Field strength of spurious radiation measurements according to CFR 47 §24.238 and §27.53(h) / RSS-133 6.5, RSS-139 6.6

Date	Temperature	Humidity
2020-02-14	23 °C ± 3 °C	32 % ± 5 %
2020-02-17	23 °C ± 3 °C	30 % ± 5 %
2020-02-18	23 °C ± 3 °C	30 % ± 5 %
2020-02-19	22 °C ± 3 °C	26 % ± 5 %
2020-02-26	22 °C ± 3 °C	21 % ± 5 %

The test site conforms to the site validation criterion specified in ANSI C63.4.

The measurements were performed with both horizontal and vertical polarization of the antenna. The antenna distance and test object height in the different frequency ranges can been seen below.

The antenna distance was 3 m in the frequency range 30 MHz – 18 GHz and 1 m in the frequency range 18 GHz – 26.5 GHz.

The EUT was placed 0.8 m above reference ground plane in frequency range 30 MHz – 1 GHz and 1.5 m above reference ground plane in frequency range 1 GHz – 26.5 GHz.

The measurement was performed with an RBW of 1 MHz.

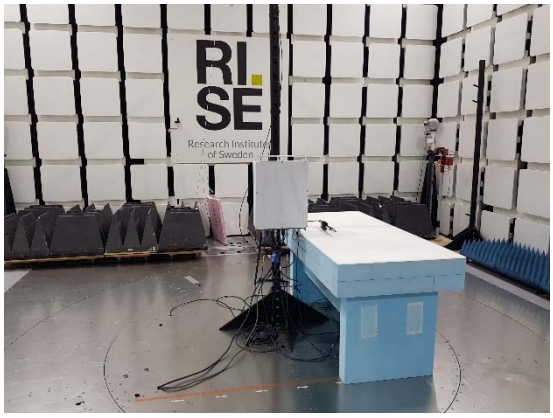
A propagation loss in free space was calculated. The used formula was $\gamma = 20\log\left(\frac{4\pi D}{\lambda}\right)$, γ is the propagation loss and D is the antenna distance.

The measurement procedure was as the following:

1. A pre-measurement is performed with peak detector. For measurement < 1 GHz the test object was measured in eight directions with the antenna at three heights, 1.0 m, 1.5 m and 2.0 m. For measurements > 1 GHz the test object was measured in seventeen directions with the antenna height 1.5 m, 2.0 m and 2.5 m with elevation angle.
2. Spurious radiation on frequencies closer than 20 dB to the limit in the pre-measurement is scanned 0-360 degrees and the antenna is scanned 1- 4 m with elevation angle for maximum response. The emission is then measured with the RMS detector and the RMS value is reported. Frequencies closer than 10 dB to the limit when measured with the RMS detector were measured with the substitution method according to ANSI 63.26.

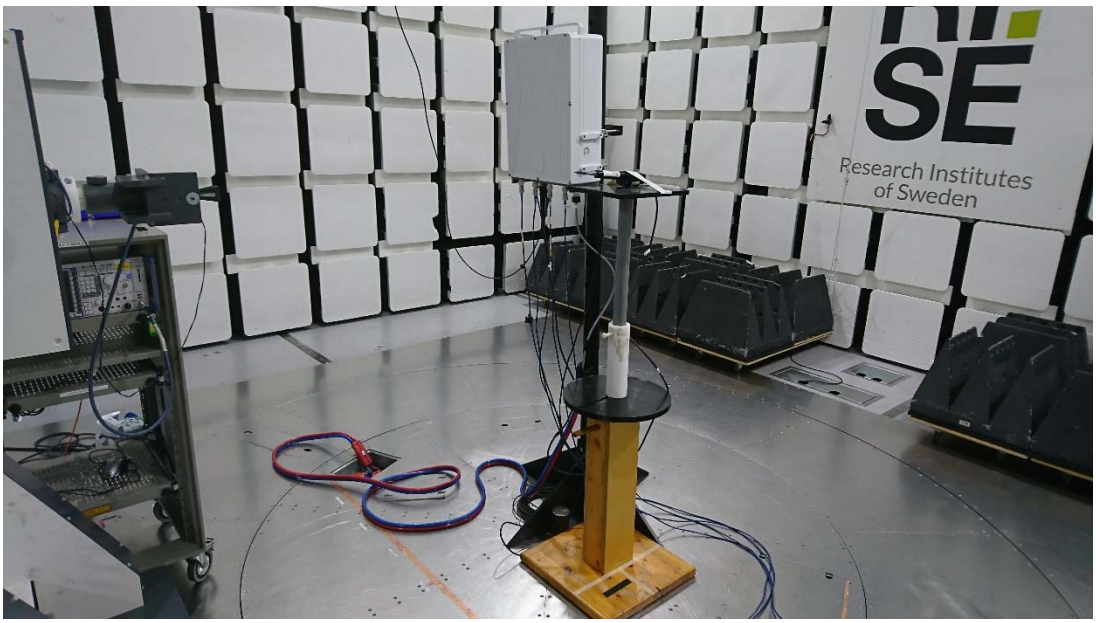
The test set-up during the spurious radiation measurements is shown in the pictures below:

Test setup 30-1000 MHz:



Test setup 1-18 GHz:

Test setup 18-26.5 GHz:



Measurement equipment

Measurement equipment	RISE number
Test site Tesla	503 881
R&S ESU 40	901 385
Control computer with R&S software EMC32 version 10.60.10	BX62351
High pass filter 3-18 GHz	BX40074
Flann Standard Gain Horn 20240-20	BX92412
Teseq BiConiLog Antenna CBL6143A	BX92331
Coaxial cable, Tesla emission	BX91490
Coaxial cable	503 508
Coaxial cable	503 509
EMCO Horn Antenna 3115	502 175
µComp Nordic, Low Noise Amplifier	901 545
Miteq, Low Noise Amplifier	503 278
Temperature and humidity meter, Testo 625	504 188

Results

representing worst case:
Symbolic name T_5, TX top frequency, BW 5 MHz, E-TM3.2

Diagram 1a-d: Band 25 4x 40 W + Band 66 4x 40 W configuration.

Frequency (MHz)	Spurious emission level (dBm)	
	Vertical	Horizontal
30-26500	All emission > 20 dB below limit	All emission > 20 dB below limit

Measurement uncertainty: 3.1 dB

CFR 47 §24.238, §27.53(h) and RSS-133 6.5, RSS-139 6.6

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.

Complies?	Yes

Diagram 1a:

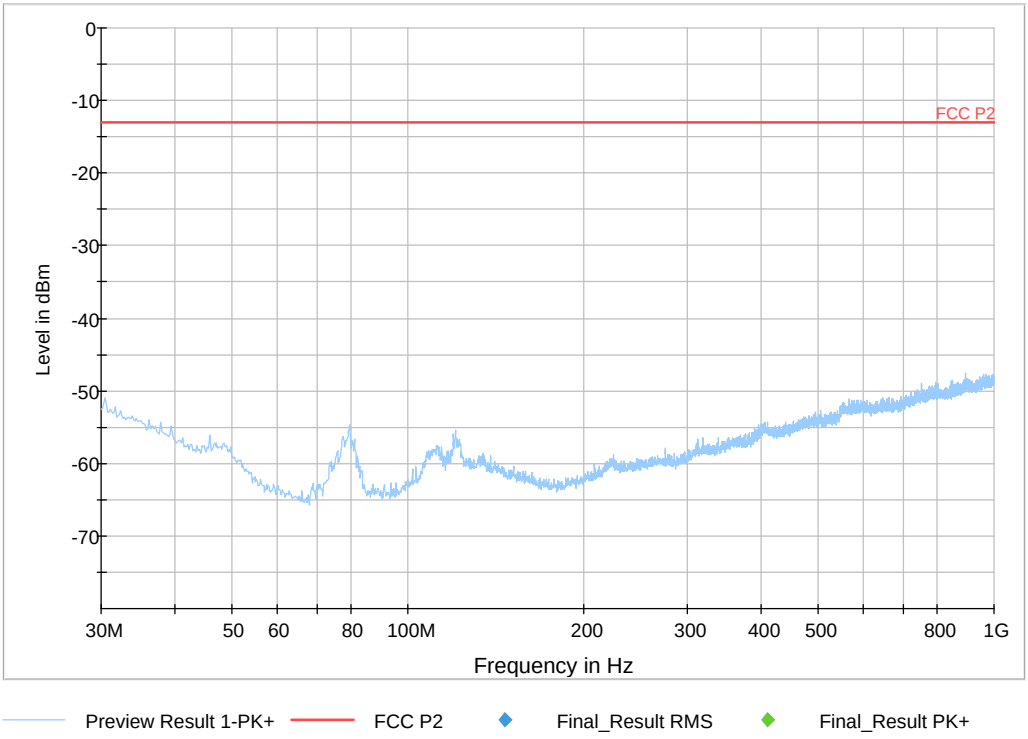
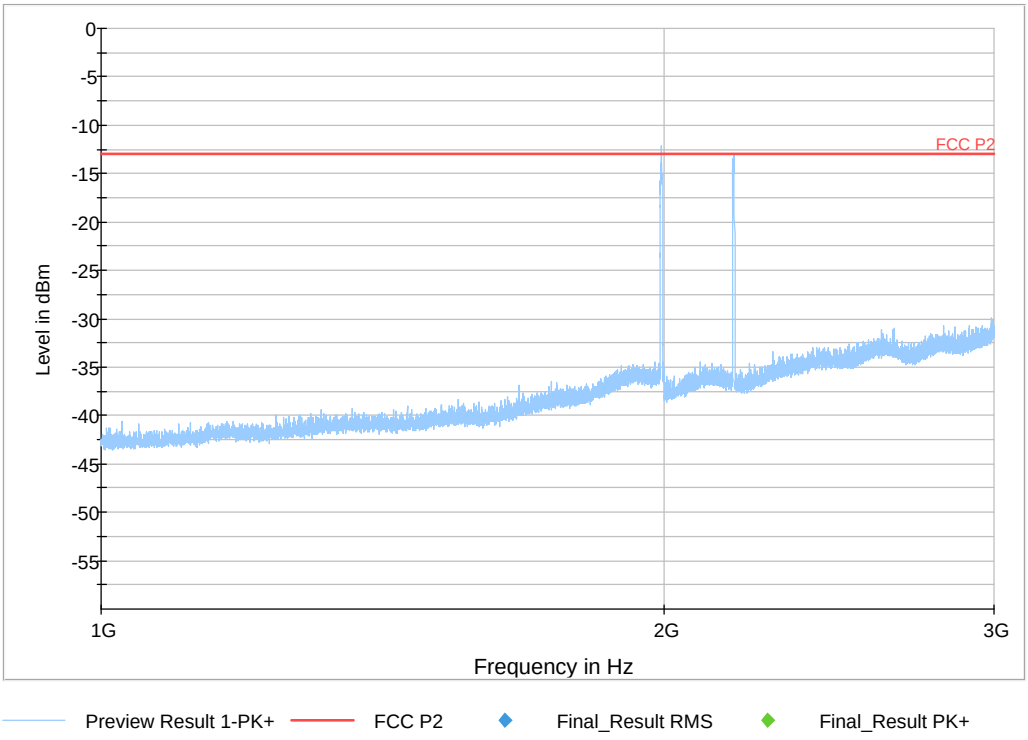


Diagram 1b:



Note: The emissions at 1992.5 MHz and 2177.5 MHz are the carrier frequency and shall be ignored in the context.

Diagram 1c:

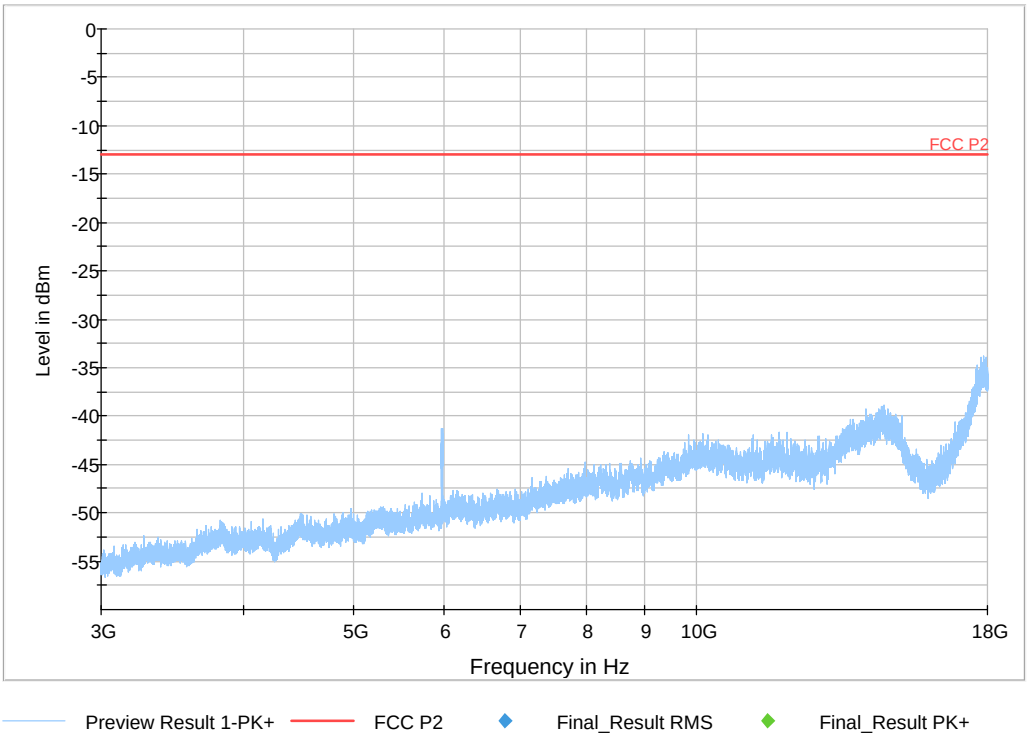
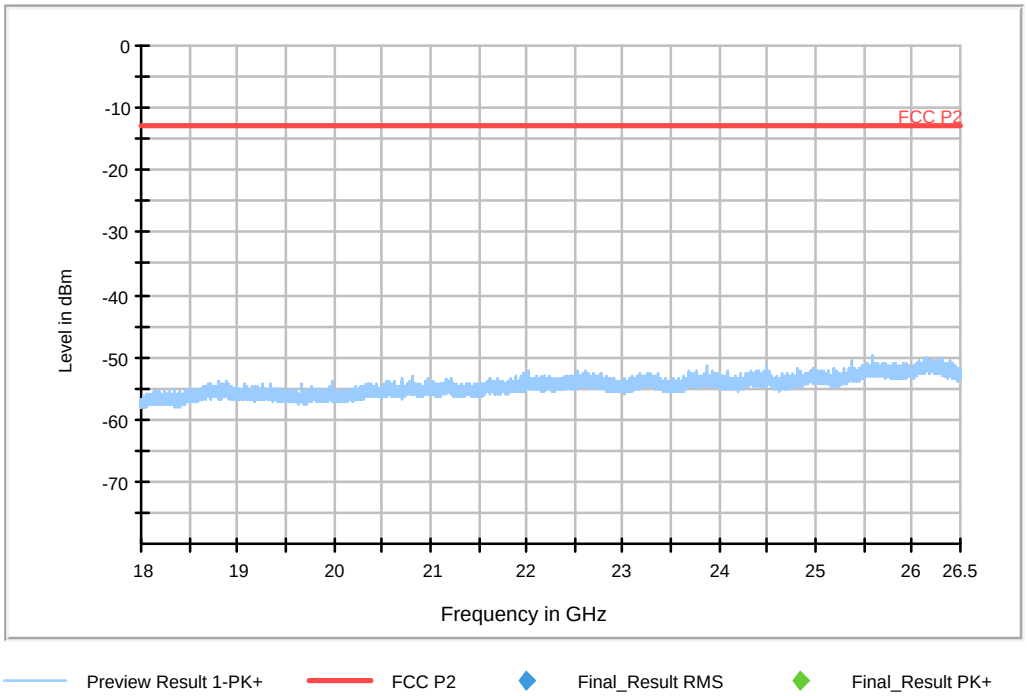


Diagram 1d:



Frequency stability measurements according to CFR 47 §24.235 and §27.54 / RSS-133 6.3 and RSS-139 6.4

Date	Temperature (test equipment)	Humidity (test equipment)
2020-03-16	23 °C ± 3 °C	15 % ± 5 %
2020-03-17	23 °C ± 3 °C	20 % ± 5 %
2020-03-18	23 °C ± 3 °C	18% ± 5 %
2020-03-19	23 °C ± 3 °C	20 % ± 5 %
2020-03-20	23 °C ± 3 °C	22 % ± 5 %

Test set-up and procedure

The measurement was made per 3GPP TS 36.141. The output was connected to a spectrum analyser. The spectrum analyser was connected to an external 10 MHz reference standard during the measurements.

Measurement equipment	RISE number
Rohde & Schwarz signal analyzer FSQ 40	504 143
Directional coupler	901 496
RF attenuator	902 282
Coaxial cable Megaphase	BX50191
Coaxial cable Sucoflex 102EA	BX50237
Temperature Chamber	503 360
Testo 635, temperature and humidity meter	504 203
Multimeter Fluke 87	502 190

Results LTE Frequency error

Nominal transmitter frequency was for B25 1960 MHz (M) with a bandwidth of 5 MHz and rated output power level at connector RF A at 46 dBm.
Nominal transmitter frequency was for B66 2145 MHz (M) with a bandwidth of 5 MHz and rated output power level at connector RF A at 46 dBm.

Test conditions		Frequency error (Hz) B25	Frequency error (Hz) B66
Supply voltage DC (V)	Temp. (°C)		
40.8	+20	6	5
55.2	+20	6	6
48	+20	5	5
48	+30	9	9
48	+40	5	6
48	+50	6	5
48	+10	5	5
48	0	7	5
48	-10	8	6
48	-20	6	5
48	-30	6	7
Maximum freq. error (Hz)		9	9
Measurement uncertainty		$< \pm 1 \times 10^{-7}$	

Results GSM Frequency error

Nominal transmitter frequency was for B2 1960 MHz (M) with a bandwidth of 200 kHz and rated output power level at connector RF A at 43 dBm.

Test conditions		Frequency error (Hz) B2
Supply voltage DC (V)	Temp. (°C)	
40.8	+20	19
55.2	+20	17
48	+20	18
48	+30	14
48	+40	15
48	+50	13
48	+10	14
48	0	13
48	-10	15
48	-20	14
48	-30	15
Maximum freq. error (Hz)		19
Measurement uncertainty		$< \pm 1 \times 10^{-7}$

B25 LTE Frequency margin

Rated output power level at connector RF A (maximum): 43 dBm for 3MHz Carrier Bandwidth and 47.8 dBm for 20 MHz carrier Bandwidth

Test conditions			Frequency margin to band edge at -19 dBm			
Supply voltage DC [V]	Temp [°C].	Carrier Bandwidth [MHz]	Test frequency Symbolic name Bottom		Test frequency Symbolic name Top	
			fL [MHz]	Offset to lower band edge (1930 MHz) [kHz]	fH [MHz]	Offset to upper band edge (1995 MHz) [kHz]
-48.0	+20	3	1930.002	2	1994.997	3
-48.0	+20	20	1930.223	223	1994.779	221

B66 LTE Frequency margin

Rated output power level at connector RF B (maximum): 47.8 dBm

Test conditions			Frequency margin to band edge at -19 dBm			
Supply voltage DC [V]	Temp [°C].	Carrier Bandwidth [MHz]	Test frequency Symbolic name Bottom		Test frequency Symbolic name Top	
			fL [MHz]	Offset to lower band edge (2110 MHz) [kHz]	fH [MHz]	Offset to upper band edge (2180 MHz) [kHz]
-48.0	+20	5	2110.032	32	2179.968	31
-48.0	+20	20	2110.142	142	2179.838	162

B2 GSM Frequency margin

Rated output power level at connector RF A (maximum): 43.0 dBm

Test conditions			Frequency margin to band edge at -13 dBm			
Supply voltage DC [V]	Temp [°C].	Carrier Bandwidth [MHz]	Test frequency Symbolic name Bottom		Test frequency Symbolic name Top	
			fL [MHz]	Offset to lower band edge (1930 MHz) [kHz]	fH [MHz]	Offset to upper band edge (1990 MHz) [kHz]
-48.0	+20	0.4	1930.179	179	1989.820	180

The frequency error results clearly shows that the frequency stability is good enough to ensure that the transmitted carrier stay within the operating band.

Remark

It was deemed sufficient to test one combination of TX frequency, channel bandwidth configuration and test model (modulation), as all combinations share a common internal reference to derive the TX frequency from.

Limits

CFR 47 §24.235 and §27.54 / IC RSS-133 6.3 and IC RSS-139 6.4

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

Complies?	Yes

Photos of test object

Front side

Rear side

Left side

Right side

Bottom side

Top side

Labels:

Radiated measurements:

Test object label:

SFP module Data 1:

SFP module Data 2:

Conducted measurements:

Test object label:

SFP module Data 1:

SFP module Data 2:

End of report.