

Results

LTE Cat-M1 Band 25:

A preliminary scan determined the worst-case:

BW=10 MHz. 16QAM. RB Size=1. RB Offset=2. Narrow Band=0.

The next results are for this worst-case configuration.

Frequency range 9 KHz - 20 GHz:

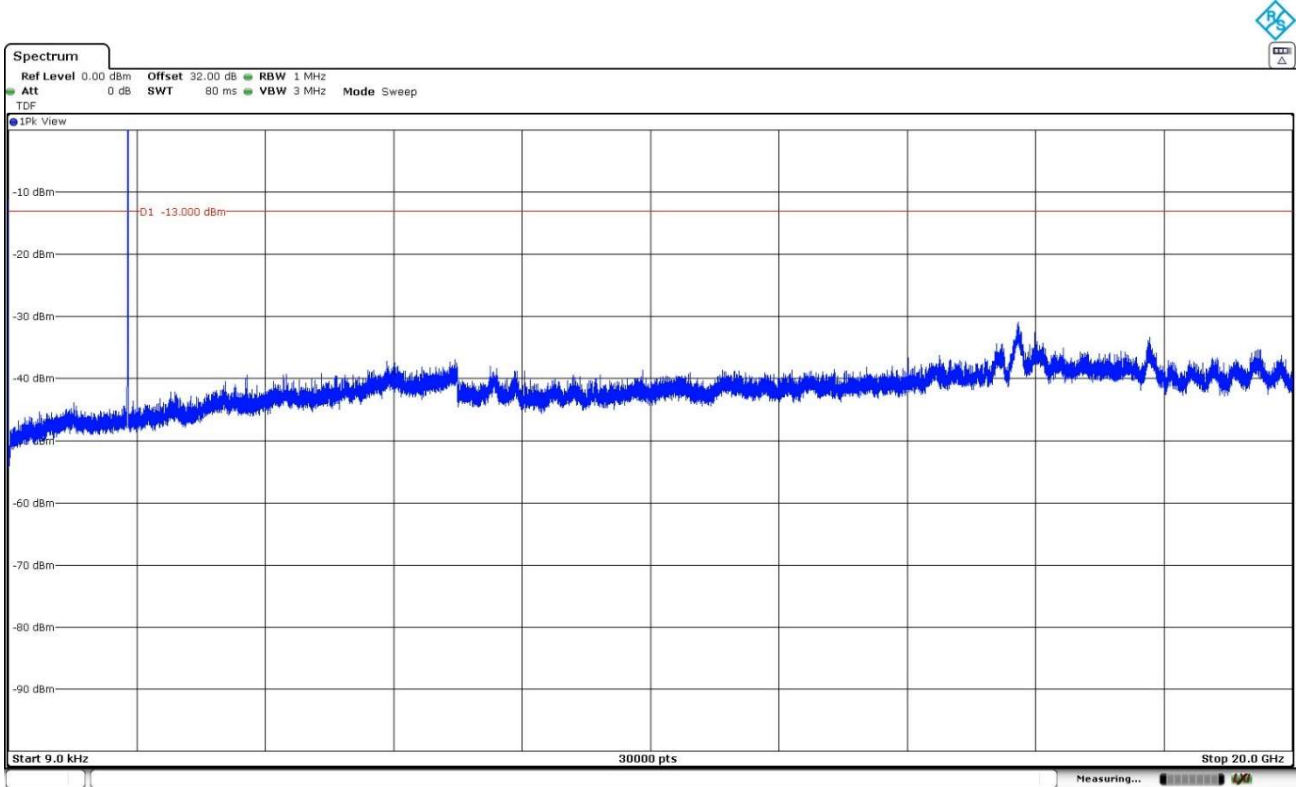
- Low Channel: No spurious frequencies at less than 20 dB below the limit.
- Middle Channel: No spurious frequencies at less than 20 dB below the limit.
- High Channel: No spurious frequencies at less than 20 dB below the limit.

Measurement uncertainty (dB): $<\pm 2.76$

Verdict: PASS

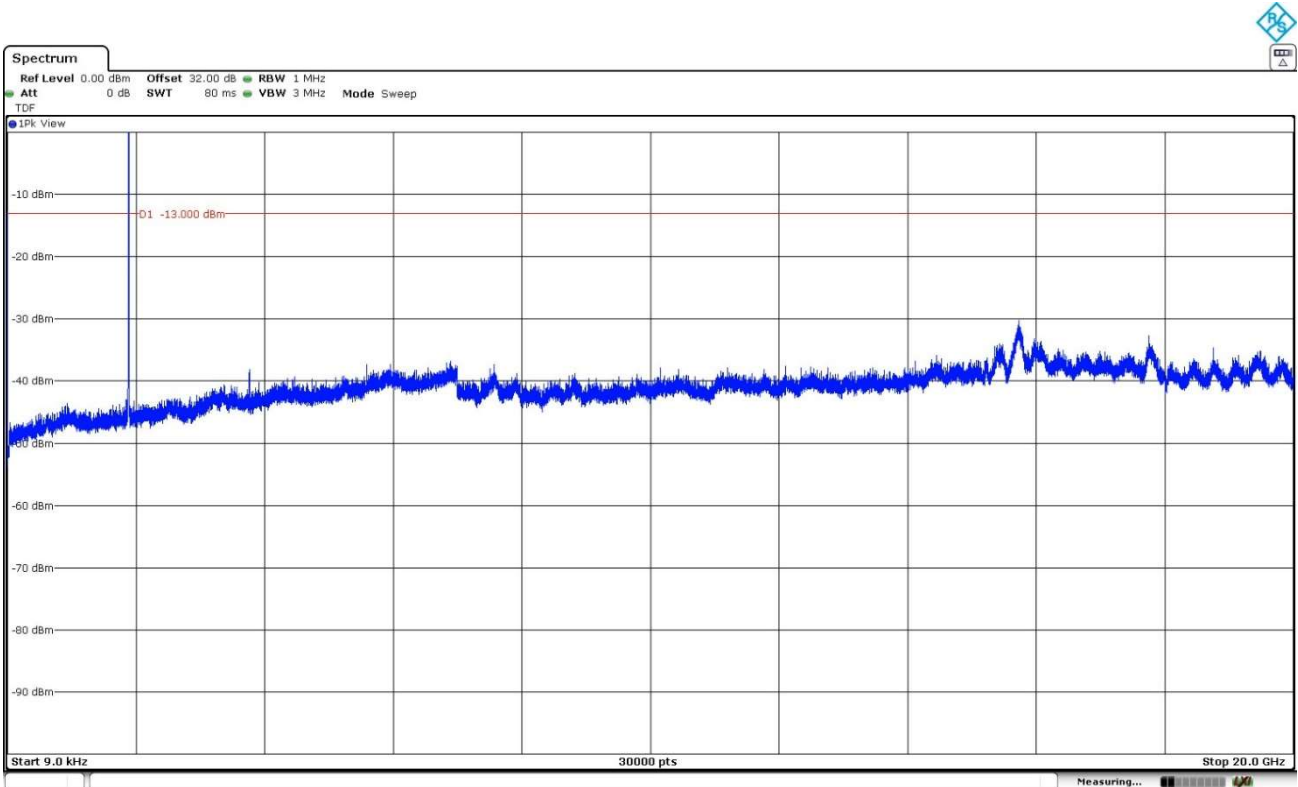
LTE Cat-M1 Band 25: BW=10 MHz. 16QAM. RB Size=1. RB Offset=2. Narrow Band=0.

Low Channel:



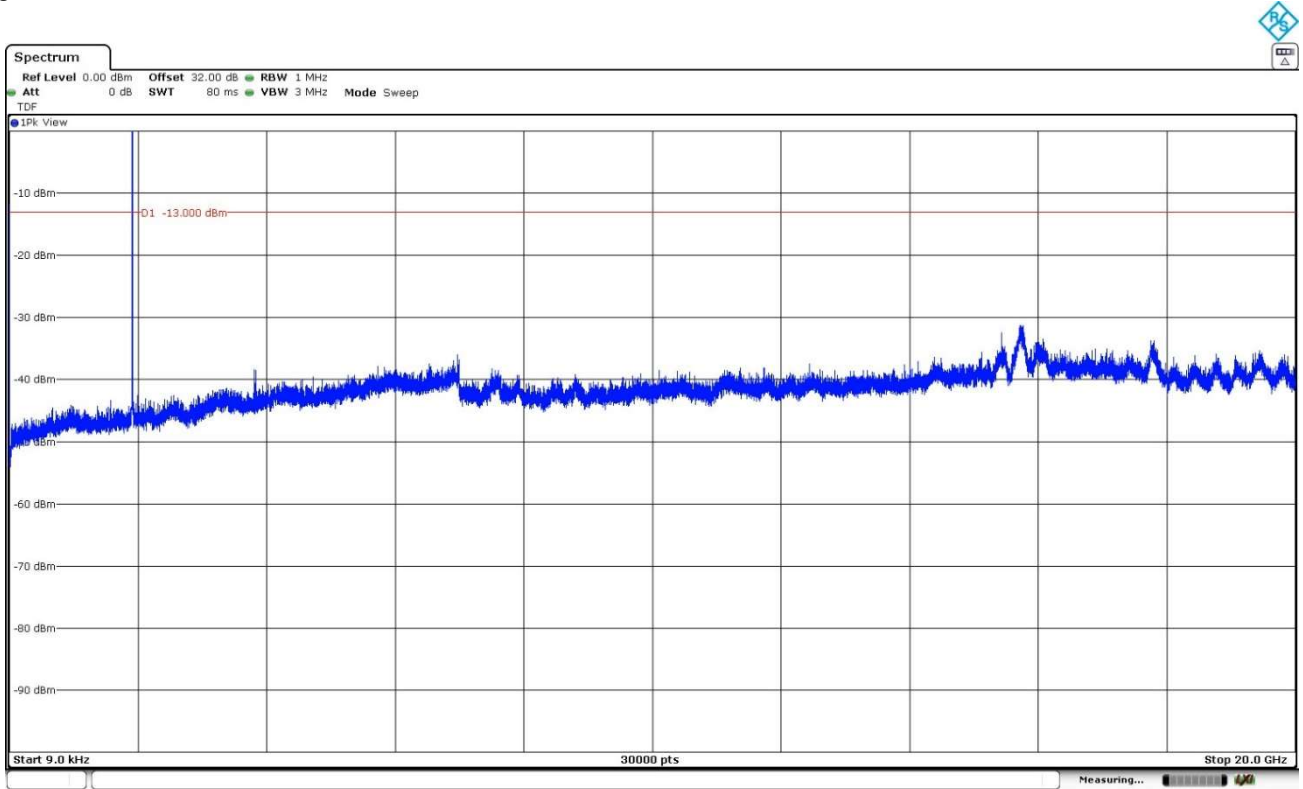
The peak above the limit is the carrier frequency.

Middle Channel:



The peak above the limit is the carrier frequency.

High Channel:



The peak above the limit is the carrier frequency.

Spurious Emissions at Antenna Terminals at Block Edges

Limits

FCC §2.1051 and §24.238. RSS-133 Clause 6.5.

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.

At P_o transmitting power, the specified minimum attenuation becomes $43 + 10 \log(P_o)$, and the level in dBm relative to P_o becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log(P_o \text{ in mW}) - 30] = -13 \text{ dBm}$$

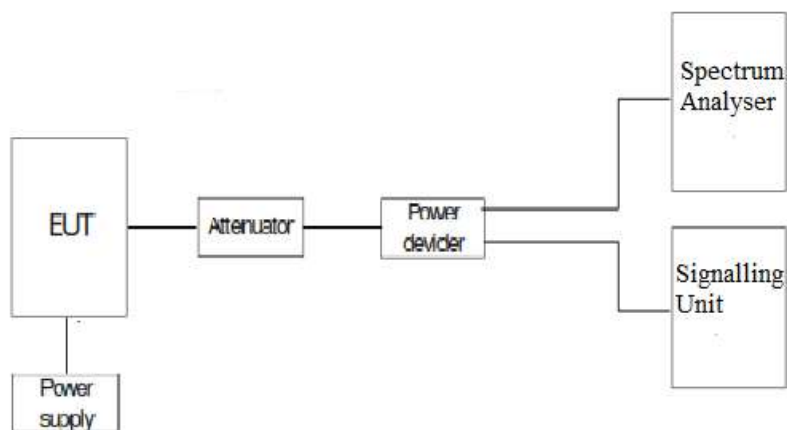
Method

The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power splitter.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

As stated in FCC part 24.238 / RSS-133 Clause 6.5, in the 1 MHz bands immediately outside and adjacent to the frequency block or band a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

Test Setup



Results

LTE Cat-M1 Band 25:

Preliminary measurements determined 16QAM, BW=1.4 MHz as the worst-case modulation in terms of band edge results. The next results are for this worst-case configuration.

LTE Cat-M1 Band 25. 16QAM.	RB=1. Offset=0. BW=1.4 MHz	RB=1. Offset =0. BW = 3 MHz	RB=1. Offset =0. BW=5 MHz	RB=1. Offset =0. BW=10 MHz	RB=1. Offset =0. BW=15 MHz	RB=1. Offset =0. BW=20 MHz
Maximum measured level at <u>Low Block Edge</u> at antenna port (dBm)	-21.26	-42.54	-36.8	-46.21	-47.77	-51.65

LTE Cat-M1 Band 25. 16QAM.	RB=5. Offset=0. BW=1.4 MHz	RB=5. Offset=0. BW = 3 MHz	RB=5. Offset=0. BW=5 MHz	RB=5. Offset=0. BW=10 MHz	RB=5. Offset=0. BW=15 MHz	RB=5. Offset=0. BW=20 MHz
Maximum measured level at <u>Low Block Edge</u> at antenna port (dBm)	-28.96	-28.53	-26.45	-33.44	-35.84	-40.44

LTE Cat-M1 Band 25. 16QAM.	RB=1. Offset=Max. BW=1.4 MHz	RB=1. Offset =Max. BW = 3 MHz	RB=1. Offset =Max. BW=5 MHz	RB=1. Offset =Max. BW=10 MHz	RB=1. Offset =Max. BW=15 MHz	RB=1. Offset =Max. BW=20 MHz
Maximum measured level at <u>High Block Edge</u> at antenna port (dBm)	-23.13	-41.21	-35.45	-44.99	-45.73	-52.09

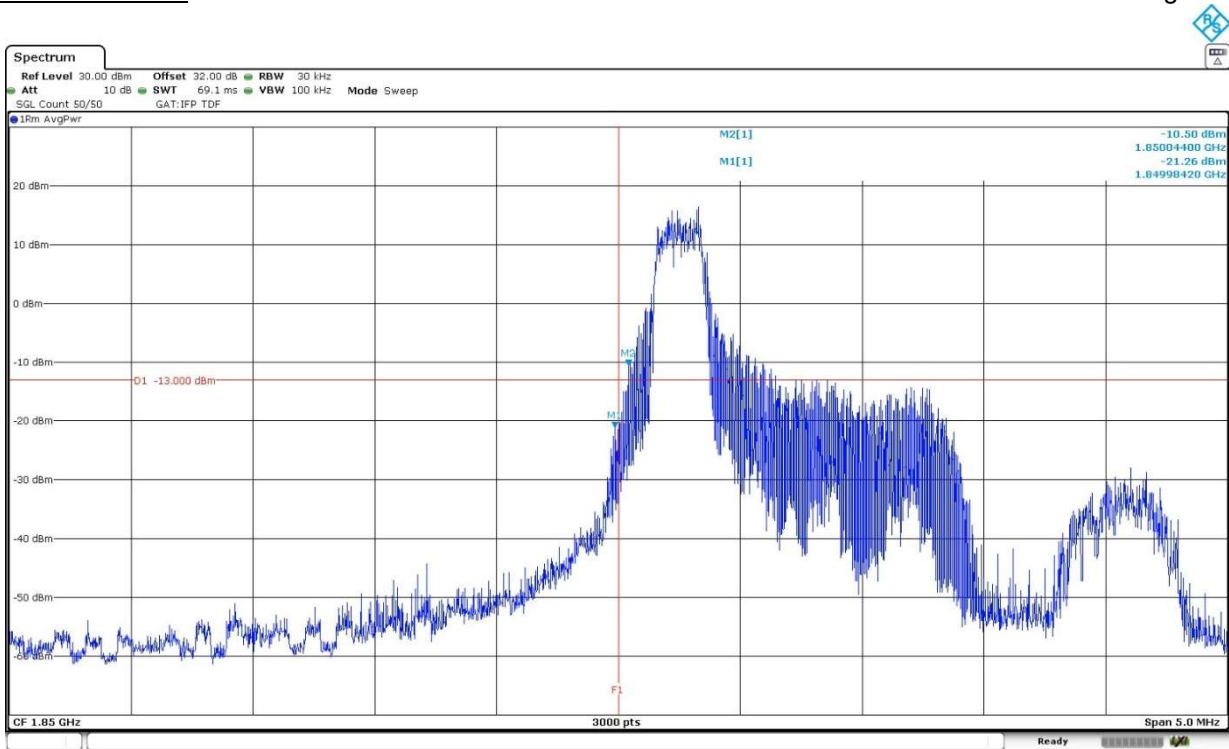
LTE Cat-M1 Band 25. 16QAM.	RB=5. Offset=1. BW=1.4 MHz	RB=5. Offset=1. BW = 3 MHz	RB=5. Offset=1. BW=5 MHz	RB=5. Offset=1. BW=10 MHz	RB=5. Offset=1. BW=15 MHz	RB=5. Offset=1. BW=20 MHz
Maximum measured level at <u>High Block Edge</u> at antenna port (dBm)	-25.94	-28.5	-24.98	-34.29	-35.34	-41.65

Measurement uncertainty (dB) ± 2.76

Verdict

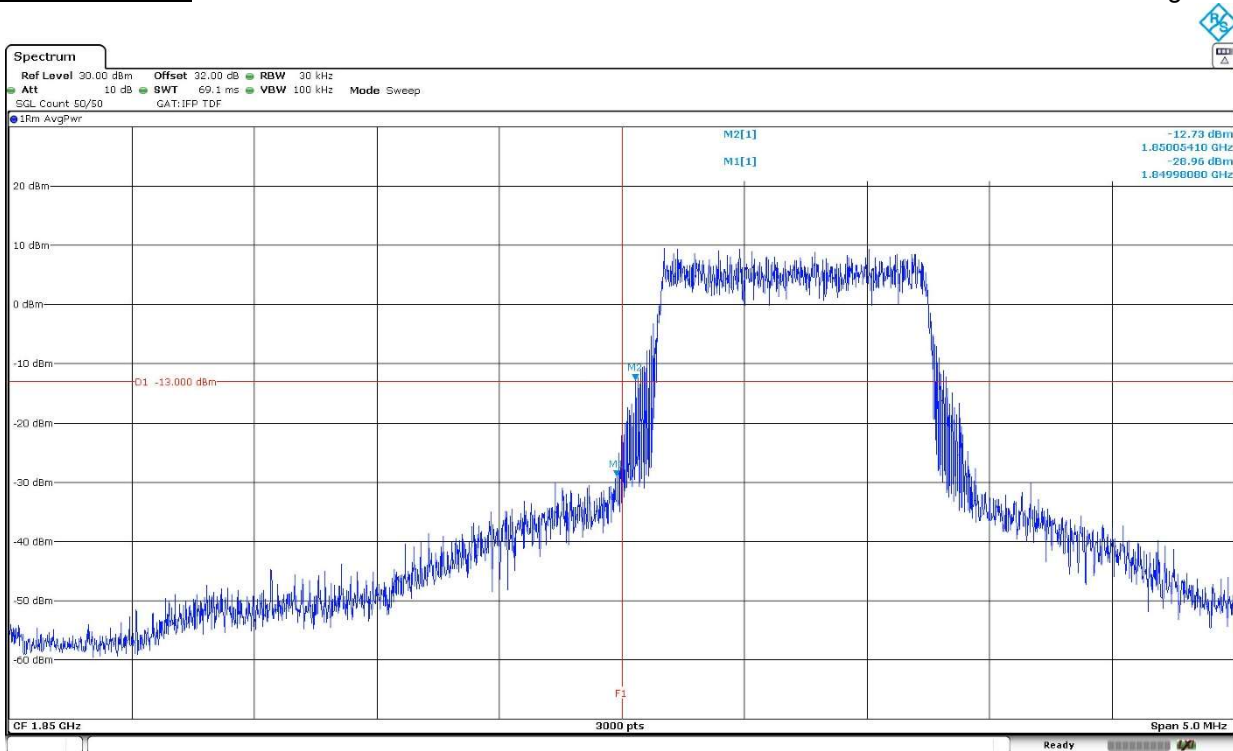
PASS

LTE Cat-M1 Band 25. BW=1.4 MHz. 16QAM. RB Size=1. RB Offset=0. Narrow Band=0. Low Block Edge:



The equipment transmits at the maximum output power.

LTE Cat-M1 Band 25. BW=1.4 MHz. 16QAM. RB Size=5. RB Offset=0. Narrow Band=0. Low Block Edge:



The equipment transmits at the maximum output power.

Radiated Emissions

Limits

* FCC § 24.238. RSS-133 Clause 6.5:

The power of emissions shall be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log (P)$ dB. P in watts.

Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater.

Method

The measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the High frequency generated within the equipment.

The EUT was placed on a non-conductive stand at 3-meter distance from the measuring antenna for measurements up to 18 GHz. Measurements above 18 GHz require the distance to be reduced to 1.5 meters.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the height and polarization of the measuring antenna. The maximum meter reading was recorded.

Measurement Limit:

At P_o transmitting power. the specified minimum attenuation becomes $43+10\log (P_o)$ and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mwatts}) - 30] = - 13 \text{ dBm}$$

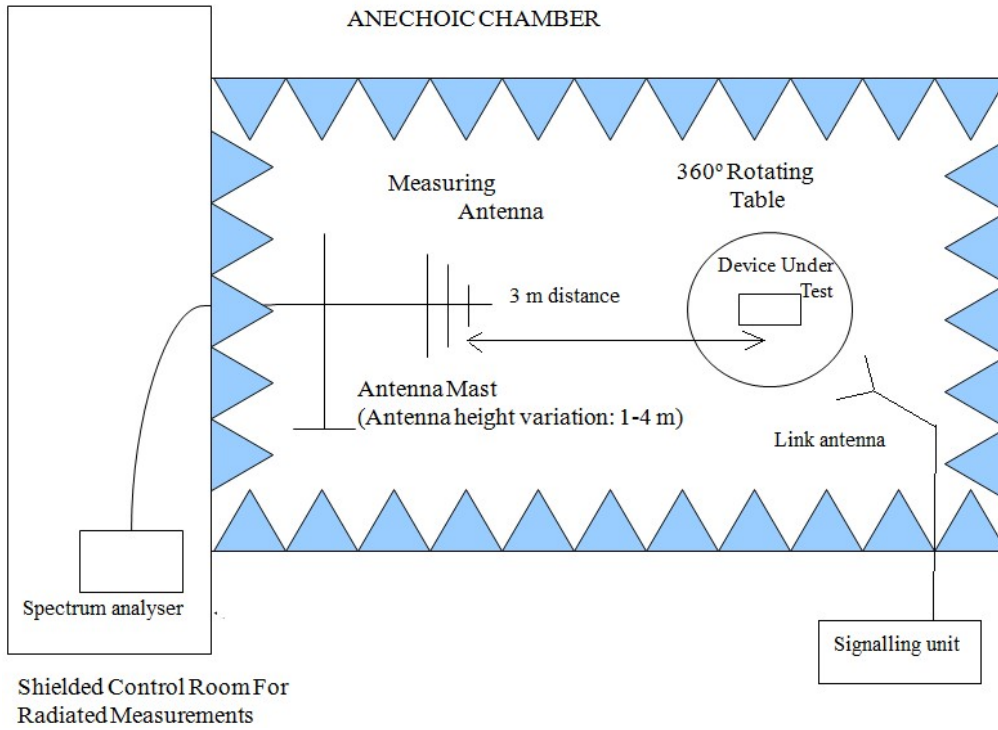
The maximum field strength (dB μ V/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

$$\text{EIRP (dBm)} = E \text{ (dB}\mu\text{V/m)} + 20 \log(D) - 104.8;$$

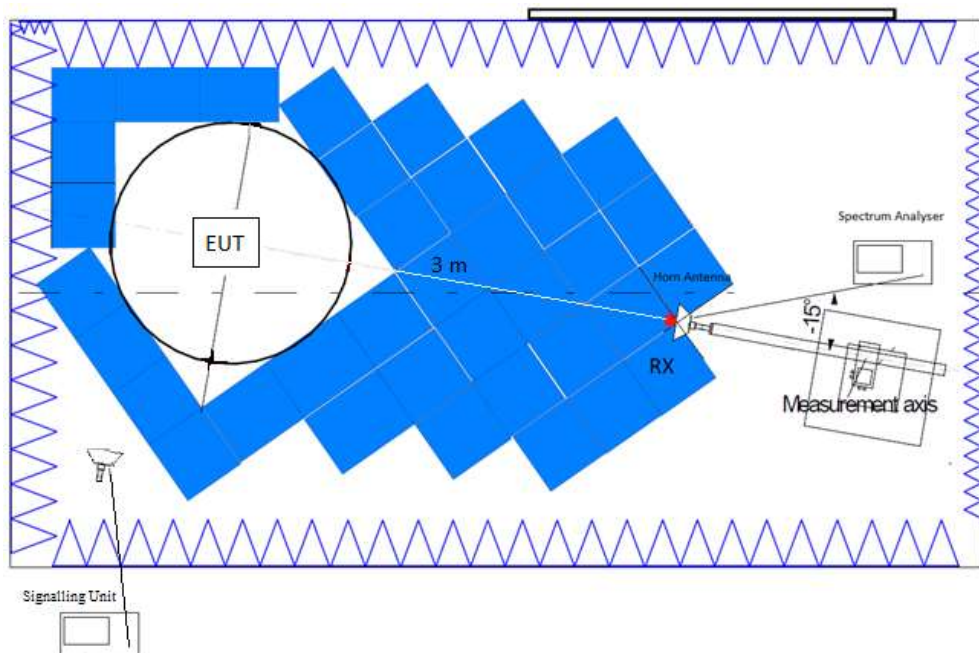
where D is the measurement distance (in the far field region) in m.

Test Setup

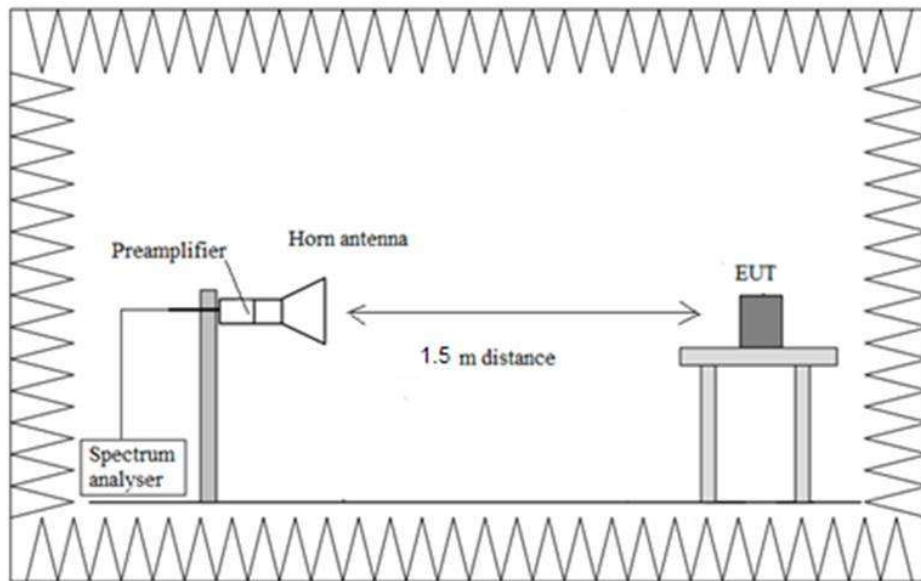
Radiated measurements below 1 GHz:



Radiated measurements above 1 GHz up to 18 GHz:



Radiated measurements above 18 GHz:



Results

LTE Cat-M1 Band 25:

A preliminary scan determined the BW=10 MHz, 16-QAM, RB Size=1, RB Offset=2, Narrow Band=0 as the worst case. The following results are for this worst-case configuration.

- LOW CHANNEL:

Frequency range 30 MHz - 1 GHz:

No spurious signals were found at less than 20 dB below the limit.

Frequency range 1 - 18 GHz:

Spurious signals were found at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
1849.375000	-23.99	H	Peak

Frequency range 18 - 20 GHz:

No spurious signals were found at less than 20 dB below the limit.

- MIDDLE CHANNEL:

Frequency range 30 MHz - 1 GHz:

No spurious signals were found at less than 20 dB below the limit.

Frequency range 1 - 18 GHz:

No spurious signals were found at less than 20 dB below the limit.

Frequency range 18 - 20 GHz:

No spurious signals were found at less than 20 dB below the limit.

- HIGH CHANNEL:

Frequency range 30 MHz - 1 GHz:

No spurious signals were found at less than 20 dB below the limit.

Frequency range 1 - 18 GHz:

Spurious signals were found at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
1970.500000	-29.99	V	Peak
2515.750000	-27.39	V	Peak

Frequency range 18 - 20 GHz:

No spurious signals were found at less than 20 dB below the limit.

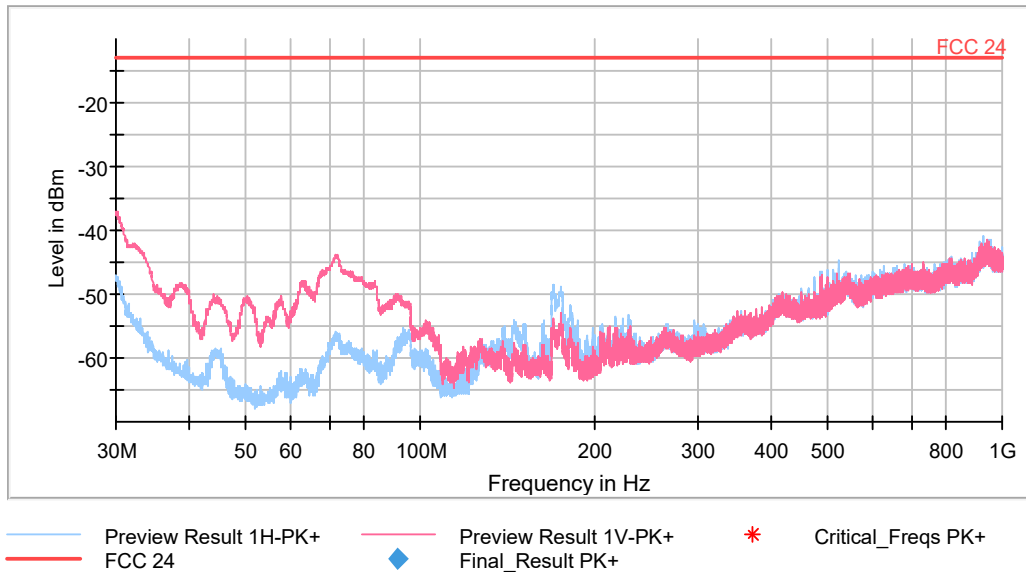
Measurement uncertainty (dB) $<\pm 5.03$ for $f < 1$ GHz
 $<\pm 4.32$ for $f \geq 1$ GHz up to 17 GHz
 $<\pm 4.58$ for $f \geq 17$ GHz up to 20 GHz

Verdict Pass

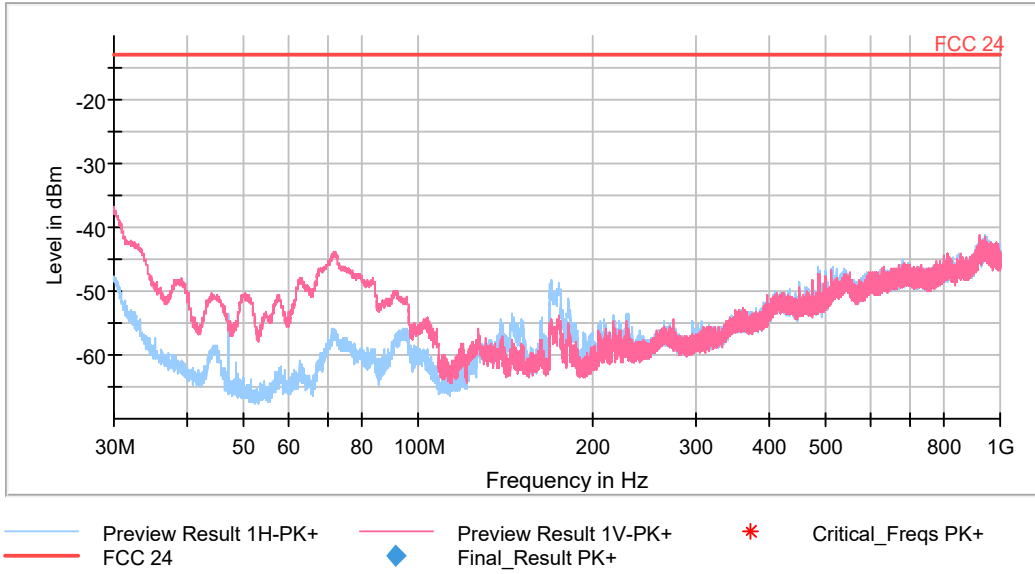
Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	30.312 kHz	PK+	1 MHz	1 s	0 dB
1 GHz - 3 GHz	62.5 kHz	PK+	1 MHz	1 s	0 dB
3 GHz - 18 GHz	468.75 kHz	PK+	1 MHz	1 s	0 dB
18 GHz - 20 GHz	62.5 kHz	PK+	1 MHz	1 s	0 dB

FREQUENCY RANGE 30 MHz - 1 GHz:

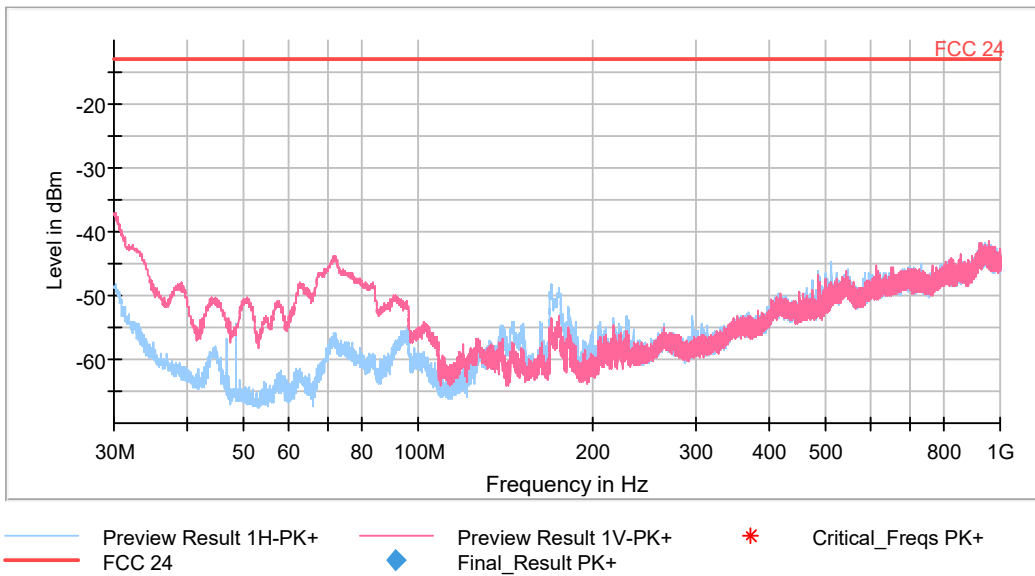
- Low Channel:



- Middle Channel:

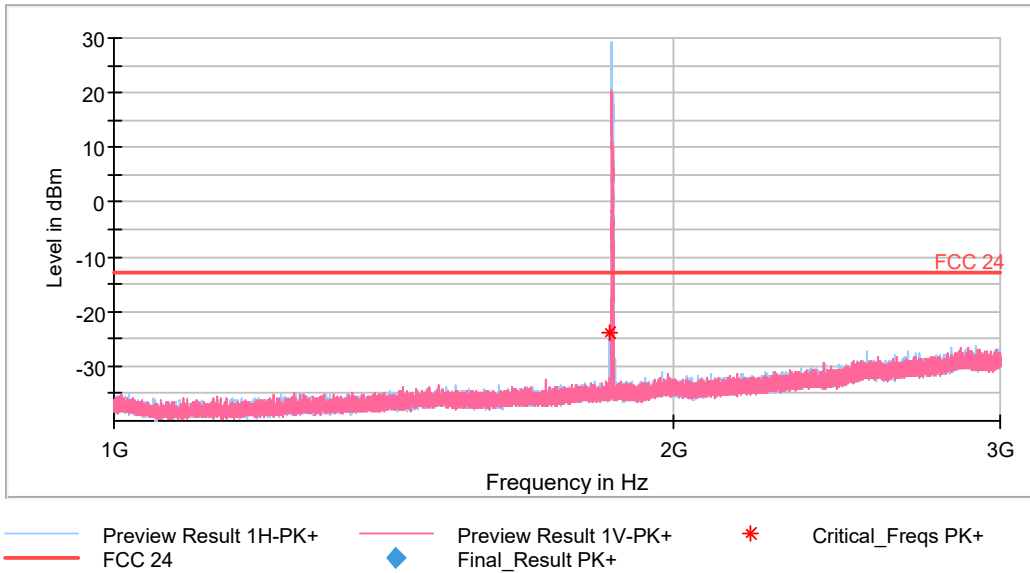


- High Channel:



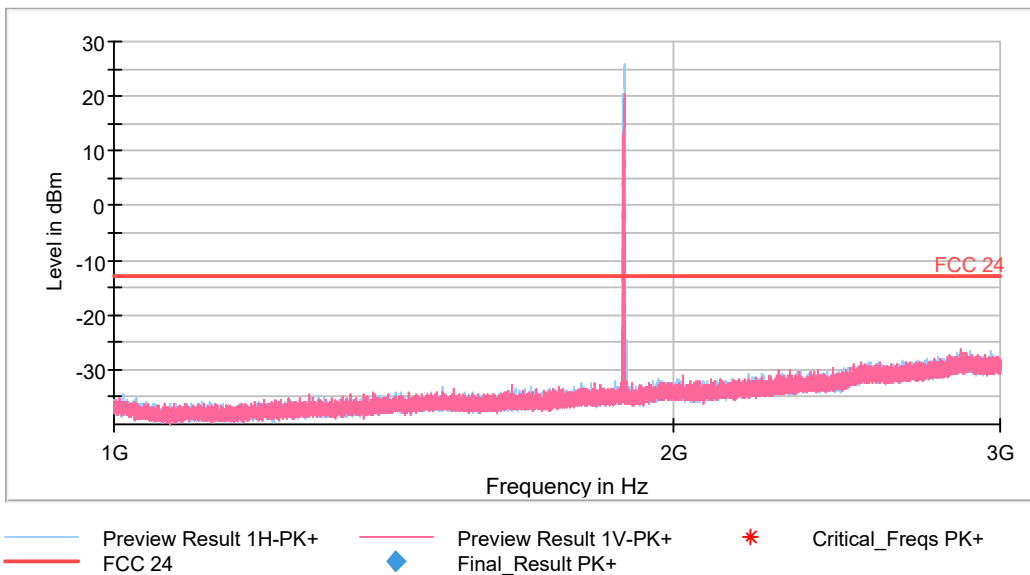
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



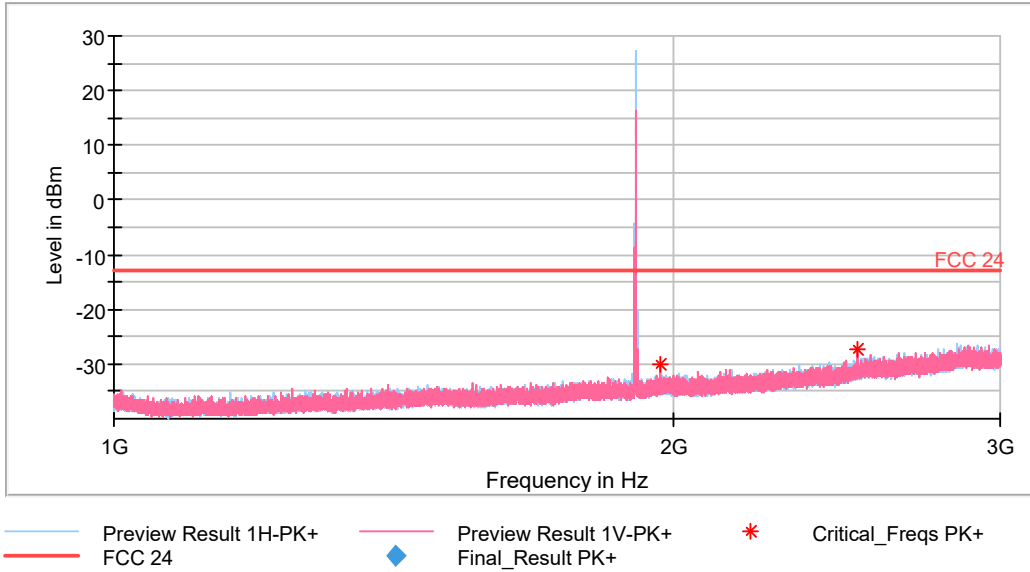
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

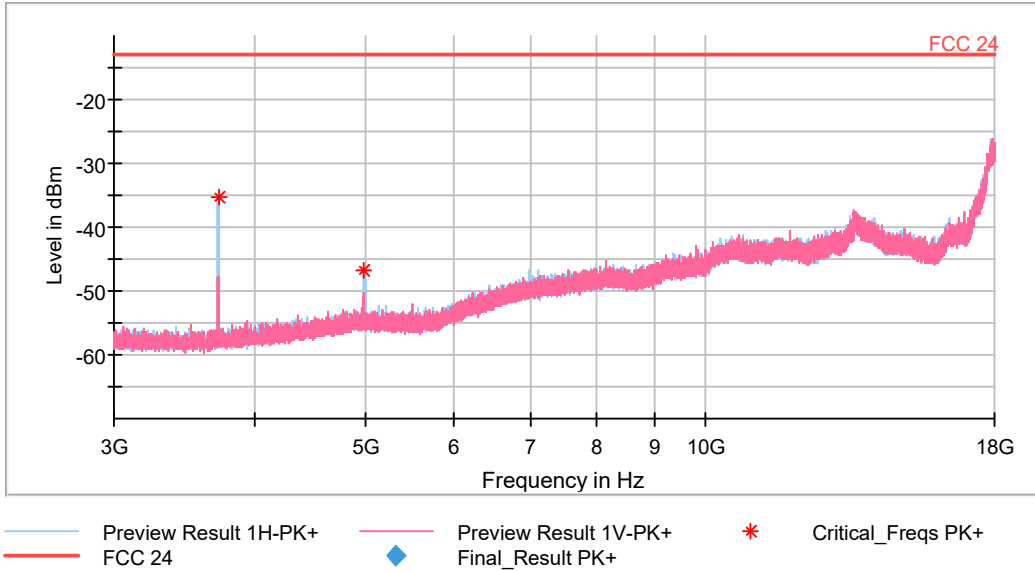
- High Channel:



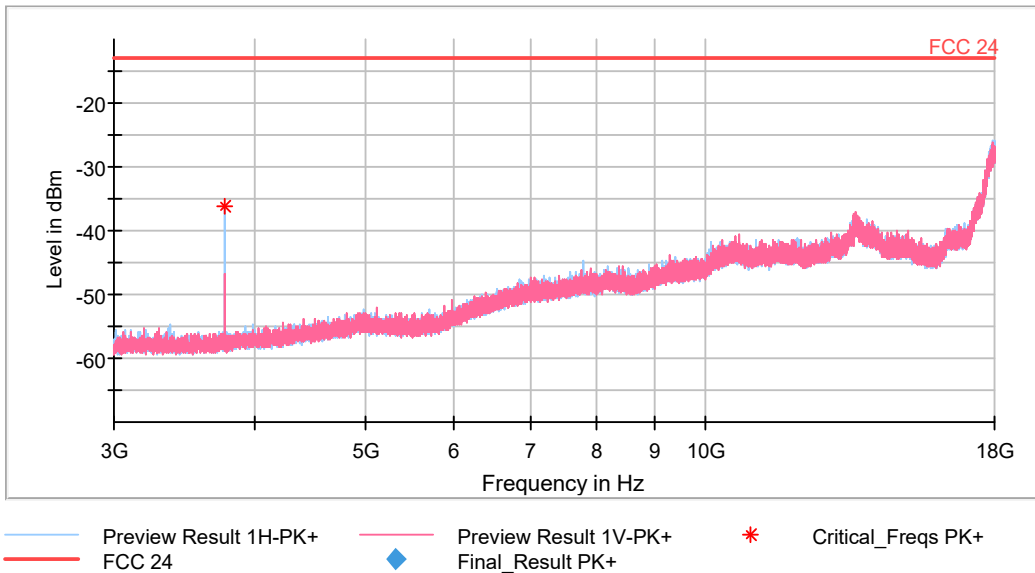
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 18 GHz:

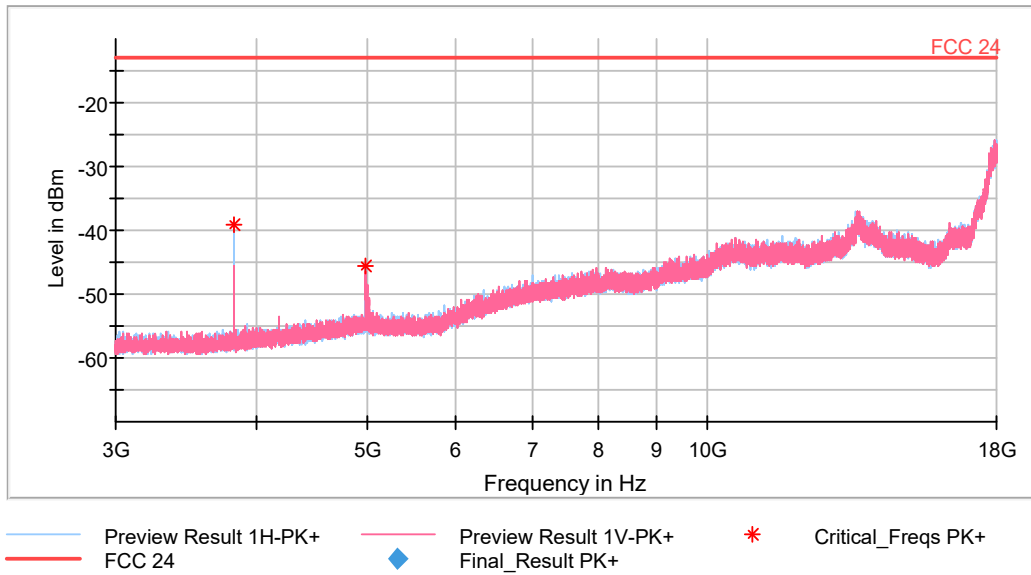
- Low Channel:



- Middle Channel:

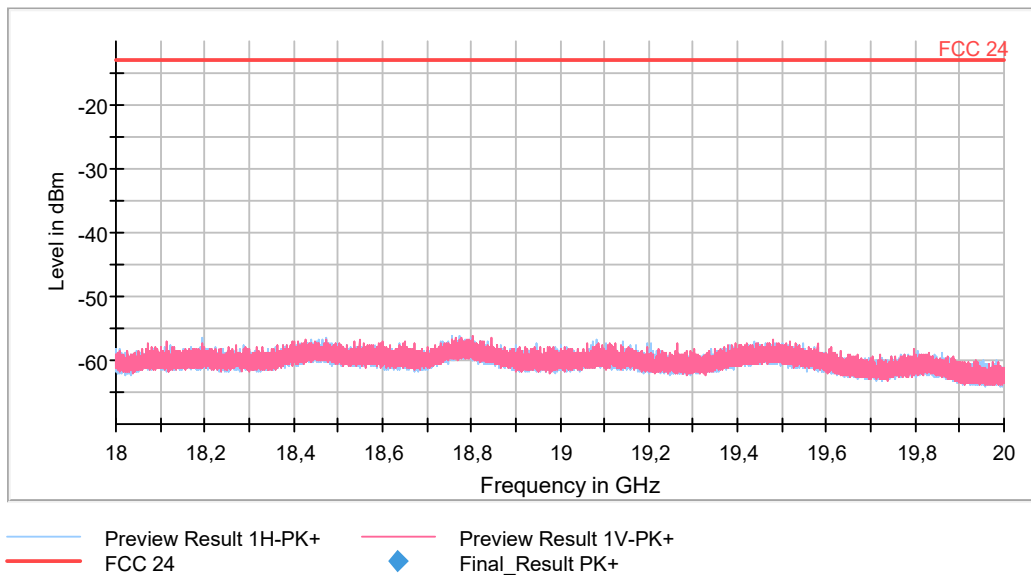


- High Channel:

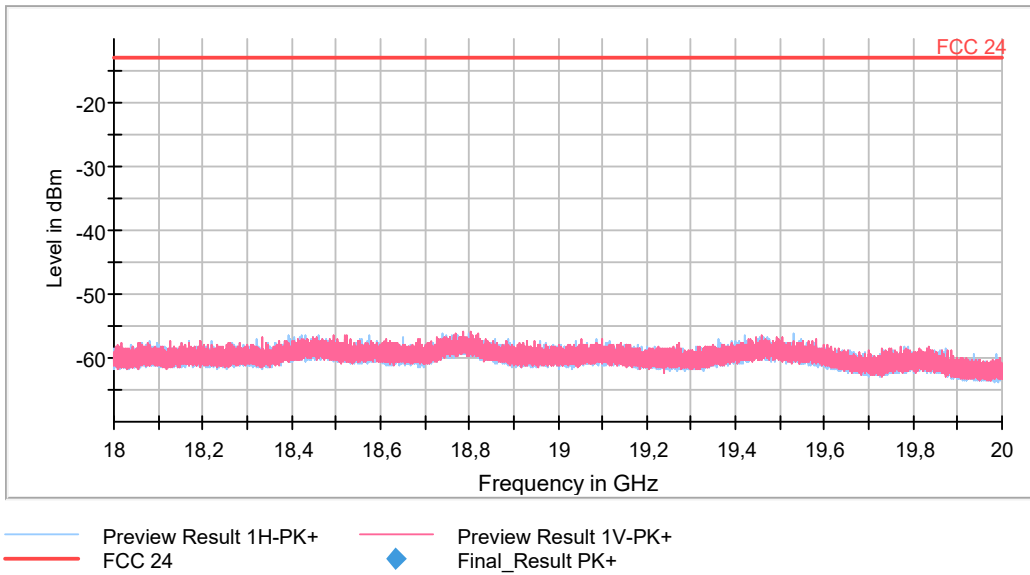


FREQUENCY RANGE 18 - 20 GHz:

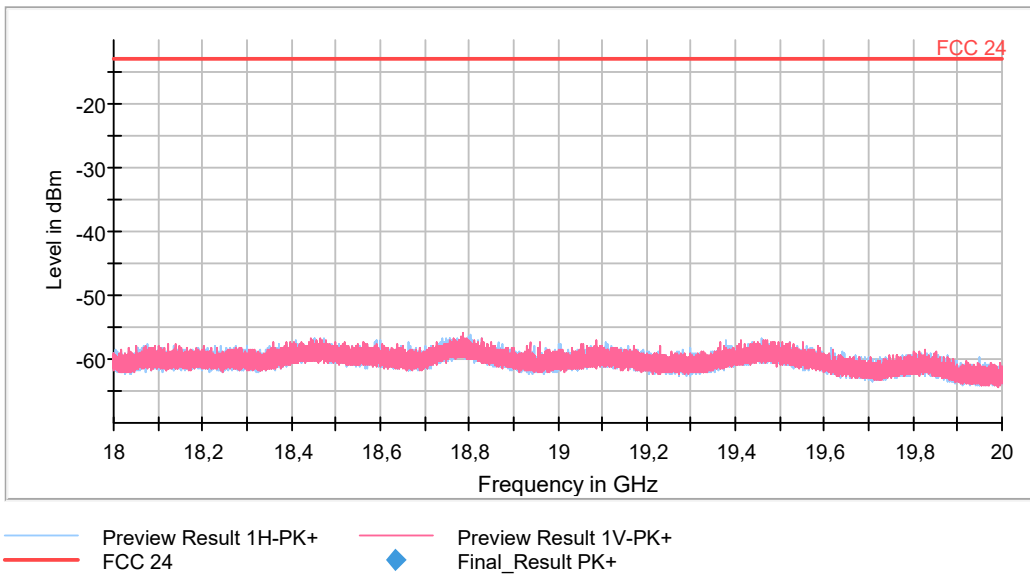
- Low Channel:



- Middle Channel:



- High Channel:



Appendix B: Test results for FCC 24 / RSS-133: LTE Cat NB1 Bands 2, 25

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TEST CONDITIONS

(*): Data provided by the Applicant.

POWER SUPPLY (*):

Vnormal: 5 Vdc.
 Vmin 3
 Vmax 5.5 Vdc
 Type of Power Supply: Internal DC.

ANTENNA (*):

Bands	Gain (dBi)	Type
LTE 2	+3.0	SMD
LTE 25	+3.0	SMD

TEST FREQUENCIES:

LTE Cat NB1 Band 2. Pi/2-BPSK, Pi/4-QPSK, QPSK modulations:

Channel. Number (Frequency, MHz)		
Low	Middle	High
18602 (1850.2)*	18900 (1880)	19198 (1909.8)*
*The outermost channel which is in compliance with Block edge testing.		

NOTE: The LTE Cat NB1 Band 2 is completely included in the LTE Cat NB1 Band 25, so the channels of the LTE Cat NB1 Band 25 were tested to give conformity to the assigned block.

LTE Cat NB1 Band 25. Pi/2-BPSK, Pi/4-QPSK, QPSK modulations:

Channel (Frequency, MHz)		
Low	Middle	High
26042 (1850.2)*	26365 (1882.5)	26688 (1914.8)*
*The outermost channel which is in compliance with Block edge testing.		

RF Output Power

Limits

FCC §2.1046 and FCC §24.232. Mobile/portable stations are limited to 2 Watts (33 dBm) Effective Isotropic Radiated Power (E.I.R.P.).

The peak-to-average ratio (PAR) of the transmission shall not exceed 13 dB.

RSS-133. Clause 6.4. The peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the High PAPR during periods of continuous transmission.

Method

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500. selecting maximum transmission power of the EUT and different modes of modulation.

The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The peak-to-average power ratio (PAPR) is measured using an attenuator, power splitter and spectrum analyser with a Complementary Cumulative Distribution Function implemented.

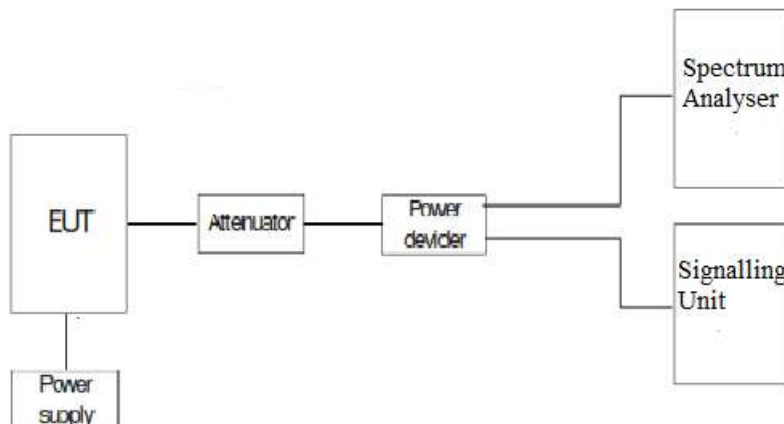
The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

Test Setup

1. CONDUCTED AVERAGE POWER:



2. PEAK-TO-AVERAGE POWER RATIO (PAPR) and Conducted Average power:



Results

1. CONDUCTED AVERAGE POWER

LTE Cat NB1 Band 25:

Worst-case of RF Power is Middle Channel, Pi/4-QPSK, BW=3.75 kHz, Tone Number=1, Tone Offset=0, MSC/TBS=3.

CHANNEL	FREQUENCY (MHz)	MODULATION	BW	Tone Number	Tone Offset (Start SubCarrier)	MCS / TBS	AVERAGE POWER (dBm)
Low 26041	1850.20 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.89
				1	47	0	22.76
			15 kHz	1	0	0	22.81
				1	11	0	22.77
		Pi/4-QPSK	3.75 kHz	1	0	3	22.80
				1	47	3	22.82
			15 kHz	1	0	3	22.76
				1	11	3	22.74
		QPSK	15 kHz	3	0	5	22.59
				3	6	5	22.54
				6	0	5	21.79
				6	6	5	21.70
Middle 26365	1882.50 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.93
				1	47	0	22.94
			15 kHz	1	0	0	22.84
				1	11	0	22.83
		Pi/4-QPSK	3.75 kHz	1	0	3	22.97
				1	47	3	22.83
			15 kHz	1	0	3	22.78
				1	11	3	22.76
		QPSK	15 kHz	3	0	5	22.51
				3	6	5	22.62
				6	0	5	21.82
				6	6	5	21.73
High 26689	1914.9 MHz	Pi/2-BPSK	3.75 kHz	1	0	0	22.83
				1	47	0	22.89
			15 kHz	1	0	0	22.80
				1	11	0	22.87
		Pi/4-QPSK	3.75 kHz	1	0	3	22.82
				1	47	3	22.83
			15 kHz	1	0	3	22.74
				1	11	3	22.70
		QPSK	15 kHz	3	0	5	22.40
				3	6	5	22.54
				6	0	5	21.68
				6	6	5	21.65
				12	0	5	20.61

MAX POWER	COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG (dBm)	RAD. POWER AVG ERP (dBm)
LOWEST	22.89	3.0	25.89	23.74
MIDDLE	22.97	3.0	25.97	23.82
HIGHEST	22.89	3.0	25.89	23.74
MAX:	22.97		25.97	

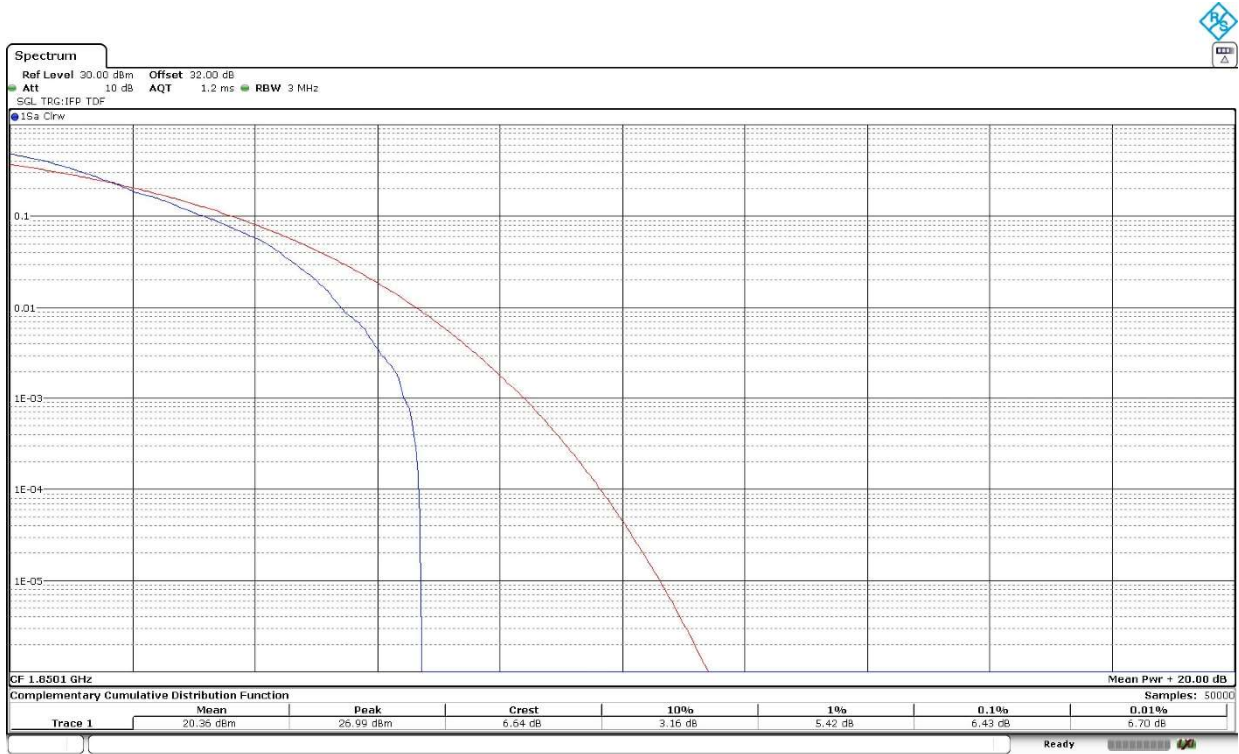
Measurement uncertainty (dB) $<\pm 0.941$

2. PEAK-TO-AVERAGE POWER RATIO (PAPR)

LTE Cat NB1 Band 25:

Worst-case of PAPR is Middle Channel, QPSK, BW=15 kHz, Tone Number=12, Tone Offset=0, MSC/TBS=5.

Low Channel:



Middle Channel:

