REPORT

issued by an Accredited Testing Laboratory

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Reference
8P01584

Testing

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Radio measurements on Radio 4415 B2 B25 equipment with FCC ID TA8AKRC161636 and IC: 287AB-AS161636

Product name: Radio 4415 B2 B25
Product number: KRC 161 636/1 and KRC 161 636/3

RISE Research Institutes of Sweden AB
Electronics - EMC

Performed by

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Date & Time: 2018-05-21 14:37:59 +02:00

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Summary

Standard Listed part of	Compliant
FCC CFR 47 part 24/ RSS 133, RSS-Gen	
2.1046/ 6.4 RF power output, conducted	Yes
2.1049/ 6.6 Occupied bandwidth	Yes
2.1051/ 6.5 Band edge	Yes
2.1051/ 6.5 Spurious emission at antenna terminals	Yes
2.1053/ 6.5 Field strength of spurious radiation	Yes
2.1055/ 6.3 Frequency stability	-, Note

Note: The test was not performed due to no changes regarding frequency determining circuitry.

Description of the test object

Equipment:	Radio equipment Radio 4415 B2 B25 Product number KRC 161 636/1 and KRC 161 636/3 FCC ID: TA8AKRC161636 IC: 287AB-AS161636
HVIN:	AS161636
FVIN:	CXP 901 7316/7, rev. R68LB
Hardware revision state:	KRC 161 636/1: R2B KRC 161 636/3: R1C
Tested configuration:	Single RAT NB IoT stand-alone operation and Multi RAT with LTE
Frequency range:	TX: 1930 – 1995 MHz (for GSM 1930 – 1990 MHz) RX: 1850 – 1915 MHz (for GSM 1850 –1910 MHz)
IBW:	NB-IoT SA and NB IoT SA + GSM: 20 MHz NB IoT SA + WCDMA and NB IoT SA + LTE: 40 MHz (Max 20 MHz carrier separation for carriers BW ≤ 3 MHz)
Output power:	Max 40 W/ antenna port
Antenna ports:	4 TX / 4 RX ports
Antenna:	No dedicated antenna, handled during licensing
RF configurations:	NB-IoT SA: max 2 carriers/ port Contiguous Spectrum (CS), Non-Contiguous Spectrum (NCS), NB-IoT SA: TX Diversity one carrier NB-IoT SA + GSM: max 6 carriers/ port for NB-IoT SA max 2 carriers/ port and for GSM max 4 carriers/ port NB-IoT SA +WCDMA max 6 carriers/ port for IoT max 2 carriers/ port and for WCDMA max 5 carriers/ port NB-IoT SA +LTE max 6 carriers/ port for NB-IoT SA max 2 carriers/ port and for LTE max 5 carriers/ port

Channel bandwidths:	200 kHz
Modulations:	QPSK
RF power Tolerance:	+0.6/ -2.5 dB
CPRI Speed	Up to 10.1 Gbit/s
Nominal supply voltage:	-48VDC

The information above is supplied by the manufacturer.

Note: KRC 161 636/1 and KRC 161 636/3 are electrically identical according to the manufacturer.

Purpose of test

The purpose of this test is to justify a Permissive Change to include Single RAT NB IoT stand-alone operation, and Multi RAT NB IoT stand-alone + LTE, NB IoT stand-alone + WCDMA and NB IoT stand alone + GSM.

Operation modes during measurements

Measurements with multi RAT configuration was limited to NB IoT stand-alone + LTE representing worst case but includes configurations stated in section *Purpose of test.*
Measurements with NB IoT stand-alone carriers were performed with the test object transmitting test model N-TM representing QPSK as defined in 3GPP TS 36.141.
Measurements with LTE carriers measurements were performed with the test object transmitting test model E-TM1.1 representing QPSK as defined in 3GPP TS 36.141.

All measurements were performed with the test object configured for maximum transmit power. The measured configurations covers worst case settings.

The duty cycle was determined using the method described in ANSI 63.26 section 5.2.4.4.2. Then $10\log(\frac{1}{duty\ cycle})$ was added to the measured power level to compute the average power during constant transmission.
A 86 % duty cycle of the IoT carrier resulted in a 0.65 dBm adjustment added to the measured value.

In multi RAT mode, when added a LTE carrier the total combined duty cycle was 90.7 % calculated $10\log(\frac{1}{((1+0.86+0.86)/3)})$ resulting in a total power adjustment of 0.42 dBm.

Conducted measurements

The test object was supplied with -48 VDC by an external power supply. Additional connections are documented in the set-up drawings for conducted measurements.

Radiated measurements

The test object was powered with -48 VDC by an external power supply. Additional connections are documented in the set-up drawings for radiated measurements.

References

Measurements were done according to relevant parts of the following standards:
ANSI C63.4-2014
CFR 47 part 2, March 2018
CFR 47 part 24, March 2018
ANSI C63.26-2015
KDB 662911 D01 Multiple Transmitter Output v02r01
KDB 971168 D01 Power Meas License Digital Systems v03r01
KDB 971168 D03 IM Emission Repeater Amp v01
3GPP TS 36 141 version 13.6.0
3GPP TS 37.141, version 13.5.0
RSS-Gen Issue 4
RSS-133 Issue 6

Measurement equipment

	Calibration Due	RISE number
Test site Tesla	2019-12	503 881
R&S ESU 40	2018-07	901 385
R&S FSQ 40	2018-07	504 143
R&S FSW 43	2018-08	902 073
Control computer with R&S software EMC32 version 10.20.01	-	BX62351
High pass filter 3-26.5 GHz	2019-02	BX40074
High pass filter 3-26.5 GHz	2018-06	901 502
RF attenuator Weinschel WA73-20-11	2018-05	900 691
Coaxial cable Sucoflex 102EA	2018-05	BX50191
Coaxial cable Sucoflex 102EA	2018-05	BX50236
Coaxial cable Rosenberg	2018-08	503 508
Coaxial cable Rosenberg	2018-08	503 509
Coaxial cable Huber+Suhner	2018-09	BX62218
ETS Lindgren BiConiLog Antenna 3142E	2019-03	BX61914
EMCO Horn Antenna 3115	2019-12	502 175
Flann std gain horn 20240-20	-	503 674
µComp Nordic, Low Noise Amplifier	2019-01	901 545
Miteq, Low Noise Amplifier	2018-12	503 278
Temperature and humidity meter, Testo 635	2018-06	504 203
Temperature and humidity meter, Testo 625	2018-06	504 188

Uncertainties

Measurement and test instrument uncertainties are described in the quality assurance documentation ”SP-QD 10885”. The uncertainties are calculated with a coverage factor k=2 (95% level of confidence).
Compliance evaluation is based on a shared risk principle with respect to the measurement uncertainty.

Reservation

The test results in this report apply only to the particular test object as declared in the report.

Delivery of test object

The test object was delivered: 2018-01-26.

Manufacturer’s representative

Mikael Jansson, Ericsson AB.

Test engineers

Tomas Isbring for radiated tests, RISE
Andreas Johnson for conducted tests, RISE.

Test participant(-s)

None.

Test frequencies used for radiated and conducted measurements

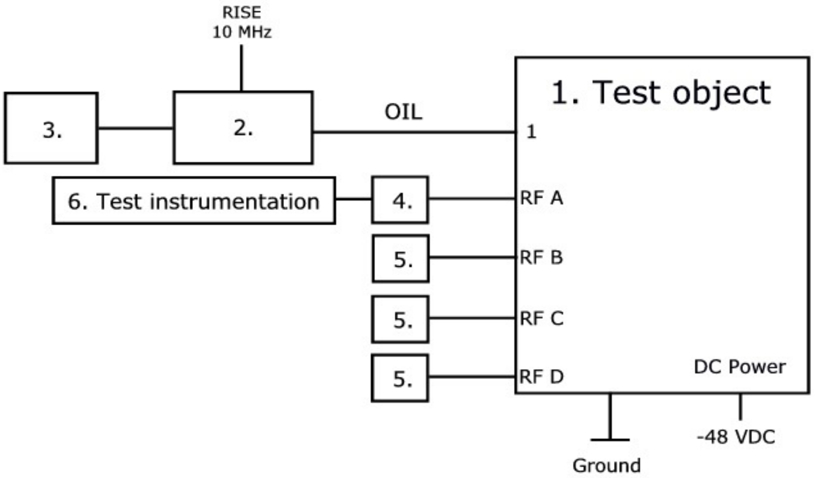
EARFCN Downlink B25	Frequency [MHz]	Symbolic name	Comment
8042	1930.2	IoTB	TX bottom frequency NB IoT stand alone
8365	1962.5	IoTM	TX mid frequency NB IoT stand alone
8688	1994.8	IoTT	TX top frequency NB IoT stand alone
8042 8238	1930.2 1949.8	IoT2B	2 carrier bottom frequencies config 1NB IoT stand alone
8492 8688	1975.2 1994.8	IoT2T	2 carrier top frequencies config 1 NB IoT stand alone
8042 8056	1930.2 1931.6	IoT2Bs	2 carrier bottom frequencies config 2 NB IoT stand alone
8674 8688	1993.4 1994.8	IoT2Ts	2 carrier top frequencies config 2 NB IoT stand alone
8042 8056 8215	1930.2 1931.6 1947.5	1L2IoTb	Multi RAT bottom configuration
8290 8449 8463	1955.0 1970.9 1972.3	1L2IoTm	Multi RAT mid configuration
8495 8674 8688	1977.5 1993.4 1994.8	1L2IoTt	Multi RAT top configuration

Test frequencies used for radiated measurements

EARFCN Downlink B25	Frequency [MHz]	Symbolic name	Comment
8042	1930.2	IoTB	TX bottom frequency NB IoT stand alone
8365	1962.5	IoTM	TX mid frequency NB IoT stand alone
8688	1994.8	IoTT	TX top frequency NB IoT stand alone
8042 8044	1930.2 1930.4	IoT2Bn	2 carrier TX bottom frequency NB IoT stand alone
8384 8386	1964.4 1964.6	IoT2Mn	2 carrier TX mid frequency config 1 NB IoT stand alone
8686 8688	1994.6 1994.8	IoT2Tn	2 carrier TX top frequency NB IoT stand alone
8686 8688	1952.7 1972.3	IoT2M	2 carrier TX mid frequency config 2 NB IoT stand alone
8042 8044 8213	1930.2 1930.4 1947.3	1L2IoT BIM	2 carriers TX SA-IoT + 1 carrier TX 1.4 MHz LTE, BIM configuration
8497 8686 8688	1975.7 1994.6 1994.8	1L2IoT TIM	1 carrier TX 1.4 MHz LTE + 2 carriers TX SA-IoT, TIM configuration
8042 8092 8213	1930.2 1935.2 1947.3	1L2IoT B	2 carriers TX SA-IoT + 1 carrier TX 1.4 MHz LTE, bottom configuration

All RX frequencies were configured 80 MHz above the corresponding TX frequency according the applicable duplex offset for the operating band.

Test setup: conducted measurements



Test object:

1.	Radio 4415 B2 B25, KRC 161 636/1, rev. R2B, s/n: B440941505 With Radio Software: CXP 901 7316/7, rev. R68LB. FCC ID: TA8AKRC161636 and IC: 287AB-AS161636

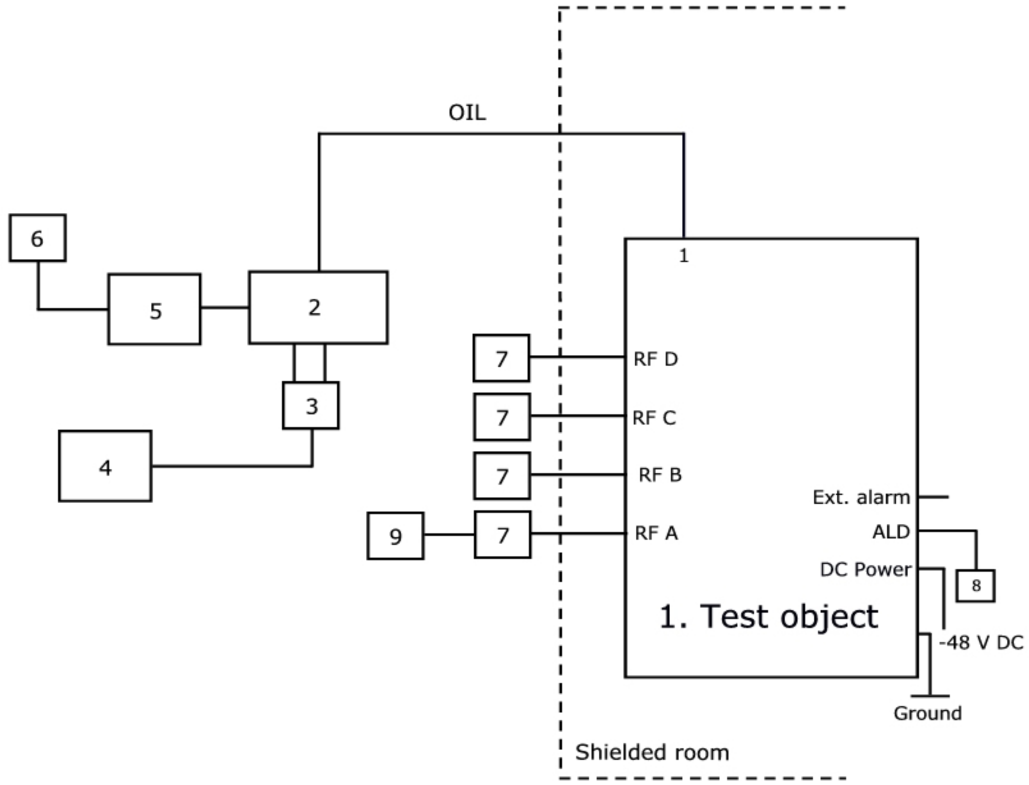
Associated equipment:

2.	RBS 6601 Main Unit: SUP 6601, 1/BFL 901 009/4, rev. R1E, s/n: BR81844322 DUS 41 01, KDU 137 624/1, rev. R5A/A, s/n: D16H292129 with software: CXP 102 051/27, rev. R22A156

Functional test equipment:

3.	Computer, HP EliteBook 8560w, BAMS - 1001236852
4.	RF Attenuator: RISE number: 900 691
5.	Terminator, 50 ohm
6.	RISE Test Instrumentation according to measurement equipment list for each test. The signal analyzer was connected to the RISE 10 MHz reference standard during all measurements.

Test setup: radiated measurements



1.	Radio 4415 B2 B25, KRC 161 636/1, rev. R2B, s/n: B440941505 With Radio Software: CXP 901 7316/7, rev. R68LB. FCC ID: TA8AKRC161636 and IC: 287AB-AS161636

Associated equipment:

2.	RBS 6601 Main Unit: SUP 6601, 1/BFL 901 009/4, rev. R1E, s/n: BR81844322 DUS 41 01, KDU 137 624/1, rev. R5A/A, s/n: D16H292129 with software: CXP 102 051/27, rev. R22A156
3.	Netgear switch GS108E
5.	GPS 02 01, NCD 901 41/1, rev. R1D, s/n: TU8KH75515
6.	GPS Active Antenna, KRE 101 2082/1

Functional test equipment:

4.	Computer, HP EliteBook 8560w, BAMS - 1001236852
7.	Attenuator
8.	ALD Control, Andrew, model: ATM200-A20, s/n: DESA101412073
9.	R&S ESIB 26, RISE number: 503 292, for supervision purpose only

Interfaces:

Power input configuration DC: -48 VDC	Power
RF A, 4.3-10 connector, combined TX/RX	Antenna
RF B, 4.3-10 connector, combined TX/RX	Antenna
RF C, 4.3-10 connector, combined TX/RX	Antenna
RF D, 4.3-10 connector, combined TX/RX	Antenna
1, Optical Interface Link, single mode opto fibre	Signal
2, Optical Interface Link, not used in this configuration	Signal
EXT Alarm, shielded multi-wire	Signal
ALD, shielded multi-wire	Signal
Ground wire	Ground

RF power output measurements according to CFR 47 §24.232 / IC RSS-133 6.4, conducted

Date	Temperature	Humidity
2018-02-22	21 °C ± 3 °C	18 % ± 5 %
2018-02-27	25 °C ± 3 °C	12 % ± 5 %
2018-03-01	28 °C ± 3 °C	12 % ± 5 %

Test set-up and procedure

The measurements were made per definition in ANSI C63.26, 5.2.3.4. The test object was connected to a signal analyser measuring peak and RMS output power in CDF mode. A resolution bandwidth of 80 MHz was used.

Measurement equipment	RISE number
R&S FSW 43	902 073
Coaxial cable Sucoflex 102EA	BX50191
Coaxial cable Sucoflex 102EA	BX50236
RF attenuator	900 691
Testo 635, temperature and humidity meter	504 203

Measurement uncertainty: 1.1 dB

Results

Single carrier N-TM

Rated output power level at each RF port 1x 43 dBm.

	Output power CCDF [RMS dBm/ PAR dB]				
Symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
IoTB	42.65/ 5.58	42.59/5.48	42.74/ 5.51	42.61/ 5.48	48.67
IoTM	42.49/ 5.60	42.75/ 5.45	42.86/ 5.51	42.76/ 5.48	48.74
IoTT	42.22/ 5.66	42.14/ 5.52	42.29/ 5.58	42.28/ 5.52	48.25

[1)]: In-band power measurements according to ANSI C63.26 section 6.4.3.1
Note: The PAR value is the 0.1 % Peak to Average Ratio.

Multi carrier N-TM

Rated output power level at each RF port 2x 43 dBm.

	Output power CCDF [RMS dBm/ PAR dB]				
Symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
IoT2B	45.10/ 7.62	45.03/ 7.64	45.14/ 7.70	45.16/ 7.70	51.13
IoT2T	45.32/ 7.66	45.24/ 7.64	45.37/ 7.68	45.16/ 7.68	51.29

Multi RAT IoT: N-TM, LTE: E-TM 1.1

	Output power CCDF [RMS dBm/ PAR dB]				
Symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
1L2IoT	45.11/ 7.60	45.09/ 7.62	45.13/ 7.60	45.06/ 7.62	51.12
1L2IoTm	45.27/ 7.60	45.26/ 7.60	45.26/ 7.60	45.31/ 7.60	51.30

[1)]: In-band power measurements according to ANSI C63.26 section 6.4.3.1
Note: The PAR value is the 0.1 % Peak to Average Ratio.

Single carrier N-TM

Rated output power level at RF connector 1x 43 dBm/ port.

	Output power per 1 MHz [RMS dBm]				
Symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[2)]
IoTM	42.97	43.12	43.28	43.02	49.28

[2)]: Measure and add 10 log(N_{ant}) according to ANSI C63.26 section 6.4.3.2.4

Remark

ERP/EIRP compliance is addressed at the time of licensing. as required by the responsible FCC/IC Bureau(s). Licensee's are required to take into account maximum antenna gain used in combination with above power settings to prevent the radiated output power to exceed the limits.

Limits

§24.232	The maximum output power may not exceed 3280 W/MHz (EIRP). The Peak to Average Ratio (PAR) may not exceed 13 dB.
RSS-133	The maximum equivalent isotopically radiated power (EIRP) limits in SRSP-510 apply, resulting in a maximum EIRP of 3280 W/MHz. The Peak to Average Ratio (PAR) may not exceed 13 dB.

Complies?	Yes

Occupied bandwidth measurements according to CFR47 2.1049 / RSS-Gen 6.6

Date	Temperature	Humidity
2018-02-27	25 °C ± 3 °C	12 % ± 5 %

Test set-up and procedure

The measurements were made per definition in ANSI C63.26, 5.4.4. The output was connected to a signal analyzer with the Peak detector activated in max hold.

Measurement equipment	RISE number
R&S FSW 43	902 073
Coaxial cable Sucoflex 102EA	BX50191
Coaxial cable Sucoflex 102EA	BX50236
RF attenuator	900 691
Testo 635. temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier N-TM

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [kHz]
1	IoTB	RF A	199.2
2	IoTM	RF A	198.6
3	IoTT	RF A	199.1
4	IoTM	RF B	198.4
5	IoTM	RF C	187.0
6	IoTM	RF D	195.8

Diagram 1:

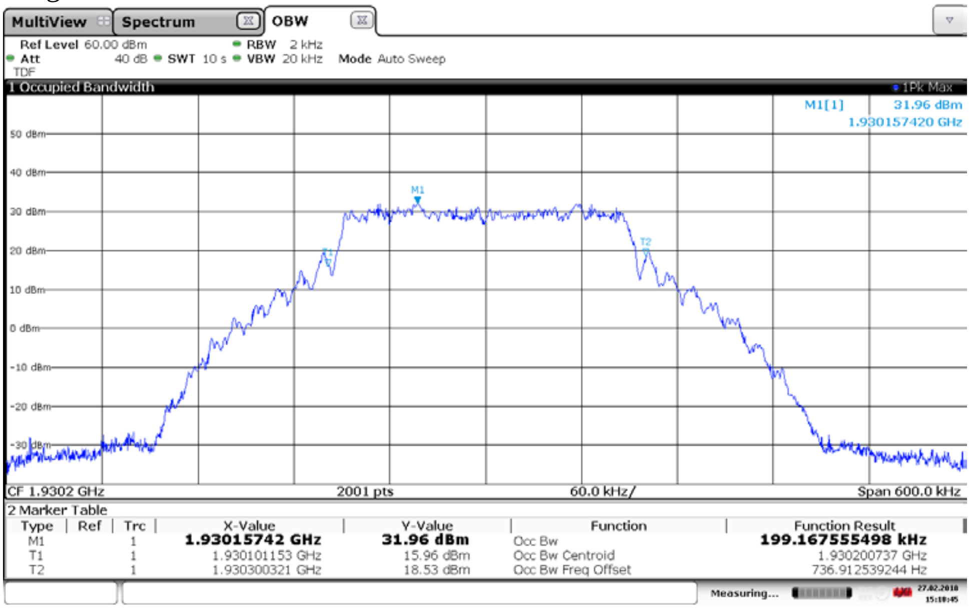


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Diagram 2:

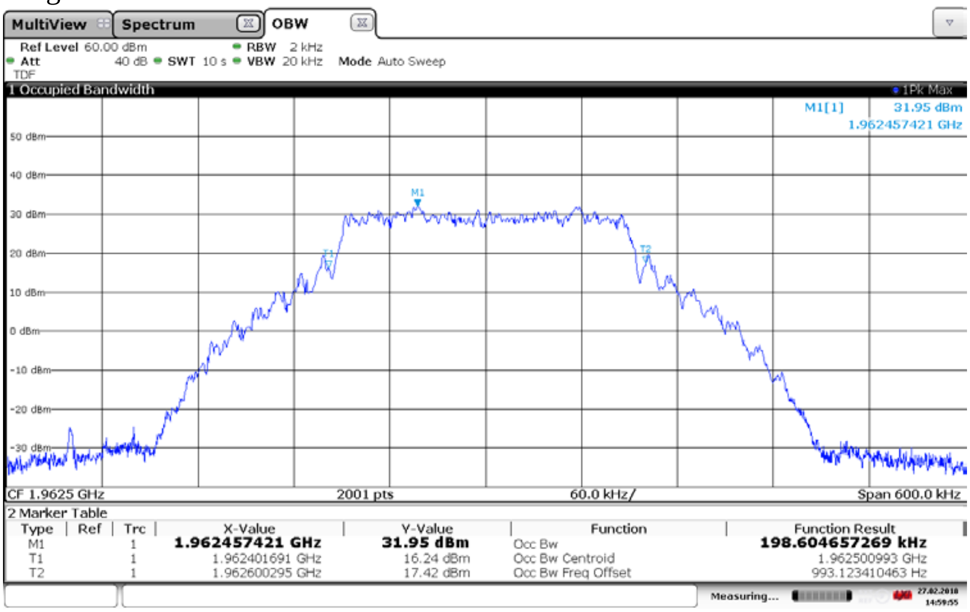

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Diagram 3:

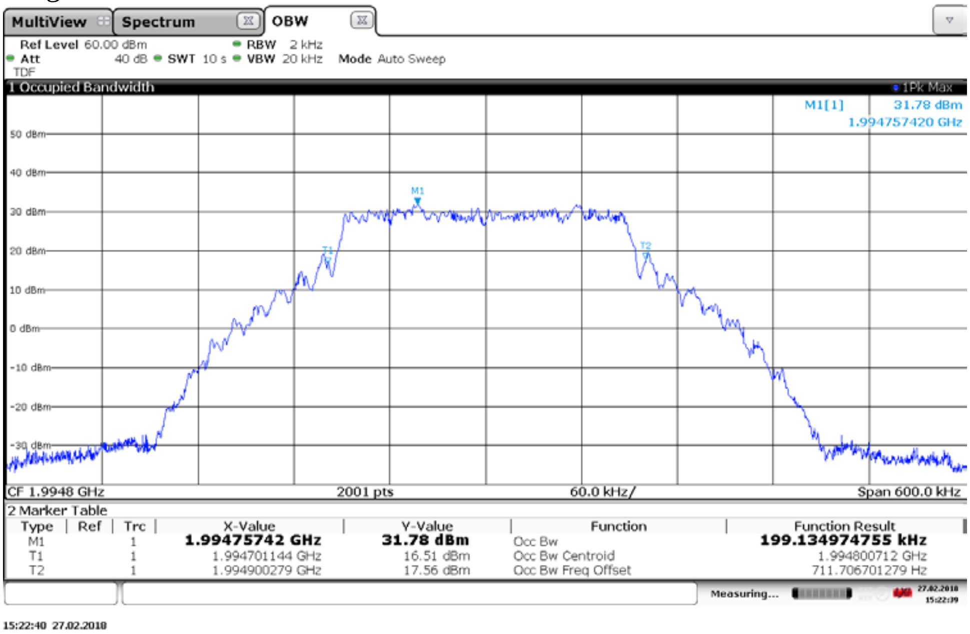


Diagram 4:

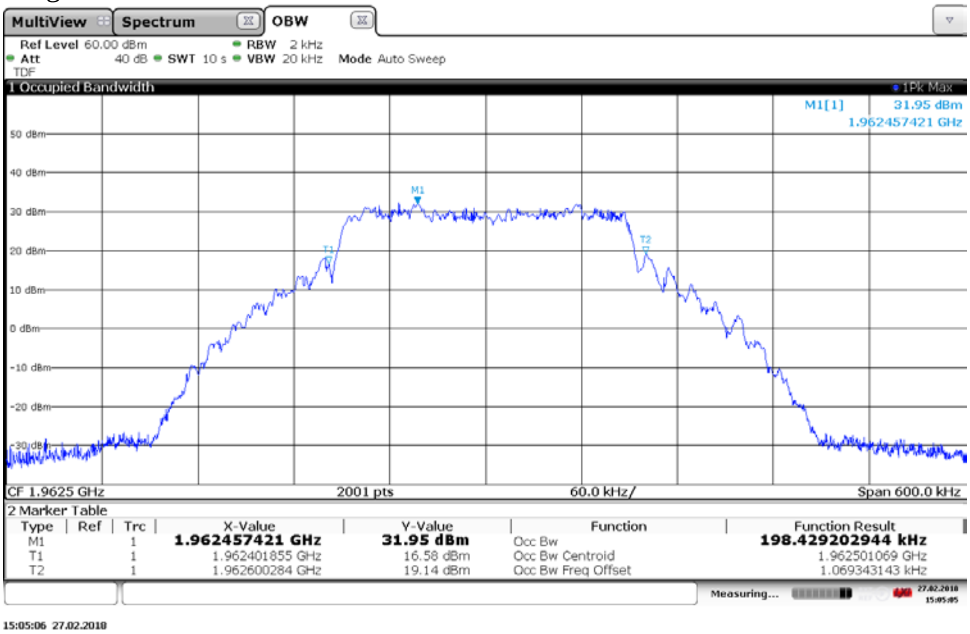


Diagram 5:

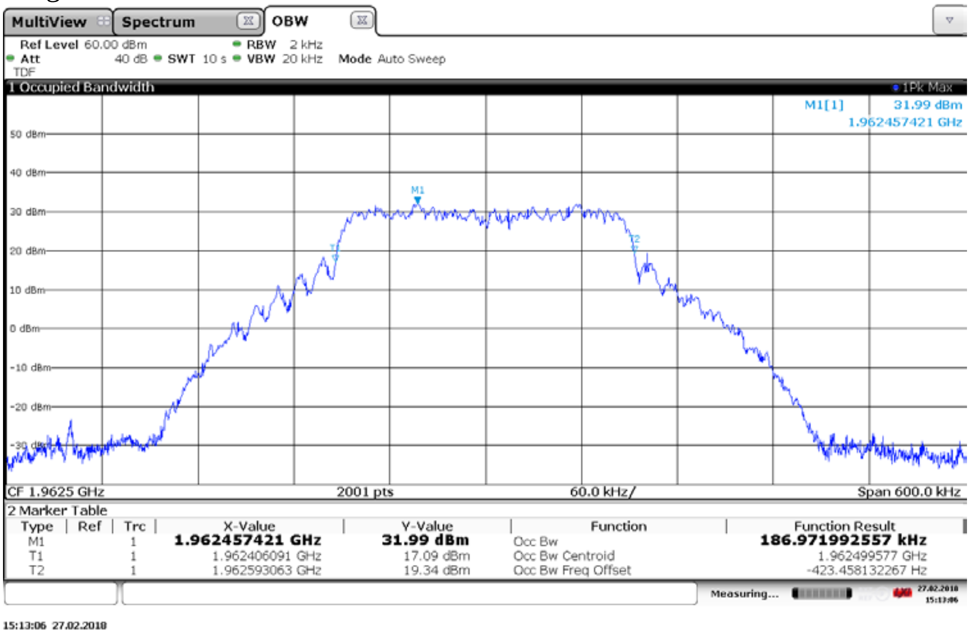
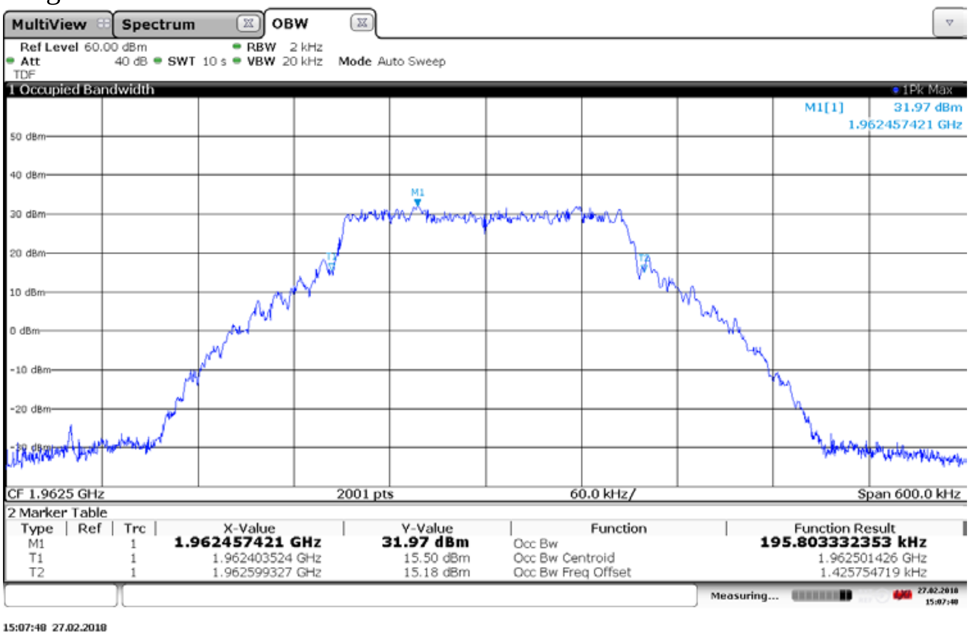


Diagram 6:



Band edge measurements according to CFR 47 §2.1049

Date	Temperature	Humidity
2018-02-27	25 °C ± 3 °C	12 % ± 5 %
2018-02-28	25 °C ± 3 °C	12 % ± 5 %
2018-04-06	22 °C ± 3 °C	9 % ± 5 %

Test set-up and procedure

The measurements were made per definition in ANSI C63.26, 5.7.3. The test object was connected to a spectrum analyzer with the RMS detector activated.

A RBW 1% of EBW was used up to 1 MHz away from the band edges. A smaller resolution bandwidth is permitted provided that the measured power is integrated over the full required measurement bandwidth. Where a smaller RBW was used the limit in the plot is adjusted by 10 log (RBW_{used}/$RBW_{specified}$) [dB] according to the following table:

Carrier BW	RBW_{used}	$RBW_{specified}$ (1% of EBW)	Limit correction	Adjusted limit
200 kHz	2 kHz	2.88kHz	-1.6 dBm	-14.6 dBm

From 1 MHz to 30 MHz away from the band edges a RBW of 100 kHz was used. To compensate for the reduced RBW the limit was adjusted by 10 dB to -23 dBm in this frequency range.

Measurement equipment	RISE number
R&S FSW 43	902 073
Coaxial cable Sucoflex 102EA	BX50191
Coaxial cable Sucoflex 102EA	BX50236
RF attenuator	900 691
Testo 635. temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier N-TM

Diagram	Symbolic name	Tested Port
1 a-b	IoTB	RF A
2 a-b	IoTT	RF A
3 a-b	IoTB	RF B
4 a-b	IoTT	RF B
5 a-b	IoTB	RF C
6 a-b	IoTT	RF C
7 a-b	IoTB	RF D
8 a-b	IoTT	RF D

Multi carrier N-TM

Diagram	Symbolic name	Tested Port
9 a-b	IoT2Bs	RF A
10 a-b	IoT2Ts	RF A
11 a-b	IoT2Bs	RF B
12 a-b	IoT2Ts	RF B
13 a-b	IoT2Bs	RF C
14 a-b	IoT2Ts	RF C
15 a-b	IoT2Bs	RF D
16 a-b	IoT2Ts	RF D

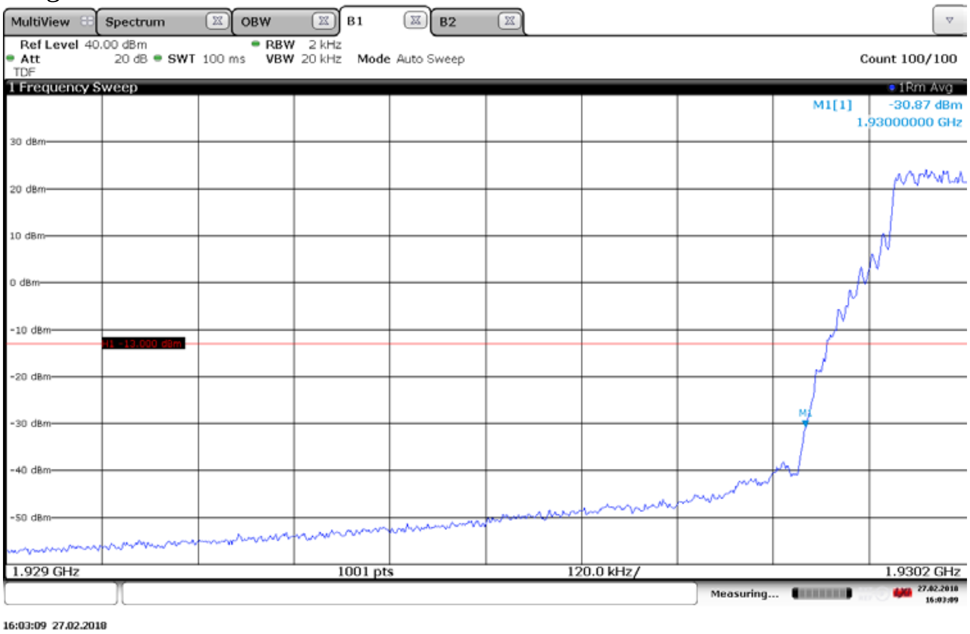
Limits

CFR 47 §24.238 and RSS-133 6.5

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

Diagram 1a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 1b:

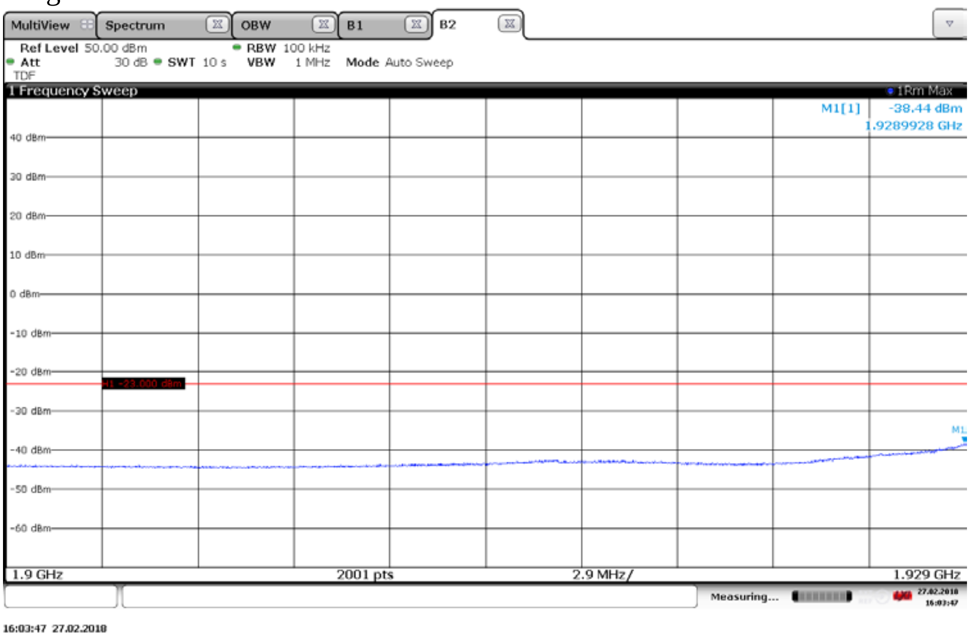
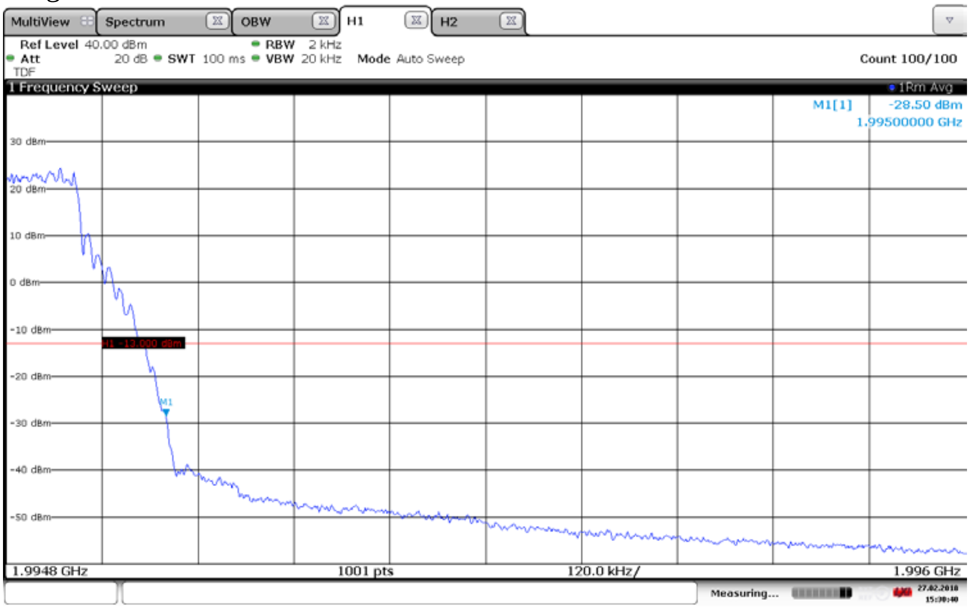


Diagram 2a:



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Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 2b:

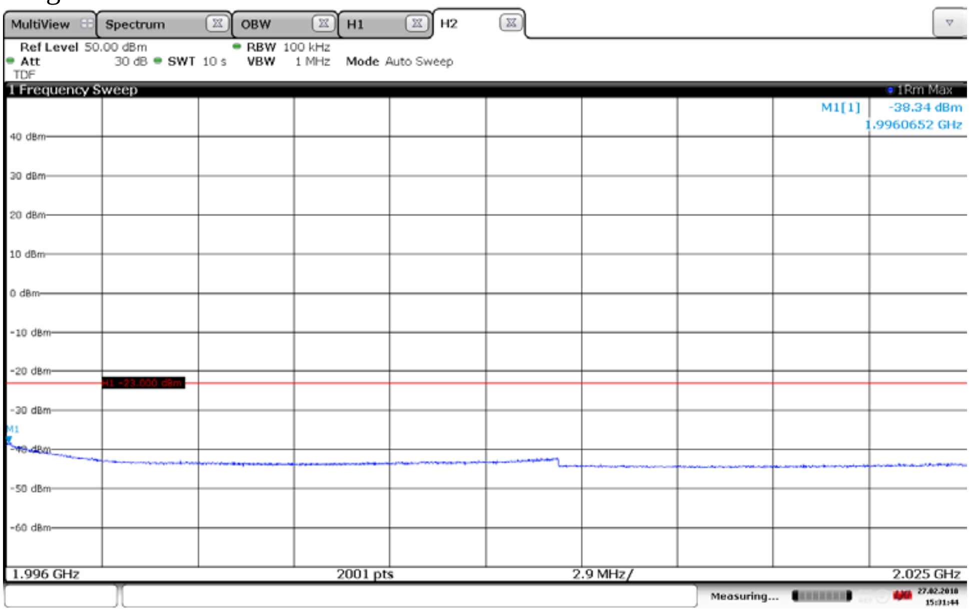

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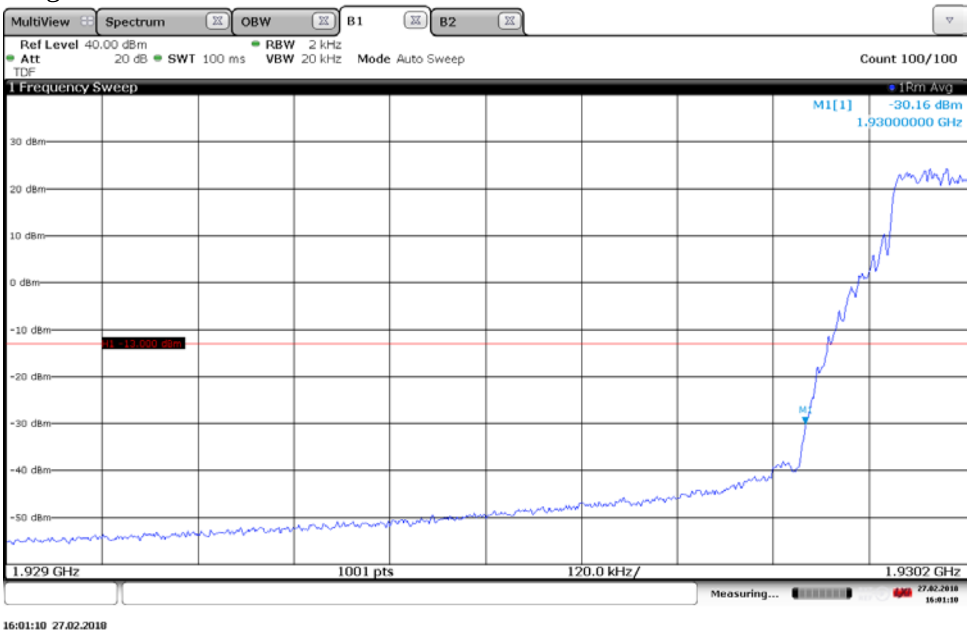
Diagram 3a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 3b:

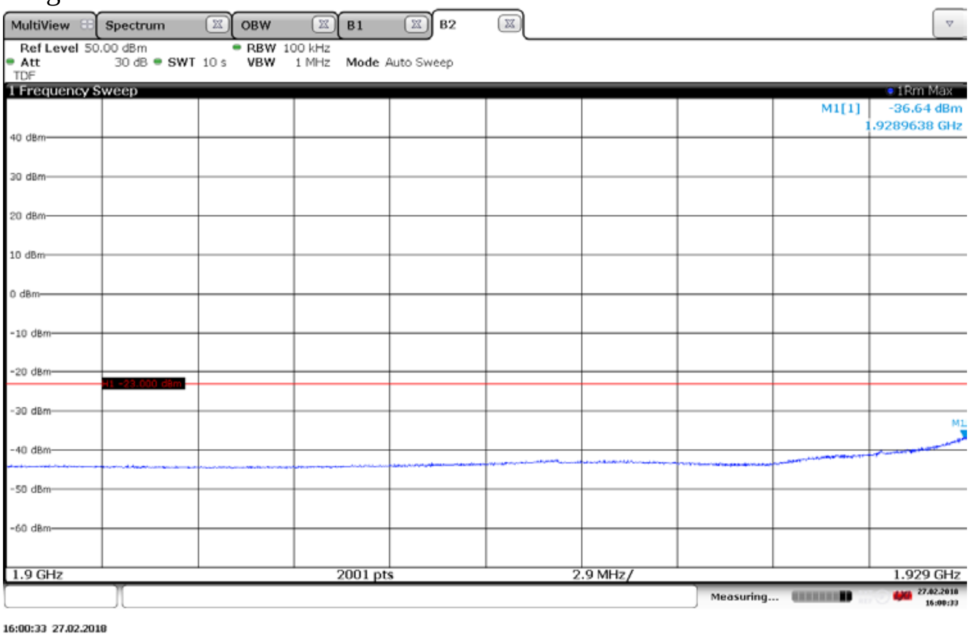
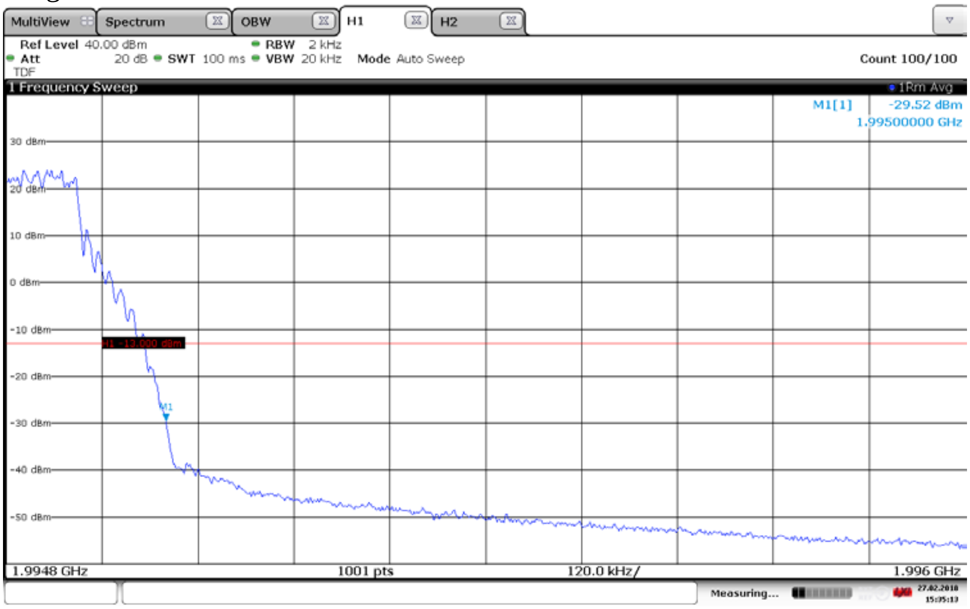


Diagram 4a:



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Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 4b:

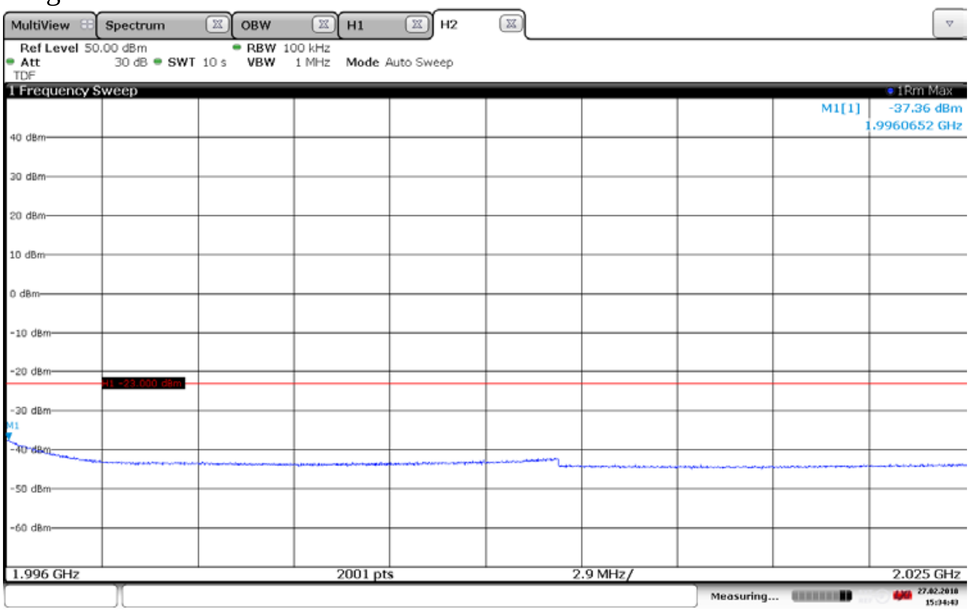

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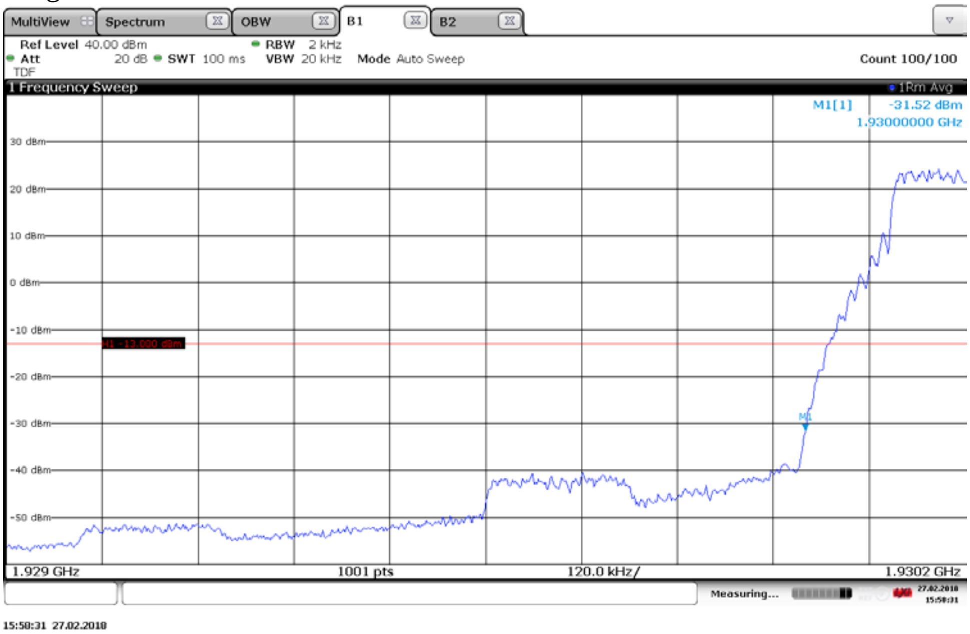
Diagram 5a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 5b:

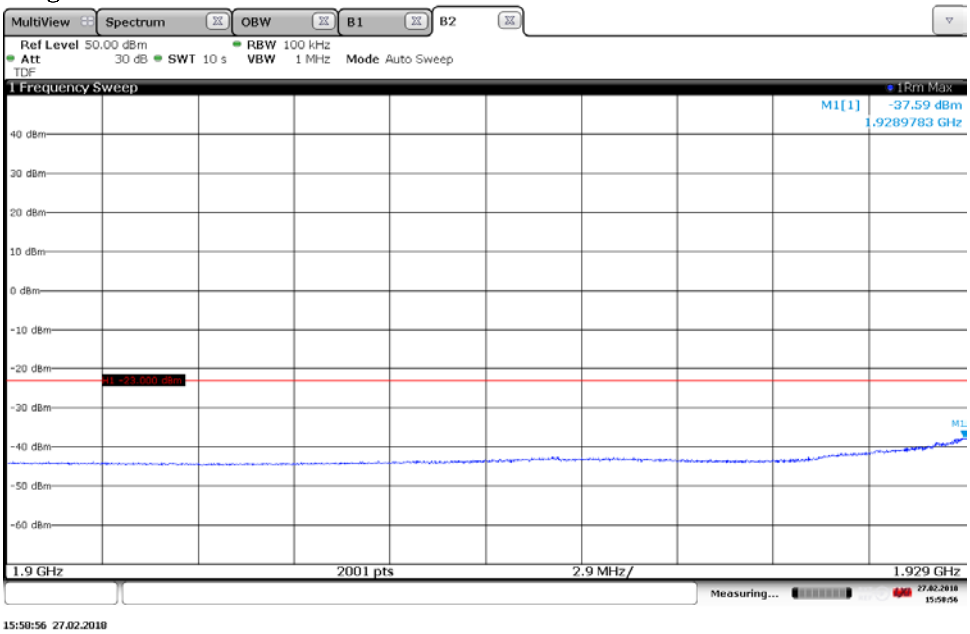
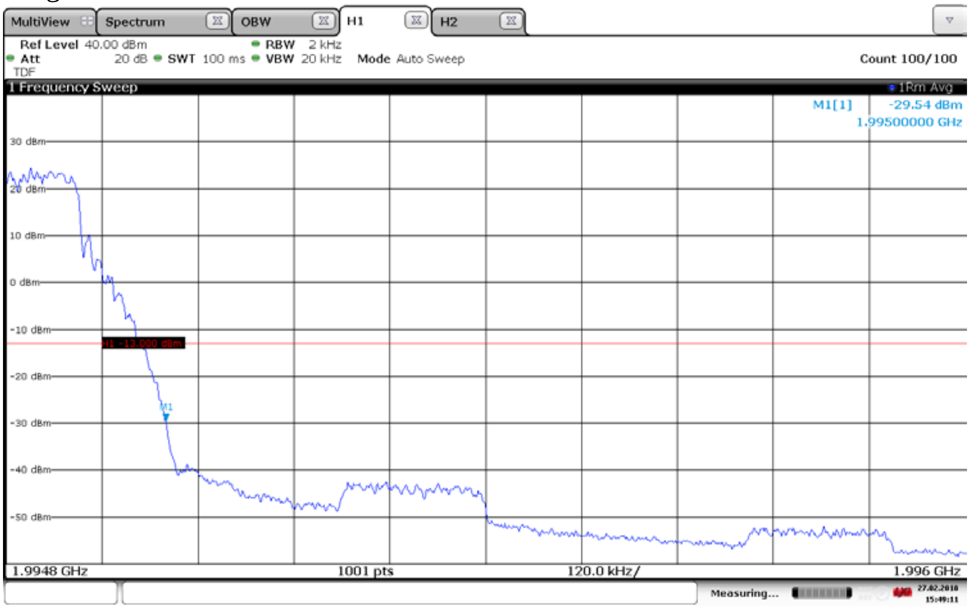


Diagram 6a:



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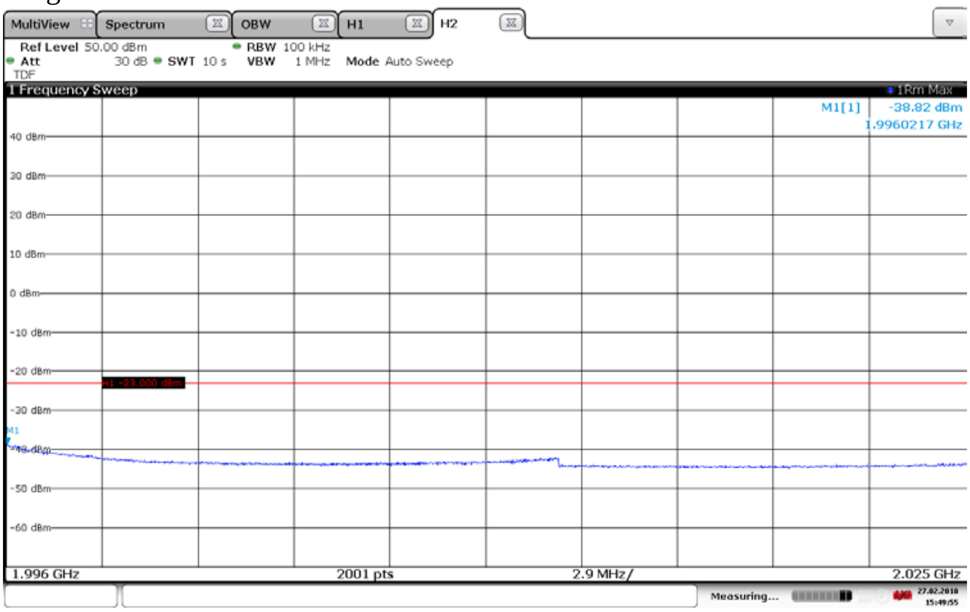
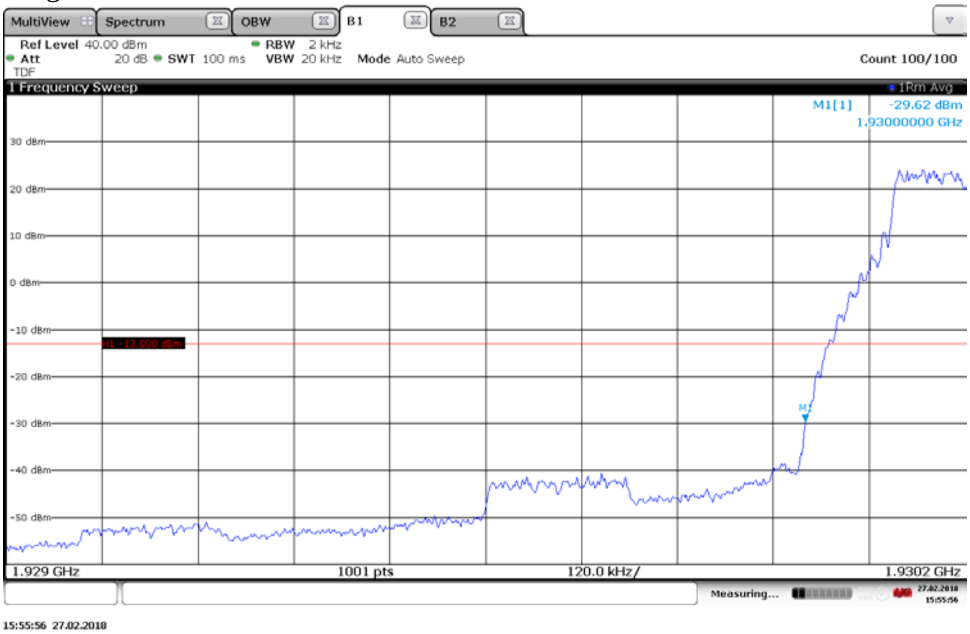
Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 6b:



15:49:56 27.02.2018

Diagram 7a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 7b:

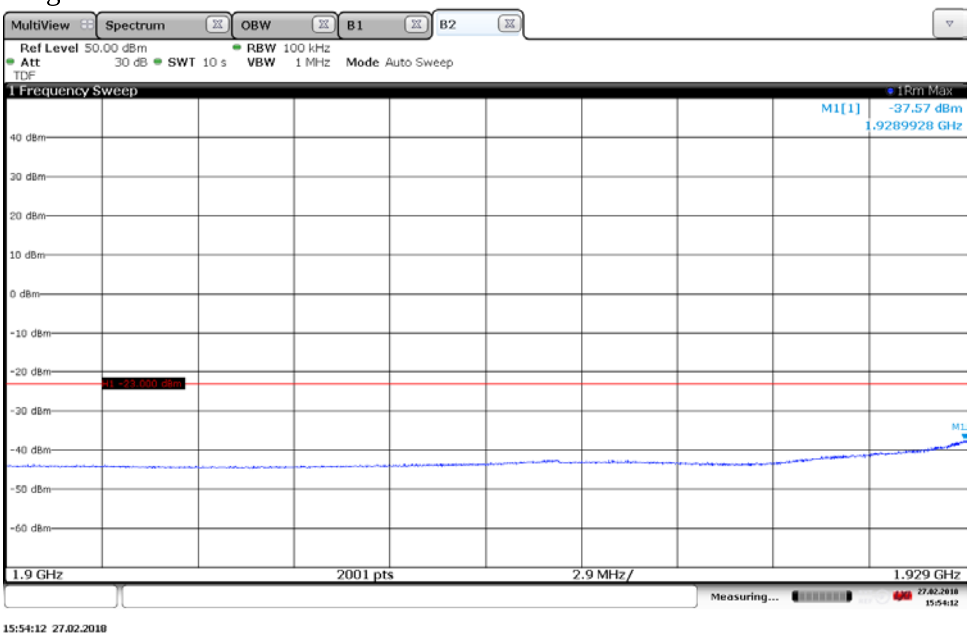
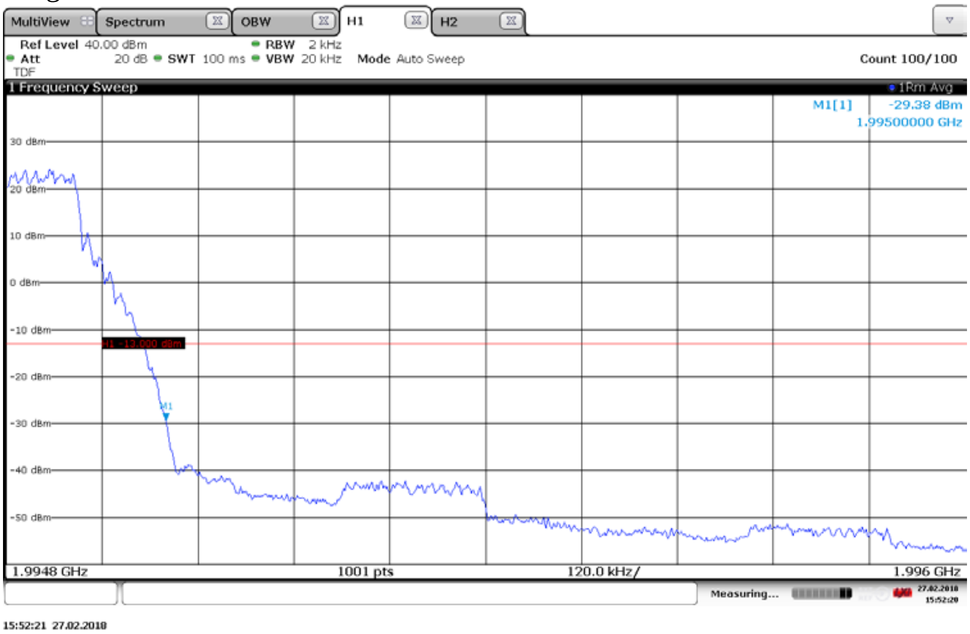


Diagram 8a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 8b:

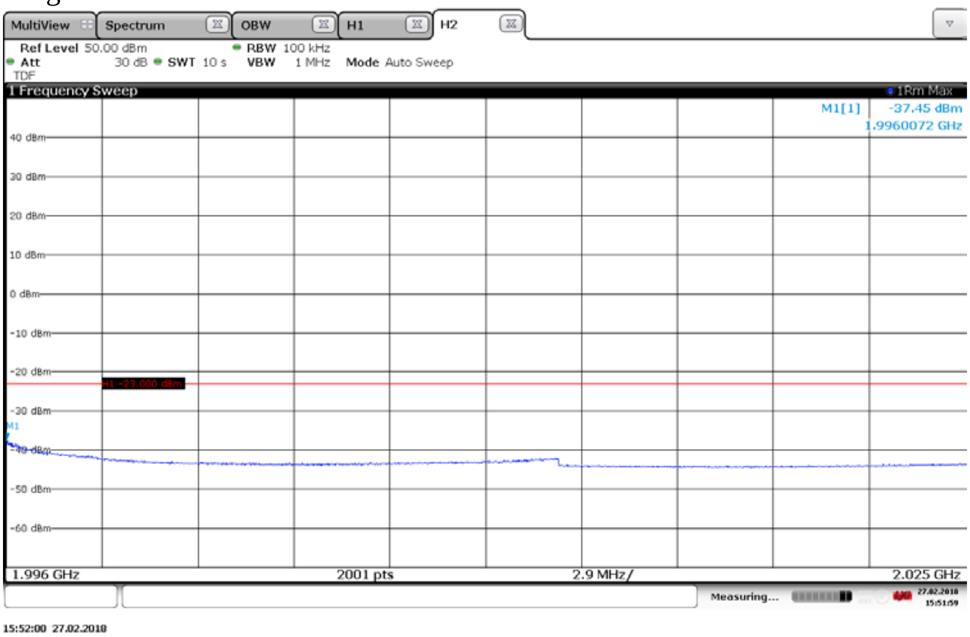
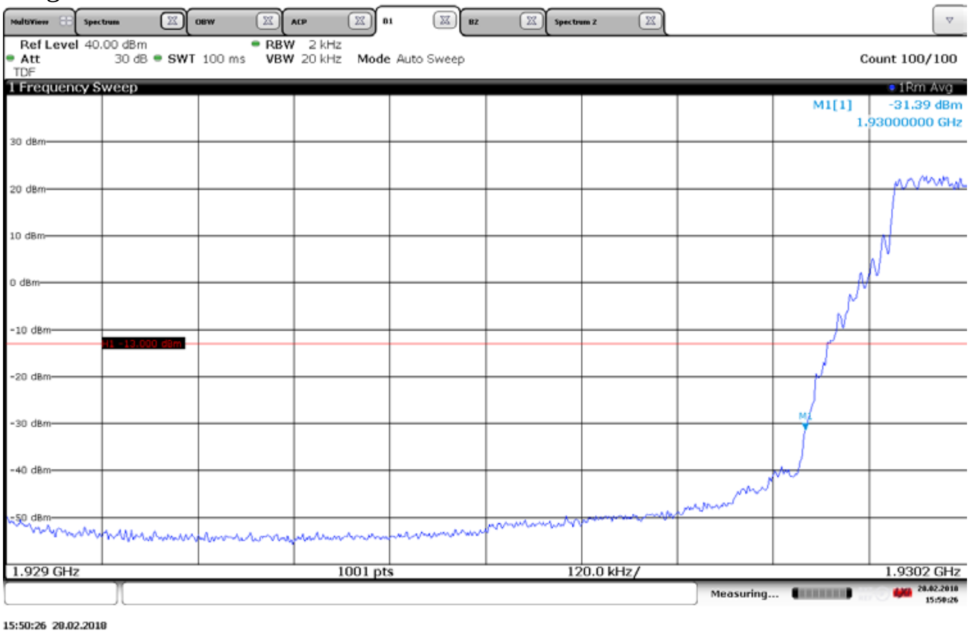


Diagram 9a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 9b:

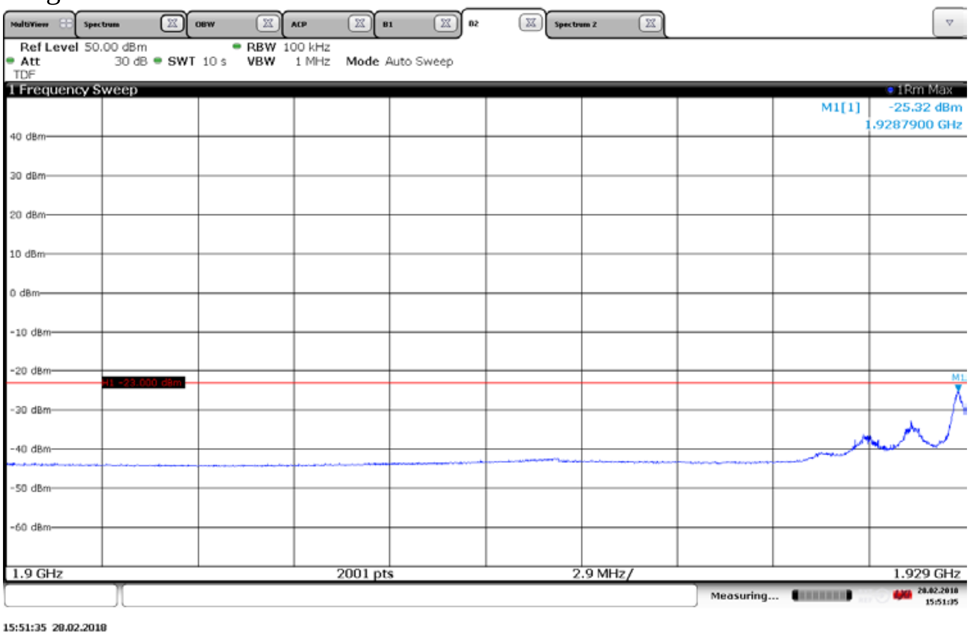
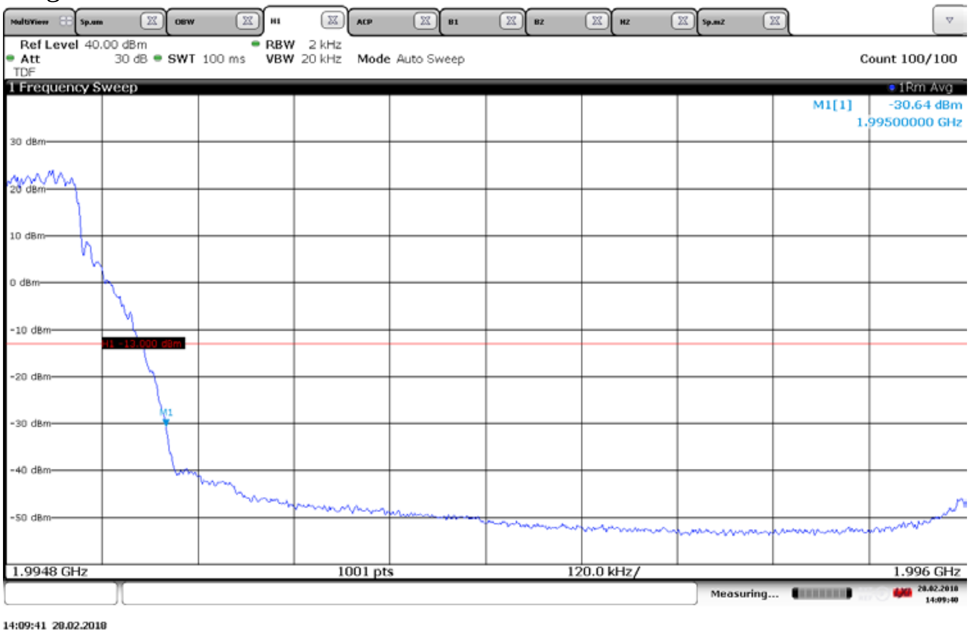
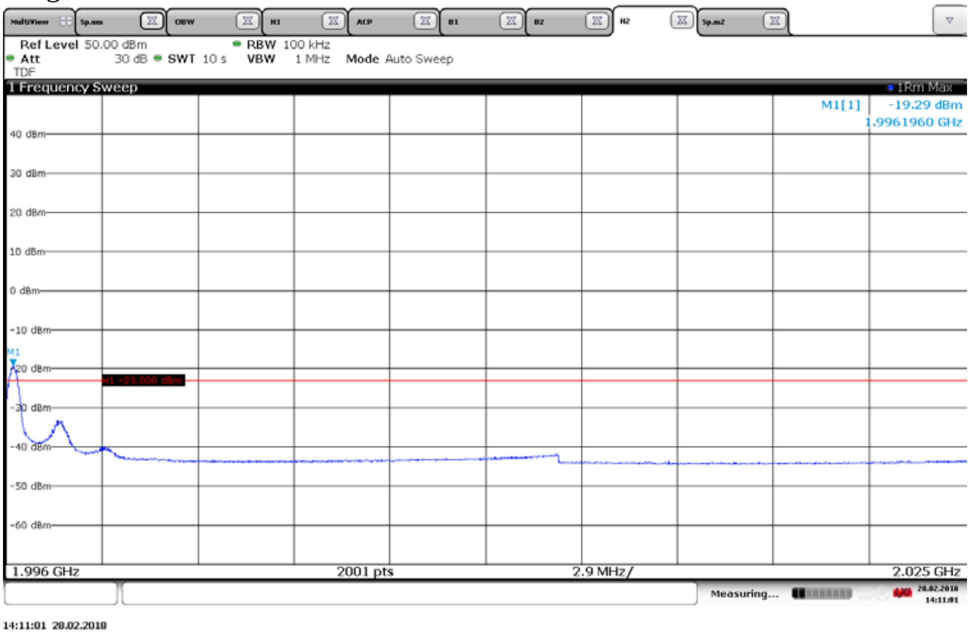


Diagram 10a:



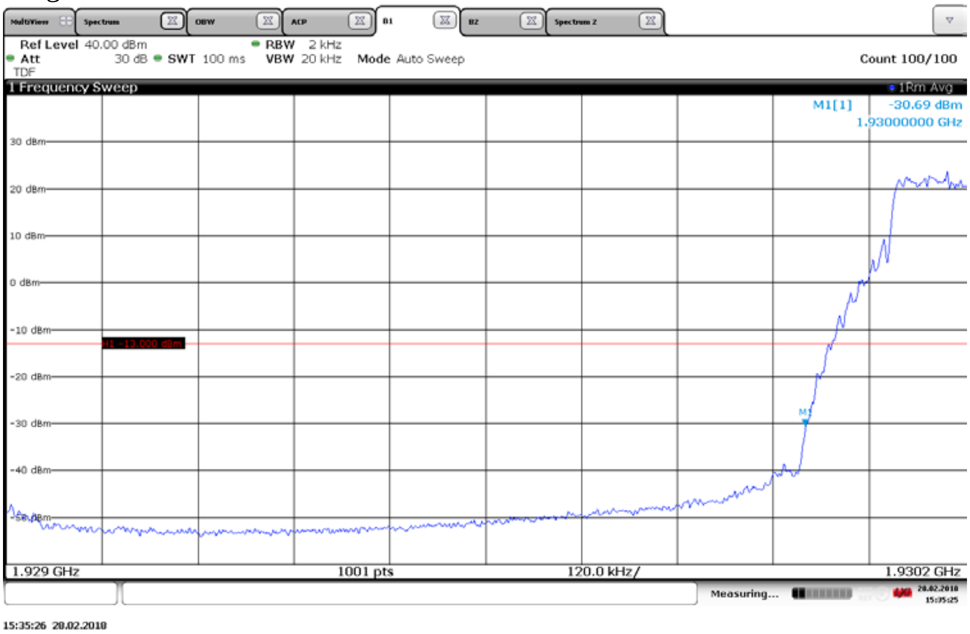
Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 10b:



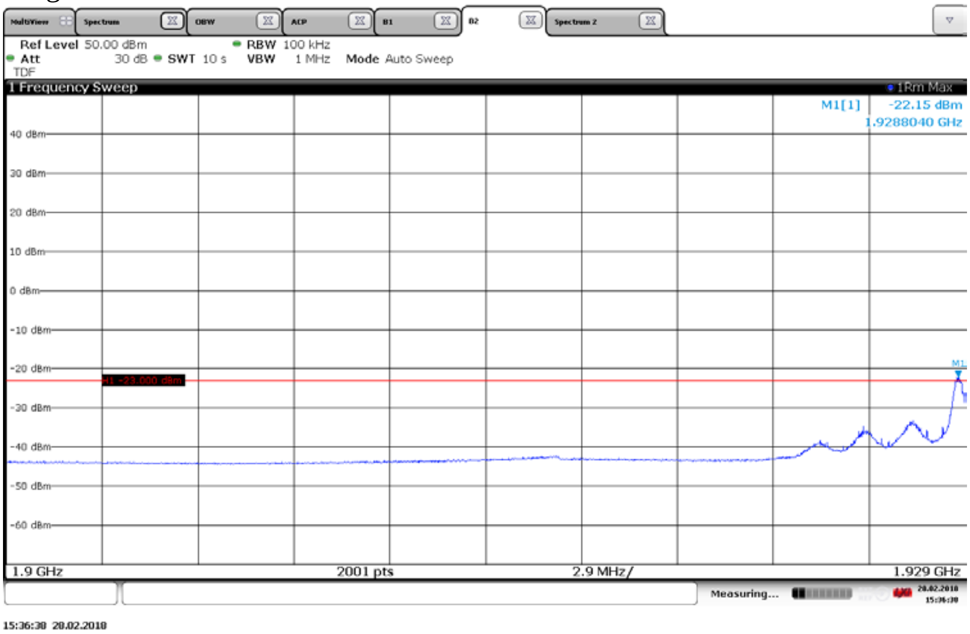
The emission at 1996.2 MHz was -15.68 dBm measured with the channel power method with 1 MHz channel bandwidth. The result should be compared to the limit -13 dBm.

Diagram 11a:



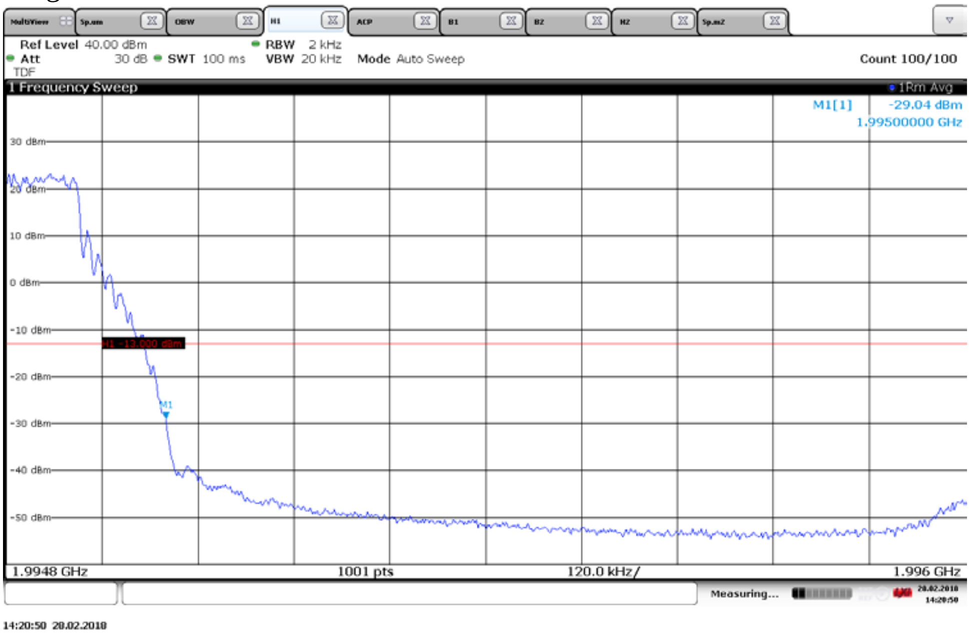
Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 11b:



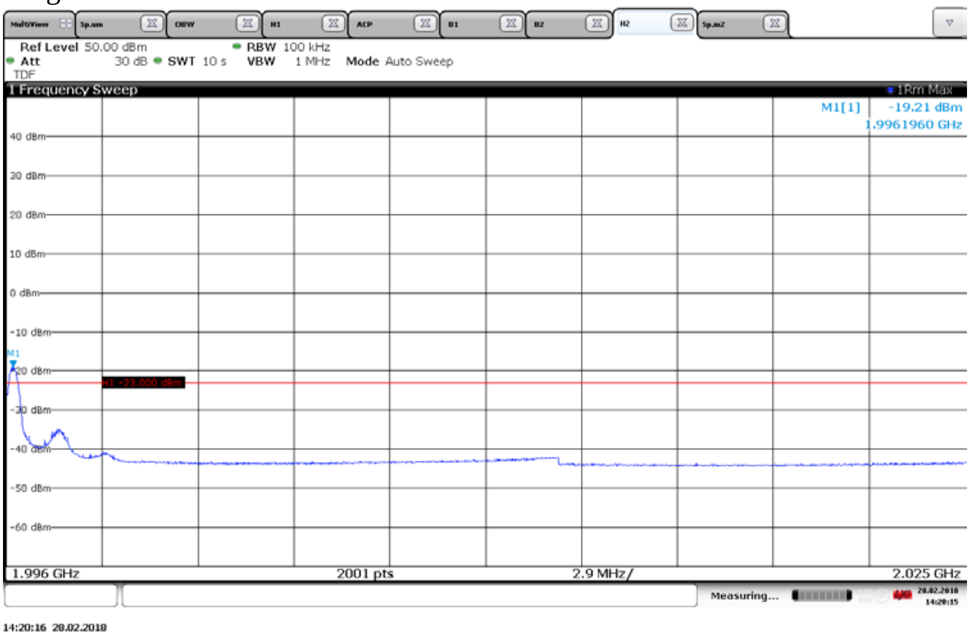
The emission at 1928.8 MHz was -18.49 dBm measured with the channel power method with 1 MHz channel bandwidth. The result should be compared to the limit -13 dBm.

Diagram 12a:



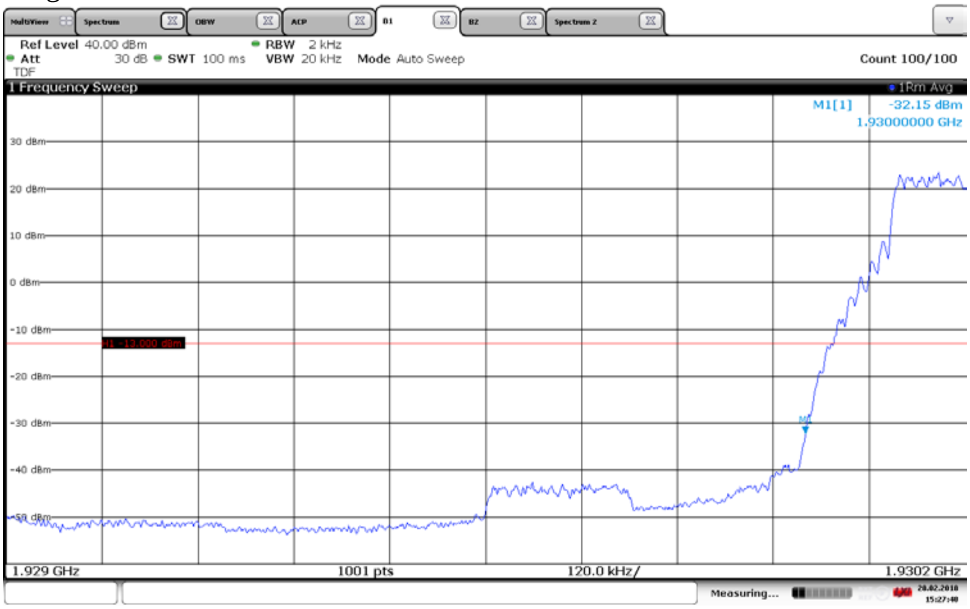
Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 12b:



The emission at 1996.2 MHz was -15.22 dBm measured with the channel power method with 1 MHz channel bandwidth. The result should be compared to the limit -13 dBm.

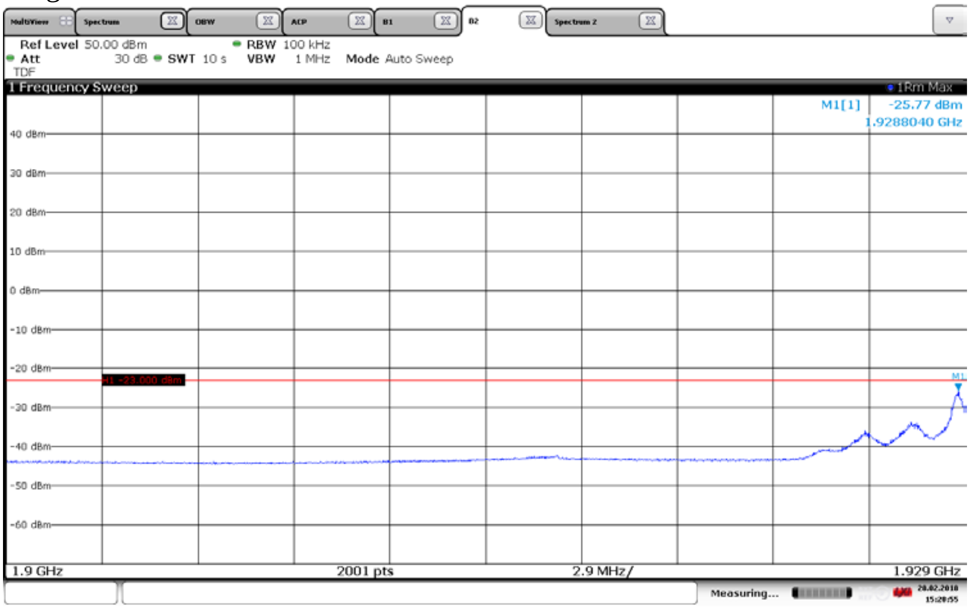
Diagram 13a:



15:27:49 20.02.2018

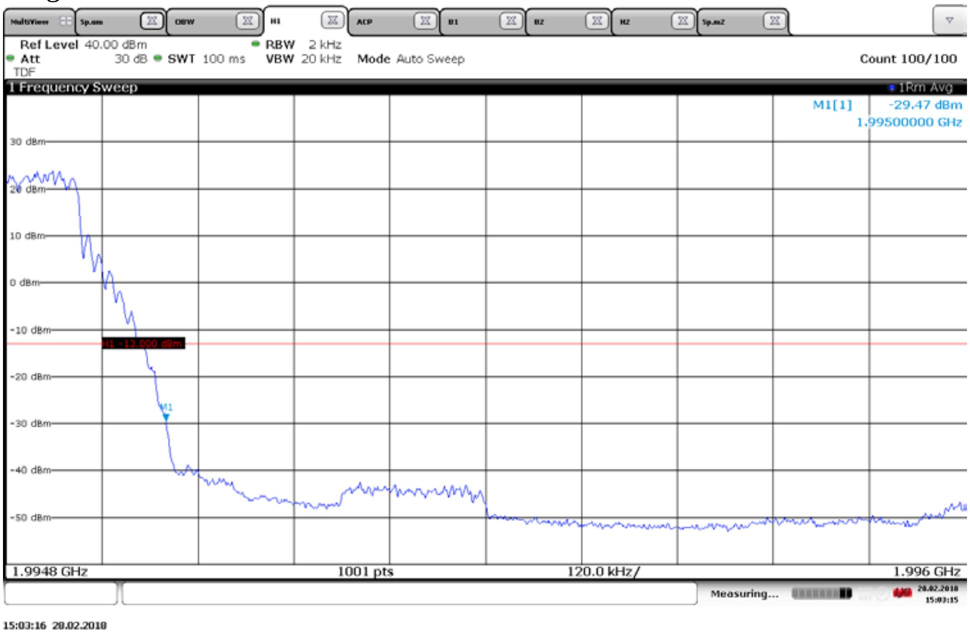
Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 13b:



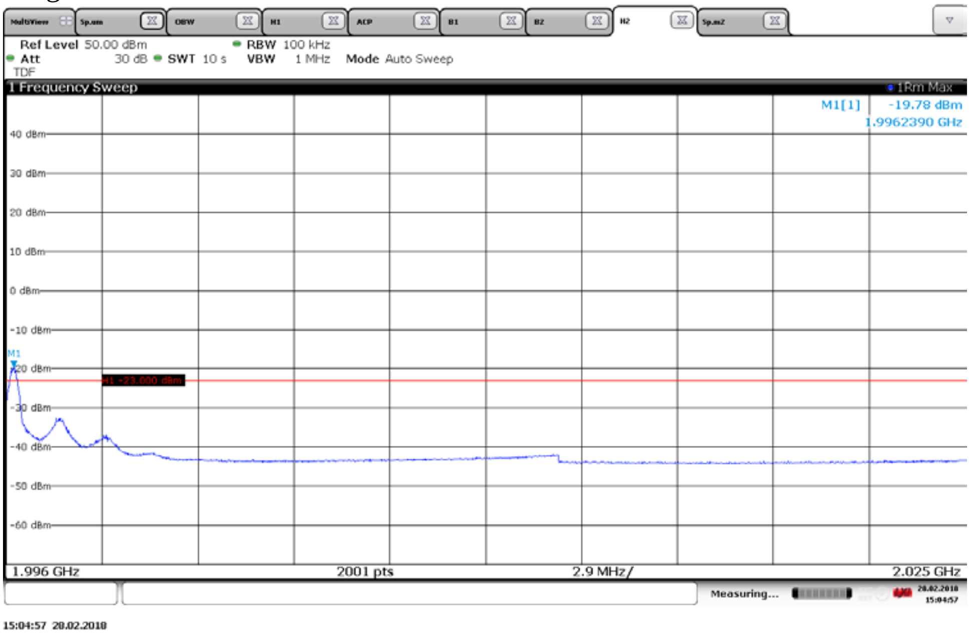
15:28:56 20.02.2018

Diagram 14a:



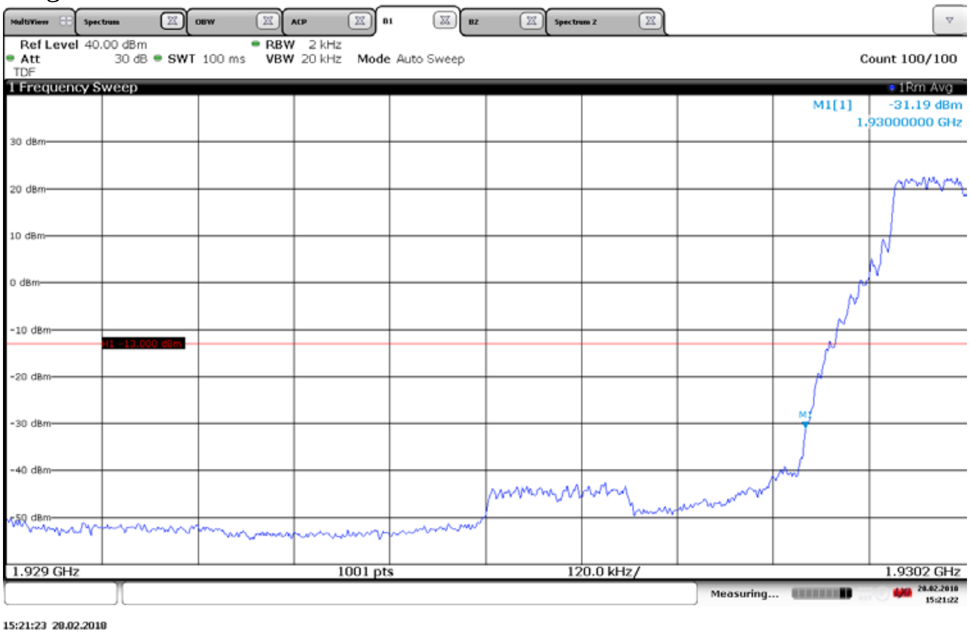
Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 14b:



The emission at 1996.2 MHz was -16.66 dBm measured with the channel power method with 1 MHz channel bandwidth. The result should be compared to the limit -13 dBm.

Diagram 15a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 15b:

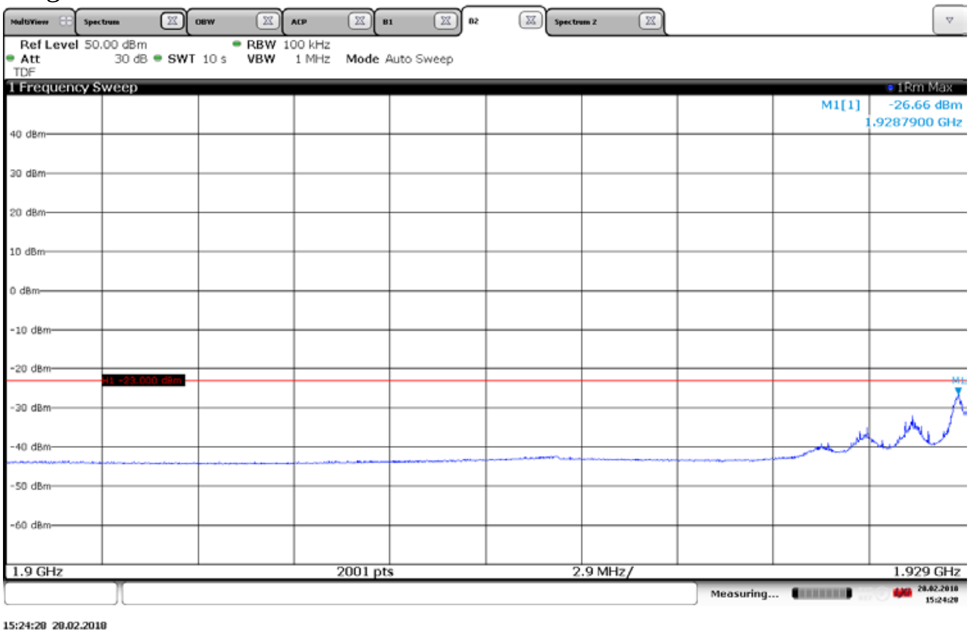
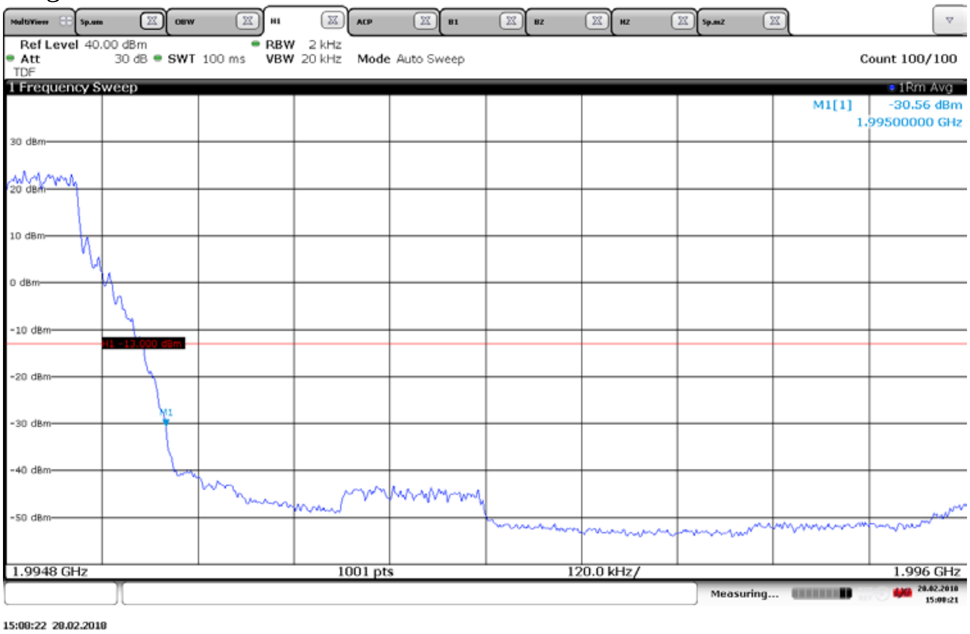
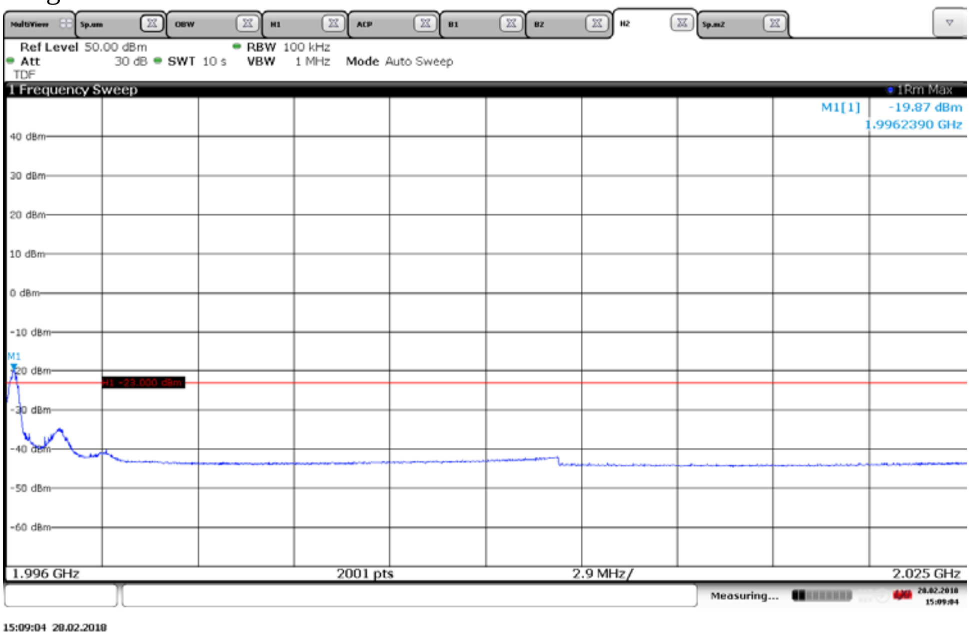


Diagram 16a:



Note: The limit in the diagram shall be -14.6 dBm instead of -13 dBm.

Diagram 16b:



The emission at 1996.2 MHz was -16.55 dBm measured with the channel power method with 1 MHz channel bandwidth. The result should be compared to the limit -13 dBm.

Conducted spurious emission measurements according to CFR 47 §24.238 / IC RSS-133 6.2

Date	Temperature	Humidity
2018-02-28	25 °C ± 3 °C	12 % ± 5 %
2018-03-01	28 °C ± 3 °C	12 % ± 5 %
2018-04-06	22 °C ± 3 °C	9 % ± 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
Coaxial cable Sucoflex 102EA	BX50191
Coaxial cable Sucoflex 102EA	BX50236
RF attenuator	900 691
HP filter	BX40074
Testo 635. temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier N-TM

Diagram	Symbolic name	Tested Port
1 a-b	IoTB	RF A
2 a-b	IoTB	RF B
3 a-b	IoTB	RF C
4 a-b	IoTM	RF C
5 a-b	IoTT	RF C
6 a-b	IoTB	RF D

Multi carrier N-TM

Diagram	Symbolic name	Tested Port
7 a-c	IoT2B	RF C
8 a-c	IoT2Ts	RF C

Multi RAT IoT: N-TM, LTE: E-TM1.1

Diagram	Symbolic name	Tested Port
9 a-c	1L2IoTb	RF C
10 a-c	I1L2IoTt	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.

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 1995 MHz. The measurements were made up to 20 GHz (10x1995 MHz = 19950 MHz).

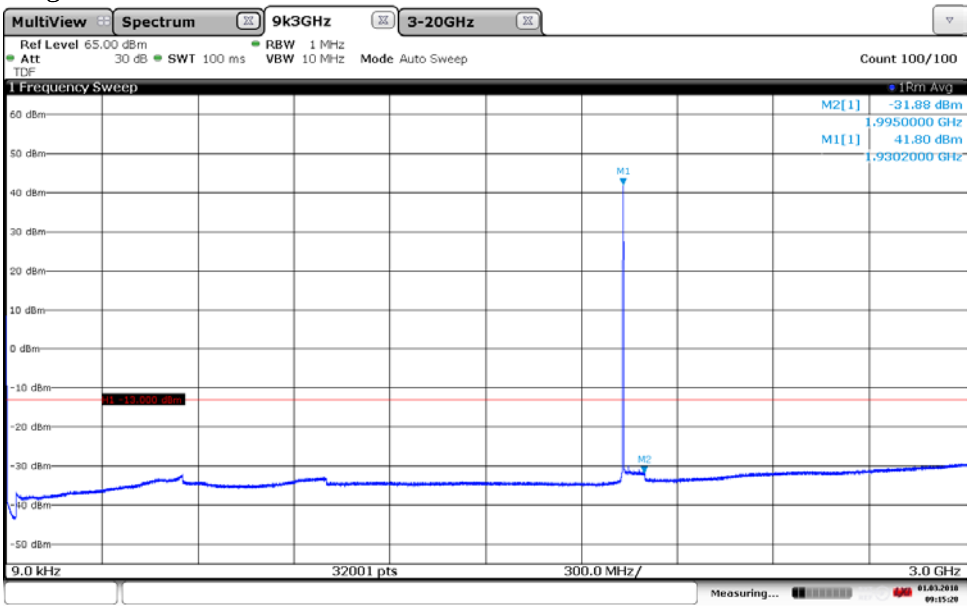
Limits

CFR 47 §24.238 and RSS-133 6.5

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.

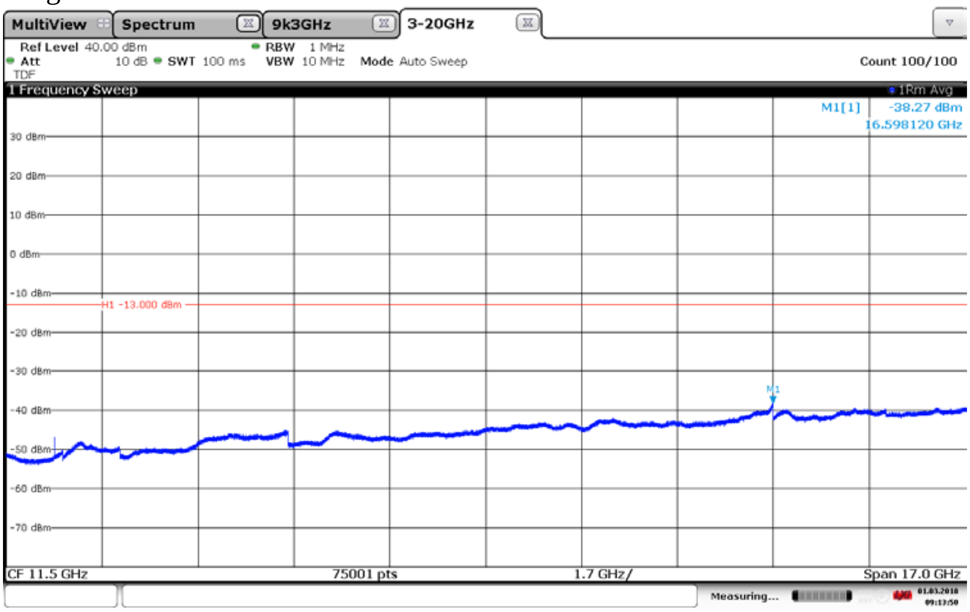
Complies?	Yes

Diagram 1a:



09:15:29 01.03.2018

Diagram 1b:



09:13:50 01.03.2018

Diagram 2a:

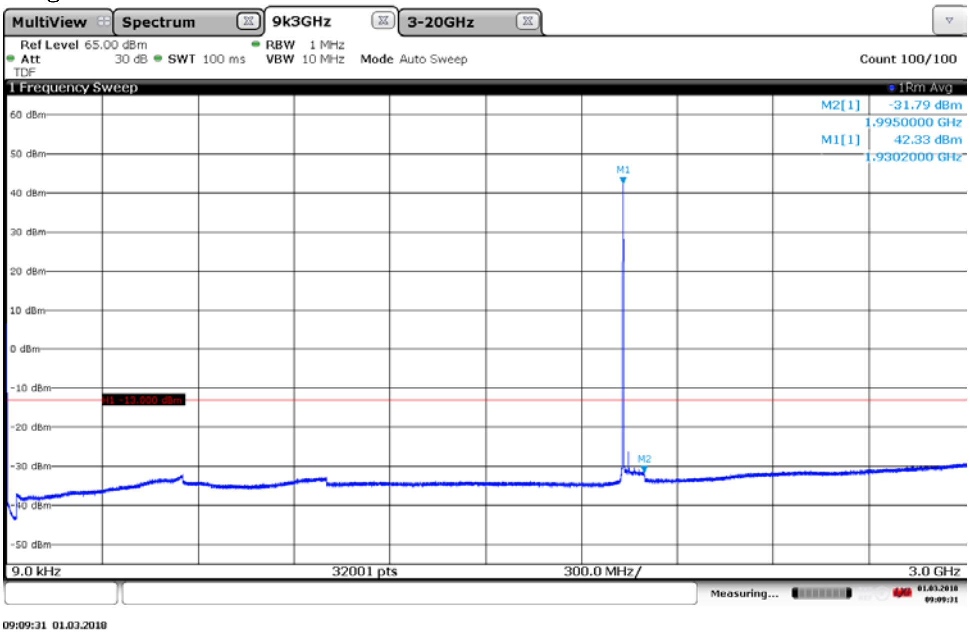


Diagram 2b:

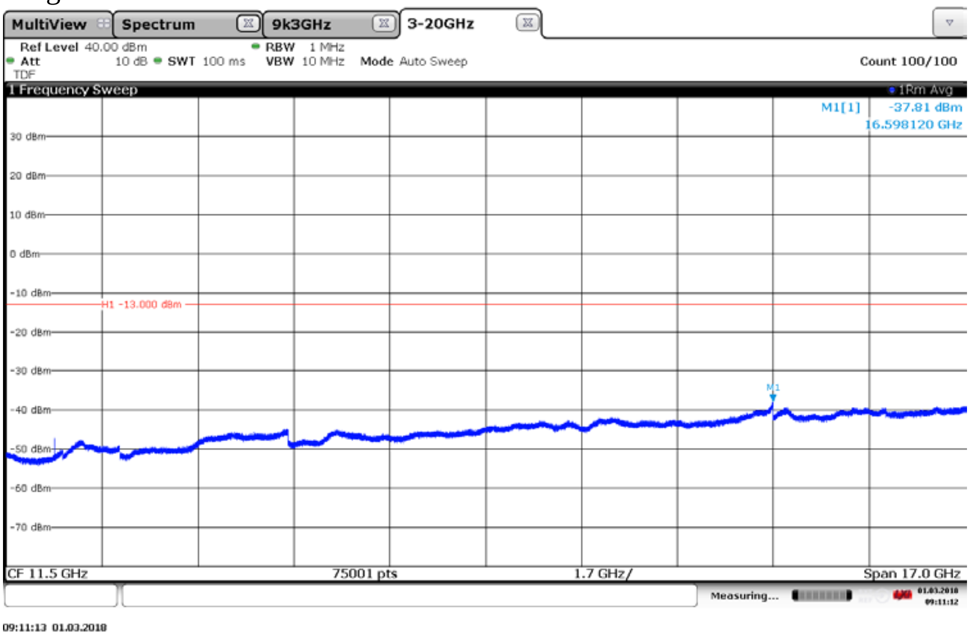


Diagram 3a:

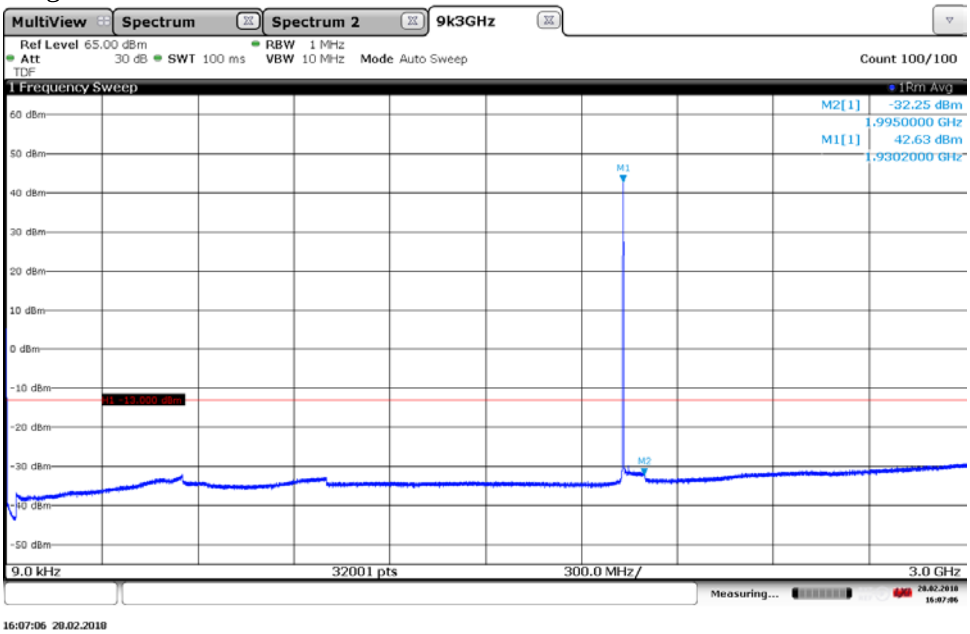


Diagram 3b:

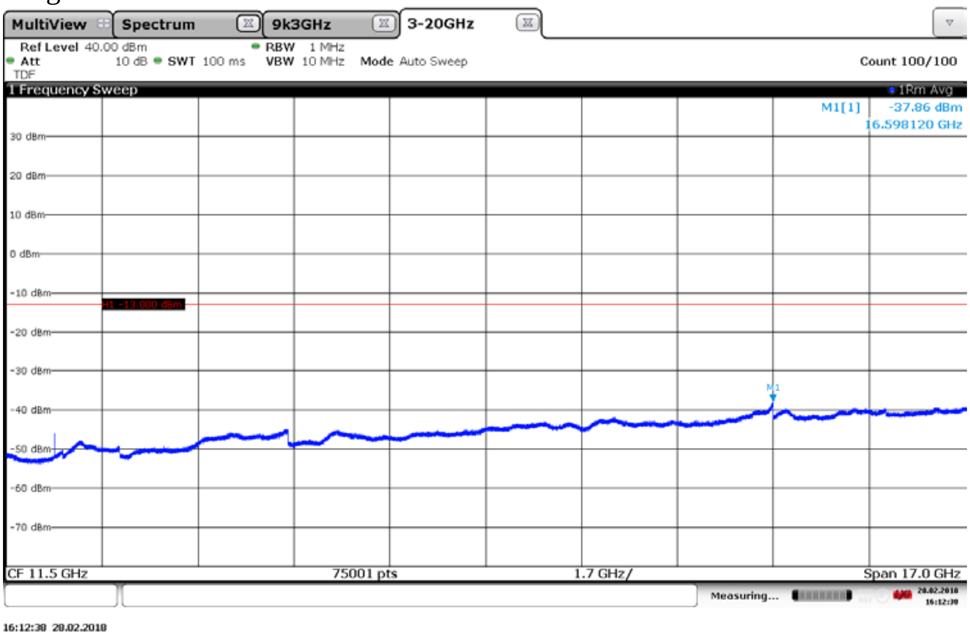


Diagram 4a:

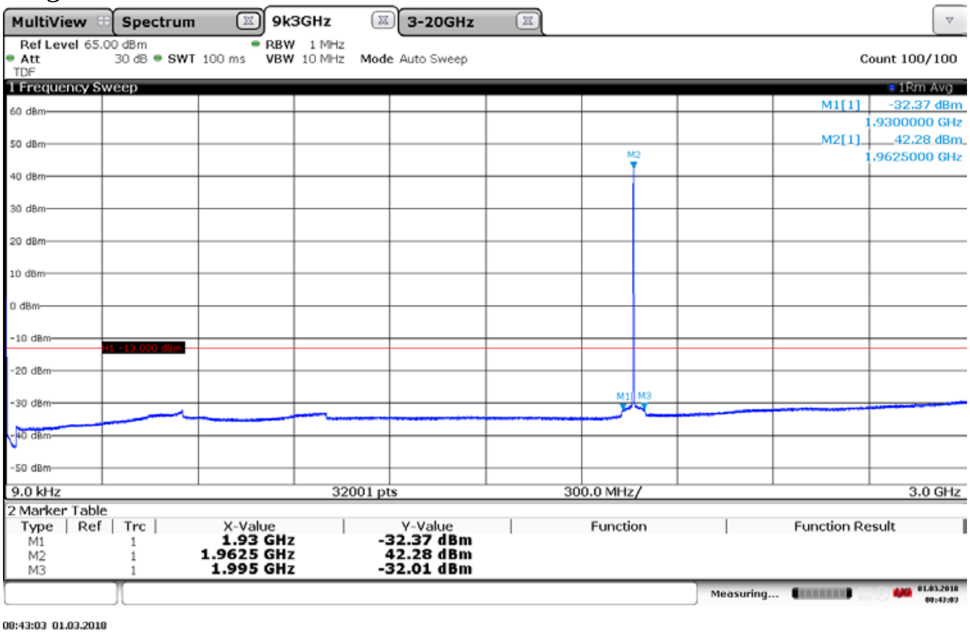


Diagram 4b:

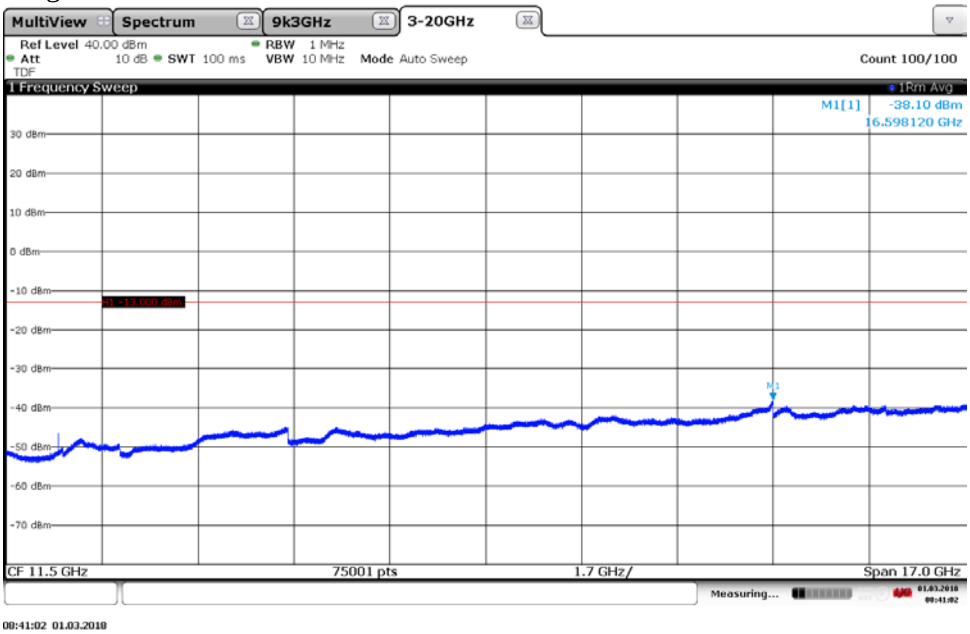


Diagram 5a:

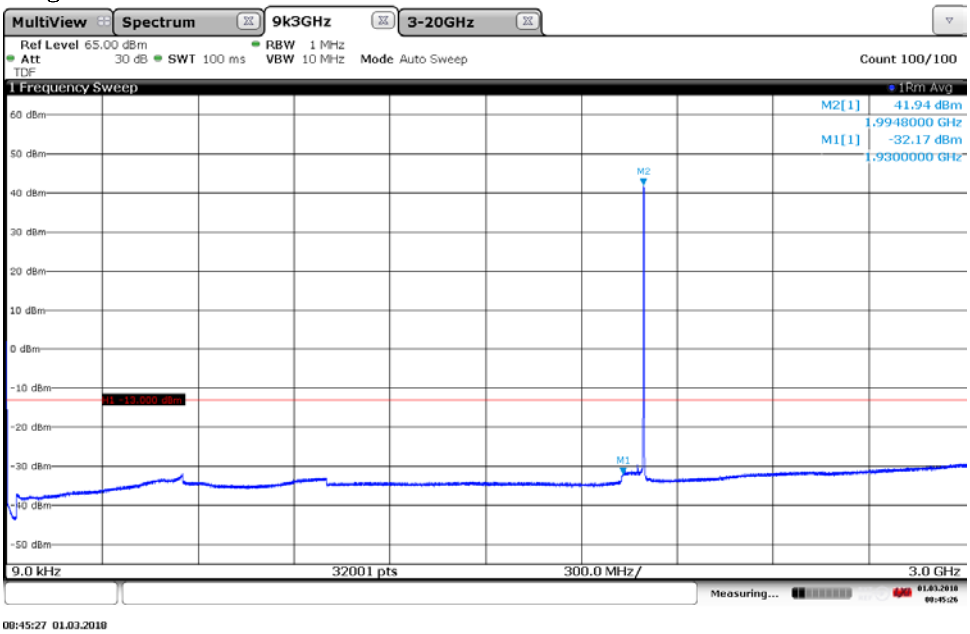


Diagram 5b:

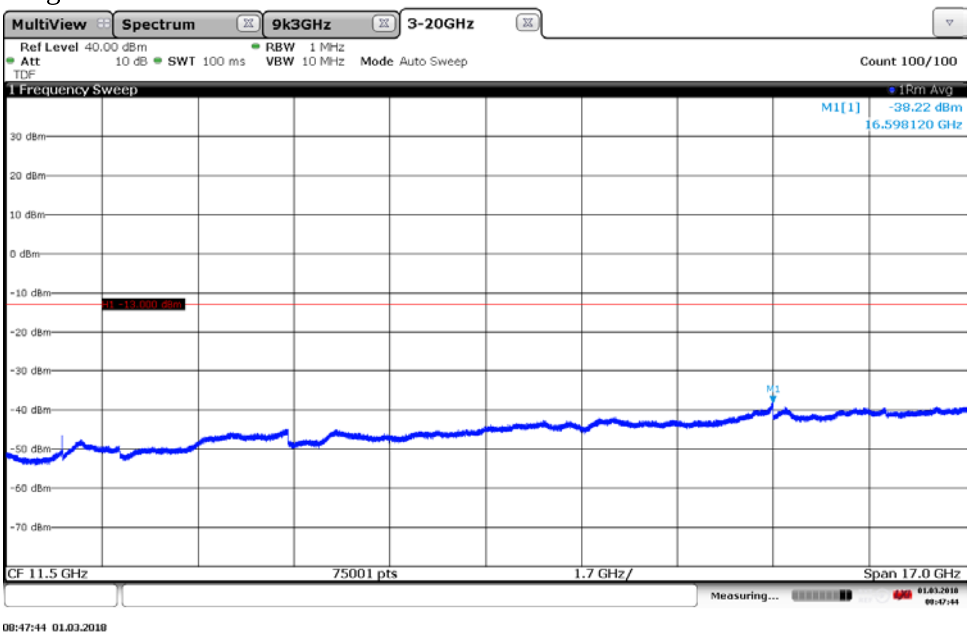
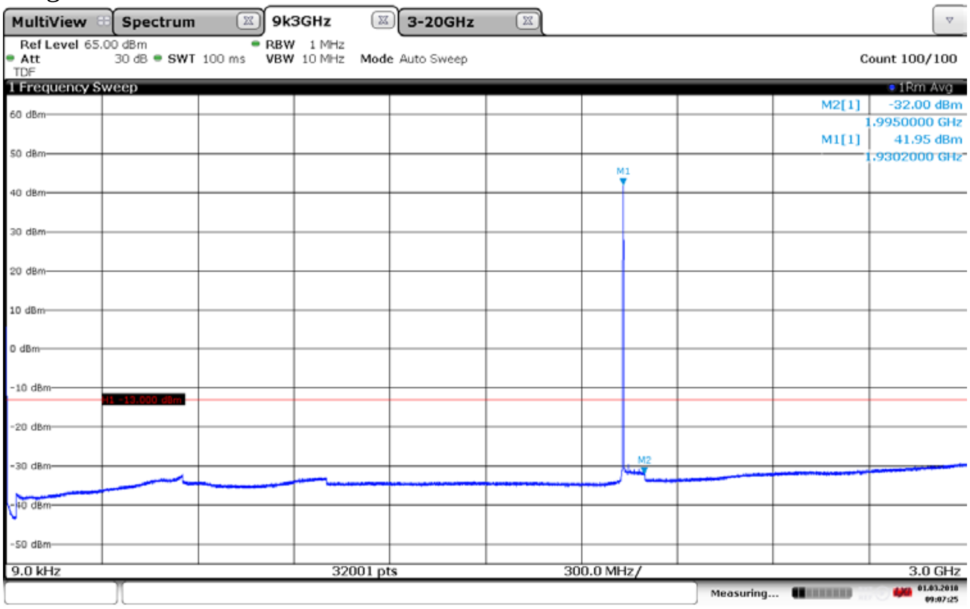
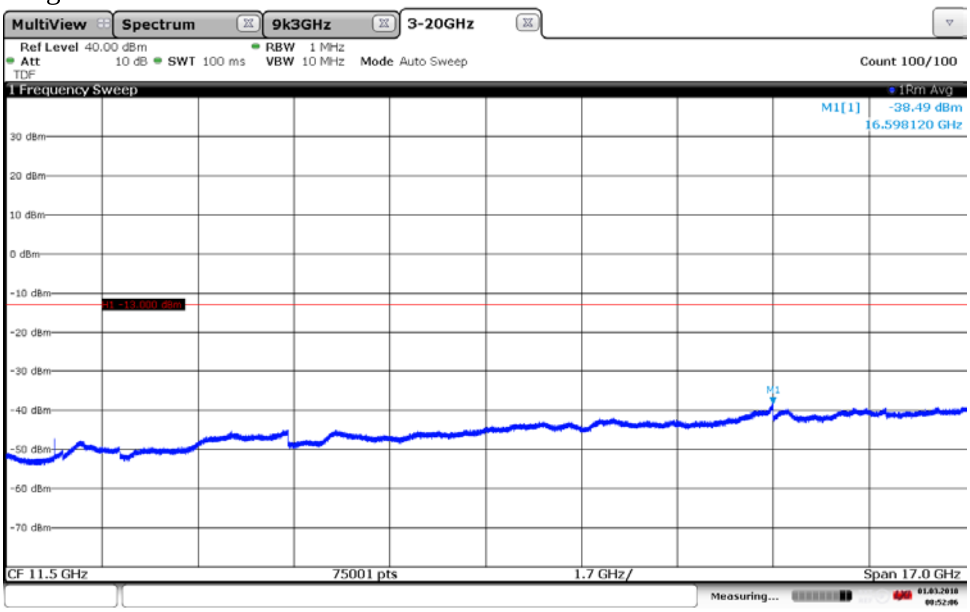


Diagram 6a:



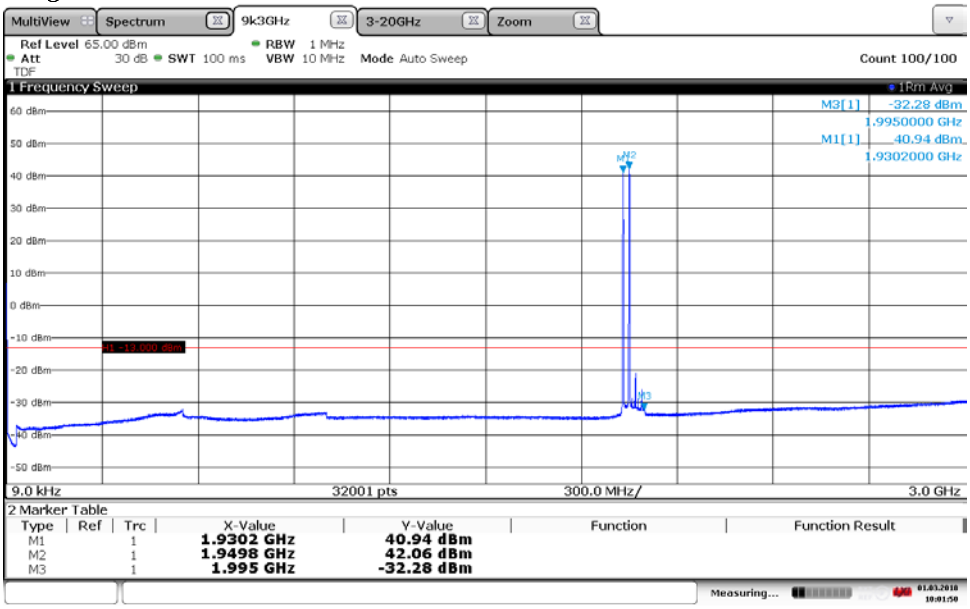
09:07:26 01.03.2018

Diagram 6b:



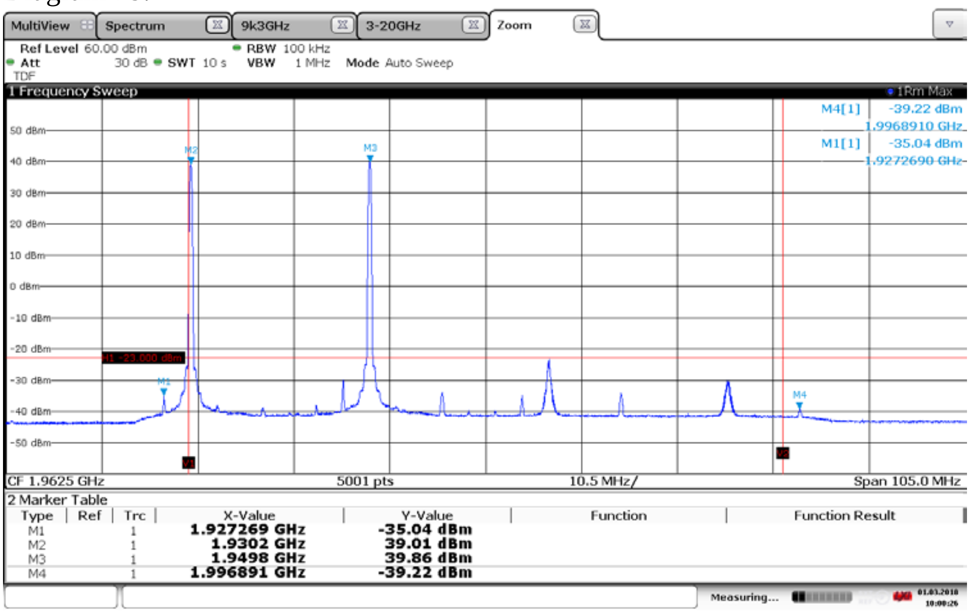
08:52:07 01.03.2018

Diagram 7a:



10:01:50 01.03.2018

Diagram 7b:



10:00:26 01.03.2018

Diagram 7c:

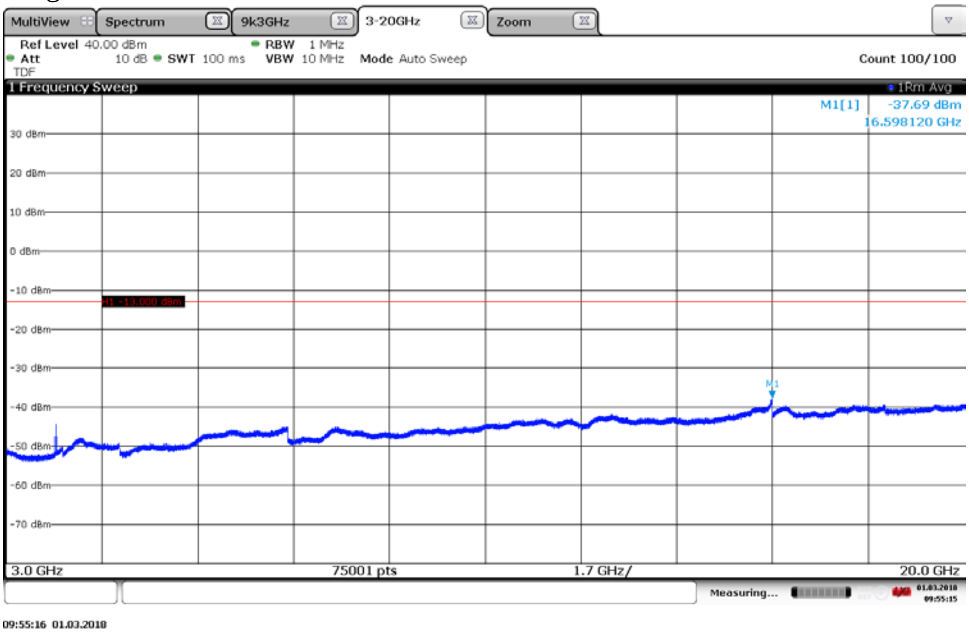

MultiView
Spectrum
9k3GHz
3-20GHz
Zoom
Ref Level 40.00 dBm
RBW 1 MHz
Att 10 dB SWT 100 ms VBW 10 MHz Mode Auto Sweep
TDF
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -37.69 dBm
16.598120 GHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
3.0 GHz
75001 pts
1.7 GHz/
20.0 GHz
Measuring...
09:55:16 01.03.2018

Diagram 8a:

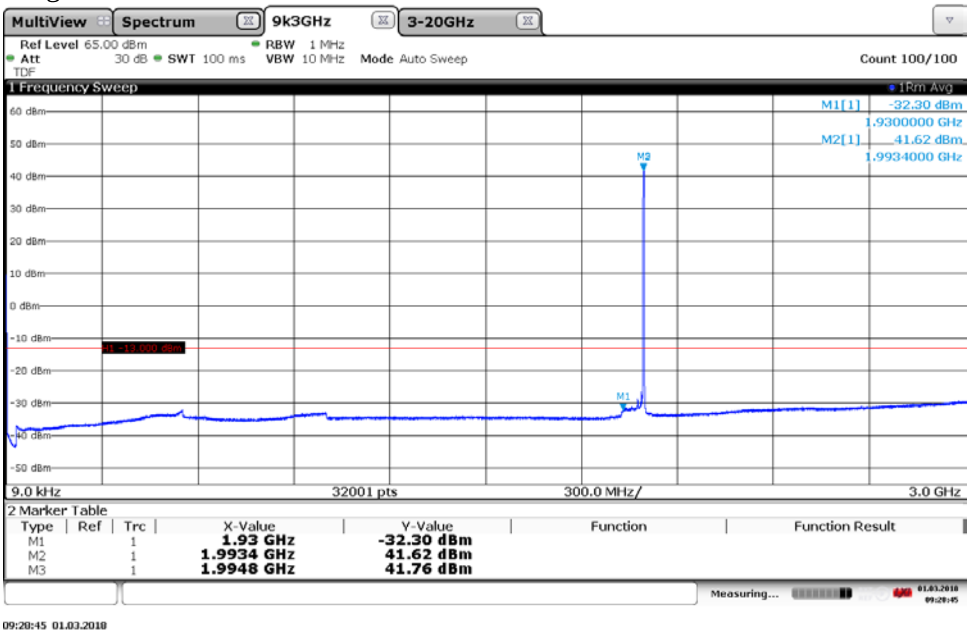
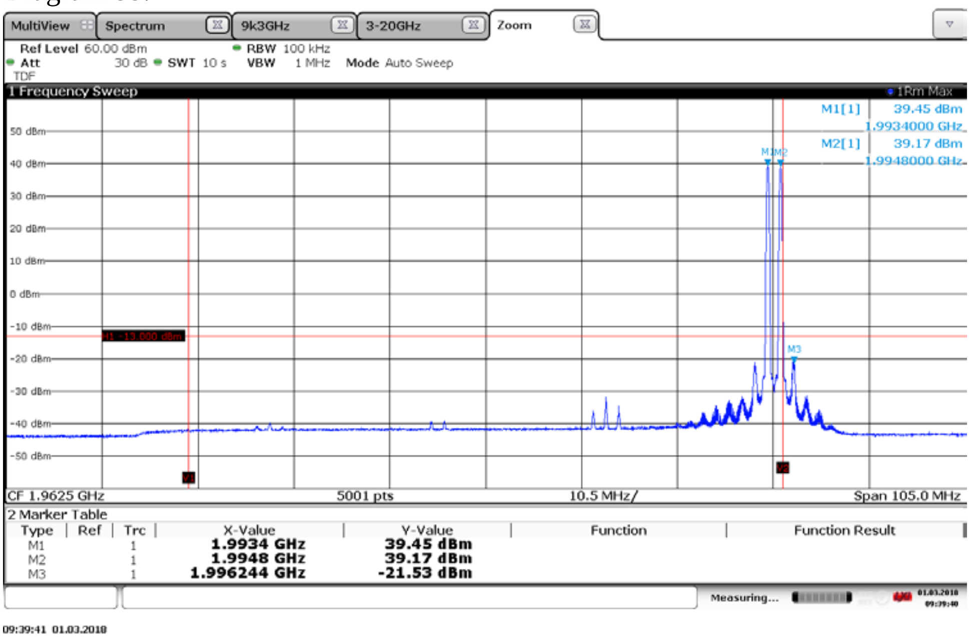


Diagram 8b:



Note: The emission at 1996.2 MHz was -16.66 dBm measured with the channel power method with 1 MHz channel bandwidth.

Diagram 8c:

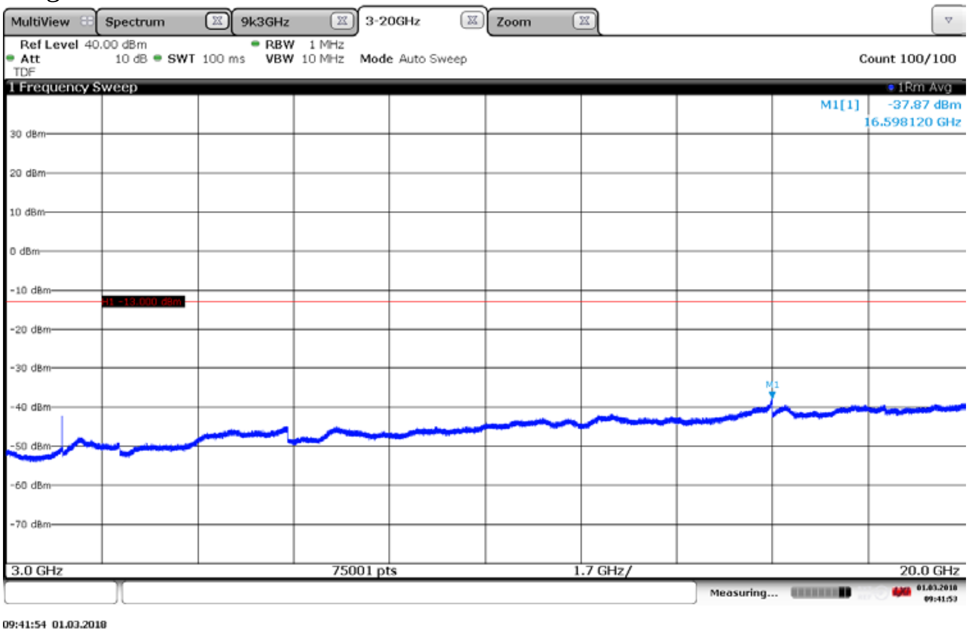
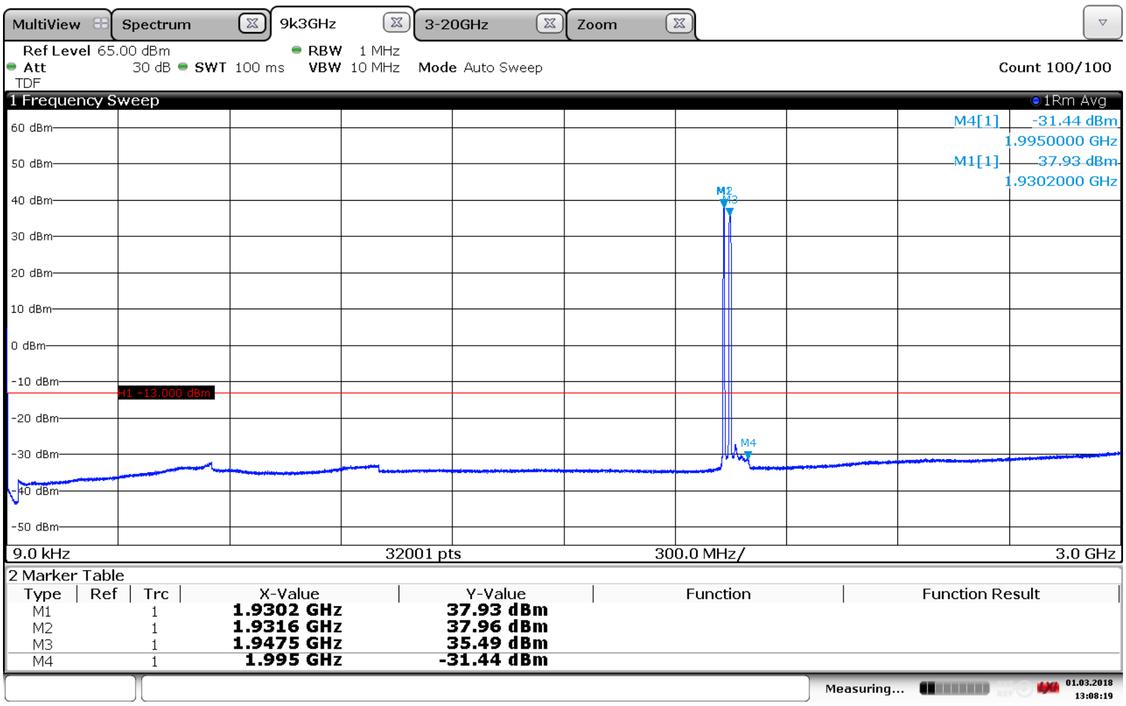
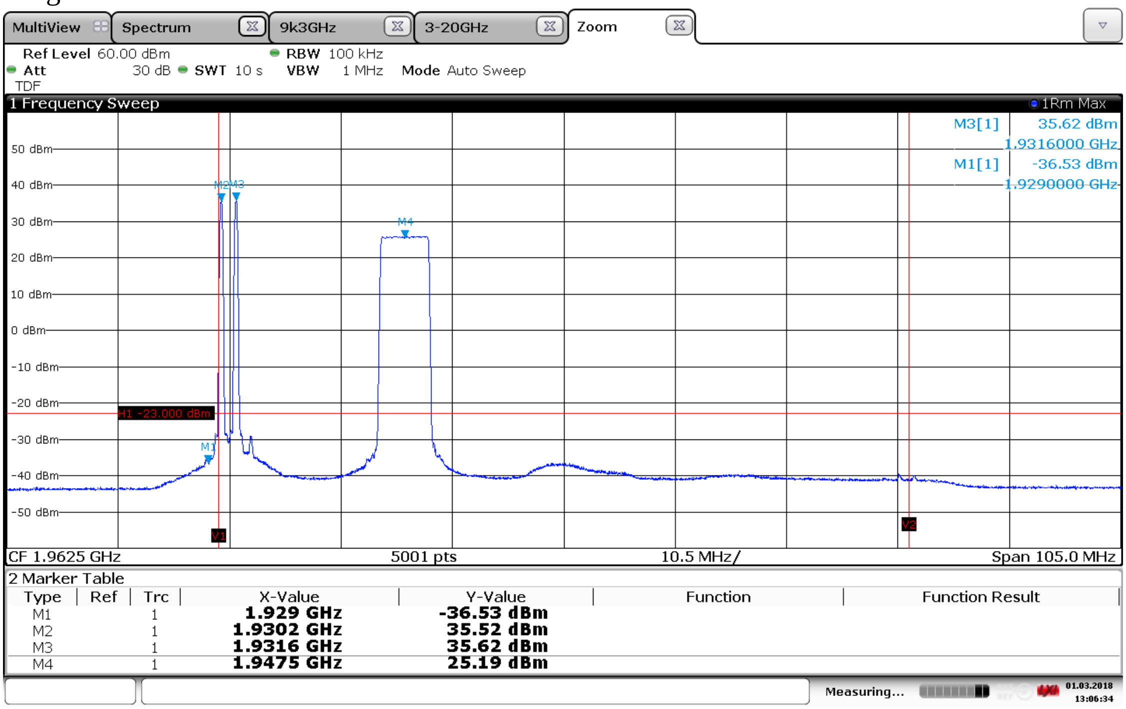

MultiView
Spectrum
9k3GHz
3-20GHz
Zoom
Ref Level 40.00 dBm
Att 10 dB SWT 100 ms
RBW 1 MHz
VBW 10 MHz
Mode Auto Sweep
TDF
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -37.87 dBm
16.598120 GHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
3.0 GHz
75001 pts
1.7 GHz/
20.0 GHz
Measuring...
01.03.2018
09:41:53
09:41:54 01.03.2018

Diagram 9a:



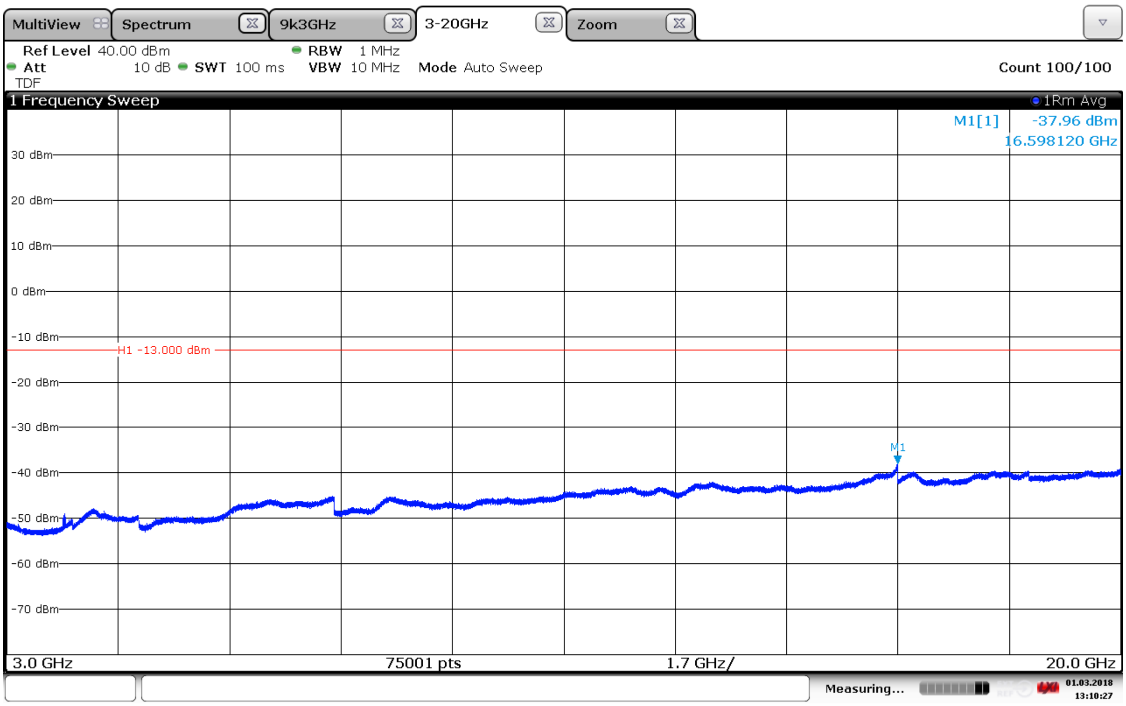
13:08:20 01.03.2018

Diagram 9b:



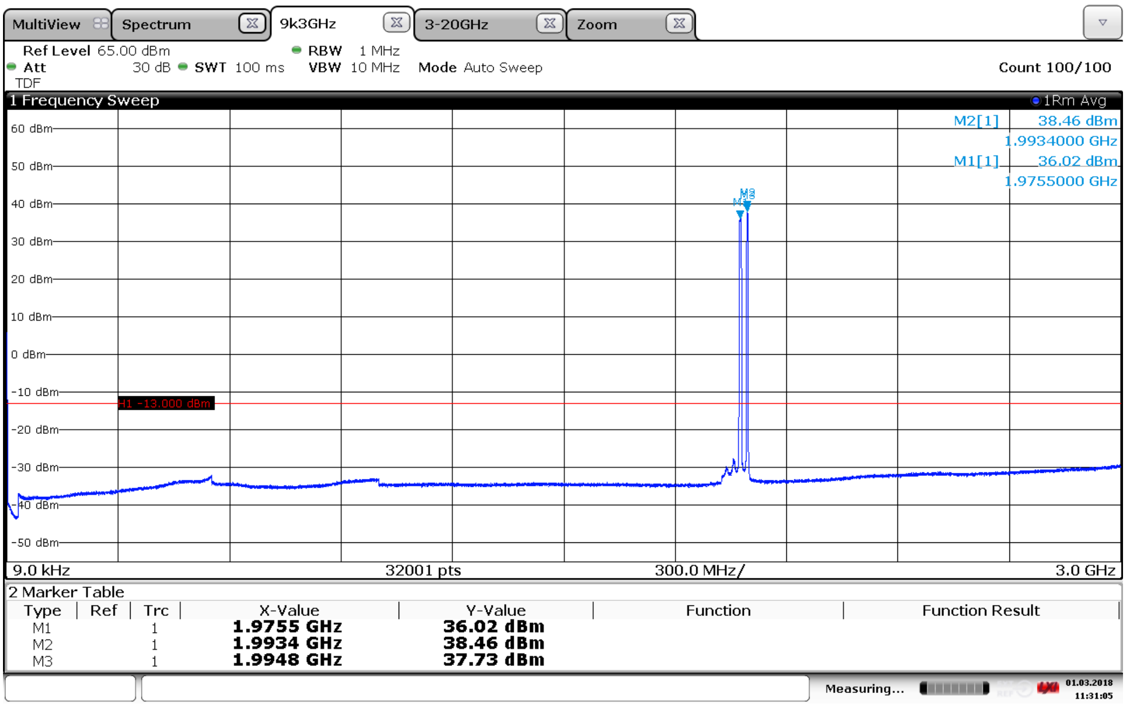
13:06:34 01.03.2018

Diagram 9c:



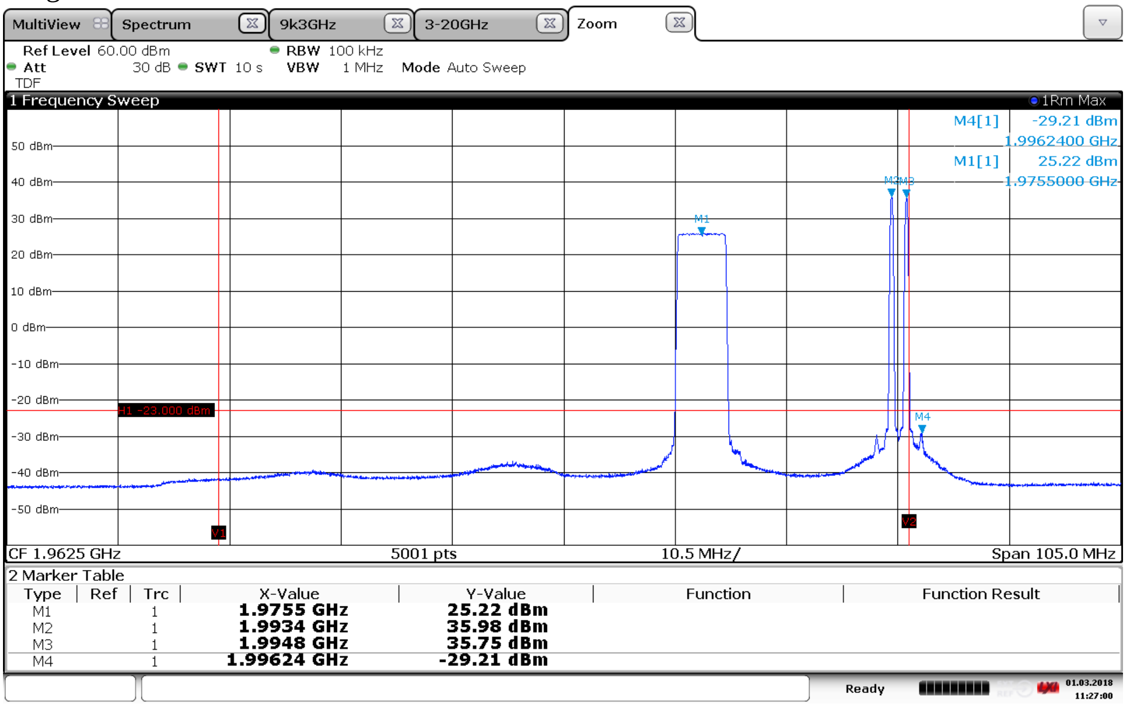
13:10:27 01.03.2018

Diagram 10a:



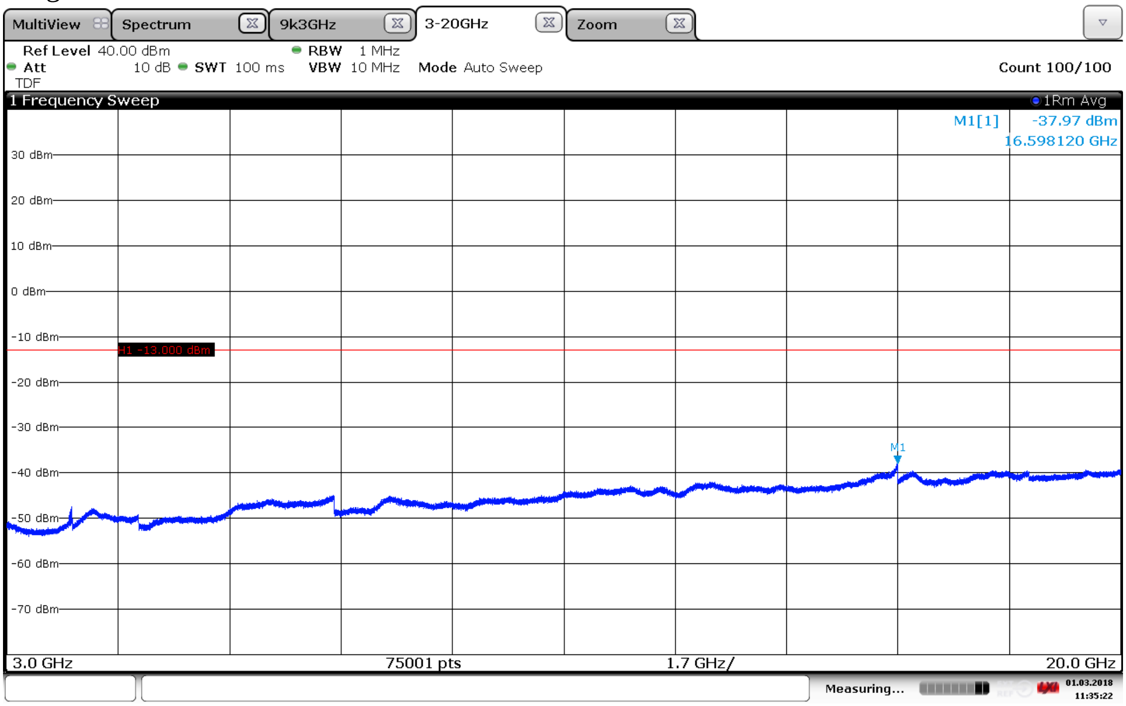
11:31:05 01.03.2018

Diagram 10b:



11:27:00 01.03.2018

Diagram 10c:



11:35:23 01.03.2018

Field strength of spurious radiation measurements according to CFR 47 §2.1053 / IC RSS-133 6.5

Date	Temperature	Humidity
2018-02-06	21 °C ± 3 °C	20 % ± 5 %
2018-02-08	21 °C ± 3 °C	29 % ± 5 %
2018-02-09	21 °C ± 3 °C	23 % ± 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 was 3 m in the frequency range 30 MHz – 18 GHz and 1 m in the frequency range 18 GHz – 20 GHz.

RF absorbers were covering a floor area in the frequency range 1 GHz – 18 GHz to comply with site validation requirements according to ANSI C63.4-2014.

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 – 20 GHz.

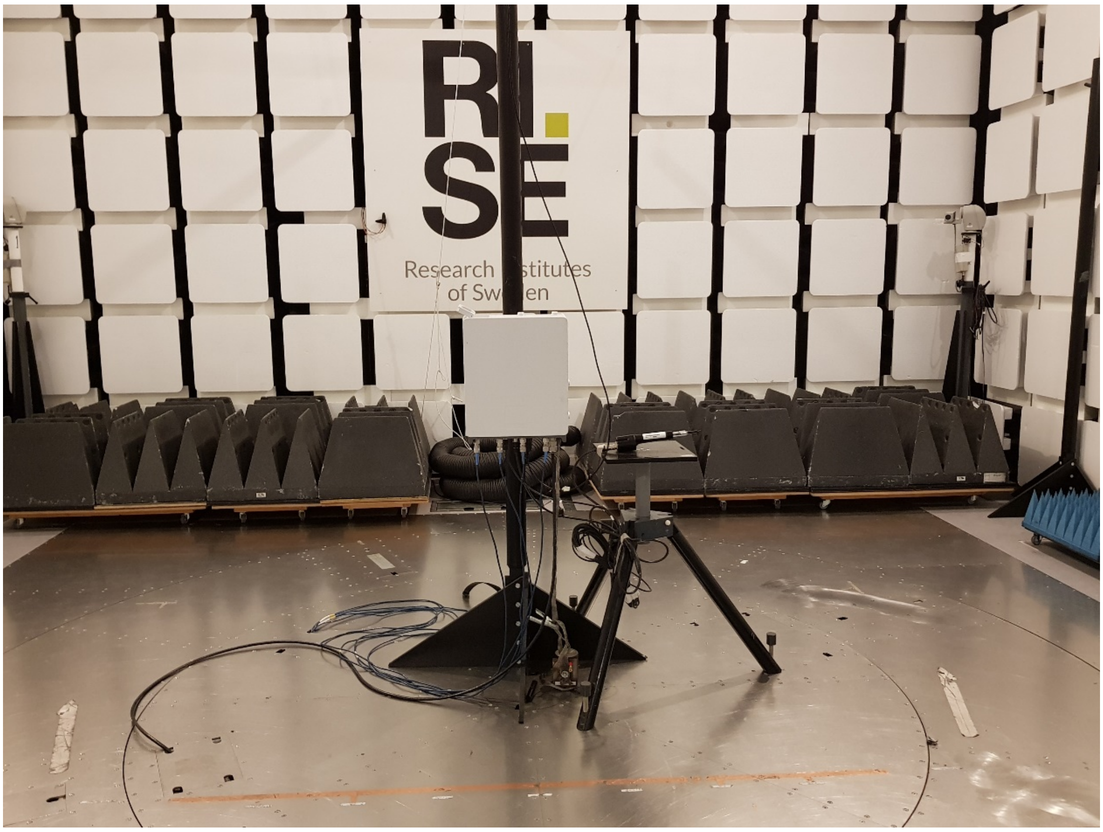
The measurement was performed with a RBW of 1 MHz.

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

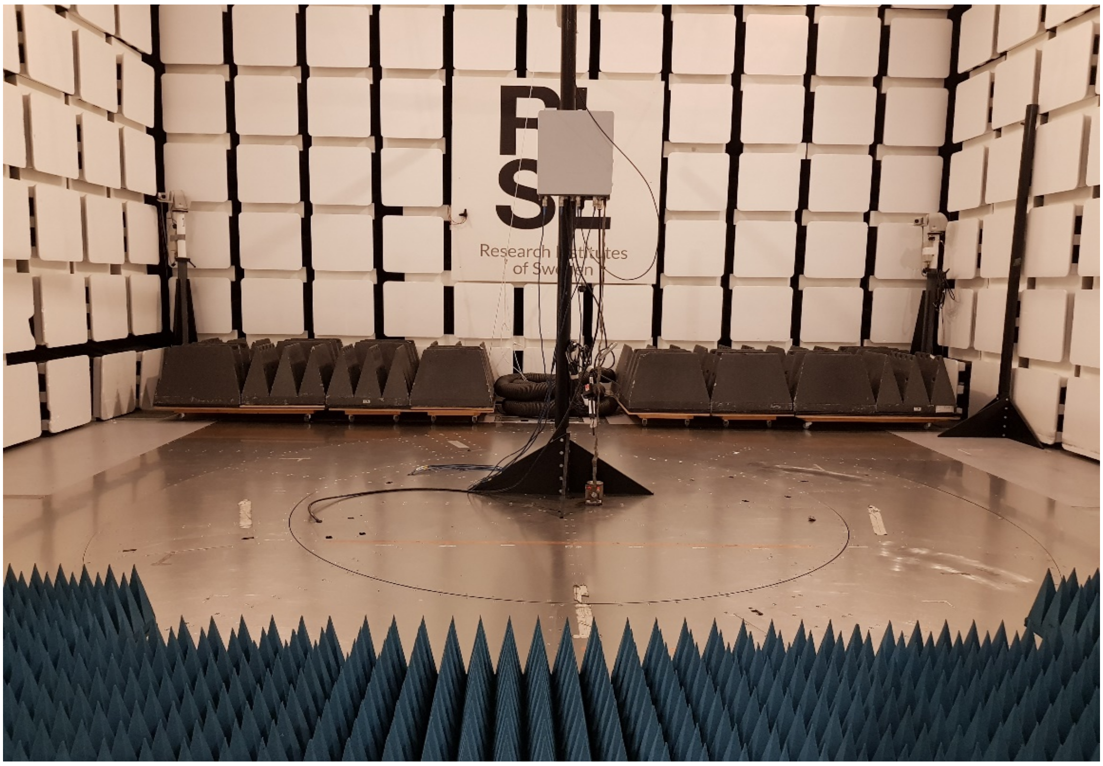
The measurement procedure was as the following:

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 1.0 m. 1.5 m and 2m.
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 picture below:
30-1000 MHz



1-20GHz



Measurement equipment

Measurement equipment	RISE number
Semi anechoic chamber Tesla	503 881
R&S ESU 40	901 385
EMC 32 ver. 9.15.0	BX62351
Coaxial cable Rosenberg	503 508
Coaxial cable Rosenberg	503 509
Coaxial cable Huber+Suhner	BX62218
ETS Lindgren BiConiLog 3142E	BX61914
ETS Lindgren Horn Antenna 3115	502 175
Flann STD Gain Horn Antenna 20240-20	503 674
µComp Nordic. Low Noise Amplifier	901 545
Miteq. Low Noise Amplifier	503 278
HP Filter 3-26.5 GHz	901 502
Temperature and humidity meter. Testo 625	504 188

Results

Tested configurations: IoTB. IoTM. IoTT. IoT2Bn. IoT2Mn. IoT2Tn. IoT2M. 1L2IoT BIM. 1L2IoT TIM and 1L2IoT B

representing worst case: Symbolic name IoT2Mn. NB IoT stand alone with test model N-TM. Diagram 1 a-d

Frequency (MHz)	Spurious emission level (dBm)	
	Vertical	Horizontal
30-20000	All emission > 20 dB below limit	All emission > 20 dB below limit

Measurement uncertainty: 3.1 dB

Limits

CFR 47 §24.238 and IC RSS-133 6.5

(g) 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

Diagram 1a:

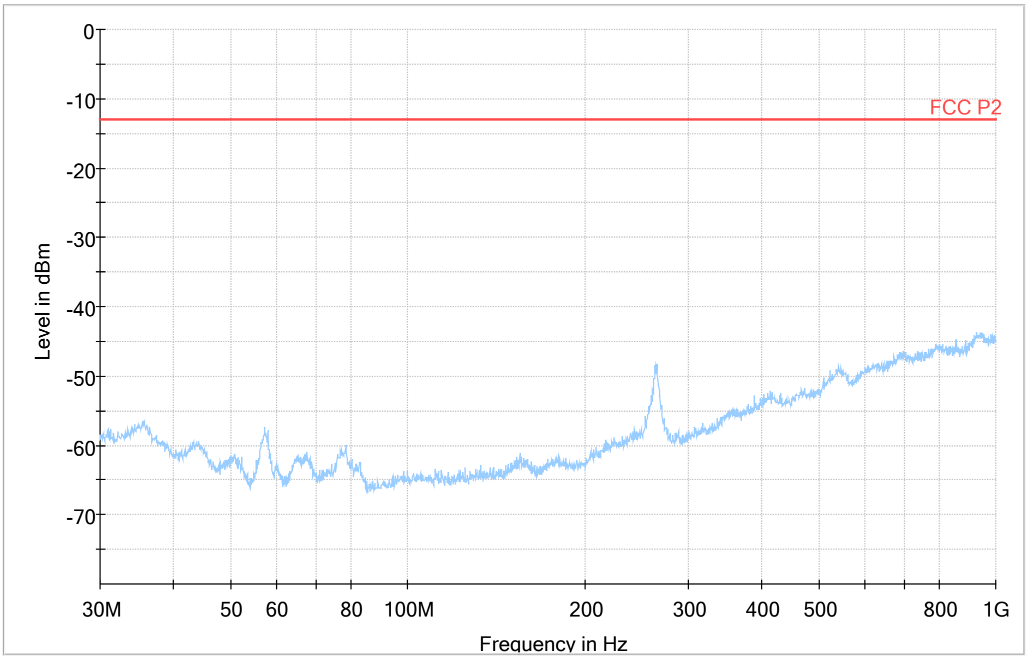
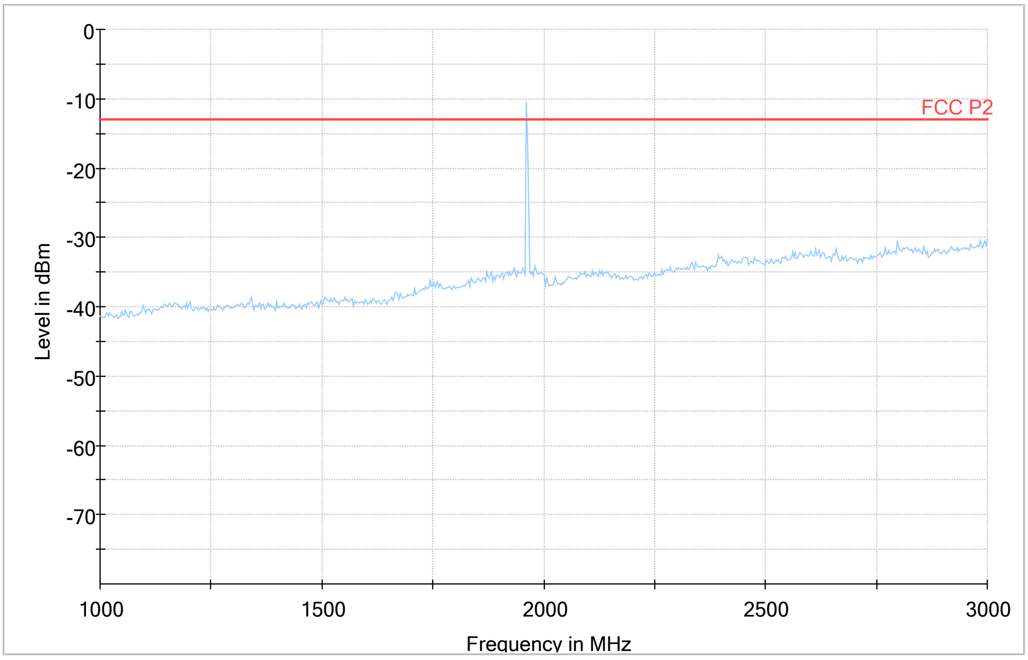


Diagram 1b:



Note: The emission at 1962.5 MHz is the carrier frequency and shall be ignored in the context.

Diagram 1c:

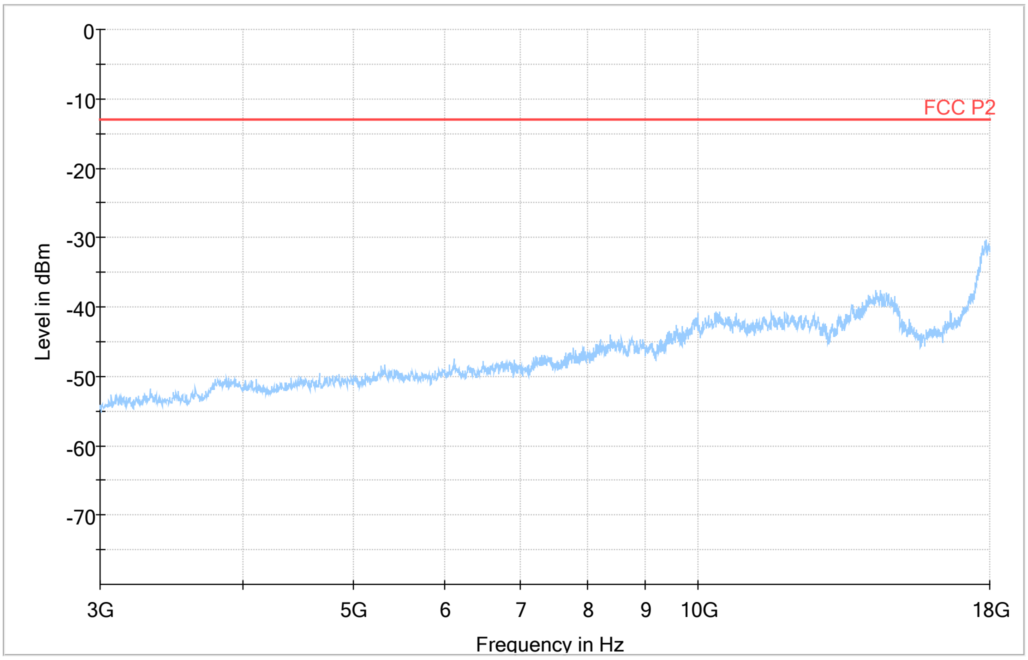
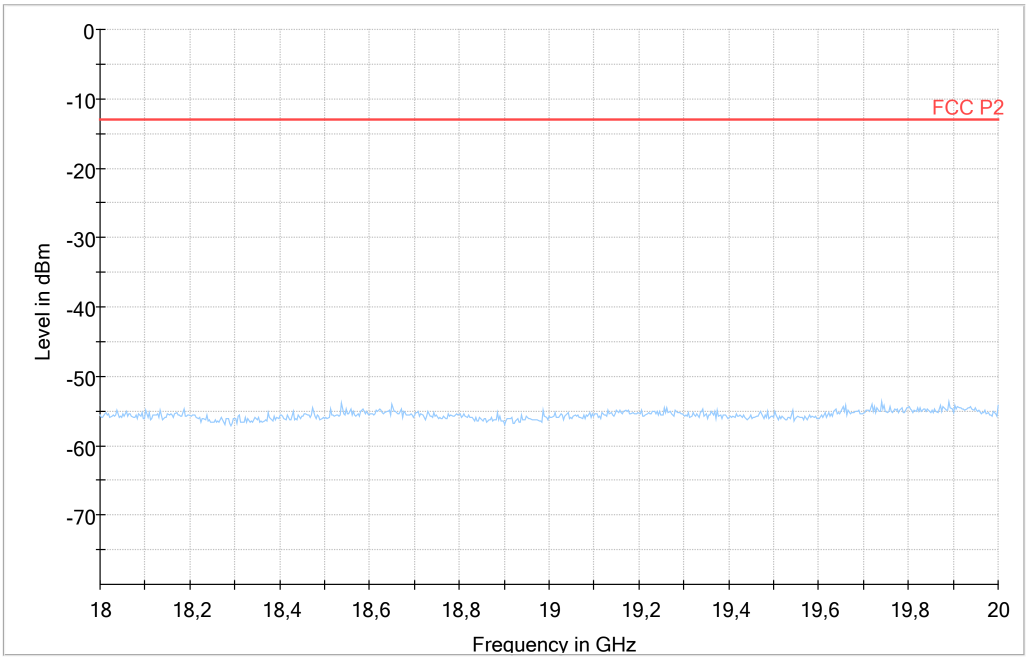


Diagram 1d:



Photos of test object

Front side

Rear side

Left side

Right side

Bottom side

Top side

Labels:

Radio label:

SFP module: