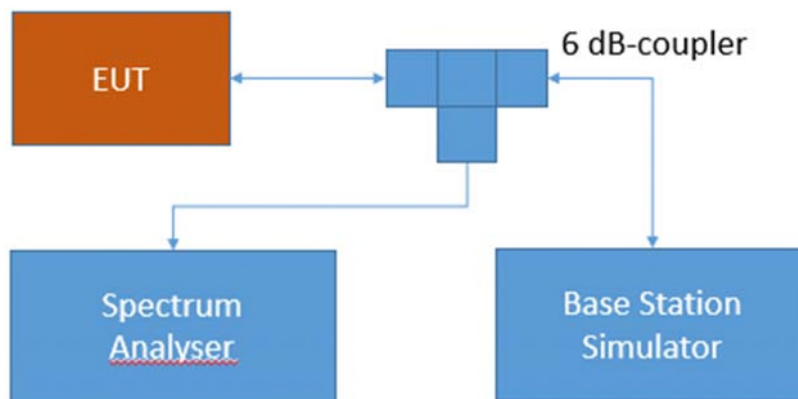
Standard **FCC PART 22 Subpart H**

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

### 5.7.1 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 ISSED 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 Analyser 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

## 5.7.2 TEST REQUIREMENTS / LIMITS

### FCC Part 22, § 22.913

There exists no applicable limit

### RSS-132; 5.4 Transmitter Output Power and Equivalent Isotropically Radiated 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 using a signal corresponding to the highest PAPR during periods of continuous transmission.

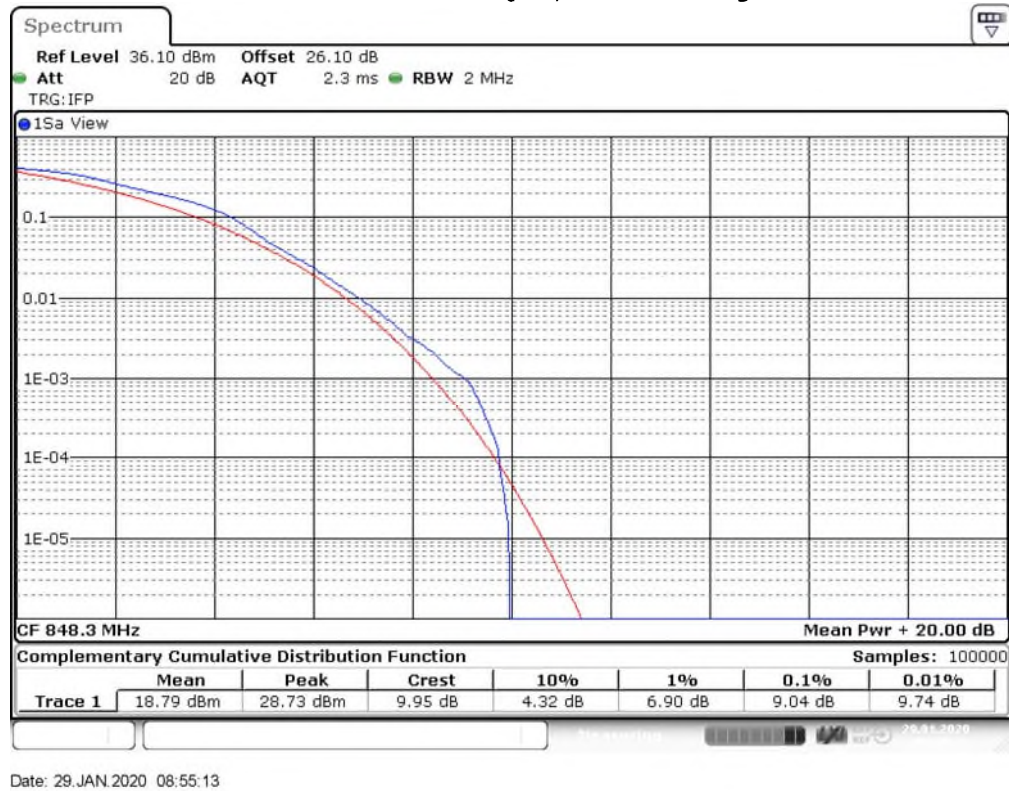
## 5.7.3 TEST PROTOCOL

Ambient temperature: 24 °C  
Relative humidity: 38 %

Radio Technology	Channel	Ressource Blocks / Subcarrier	Bandwidth [MHz]	Peak to Average Ratio [dB]	Limit (IC) [dB]
CAT-M1 eFDD 5 QPSK	low	6	1,4	8,32	13
CAT-M1 eFDD 5 QPSK	mid	6	1,4	8,38	13
CAT-M1 eFDD 5 QPSK	high	6	1,4	8,49	13
CAT-M1 eFDD 5 16QAM	low	5	1,4	8,67	13
CAT-M1 eFDD 5 16QAM	mid	5	1,4	8,67	13
CAT-M1 eFDD 5 16QAM	high	5	1,4	9,04	13
CAT-M1 eFDD 26 QPSK	low	6	1,4	8,32	13
CAT-M1 eFDD 26 QPSK	mid	6	1,4	7,57	13
CAT-M1 eFDD 26 QPSK	high	6	1,4	7,86	13
CAT-M1 eFDD 26 16QAM	low	5	1,4	8,64	13
CAT-M1 eFDD 26 16QAM	mid	5	1,4	8,06	13
CAT-M1 eFDD 26 16QAM	high	5	1,4	8,64	13

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

#### 5.7.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE") CAT-M1 eFDD 5 16QAM, Channel = high



#### 5.7.5 TEST EQUIPMENT USED

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## 5.8 RF OUTPUT POWER

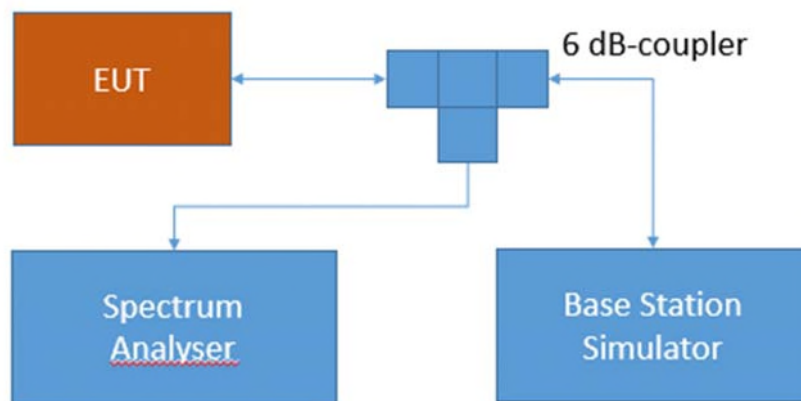
Standard **FCC PART 24 Subpart E**

**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 ISSED 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: 24 °C  
Relative humidity: 38 %

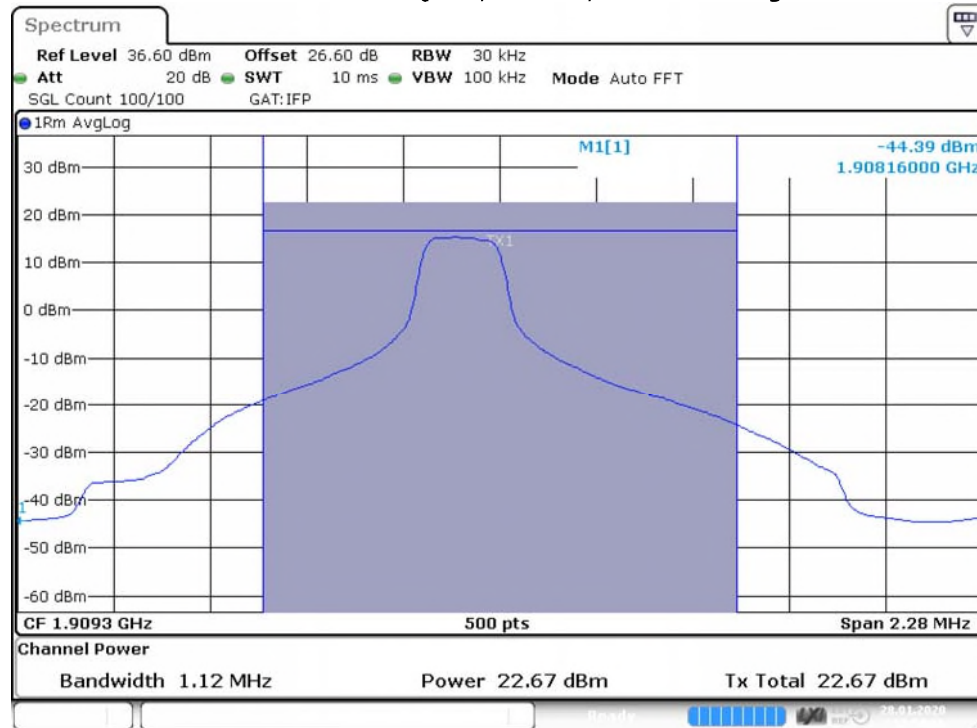
Radio Technology	Channel	Resource Blocks / Sub-carrier	Bandwidth [MHz]	RMS Conducted Power [dBm]	FCC EIRP Limit [W]	IC EIRP Limit [W]	Maximum Antenna Gain FCC [dBi]	Maximum Antenna Gain IC [dBi]
CAT-M1 eFDD 2 QPSK	low	1	1,4	22,57	2	2	10,43	10,43
CAT-M1 eFDD 2 QPSK	low	3	1,4	21,42	2	2	11,58	11,58
CAT-M1 eFDD 2 QPSK	low	6	1,4	20,4	2	2	12,6	12,6
CAT-M1 eFDD 2 QPSK	mid	1	1,4	22,43	2	2	10,57	10,57
CAT-M1 eFDD 2 QPSK	mid	3	1,4	21,38	2	2	11,62	11,62
CAT-M1 eFDD 2 QPSK	mid	6	1,4	20,27	2	2	12,73	12,73
CAT-M1 eFDD 2 QPSK	high	1	1,4	22,67	2	2	10,33	10,33
CAT-M1 eFDD 2 QPSK	high	3	1,4	21,48	2	2	11,52	11,52
CAT-M1 eFDD 2 QPSK	high	6	1,4	20,52	2	2	12,48	12,48
CAT-M1 eFDD 2 16QAM	low	1	1,4	20,87	2	2	12,13	12,13
CAT-M1 eFDD 2 16QAM	low	5	1,4	20,62	2	2	12,38	12,38
CAT-M1 eFDD 2 16QAM	mid	1	1,4	20,9	2	2	12,1	12,1
CAT-M1 eFDD 2 16QAM	mid	5	1,4	20,41	2	2	12,59	12,59
CAT-M1 eFDD 2 16QAM	high	1	1,4	21,16	2	2	11,84	11,84
CAT-M1 eFDD 2 16QAM	high	5	1,4	20,64	2	2	12,36	12,36
CAT-M1 eFDD 25 QPSK	low	1	1,4	22,62	2	2	10,38	10,38
CAT-M1 eFDD 25 QPSK	low	3	1,4	21,43	2	2	11,57	11,57
CAT-M1 eFDD 25 QPSK	low	6	1,4	20,42	2	2	12,58	12,58
CAT-M1 eFDD 25 QPSK	mid	1	1,4	22,5	2	2	10,5	10,5
CAT-M1 eFDD 25 QPSK	mid	3	1,4	21,45	2	2	11,55	11,55
CAT-M1 eFDD 25 QPSK	mid	6	1,4	20,38	2	2	12,62	12,62
CAT-M1 eFDD 25 QPSK	high	1	1,4	22,59	2	2	10,41	10,41
CAT-M1 eFDD 25 QPSK	high	3	1,4	21,52	2	2	11,48	11,48
CAT-M1 eFDD 25 QPSK	high	6	1,4	20,37	2	2	12,63	12,63
CAT-M1 eFDD 25 16QAM	low	1	1,4	20,89	2	2	12,11	12,11
CAT-M1 eFDD 25 16QAM	low	5	1,4	20,53	2	2	12,47	12,47
CAT-M1 eFDD 25 16QAM	mid	1	1,4	20,88	2	2	12,12	12,12
CAT-M1 eFDD 25 16QAM	mid	5	1,4	20,55	2	2	12,45	12,45
CAT-M1 eFDD 25 16QAM	high	1	1,4	20,95	2	2	12,05	12,05
CAT-M1 eFDD 25 16QAM	high	5	1,4	20,61	2	2	12,39	12,39

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



#### 5.8.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

CAT-M1 eFDD 2 QPSK, RB = 1, Channel = high



Date: 28.JAN.2020 12:59:57

#### 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 ISSED 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  $\pm 2.5$  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

CAT-M1 eFDD 2 QPSK, RB=6, Channel = mid

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

CAT-M1 eFDD 25 QPSK, RB=6, Channel = mid

Temp. °C	Duration min	Voltage	Limit Hz	Freq. error Average (Hz)	Freq. error Max. (Hz)	Verdict
-30	0	normal	4706.25	-8	-16	passed
-30	5			-11	-28	passed
-30	10			-18	-26	passed
-20	0	normal	4706.25	9	21	passed
-20	5			20	29	passed
-20	10			26	35	passed
-10	0	normal	4706.25	21	27	passed
-10	5			-9	-15	passed
-10	10			1	11	passed
0	0	normal	4706.25	6	18	passed
0	5			3	15	passed
0	10			-3	-14	passed
10	0	normal	4706.25	8	16	passed
10	5			8	18	passed
10	10			4	13	passed
20	0	low	4706.25	-18	-27	passed
20	5			-6	-15	passed
20	10			-10	-17	passed
20	0	normal	4706.25	-2	-14	passed
20	5			-8	-22	passed
20	10			-6	-20	passed
20	0	high	4706.25	9	22	passed
20	5			1	14	passed
20	10			8	17	passed
30	0	normal	4706.25	4	16	passed
30	5			3	13	passed
30	10			1	7	passed
40	0	normal	4706.25	14	23	passed
40	5			18	26	passed
40	10			24	32	passed
50	0	normal	4706.25	6	17	passed
50	5			15	24	passed
50	10			17	25	passed

#### 5.9.4 TEST EQUIPMENT USED

- Radio Lab

## 5.10 SPURIOUS EMISSIONS AT ANTENNA TERMINAL

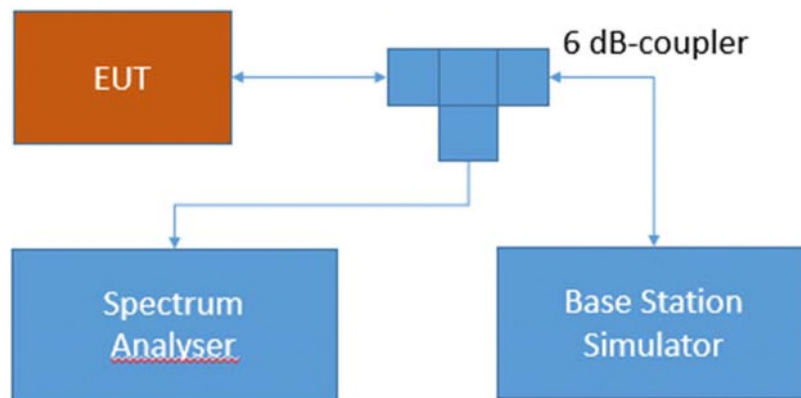
Standard **FCC PART 24 Subpart E**

**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 ISSED 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  $43 + 10 \log_{10}(P)$  (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  $43 + 10 \log_{10}(P)$  (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: 24 °C  
Relative humidity: 38 %

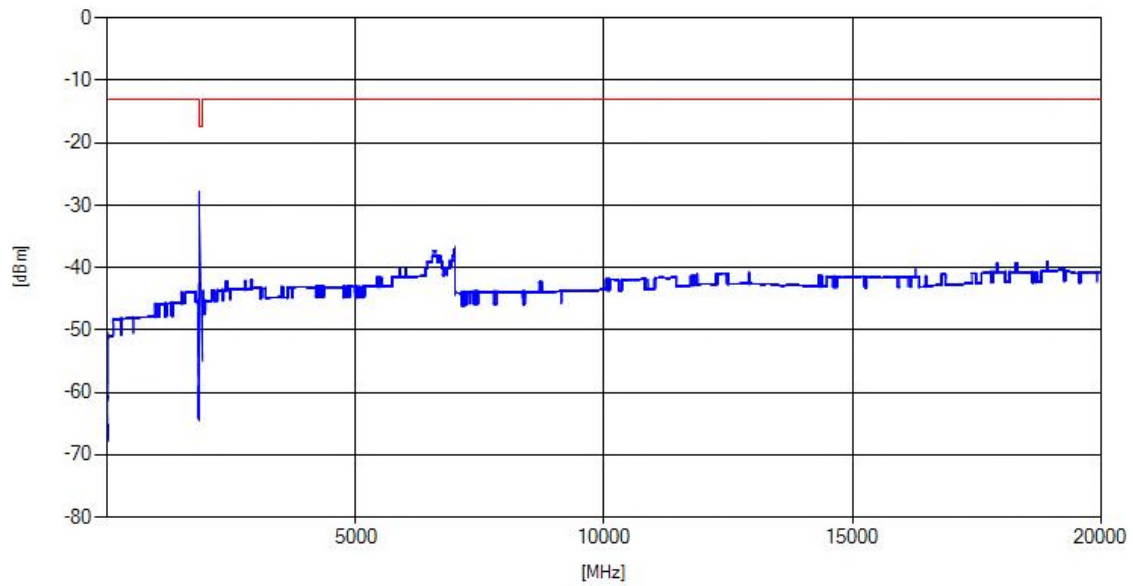
Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
eFDD2	low	rms	maxhold	5	1849,9	-27,77	-17,5	10,27
eFDD2	mid	rms	maxhold	-	-	-	-13	>20
eFDD2	high	rms	maxhold	-	-	-	-13	>20

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
eFDD25	low	rms	maxhold	5	1850	-28,24	-17,5	10,74
eFDD25	mid	rms	maxhold	-	-	-	-13	>20
eFDD25	high	rms	maxhold	-	-	-	-13	>20

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

#### 5.10.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

CAT-M1 eFDD 2 QPSK, RB=1, Channel = low



#### 5.10.5 TEST EQUIPMENT USED

- Radio Lab

## 5.11 FIELD STRENGTH OF SPURIOUS RADIATION

Standard **FCC PART 24 Subpart E**

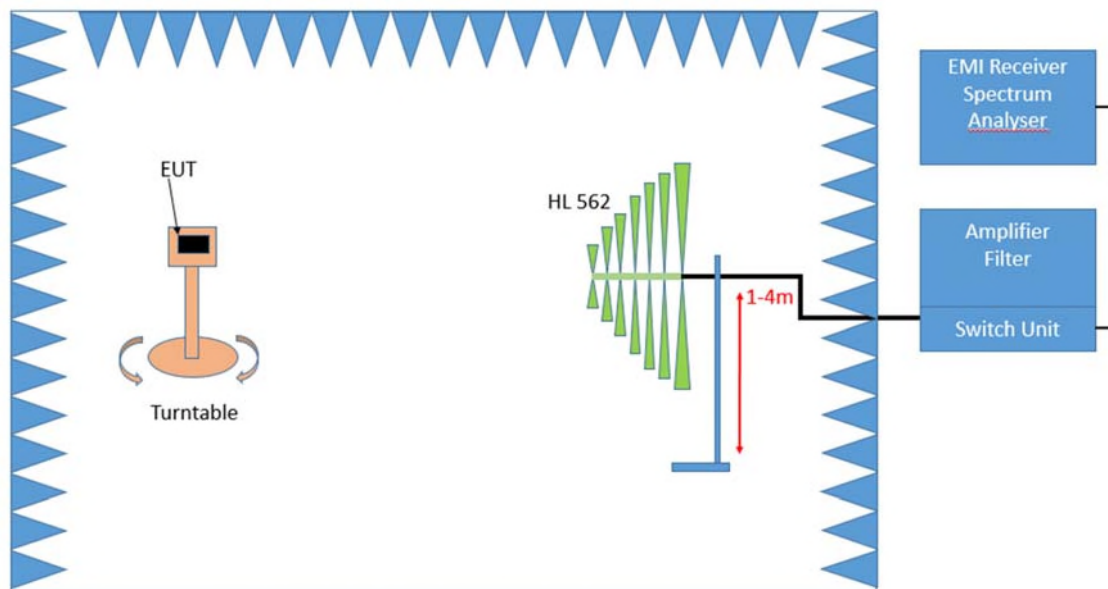
**The test was performed according to:**  
ANSI C63.26: 2015

### 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 ISSED RSS-Standard for the operating band of the cellular device.

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

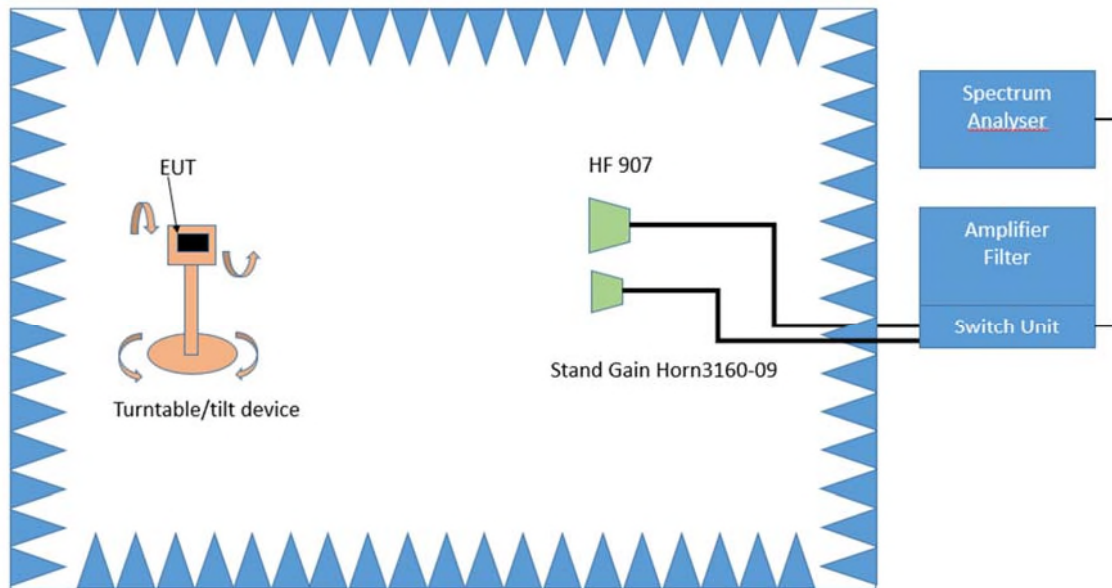
Frequency Range: 30 MHz – 1 GHz:



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 m<sup>2</sup> 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 – 3 m
- Height variation step size: 2 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  $\pm 45^\circ$  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  $\pm$

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
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: coupled
- Turntable angle range:  $\pm 45^\circ$  around the determined value
- Height variation range:  $\pm 100$  cm around the determined value
- 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  $45^\circ$ .

The turn table step size (azimuth angle) for the preliminary measurement is  $45^\circ$ .

- Antenna distance: 3 m
- Detector: Peak
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep time: coupled
- Turntable angle range:  $-180^\circ$  to  $135^\circ$
- Turntable step size:  $45^\circ$
- 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 in step 2 is omitted. Instead of this, a maximum search with a step size  $\pm 45^\circ$  for the elevation axis is performed.

The turn table azimuth will slowly vary by  $\pm 22.5^\circ$ .

The elevation angle will slowly vary by  $\pm 45^\circ$

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: 24 °C  
Relative humidity: 38 %

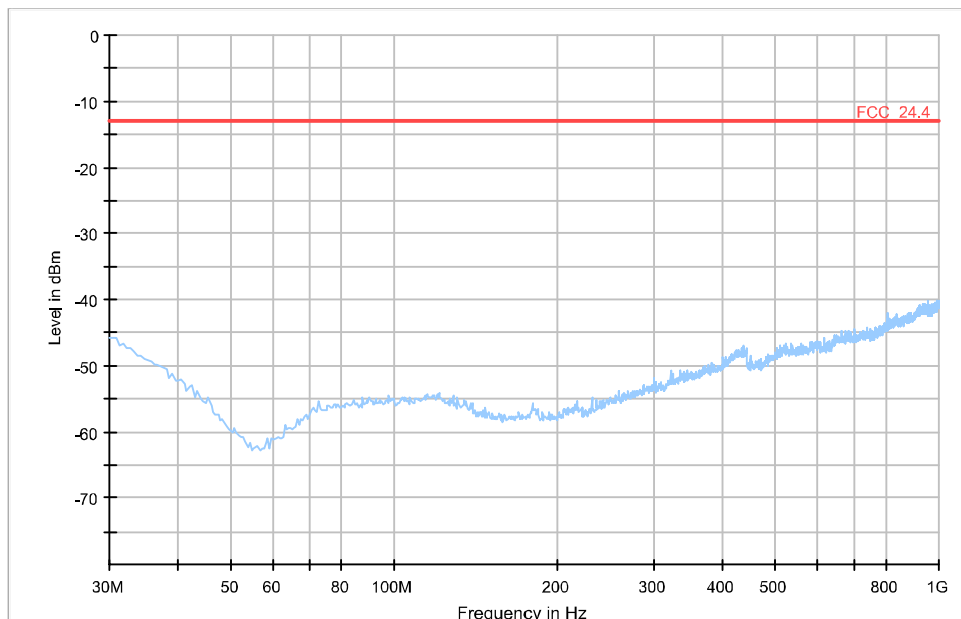
Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
eFDD2	low	rms	maxhold	100	1848.8	-37.9	-23	14.9
eFDD2	mid	rms	maxhold	-	-	-	-13	>20
eFDD2	high	rms	maxhold	100	1911.4	-46.1	-23	23.1

Radio Technology	Channel	Detector	Trace	Resolution Bandwidth /kHz	Frequency /MHz	Peak Value /dBm	Limit /dBm	Margin to Limit /dB
eFDD25	low	rms	maxhold	1000	1847.58	-36.5	-13	23.5
eFDD25	mid	rms	maxhold	-	-	-	-13	>20
eFDD25	high	rms	maxhold	1000	1917.64	-35.6	-13	>20

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

### 5.11.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

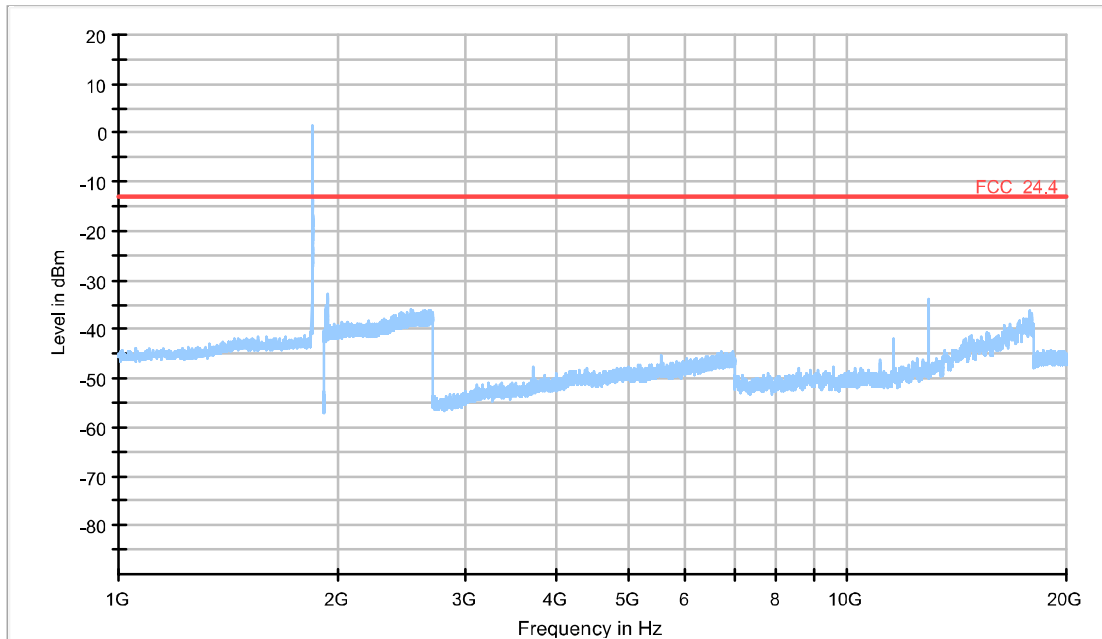
CAT-M1 eFDD 2 QPSK, RB=1, Channel = low  
30 MHz – 1 GHz



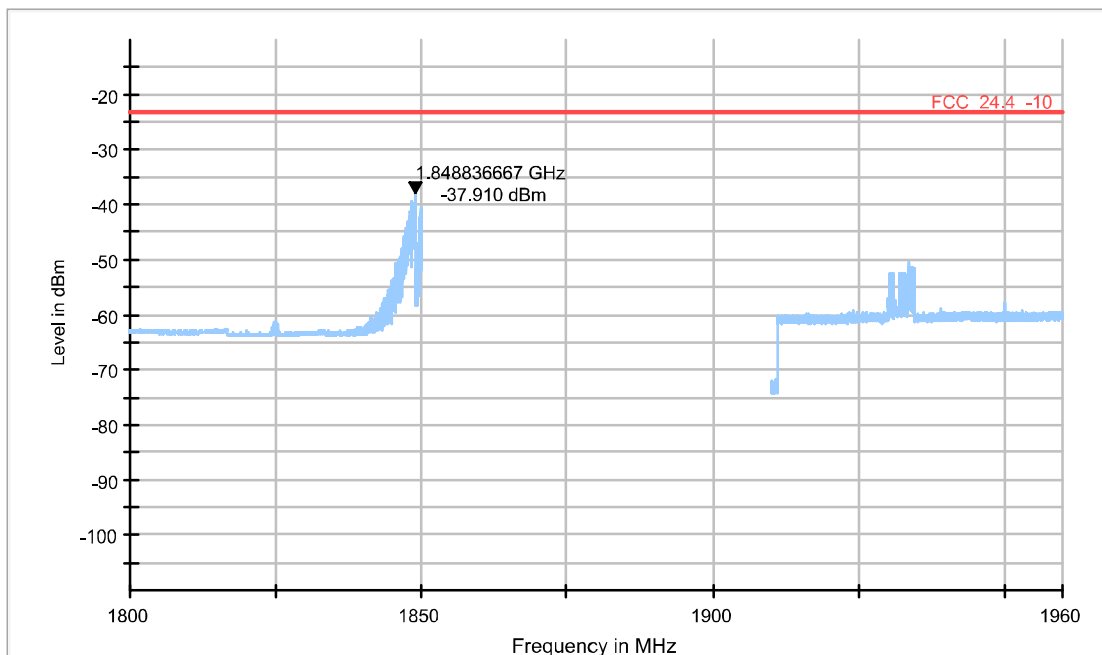
### Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin	Meas. Time (ms)	Bandwidth (kHz)	Height	Pol	Azimuth	Corr. (dB)	Comment
--	--	--	--	--	--	--	--	--	--	

1 GHz – 20 GHz



final measurement at lower band edge



#### 5.11.5 TEST EQUIPMENT USED

- Radiated Emissions

## 5.12 EMISSION AND OCCUPIED BANDWIDTH

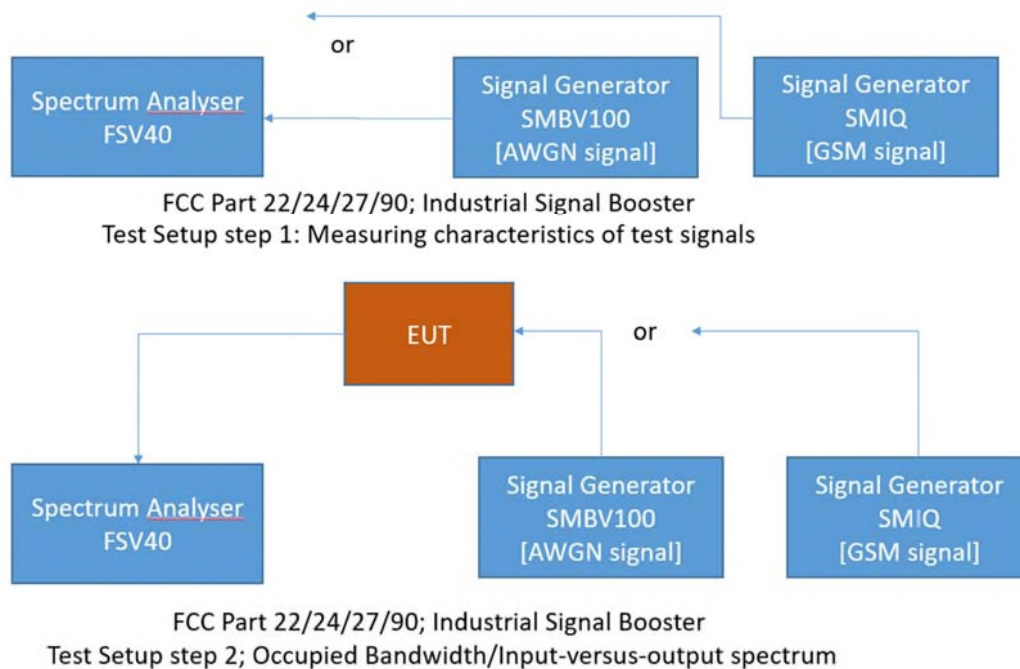
Standard **FCC PART 24 Subpart E**

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

### 5.12.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable conducted spurious emission test case per FCC §2.1049 and RSS-GEN 6.7. The limit and the requirements come from the applicable rule part and ISSED RSS-Standard for the operating band of the cellular device.

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



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.

## 5.12.2 TEST REQUIREMENTS / LIMITS

### **FCC Part 2.1049; Occupied Bandwidth:**

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(h) Transmitters employing digital modulation techniques—when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

(i) Transmitters designed for other types of modulation—when modulated by an appropriate signal of sufficient amplitude to be representative of the type of service in which used. A description of the input signal should be supplied.

### **RSS-GEN; 6.7 Occupied Bandwidth (or 99% emission bandwidth) and x dB bandwidth**

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span. The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

### 5.12.3 TEST PROTOCOL

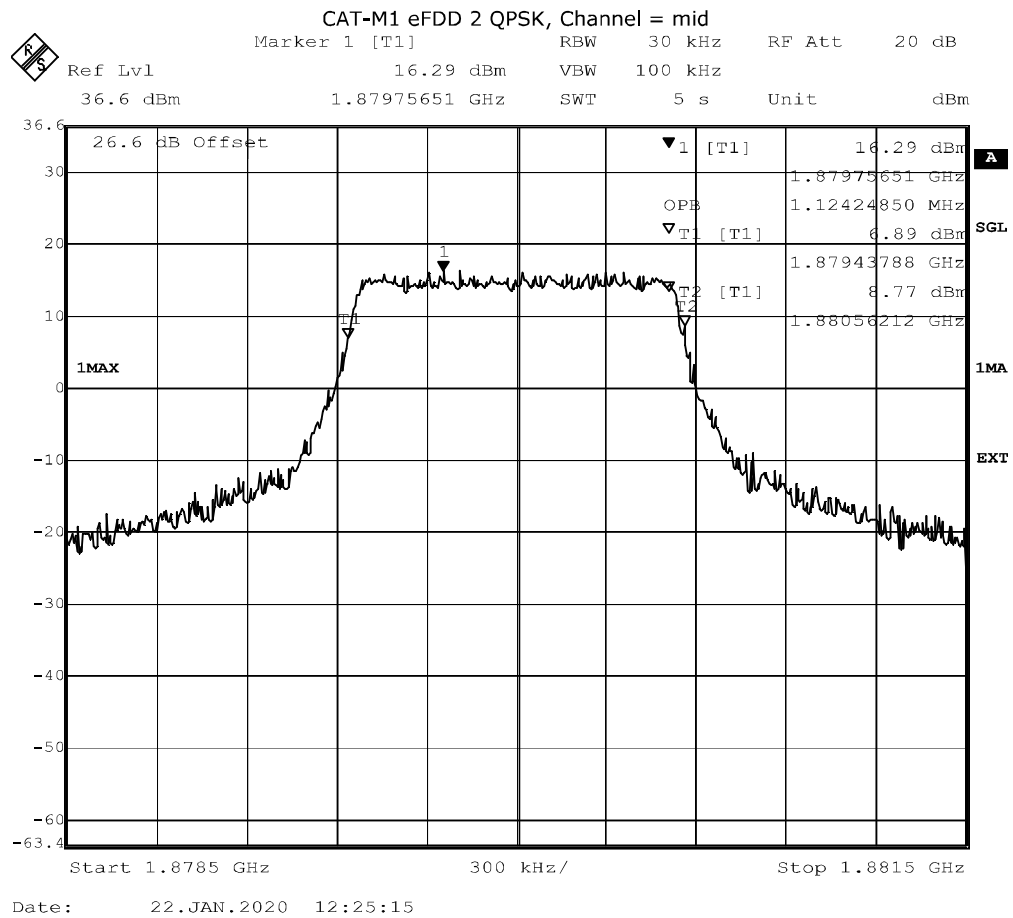
Ambient temperature: 24 °C  
Relative humidity: 38 %

Radio Technology	Channel	Ressource Blocks / Subcarrier	Bandwidth (MHz)	Nominal BW [MHz]	99 % BW [kHz]
CAT-M1 eFDD 2 QPSK	low	6	1.4	1.4	1118,24
CAT-M1 eFDD 2 QPSK	mid	6	1.4	1.4	1124,25
CAT-M1 eFDD 2 QPSK	high	6	1.4	1.4	1124,25
CAT-M1 eFDD 2 16QAM	low	5	1.4	1.4	967,94
CAT-M1 eFDD 2 16QAM	mid	5	1.4	1.4	973,95
CAT-M1 eFDD 2 16QAM	high	5	1.4	1.4	967,94
CAT-M1 eFDD 25 QPSK	low	6	1.4	1.4	1124,25
CAT-M1 eFDD 25 QPSK	mid	6	1.4	1.4	1124,25
CAT-M1 eFDD 25 QPSK	high	6	1.4	1.4	1130,26
CAT-M1 eFDD 25 16QAM	low	5	1.4	1.4	967,94
CAT-M1 eFDD 25 16QAM	mid	5	1.4	1.4	967,94
CAT-M1 eFDD 25 16QAM	high	5	1.4	1.4	967,94

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



#### 5.12.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")



#### 5.12.5 TEST EQUIPMENT USED

### 5.13 BAND EDGE COMPLIANCE

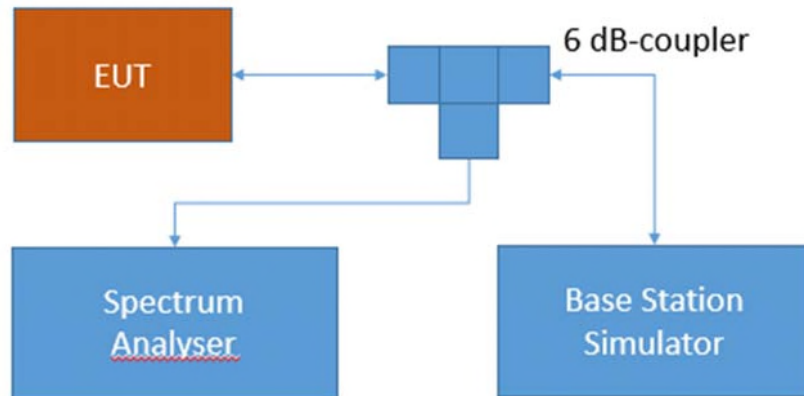
Standard **FCC PART 24 Subpart E**

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

#### 5.13.1 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 ISSED 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.

#### 5.13.2 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**

### **§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.

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### 5.13.3 TEST PROTOCOL

Ambient temperature: 24 °C  
Relative humidity: 38 %

Radio Technology	Channel	Ressource Blocks / Subcarrier	Bandwidth (MHz)	RMS [dBm]	Limit /dBm	Margin to Limit /dB
CAT-M1 eFDD 2 QPSK	low	6	1,4	-24,32	-13	11,32
CAT-M1 eFDD 2 QPSK	high	6	1,4	-24	-13	11
CAT-M1 eFDD 2 16QAM	low	5	1,4	-22,44	-13	9,44
CAT-M1 eFDD 2 16QAM	high	5	1,4	-27,14	-13	14,14
CAT-M1 eFDD 25 QPSK	low	6	1,4	-23,55	-13	10,55
CAT-M1 eFDD 25 QPSK	high	6	1,4	-23,4	-13	10,4
CAT-M1 eFDD 25 16QAM	low	5	1,4	-22,19	-13	9,19
CAT-M1 eFDD 25 16QAM	high	5	1,4	-27,84	-13	14,84

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

### 5.13.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

### 5.13.5 TEST EQUIPMENT USED

## 5.14 PEAK TO AVERAGE RATIO

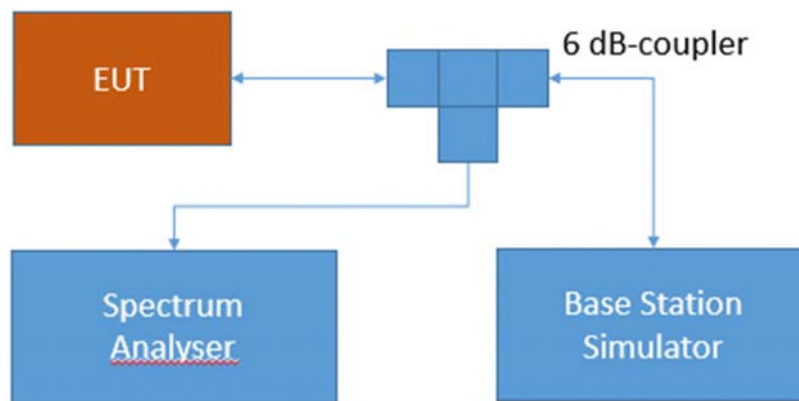
Standard **FCC PART 24 Subpart E**

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

### 5.14.1 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 ISSED 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

### 5.14.2 TEST REQUIREMENTS / LIMITS

#### **FCC Part 24, § 24.232**

(d) 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 (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. 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-133; 6.4 Transmitter Output Power and Equivalent Isotropically Radiated 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 using a signal corresponding to the highest PAPR during periods of continuous transmission.

#### **5.14.3 TEST PROTOCOL**

Ambient temperature: 24 °C  
Relative humidity: 38 %

Radio Technology	Channel	Ressource Blocks / Subcarrier	Bandwidth [MHz]	Peak to Average Ratio	Limit (IC) [dB]
CAT-M1 eFDD 2 QPSK	low	6	1,4	8,29	13
CAT-M1 eFDD 2 QPSK	mid	6	1,4	7,83	13
CAT-M1 eFDD 2 QPSK	high	6	1,4	7,04	13
CAT-M1 eFDD 2 16QAM	low	5	1,4	9,19	13
CAT-M1 eFDD 2 16QAM	mid	5	1,4	8,06	13
CAT-M1 eFDD 2 16QAM	high	5	1,4	7,39	13
CAT-M1 eFDD 25 QPSK	low	6	1,4	8,14	13
CAT-M1 eFDD 25 QPSK	mid	6	1,4	7,07	13
CAT-M1 eFDD 25 QPSK	high	6	1,4	6,70	13
CAT-M1 eFDD 25 16QAM	low	5	1,4	8,23	13
CAT-M1 eFDD 25 16QAM	mid	5	1,4	7,77	13
CAT-M1 eFDD 25 16QAM	high	5	1,4	7,33	13

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