REPORT

issued by an Accredited Testing Laboratory

SP 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

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Testing
ISO/IEC 17025

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/ 4.6.1 Occupied bandwidth	Yes
2.1051/ 6.6 Band edge	Yes
2.1051/ 6.2 Spurious emission at antenna terminals	Yes
2.1053/ 6.5 Field strength of spurious radiation	Yes
2.1055/ 6.3 Frequency stability	Yes

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
Hardware revision state:	R1B
Tested configuration:	Single RAT LTE
Frequency range:	TX: 1930 – 1995 MHz RX: 1850 – 1915 MHz
IBW:	65 MHz 20 MHz for carrier BW ≤ 3MHz
Output power:	Max 40 W/ antenna port
Antenna ports:	4 TX / 4 RX ports
Antenna:	No dedicated antenna, handled during licensing
RF configurations:	Single and multi-carrier, 1-6 carriers/ port TX Diversity, 2x2 MIMO, 4x4 MIMO, Contiguous Spectrum (CS), Non-Contiguous Spectrum (NCS), NB IoT in-band operation. Carrier Aggregation (CA) intra-band and inter-band[1] supported
Channel bandwidths:	1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz
Modulations:	QPSK, 16QAM, 64QAM and 256QAM
RF power Tolerance:	+0.6/ -2.5 dB
CPRI Speed	Up to 10.1 Gbit/s
Nominal supply voltage:	-48VDC

[1] Carrier Aggregation (CA) inter-band requires an additional unit operating on the other band.

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 the tests is to verify compliance to the performance characteristics specified in applicable items of FCC CFR 47 part 24, Industry Canada RSS-133 and RSS-Gen.

Operation modes during measurements

LTE measurements were performed with the test object transmitting test models as defined in 3GPP TS 37.141. Test model E-TM1.1 was used to represent QPSK, test model E-TM3.2 to represent 16QAM, test model E-TM3.1 to represent 64QAM modulation and E-TM3.1A to represent 256QAM modulation.

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

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, April 2017
CFR 47 part 24, April 2017
ANSI C63.26-2015
KDB 662911 D01 Multiple Transmitter Output v02r02
KDB 971168 D01 Power Meas License Digital Systems v02r02
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	2017-12	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
ETS Lindgren BiConiLog Antenna 3142E	2019-03	BX61914
EMCO Horn Antenna 3115	2019-12	502 175
µComp Nordic, Low Noise Amplifier	2017-12	901 545
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: 2017-09-07.

Manufacturer’s representative

Mikael Jansson, Ericsson AB.

Test engineers

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

Test participant(-s)

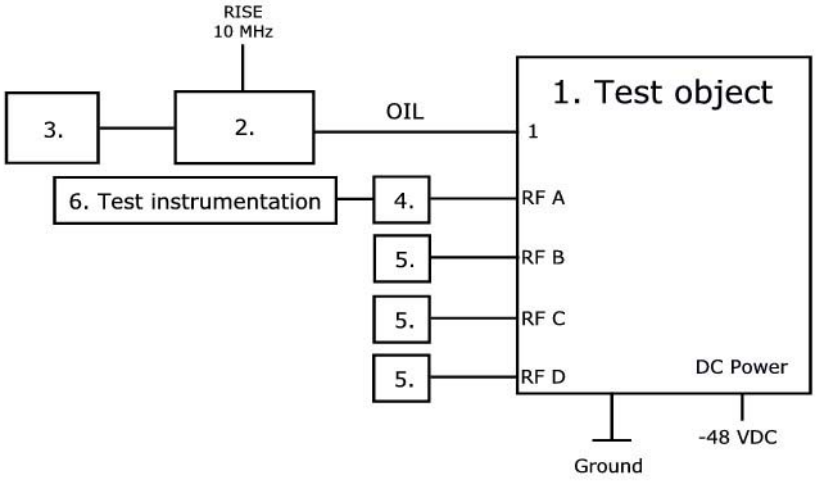
None.

Test frequencies used for radiated and conducted measurements

EARFCN Downlink B25	Frequency [MHz]	Symbolic name	Comment
8047	1930.7	$B_{1.4}$	TX bottom frequency in 1.4 MHz BW configuration
8055	1931.5	B_3	TX bottom frequency in 3 MHz BW configuration
8065	1932.5	B_5	TX bottom frequency in 5 MHz BW configuration
8090	1935.0	B_{10}	TX bottom frequency in 10 MHz BW configuration
8115	1937.5	B_{15}	TX bottom frequency in 15 MHz BW configuration
8140	1940.0	B_{20}	TX bottom frequency in 20 MHz BW configuration
8365	1962.5	$M_{1.4\text{-}20}$	TX mid frequency in 1.4-20 MHz BW configuration
8683	1994.3	$T_{1.4}$	TX top frequency in 1.4 MHz BW configuration
8675	1993.5	T_3	TX top frequency in 3 MHz BW configuration
8665	1992.5	T_5	TX top frequency in 5 MHz BW configuration
8640	1990.0	T_{10}	TX top frequency in 10 MHz BW configuration
8615	1987.5	T_{15}	TX top frequency in 15 MHz BW configuration
8590	1985.0	T_{20}	TX top frequency in 20 MHz BW configuration
8358 8372	1961.8 1963.2	$M2_{1.4}$	2 carriers TX 1.4MHz band mid constellation
8240 8290 8340 8390 8440 8490	1950.0 1955.0 1960.0 1965.0 1970.0 1975.0	$M6_5$	6 carriers TX 5 MHz band mid constellation
8047 8061 8233	1930.7 1932.1 1949.3	Bim	3 carriers TX 1.4 MHz configuration
8497 8669 8683	1975.7 1992.9 1994.3	Tim	3 carriers TX 1.4 MHz configuration
8265 8465	1952.5 1972.5	$CA_{20\text{-}20}$	Carrier Aggregation TX 20 MHz + 20 MHz configuration
8365	1962.5	IoT	TX Mid frequency in 5MHz BW configuration + NB IoT-inband in resource block 2

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. R1B, s/n: D16W963153 With Radio Software: CXP 901 7316/7, rev. R67HA. FCC ID: TA8AKRC161636 and IC: 287AB-AS161636

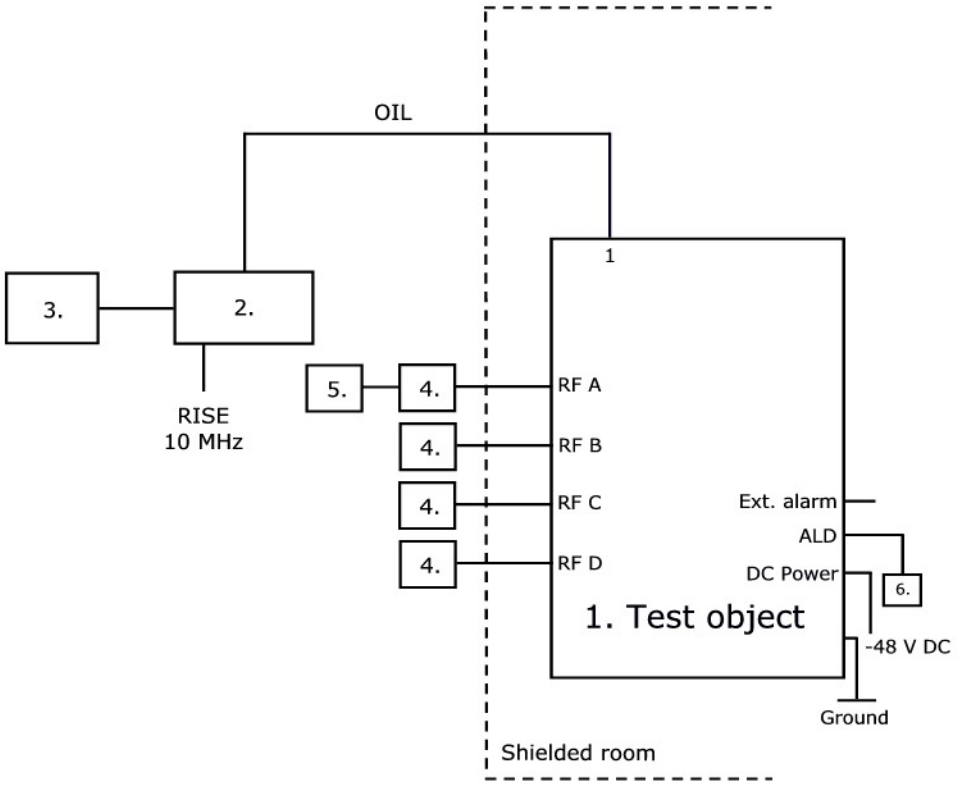
Associated equipment:

2.	Testing Equipment: CT10, LPC 102 467/1, rev. R1C, s/n: T01F375047, BAMS – 1001466801 with software CXA 104 446/1, rev. R8AA

Functional test equipment:

3.	Computer, HP EliteBook 8560w, BAMS - 1001236851
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. R1B, s/n: D16W963156 With Radio Software: CXP 901 7316/7, rev. R67HA. FCC ID: TA8AKRC161636 and IC: 287AB-AS161636

Associated equipment:

2.	Testing Equipment: CT10, LPC 102 467/1, rev. R1C, s/n: T01F375046, BAMS – 1001466800 with software CXA 104 446/1, rev. R8AA

Functional test equipment:

3.	Computer, HP EliteBook 8560w, BAMS - 1001236854
4.	Attenuator
5.	R&S ESIB 26, RISE no: 503 292, for supervision purpose only
6.	ALD Control, Andrew, model: ATM200-A20, s/n: DESA101412073

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
2017-09-07	22 °C ± 3 °C	43 % ± 5 %
2017-09-08	22 °C ± 3 °C	48 % ± 5 %
2017-09-11	21 °C ± 3 °C	53 % ± 5 %
2017-10-16	23 °C ± 3 °C	40 % ± 5 %

Test set-up and procedure

The test object was connected to a signal analyzer 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
RF attenuator	900 691
Testo 635, temperature and humidity meter	504 203

Measurement uncertainty: 1.1 dB

Results

Single carrier ETM 1.1 QPSK

Rated output power level at each RF port 1x 46 dBm/ port.

	Output power CCDF [RMS dBm/ PAR dB]				
Symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
$B_{1.4}$	45.13/7.40	45.18/7.38	45.19/7.38	45.04/7.40	51.16
B_5	45.25/7.34	45.29/7.34	45.41/7.34	45.20/7.34	51.31
$M_{1.4}$	45.78/ 7.40	45.94/ 7.38	45.84/ 7.38	45.74/ 7.38	51.85
M_3	45.89/7.36	45.97/7.34	45.79/7.36	45.73/7.32	51.87
M_5	45.90/7.34	45.89/7.32	45.76/7.36	45.74/7.30	51.84
M_{10}	45.90/7.34	45.98/7.32	45.77/7.36	45.84/7.34	51.89
M_{15}	45.88/7.34	45.93/7.32	45.76/7.36	45.90/7.34	51.89
M_{20}	45.80/7.34	45.91/7.34	45.80/7.34	45.79/7.34	51.85
$T_{1.4}$	45.58/7.40	45.59/7.40	45.56/7.38	45.52/7.40	51.58
T_5	45.67/ 7.34	45.78/ 7.34	45.88/ 7.34	45.64/ 7.34	51.76

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
Note: The PAR value is the 0.1 % Peak to Average Ratio.

Single carrier ETM 3.2 16 QAM

Rated output power level at each RF port 1x 46 dBm/ port.

	Output power CCDF [RMS dBm/ PAR dB]				
symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
M_5	45.89/ 7.32	45.92/ 7.32	45.86/ 7.30	45.87/ 7.36	51.91

Single carrier ETM 3.1 64 QAM

Rated output power level at each RF port 1x 46 dBm/ port.

	Output power CCDF [RMS dBm/ PAR dB]				
symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
M_5	45.80/ 7.32	45.87/ 7.32	45.85/ 7.32	45.86/ 7.36	51.87

Single carrier ETM 3.1a 256 QAM

Rated output power level at each RF port 1x 46 dBm/ port.

	Output power CCDF [RMS dBm/ PAR dB]				
symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
M_5	45.79/ 7.34	45.85/ 7.34	45.82/ 7.34	45.82/7.38	51.84

Multi carrier ETM 1.1 QPSK

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

	Output power CCDF [RMS dBm/ PAR dB]				
Symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
$M2_{1.4}$	45.84/ 7.14	45.84/7.14	45.81/ 7.14	45.77/ 7.14	51.84

Multi carrier ETM 1.1 QPSK

Rated output power level at each RF port 6x 38.2 dBm/ port.

	Output power CCDF [RMS dBm/ PAR dB]				
Symbolic name	Port RF A	Port RF B	Port RF C	Port RF D	Total power[1)]
$M6_5$	45.62/ 7.18	45.67/7.20	45.54/ 7.20	45.60/ 7.20	51.63

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output

Note: The PAR value is the 0.1 % Peak to Average Ratio.

Carrier Aggregation ETM 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)]
$CA_{20\text{-}20}$	45.60/ 7.24	45.63/7.24	45.50/ 7.26	45.56/ 7.24	51.59

NB IoT inband NTM, LTE ETM 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)]
IoT	44.84/ 8.06	45.21/7.80	44.79/ 8.08	44.84/ 8.08	50.94

Single carrier ETM 1.1 QPSK
Rated output power level at RF connector 1x 46 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[1)]
$M_{1.4}$	44.71	44.74	44.76	44.61	50.73
M_3	41.69	41.74	41.63	41.61	47.69
M_5	39.58	39.63	39.48	39.49	45.57
M_{10}	36.58	36.69	36.51	36.59	42.61
M_{15}	34.90	34.96	34.75	34.86	40.89
M_{20}	33.57	33.72	33.59	33.56	39.63

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.

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 Base station transmitters operating in the band 1930-1995 MHz shall not have output power exceeding 100 watts. When the transmitter power is measured in terms of average value, the peak-to-average ratio(PAR) of the power shall not exceed 13 dB

There is no EIRP limit specified for base station equipment in the RSS-133.

EIRP compliance is addressed at the time of licensing, as required by the responsible IC Bureau. Licensee's are required to take into account the antenna gain to get the maximum usable power settings to prevent the radiated output power to exceed the EIRP limits specified in SRSP-510

Complies?	Yes

Occupied bandwidth measurements according to CFR47 2.1049 / RSS-Gen 4.6.1

Date	Temperature	Humidity
2017-09-11	21 °C ± 3 °C	53 % ± 5 %
2017-10-16	23 °C ± 3 °C	40 % ± 5 %

Test set-up and procedure

The measurements were made per definition in § 2.1049. 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
RF attenuator	900 691
Testo 635, temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier ETM 1.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
1	M_5	RF B	4.478

Single carrier ETM 3.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
2	M_5	RF A	4.495
3	B_5	RF B	4.491
4	$M_{1.4}$	RF B	1.101
5	M_3	RF B	2.695
6	M_5	RF B	4.493
7	M_{10}	RF B	8.974
8	M_{15}	RF B	13.458
9	M_{20}	RF B	17.900
10	T_5	RF B	4.494
11	M_5	RF C	4.494
12	M_5	RF D	4.494

Single carrier ETM 3.2

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
13	M_5	RF B	4.478

Single carrier ETM 3.1a

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
14	M_5	RF B	4.486

Carrier Aggregation ETM 3.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
15	$CA_{20\text{-}20}$	RF B	37.903

NB IoT inband NTM, LTE ETM 1.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
16	IoT	RF B	4.496

Diagram 1:

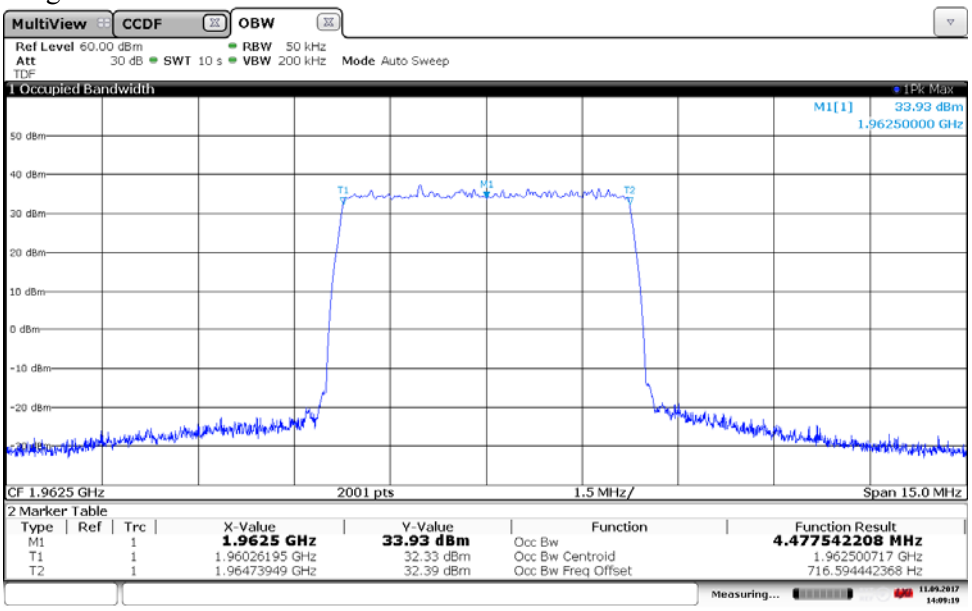


Diagram 2:

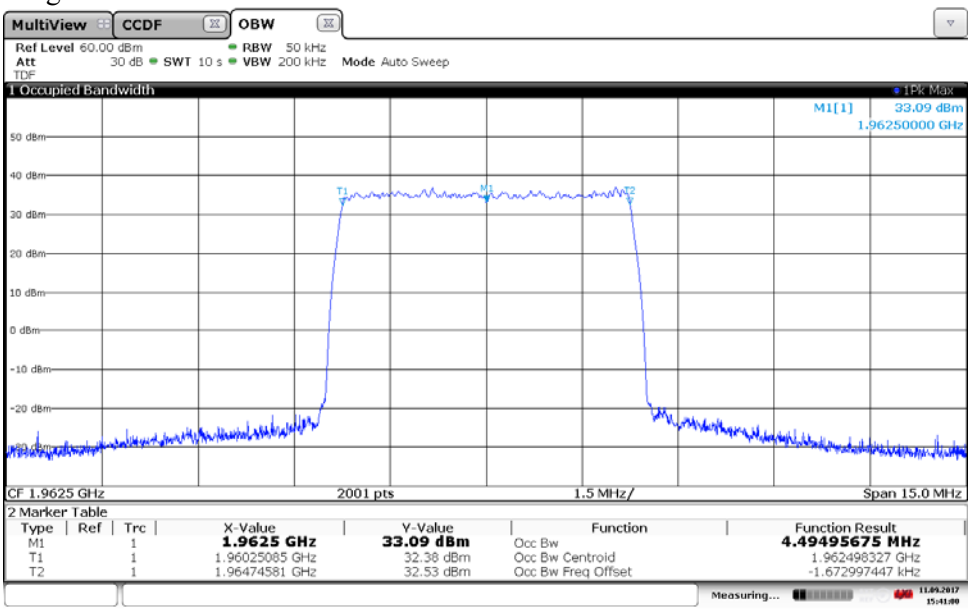


Diagram 3:

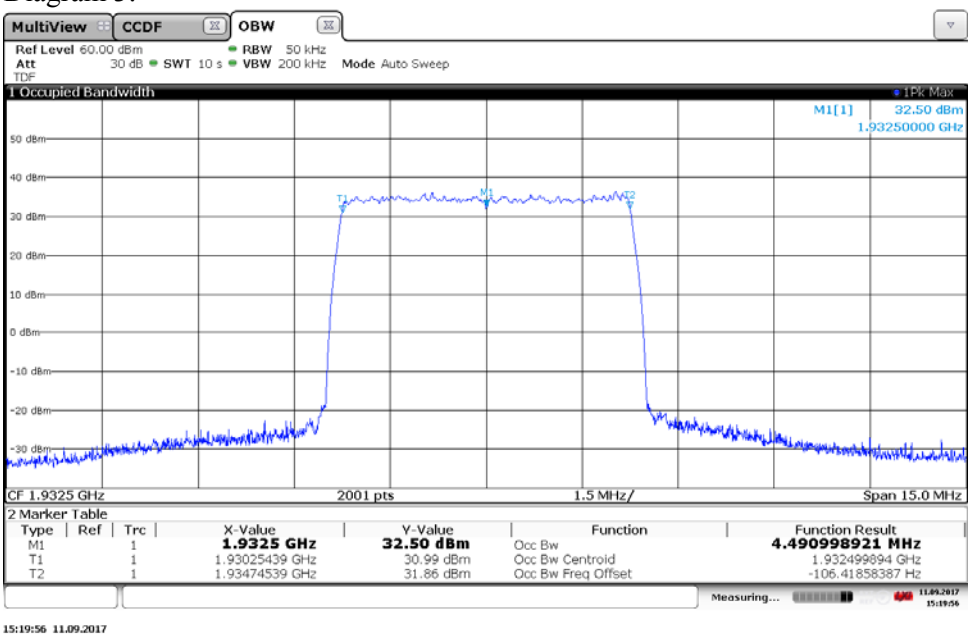


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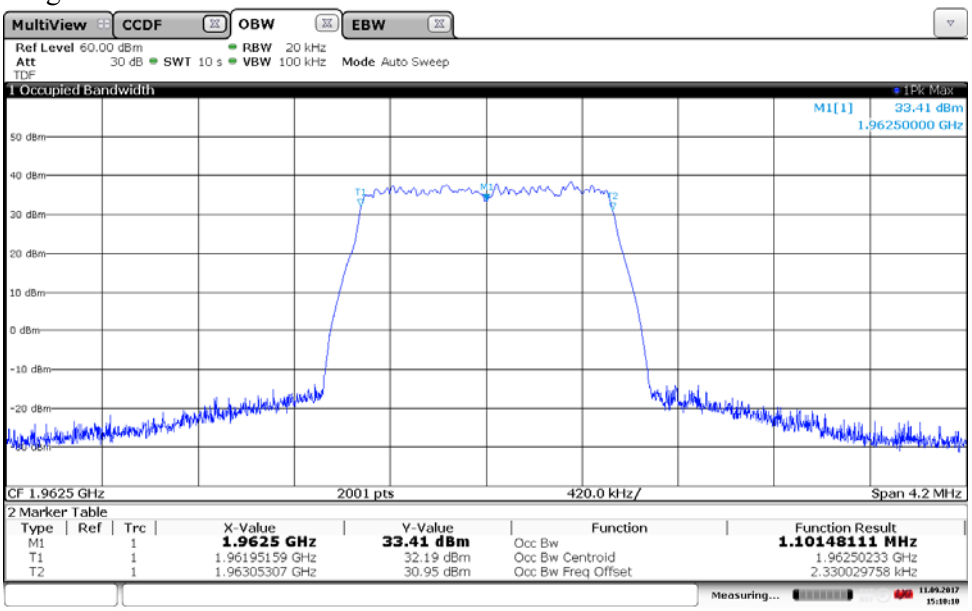
Diagram 4:



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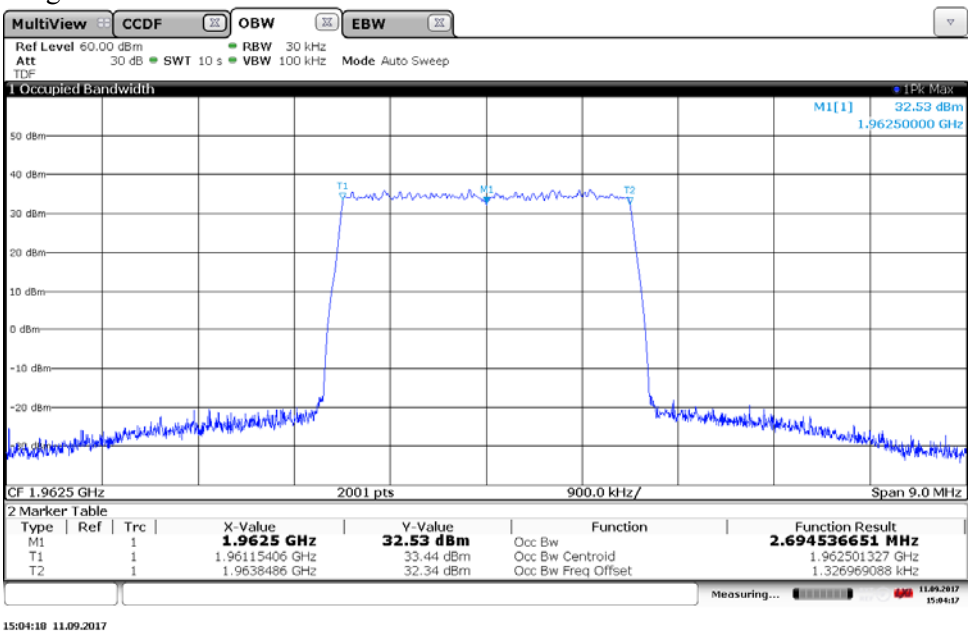

Diagram 6:

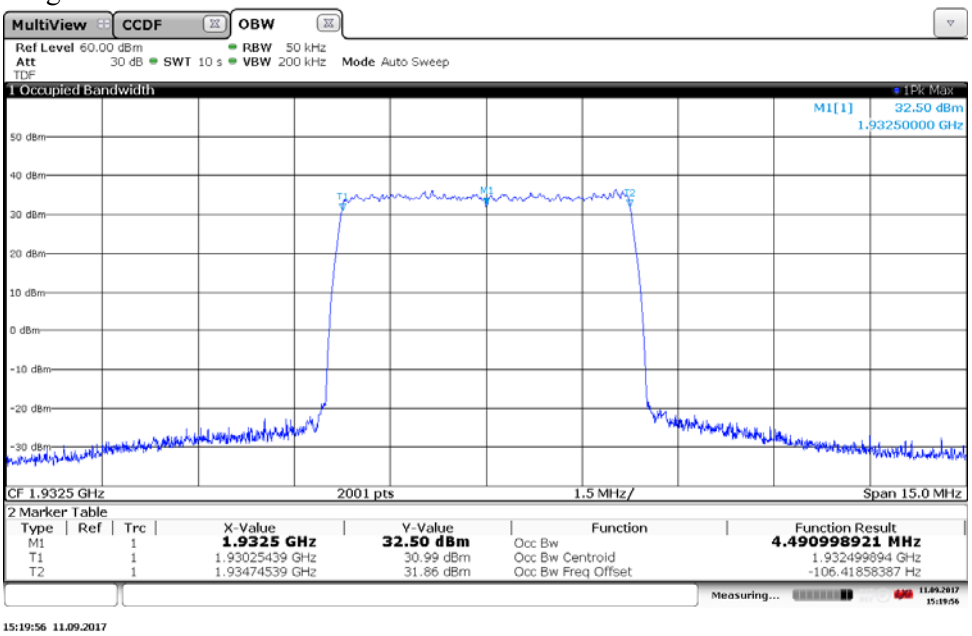

Diagram 7:

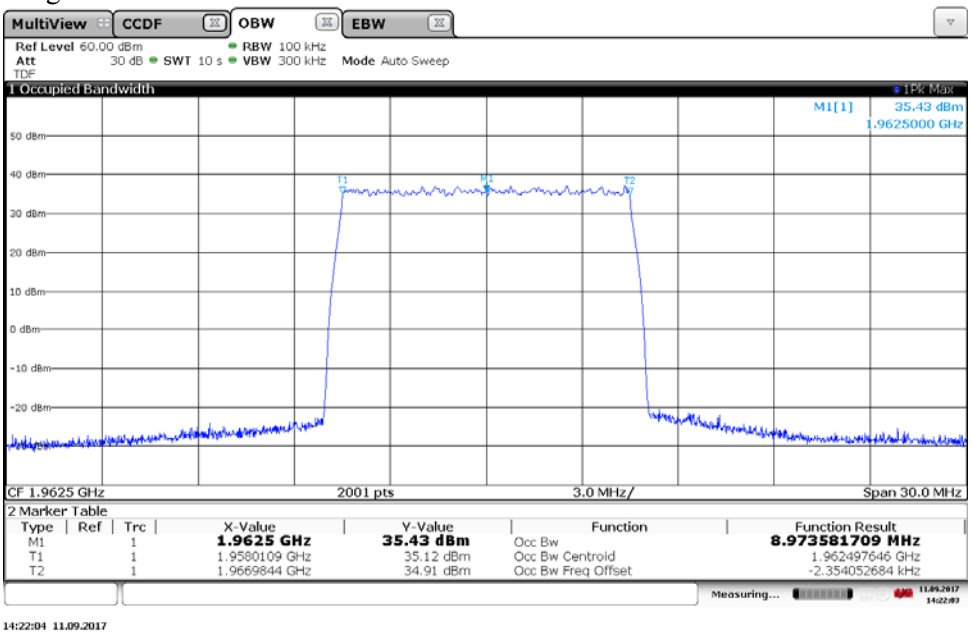

Diagram 8:

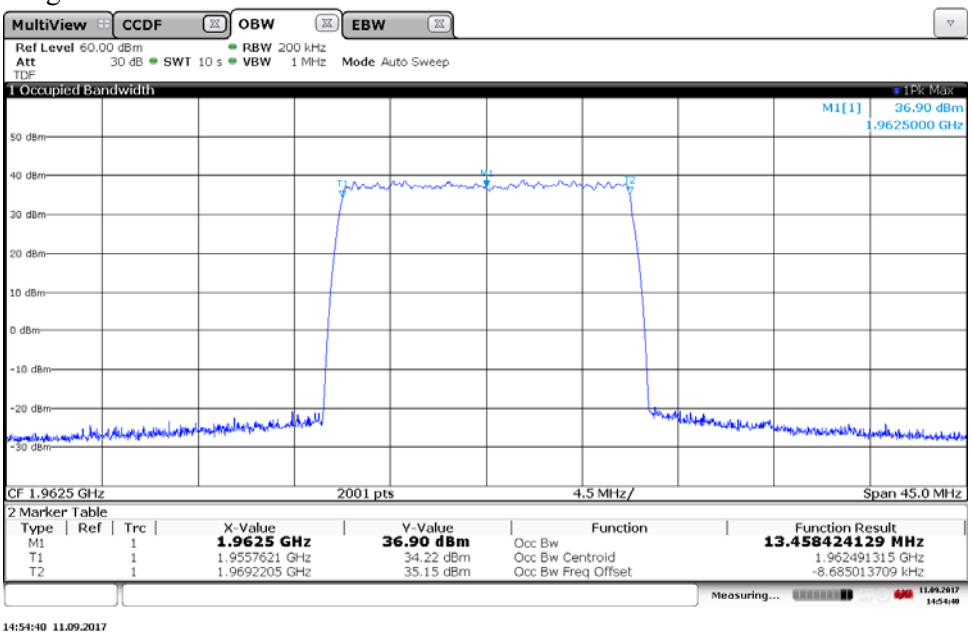

Diagram 9:

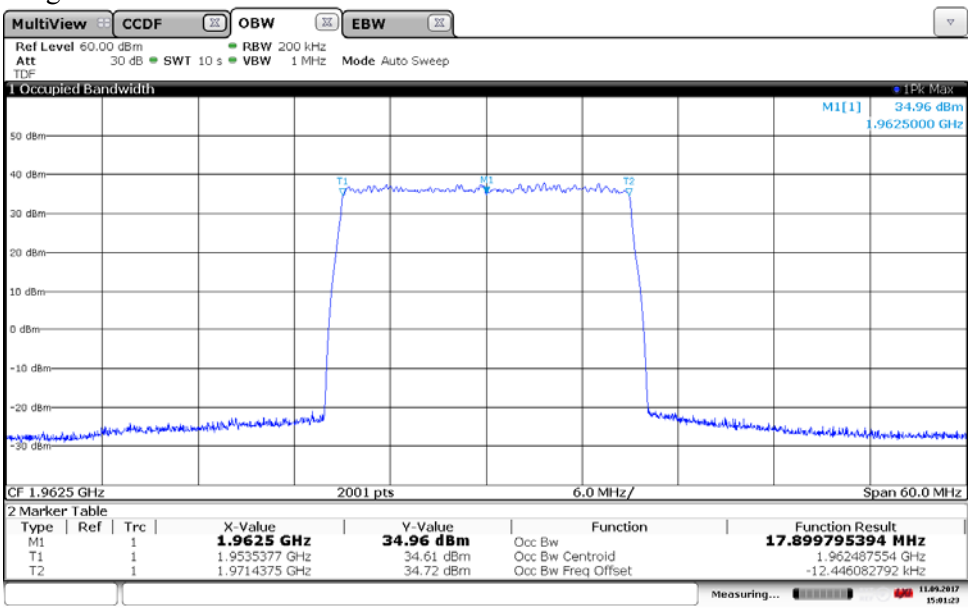

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Diagram 10:

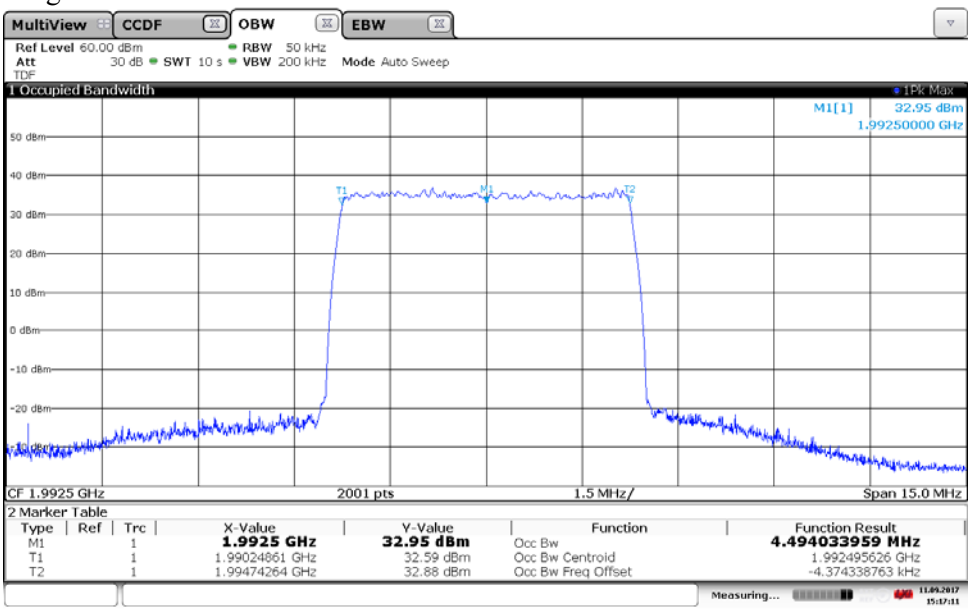

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Diagram 11:

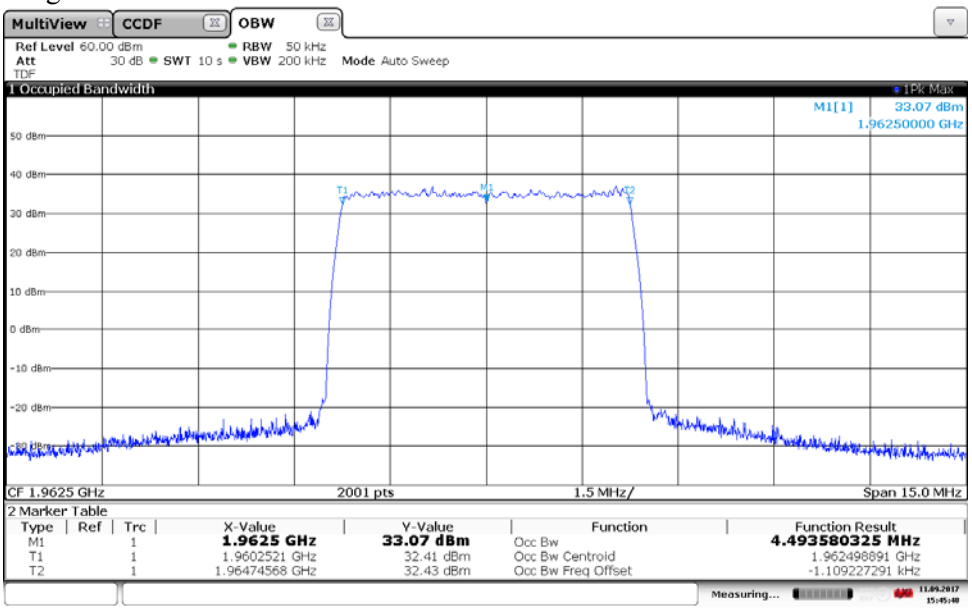


Diagram 12:

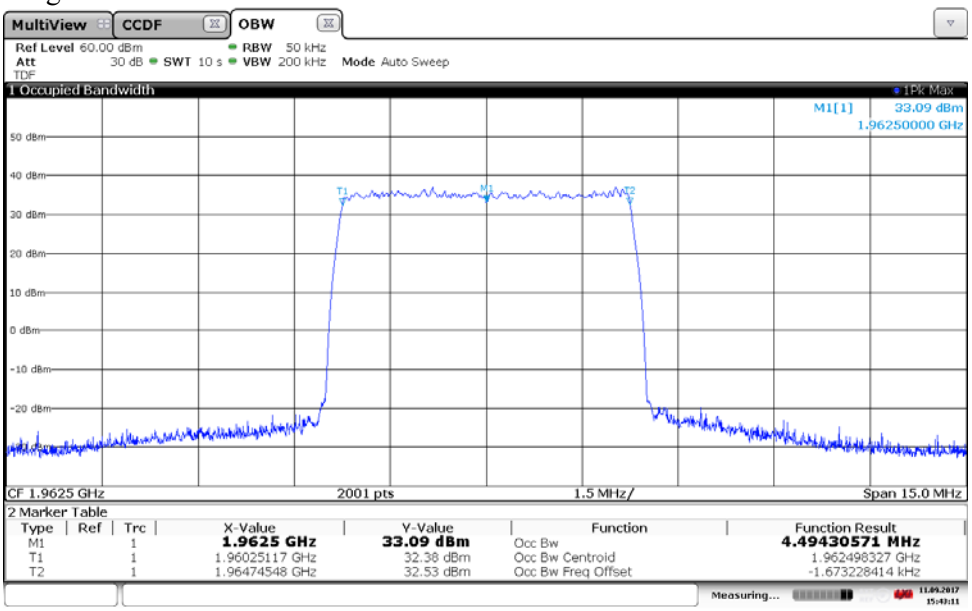
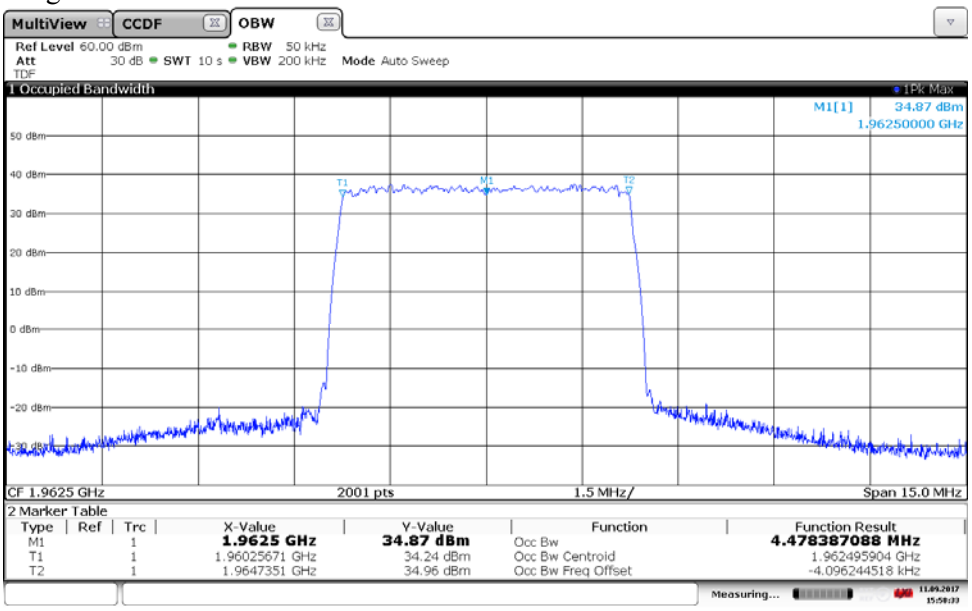


Diagram 13:



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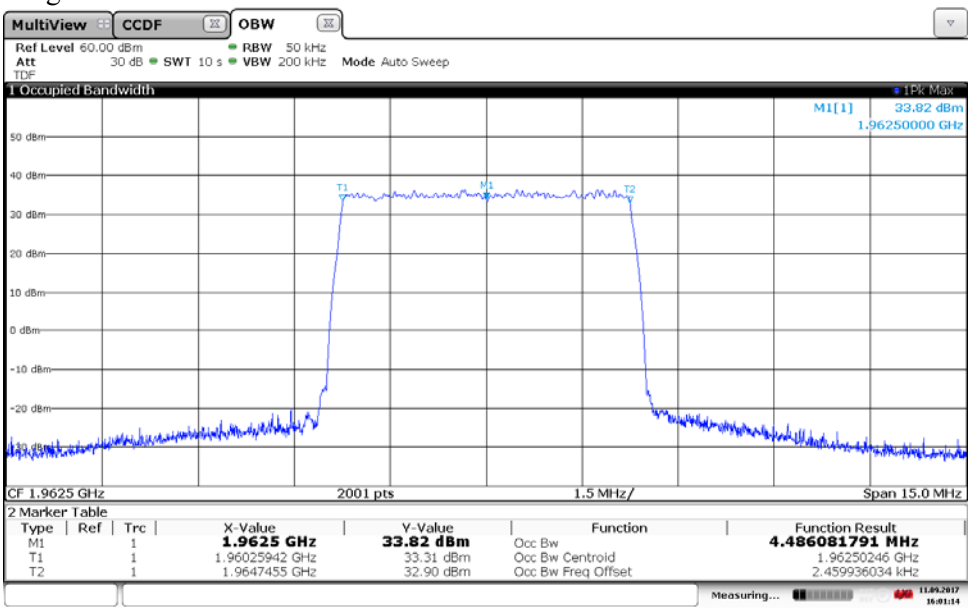

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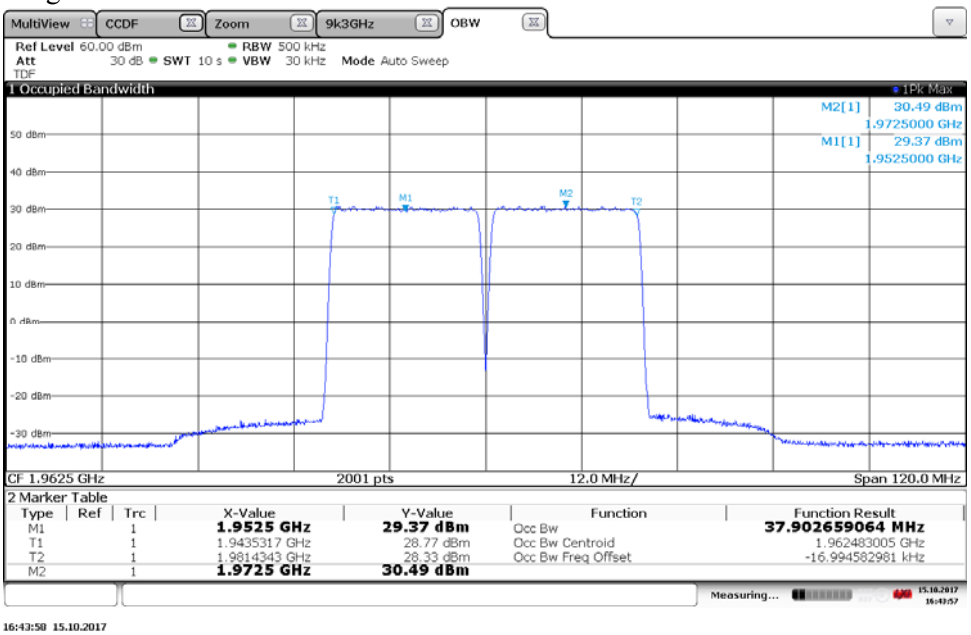
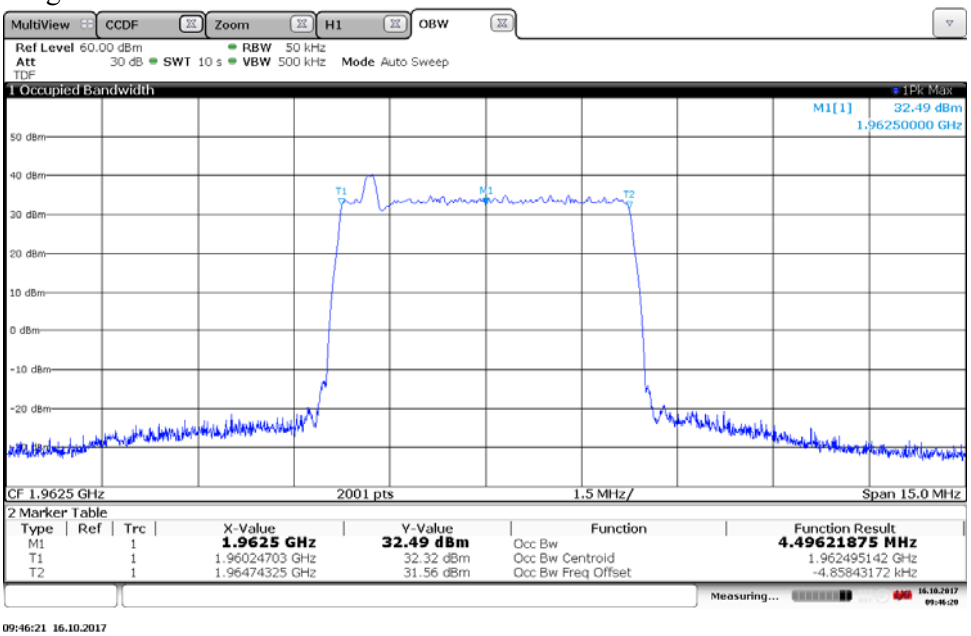


Diagram 16:



Band edge measurements according to CFR 47 §2.1049

Date	Temperature	Humidity
2017-09-12	21 °C ± 3 °C	49 % ± 5 %
2017-09-14	22 °C ± 3 °C	52 % ± 5 %

Test set-up and procedure

The measurements were made per definition in CFR 47 §24.238.The test object was connected to a spectrum analyzer with the RMS detector activated. The spectrum analyzer was connected to an external 10 MHz reference standard during the measurements.

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
1.4 MHz	10 kHz	13.1 kHz	-1.2 dBm	-14.2 dBm
3 MHz	10 kHz	29.4 kHz	-4.7 dBm	-17.7 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.

Before comparing the results to the limit, 6 dB [10 log (4)] to cover 4x4 MIMO, should be added according to method c “measure and add 10 log(N_{ANT})” of FCC KDB662911 D01 Multiple Transmitter Output.

Measurement equipment	RISE number
R&S FSW 43	902 073
RF attenuator	900 691
Testo 635, temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier TM 1.1

Diagram	Symbolic name	Tested Port
1 a-b	B_3	RF A
2 a-b	$B_{1.4}$	RF B
3 a-b	B_3	RF B
4 a-b	B_5	RF B
5 a-b	B_{10}	RF B
6 a-b	B_{15}	RF B
7 a-b	B_{20}	RF B
8 a-b	B_3	RF C
9 a-b	B_3	RF D
10 a-b	T_3	RF A
11 a-b	$T_{1.4}$	RF B
12 a-b	T_3	RF B
13 a-b	T_5	RF B
14 a-b	T_{10}	RF B
15 a-b	T_{15}	RF B
16 a-b	T_{20}	RF B
17 a-b	T_3	RF C
18 a-b	T_3	RF D

Multi carrier TM 1.1

Diagram	Symbolic name	Tested Port
19 a-b	Bim	RF B
20 a-b	Tim	RF B

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:

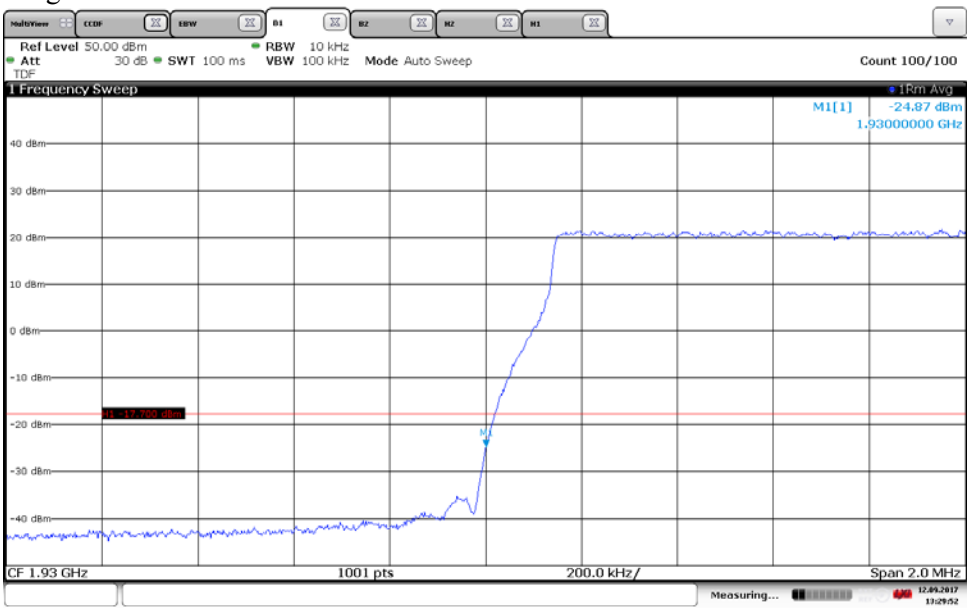


Diagram 1b:

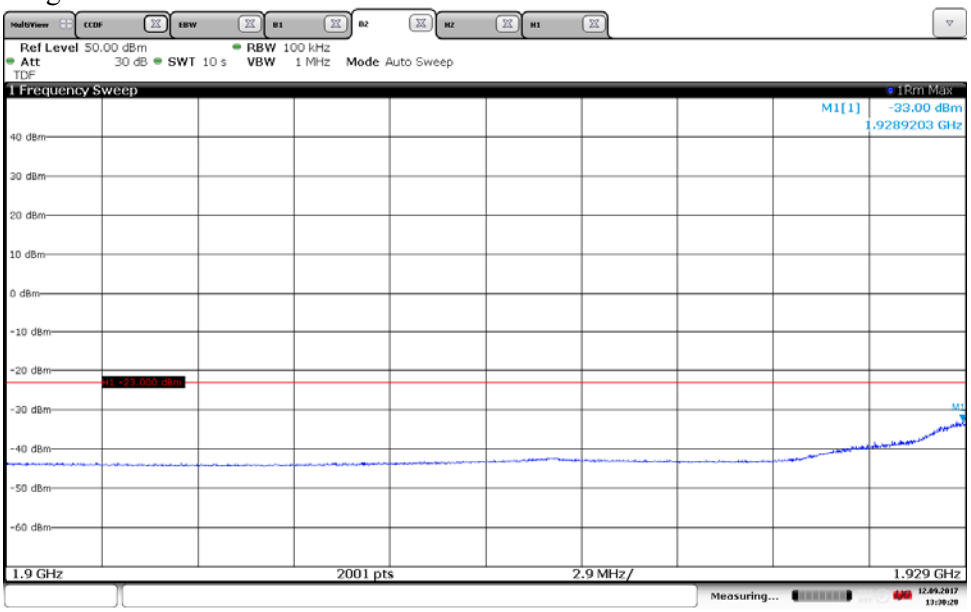


Diagram 2a:

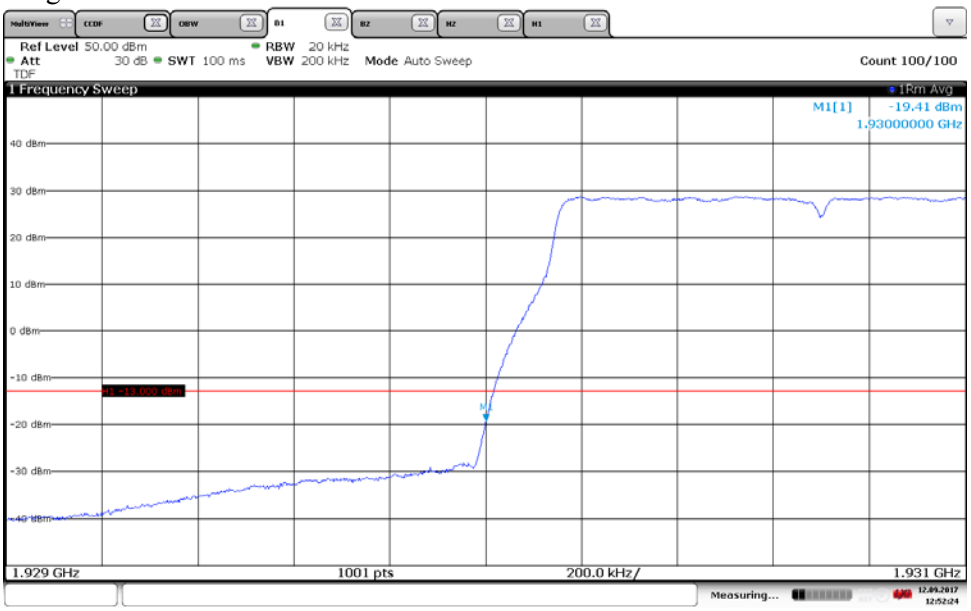


Diagram 2b:

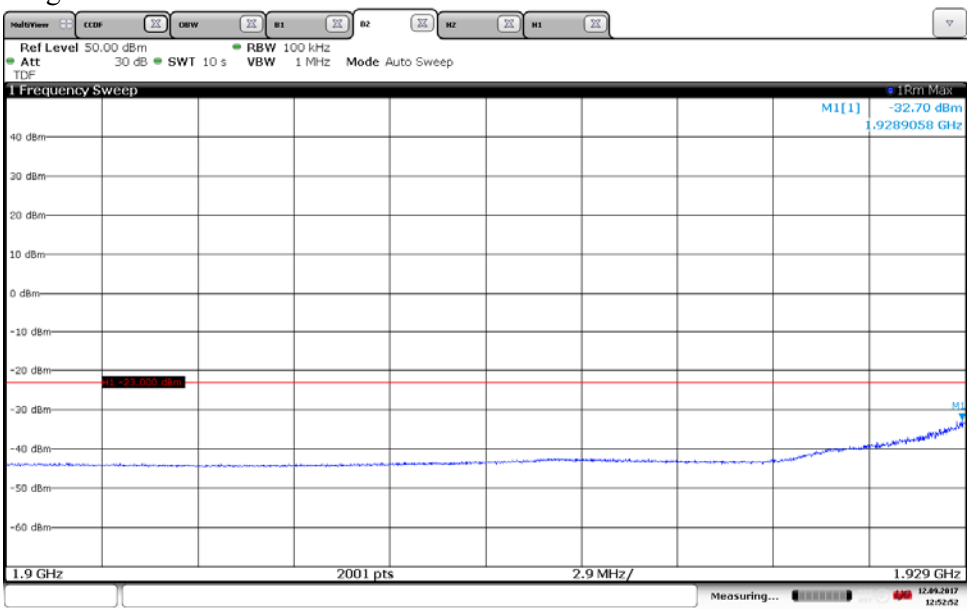


Diagram 3a:

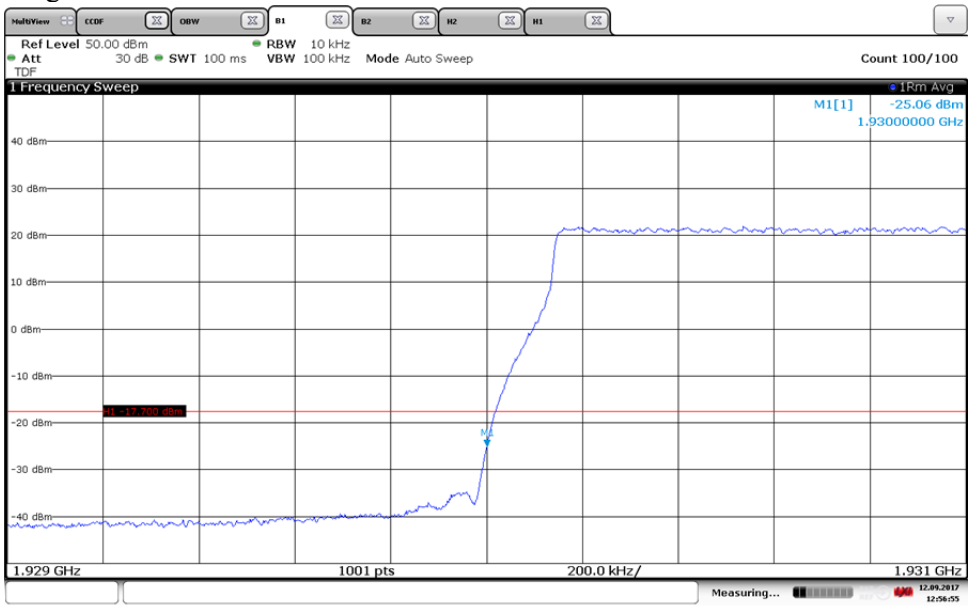


Diagram 3b:

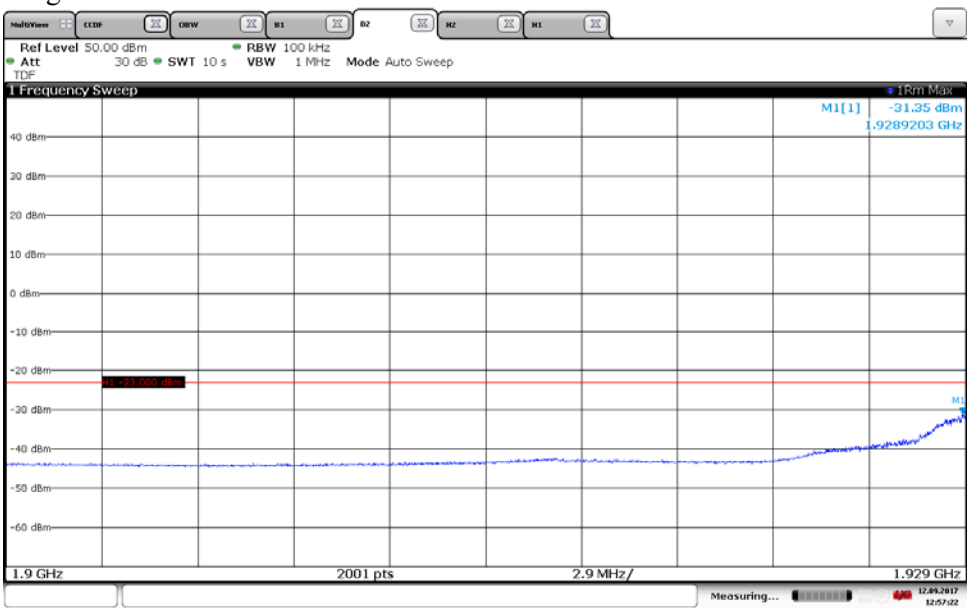


Diagram 4a:

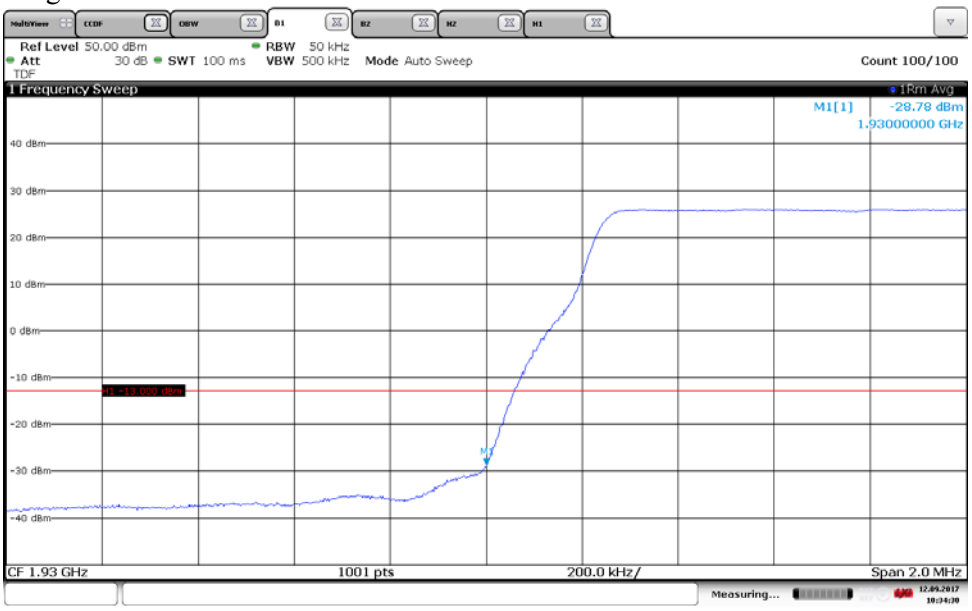


Diagram 4b:

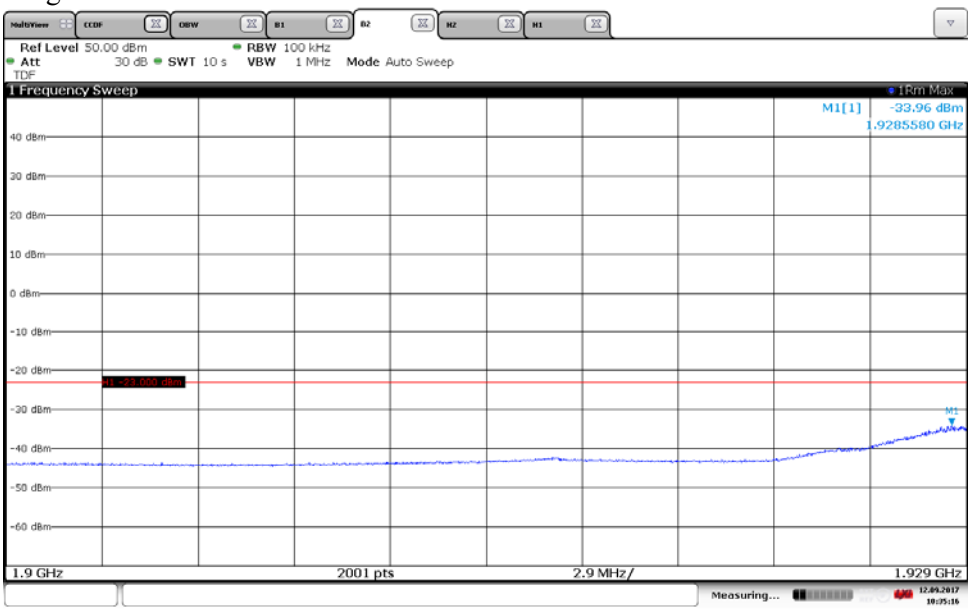


Diagram 5a:

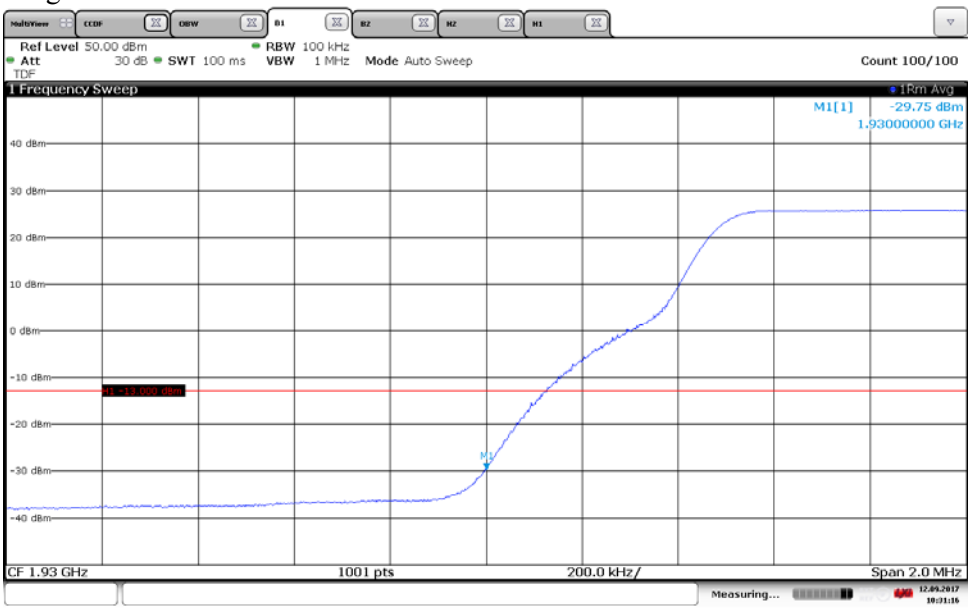


Diagram 5b:

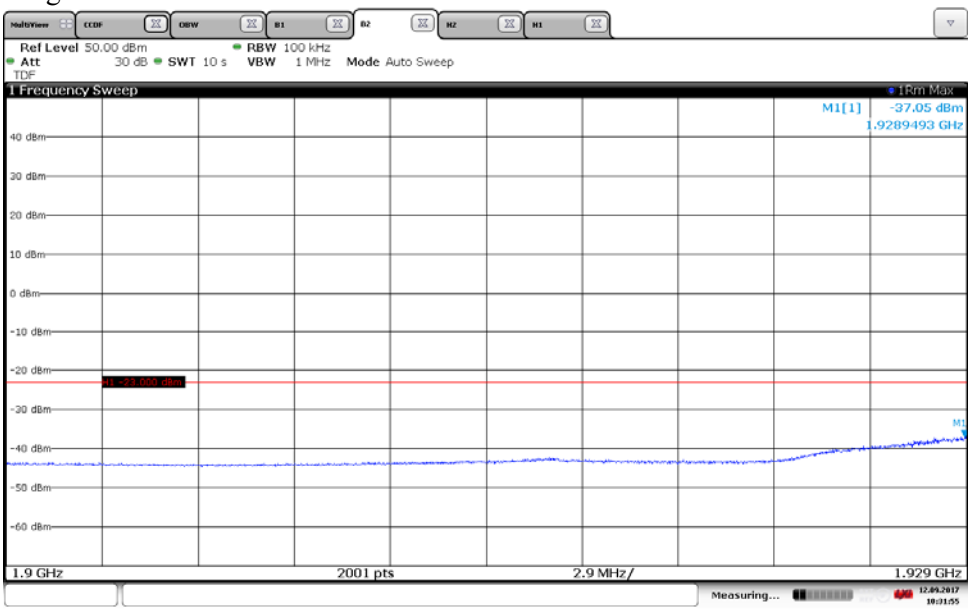


Diagram 6a:

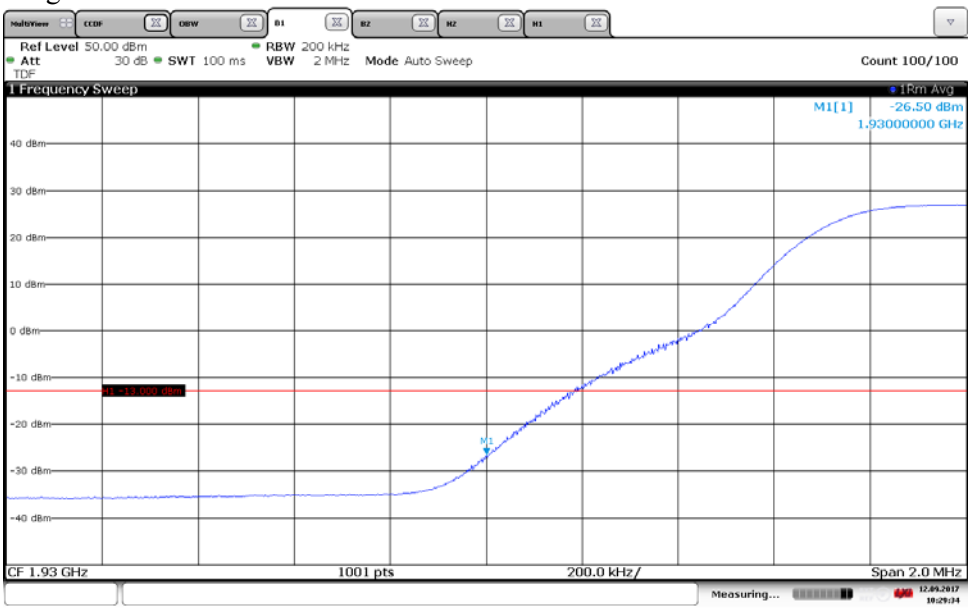


Diagram 6b:

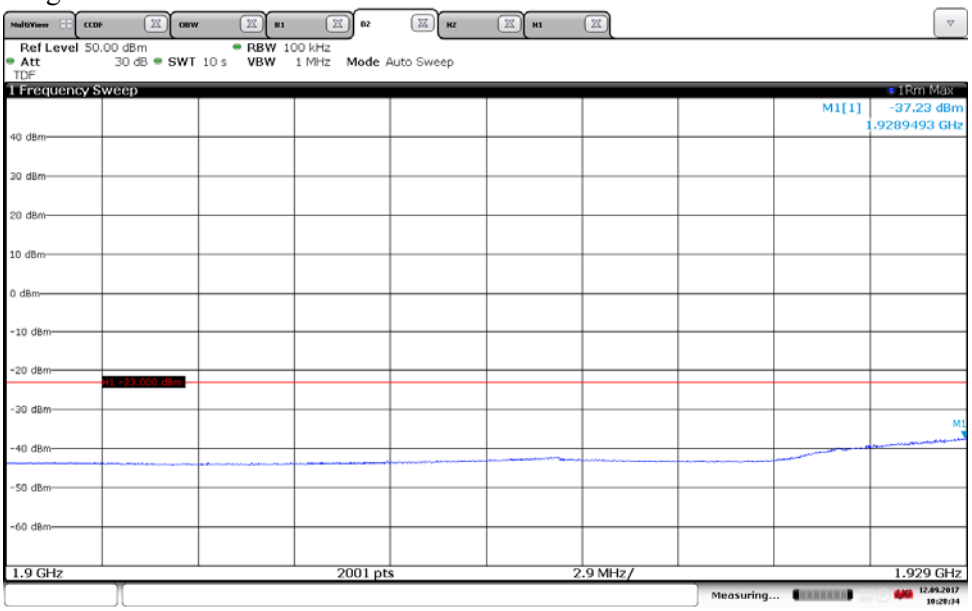


Diagram 7a:

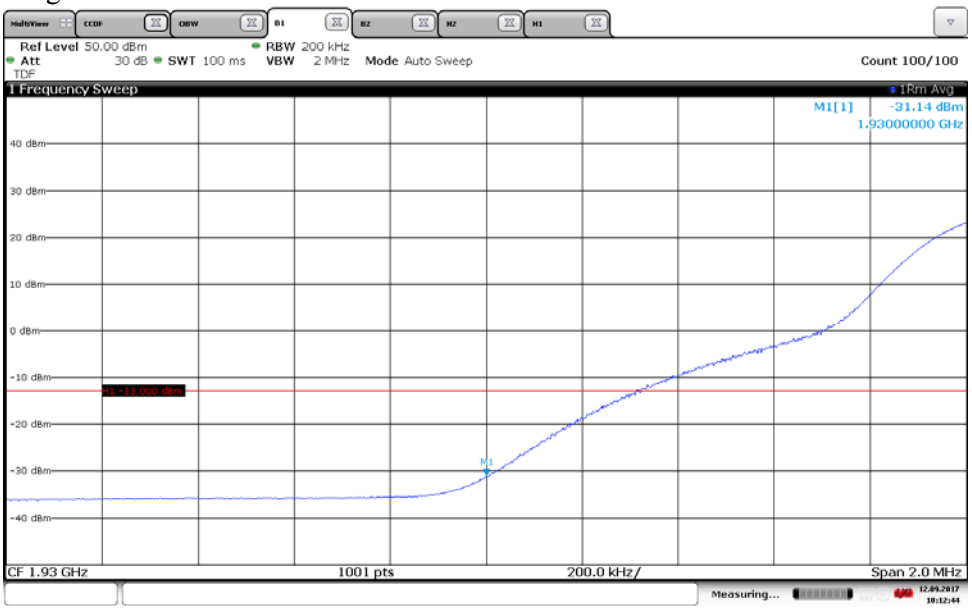


Diagram 7b:

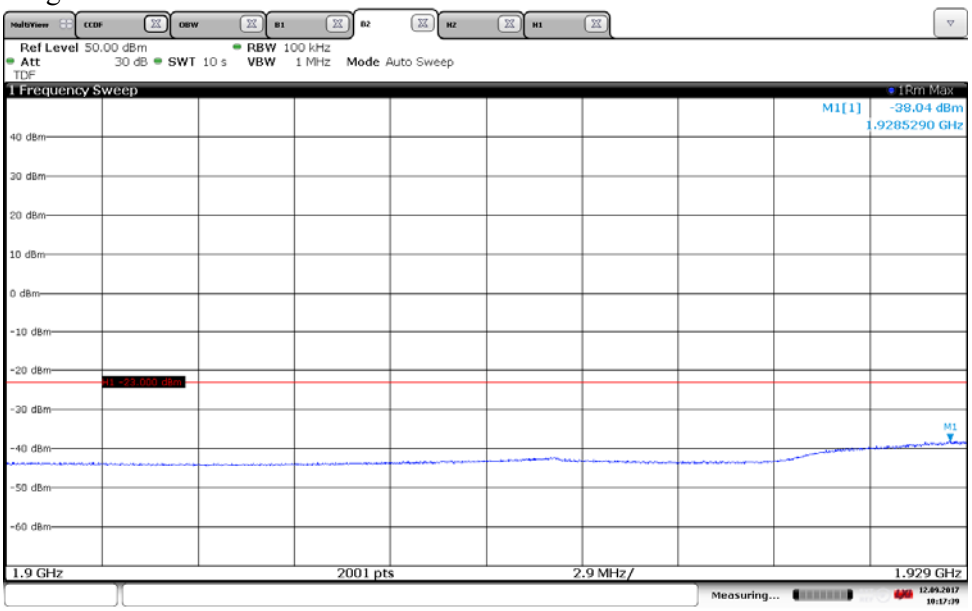


Diagram 8a:

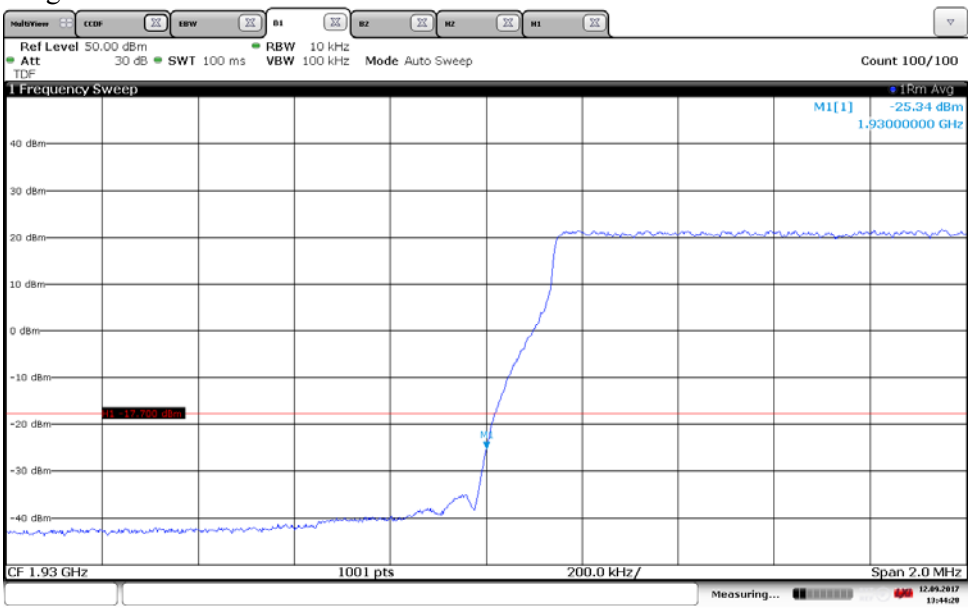


Diagram 8b:

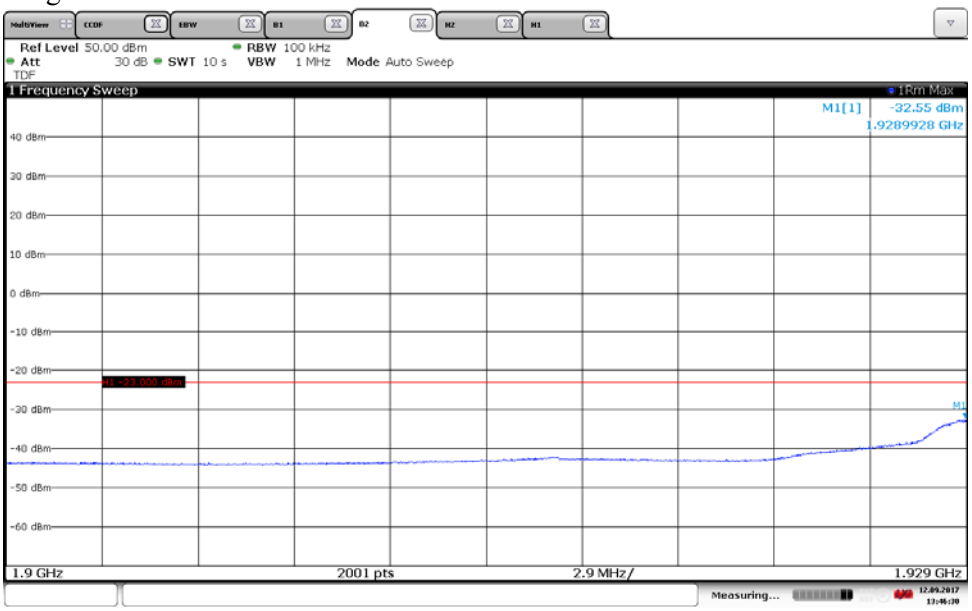


Diagram 9a:

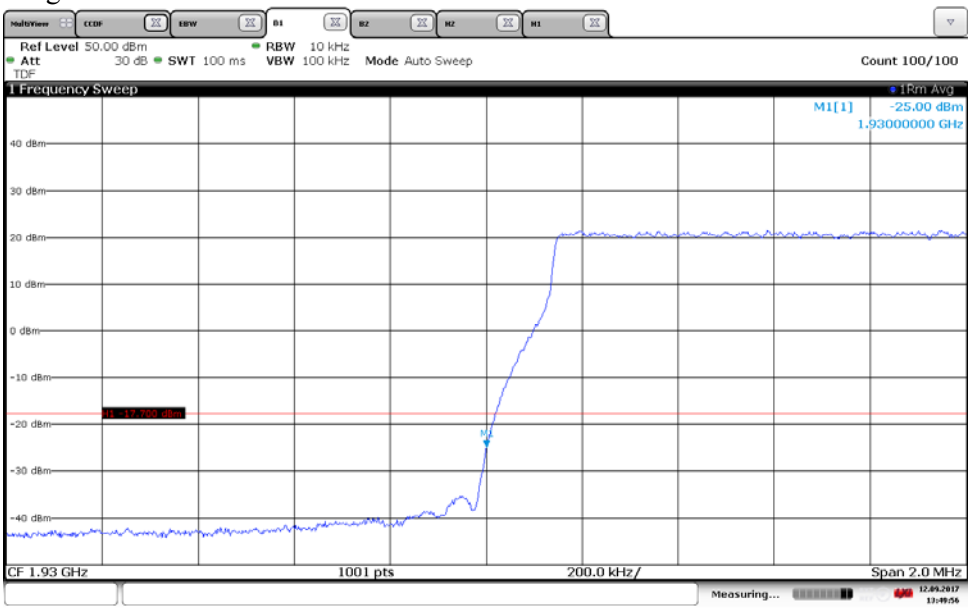


Diagram 9b:

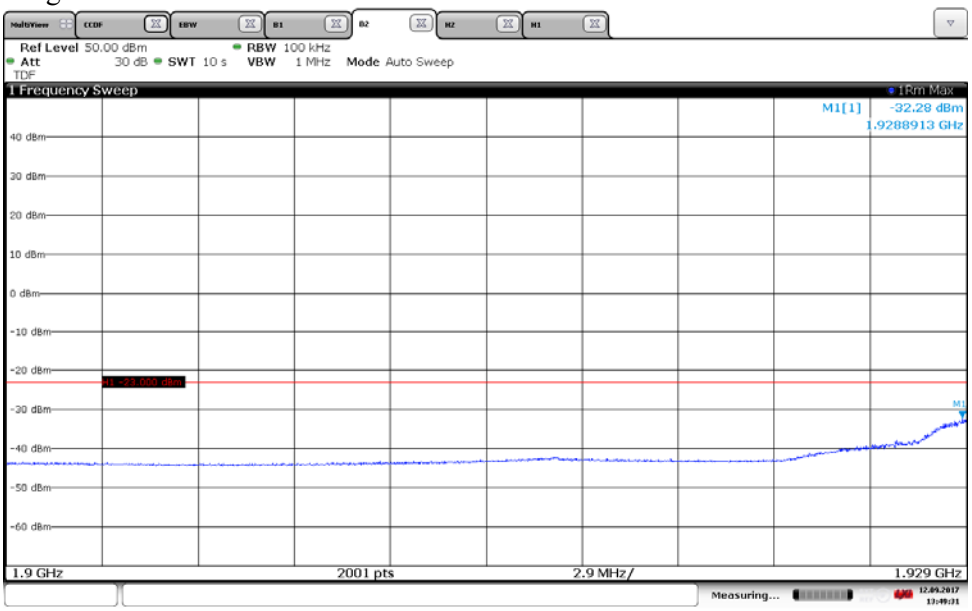


Diagram 10a:

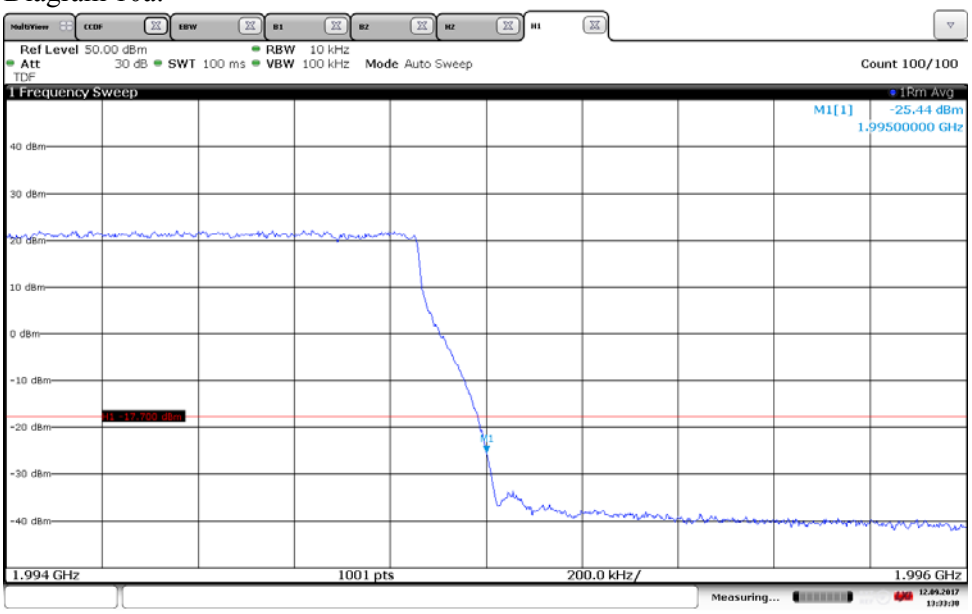


Diagram 10b:

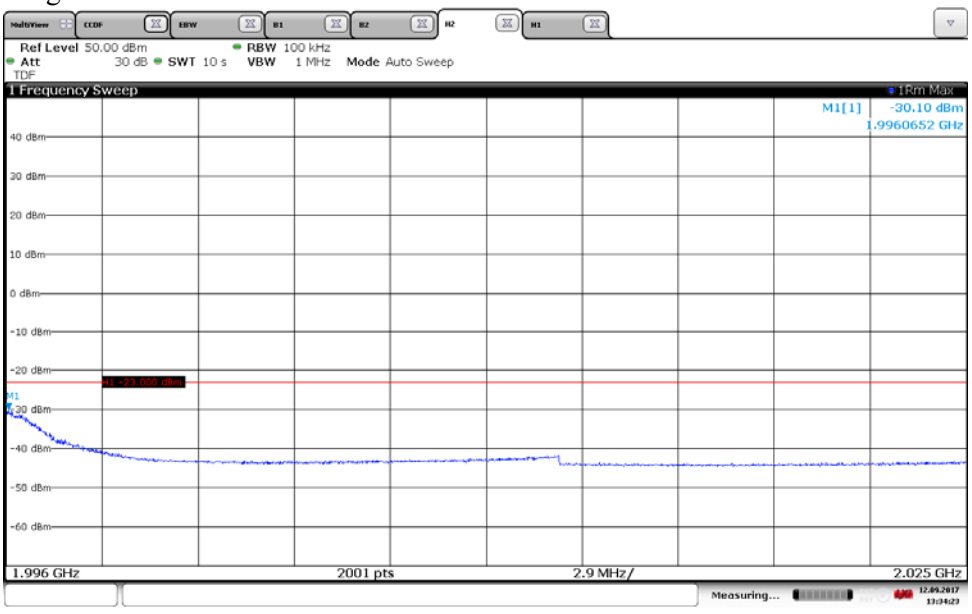


Diagram 11a:

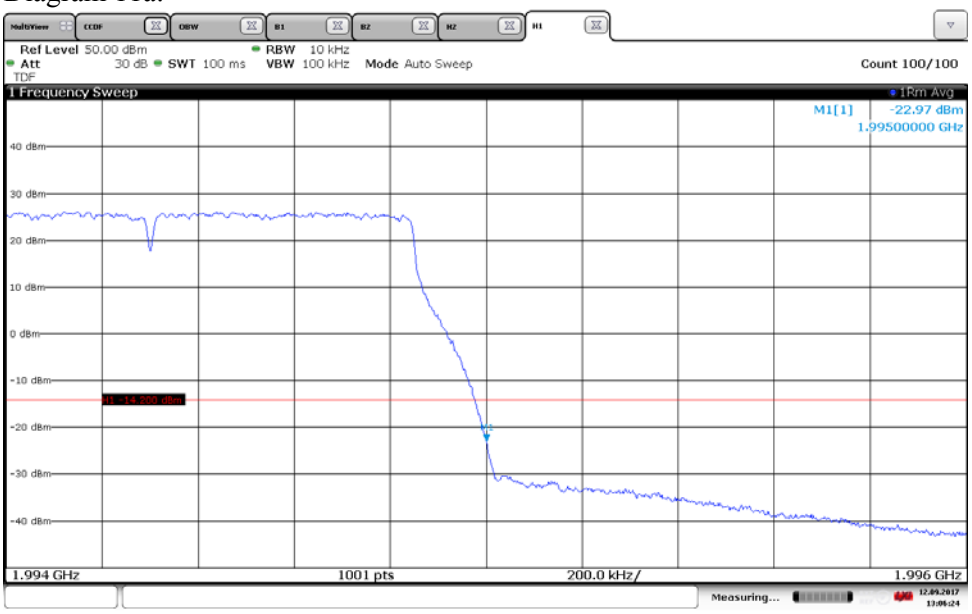


Diagram 11b:

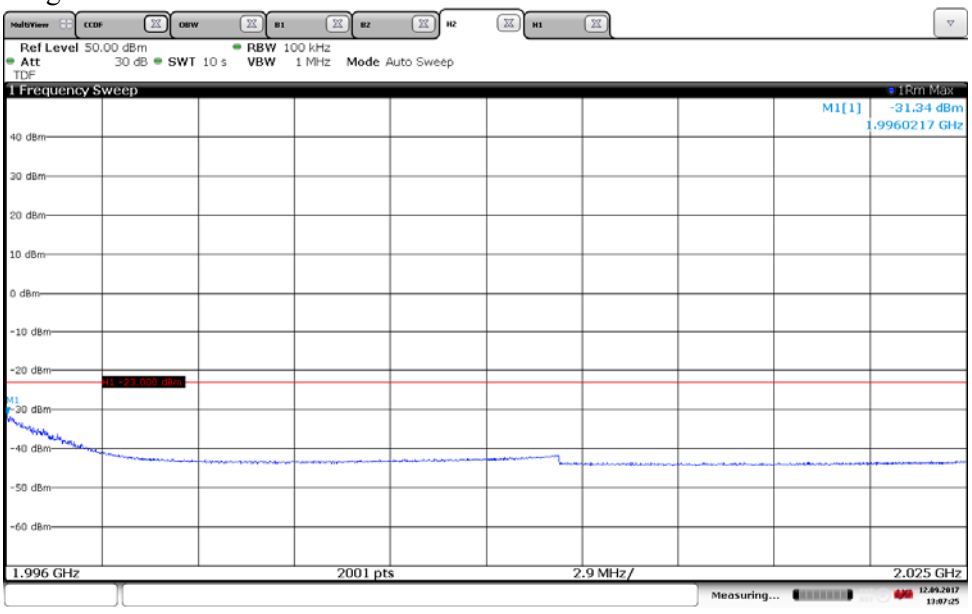


Diagram 12a:

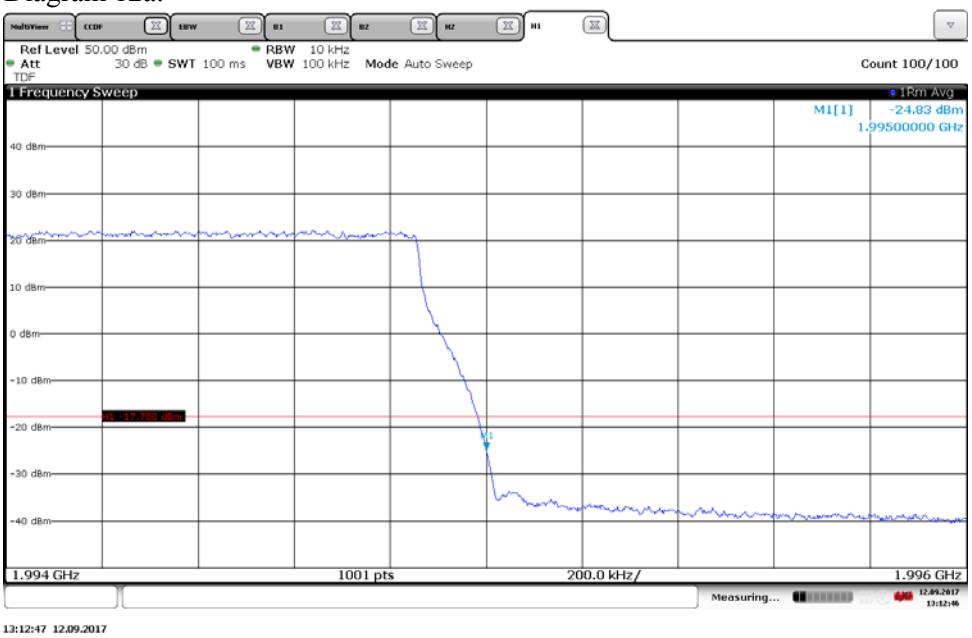


Diagram 12b:

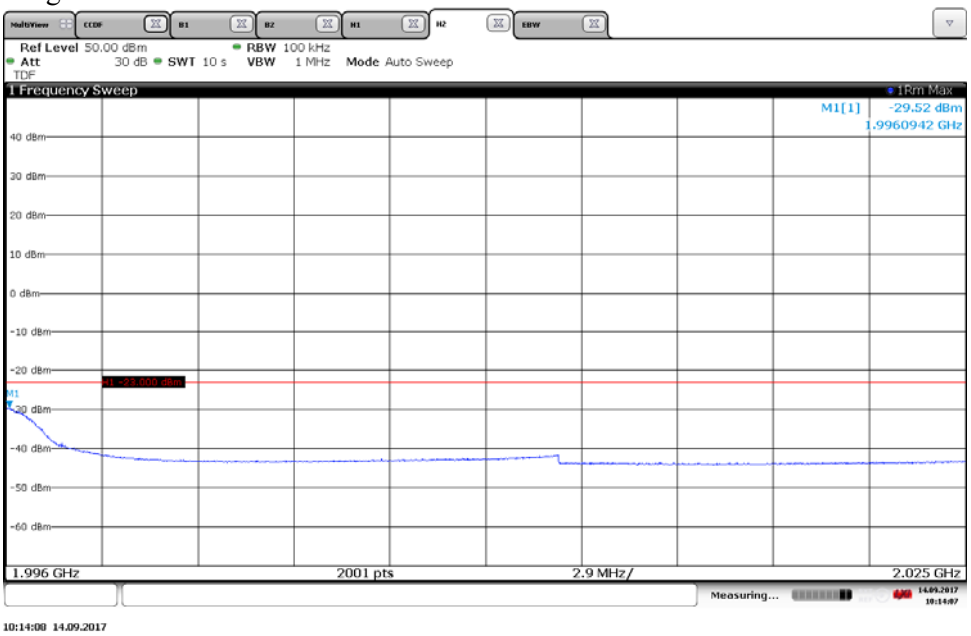


Diagram 13a:

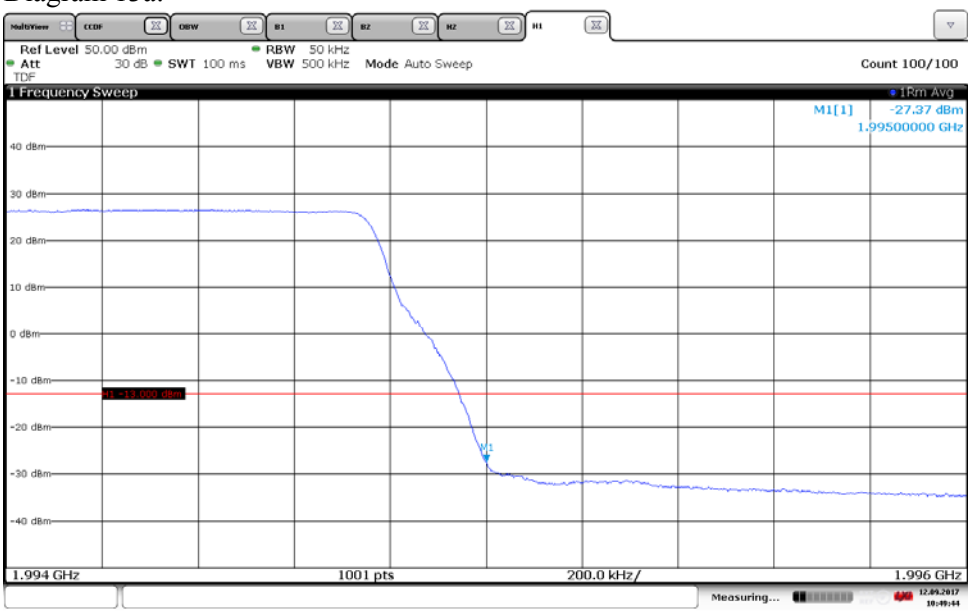


Diagram 13b:

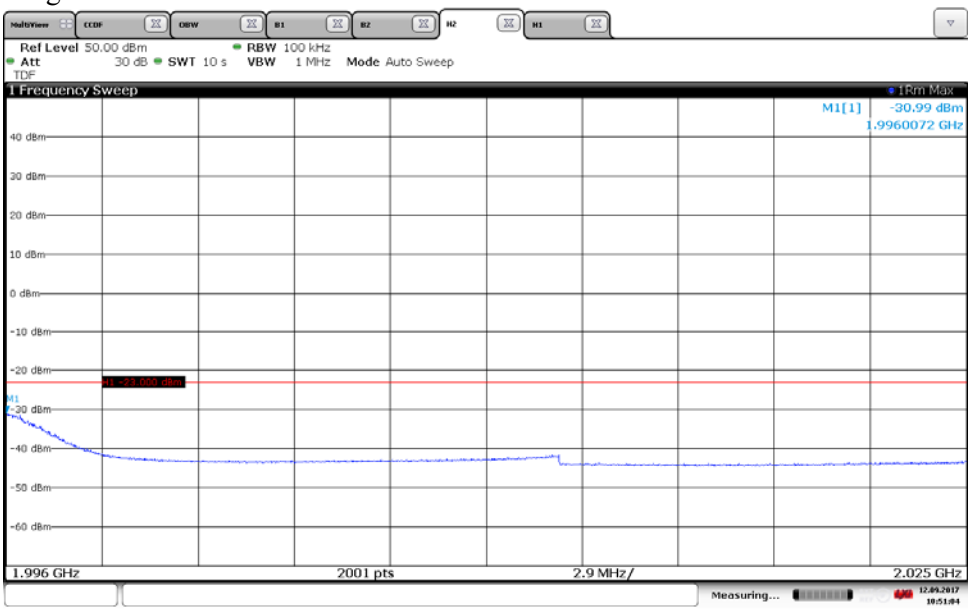


Diagram 14a:

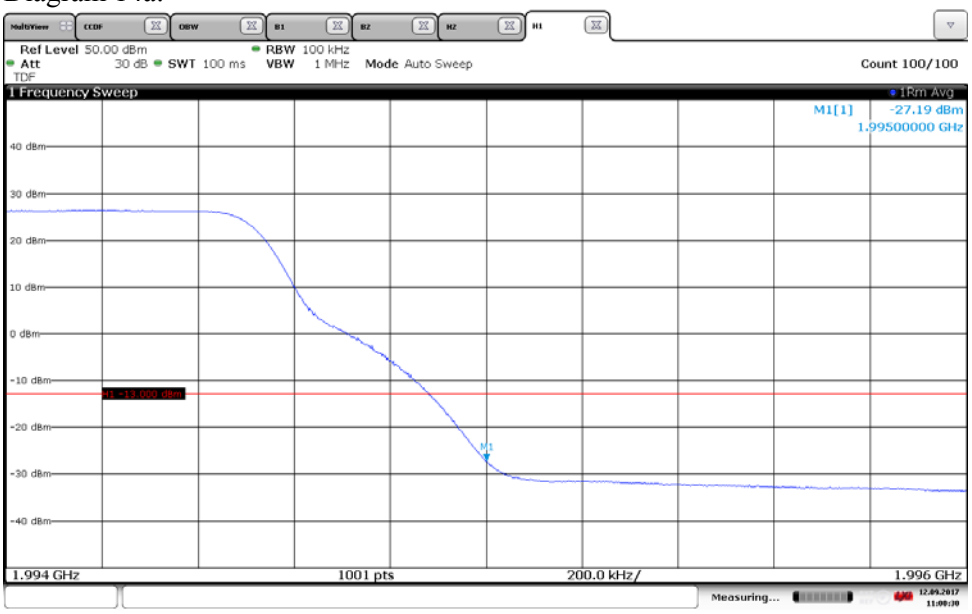


Diagram 14b:

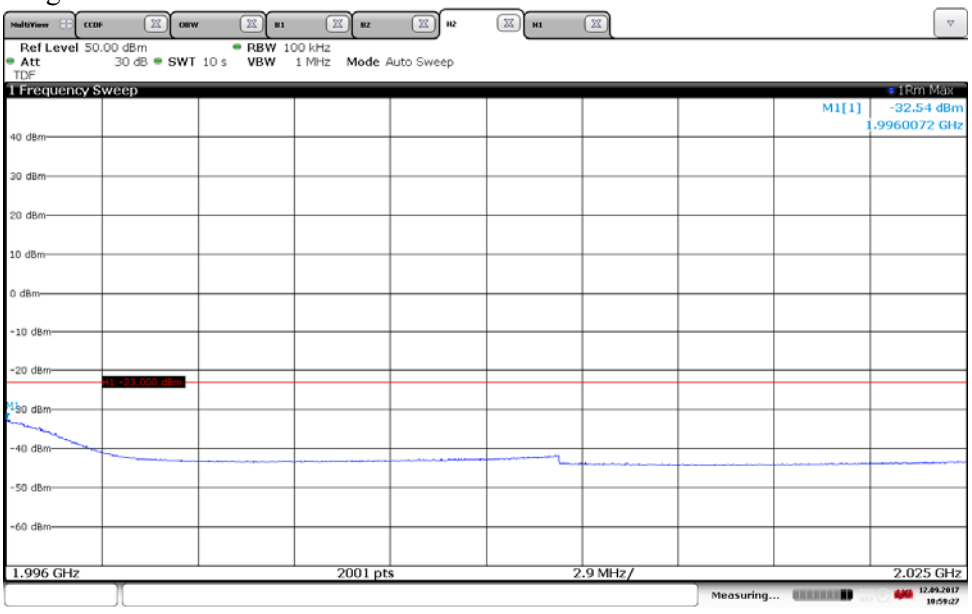


Diagram 15a:

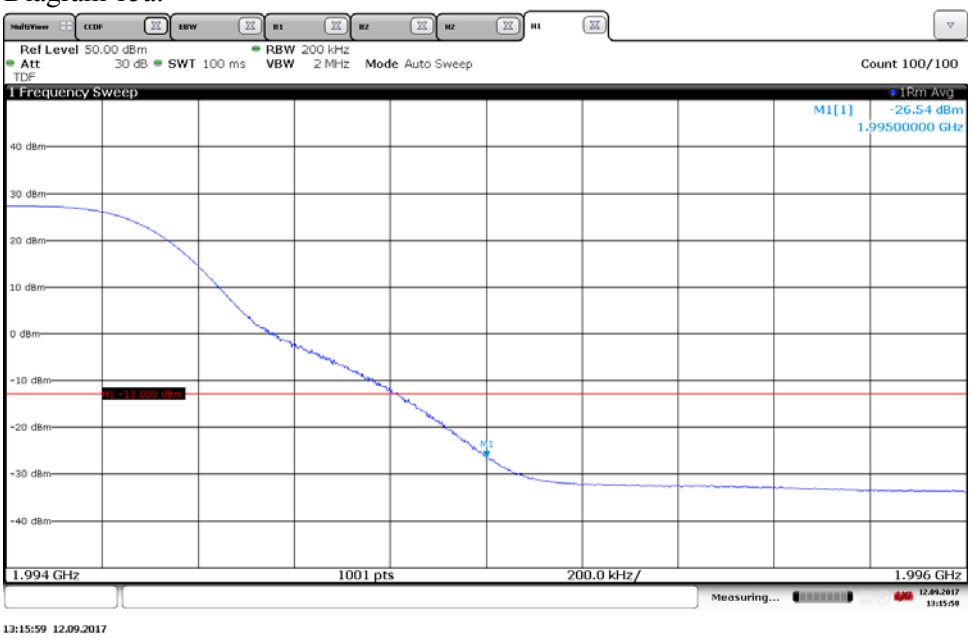


Diagram 15b:

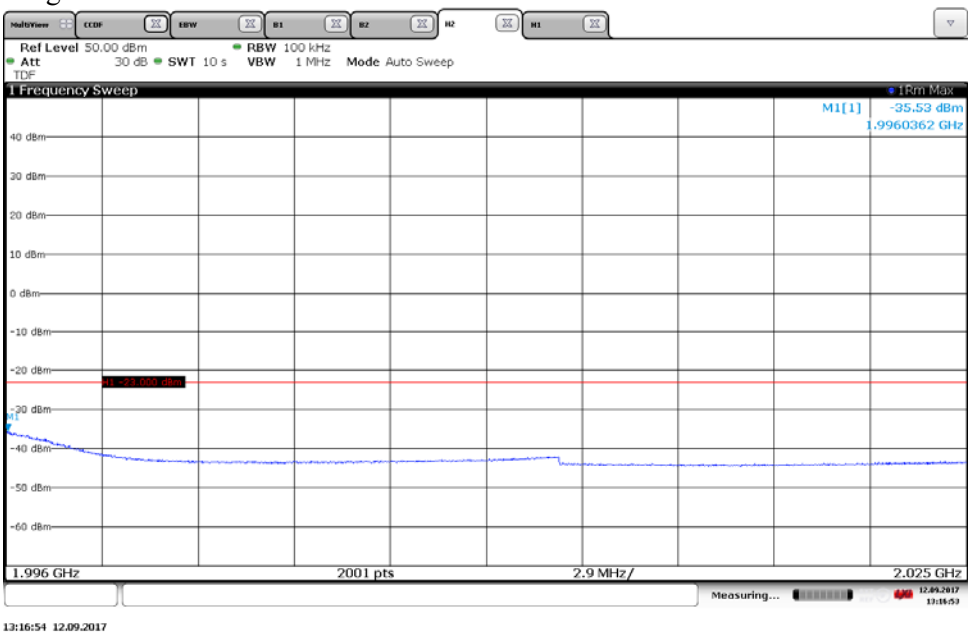


Diagram 16a:

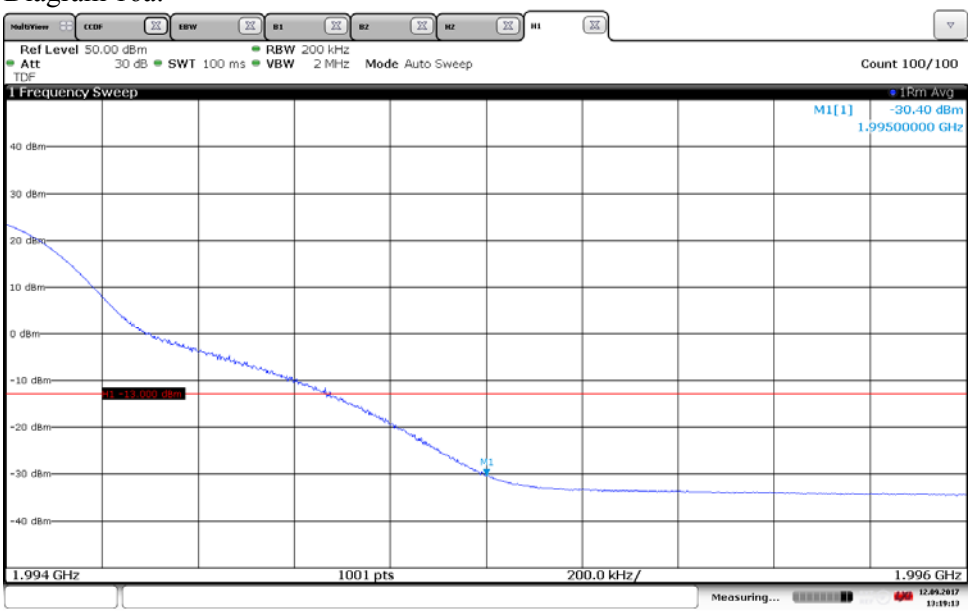


Diagram 16b:

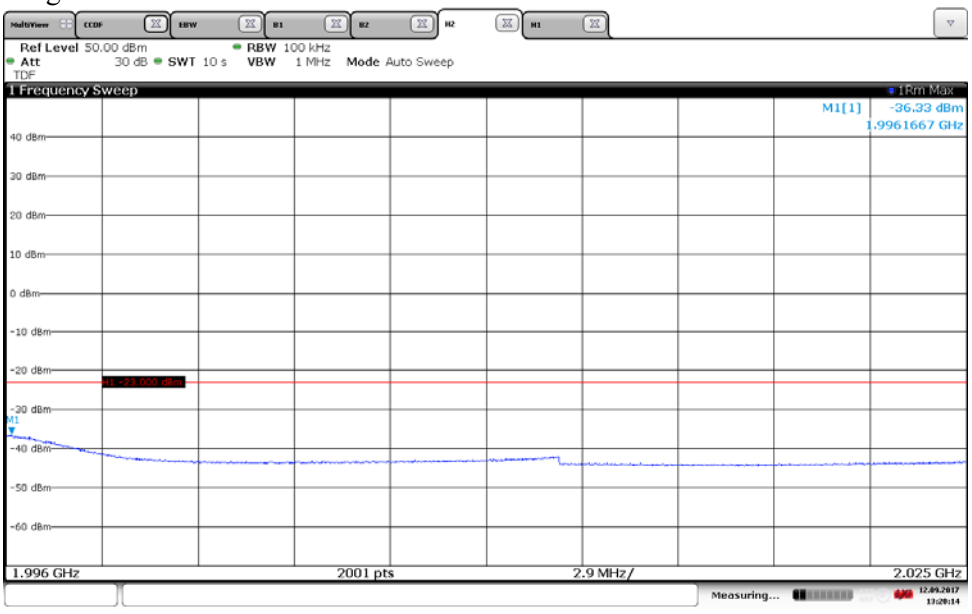


Diagram 17a:

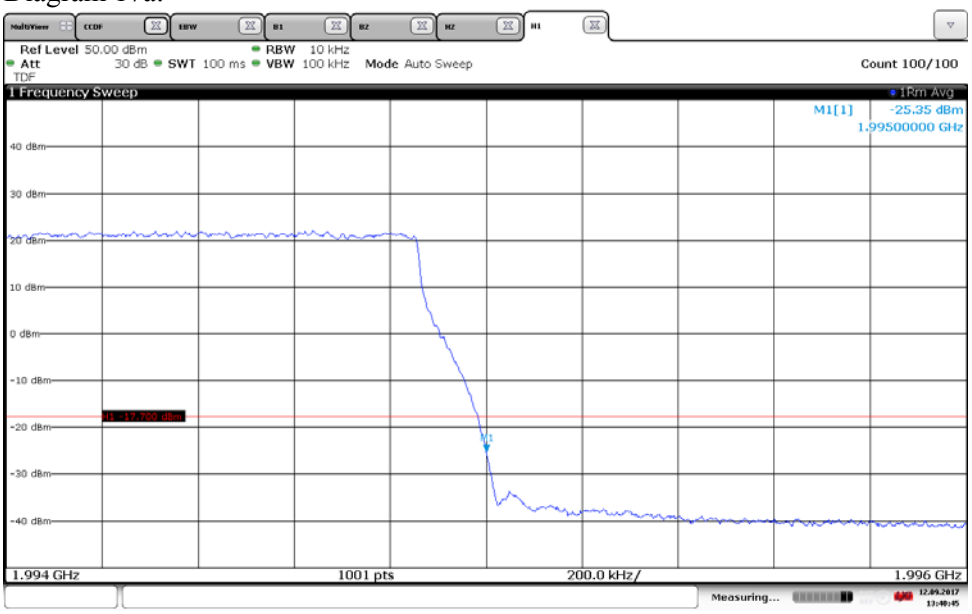


Diagram 17b:

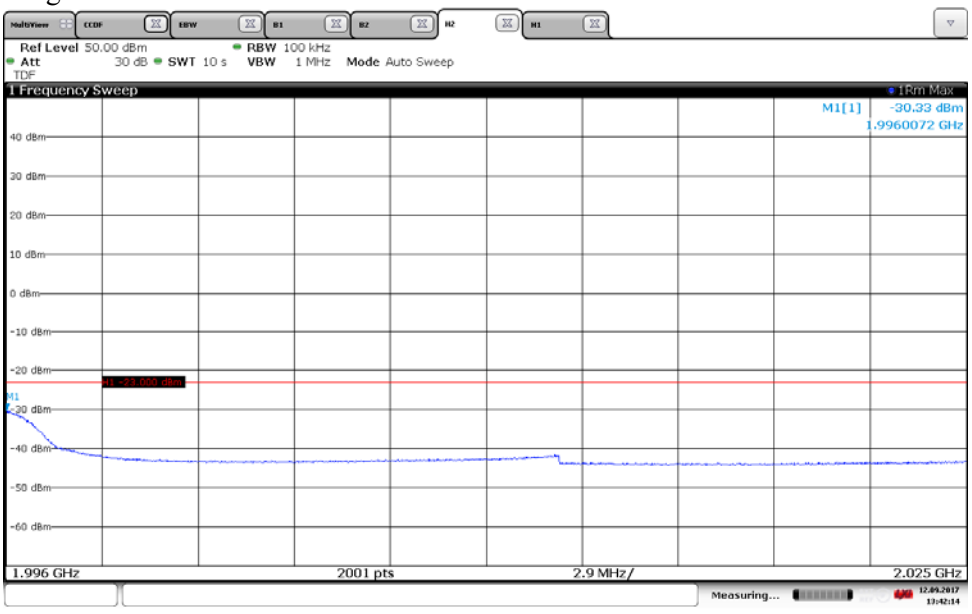


Diagram 18a:

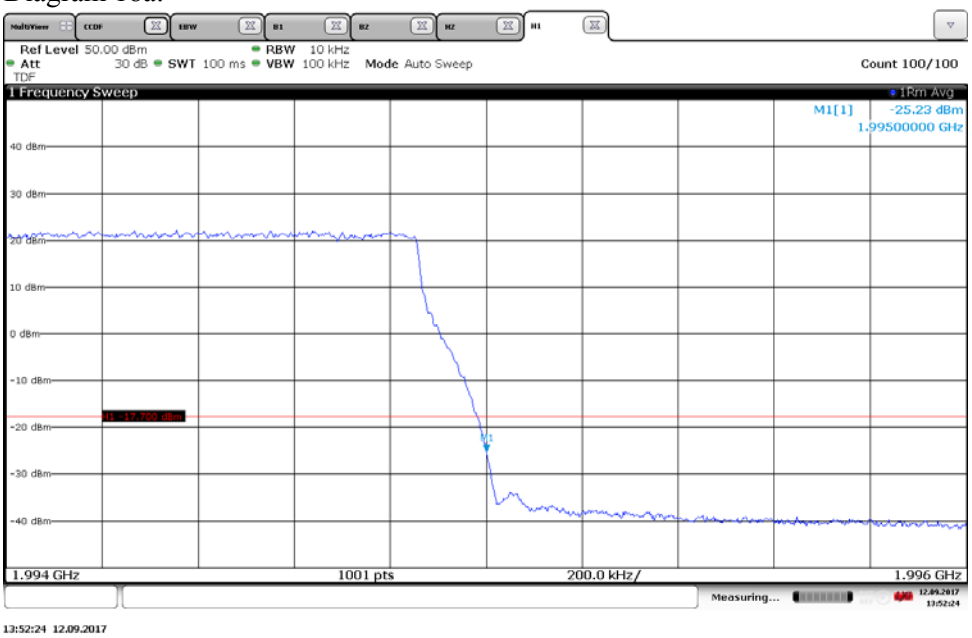


Diagram 18b:

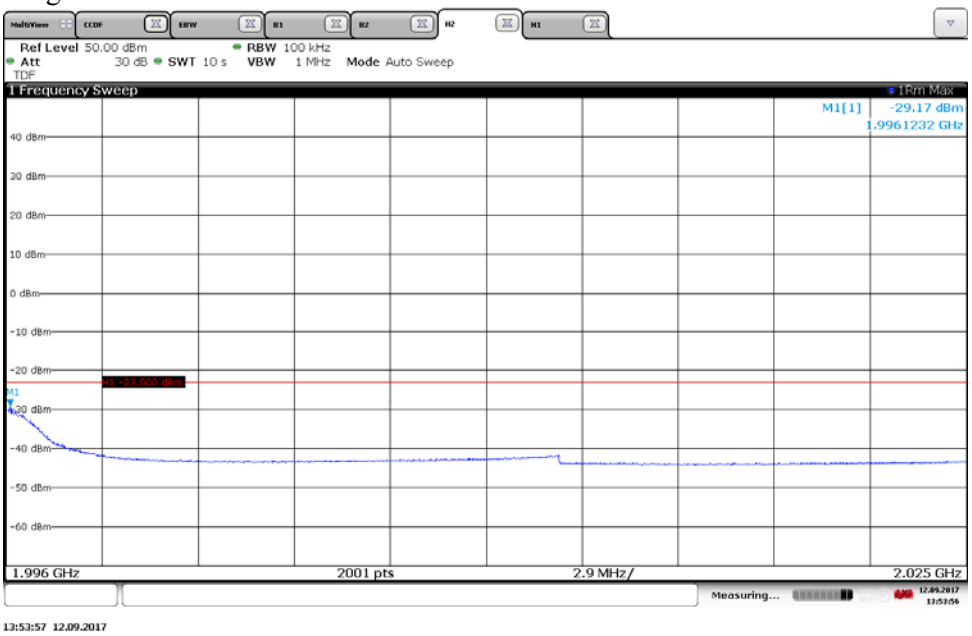


Diagram 19a:

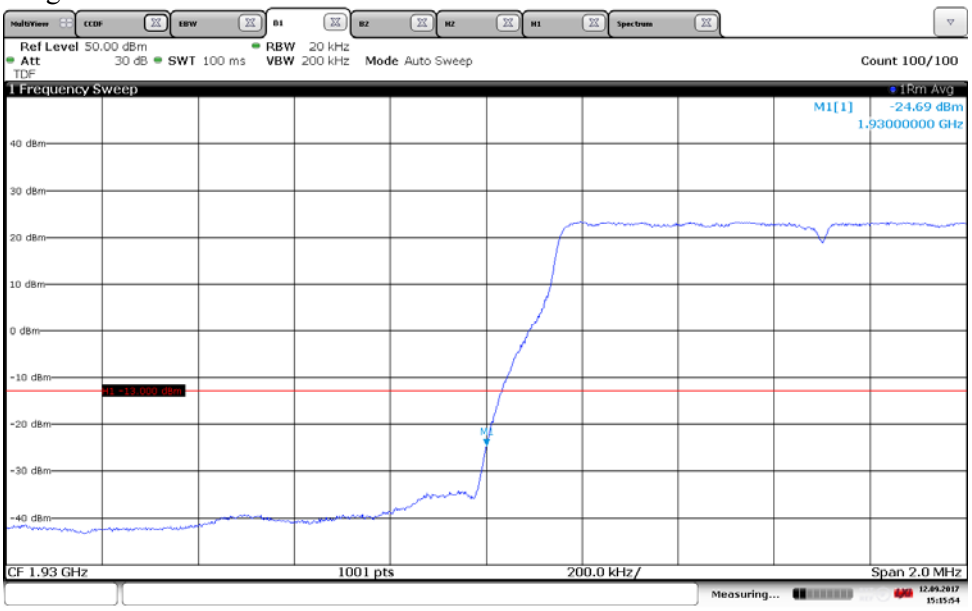


Diagram 19b:

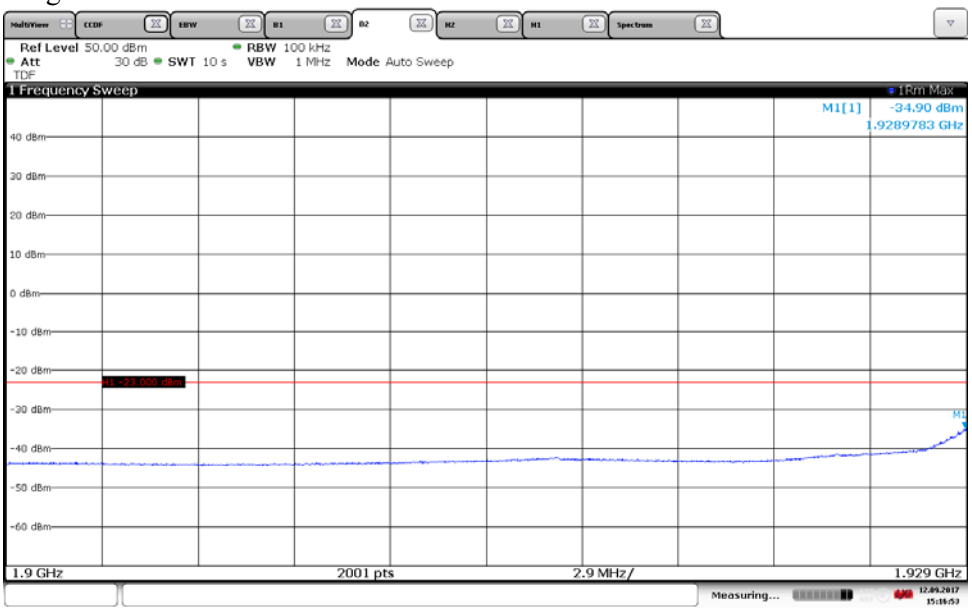


Diagram 20a:

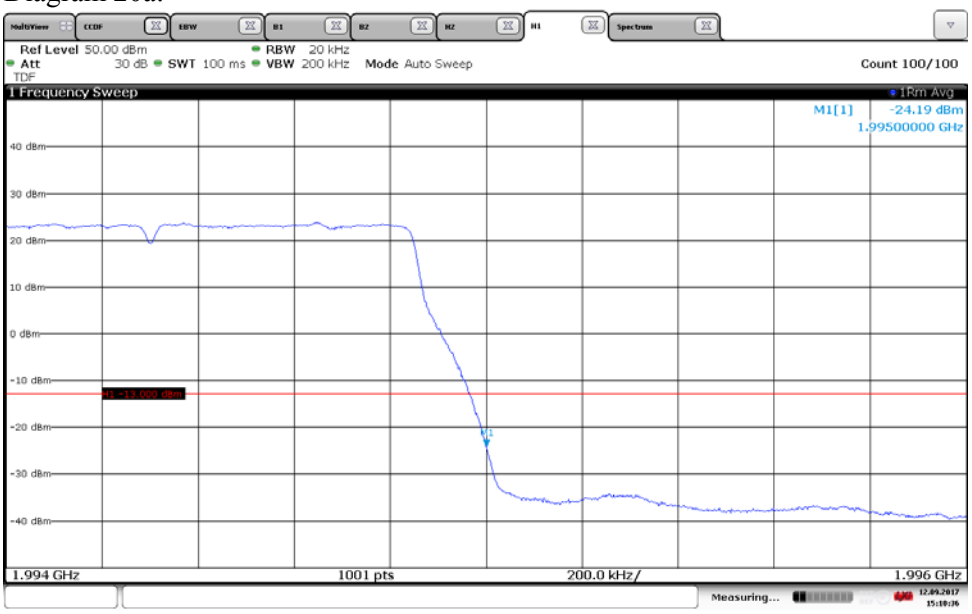
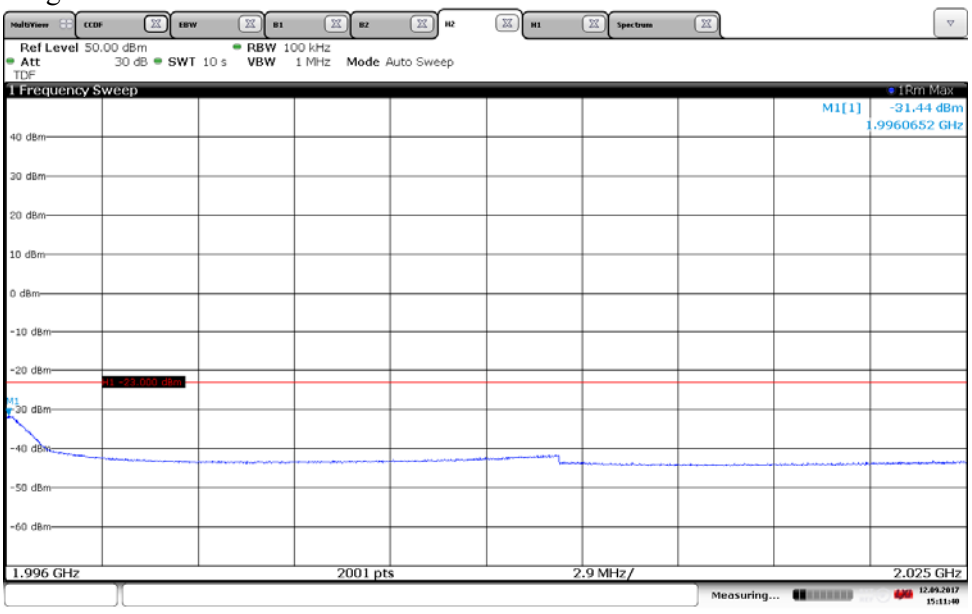


Diagram 20b:



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

Date	Temperature	Humidity
2017-09-13	21 °C ± 3 °C	49 % ± 5 %
2017-10-16	23 °C ± 3 °C	40 % ± 5 %

Test set-up and procedure

The measurements were made per definition in §24.238. The output was connected to a spectrum analyzer with a RBW setting of 1 MHz and RMS detector activated. The spectrum analyzer was connected to an external 10 MHz reference standard during the measurements.

Before comparing the results to the limit, 6 dB [10 log (4)] to cover 4x4 MIMO, should be added according to method c "measure and add 10 log(N_{ANT})" of FCC KDB662911 D01 Multiple Transmitter Output.

Measurement equipment	RISE number
R&S FSW 43	902 073
RF attenuator	900 691
HP filter	BX40074
Testo 635, temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier E-TM 1.1

Diagram	Symbolic name	Tested Port
1 a-b	$M_{1.4}$	RF A
2 a-b	$B_{1.4}$	RF B
3 a-b	$M_{1.4}$	RF B
4 a-b	M_3	RF B
5 a-b	M_5	RF B
6 a-b	M_{10}	RF B
7 a-b	M_{15}	RF B
8 a-b	M_{20}	RF B
9 a-b	$T_{1.4}$	RF B
10 a-b	$M_{1.4}$	RF C
11 a-b	$M_{1.4}$	RF D

Multi carrier E-TM 1.1

Diagram	Symbolic name	Tested Port
12 a-c	M2	RF B
13 a-c	M6	RF B
14 a-c	Bim	RF B
15 a-c	Tim	RF B
16 a-c	$CA_{20\text{-}20}$	RF B
17 a-c	IoT	RF B

Note: Measurements were mainly limited to port RF B 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:

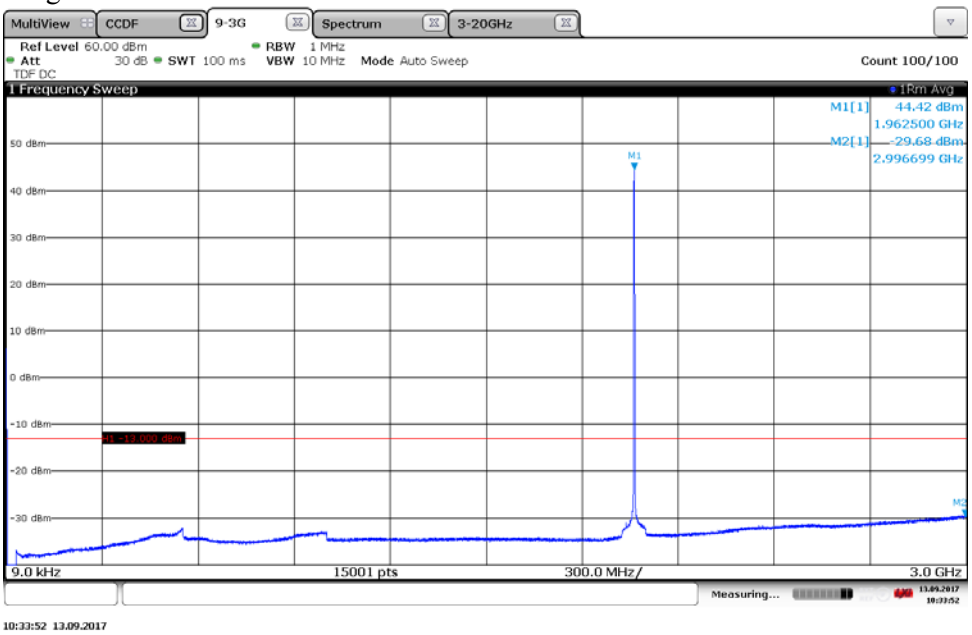


Diagram 1b:

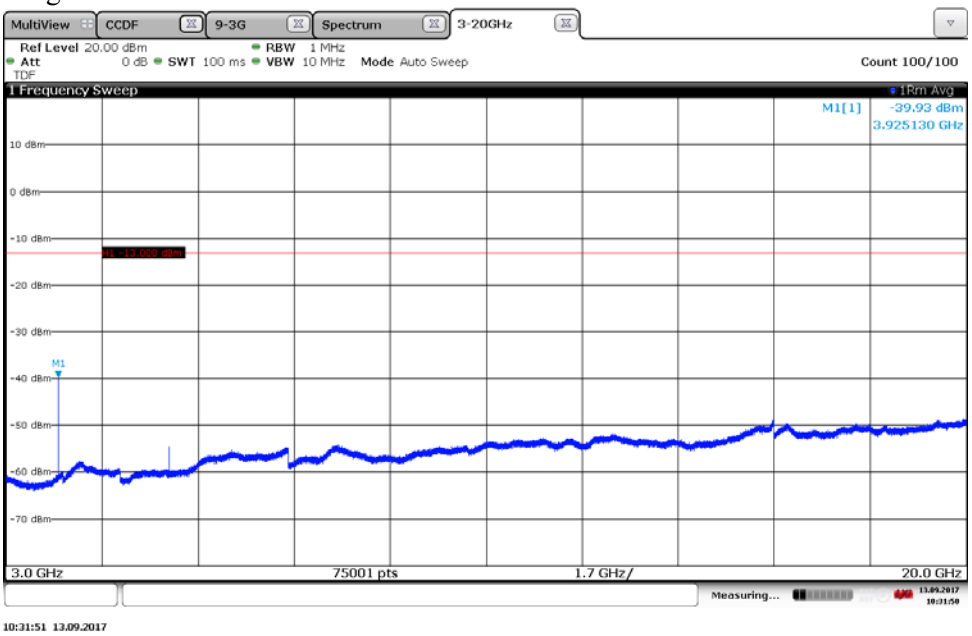


Diagram 2a:

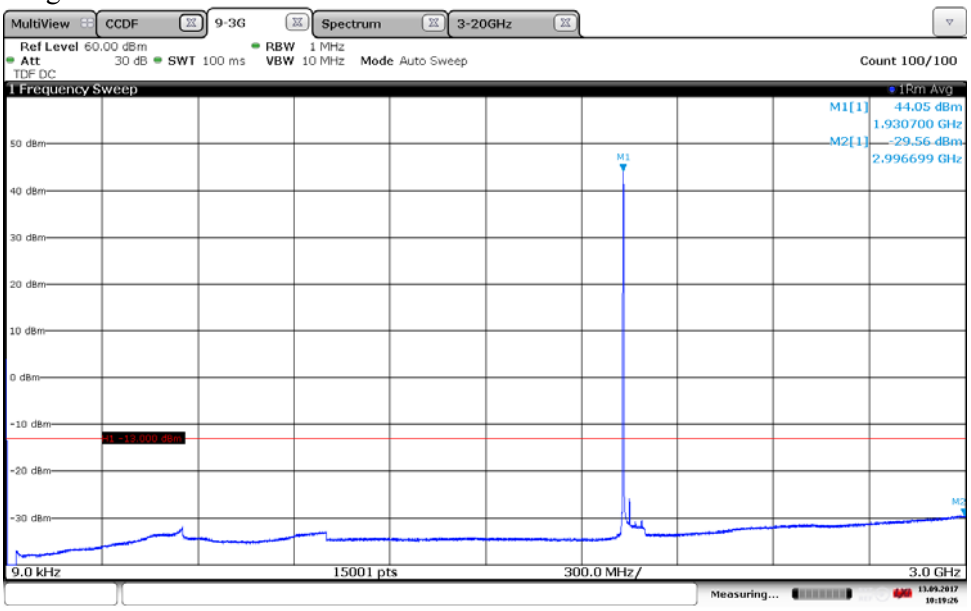


Diagram 2b:

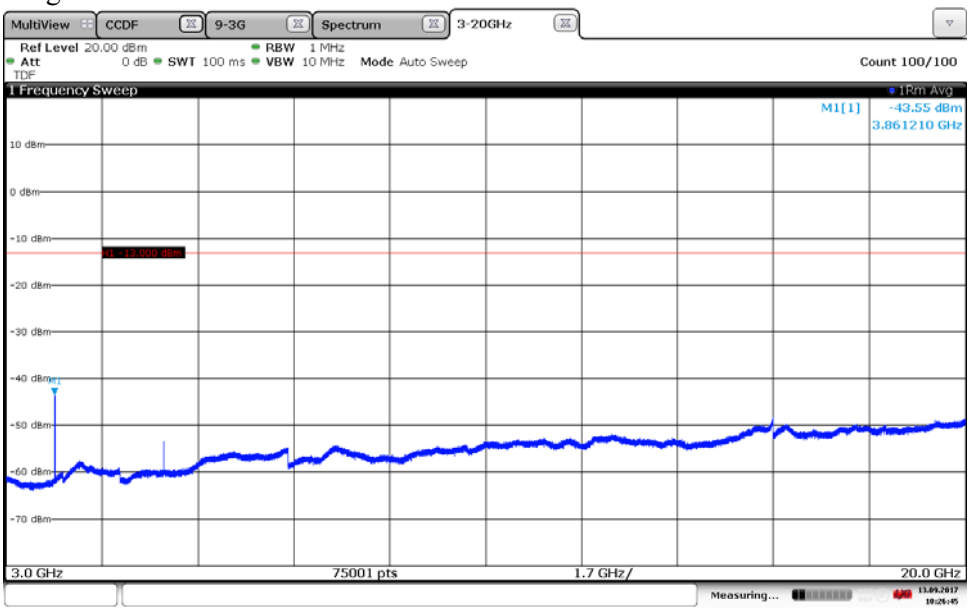


Diagram 3a:

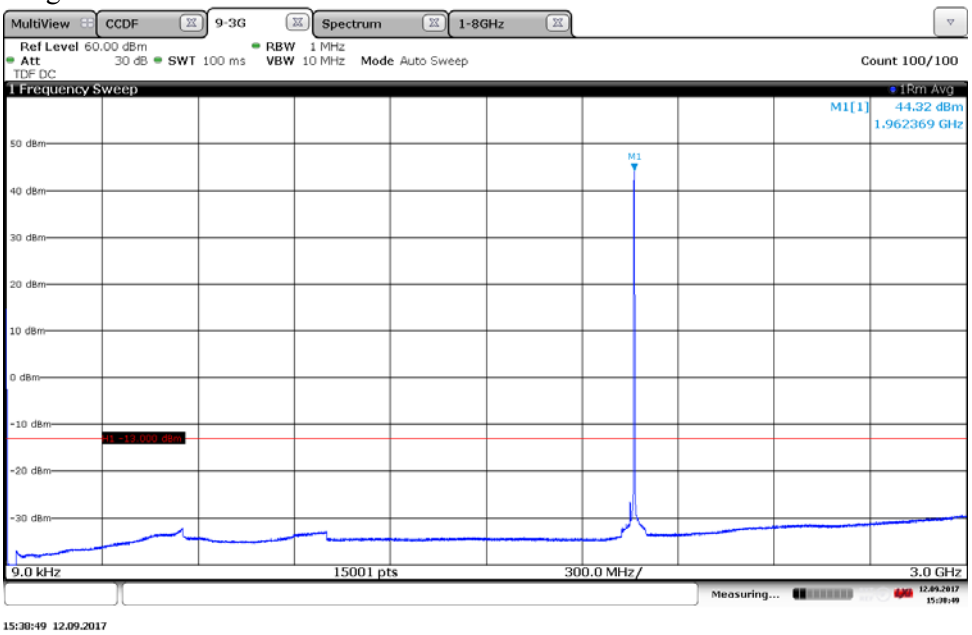


Diagram 3b:

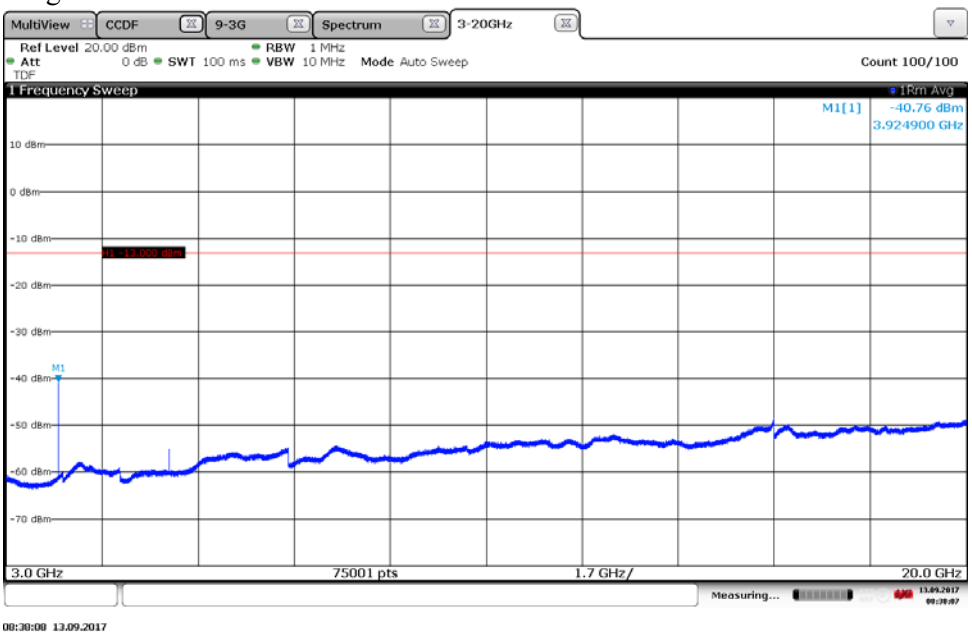


Diagram 4a:

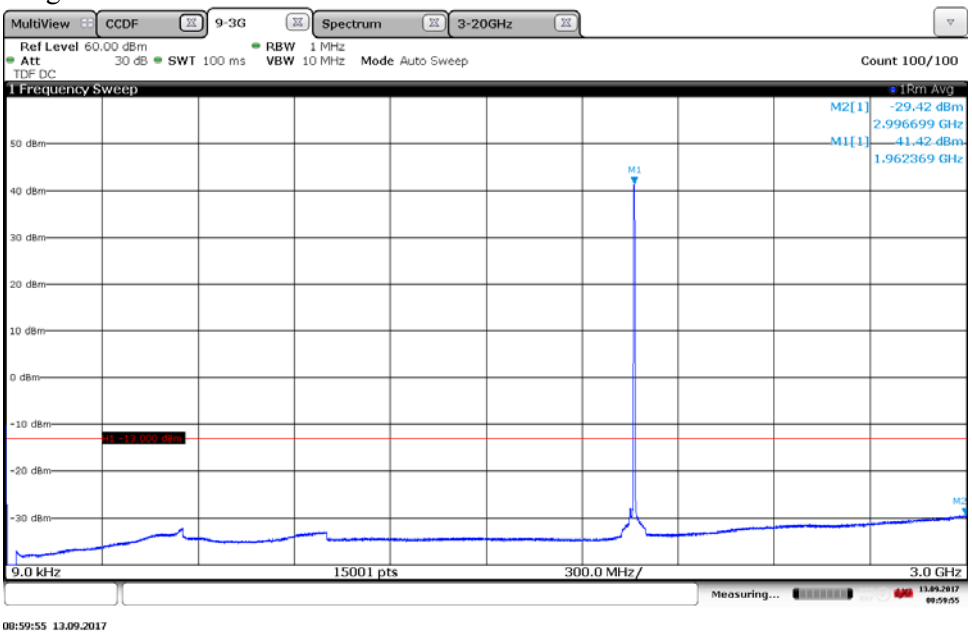


Diagram 4b:

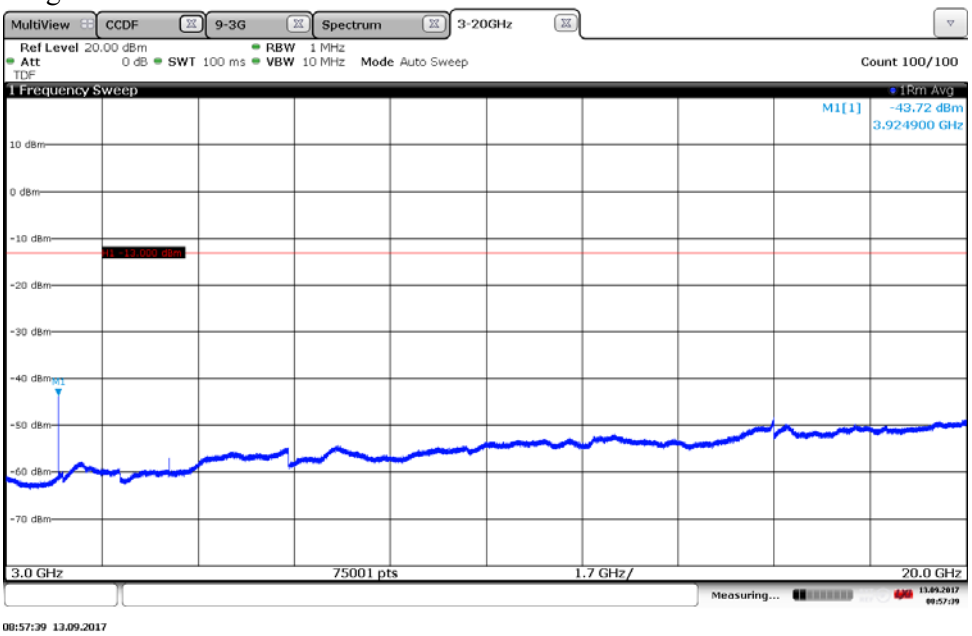


Diagram 5a:

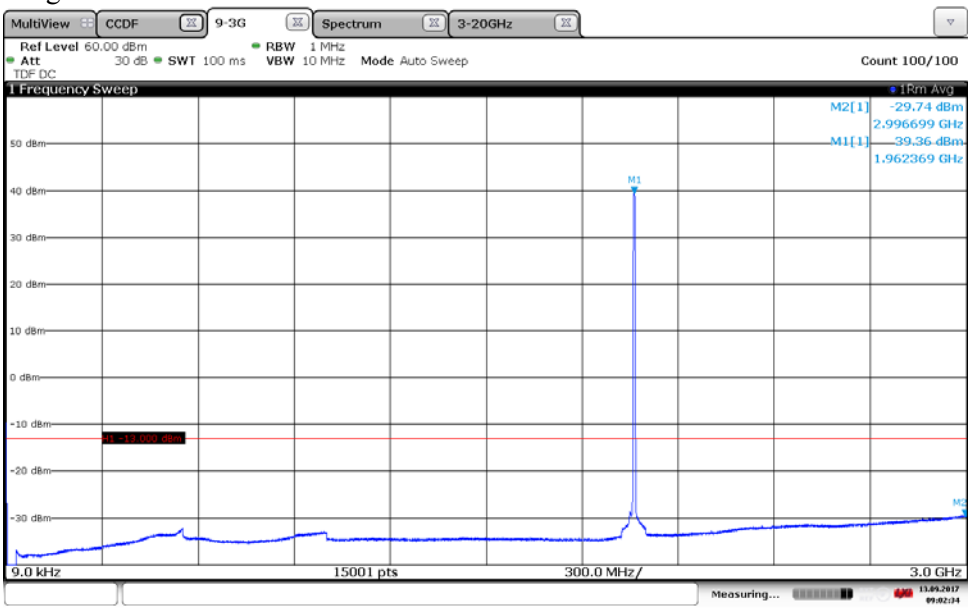


Diagram 5b:

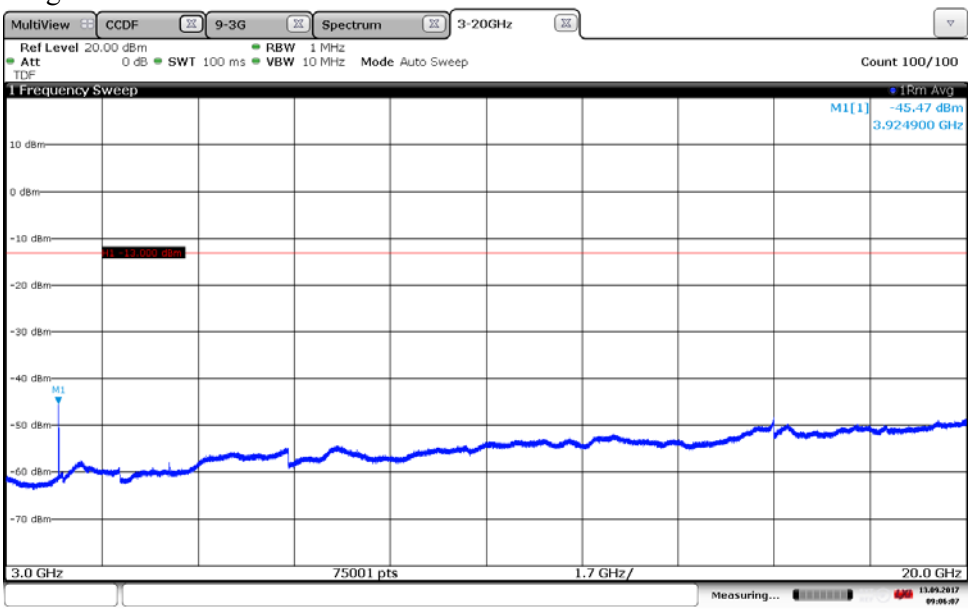


Diagram 6a:

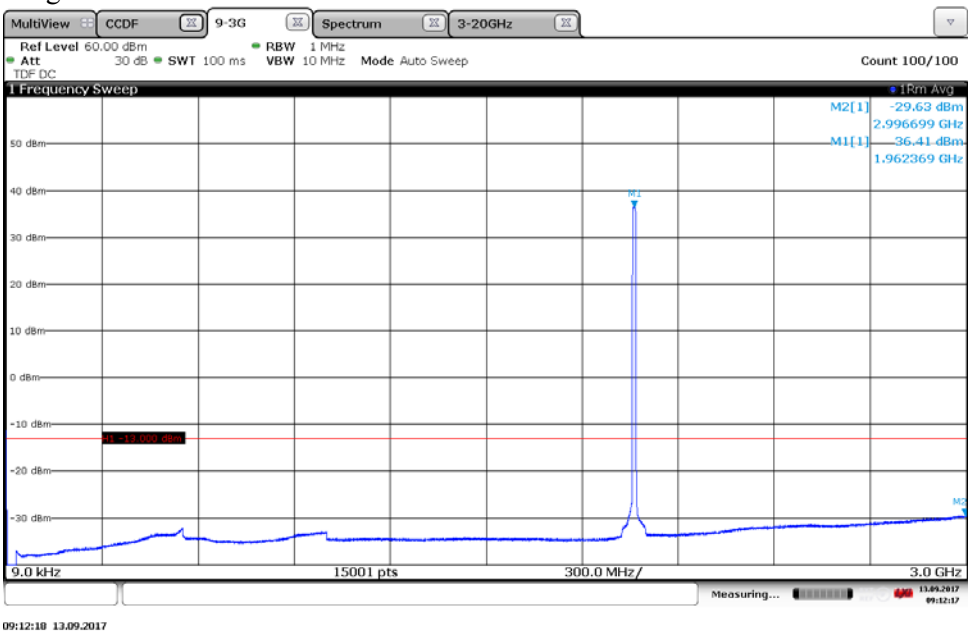


Diagram 6b:

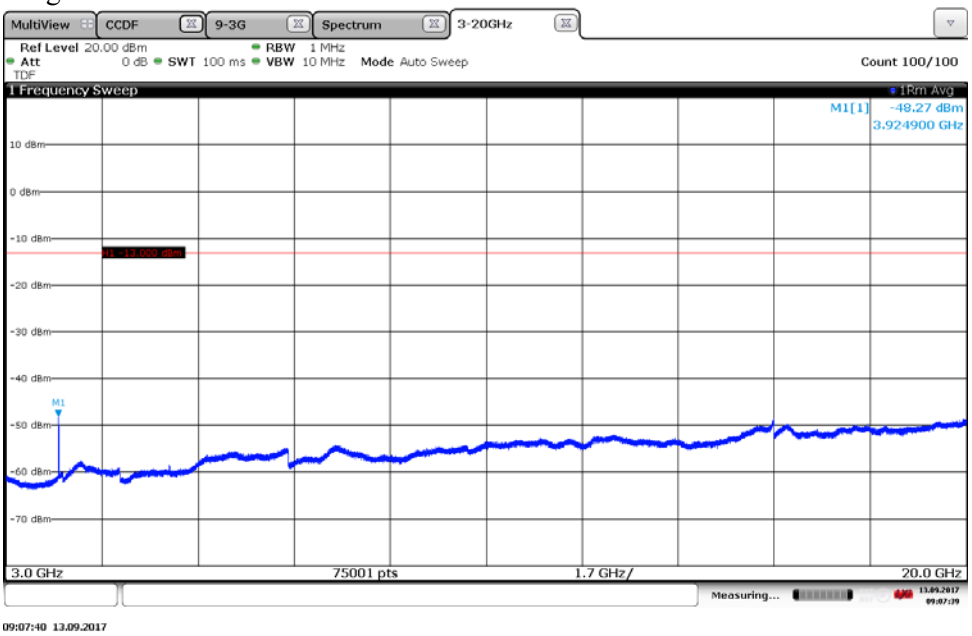


Diagram 7a:

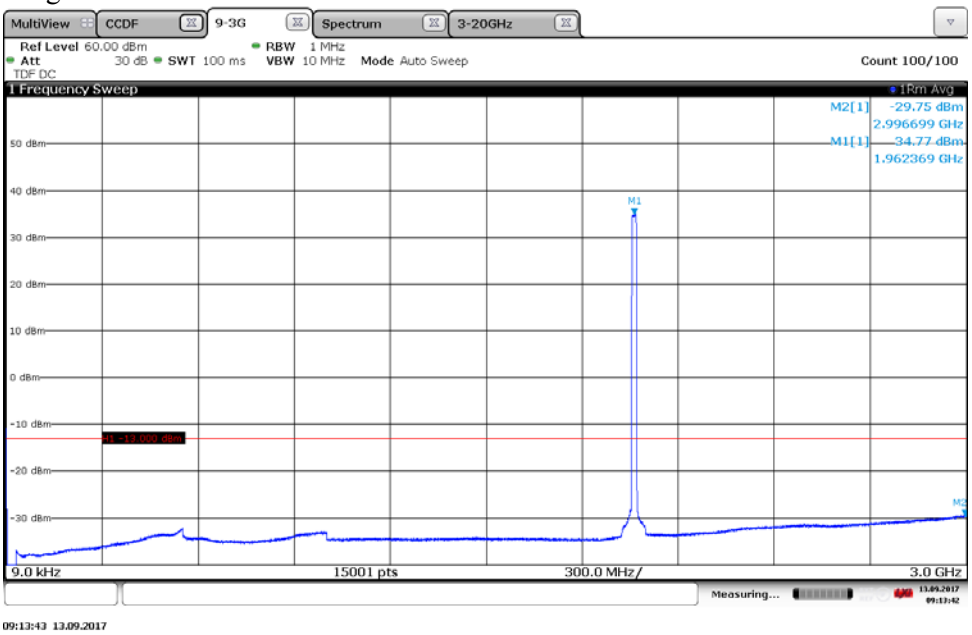


Diagram 7b:

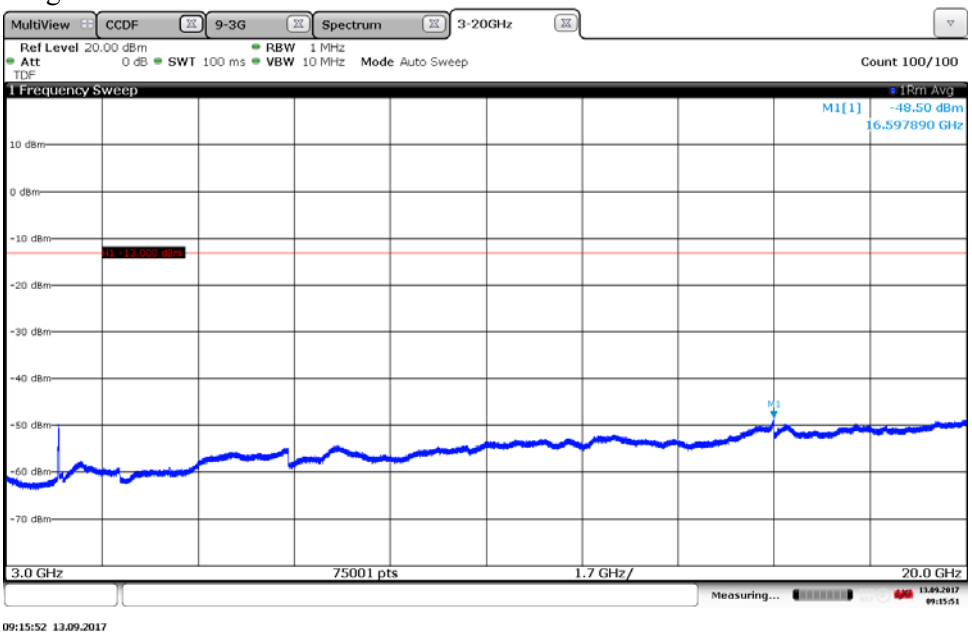


Diagram 8a:

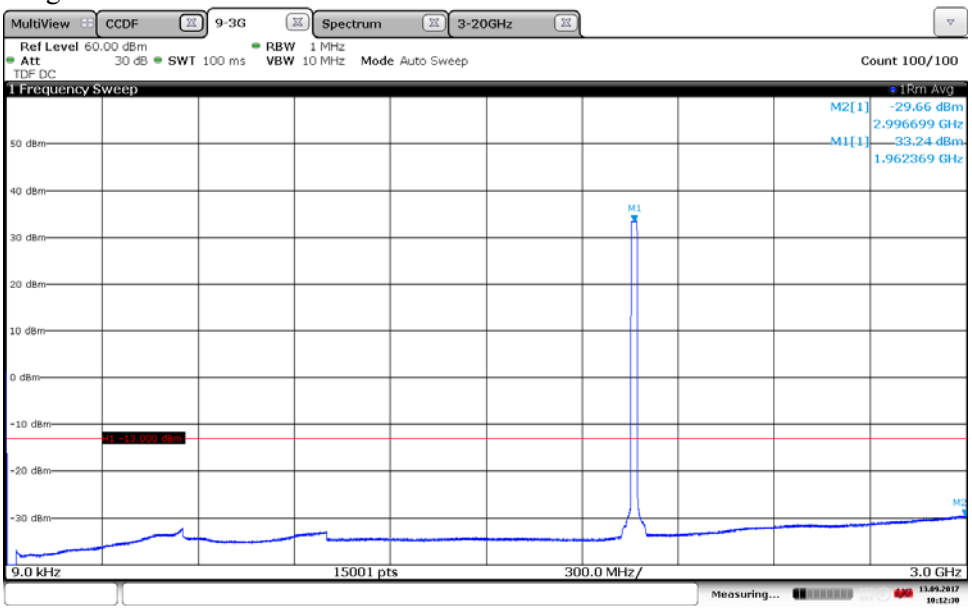


Diagram 8b:

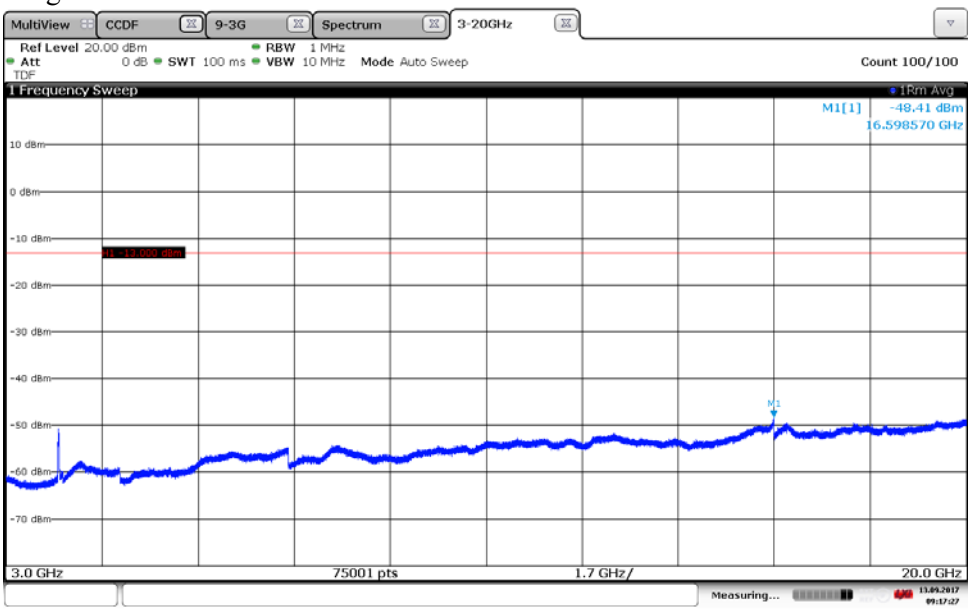


Diagram 9a:

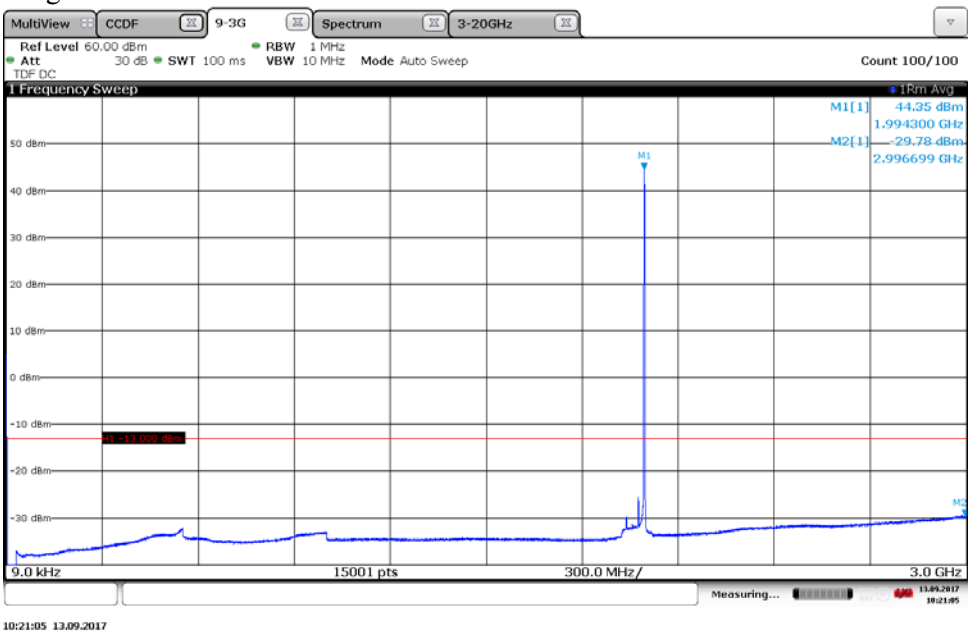


Diagram 9b:

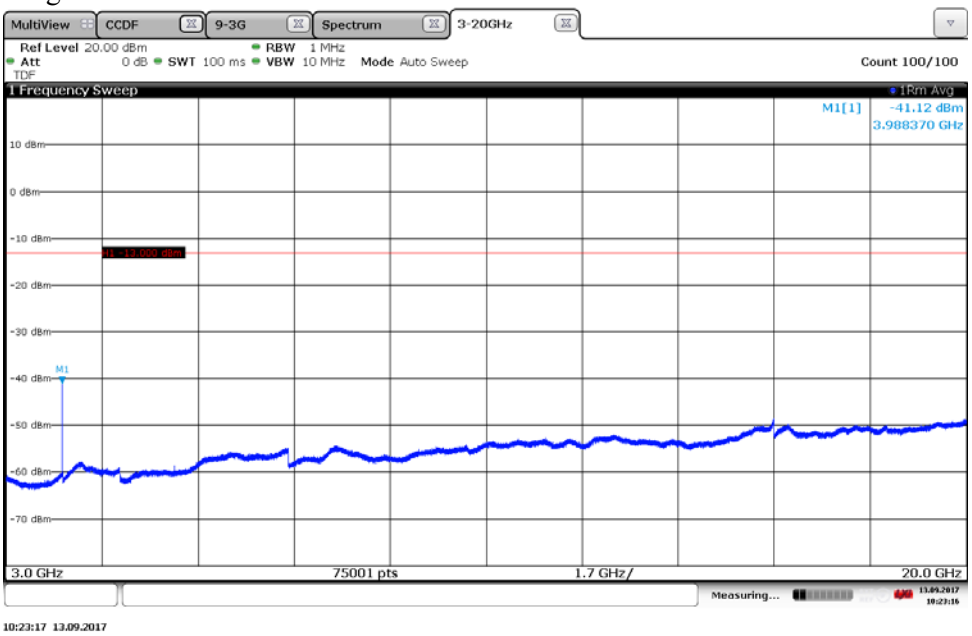


Diagram 10a:

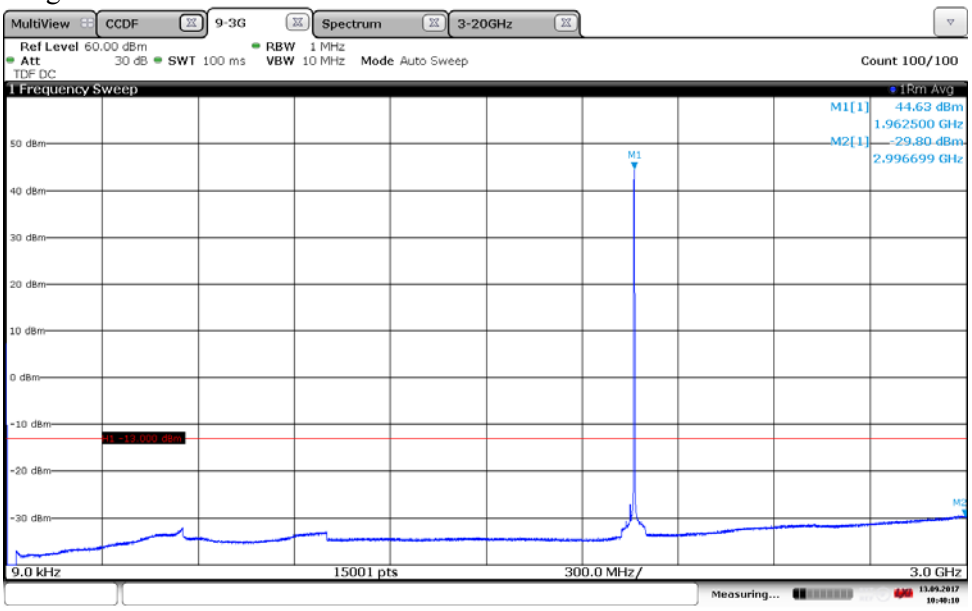


Diagram 10b:

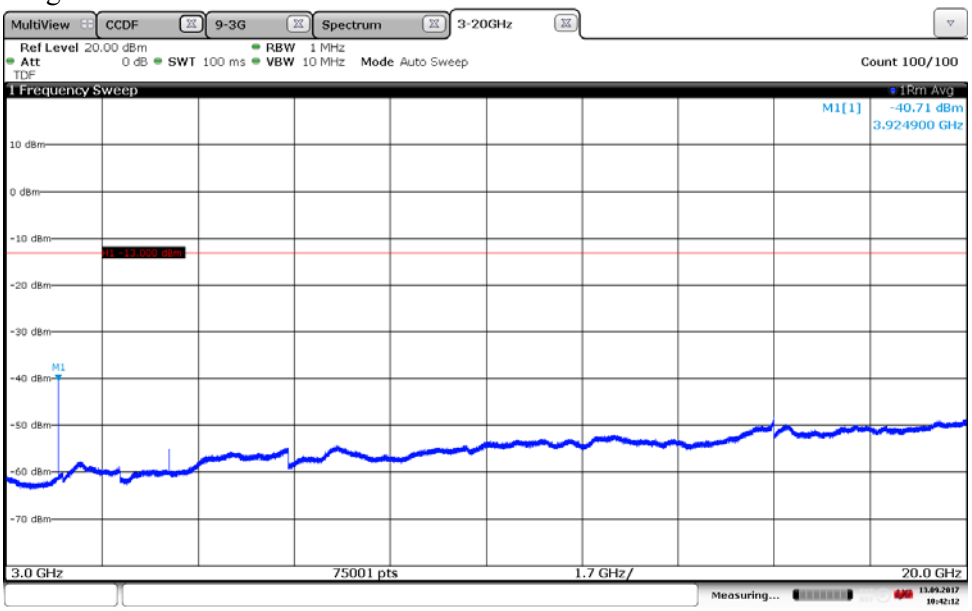


Diagram 11a:

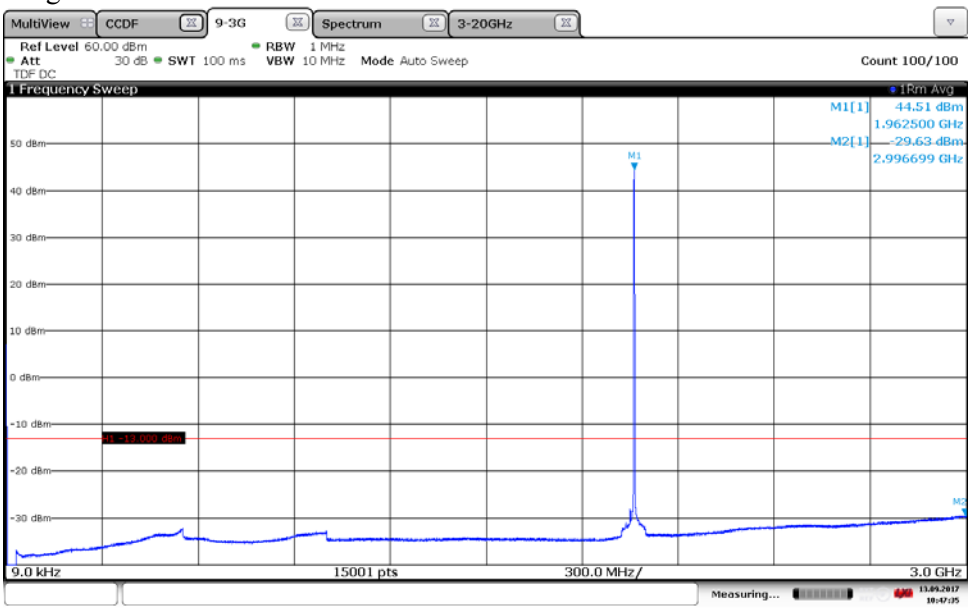


Diagram 11b:

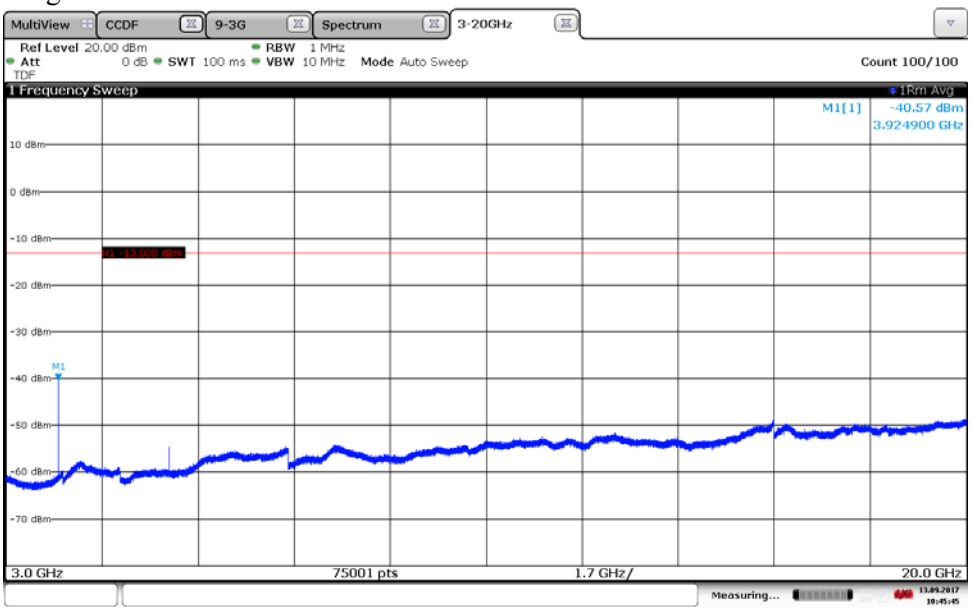


Diagram 12a:

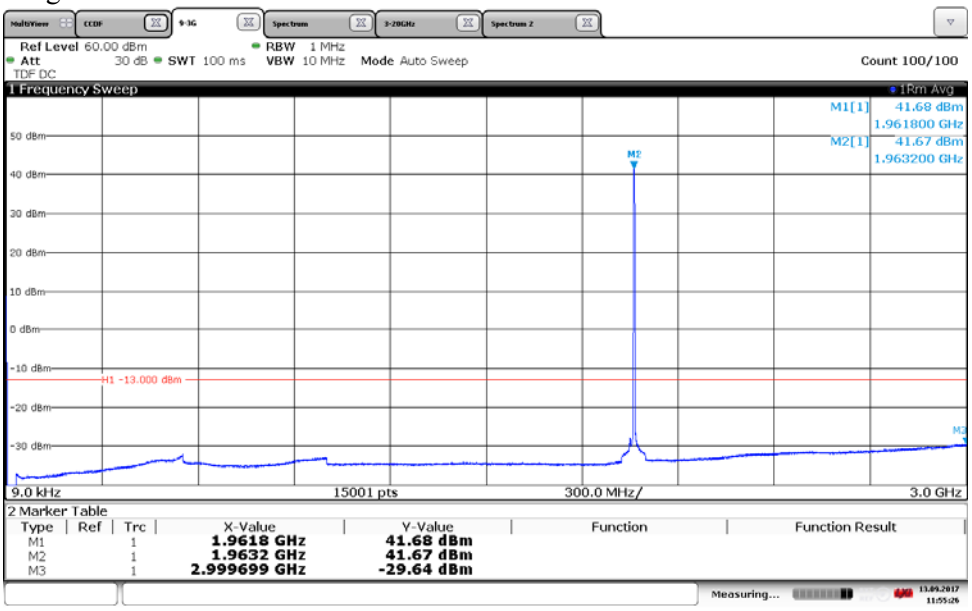
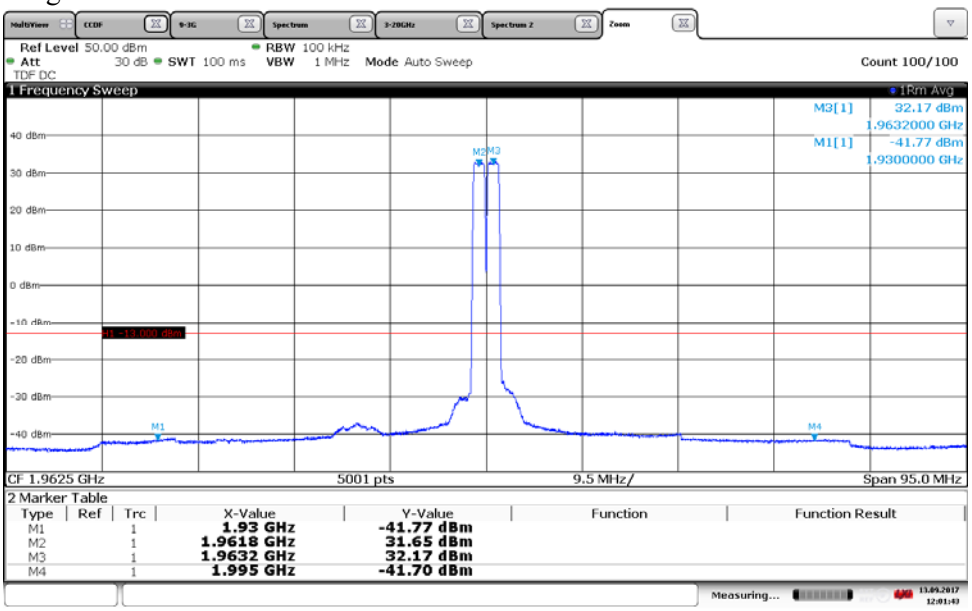


Diagram 12b:



Note: Due to the use of reduced measurement bandwidth the limit should be adjusted by 10 dB to -23 dBm.

Diagram 12c:

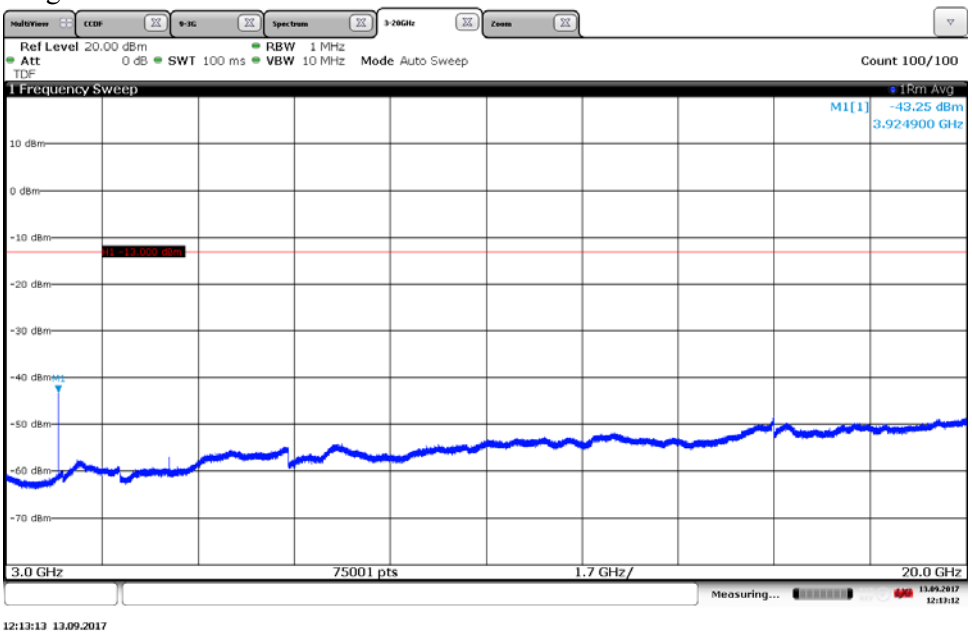

Ref Level 20.00 dBm
RBW 1 MHz
Att 0 dB SWT 100 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -43.25 dBm
3.924900 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
3.0 GHz
75001 pts
1.7 GHz/
20.0 GHz
Measuring...
12:13:13 13.09.2017

Diagram 13a:

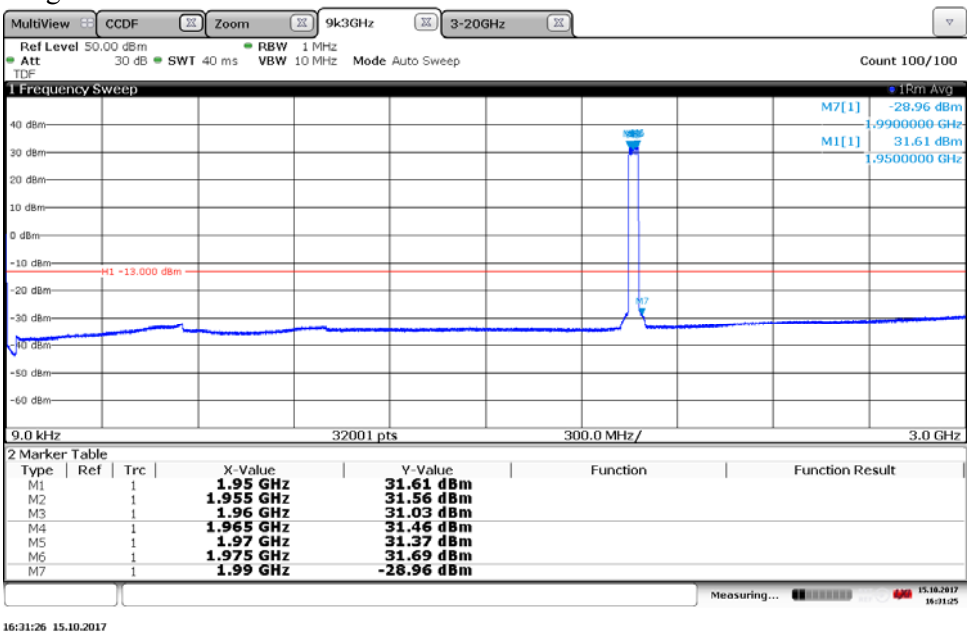
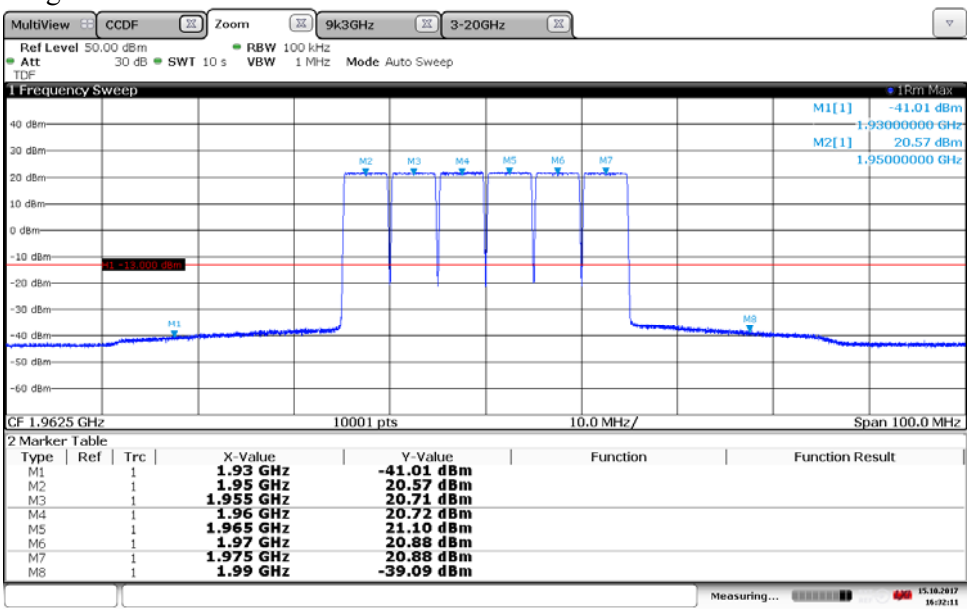


Diagram 13b:



Note: Due to the use of reduced measurement bandwidth the limit should be adjusted by 10 dB to -23 dBm.

Diagram 13c:

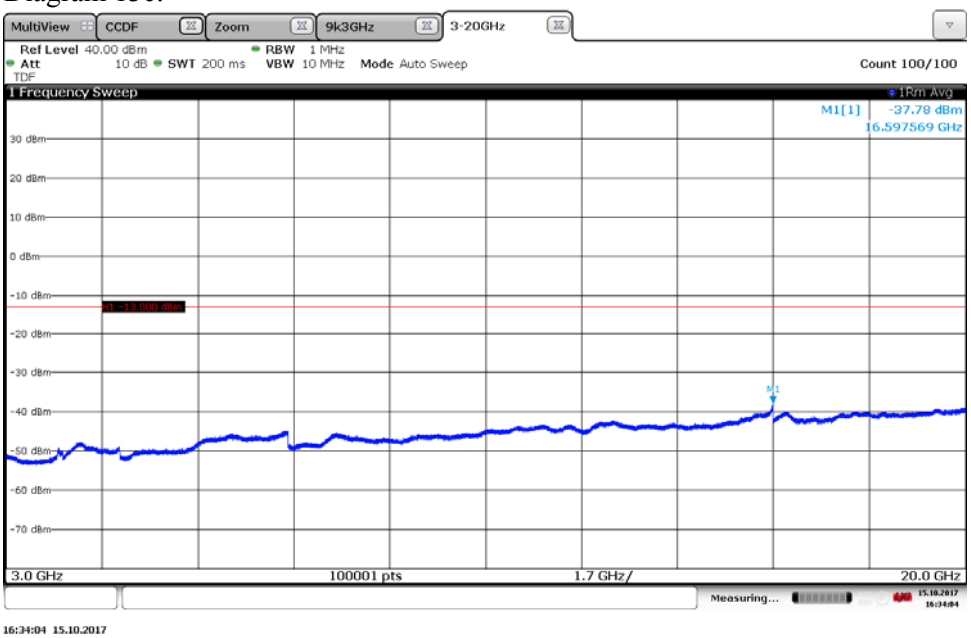
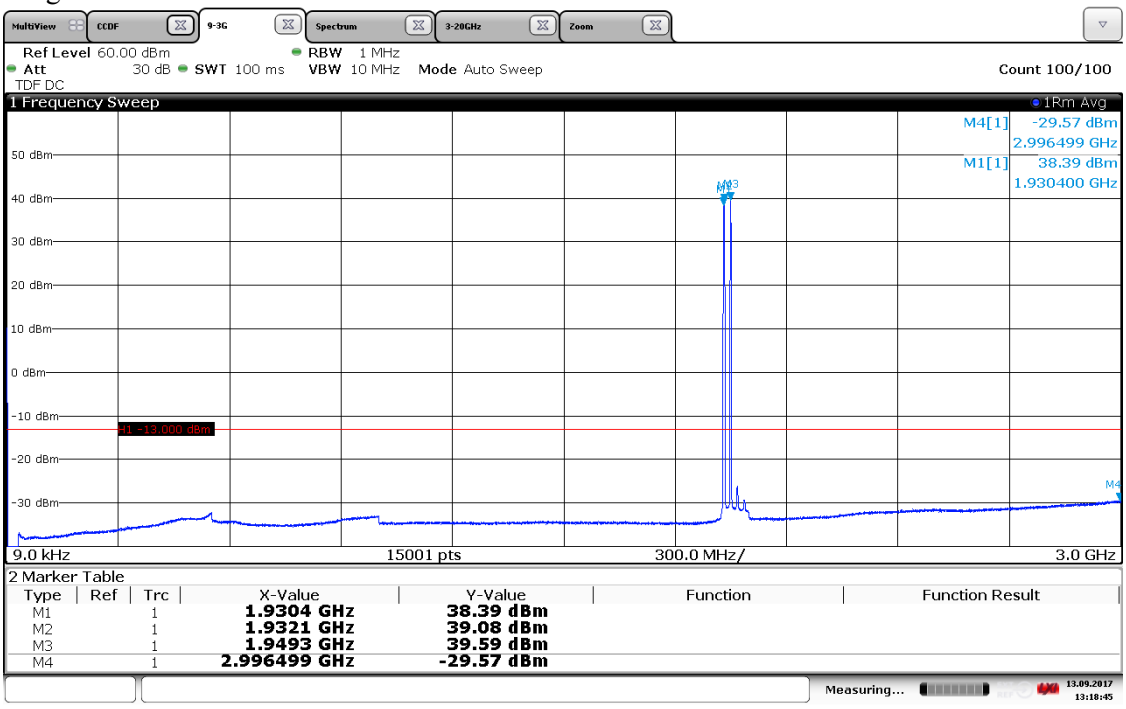
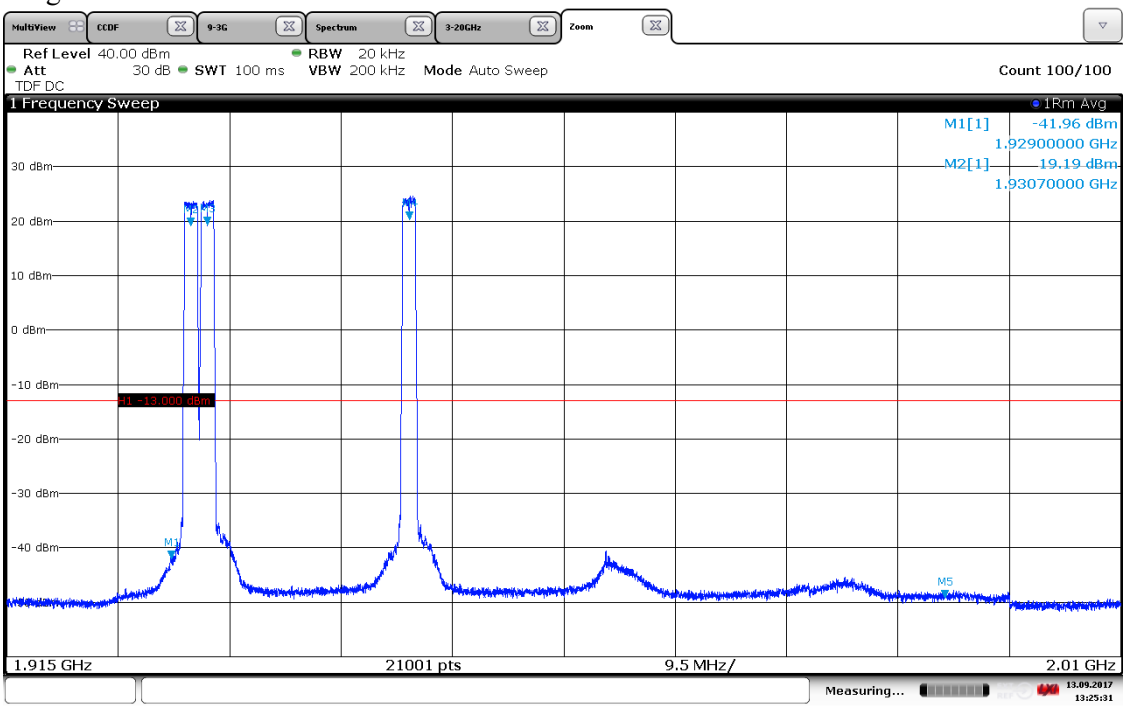

MultiView
CCDF
Zoom
9k3GHz
3-20GHz
Ref Level 40.00 dBm
RBW 1 MHz
Att 10 dB SWT 200 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -37.78 dBm
16.597569 GHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
3.0 GHz
100001 pts
1.7 GHz/
20.0 GHz
Measuring...
16:34:04 15.10.2017

Diagram 14a:



13:18:46 13.09.2017

Diagram 14b:



13:25:32 13.09.2017

Note: Due to the use of reduced measurement bandwidth the limit should be adjusted by 10dB to -23 dBm.

Diagram 14c:

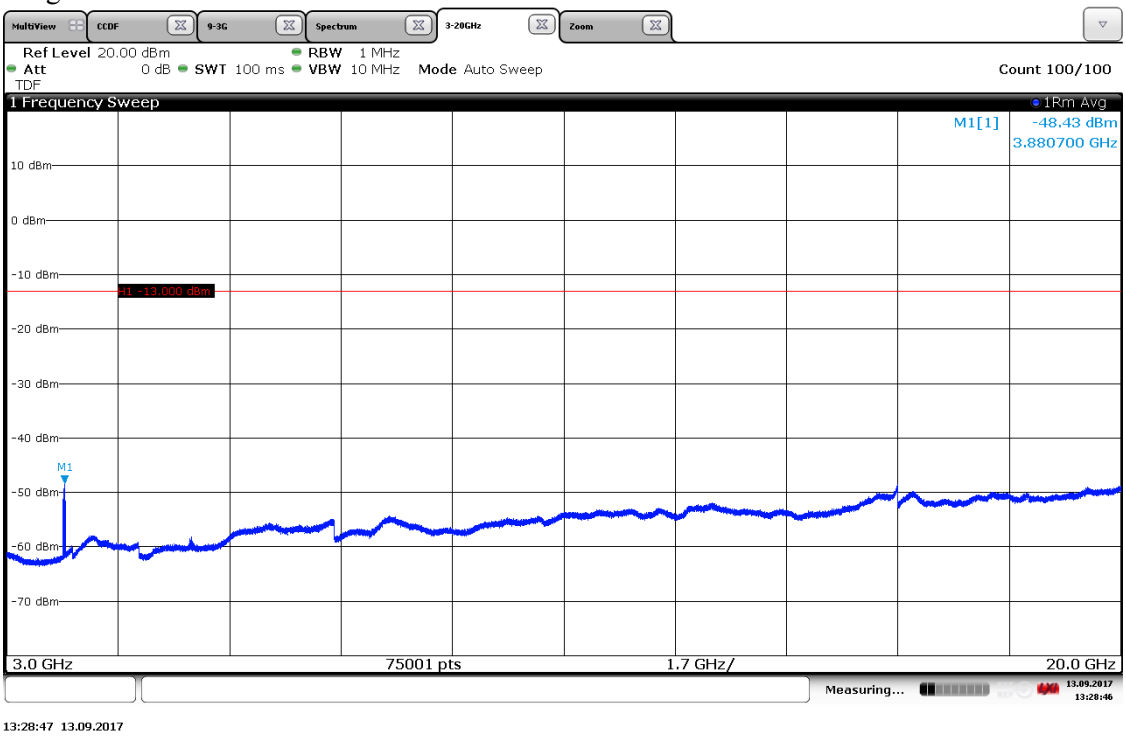
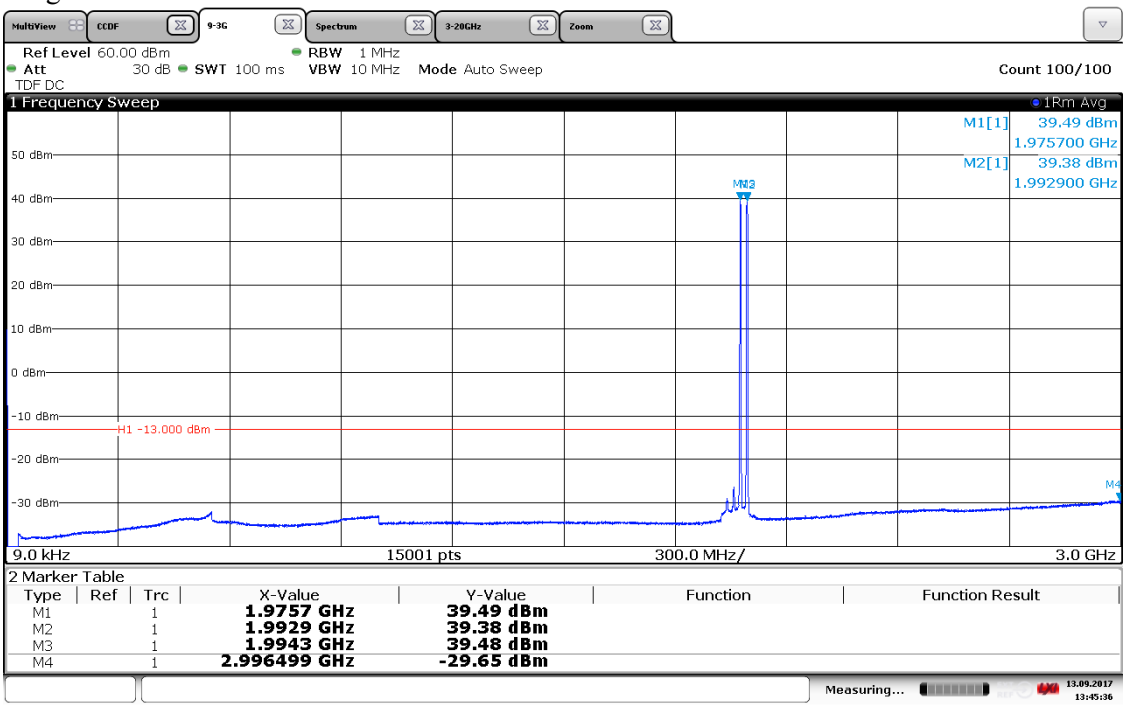
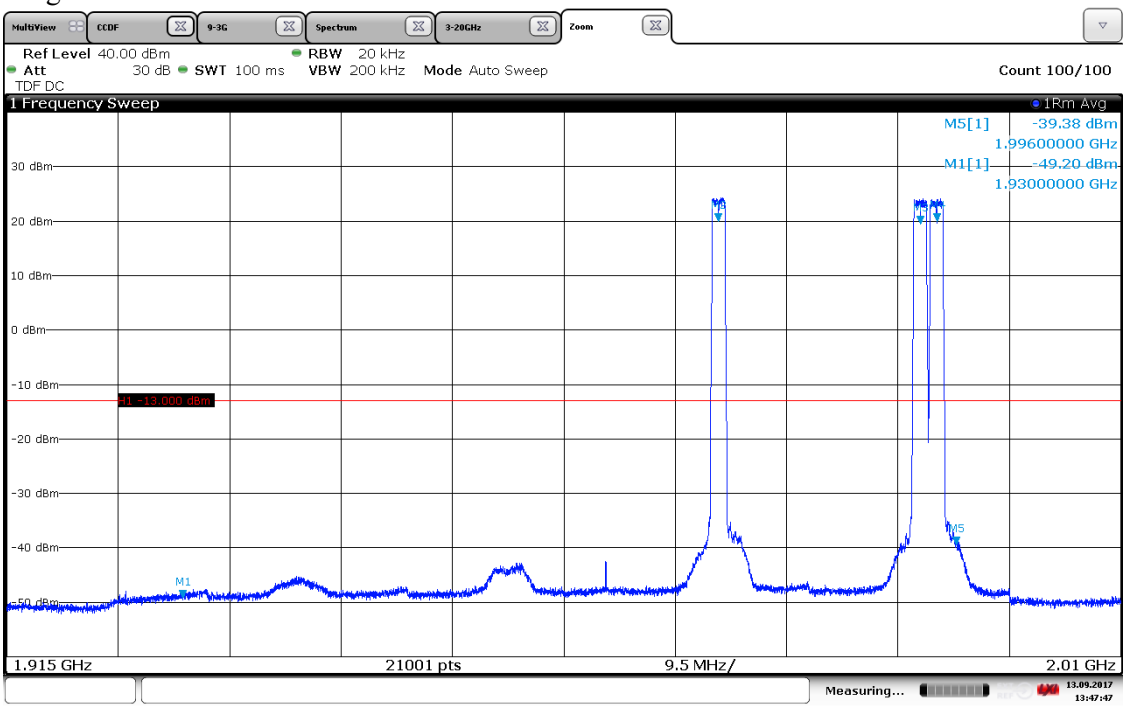

MultiView
CCDF
9-3G
Spectrum
3-20GHz
Zoom
Ref Level 20.00 dBm
RBW 1 MHz
Att 0 dB SWT 100 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
TDF
1 Frequency Sweep
1Rm Avg
M1[1] -48.43 dBm
3.880700 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1 -13.000 dBm
M1
3.0 GHz
75001 pts
1.7 GHz/
20.0 GHz
Measuring...
13.09.2017
13:28:46
13:28:47 13.09.2017

Diagram 15a:



13:45:36 13.09.2017

Diagram 15b:



13:47:47 13.09.2017

Note: Due to the use of reduced measurement bandwidth the limit should be adjusted by 10 dB to -23 dBm.

Diagram 15c:

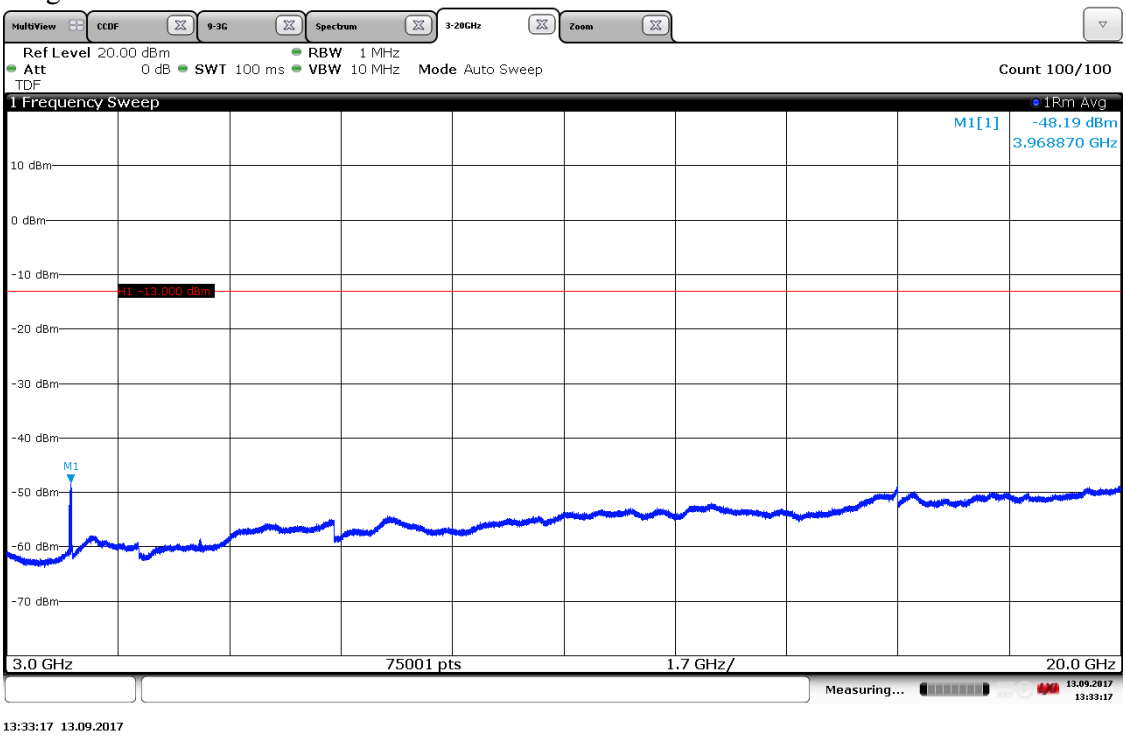
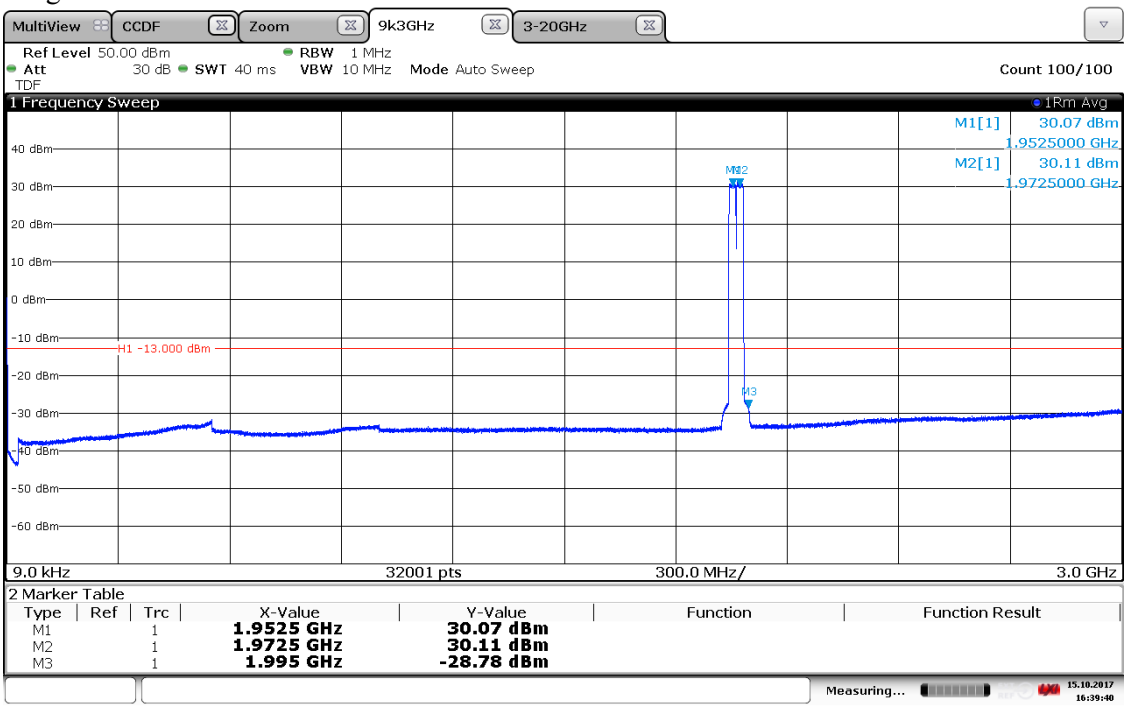
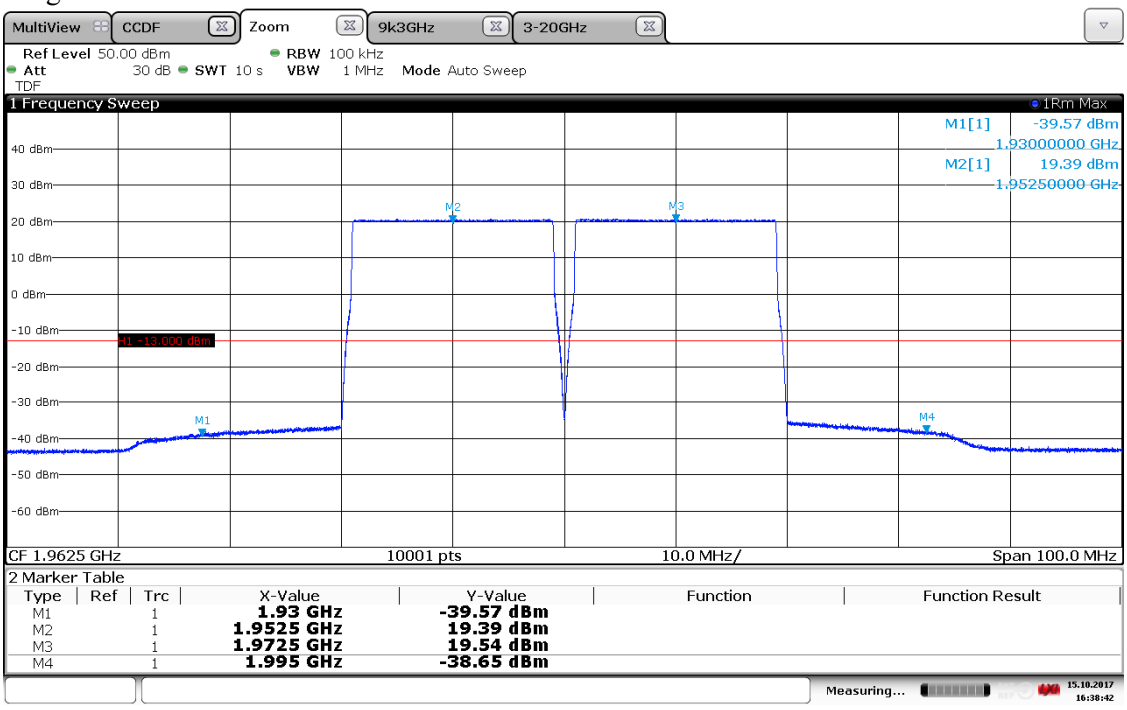

MultiView
CCDF
9-3G
Spectrum
3-20GHz
Zoom
Ref Level 20.00 dBm
RBW 1 MHz
Att 0 dB SWT 100 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
TDF
1 Frequency Sweep
1Rm Avg
M1[1] -48.19 dBm
3.968870 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
3.0 GHz
75001 pts
1.7 GHz/
20.0 GHz
Measuring...
13.09.2017
13:33:17
13:33:17 13.09.2017

Diagram 16a:



16:39:40 15.10.2017

Diagram 16b:



16:38:43 15.10.2017

Note: Due to the use of reduced measurement bandwidth the limit should be adjusted by 10 dB to -23 dBm.

Diagram 16c:

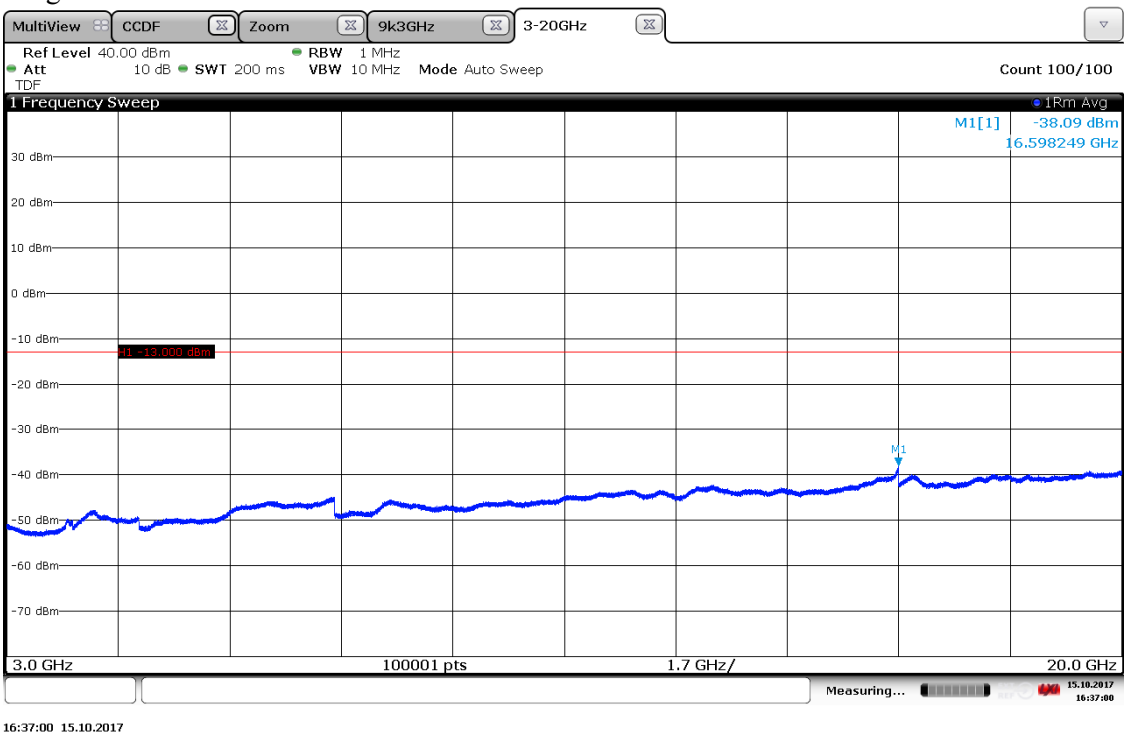
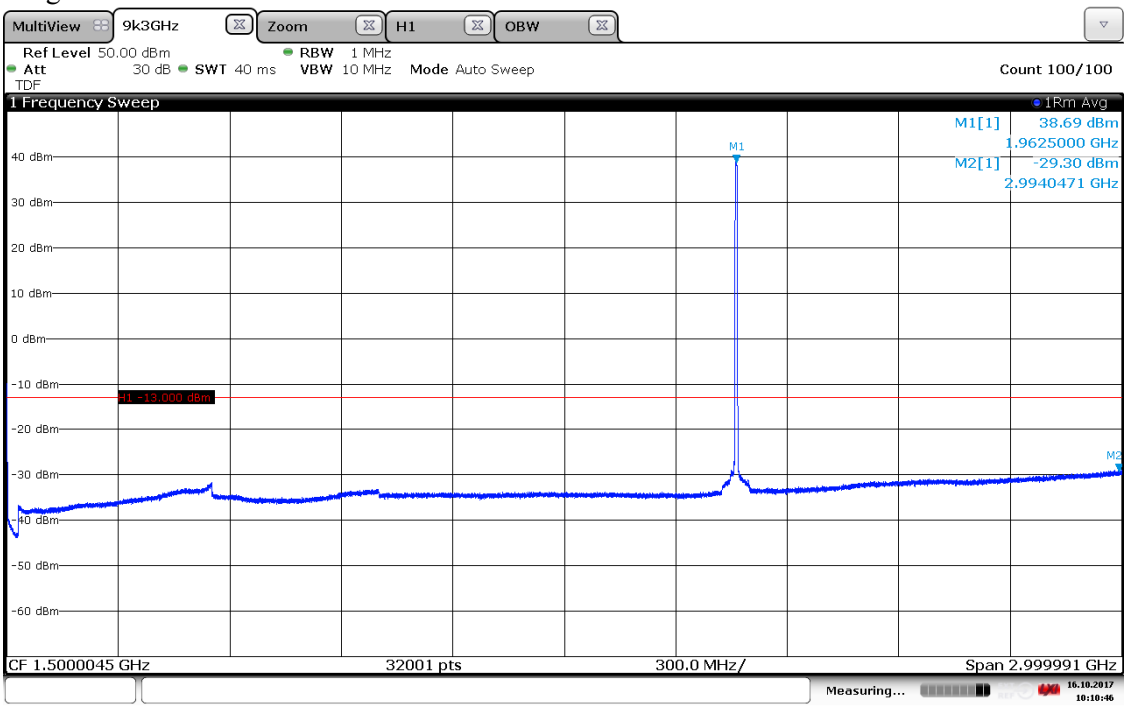
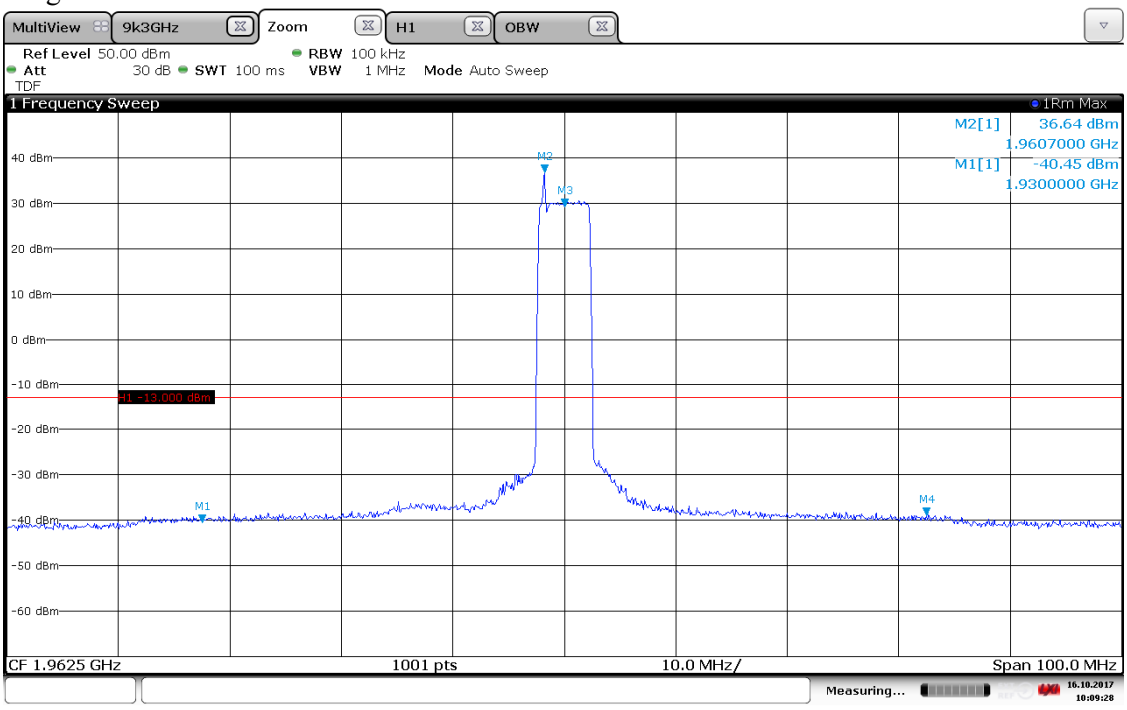

MultiView
CCDF
Zoom
9k3GHz
3-20GHz
Ref Level 40.00 dBm
RBW 1 MHz
Att 10 dB SWT 200 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
TDF
1 Frequency Sweep
1Rm Avg
M1[1] -38.09 dBm
16.598249 GHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1 -13.000 dBm
M1
3.0 GHz
100001 pts
1.7 GHz/
20.0 GHz
Measuring...
15.10.2017
16:37:00
16:37:00 15.10.2017

Diagram 17a:



10:10:47 16.10.2017

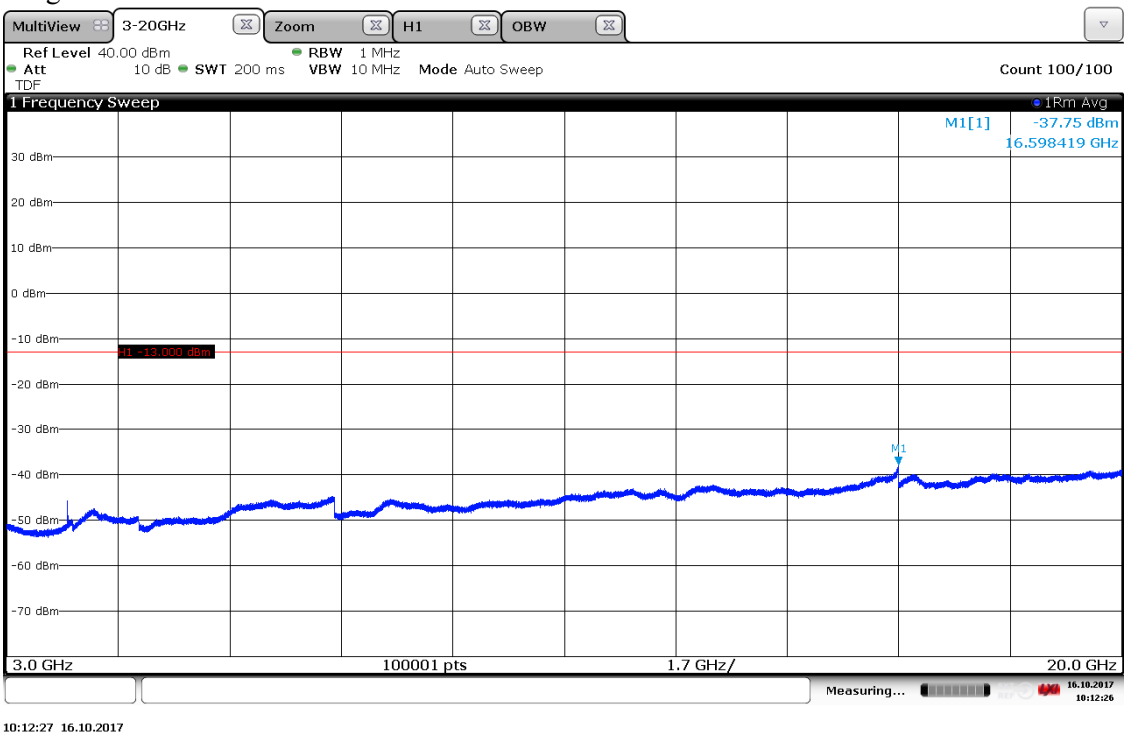
Diagram 17b:



10:09:28 16.10.2017

Note: Due to the use of reduced measurement bandwidth the limit should be adjusted by 10 dB to -23 dBm.

Diagram 17c:


MultiView
3-20GHz
Zoom
H1
OBW
Ref Level 40.00 dBm
RBW 1 MHz
Att 10 dB SWT 200 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
TDF
1 Frequency Sweep
1Rm Avg
M1[1] -37.75 dBm
16.598419 GHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1 -13.000 dBm
M1
3.0 GHz
100001 pts
1.7 GHz/
20.0 GHz
Measuring...
16.10.2017
10:12:26
10:12:27 16.10.2017

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

Date	Temperature	Humidity
2017-09-14	22 °C ± 3 °C	45 % ± 5 %
2017-10-03	22 °C ± 3 °C	47 % ± 5 %
2017-10-04	23 °C ± 3 °C	38 % ± 5 %
2017-10-05	22 °C ± 3 °C	34 % ± 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.

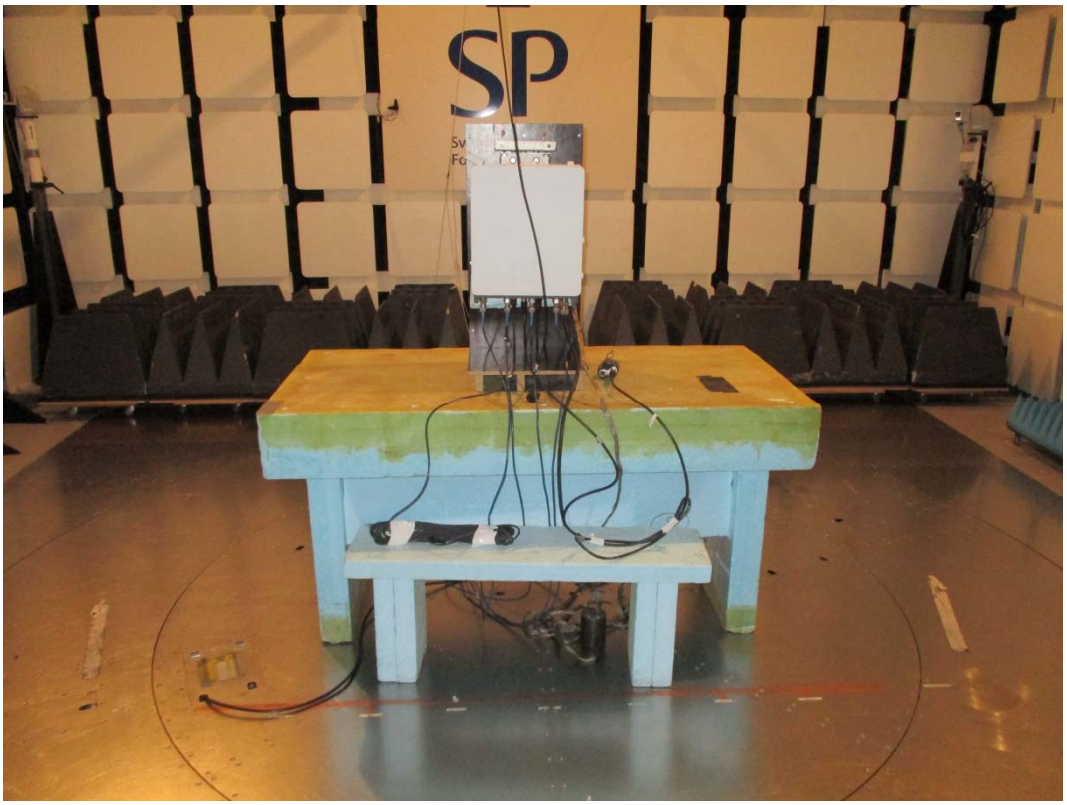
A propagation loss in free space was calculated. The used formula was

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

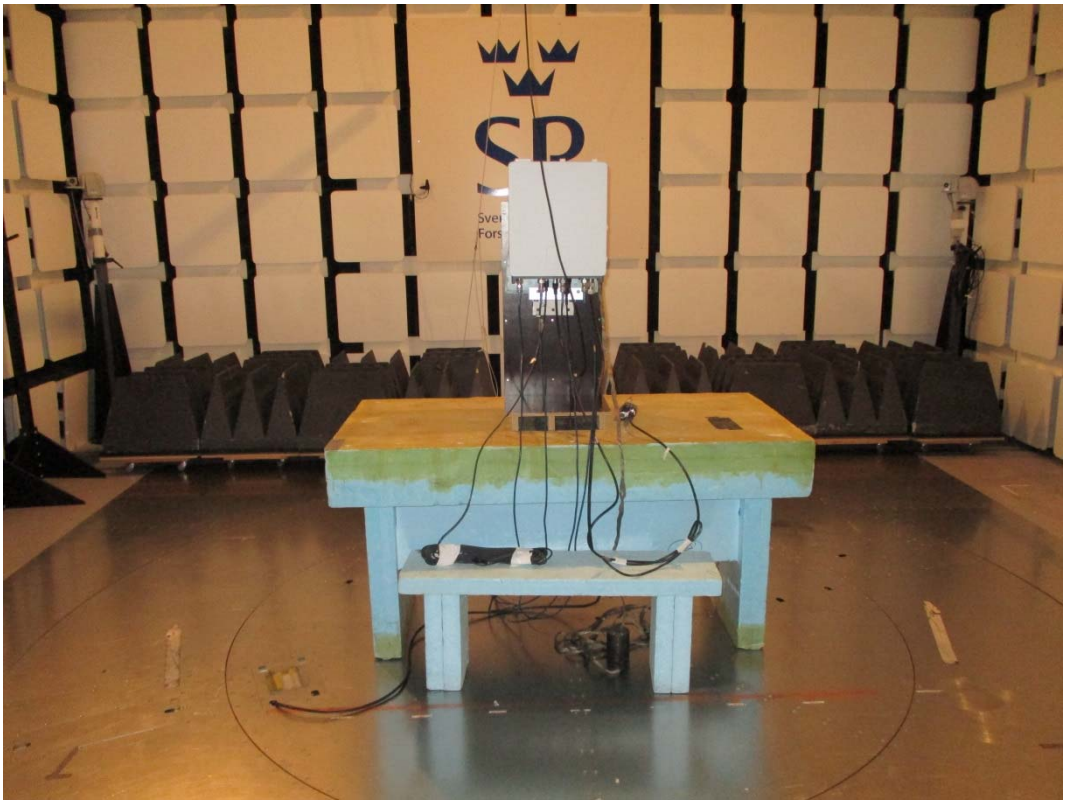
The measurement procedure was as the following:

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



1-18GHz



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
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: B, M, T, $M2_{1.4}$, M6, Bim and Tim, IoT

representing worst case: Symbolic name $M_{1.4}$, BW 1.4 MHz, TM 1.1, 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:

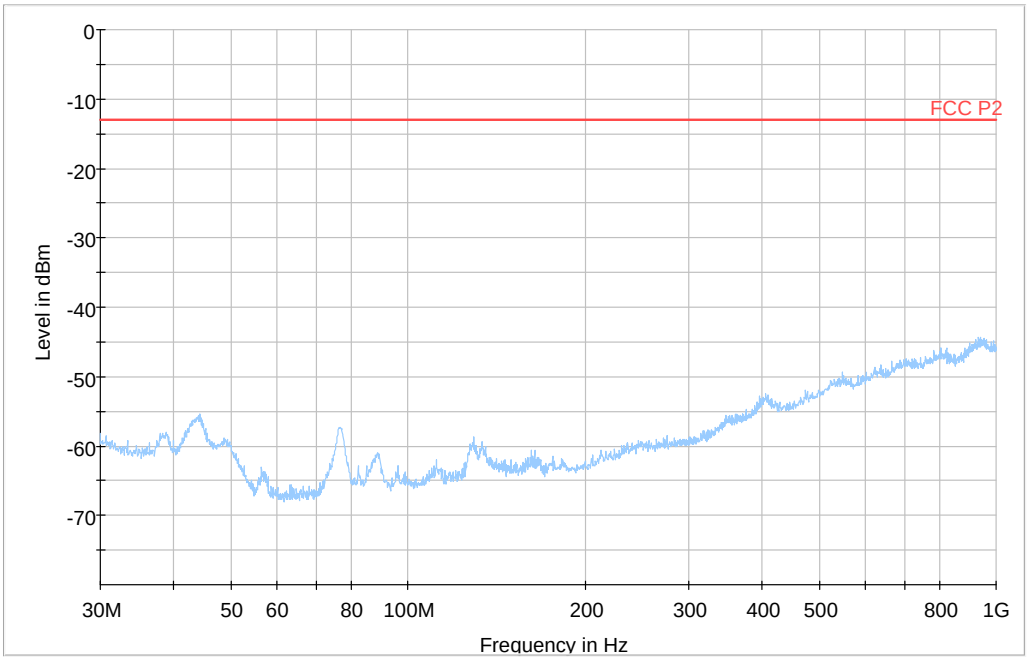
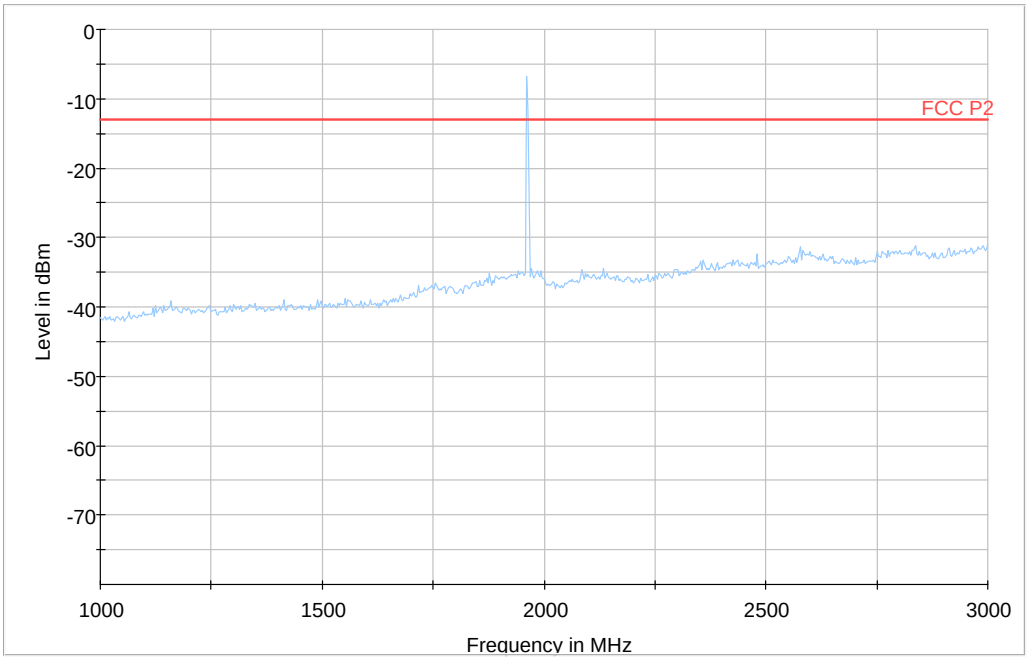
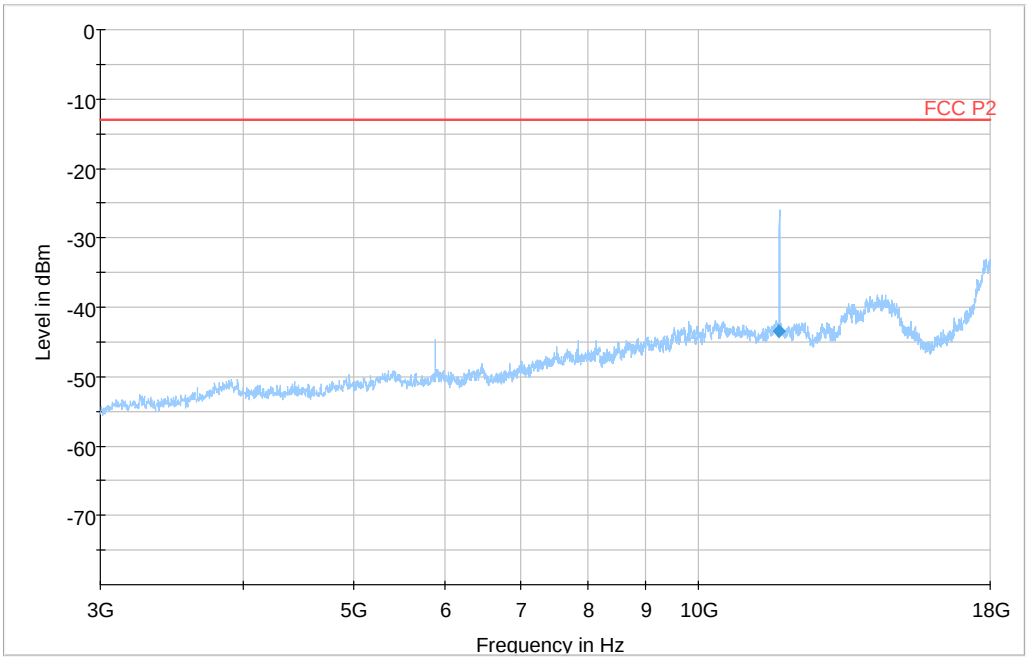


Diagram 1b:



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

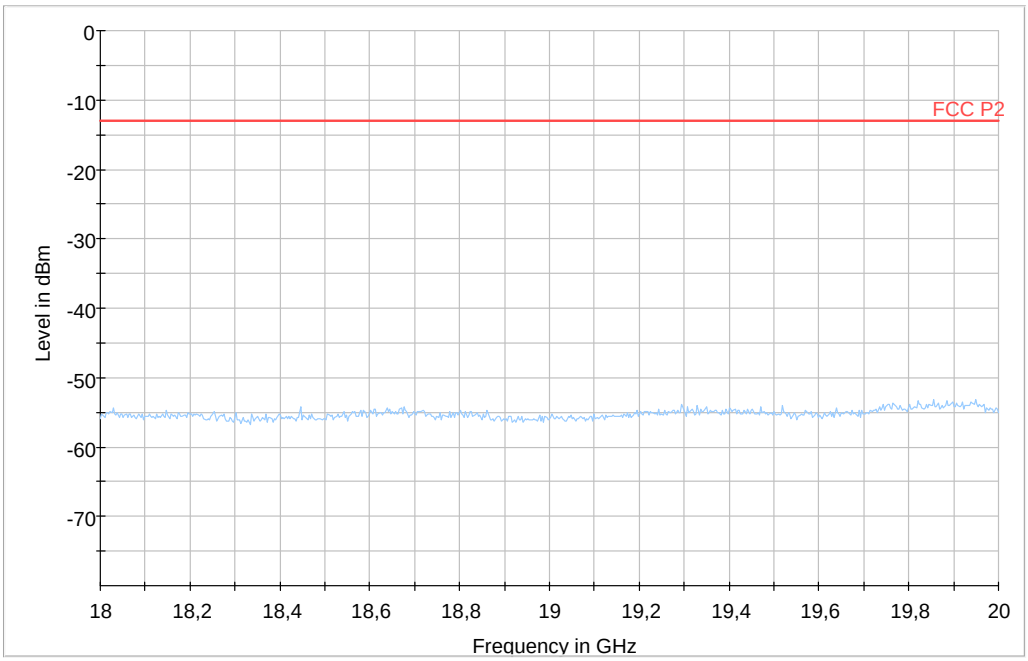
Diagram 1c:



Final Result

Frequency (MHz)	RMS (dBm)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
11775.080129	---	-27.17	---	---	5000.0	1000.000	100.0	H	150.0
11775.080129	-43.42	---	-13.00	30.42	5000.0	1000.000	100.0	H	150.0

Diagram 1d:



Frequency stability measurements according to CFR 47 § 24.235 / IC RSS 133 6.3

Date	Temperature (test equipment)	Humidity (test equipment)
2017-10-12	23 °C ± 3 °C	35% ± 5 %
2017-10-13	22 °C ± 3 °C	20% ± 5 %
2017-10-15	23 °C ± 3 °C	36% ± 5 %

Test set-up and procedure

The measurement was made per 3GPP TS 36.141. The output was connected to a spectrum analyzer. The spectrum analyzer was connected to an external 10 MHz reference standard during the measurements.
The measurement was also made per IC RSS 199 Issue 3, 4.3. Using a resolution bandwidth of 1% of the emission bandwidth, a reference point at the unwanted emission level which complies with the attenuation of 43 + 10 log10 p (watts) (i.e. -13 dBm) (for 4x 4MIMO -19 dBm) at the band edge of the lowest and highest channel was selected, and the frequency at these points was recorded as fL and fH respectively.

Measurement equipment	RISE number
R&S FSQ 40	504 143
Rohde & Schwarz signal analyzer FSW 43	902 073
RF attenuator	900 691
Temperature Chamber	503 360
Testo 635, temperature and humidity meter	504 203
Multimeter Fluke 87	502 190

Results

Nominal transmitter frequency was 1960 MHz with a bandwidth of 5 MHz. Rated output power level at connector RF A (maximum): 46 dBm.

Test conditions		Frequency error (Hz)
Supply voltage DC (V)	Temp. (°C)	
40.8	+20	8
55.2	+20	8
48	+20	7
48	+30	7
48	+40	8
48	+50	7
48	+10	11
48	0	9
48	-10	8
48	-20	9
48	-30	9
Maximum freq. error (Hz)		11
Measurement uncertainty		$< \pm 1 \times 10^{-7}$

Rated output power level at connector RF C (maximum): 46 dBm

Test conditions			Frequency margin to band edge at -19dBm			
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)
-48.0	+20	1.4	1930.001	1	1994.999	599 Hz
-48.0	+20	20	1930.191	191	1994.805	195 kHz

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

RSS-133 6.3 Frequency stability:
The carrier frequency shall not depart from the reference frequency in excess of ± 1.0 ppm (± 1930 Hz) for base stations when tested to the temperature and supply voltage variations specified in RSS-Gen.

Complies?	Yes

Photos of test object

Front side

Rear side

Left side

Right side

Bottom side

Top side

Labels:

Radiated measurements:

Radio label:

SFP module:

Conducted measurements:

Radio label:

SFP module: