

**Conducted spurious emission measurements according to CFR 47 §24.238 and §27.53(h)**

Date	Temperature	Humidity
2018-03-27	22 °C ± 3 °C	9 % ± 5 %
2018-04-04	22 °C ± 3 °C	25 % ± 5 %

**Test set-up and procedure**

The measurements were made per definition in ANSI C63.26, 5.7.4. The output was connected to a spectrum analyzer with the RMS detector activated.

Measurement equipment	RISE number
R&S FSW 43	902 073
Directional coupler	901 496
RF attenuator	902 282
HP filter	BX40074
Testo 635, temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

## Results

### Band 2 4x 40 W + Band 66A 4x 60 W configuration:

Before comparing the results to the limit, 6 dB [10 log (4)] to cover 4x4 MIMO, should be added according to ANSI C63.26 6.4.4.1 c “measure and add 10 log( $N_{ANT}$ )”.

#### Single carrier E-TM 1.1

Diagram	Symbolic name	Tested Port
1 a-b	$M_5$	RFA
2 a-b	$M_5$	RF B
3 a-b	$B_5$	RF C
4 a-b	$M_5$	RF C
5 a-b	$M_{10}$	RF C
6 a-b	$M_{15}$	RF C
7 a-b	$M_{20}$	RF C
8 a-b	$T_5$	RF C
9 a-b	$M_5$	RF D

#### Multi carrier E-TM 1.1

Diagram	Symbolic name	Tested Port
10 a-c	Bim	RF C
11 a-c	Tim	RF C

Note: Measurements were mainly limited to port RF C due to the measurement result in single carrier mode that shows that the ports are electrical identical as declared by the client.

### Band 2 2x 60 W + Band 66A 2x 80 W configuration:

Before comparing the results to the limit, 3 dB [10 log (2)] to cover 2x2 MIMO, should be added according to ANSI C63.26 6.4.4.1 c “measure and add 10 log( $N_{ANT}$ )”.

#### Single carrier E-TM 1.1

Diagram	Symbolic name	Tested Port
12 a-b	$B_5$	RF A
13 a-b	$M_5$	RF A
14 a-b	$M_{10}$	RF A
15 a-b	$M_{15}$	RF A
16 a-b	$M_{20}$	RF A
17 a-b	$T_5$	RF A
18 a-b	$M_5$	RF D

#### Multi carrier E-TM 1.1

Diagram	Symbolic name	Tested Port
19 a-c	Bim	RF A
20 a-c	Tim	RF A

Note: Measurements were mainly limited to port RF A due to the measurement result in single carrier mode that shows that the ports are electrical identical as declared by the client.

**Band 2 4x 40 W + Band 66A 4x 60 W configuration:**

Before comparing the results to the limit, 6 dB [10 log (4)] to cover 4x4 MIMO, should be added according to ANSI C63.26 6.4.4.1 c “measure and add 10 log( $N_{ANT}$ )”.

**Single carrier E-TM 1.1**

Diagram	Symbolic name	Tested Port
21 a-b	$M_5$	RF E
22 a-b	$B_5$	RF F
23 a-b	$M_5$	RF F
24 a-b	$M_{10}$	RF F
25 a-b	$M_{15}$	RF F
26 a-b	$M_{20}$	RF F
27 a-b	$T_5$	RF F
28 a-b	$M_5$	RF G
29 a-b	$M_5$	RF H

**Multi carrier E-TM 1.1**

Diagram	Symbolic name	Tested Port
30 a-c	$B_{im}$	RF F
31 a-c	$T_{im}$	RF F

Note: Measurements were mainly limited to port RF F due to the measurement result in single carrier mode that shows that the ports are electrical identical as declared by the client.

**Band 2 2x 60 W + Band 66A 2x 80 W configuration:**

Before comparing the results to the limit, 3 dB [10 log (2)] to cover 2x2 MIMO, should be added according to ANSI C63.26 6.4.4.1 c “measure and add 10 log( $N_{ANT}$ )”.

**Single carrier E-TM 1.1**

Diagram	Symbolic name	Tested Port
32 a-b	$B_5$	RF E
33 a-b	$M_5$	RF E
34 a-b	$M_{10}$	RF E
35 a-b	$M_{15}$	RF E
36 a-b	$M_{20}$	RF E
37 a-b	$T_5$	RF E
38 a-b	$M_5$	RF H

**Multi carrier E-TM 1.1**

Diagram	Symbolic name	Tested Port
39 a-c	$B_{im}$	RF E
40 a-c	$T_{im}$	RF E

Note: Measurements were mainly limited to port RF E due to the measurement result in single carrier mode that shows that the ports are electrical identical as declared by the client.

**Remark**

The emission at 9 kHz on the plots was not generated by the test object. A complementary measurement with a smaller RBW showed that it was related to the LO feed-through.

The highest fundamental frequency is 2180 MHz. The measurements were made up to 22 GHz (10x2180 MHz = 21.80 GHz).

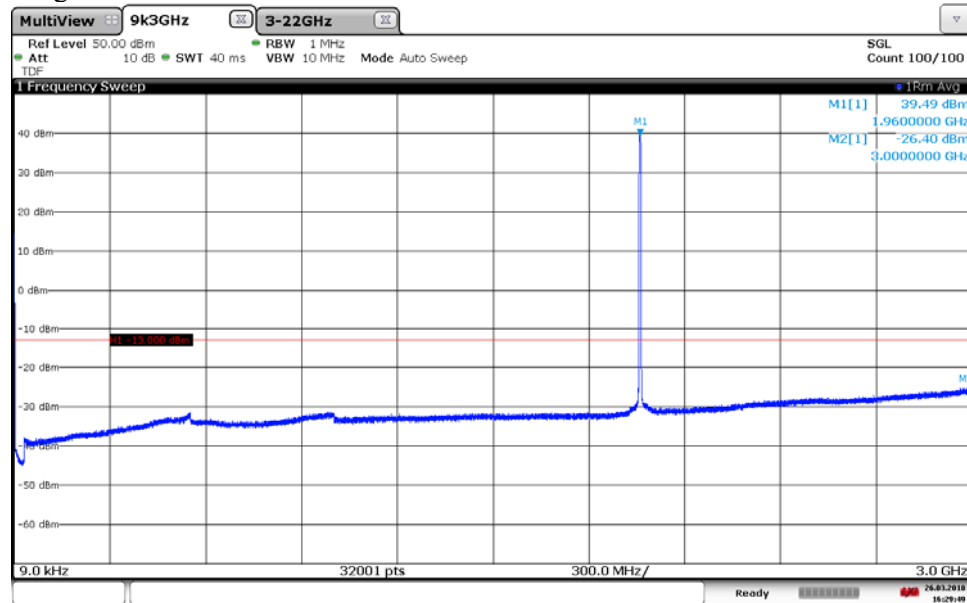
**Limits**

CFR 47 §24.238 and §27.53(h)

Outside a licensee's frequency band(s) of operation the power of any emission shall be attenuated below the transmitter power (P) by at least  $43 + 10 \log (P)$  dB, resulting in a limit of -13 dBm per 1 MHz RBW.

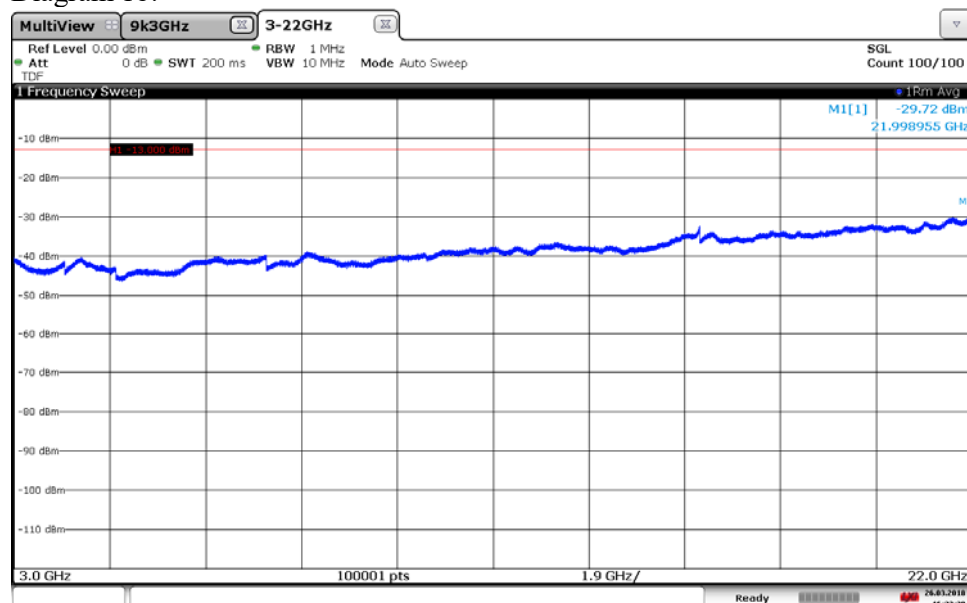
Complies?	Yes
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Diagram 1a:



16:29:50 26.03.2018

Diagram 1b:



16:33:20 26.03.2018

Diagram 2a:

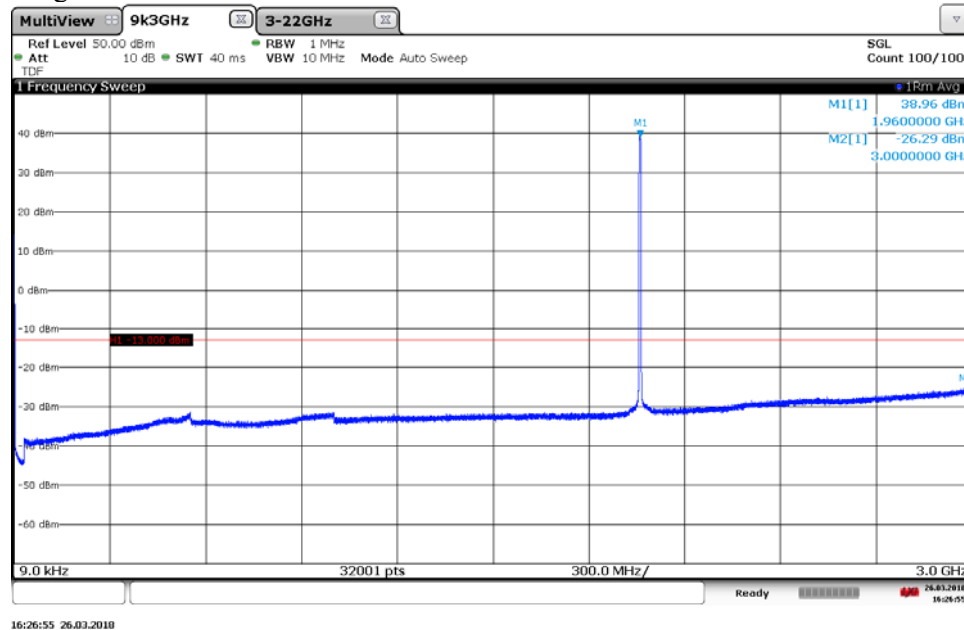


Diagram 2b:

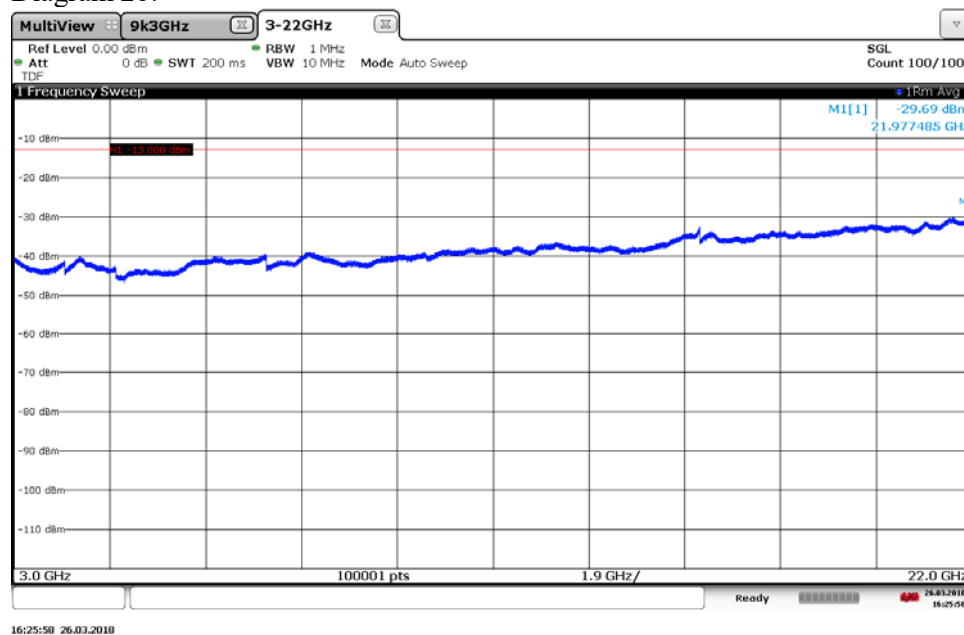


Diagram 3a:

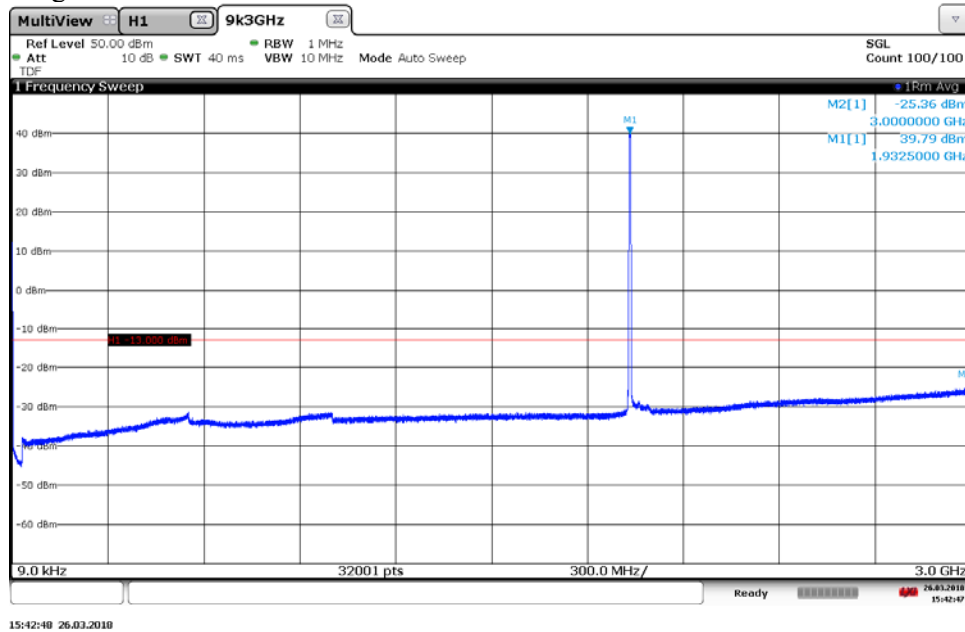


Diagram 3b:

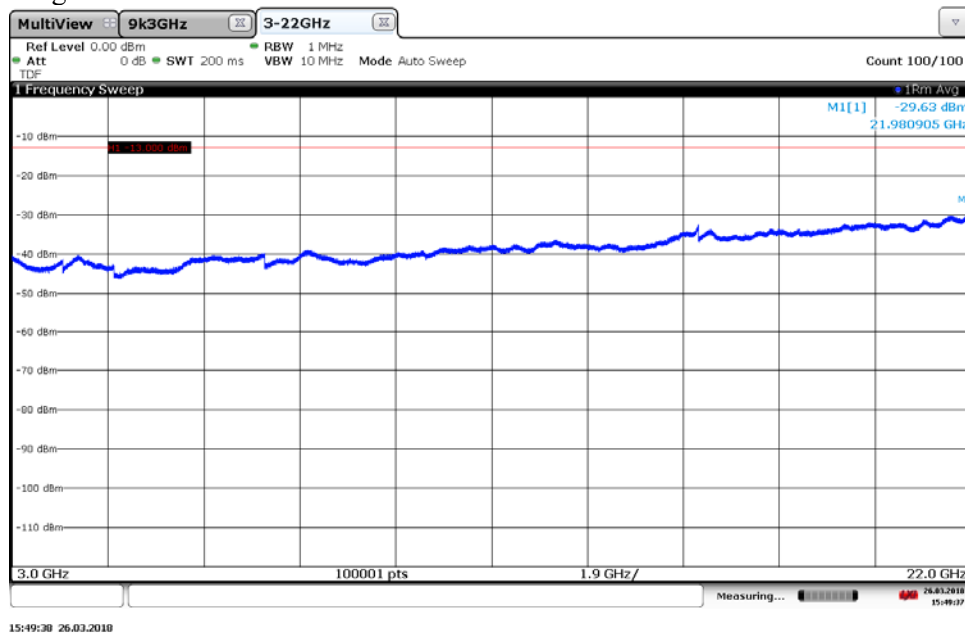


Diagram 4a:

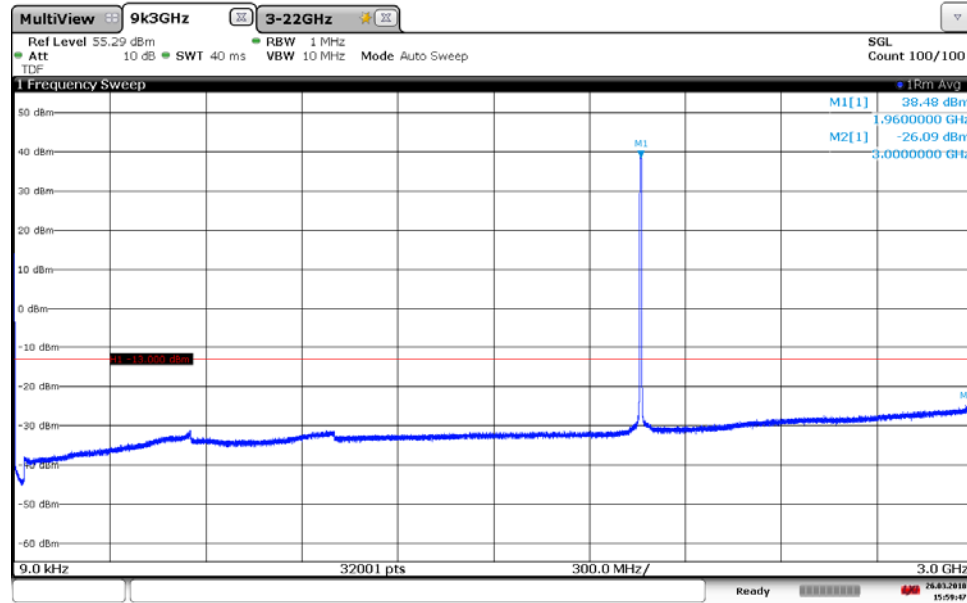


Diagram 4b:

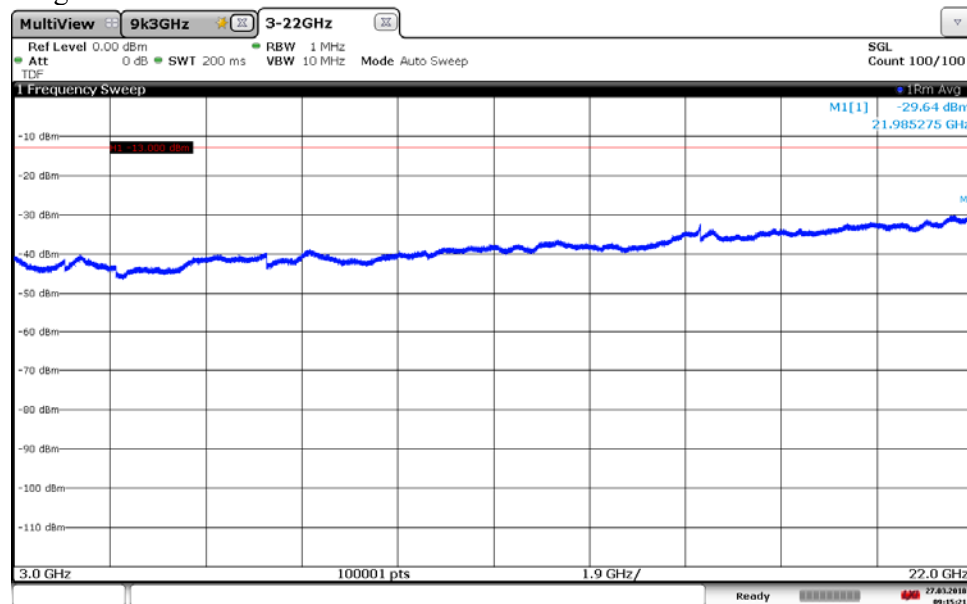




Diagram 5a:

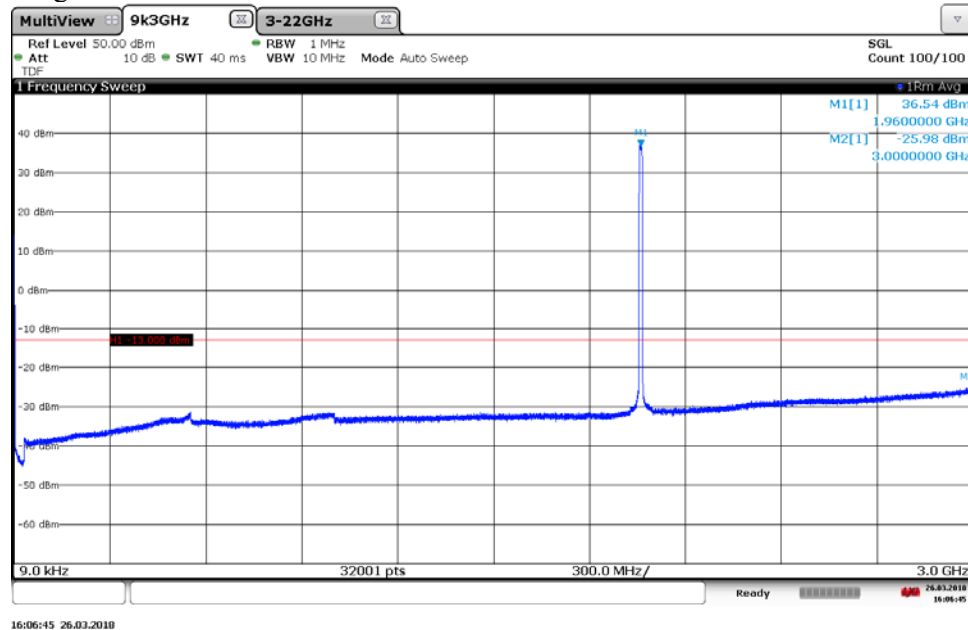


Diagram 5b:

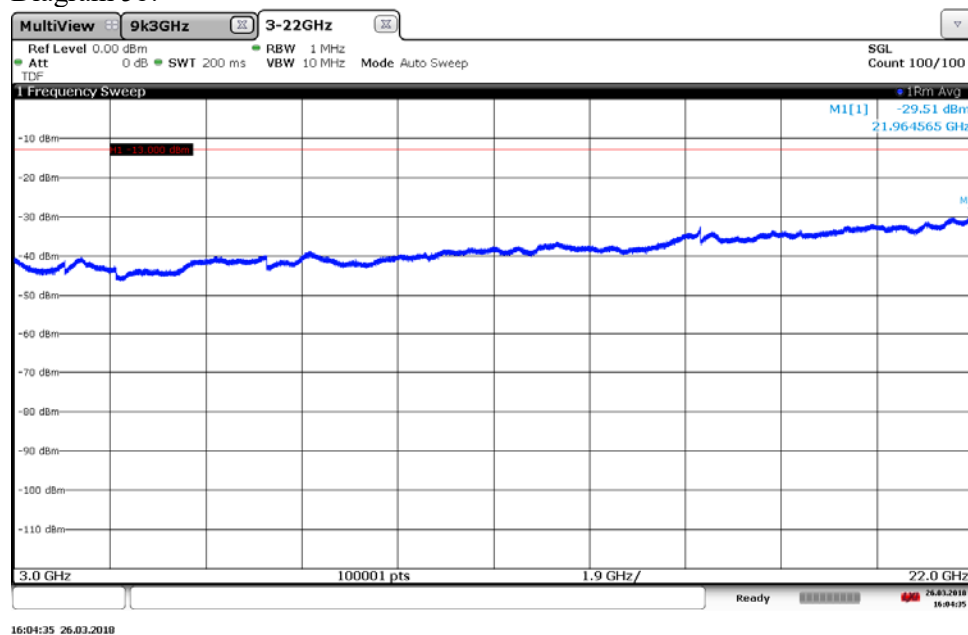


Diagram 6a:

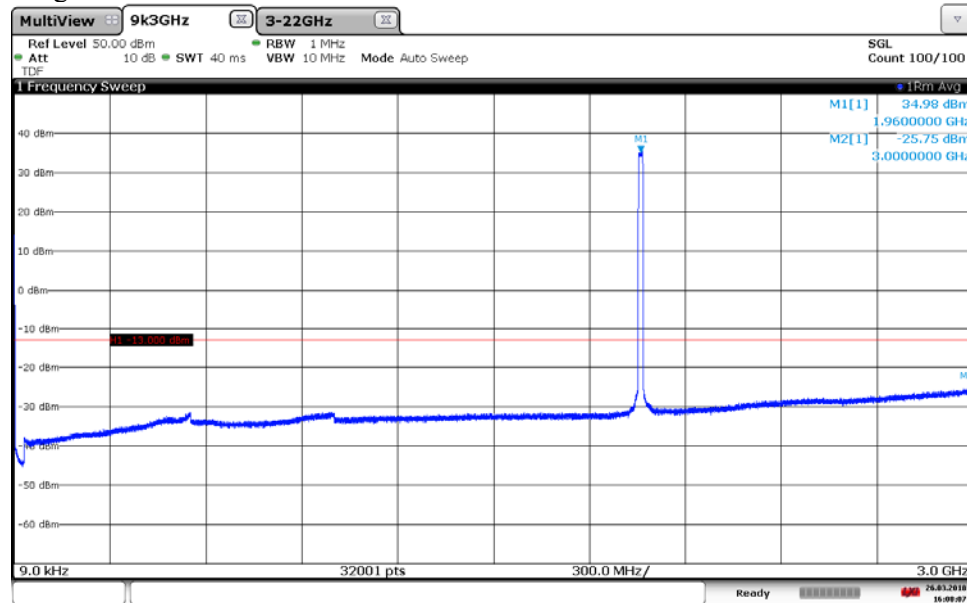


Diagram 6b:

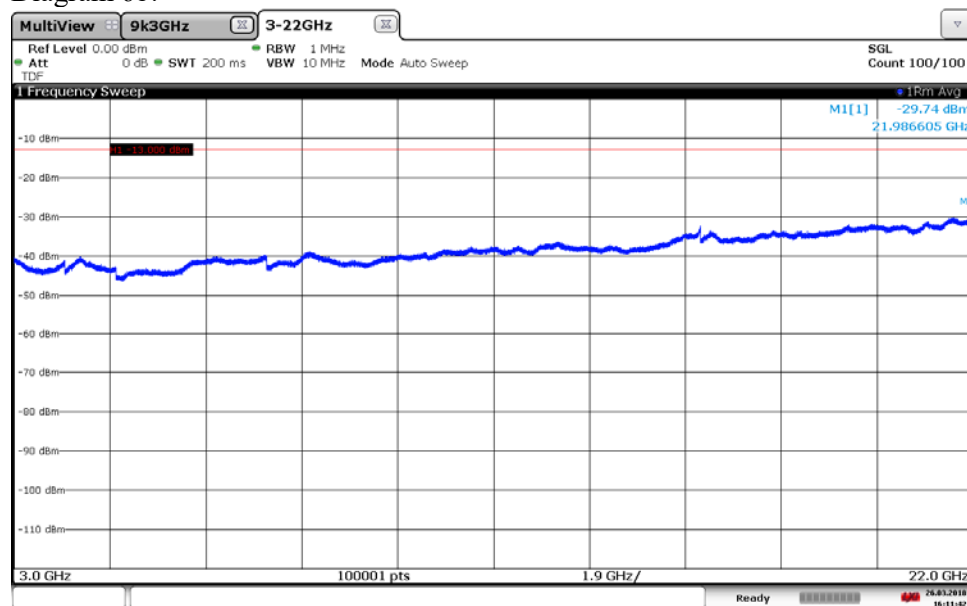
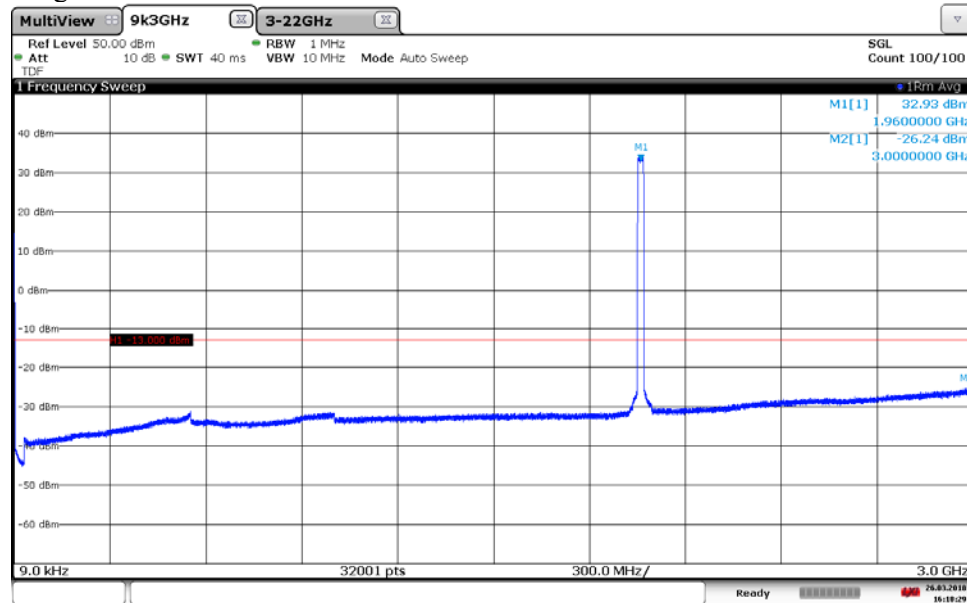
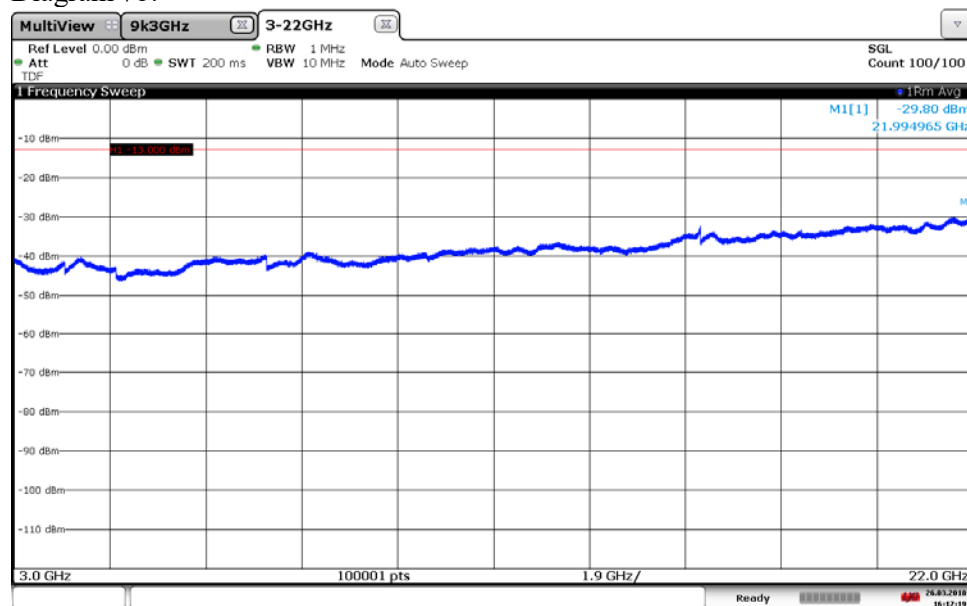


Diagram 7a:



16:18:29 26.03.2018

Diagram 7b:



16:17:19 26.03.2018

Diagram 8a:

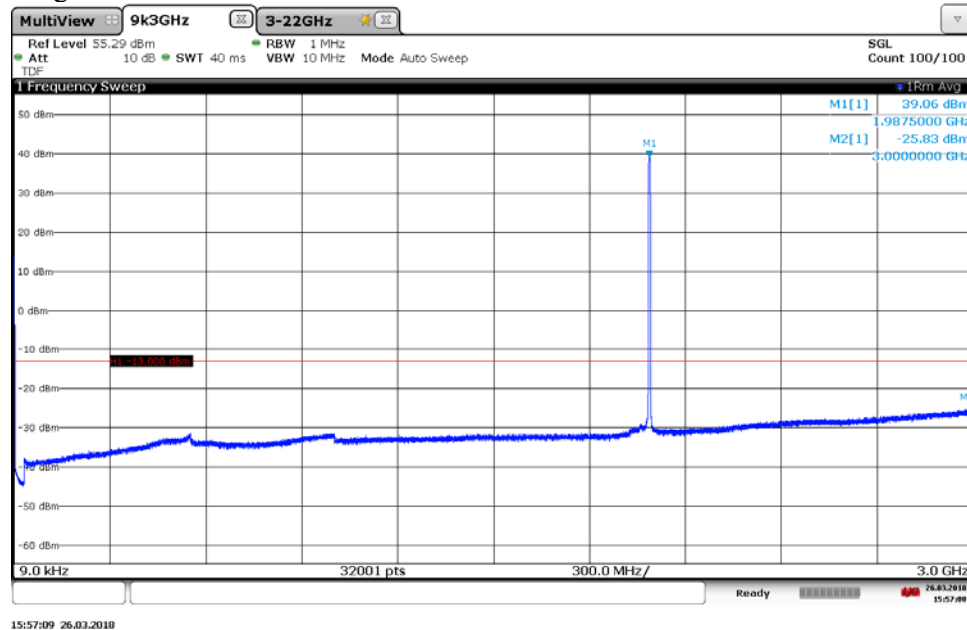


Diagram 8b:

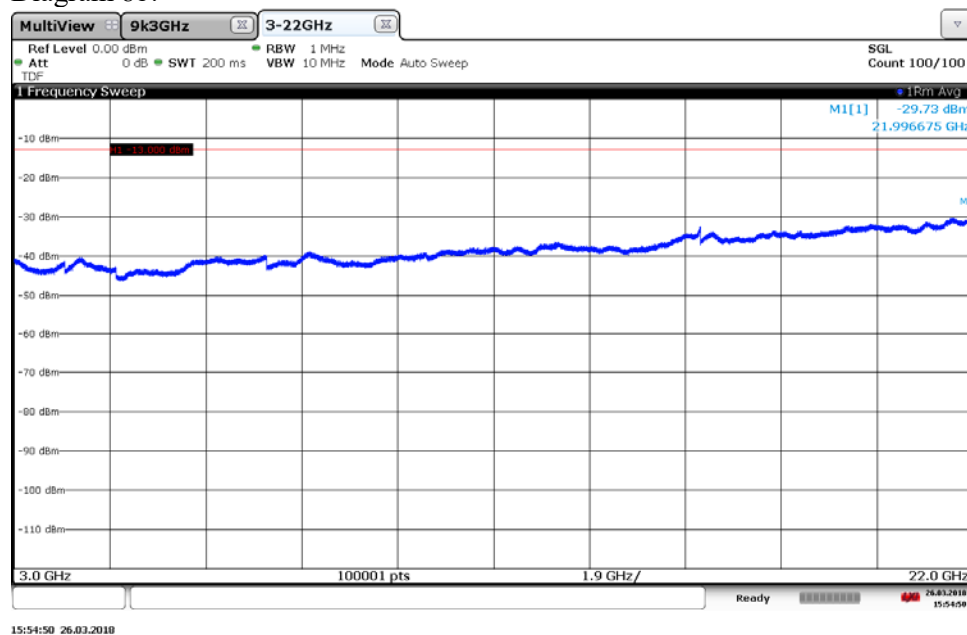
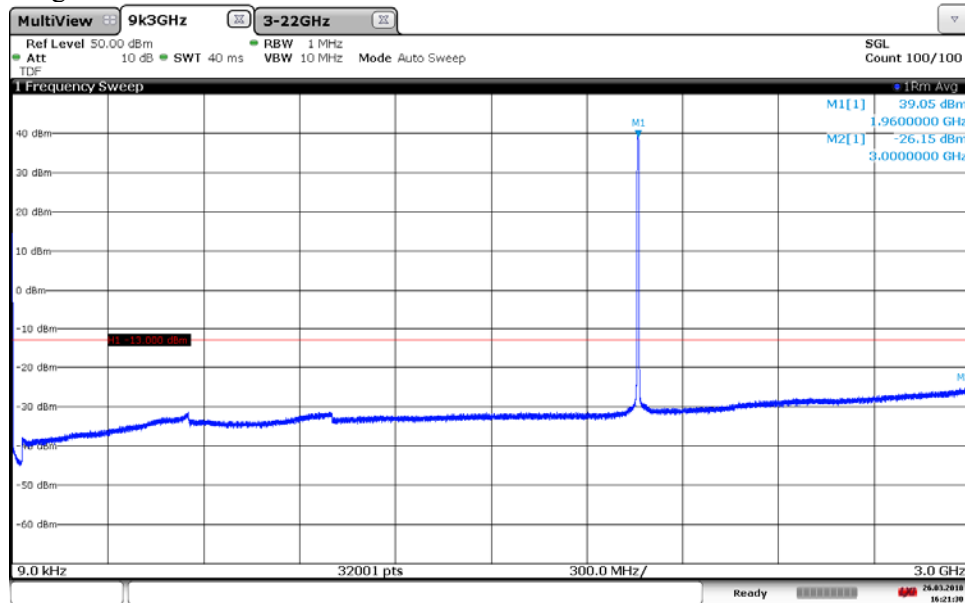
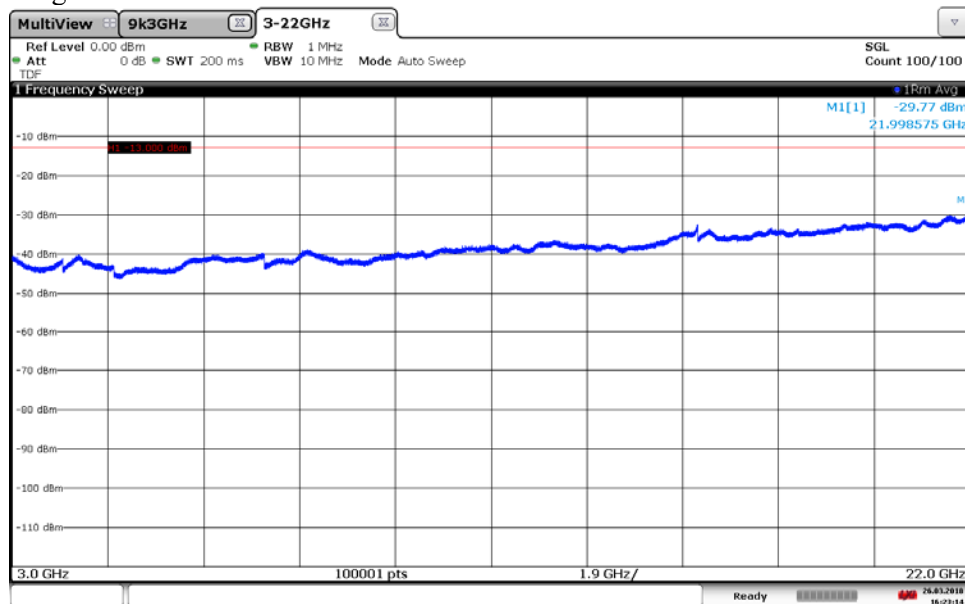


Diagram 9a:



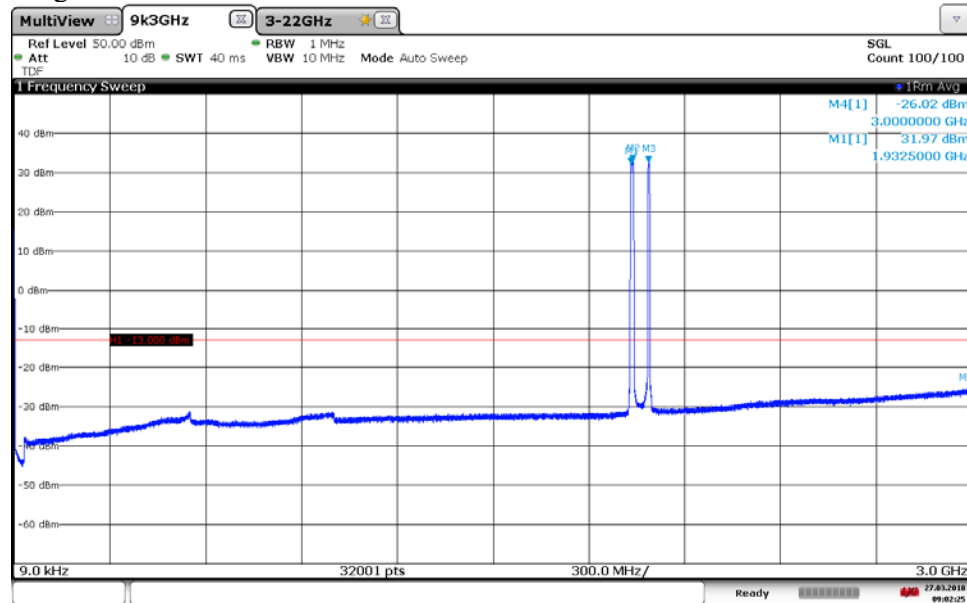
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Diagram 9b:



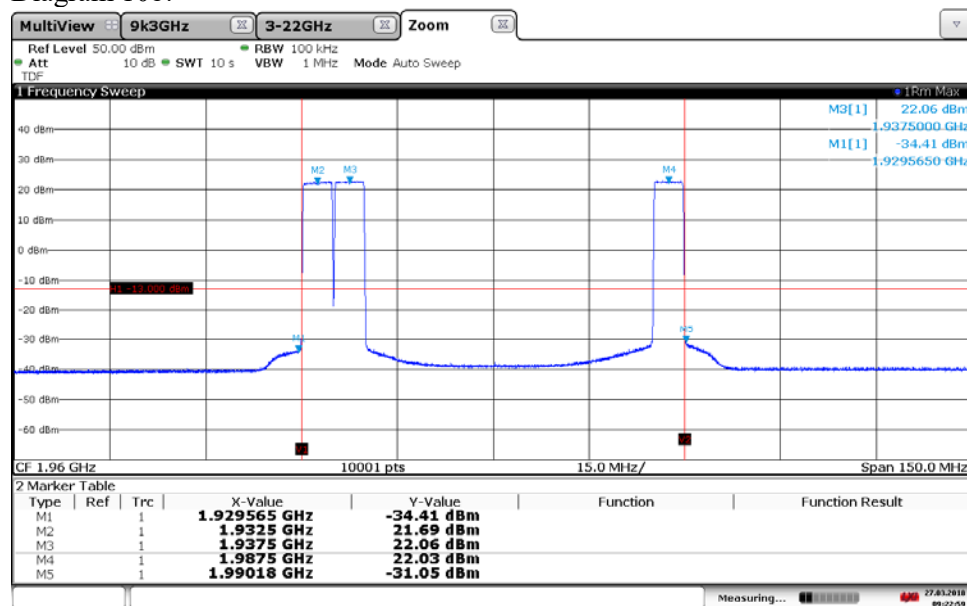
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Diagram 10a:



09:02:25 27.03.2018

Diagram 10b:



09:23:00 27.03.2018

Diagram 10c:

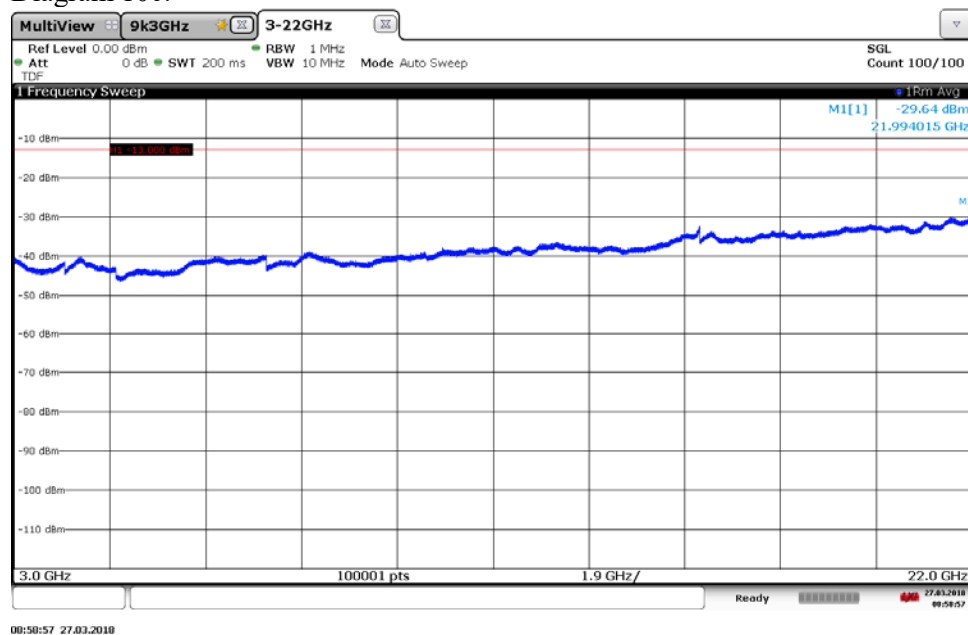
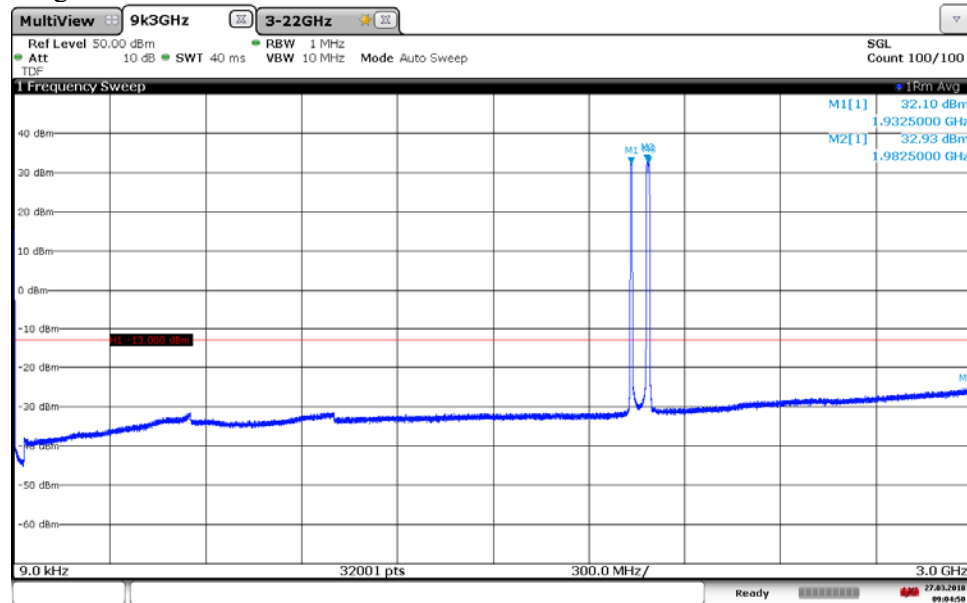
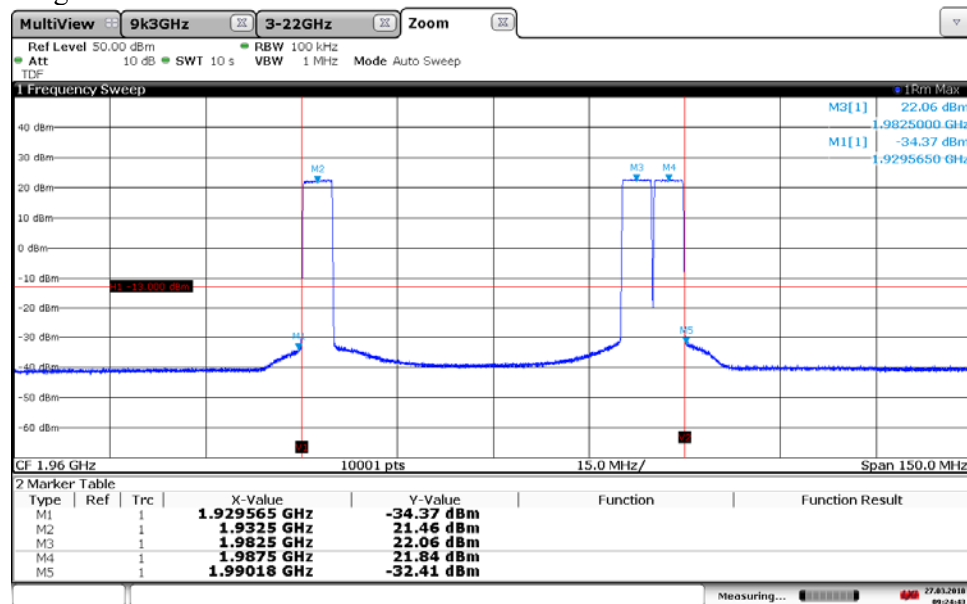


Diagram 11a:



09:04:51 27.03.2018

Diagram 11b:



09:24:44 27.03.2018



Diagram 11c:

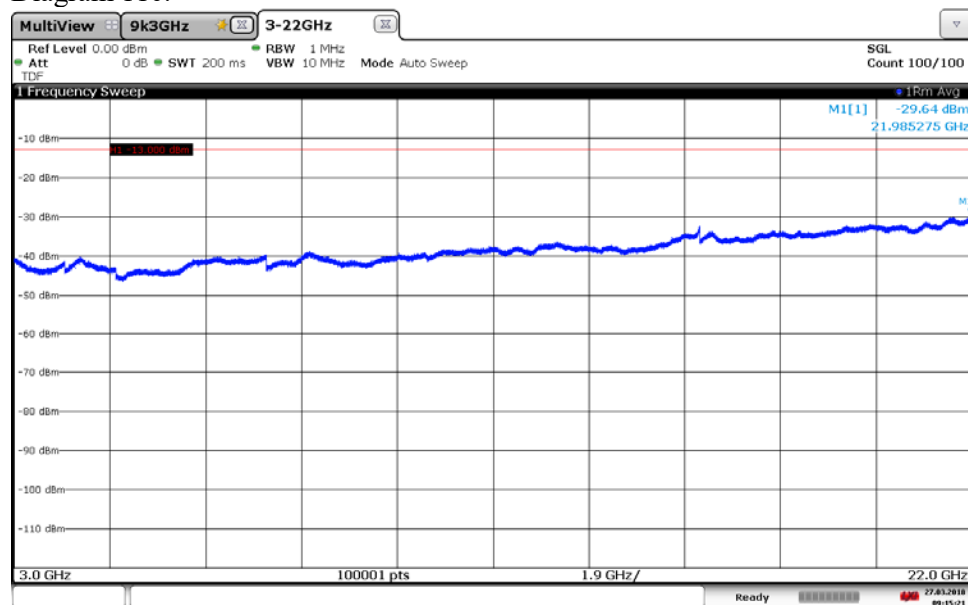
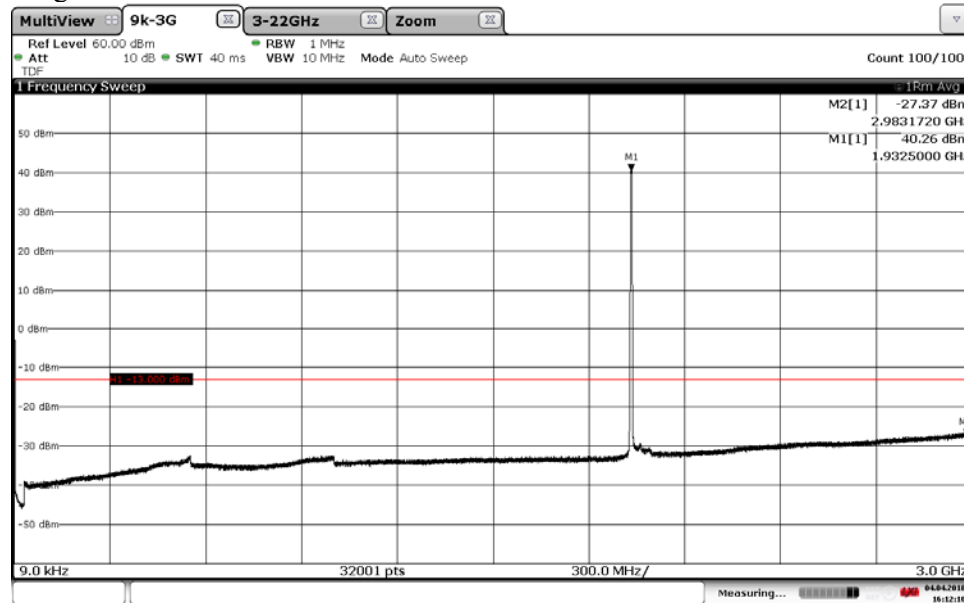
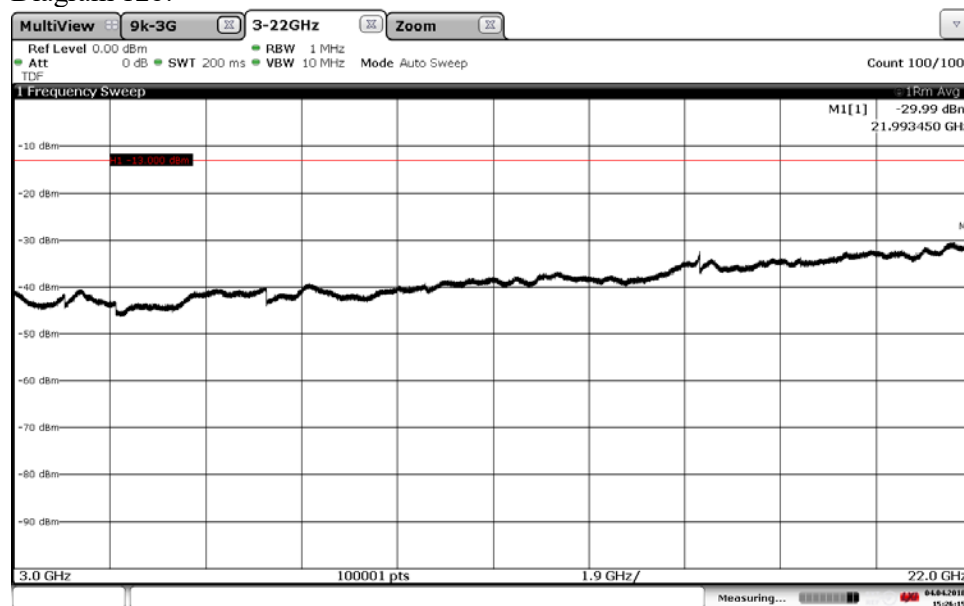


Diagram 12a:



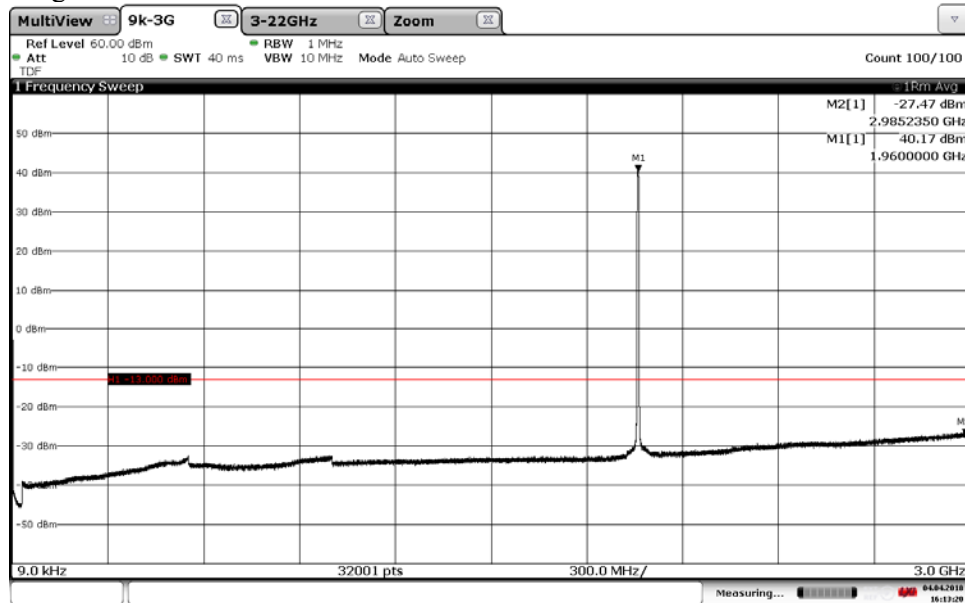
16:12:11 04.04.2018

Diagram 12b:



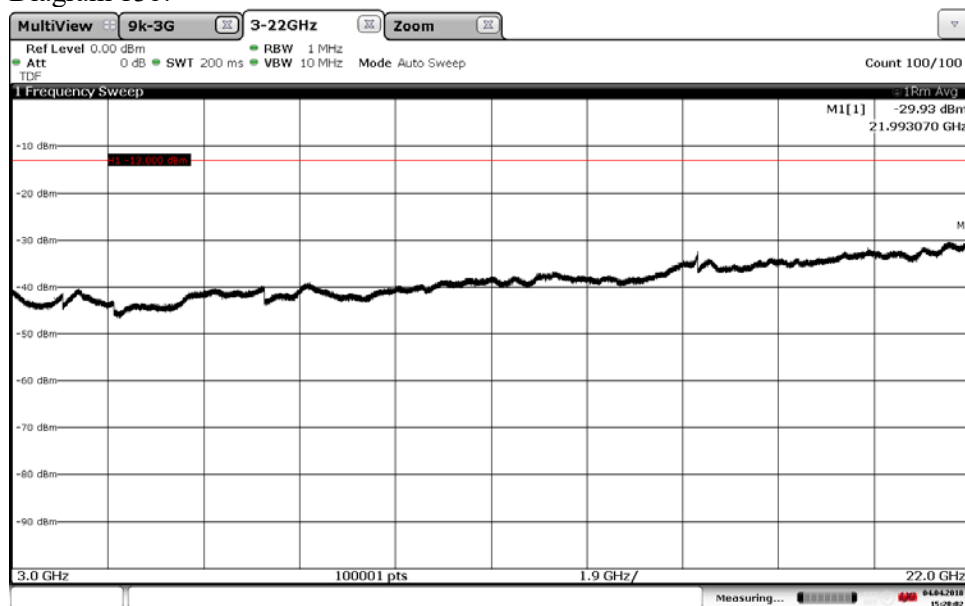
15:26:15 04.04.2018

Diagram 13a:



16:13:21 04.04.2018

Diagram 13b:



15:20:02 04.04.2018

Diagram 14a:

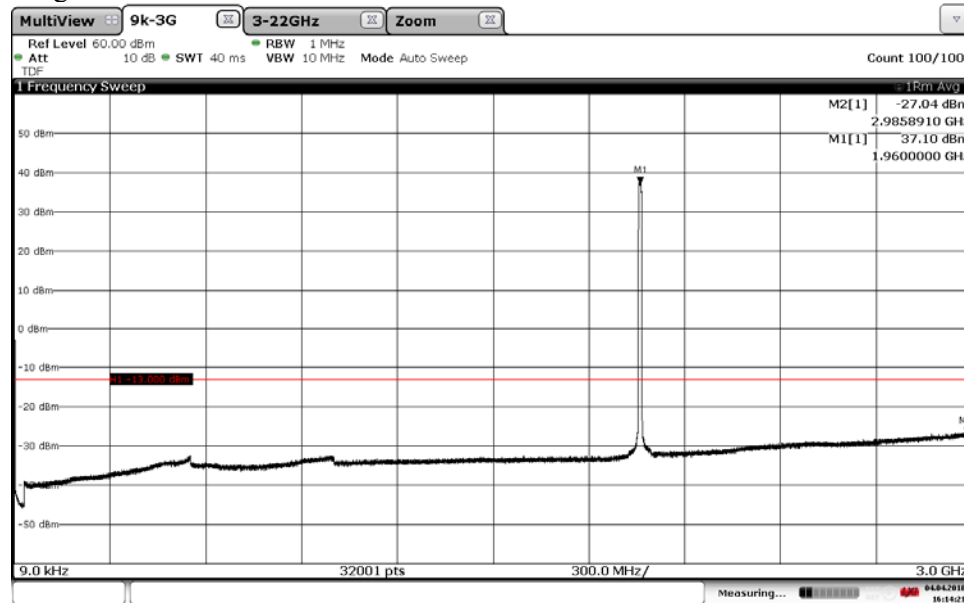


Diagram 14b:

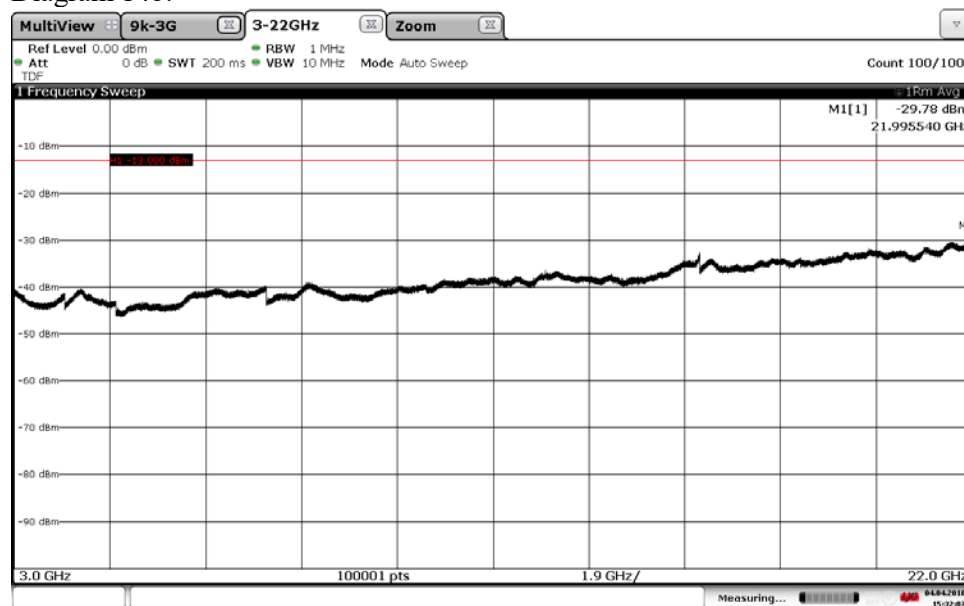
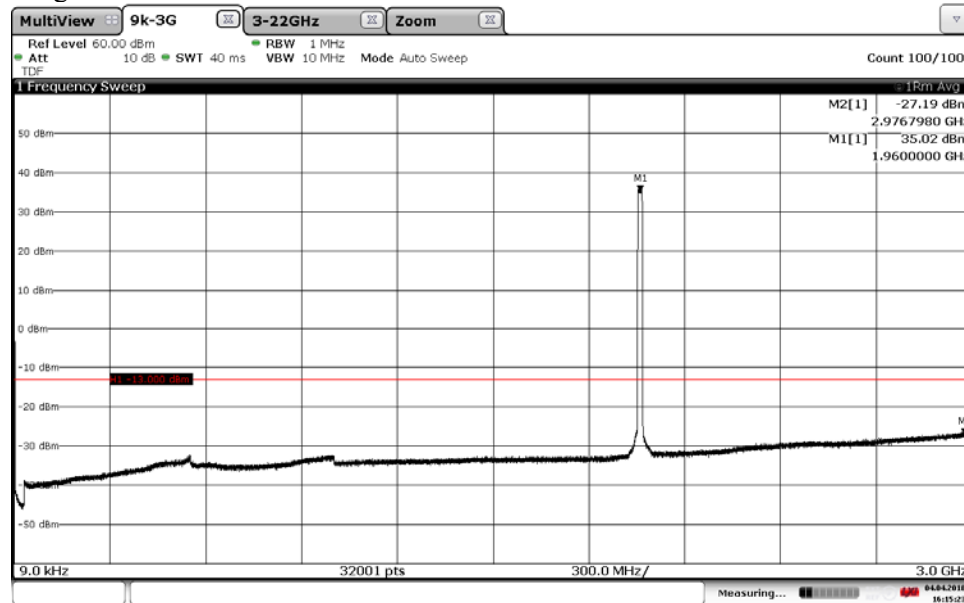
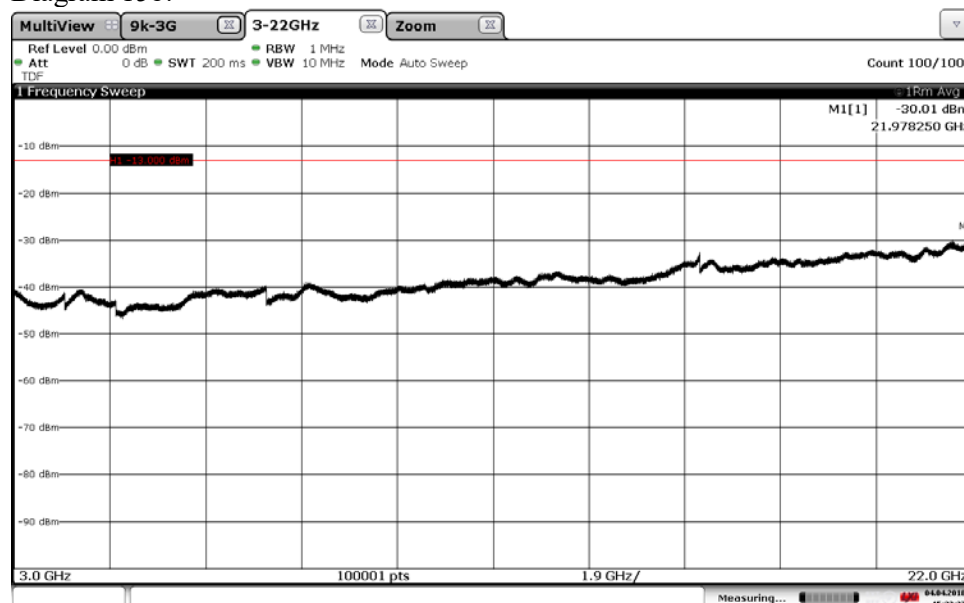


Diagram 15a:



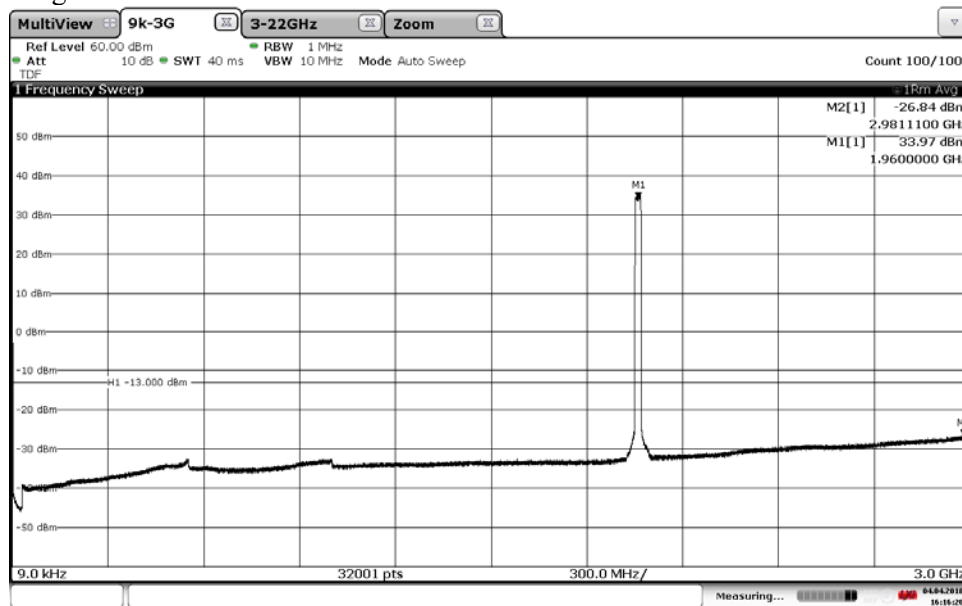
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Diagram 15b:



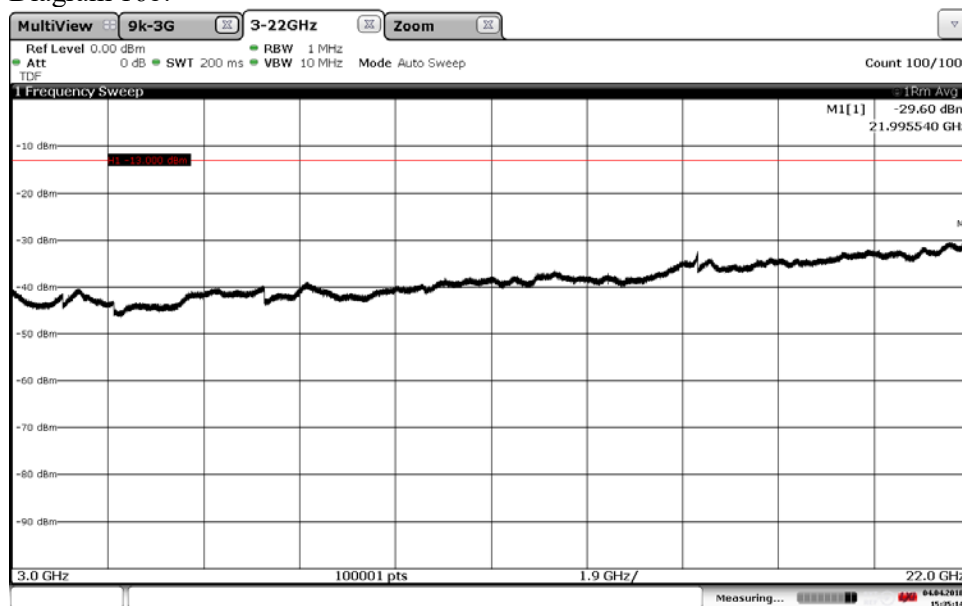
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Diagram 16a:



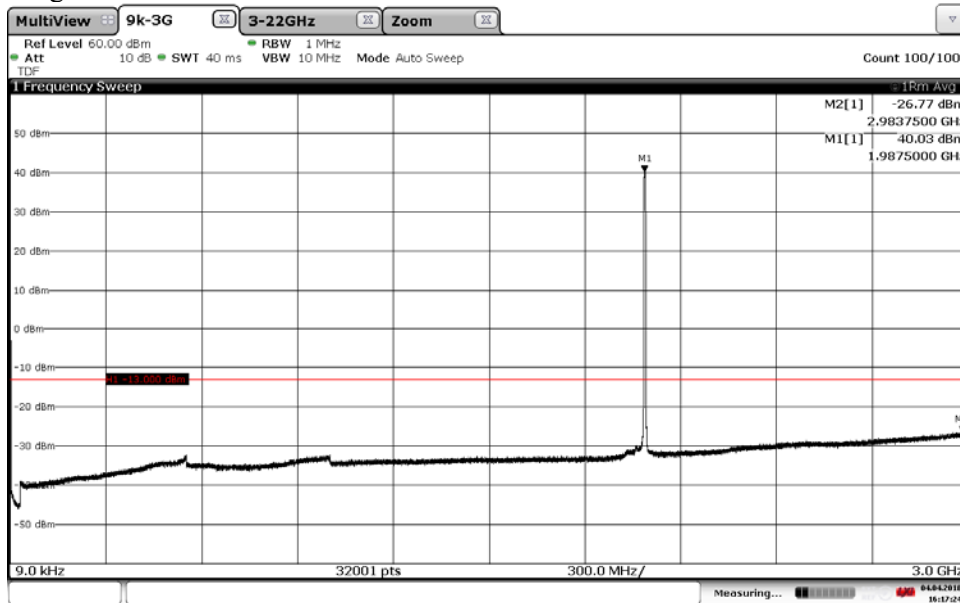
16:16:20 04.04.2018

Diagram 16b:



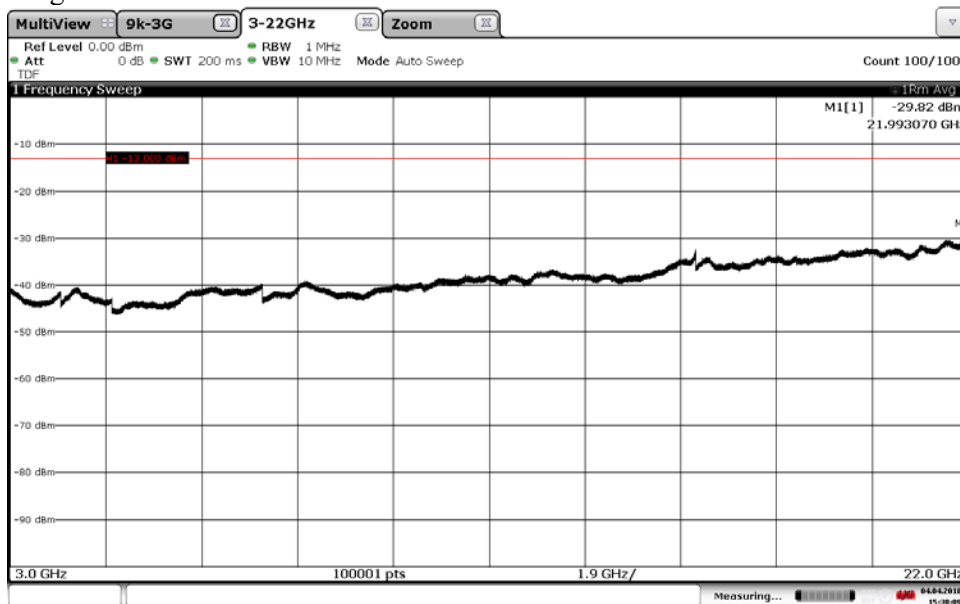
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Diagram 17a:



16:17:24 04.04.2018

Diagram 17b:



15:30:10 04.04.2018

Diagram 18a:

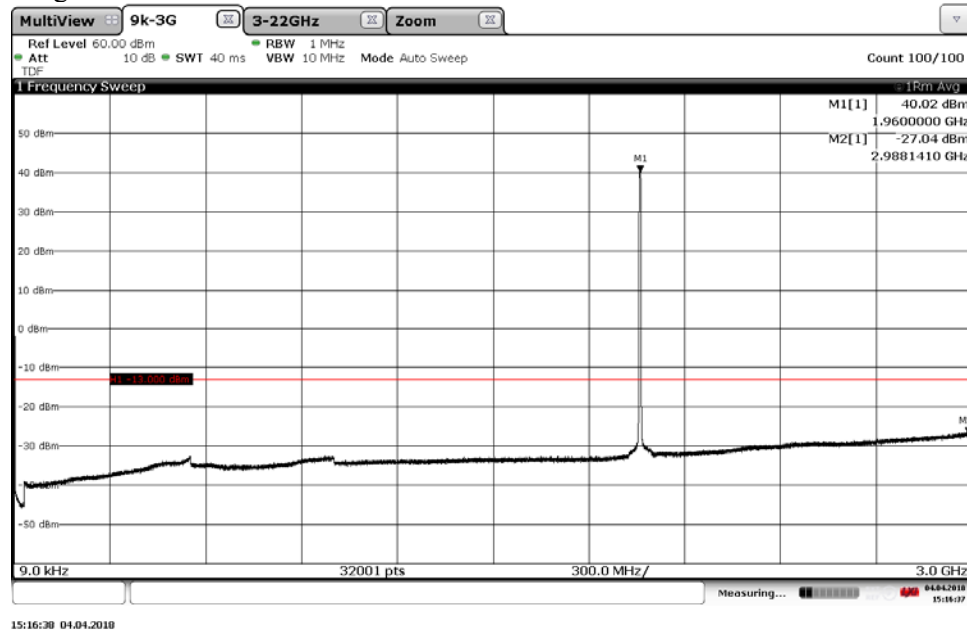


Diagram 18b:

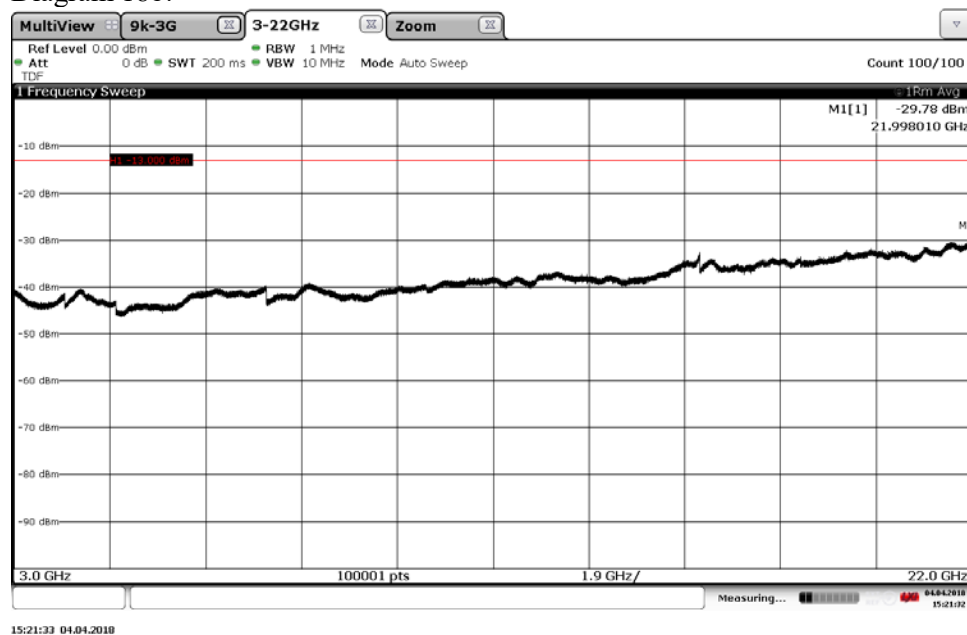
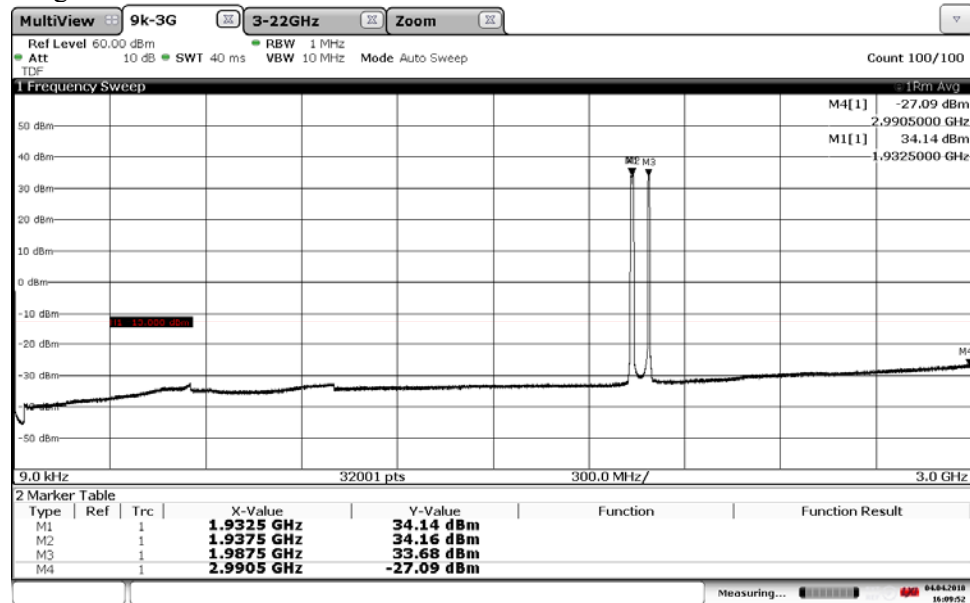


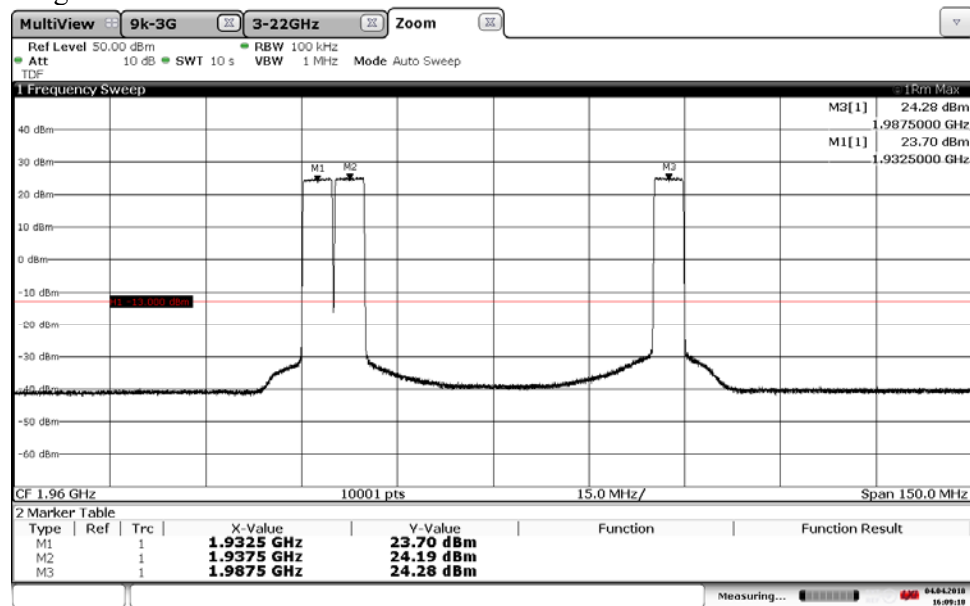


Diagram 19a:



16:09:53 04.04.2018

Diagram 19b:



16:09:19 04.04.2018

Diagram 19c:

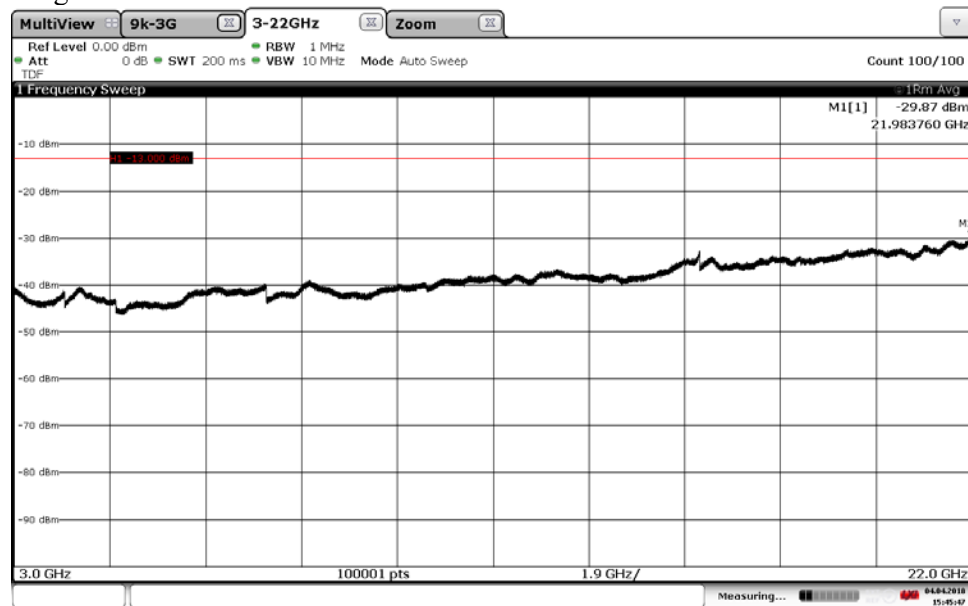


Diagram 20a:

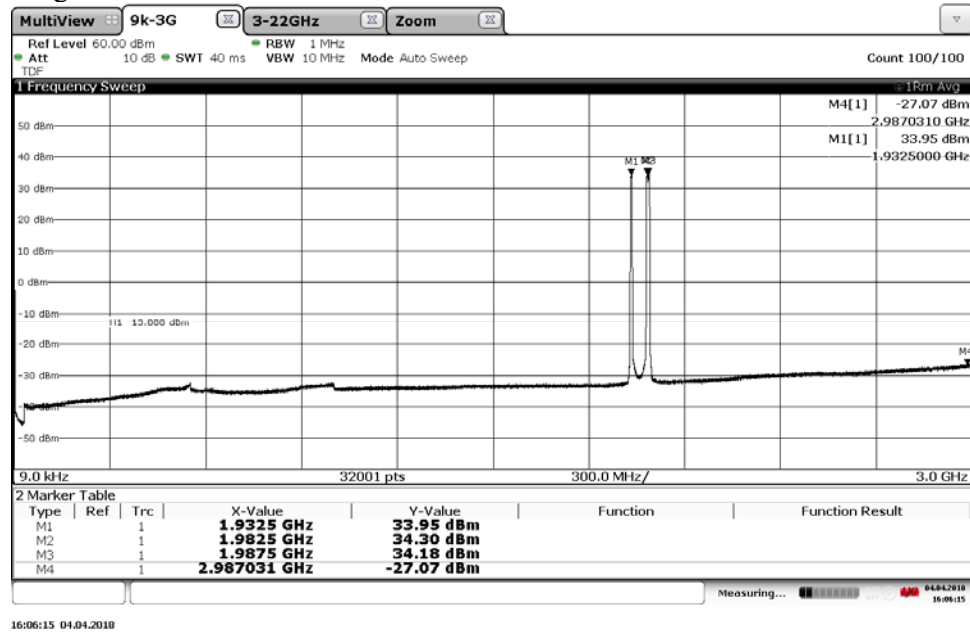


Diagram 20b:

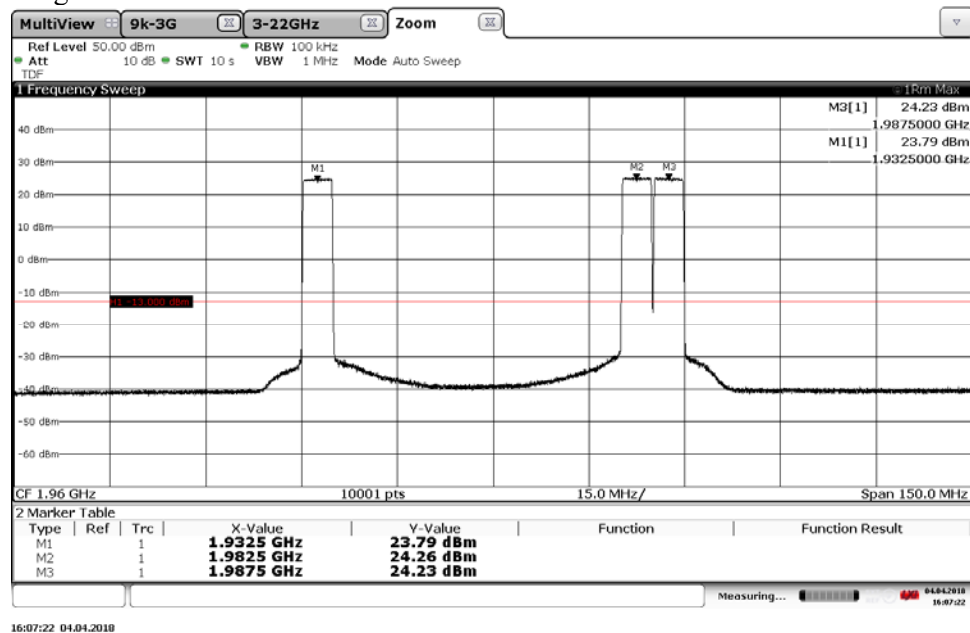
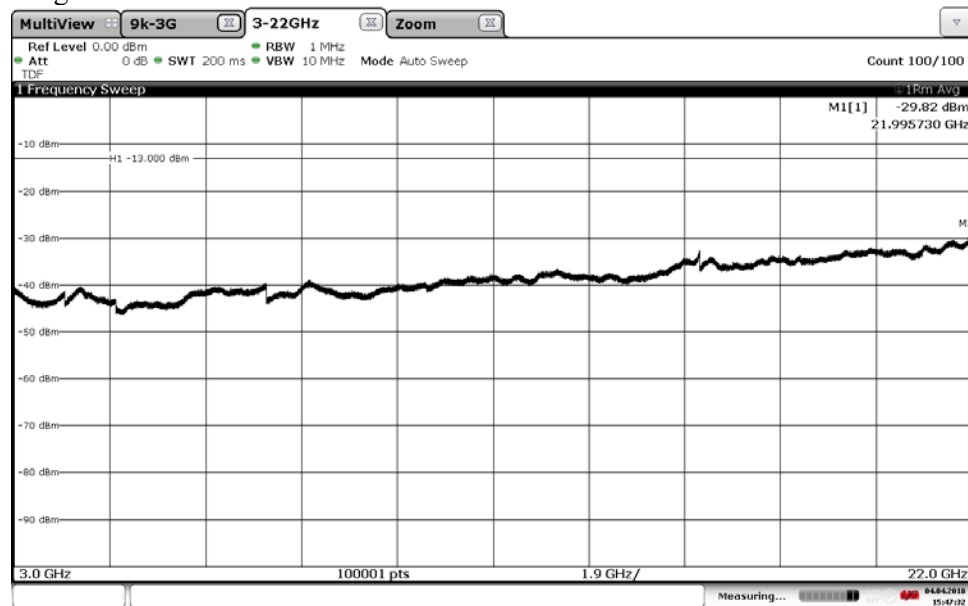


Diagram 20c:



15:47:32 04.04.2018

Diagram 21a:

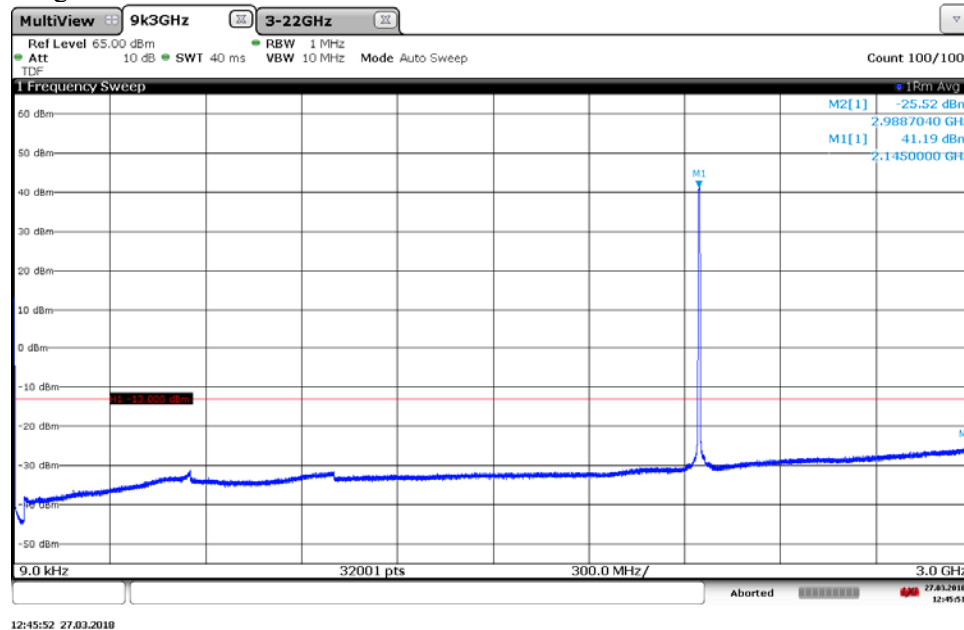


Diagram 21b:

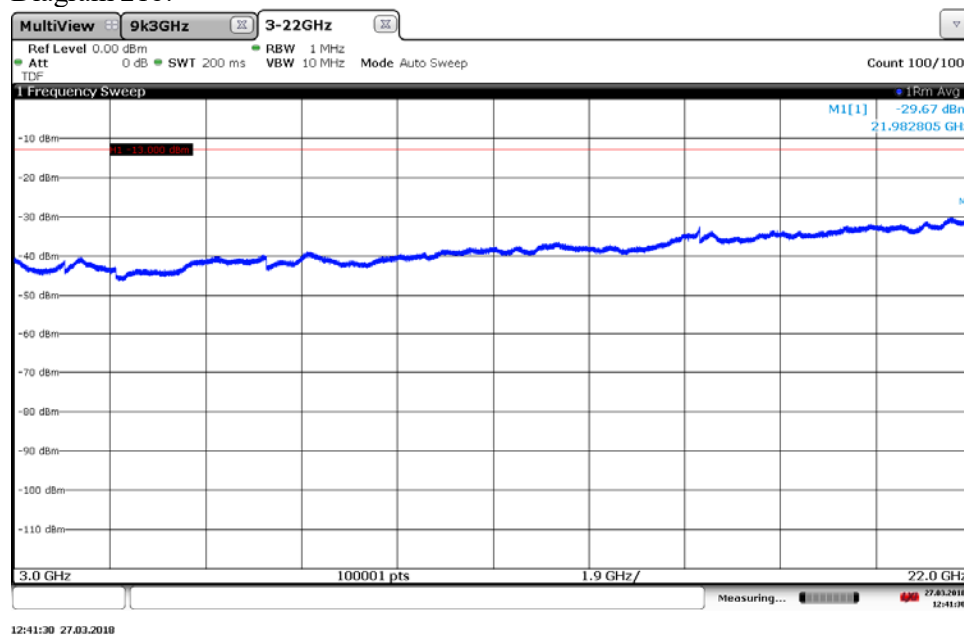


Diagram 22a:

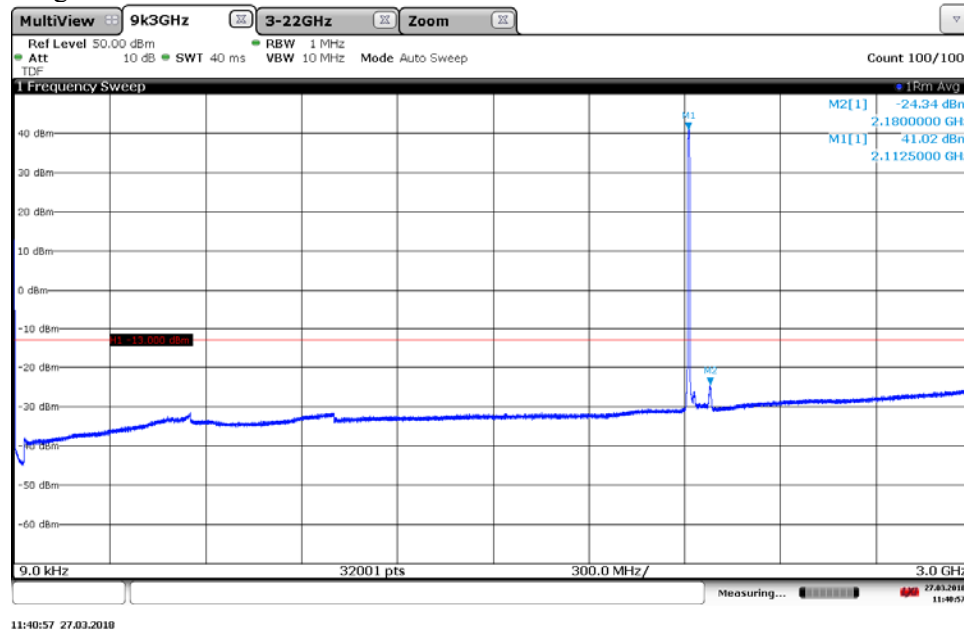


Diagram 22b:

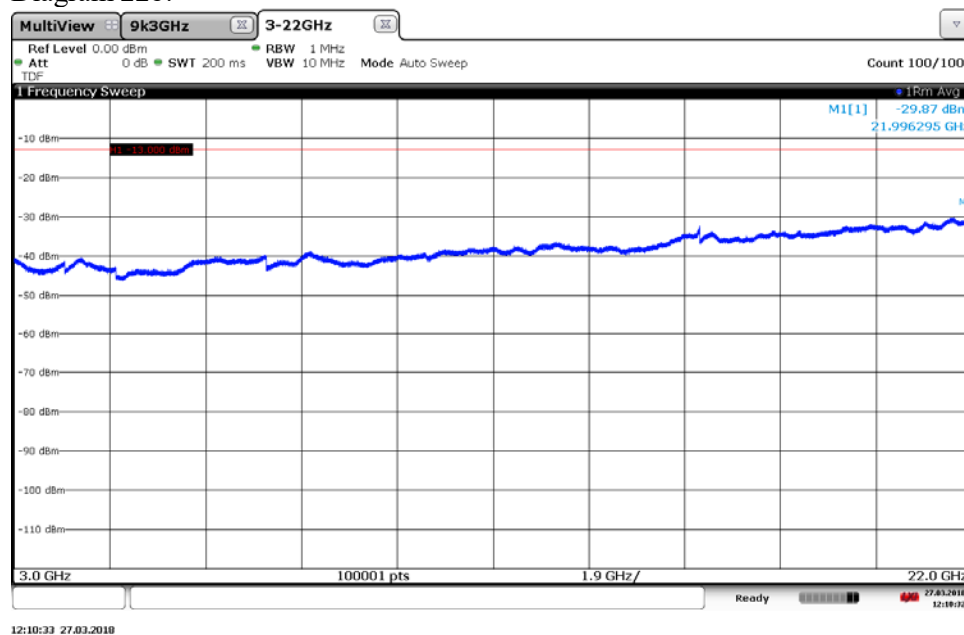
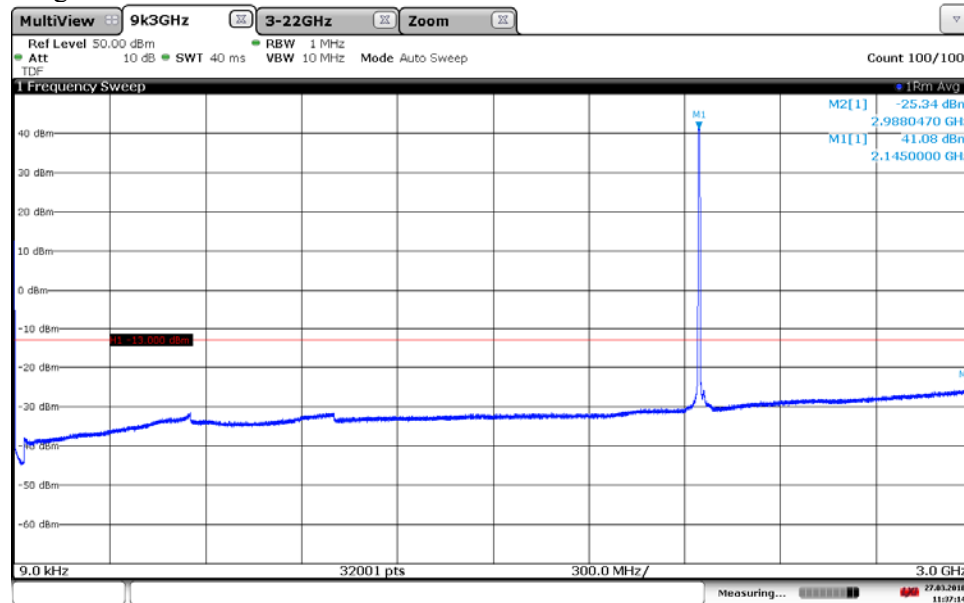
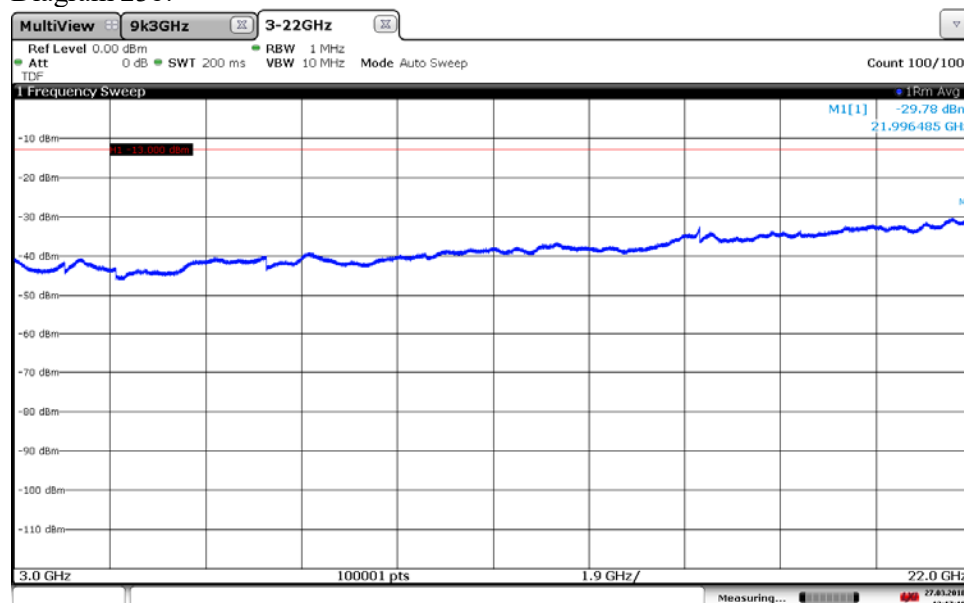


Diagram 23a:



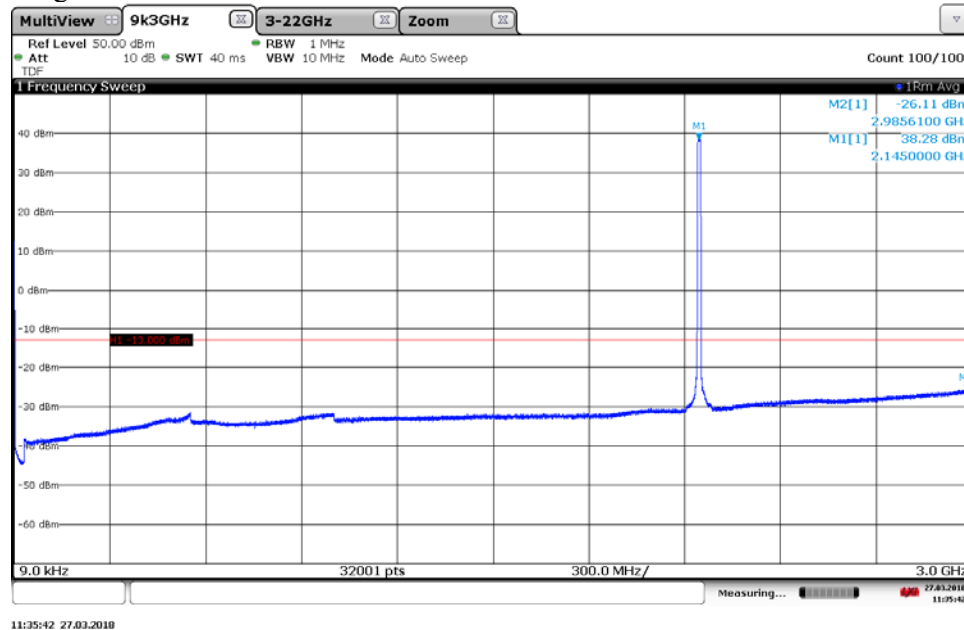
11:37:15 27.03.2018

Diagram 23b:



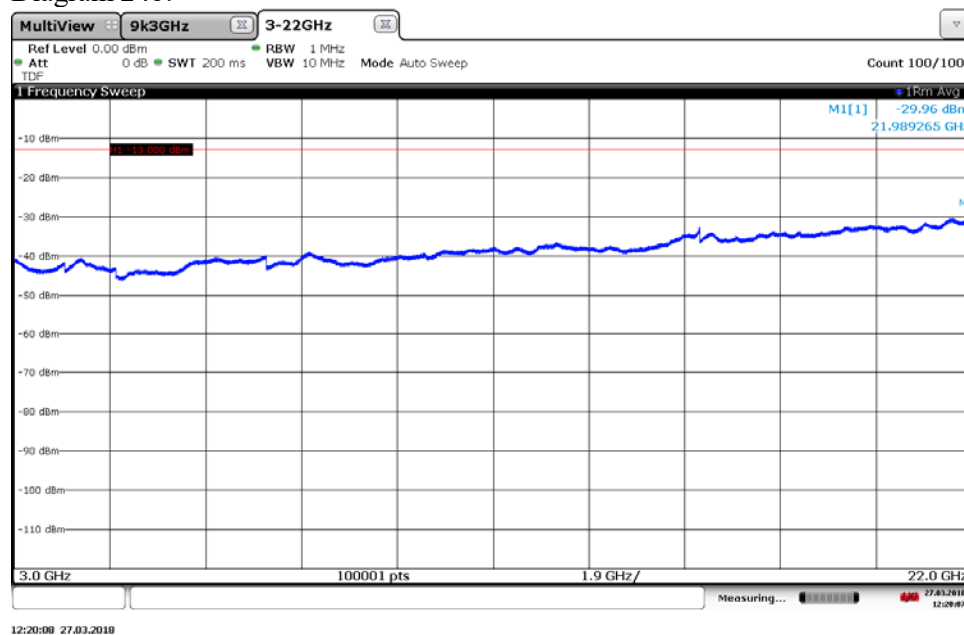
12:17:10 27.03.2018

Diagram 24a:



11:35:42 27.03.2018

Diagram 24b:



12:20:00 27.03.2018



Diagram 25a:

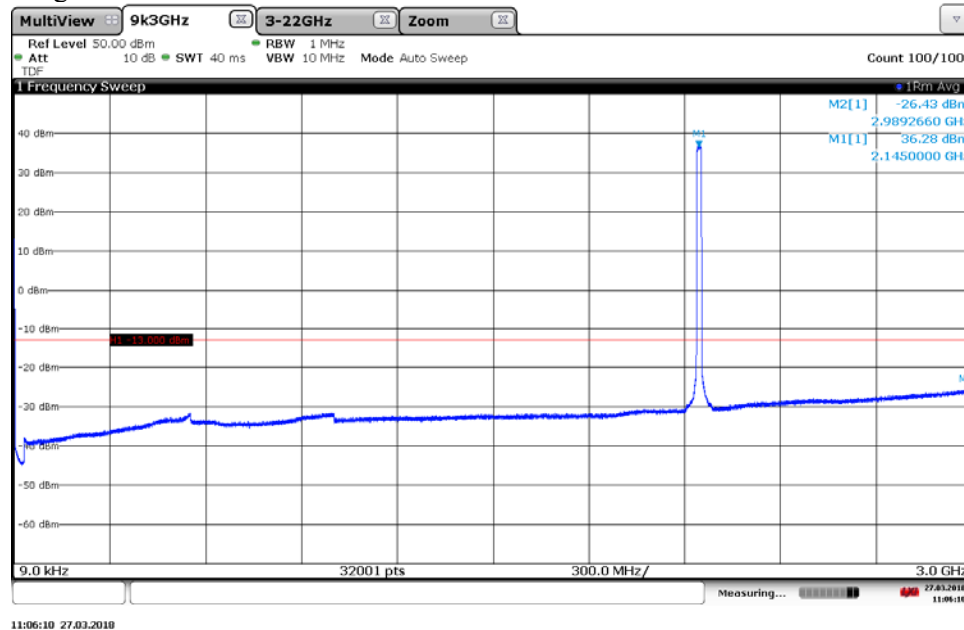


Diagram 25b:

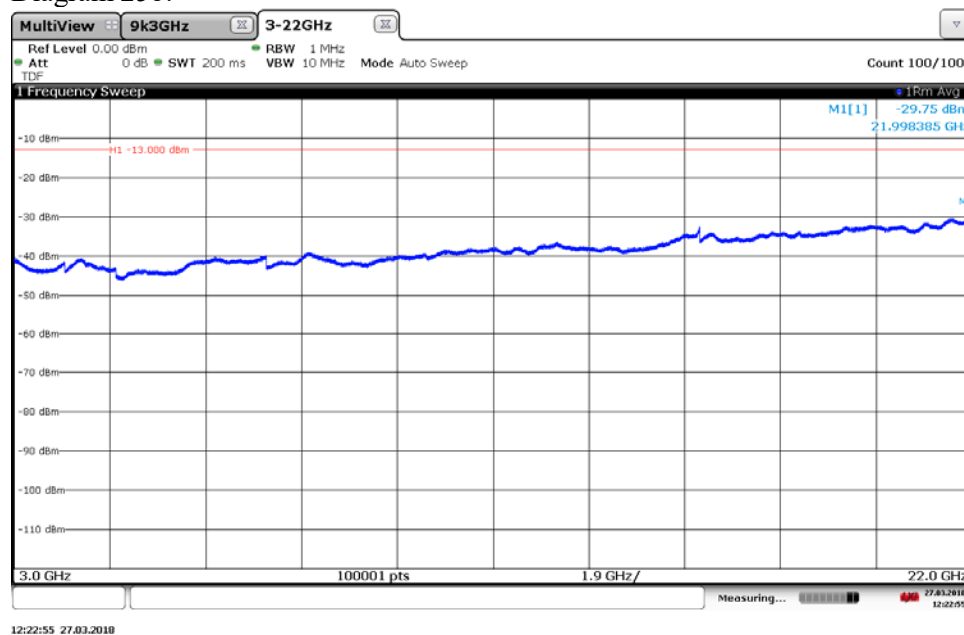


Diagram 26a:

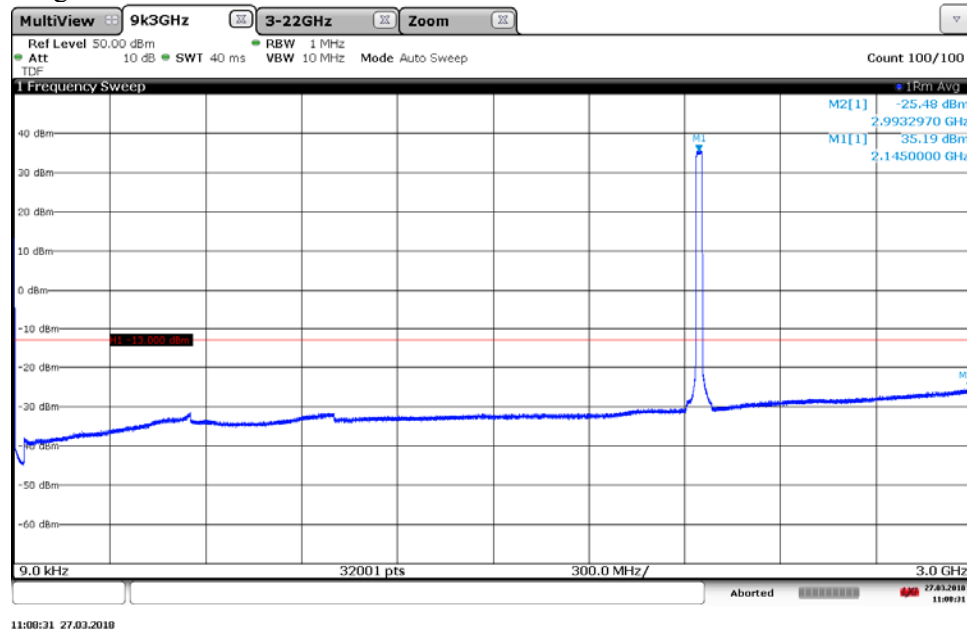


Diagram 26b:

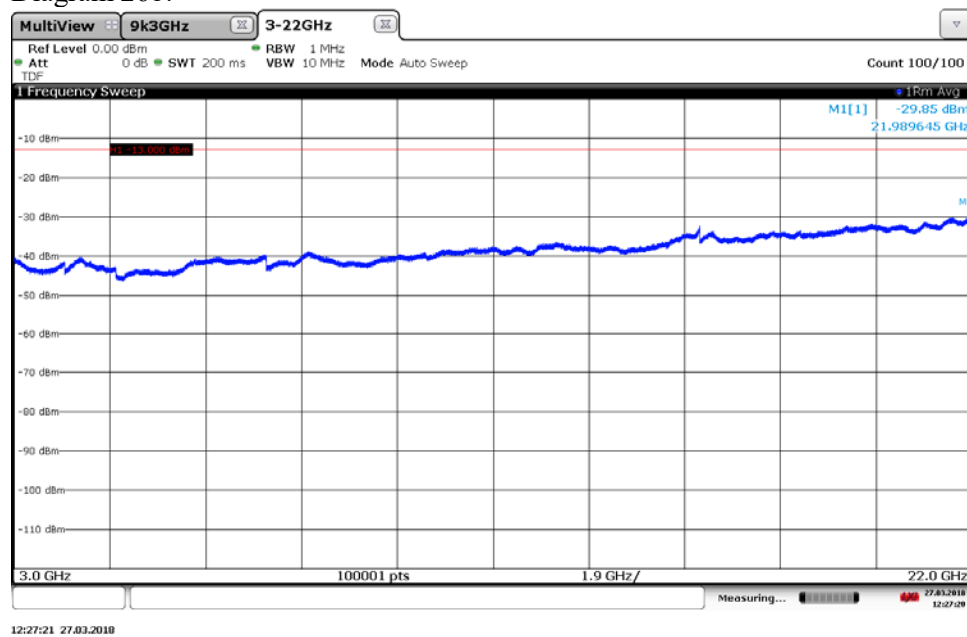


Diagram 27a:

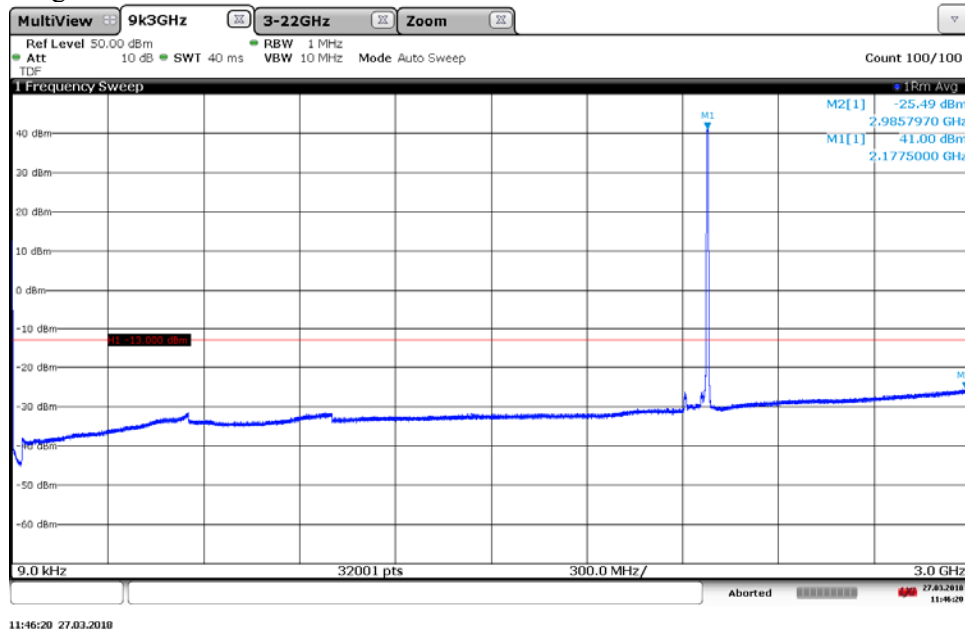


Diagram 27b:

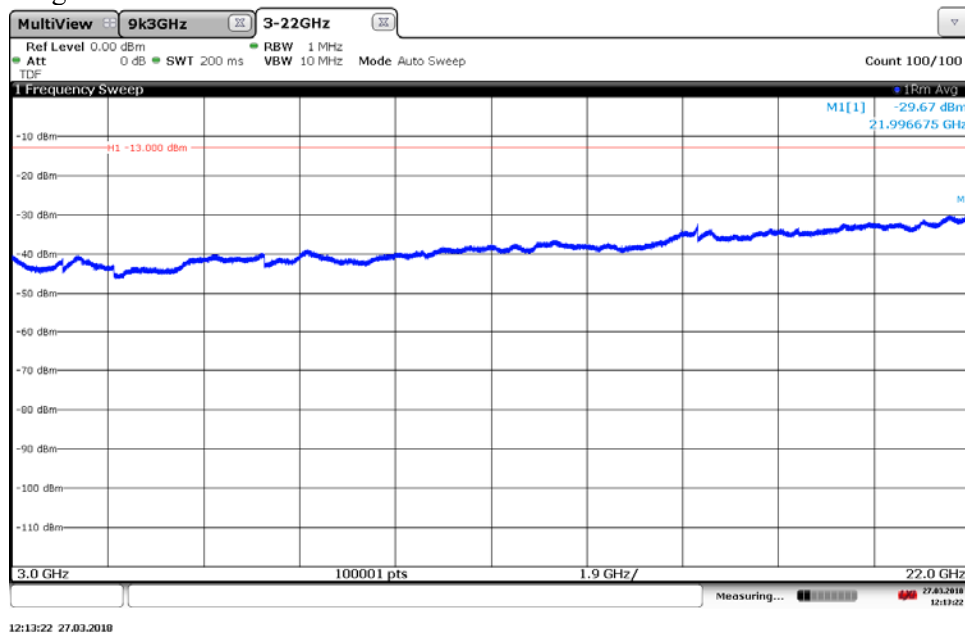


Diagram 28a:

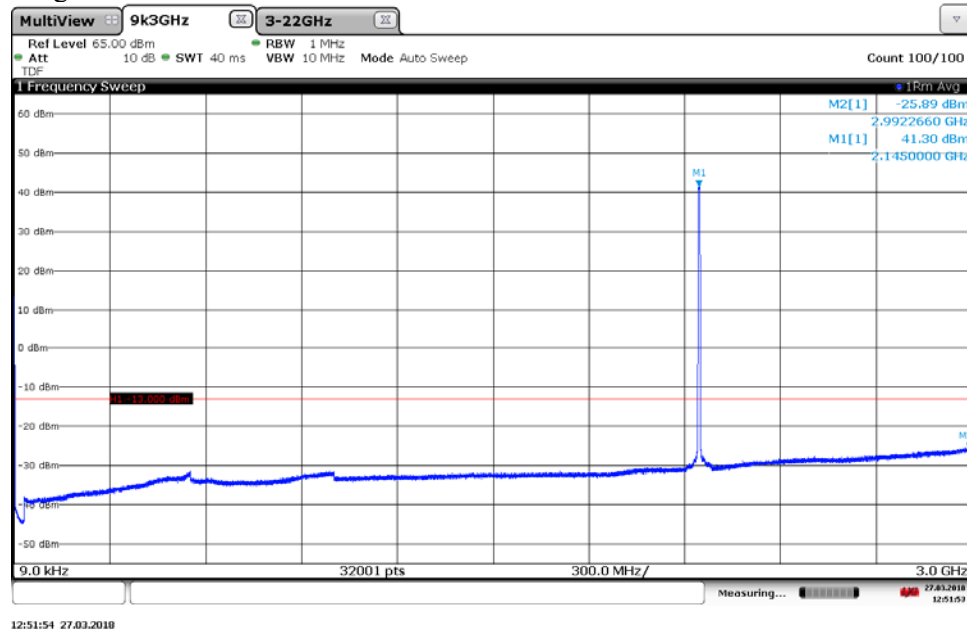


Diagram 28b:

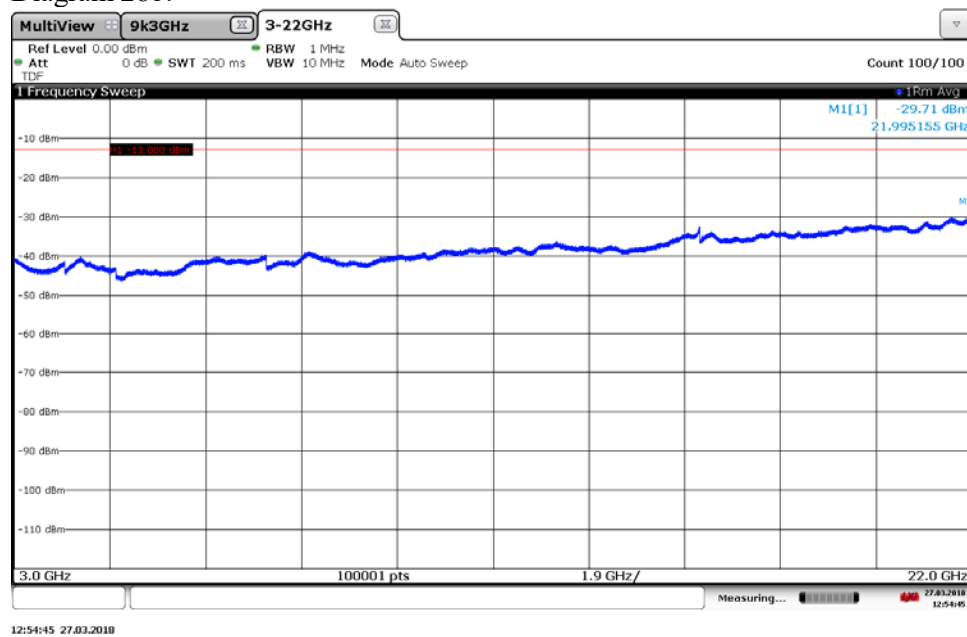


Diagram 29a:

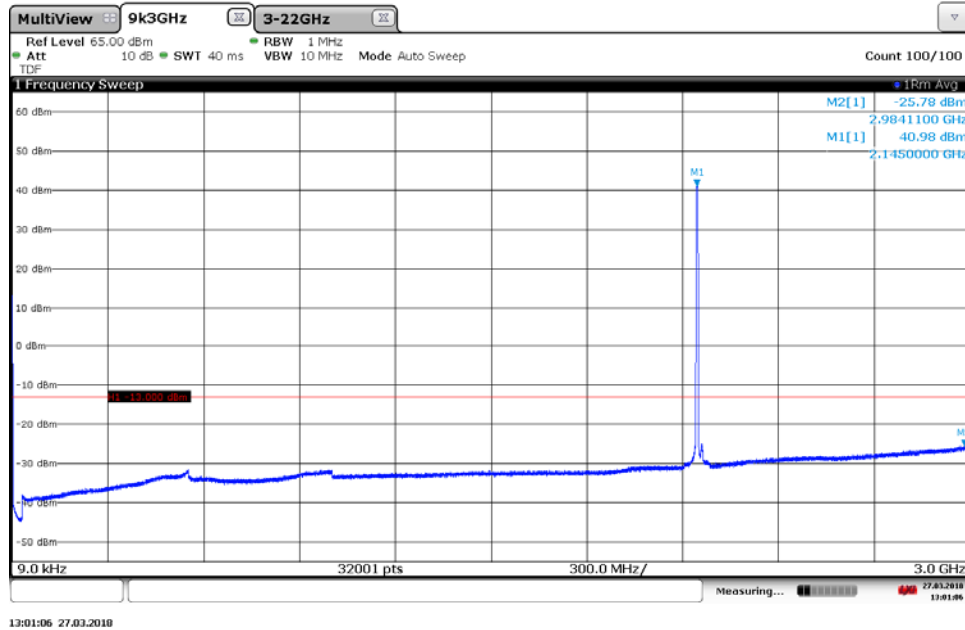


Diagram 29b:

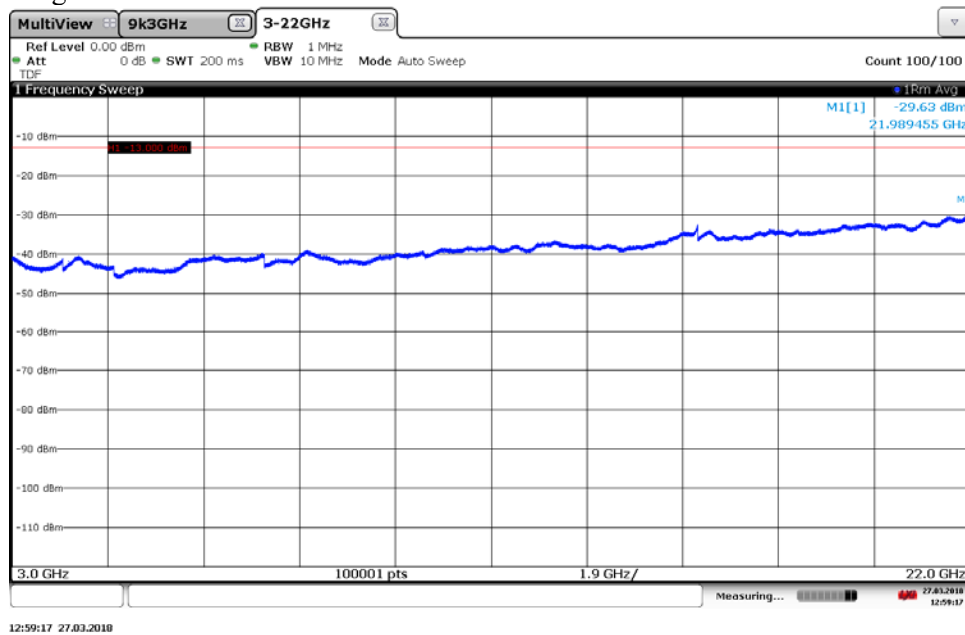
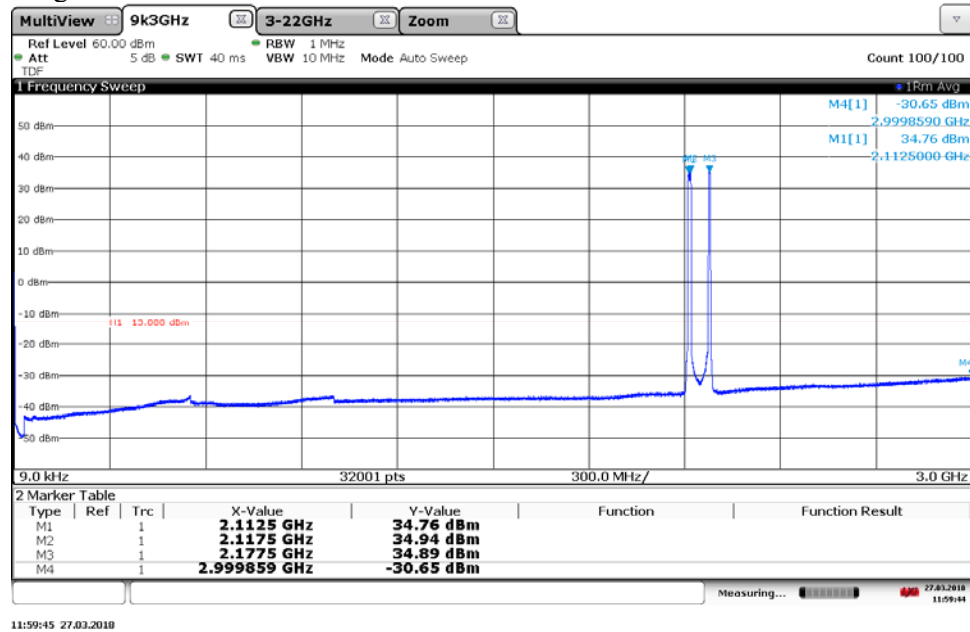
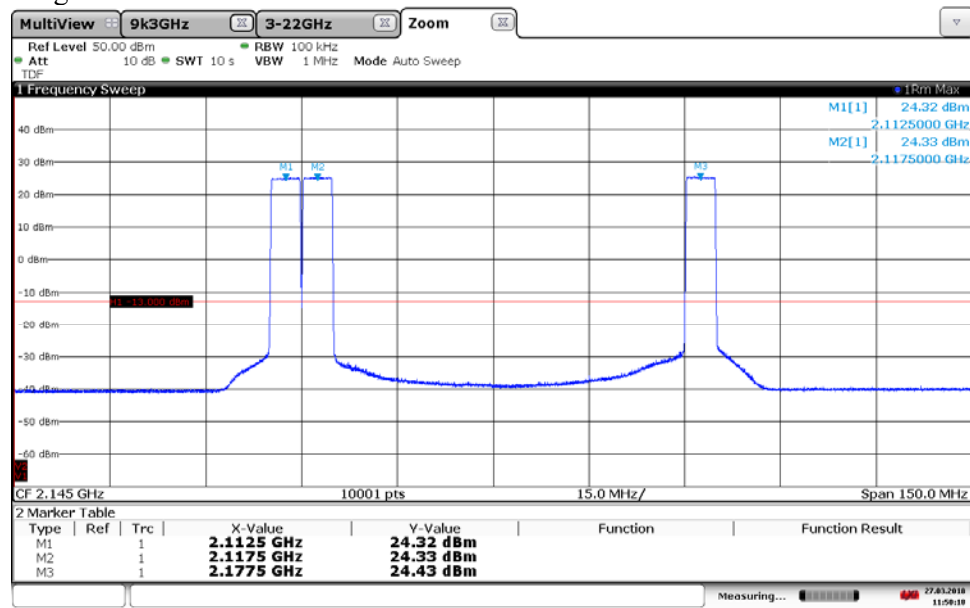


Diagram 30a:



11:59:45 27.03.2018

Diagram 30b:



11:50:18 27.03.2018

Diagram 30c:

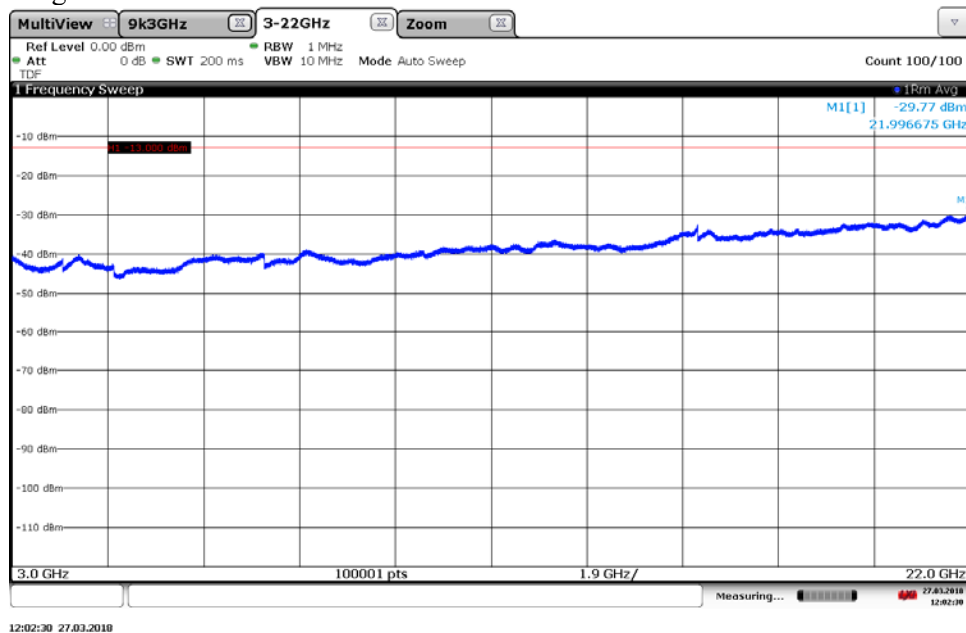


Diagram 31a:

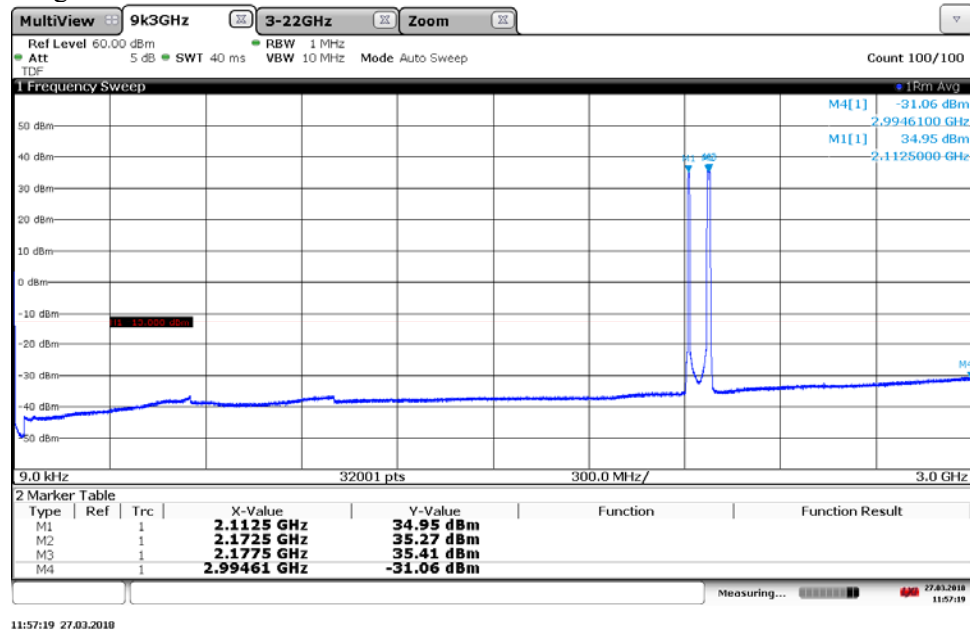


Diagram 31b:

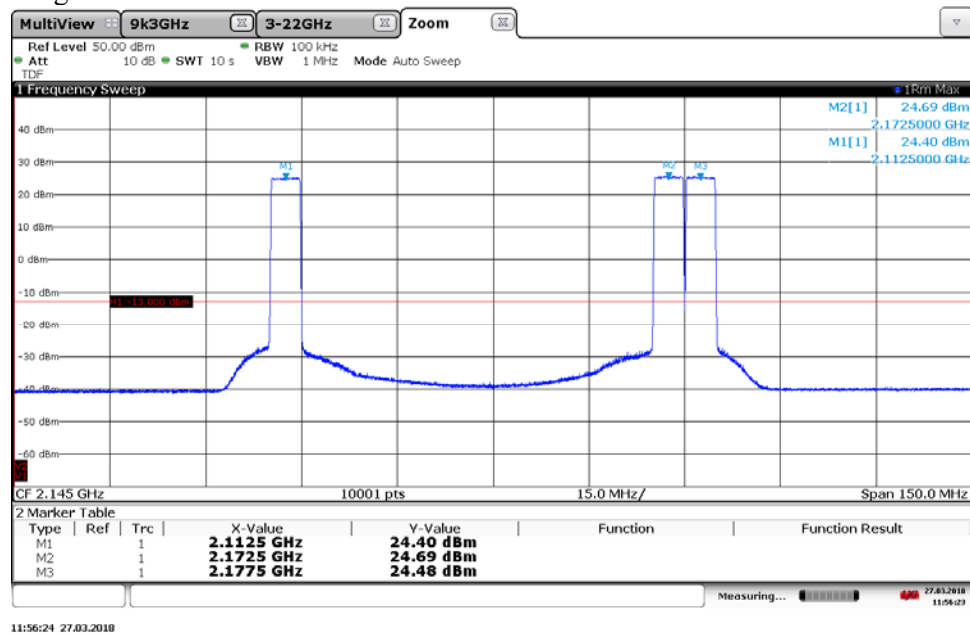




Diagram 31c:

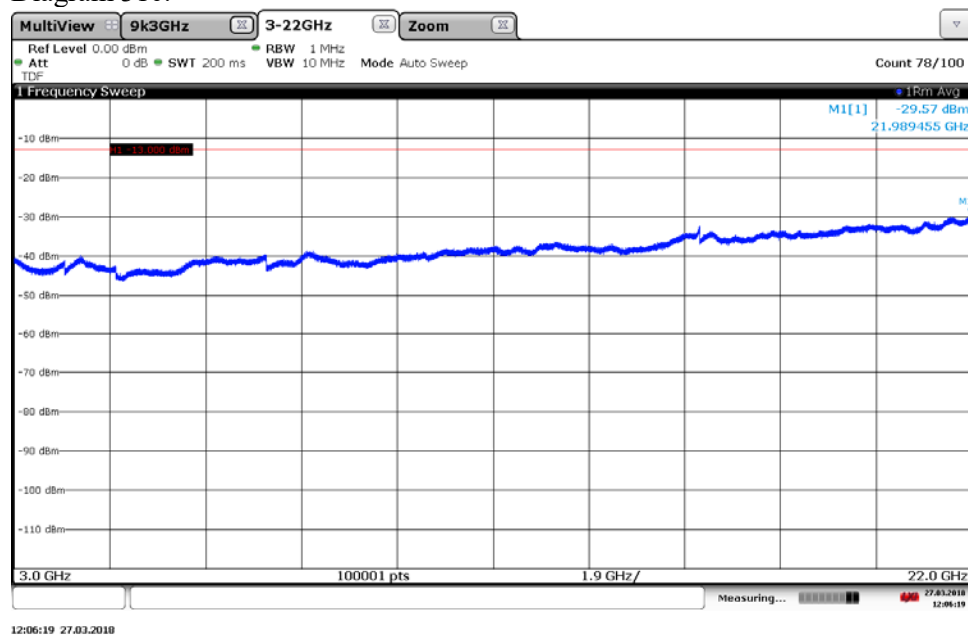


Diagram 32a:

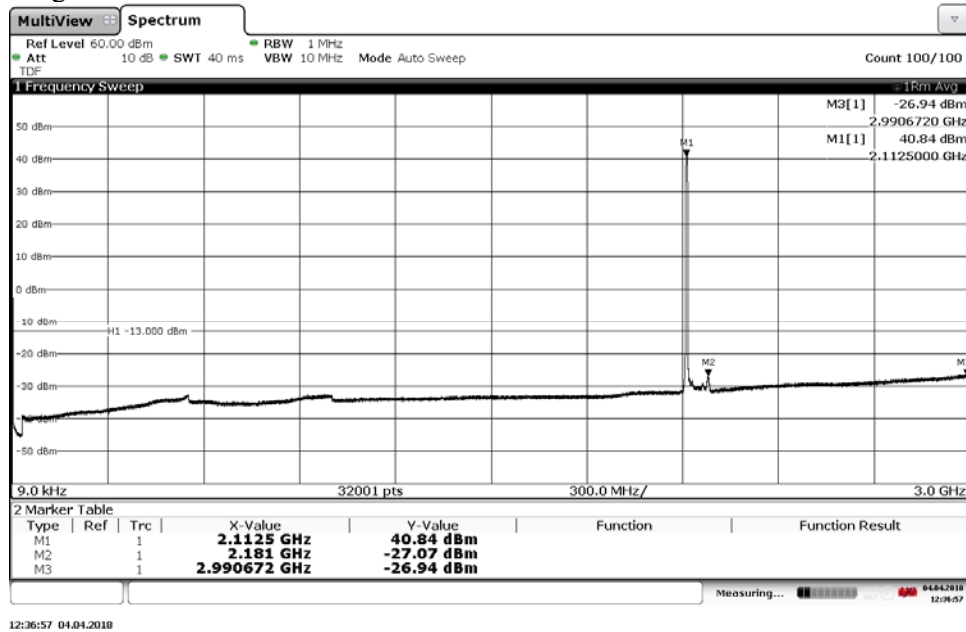


Diagram 32b:

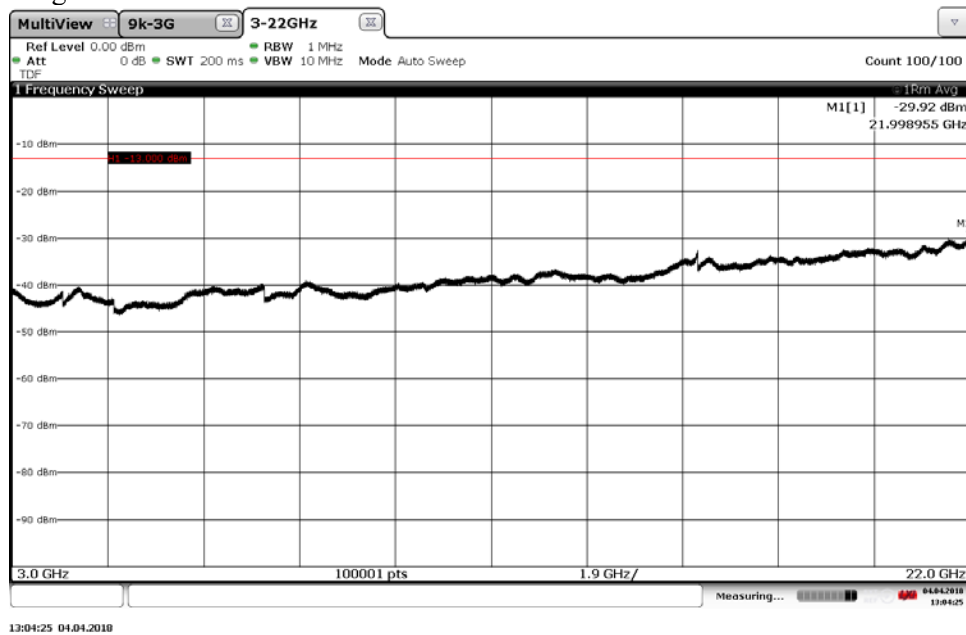
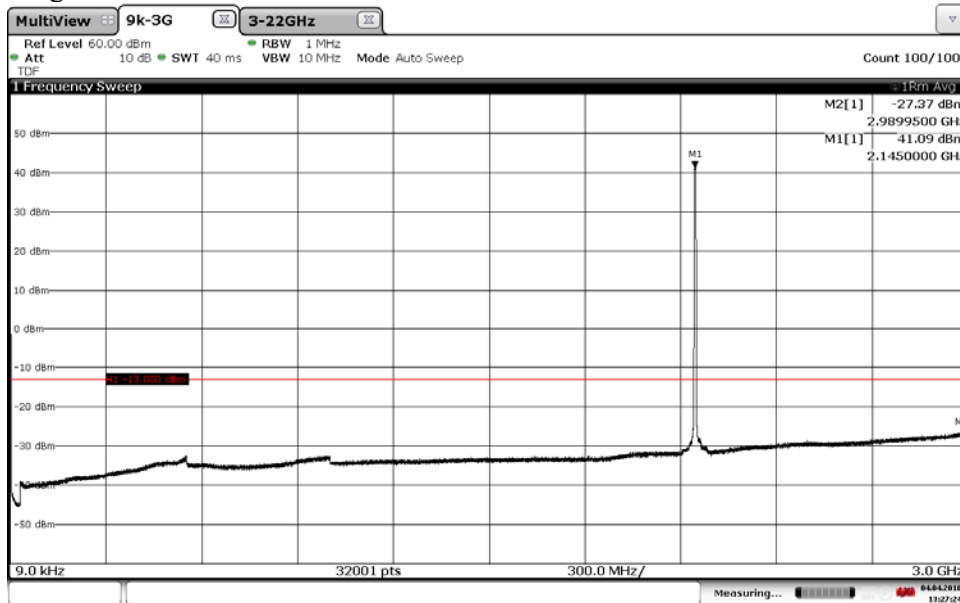
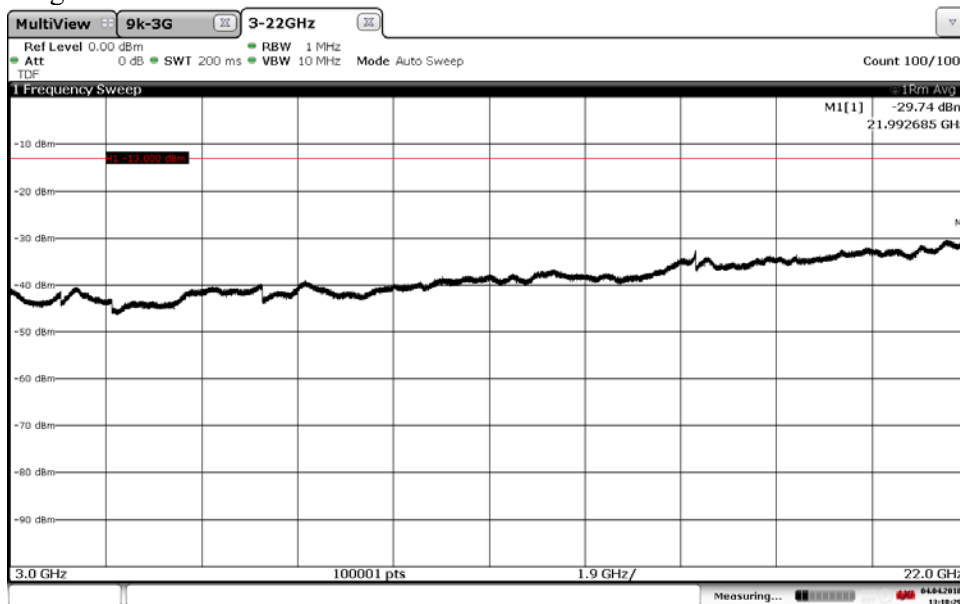


Diagram 33a:



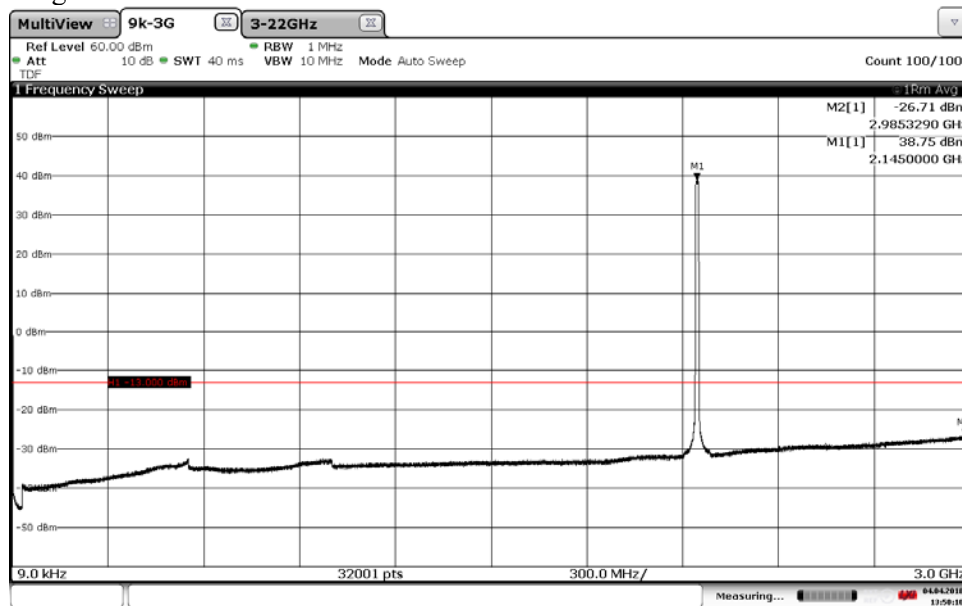
13:27:24 04.04.2018

Diagram 33b:



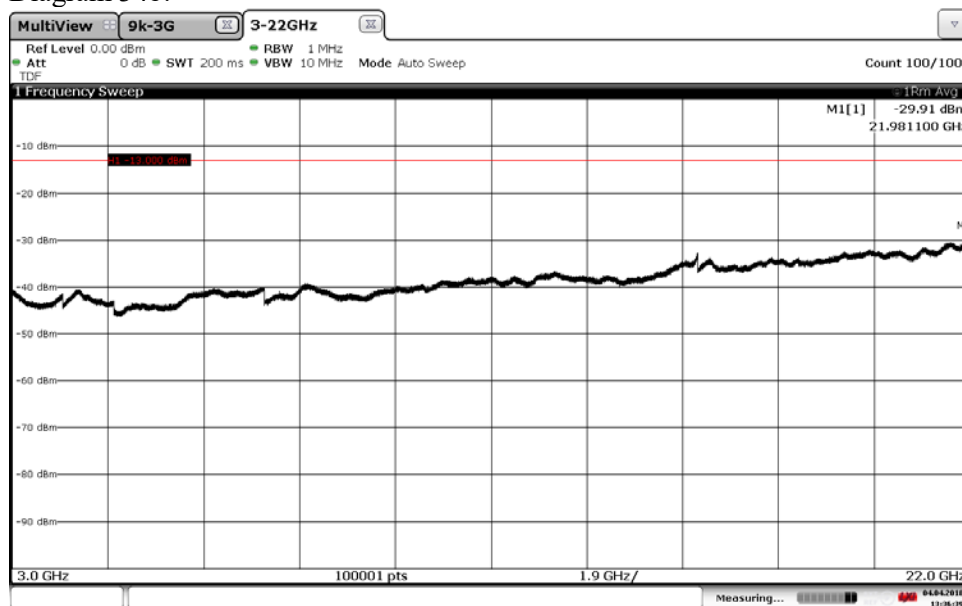
13:18:29 04.04.2018

Diagram 34a:



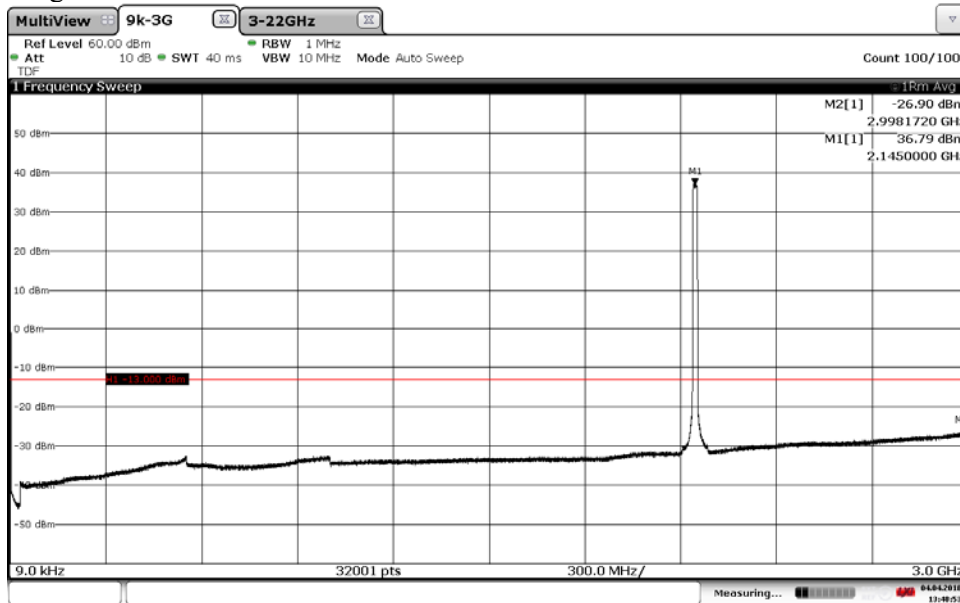
13:50:10 04.04.2018

Diagram 34b:



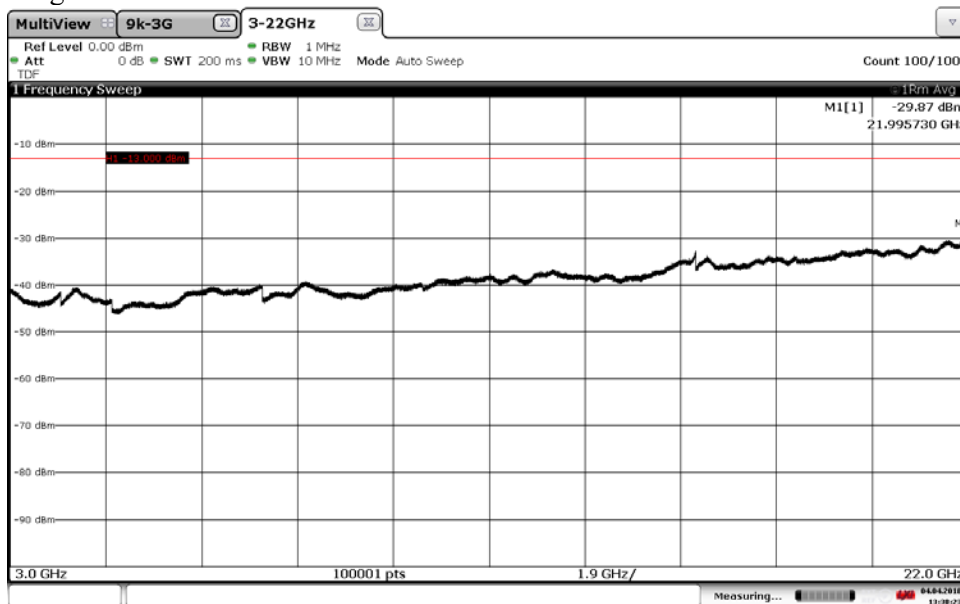
13:36:39 04.04.2018

Diagram 35a:



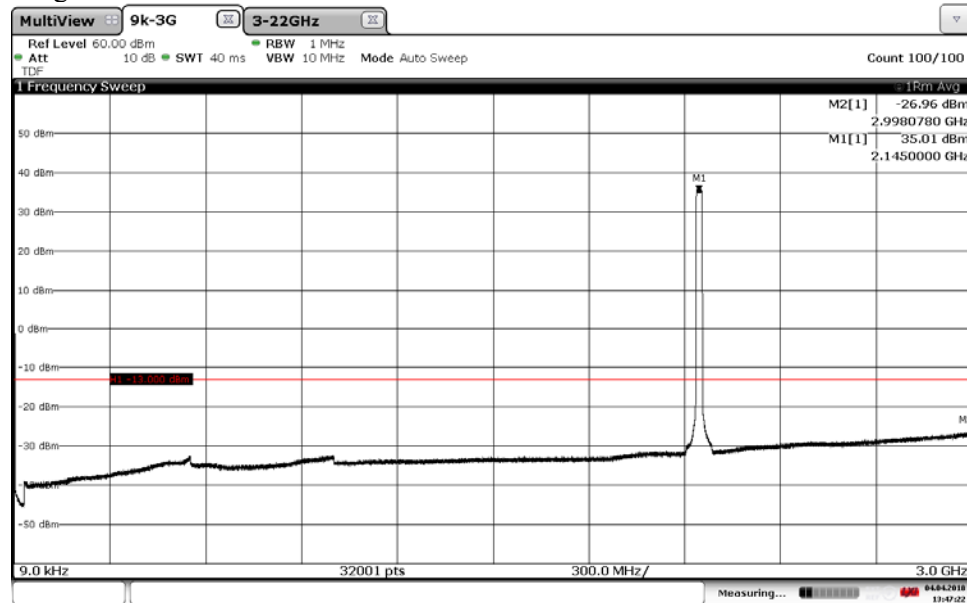
13:40:53 04.04.2018

Diagram 35b:



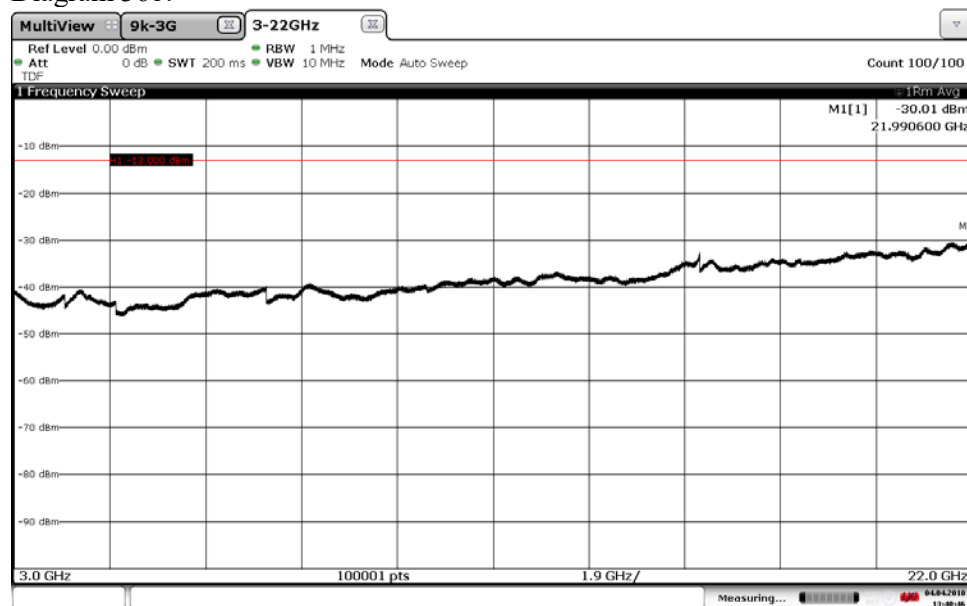
13:30:24 04.04.2018

Diagram 36a:



13:47:23 04.04.2018

Diagram 36b:



13:48:16 04.04.2018

Diagram 37a:

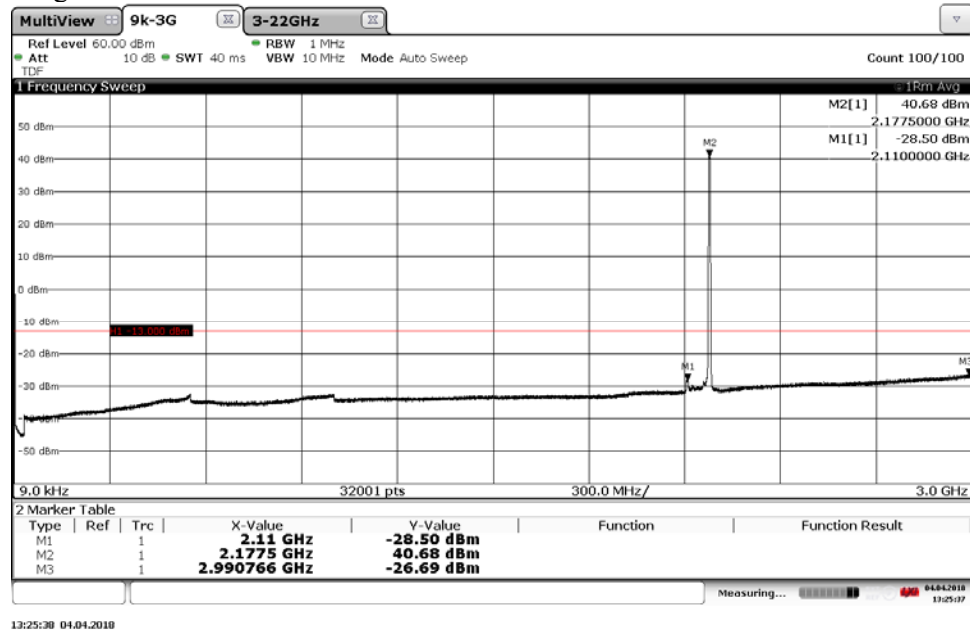


Diagram 37b:

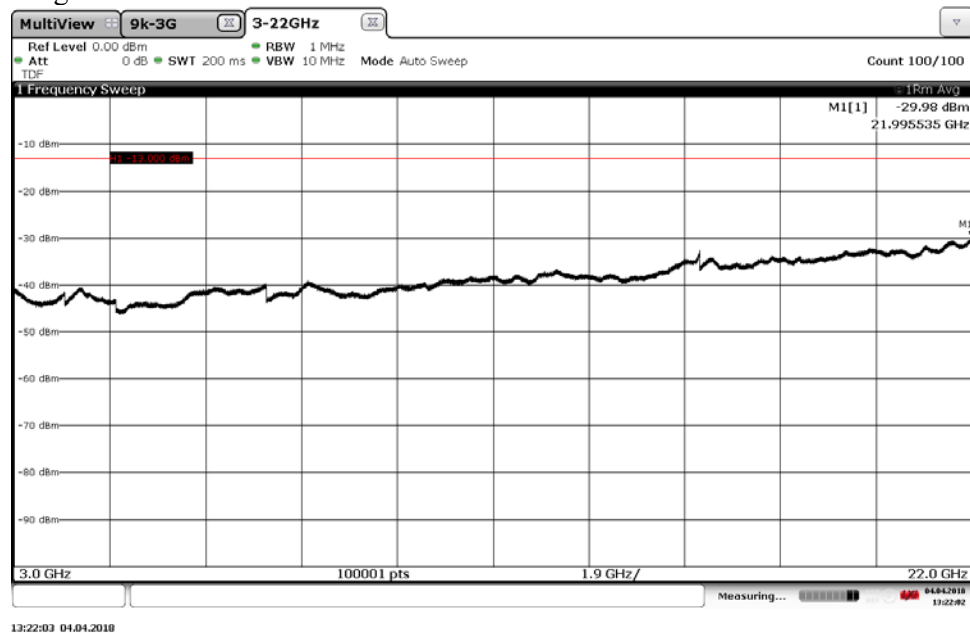


Diagram 38a:

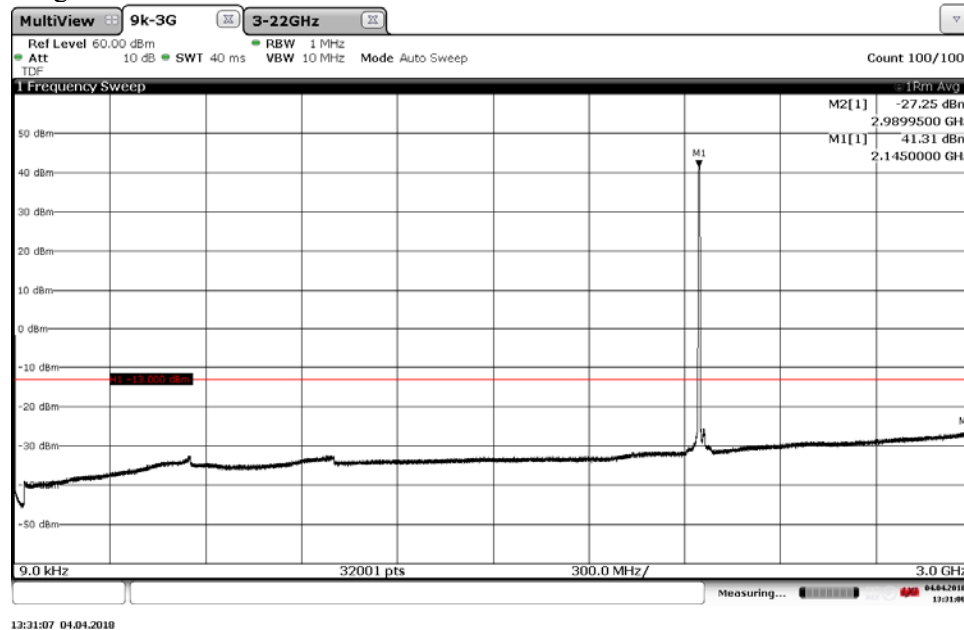


Diagram 38b:

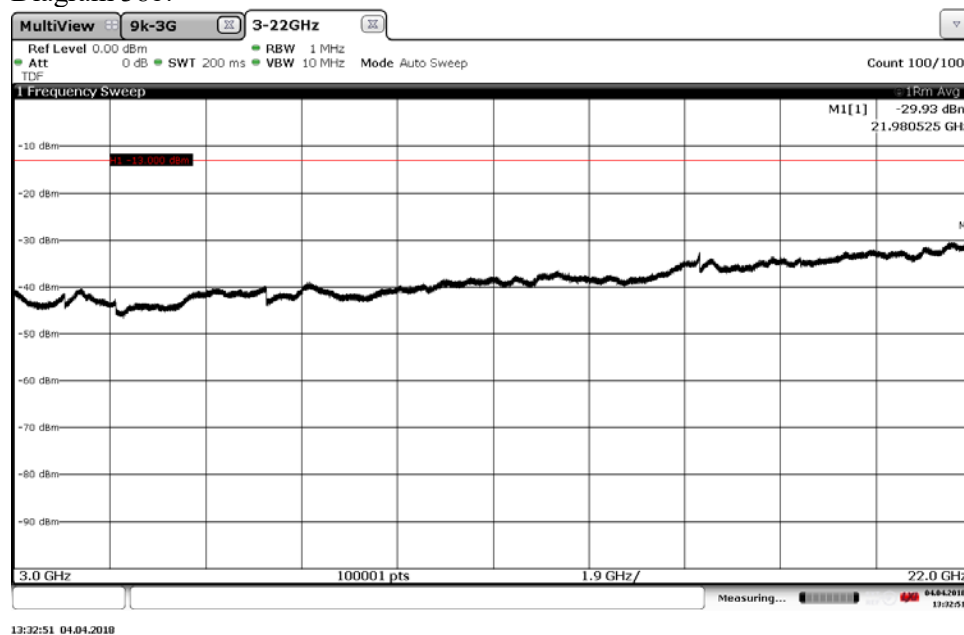




Diagram 39a:

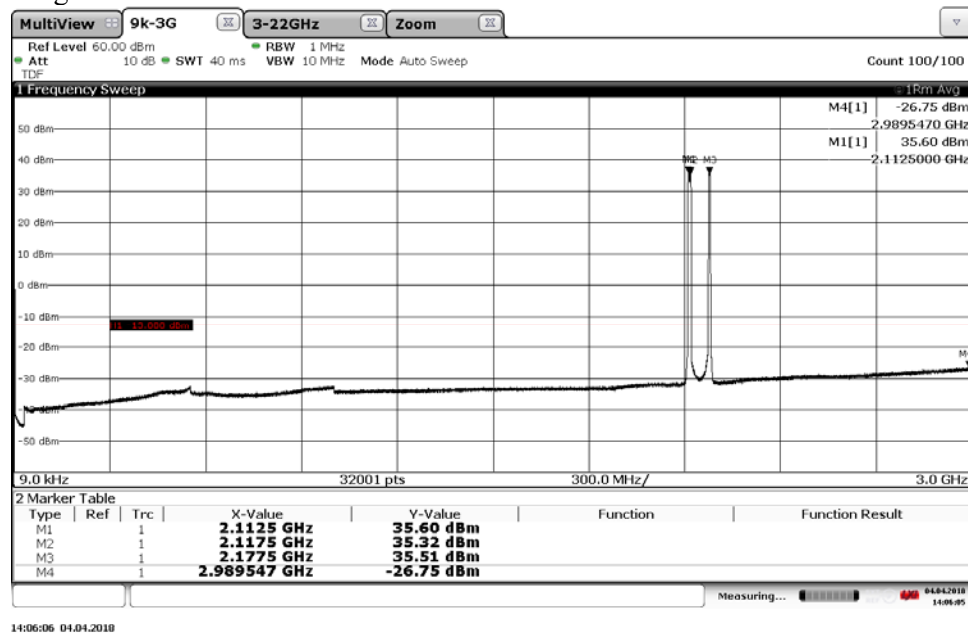


Diagram 39b:

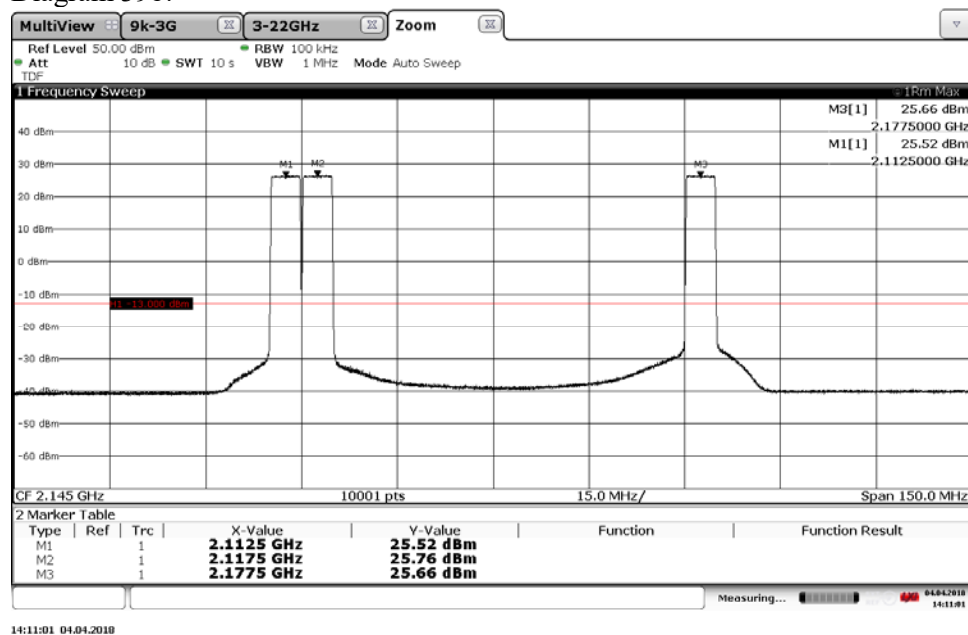
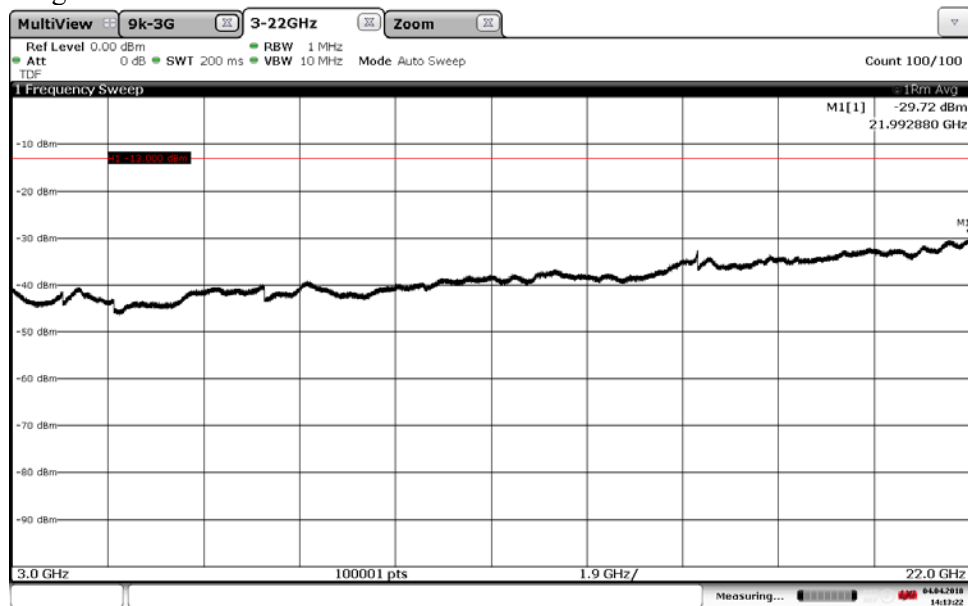


Diagram 39c:



14:13:22 04.04.2018

Diagram 40a:

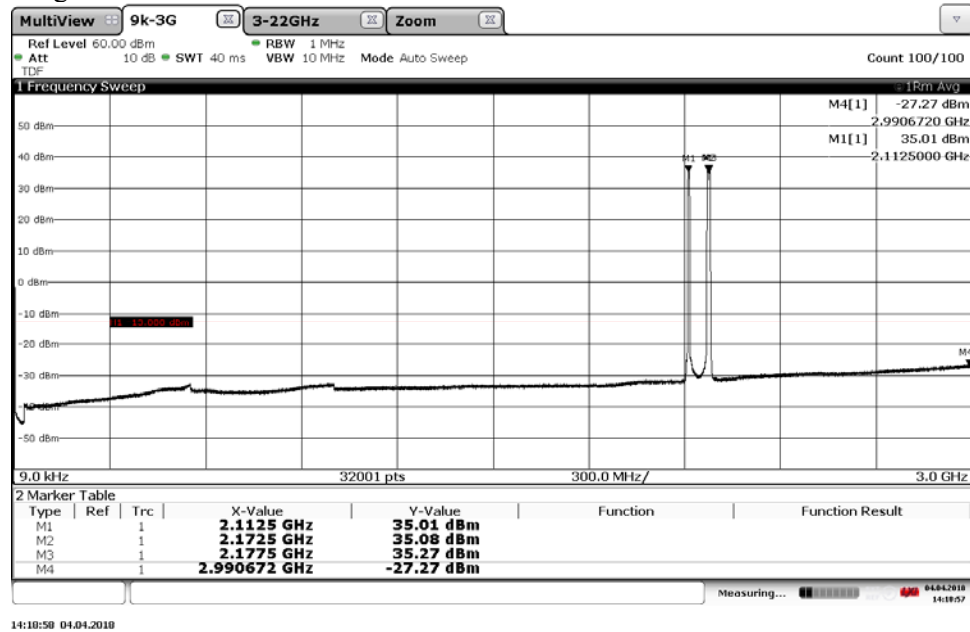


Diagram 40b:

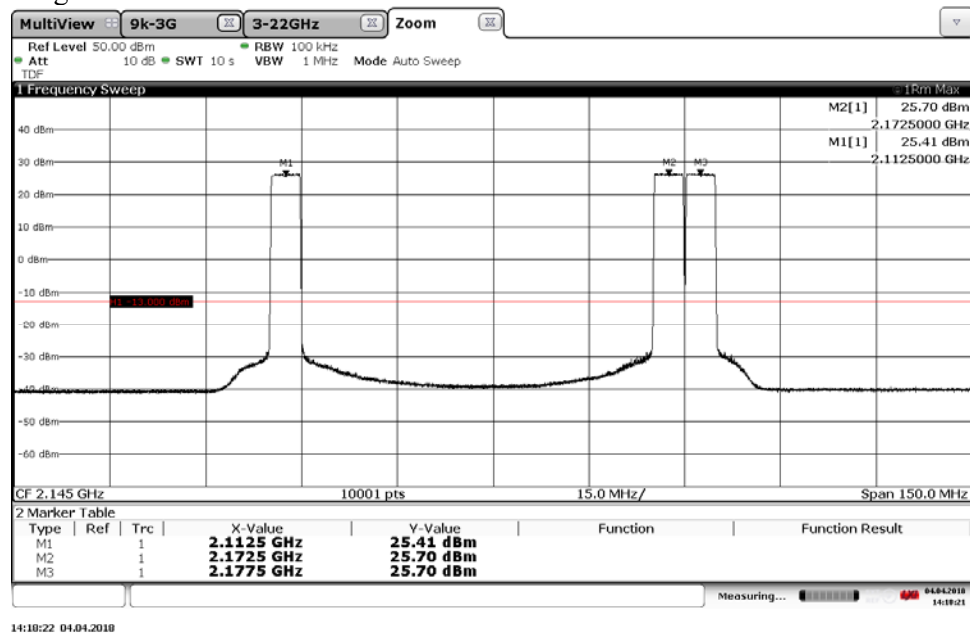
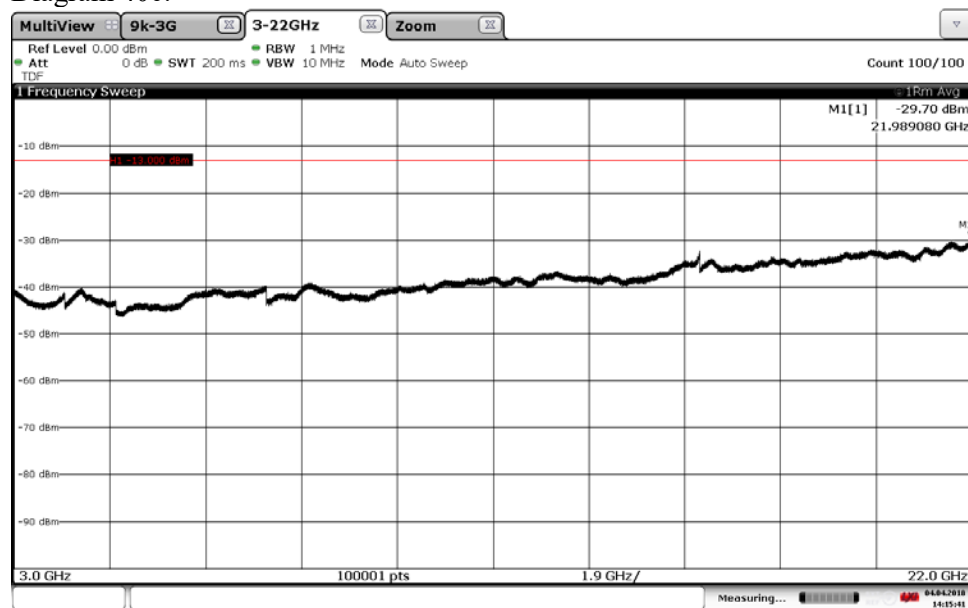


Diagram 40c:



14:15:41 04.04.2018

## Field strength of spurious radiation measurements according to 47 CFR §2.1053

Date	Temperature	Humidity
2018-03-20	22 °C ± 3 °C	20 % ± 5 %
2018-03-21	21 °C ± 3 °C	24 % ± 5 %
2018-03-22	21 °C ± 3 °C	25 % ± 5 %
2018-03-23	21 °C ± 3 °C	27 % ± 5 %

The test site conform to the site validation criterion specified in ANSI C63.4 2014. The test site complies with RSS-Gen, Industry Canada file no. 3482A-1.

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 be 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 a RBW of 1 MHz.

A propagation loss in free space was calculated. The used formula was

$$\gamma = 20 \log \left( \frac{4\pi D}{\lambda} \right), \gamma \text{ is the propagation loss and } D \text{ is the antenna distance.}$$

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 1.0 m and 1.5 m.
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 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:

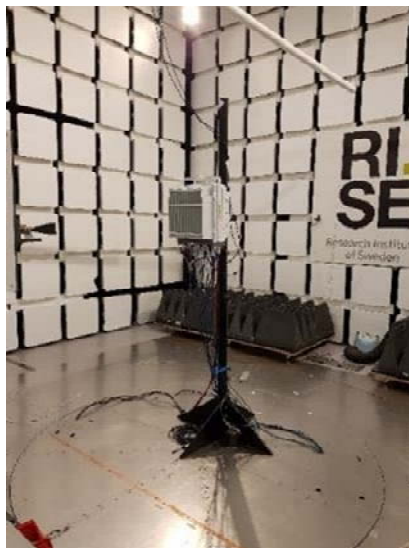
Test setup 30-1000 MHz:



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 10.20.01	BX62351
High pass filter 3-18 GHz	504 200
Flann Standard Gain Horn 20240-20	503 674
ETS Lindgren BiConiLog Antenna 3142E	BX61914
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  $T_s$ , TX top frequency, BW 5 MHz

Diagram 1a-d: Band 2 4x 40 W + Band 66A 4x 60 W configuration.

Diagram 2a-d: Band 2 2x 60 W + Band 66A 2x 80 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

### Limits

CFR 47 §24.238 and §27.53(h)

Outside a licensee's frequency band(s) of operation the power of any emission shall be attenuated below the transmitter power (P) by at least  $43 + 10 \log (P)$  dB. resulting in a limit of -13 dBm.

Complies?	Yes
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Diagram 1a:

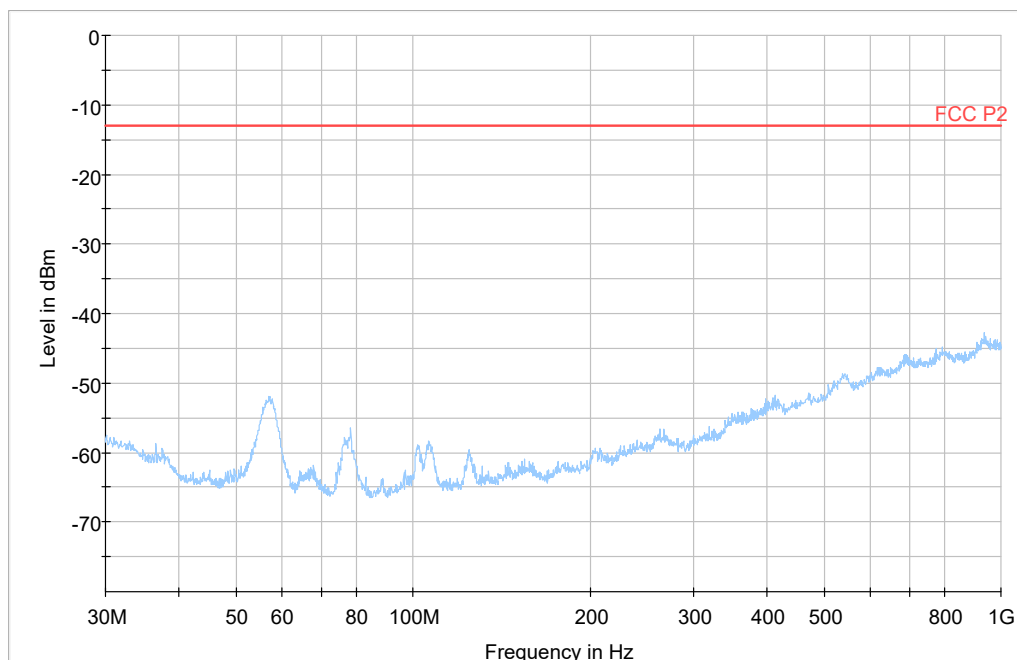
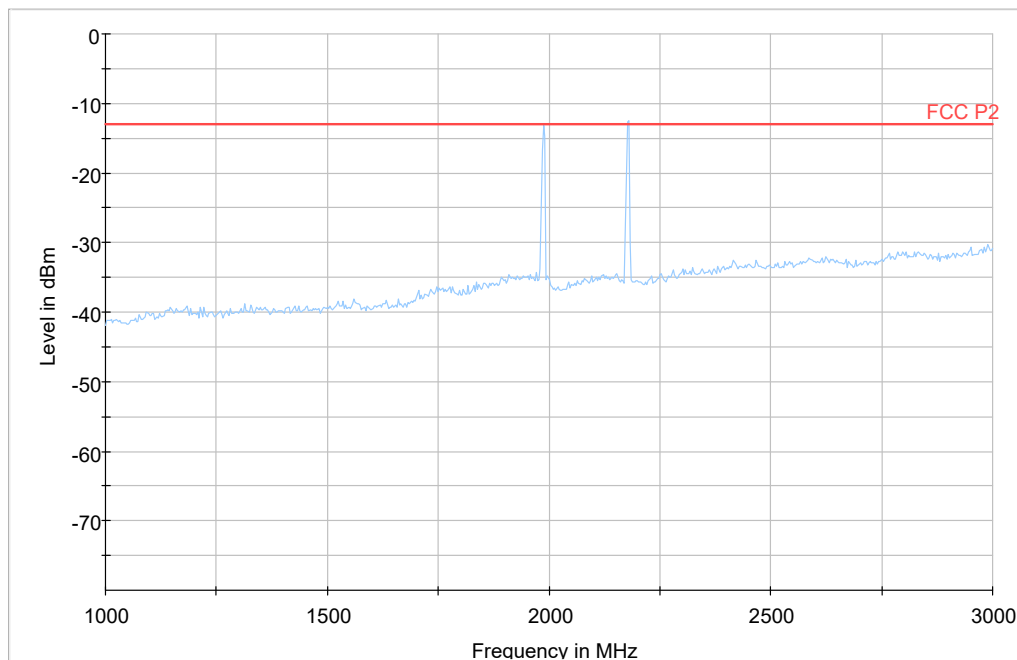


Diagram 1b:



Note: The emissions at 1987.5 MHz and 2177.5 MHz are the carrier frequency and shall be ignored in the context.

Diagram 1c:

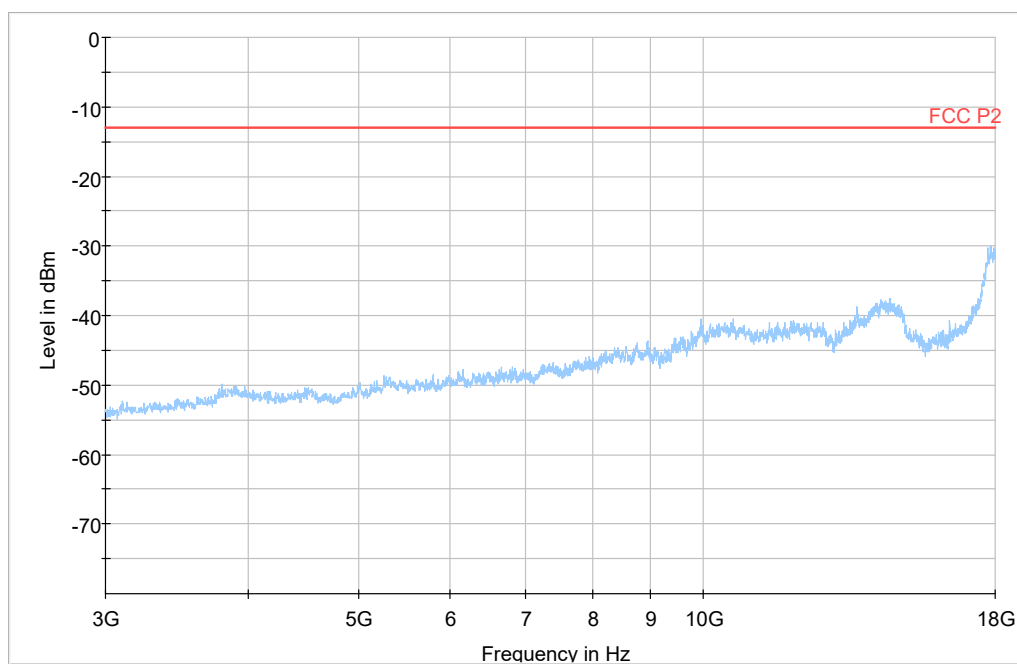


Diagram 1d:

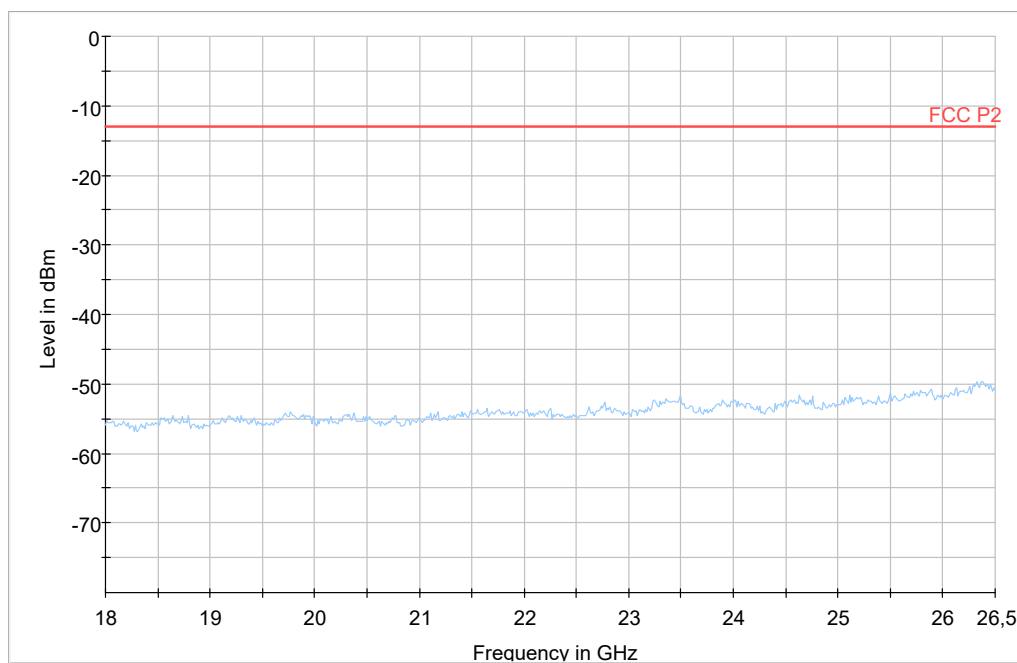


Diagram 2a:

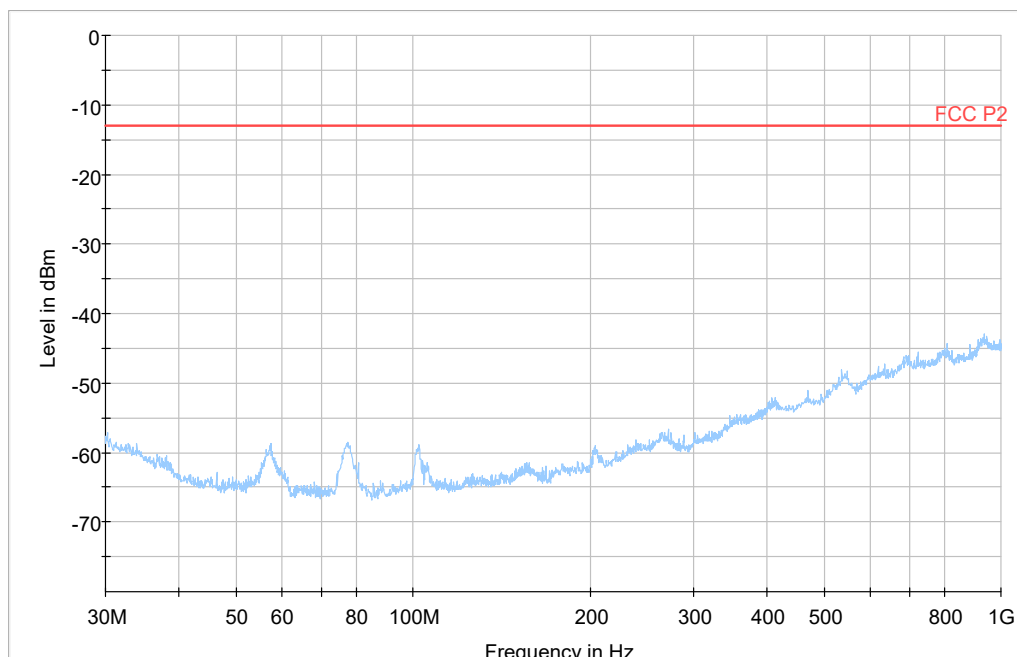
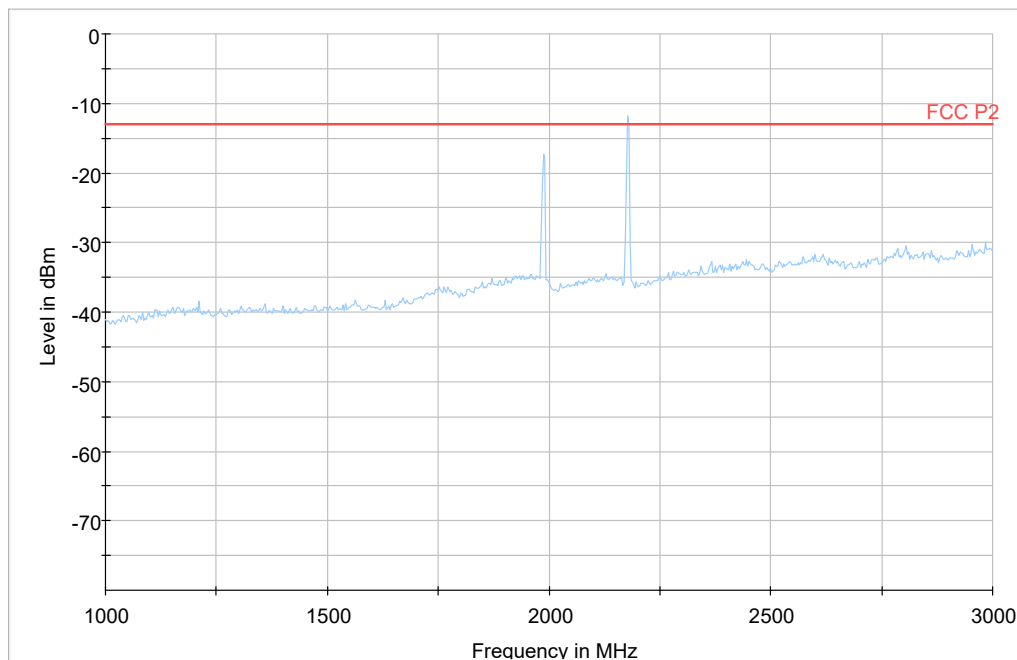


Diagram 2b:



Note: The emission at 1987.5 MHz and 2177.5 is the carrier frequency and shall be ignored in the context.

Diagram 2c:

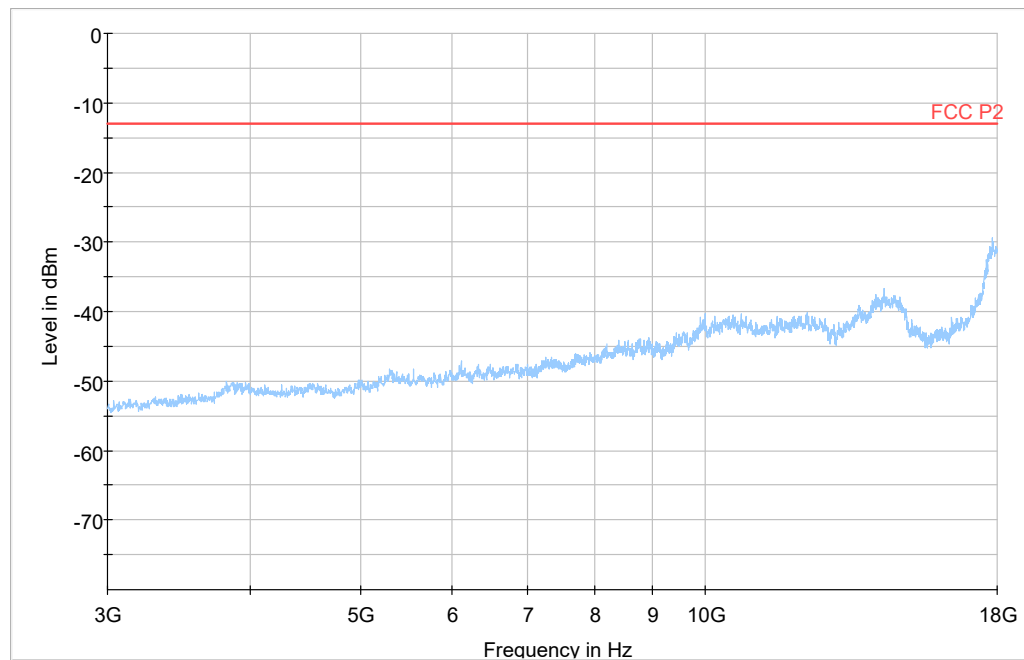
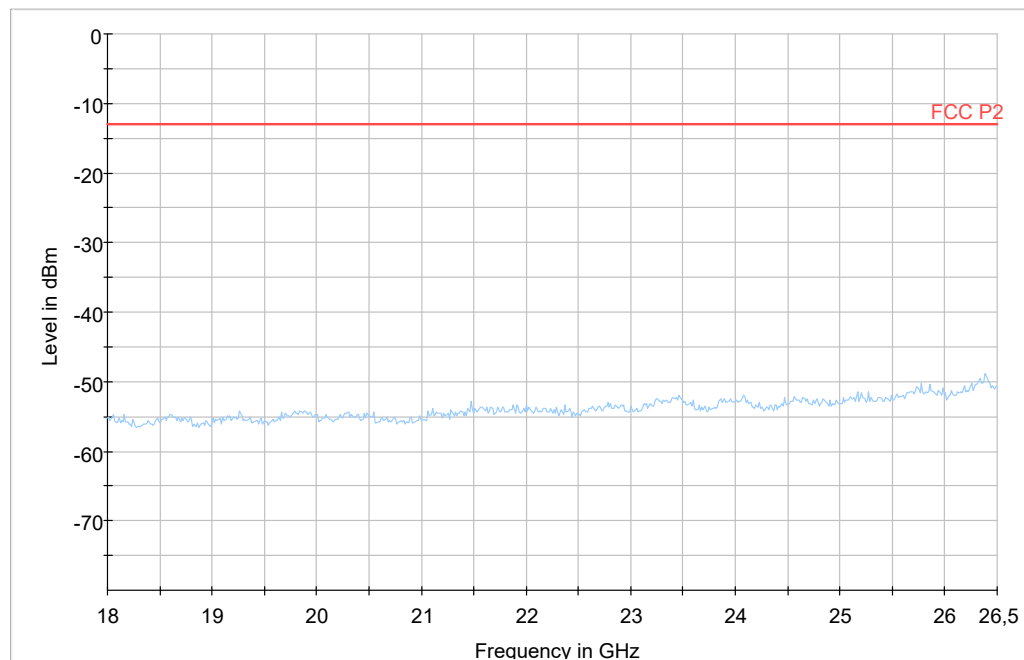


Diagram 2d:



## Frequency stability measurements according to CFR 47 §24.235 and §27.54, 2.1055

Date	Temperature (test equipment)	Humidity (test equipment)
2018-03-13	23 °C ± 3 °C	16 % ± 5 %
2018-03-14	22 °C ± 3 °C	13 % ± 5 %
2018-03-15	22 °C ± 3 °C	8 % ± 5 %
2018-04-16	22 °C ± 3 °C	32 % ± 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
Temperature Chamber	503 360
Testo 635, temperature and humidity meter	504 203
Multimeter Fluke 87	502 190

## Results

Nominal transmitter frequency was for Band 2 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 Band 66 2145 MHz (M) with a bandwidth of 5 MHz and rated output power level at connector RF E at 46 dBm.

Test conditions		Frequency error (Hz) Band 2	Frequency error (Hz) Band 66A
Supply voltage DC (V)	Temp. (°C)		
40.8	+20	12	11
55.2	+20	12	13
48	+20	13	10
48	+30	26	18
48	+40	8	8
48	+50	8	49
48	+10	9	10
48	0	7	8
48	-10	28	25
48	-20	7	8
48	-30	34	26
Maximum freq. error (Hz)		34	49
Measurement uncertainty		$< \pm 1 \times 10^{-7}$	

## Band 2

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

Test conditions			Frequency margin to band edge at -16 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	5	1932.021	21	1989.980	20
-48.0	+20	20	1930.120	120	1989.873	127

## Band 66A

Rated output power level at connector RF E (maximum): 49 dBm

Test conditions			Frequency margin to band edge at -16 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	2110.016	16	2179.986	14
-48.0	+20	20	2110.096	96	2179.905	95

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:

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

Complies?	Yes
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## 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:

