REPORT

issued by an Accredited Testing Laboratory

SP Testing

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Date	Reference	Page
2017-11-06	7P07342-L	1 (83)

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164 80 Stockholm

Radio measurements on Radio 4478 B5 equipment with FCC ID TA8AKRC161689 and IC: 287AB-AS161689

Product name: Radio 4478 B5
Product number: KRC 161 689/1 and KRC 161 689/3

RISE Research Institutes of Sweden AB
Electronics - EMC

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SWEDAC ACKREDITERING
Accred. No. 1002
Testing
ISO/IEC 17025

Summary

Standard Listed part of		Compliant
FCC CFR 47 / IC RSS-132 ISSUE 3		
2.1046 / RSS-132 5.4	RF power output	Yes
2.1049 / RSS-Gen 4.6.1	Occupied bandwidth	Yes
2.1051 / RSS-132 5.5	Band edge	Yes
2.1051 / RSS-132 5.5	Spurious emission at antenna terminals	Yes
2.1053 / RSS-132 5.5	Field strength of spurious radiation	Yes
2.1055 / RSS-132 5.3	Frequency stability	Yes

Description of the test object

Equipment:	Radio equipment Radio 4478 B5 Product number KRC 161 689/1 and KRC 161 689/3 FCC ID: TA8AKRC161689 IC: 287AB-AS161689
HVIN:	AS161689
Hardware revision state:	R1A
Tested configuration:	Single RAT LTE
Frequency bands: 3GPP B5:	TX: 869 – 894 MHz RX: 824 – 849 MHz
IBW:	25 MHz 20 MHz for carrier BW ≤ 3 MHz
Output power:	Maximum output power / port: 40 W 20 W/ carrier for carrier BW ≤ 3 MHz
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), Carrier Aggregation (CA) intra-band and inter-band[1] supported
Channel bandwidths:	1.4 MHz, 3 MHz, 5 MHz and 10 MHz
Modulations:	QPSK, 16QAM, 64QAM and 256QAM
RF power Tolerance:	+0.6/ -2.0 dB
CPRI Speed	Up to 10.1 Gbit/s

[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 161 689/1 and KRC 161 689/3 are electrically identical according to the manufacturer. Only KRC 161 689/3 was tested.

Purpose of test

The purpose of the tests is to verify compliance to the performance characteristics specified in applicable items of FCC CFR 47.

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. The settings below were used for all measurements if not otherwise noted.

LTE MIMO mode
E-TM1.1
Channel bandwidth 5 MHz.

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 27, April 2017
ANSI C63.26-2015
KDB 662911 D01 Multiple Transmitter Output v02r02
KDB 971168 D01 Power Meas License Digital Systems v03
KDB 971168 D03 IM Emission Repeater Amp v01
3GPP TS 36 141 version 13.6.0
3GPP TS 37.141, version 13.5.0

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 1-15 GHz	2018-06	504 199
High pass filter 1-20 GHz	2018-06	901 373
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: 2017-10-09.

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)

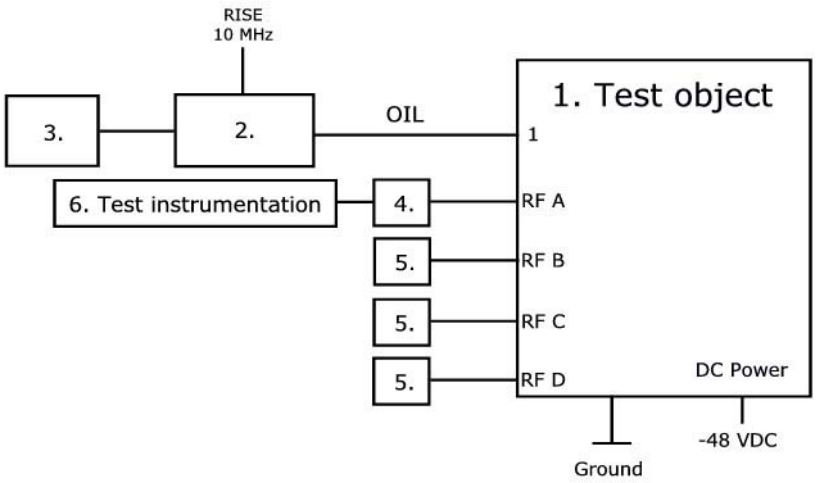
None.

Test frequencies used for radiated and conducted measurements

EARFCN Downlink	Frequency [MHz]	Symbolic name	Comment
2407	869.7	$B_{1.4}$	TX bottom frequency in 1.4 MHz BW configuration
2415	870.5	B_3	TX bottom frequency in 3 MHz BW configuration
2425	871.5	B_5	TX bottom frequency in 5 MHz BW configuration
2450	874.0	B_{10}	TX bottom frequency in 10 MHz BW configuration
2425 2475	871.5 876.5	$B2_5$	2 carriers TX mid constellation with 5 MHz BW configuration
2415 2445 2475 2505 2535 2565	870.5 873.5 876.5 879.5 882.5 885.5	$B6_3$	6 carriers TX mid constellation with 3 MHz BW configuration
2525	881.5	$M_{1.4-10}$	TX mid frequency in 1.4-10 MHz BW configuration
2643	893.3	$T_{1.4}$	TX top frequency in 1.4 MHz BW configuration
2635	892.5	T_3	TX top frequency in 3 MHz BW configuration
2625	891.5	T_5	TX top frequency in 5 MHz BW configuration
2600	889.0	T_{10}	TX top frequency in 10 MHz BW configuration
2518 2532	880.8 882.2	$M2_{1.4}$	2 carriers TX mid constellation with 1.4 MHz BW configuration
2407 2421 2593	869.7 871.1 888.3	$Bim_{1.4}$	3 carriers TX constellation with 1.4 MHz BW configuration
2457 2629 2643	874.7 891.9 893.3	$Tim_{1.4}$	3 carriers TX constellation with 1.4 MHz BW configuration
2475 2575	876.5 886.5	CA_{10-10}	Carrier Aggregation TX 10 MHz + 10 MHz configuration
2415	870.5	IoT_{3B}	TX bottom frequency in 3 MHz BW configuration + NB IoT-inband in resource block 2
2635	892.5	IoT_{3T}	TX top frequency in 3 MHz BW configuration + NB IoT-inband in resource block 12
2525	881.5	IoT_5	TX mid frequency in 5 MHz BW configuration + NB IoT-inband in resource block 2

All RX frequencies were configured 45 MHz above the corresponding TX frequency according the applicable duplex offset for the operating band.

Test setup: conducted measurements



Test object:

1.	Radio 4478 B5, KRC 161 689/3, rev. R1A, s/n: D16W992594 With Radio Software: CXP 901 7316/7, rev. R67HH. FCC ID: TA8AKRC161689 and IC: 287AB-AS161689

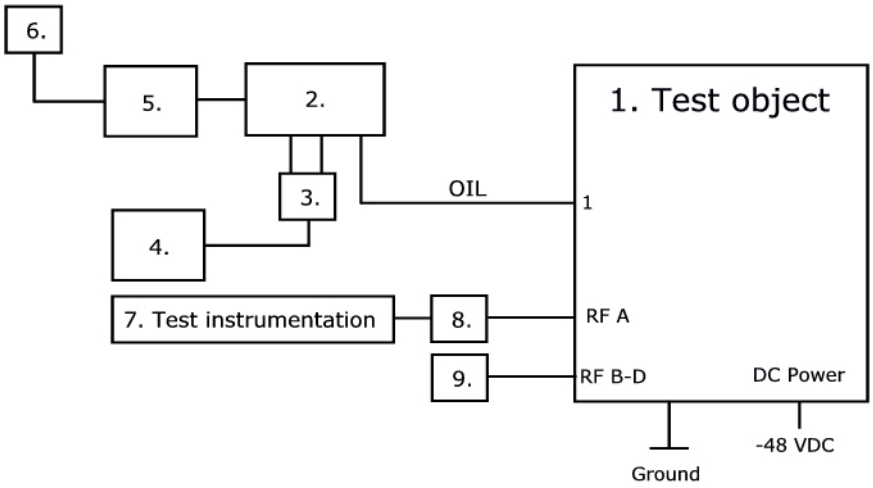
Associated equipment:

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: SP 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: conducted NB IoT-inband measurements



Test object:

1.	Radio 4478 B5, KRC 161 689/3, rev. R1A, s/n: D16W992594 With Radio Software: CXP 901 3268/15, rev. R68EG. FCC ID: TA8AKRC161689 and IC: 287AB-AS161689

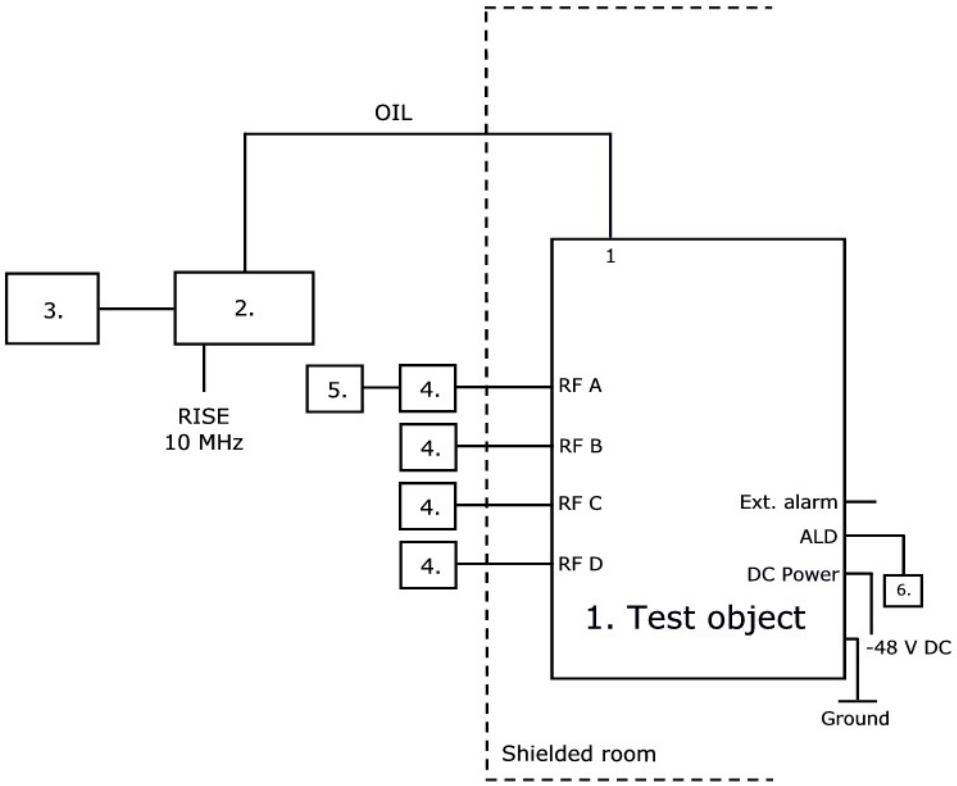
Associated equipment:

2.	RBS 6601 Main Unit: SUP 6601, 1/BFL 901 009/4, rev. R1E, s/n: BR82691785 DUS 41 01, KDU 137 624/1, rev. R7B, s/n: TU8XV49142 With software: CXP 102 051/27, rev: R27B07
3.	Switch Netgear GS108E
4.	Computer, HP EliteBook 8560w, BAMS - 1001236851
5.	GPS 02 01, NCD 901 41/1, rev. R1D, s/n: A401804384
6.	GPS Active Antenna, KRE 101 2082/1

Functional test equipment:

7.	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.
8.	RF Attenuator: SP number: 900 691
9.	Terminator, 50 ohm

Test setup: radiated measurements



Test object:

1.	Radio 4478 B5, KRC 161 689/3, rev. R1A, s/n: D16W992601 With Radio Software: CXP 901 7316/7, rev. R67HH. FCC ID: TA8AKRC161689 and IC: 287AB-AS161689

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.	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 2.1046 / IC RSS-132 5.4

Date	Temperature	Humidity
2017-10-23	23 °C ± 3 °C	18 % ± 5 %
2017-10-24	23 °C ± 3 °C	16 % ± 5 %
2017-10-30	24 °C ± 3 °C	10 % ± 5 %

Test set-up and procedure

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
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 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)]
$B_{1.4}$	42.56/ 8.38	42.59/ 8.38	42.62/ 8.38	42.60/ 8.40	48.61
B_3	42.63/ 8.40	42.63/ 8.40	42.69/ 8.42	42.72/ 8.40	48.69
$M_{1.4}$	42.63/ 8.38	42.68/ 8.38	42.64/ 8.38	42.68/ 8.38	48.68
$T_{1.4}$	42.42/ 8.38	42.45/ 8.38	42.36/ 8.38	42.28/ 8.38	48.40

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_5	45.37/ 7.36	45.45/ 7.36	45.48/ 7.36	45.43/ 7.36	51.45
B_{10}	45.45/ 7.42	45.55/ 7.42	45.55/ 7.40	45.52/ 7.42	51.54
M_5	45.29/ 7.30	45.41/ 7.30	45.41/ 7.30	45.39/ 7.30	51.40
T_5	45.36/ 7.38	45.46/ 7.40	45.41/ 7.40	45.47/ 7.40	51.45

[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 16QAM

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_{10}	45.46/ 7.42	45.46/ 7.42	45.53/ 7.40	45.48/ 7.42	51.50

Single carrier ETM 3.1 64QAM

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_{10}	45.43/ 7.44	45.45/ 7.44	45.51/ 7.42	45.47/ 7.44	51.49

Single carrier ETM 3.1a 256QAM

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_{10}	45.44/ 7.44	45.47/ 7.44	45.51/ 7.42	45.50/ 7.44	51.50

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)]
$B2_5$	45.56/ 7.32	45.50/7.32	45.59/ 7.28	45.55/ 7.32	51.57

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)]
$B6_3$	45.38/ 7.58	45.50/ 7.56	45.39/ 7.48	45.40/ 7.54	51.44

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

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

NB-IoT inband NTM

Rated output power level at RF connector 1x 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)]
IoT_{3B}	41.79/ 8.66	41.04/ 8.74	41.11/ 8.82	41.77/ 8.64	47.46
IoT_{3T}	41.31/ 8.60	41.87/ 8.58	41.93/ 8.44	41.81/ 8.36	47.76

NB-IoT inband NTM

Rated output power level at RF connector 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)]
IoT_5	44.53/ 8.04	44.53/ 8.08	45.09/ 7.76	44.70/ 8.06	50.74

Single carrier ETM 1.1 QPSK

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[1)]
$B_{1.4}$	41.58	41.63	41.71	41.60	47.65
B_3	38.71	38.71	38.82	38.72	44.76
IoT_{3T}	37.43	38.31	37.46	37.47	43.70

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)]
B_5	39.48	39.52	39.52	39.49	45.52
B_{10}	36.59	36.60	36.60	36.57	42.61

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

Remark

This unit is tested without antenna. 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 allowed antenna gain used in combination with above power settings to prevent the radiated output power to exceed the limits.

Limits

CFR47 § 22.913: The effective radiated power ERP shall not exceed 1000 W or 800 W/ MHz (PSD) per sector.
The PAR (0.1%) shall not exceed 13 dB.

RSS-132 5.4: The average equivalent isotropically radiated power (e.i.r.p.) limits in SRSP-503 apply, resulting in a maximum EIRP of 1640 W.
The PAR (0.1%) shall not exceed 13 dB.

Complies?	Yes

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

Date	Temperature	Humidity
2017-10-25	24 °C ± 3 °C	29 % ± 5 %
2017-10-30	24 °C ± 3 °C	10 % ± 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	4.477

Single carrier ETM 3.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
2	M_5	RF A	4.494
3	$B_{1.4}$	RF B	1.101
4	B_{10}	RF B	8.975
5	$M_{1.4}$	RF B	1.101
6	M_3	RF B	2.695
7	M_5	RF B	4.494
8	M_{10}	RF B	8.975
9	$T_{1.4}$	RF B	1.101
10	T_{10}	RF B	8.977
11	M_5	RF C	4.495
12	M_5	RF D	4.493

Single carrier ETM 3.2

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
13	M_5	RF B	4.477

Single carrier ETM 3.1a

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
14	M_5	RF B	4.487

Carrier Aggregation ETM 3.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
15	$CA_{10\text{-}10}$	RF B	18.885

NB-IoT inband NTM

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
16	IoT3B	RF B	2.684
17	IoT5	RF B	4.478

Diagram 1:

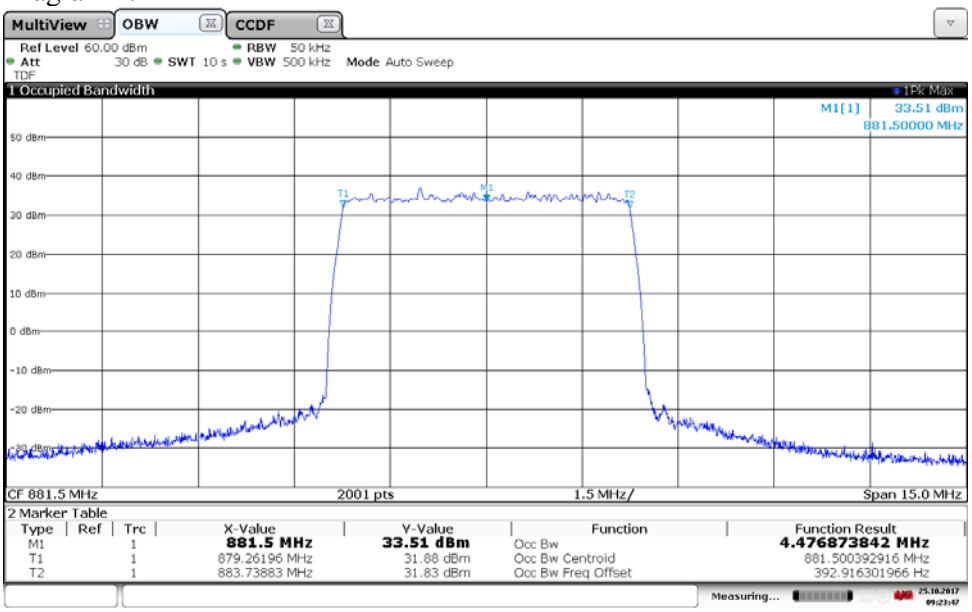


Diagram 2:

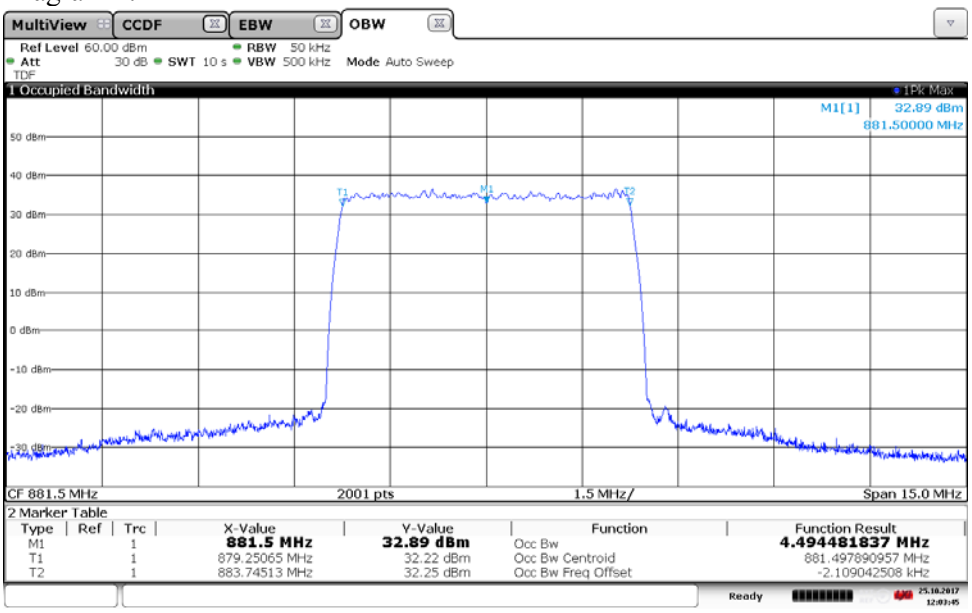


Diagram 3:

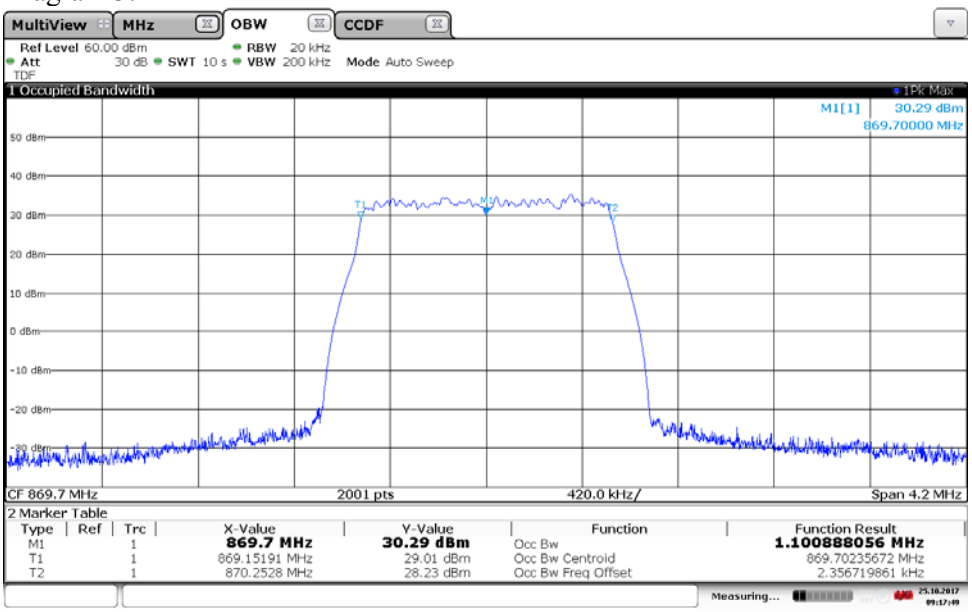


Diagram 4:

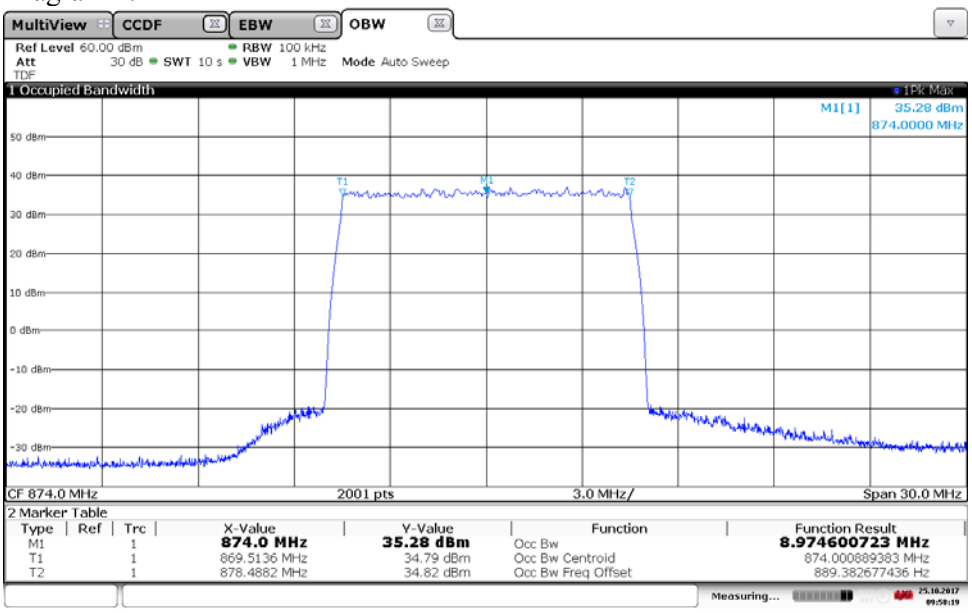


Diagram 5:

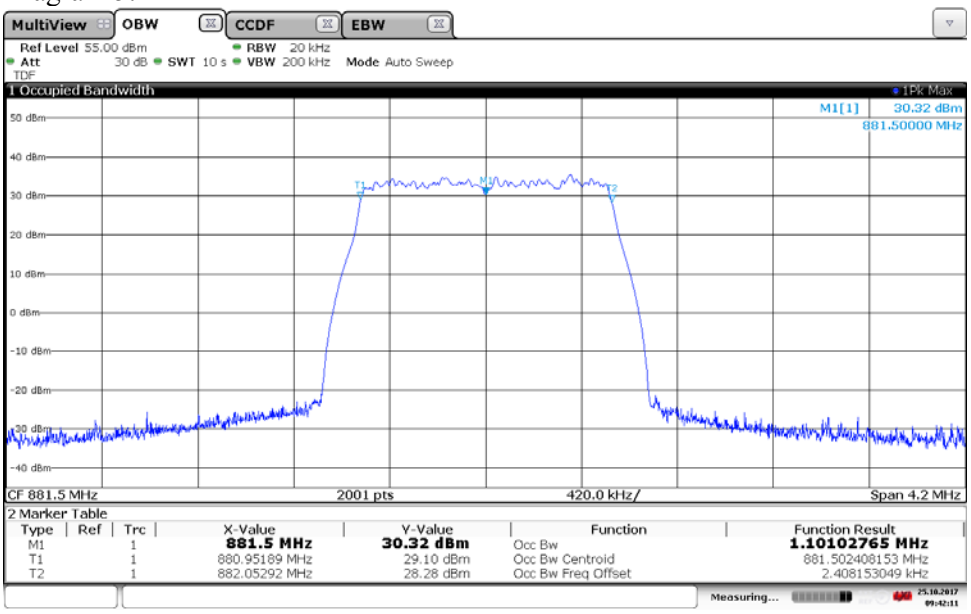


Diagram 6:

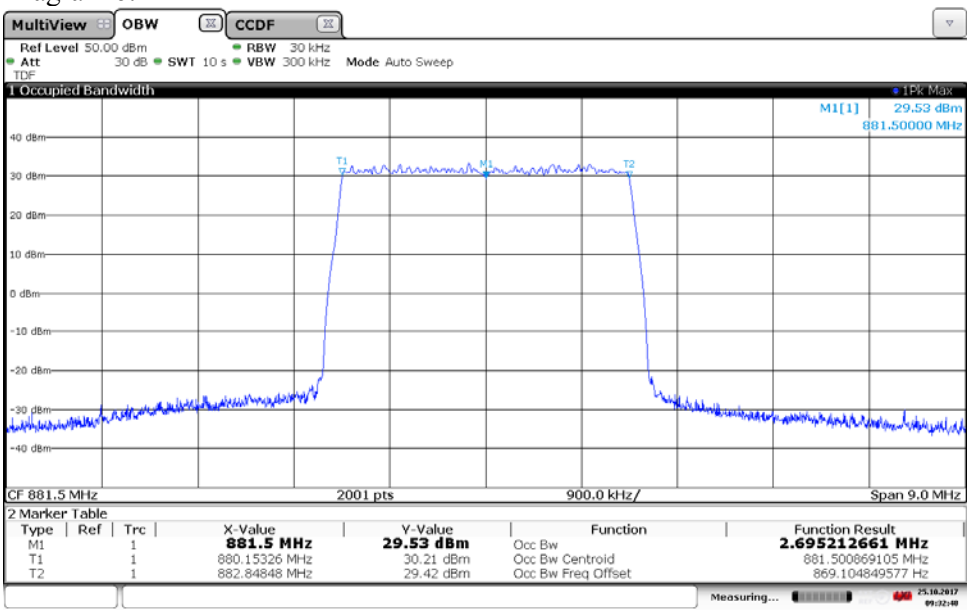


Diagram 7:

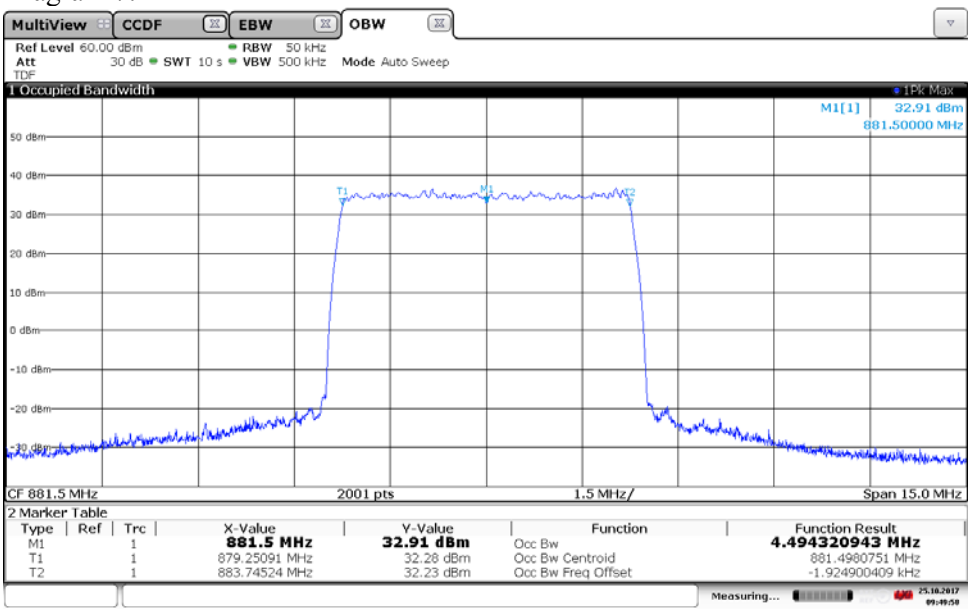


Diagram 8:

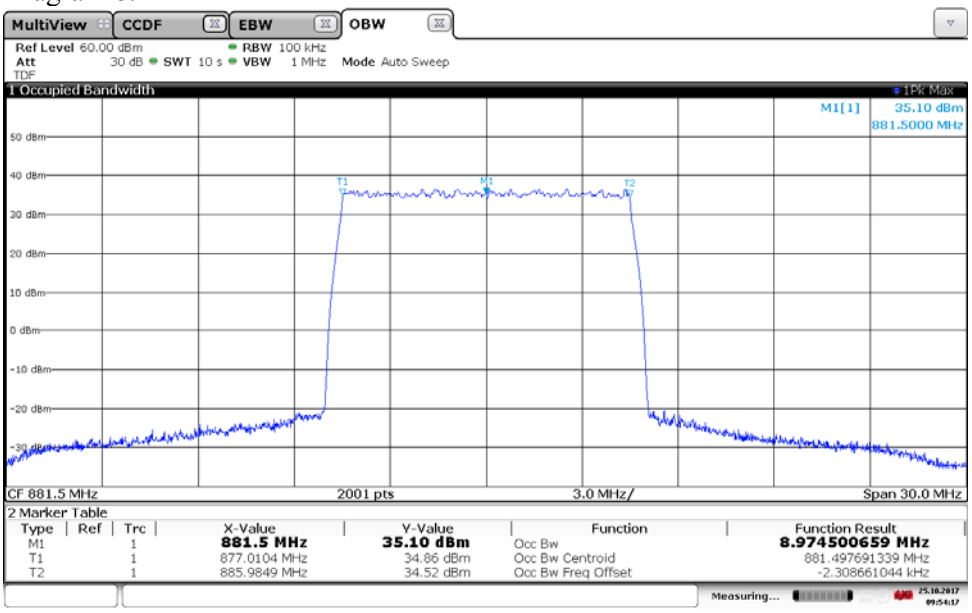


Diagram 9:

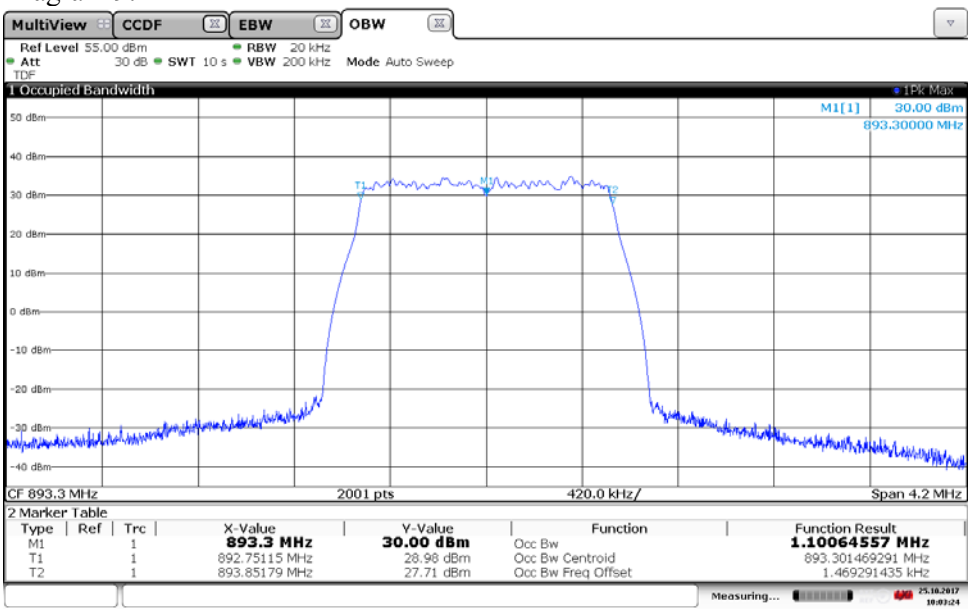


Diagram 10:

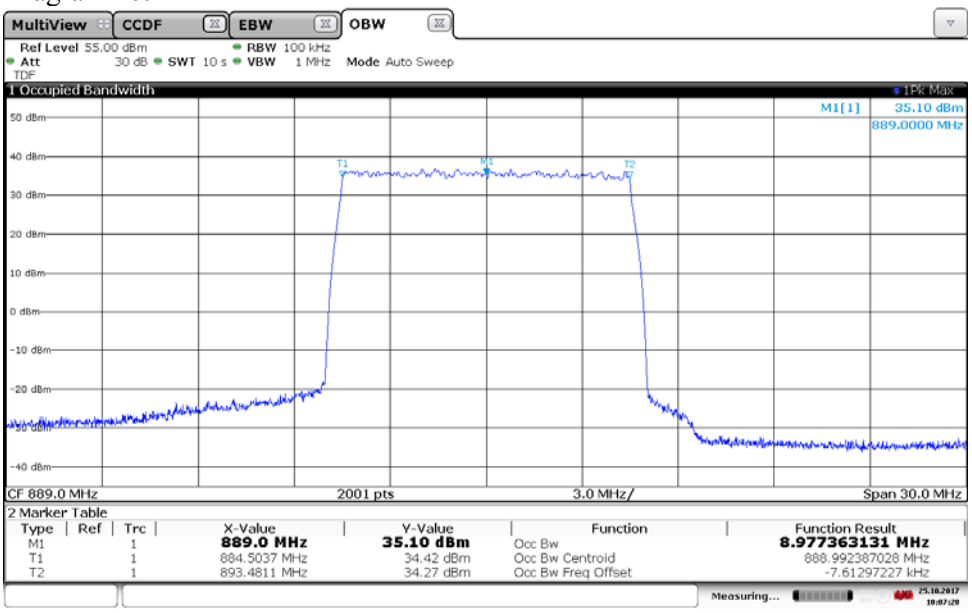


Diagram 11:

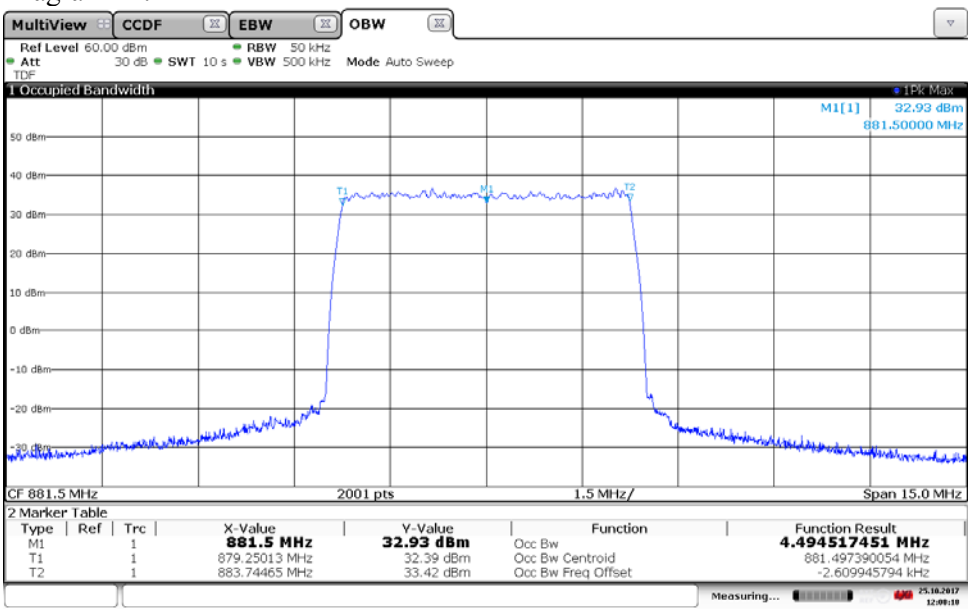


Diagram 12:

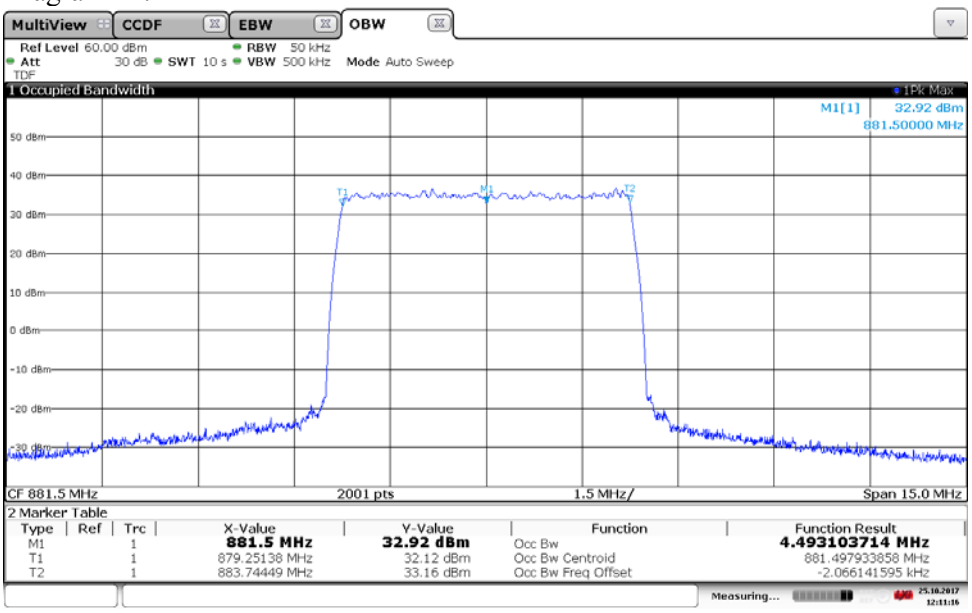
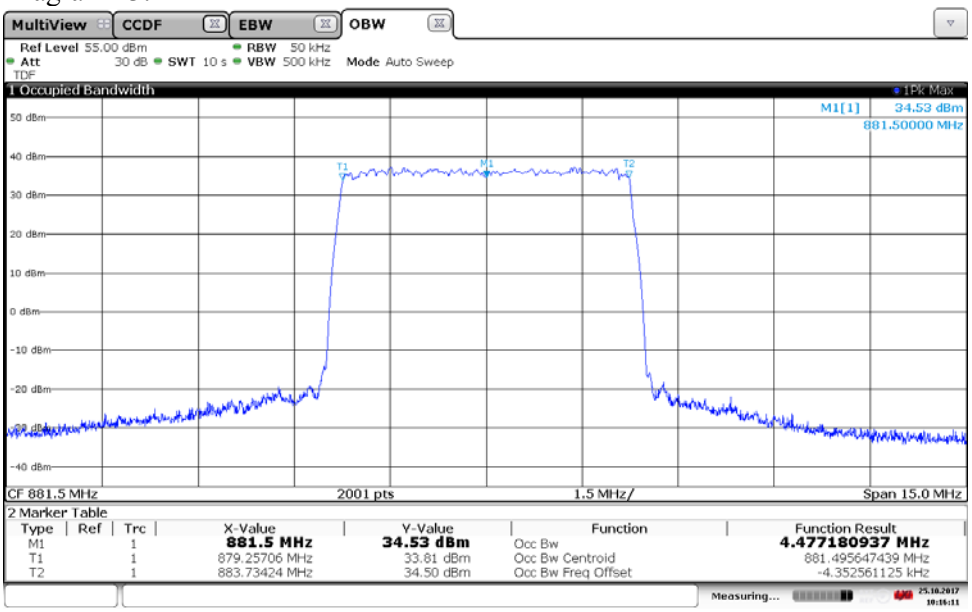
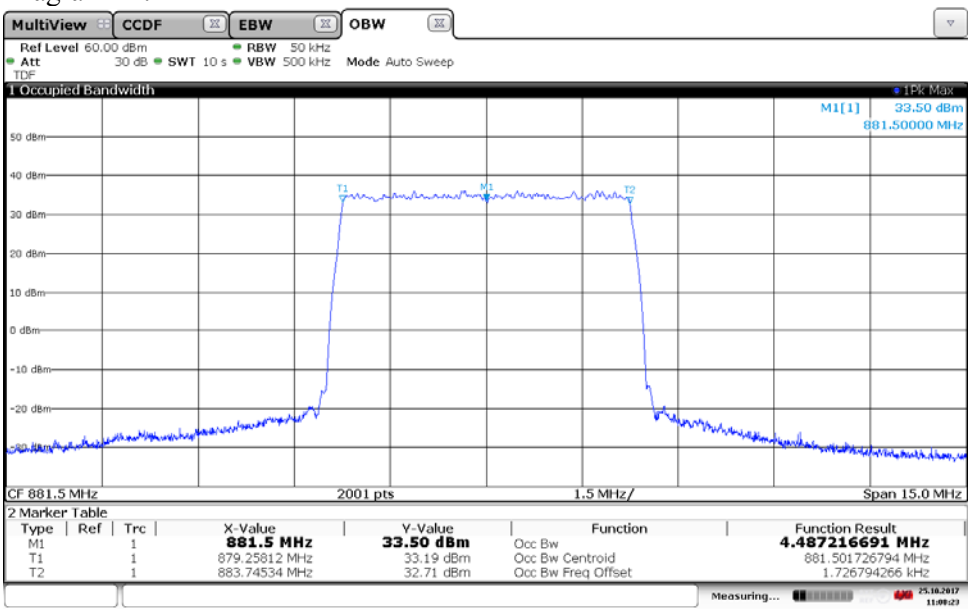


Diagram 13:



10:16:11 25.10.2017

Diagram 14:



11:00:23 25.10.2017

Diagram 15:

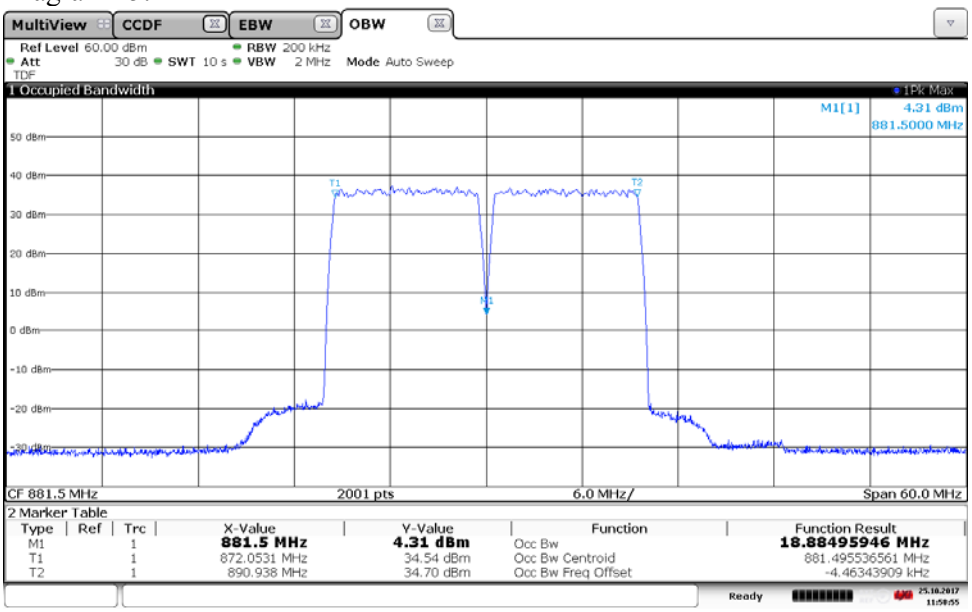


Diagram 16:

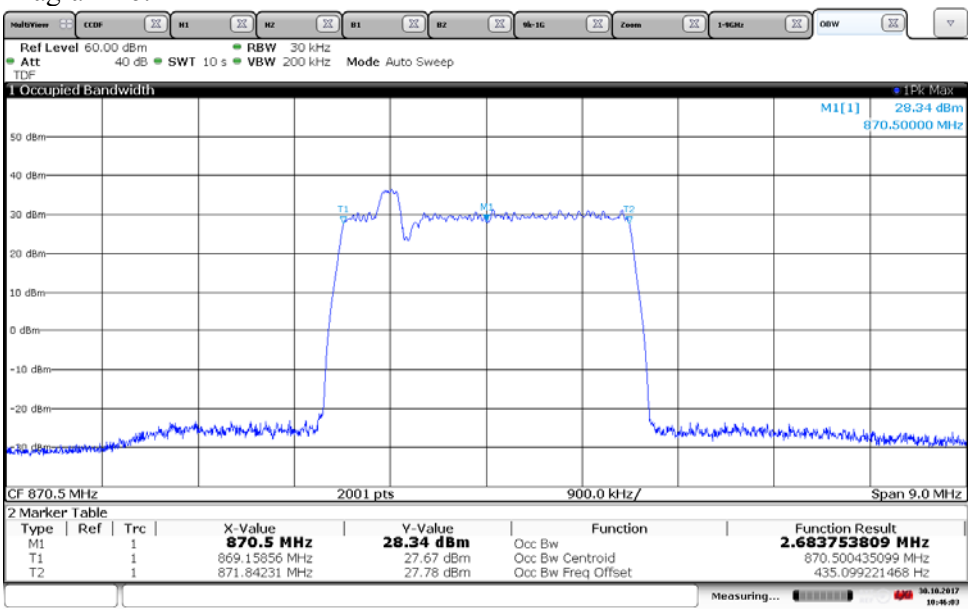
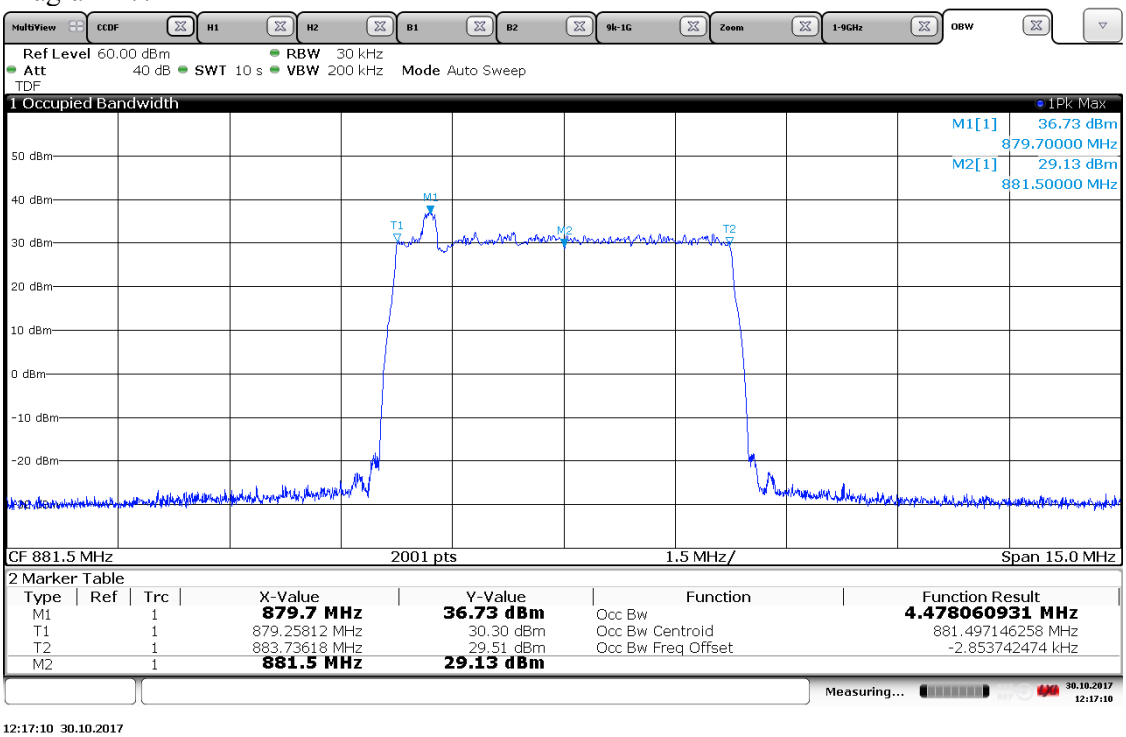


Diagram 17:


MultiView
CCDF
H1
H2
B1
B2
9k-1G
Zoom
1-9GHz
OBW
Ref Level 60.00 dBm
RBW 30 kHz
Att 40 dB SWT 10 s VBW 200 kHz Mode Auto Sweep
TDF
1 Occupied Bandwidth
1Pk Max
M1[1] 36.73 dBm
879.70000 MHz
M2[1] 29.13 dBm
881.50000 MHz
50 dBm
40 dBm
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
M1
T1
M2
T2
CF 881.5 MHz
2001 pts
1.5 MHz/
Span 15.0 MHz
2 Marker Table
Type Ref Trc X-Value Y-Value Function Function Result
M1 1 879.7 MHz 36.73 dBm Occ Bw 4.478060931 MHz
T1 1 879.25812 MHz 30.30 dBm Occ Bw Centroid 881.497146258 MHz
T2 1 883.73618 MHz 29.51 dBm Occ Bw Freq Offset -2.853742474 kHz
M2 1 881.5 MHz 29.13 dBm
Measuring...
30.10.2017
12:17:10
12:17:10 30.10.2017

Band edge measurements according to CFR 47 §2.1051 / IC RSS-132 5.5

Date	Temperature	Humidity
2017-10-25	24 °C ± 3 °C	29 % ± 5 %
2017-10-30	24 °C ± 3 °C	10 % ± 5 %

Test set-up and procedure

The measurements were made per definition in § 22.917. 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.

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	T_3	RF A
3 a-b	$B_{1.4}$	RF B
4 a-b	B_3	RF B
5 a-b	B_5	RF B
6 a-b	B_{10}	RF B
7 a-b	$T_{1.4}$	RF B
8 a-b	T_3	RF B
9 a-b	T_5	RF B
10 a-b	T_{10}	RF B
11 a-b	B_3	RF C
12 a-b	T_3	RF C
13 a-b	B_3	RF D
14 a-b	T_3	RF D

Multi carrier TM 1.1

Diagram	Symbolic name	Tested Port
15 a-b	Bim	RF B
16 a-b	Tim	RF B

NB-IoT inband NTM

Diagram	Symbolic name	Tested Port
17 a-b	IoT_{3B}	RF B
18 a-b	IoT_{3T}	RF B

The diagrams are shown on the following pages.

Limits

CFR 47 § 22.917: 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 100 kHz RBW below 1 GHz and 1MHz RBW above 1 GHz.

IC RSS-132 5.5: 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 per any 100 kHz RBW.

Complies?	Yes

Diagram 1a:

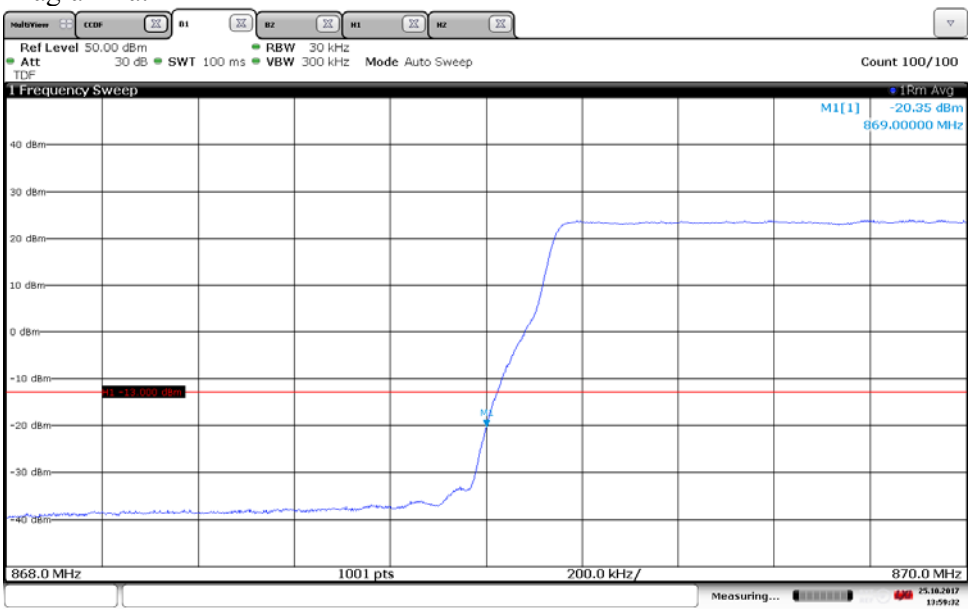


Diagram 1b:

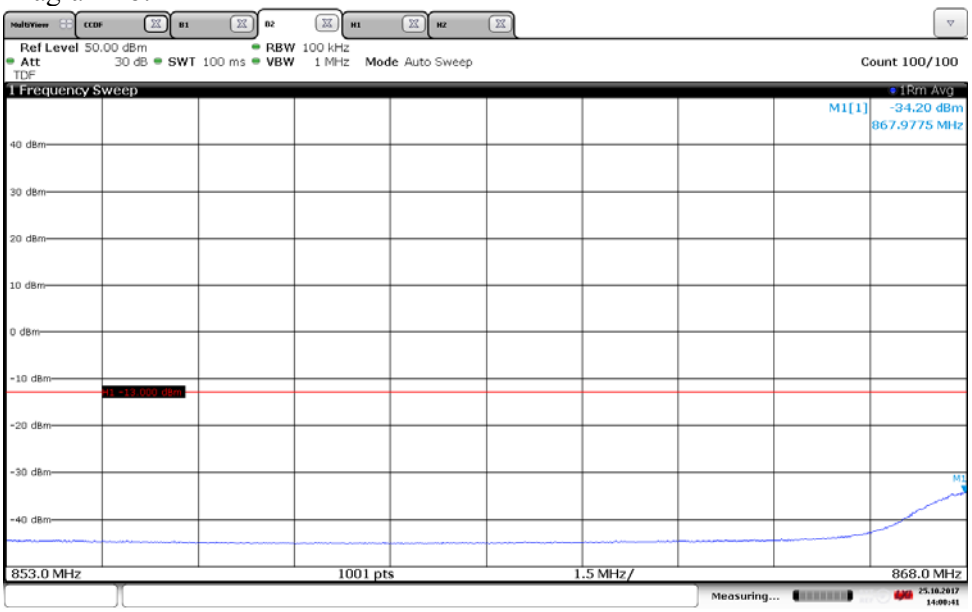


Diagram 2a:

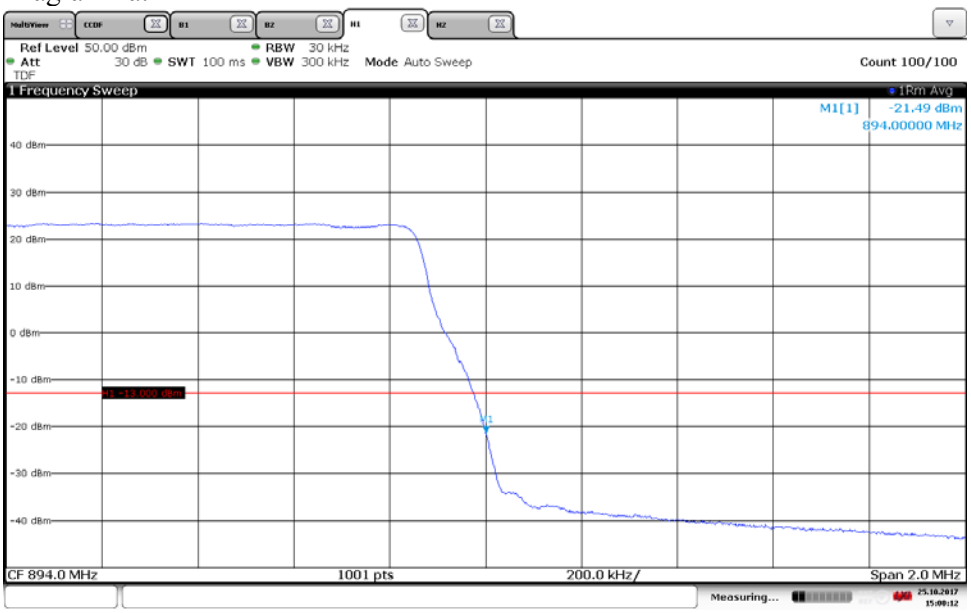


Diagram 2b:

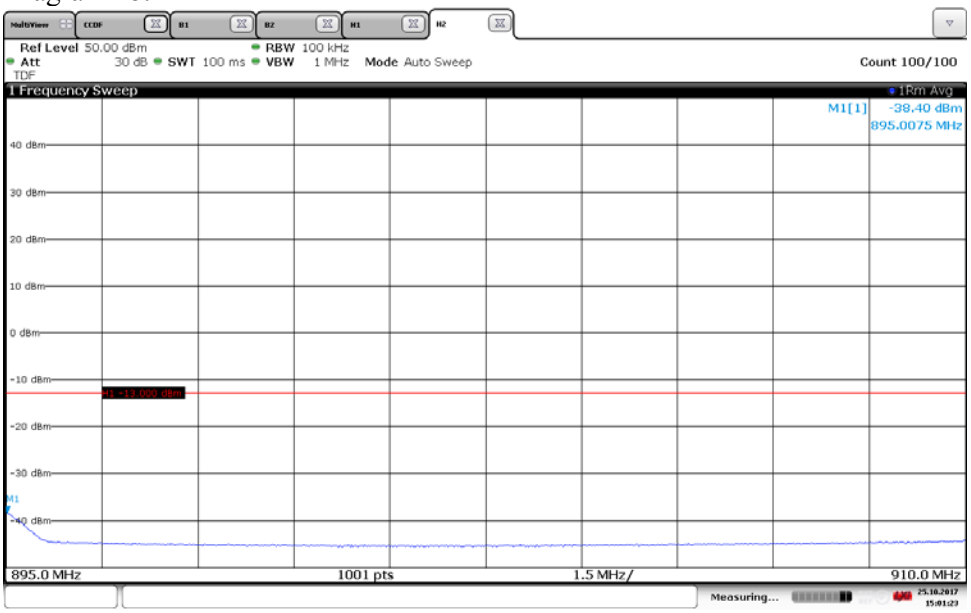


Diagram 3a:

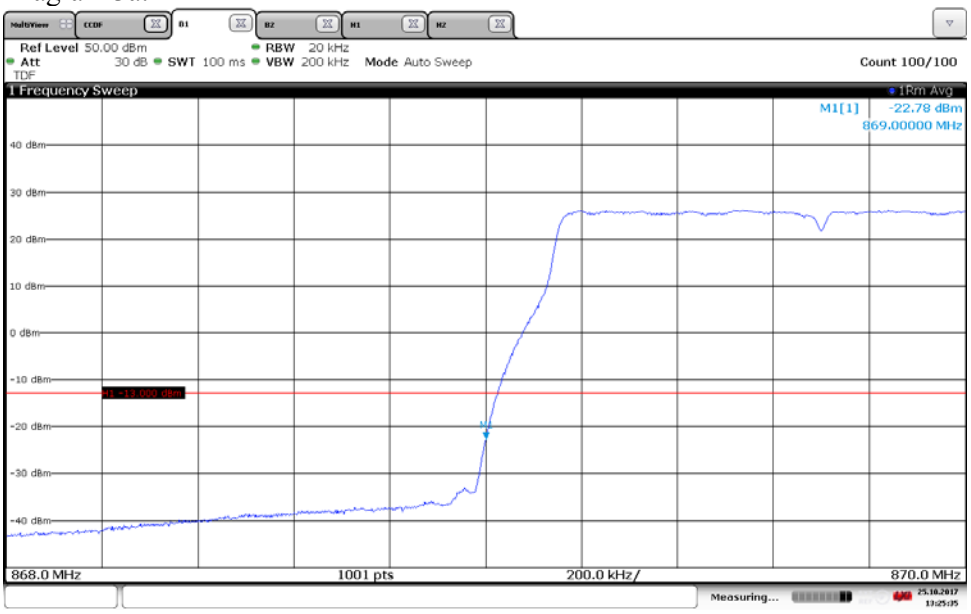


Diagram 3b:

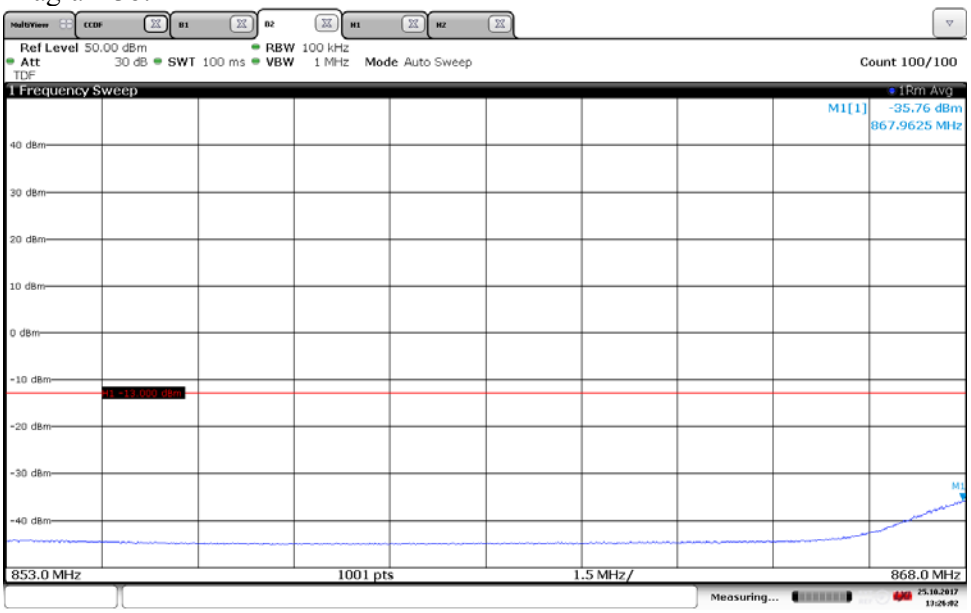


Diagram 4a:

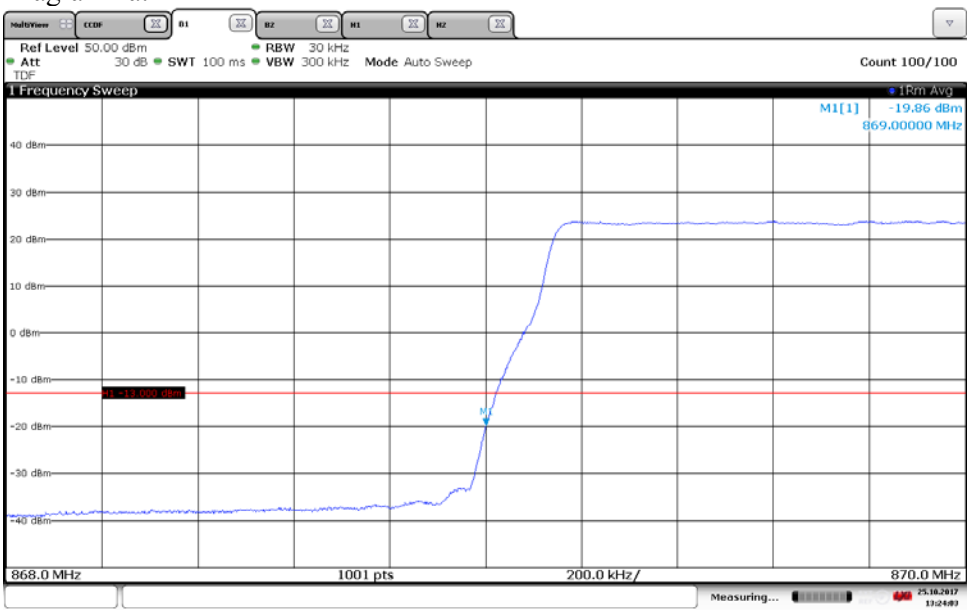


Diagram 4b:

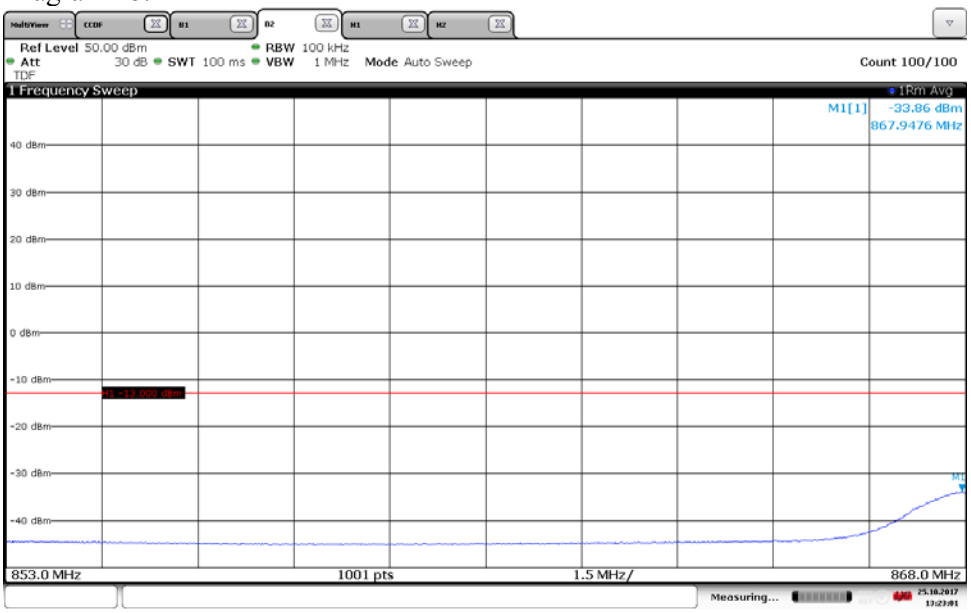


Diagram 5a:

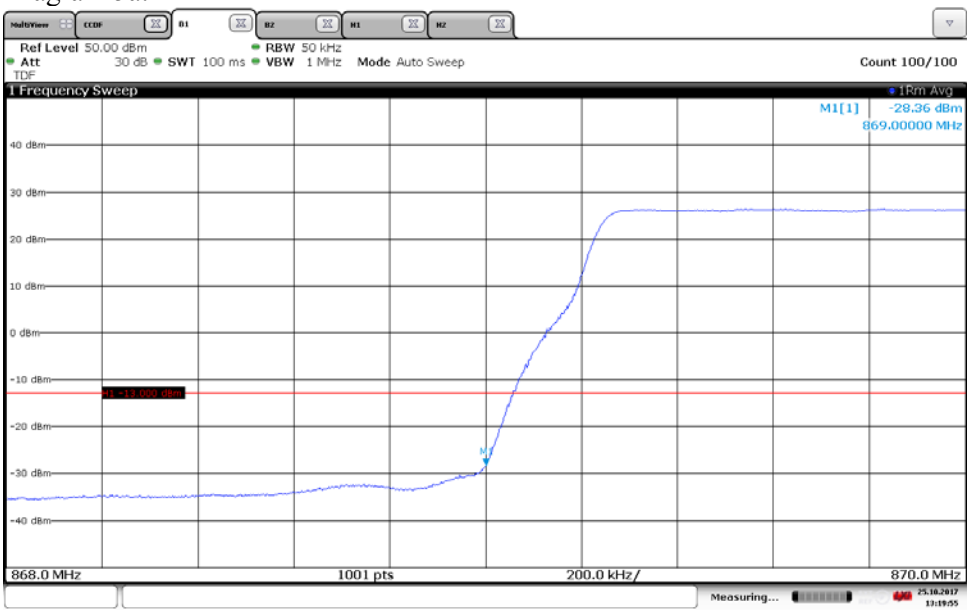


Diagram 5b:

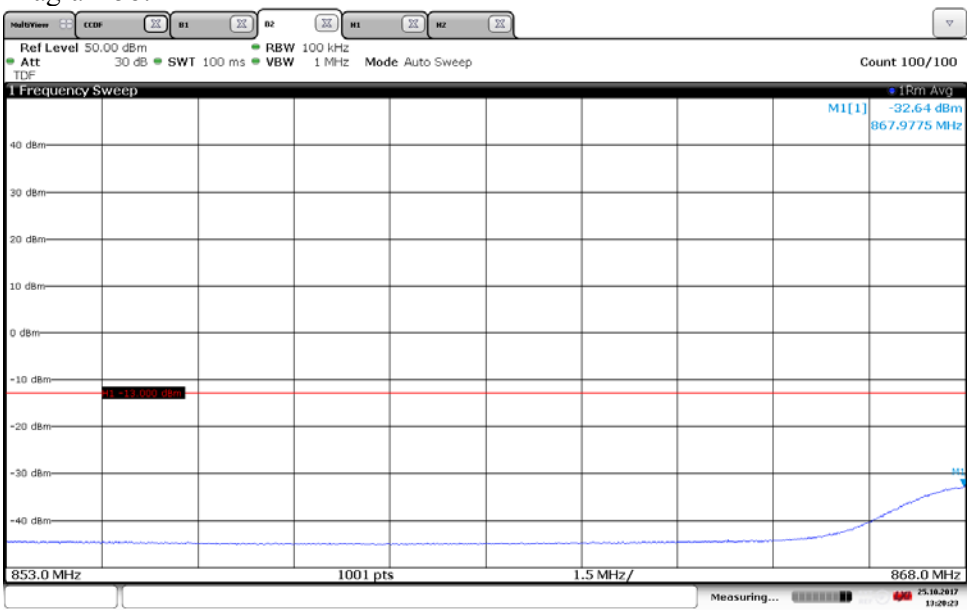


Diagram 6a:

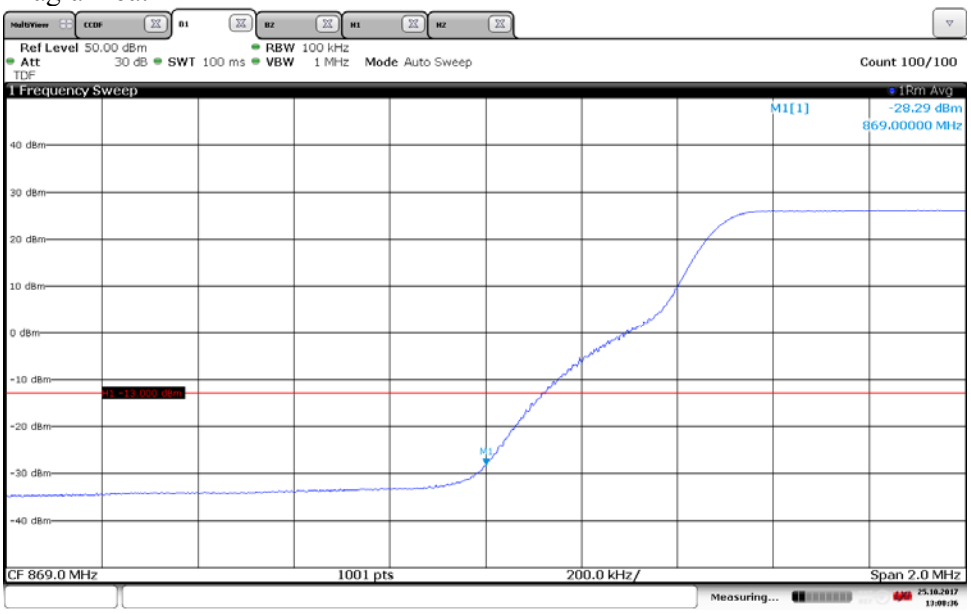


Diagram 6b:

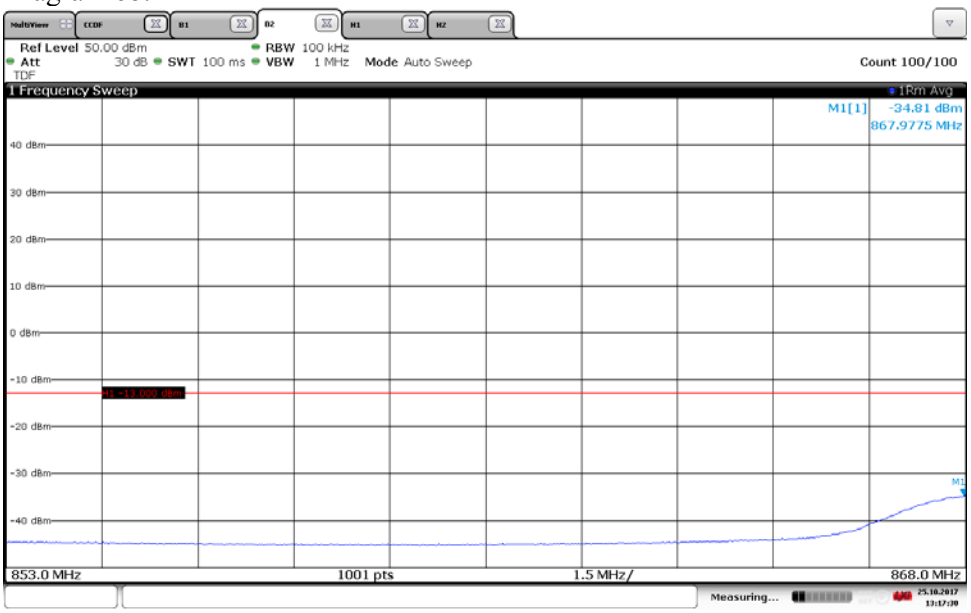


Diagram 7a:

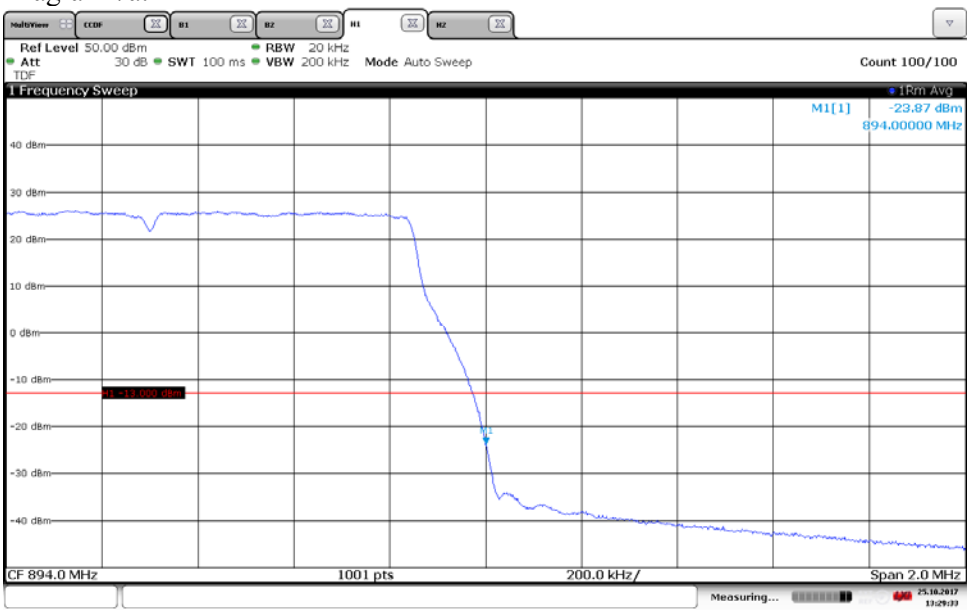


Diagram 7b:

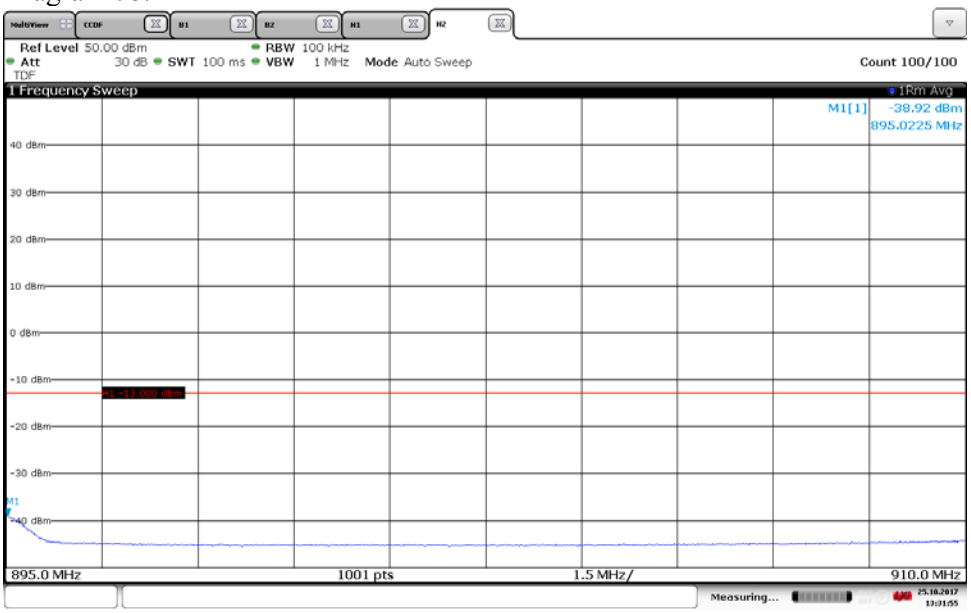


Diagram 8a:

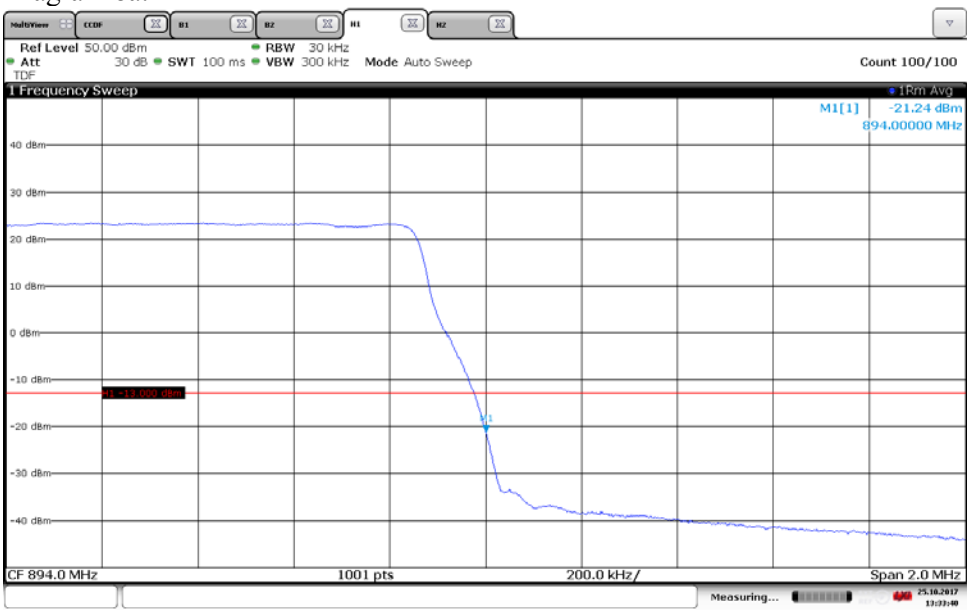


Diagram 8b:

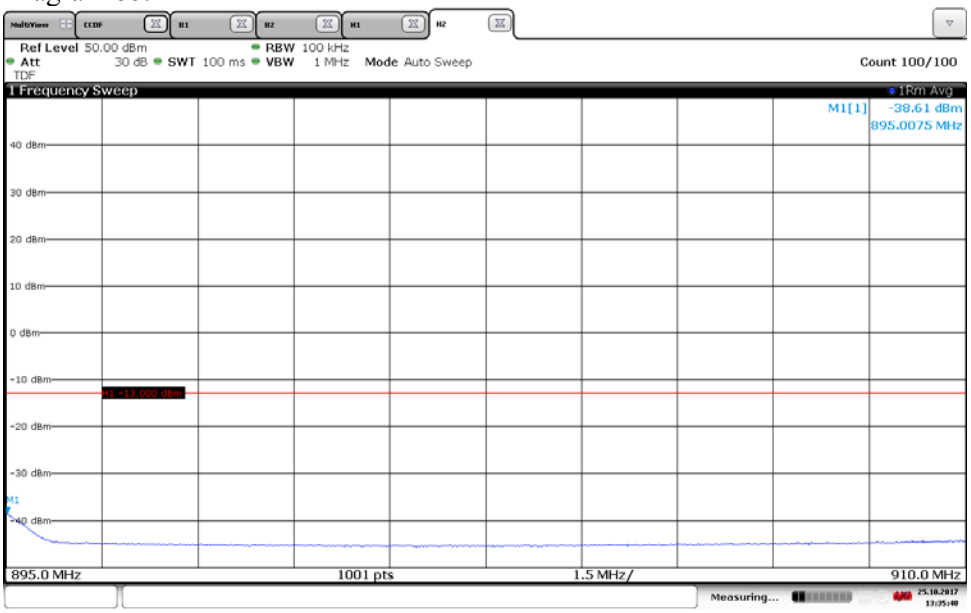


Diagram 9a:

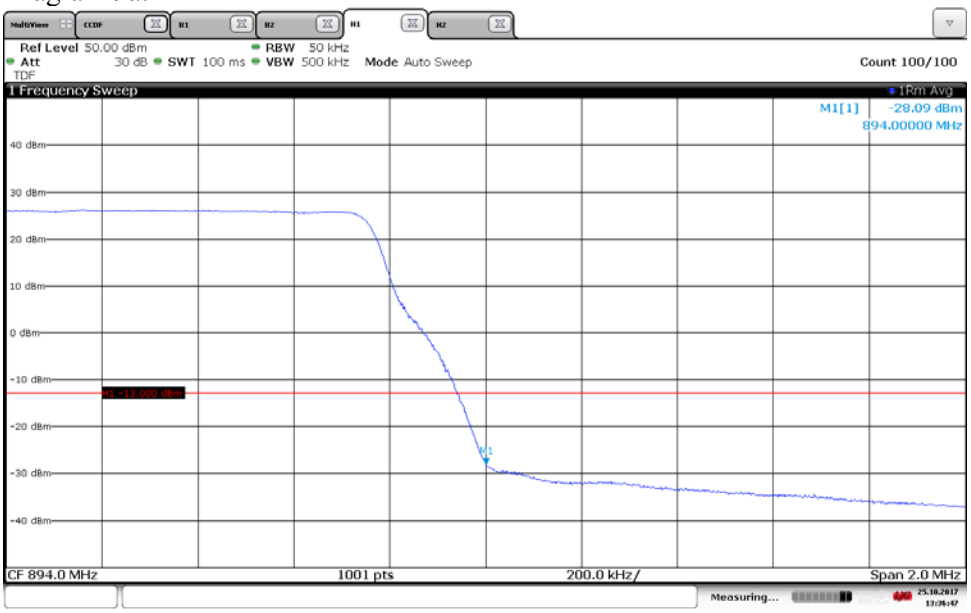


Diagram 9b:

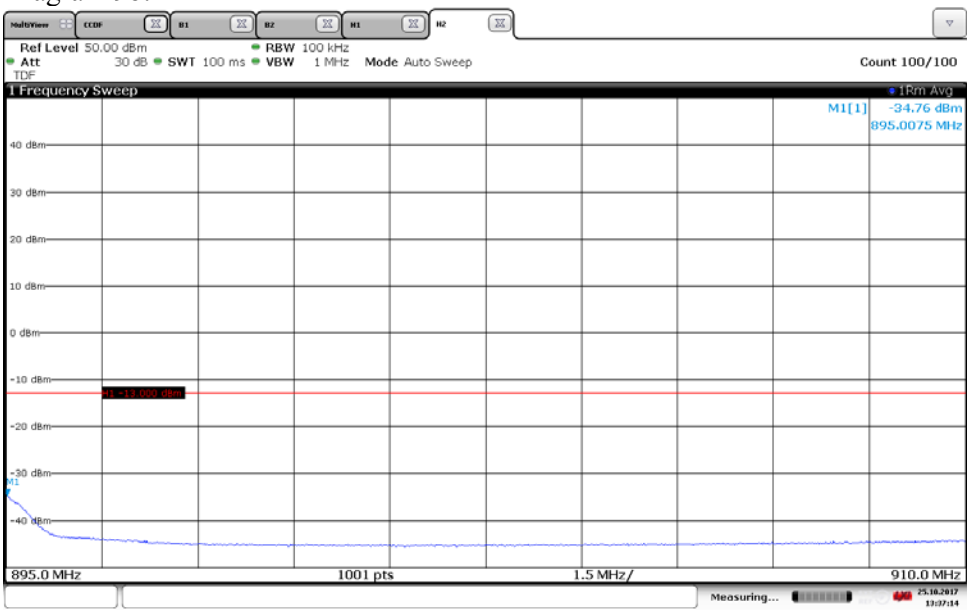


Diagram 10a:

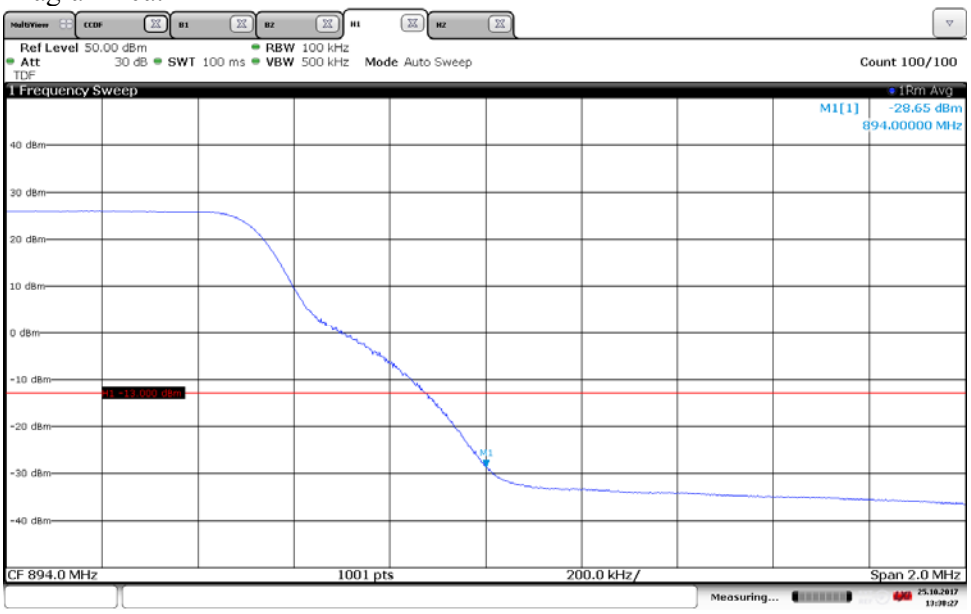


Diagram 10b:

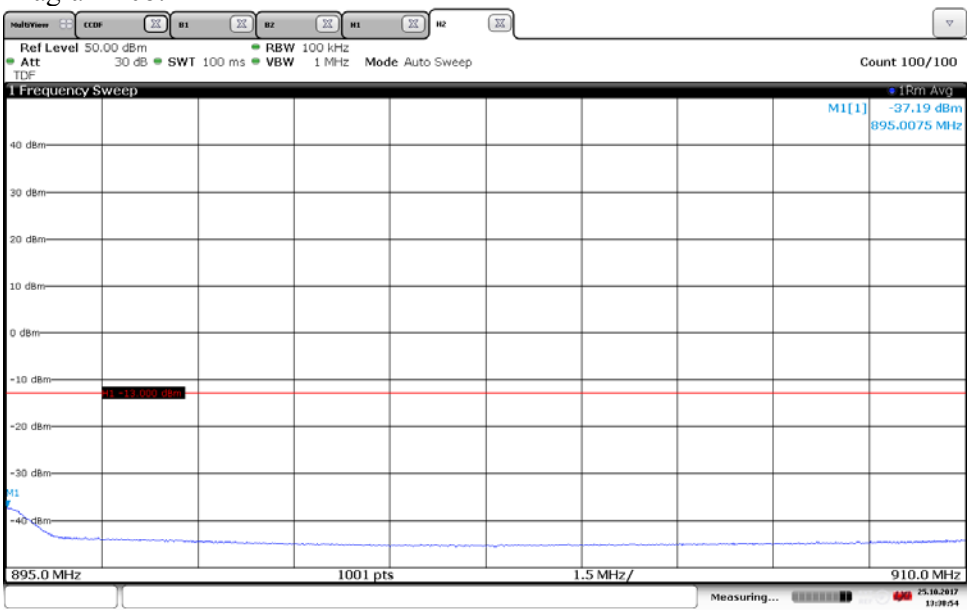


Diagram 11a:

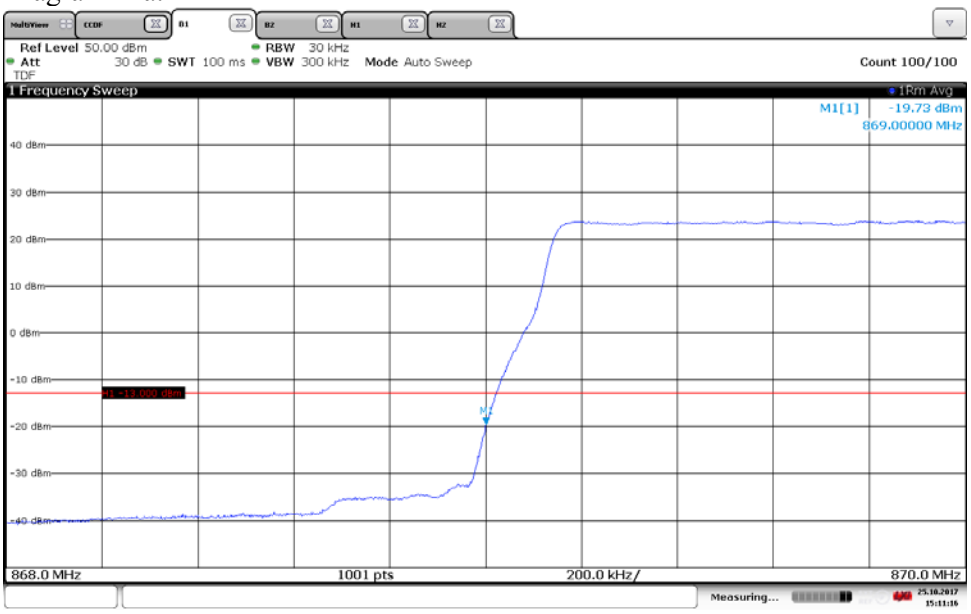


Diagram 11b:

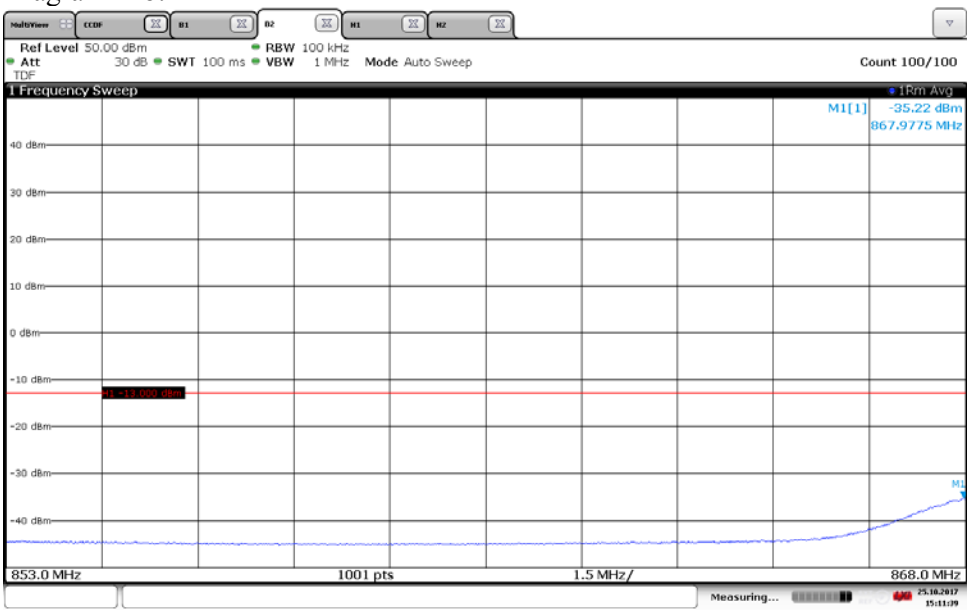


Diagram 12a:

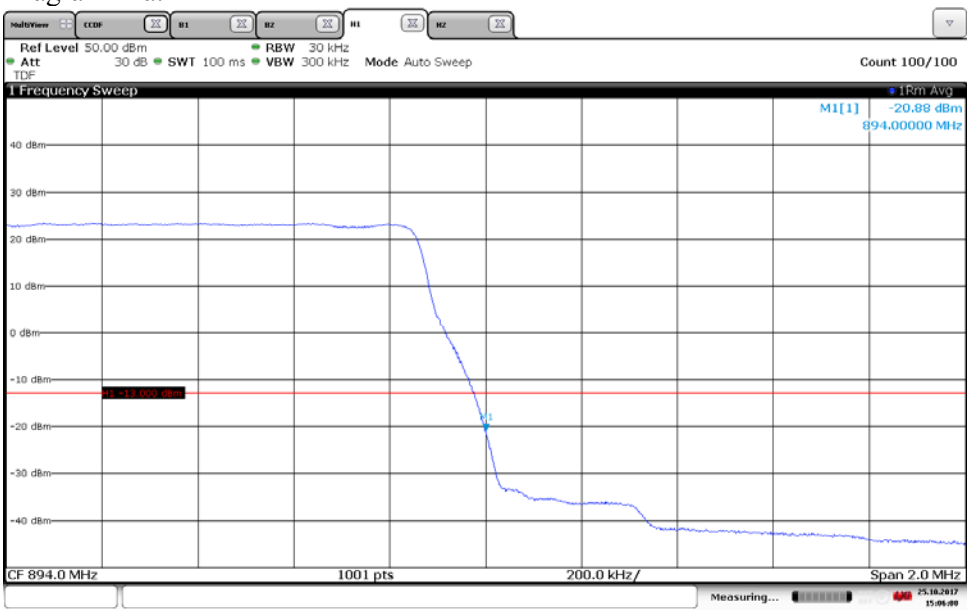


Diagram 12b:

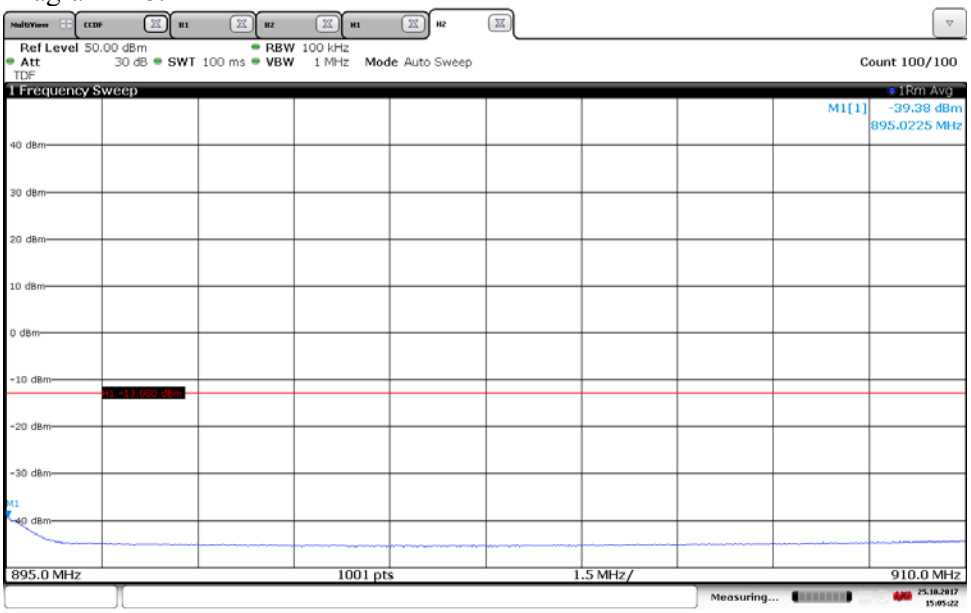


Diagram 13a:

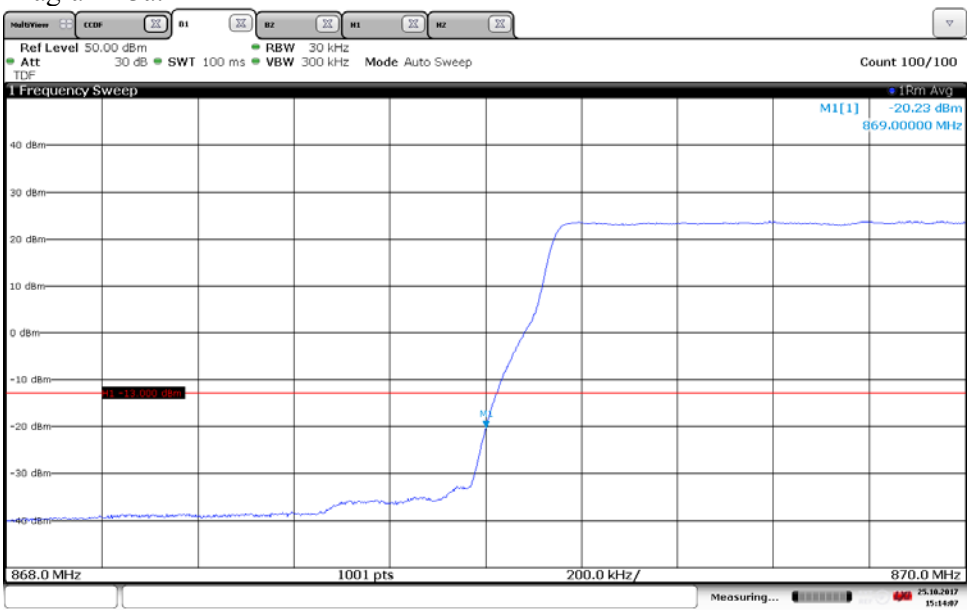


Diagram 13b:

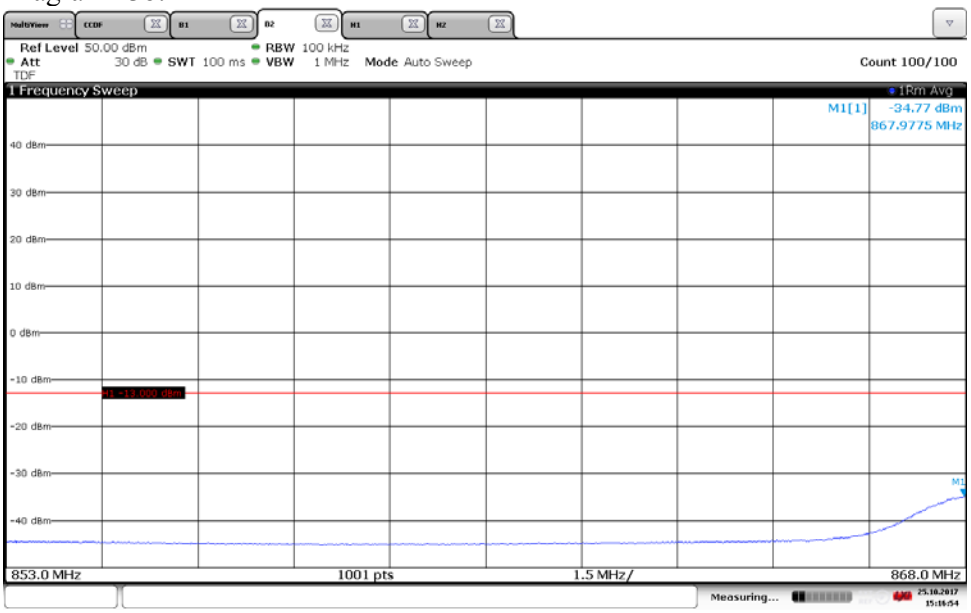


Diagram 14a:

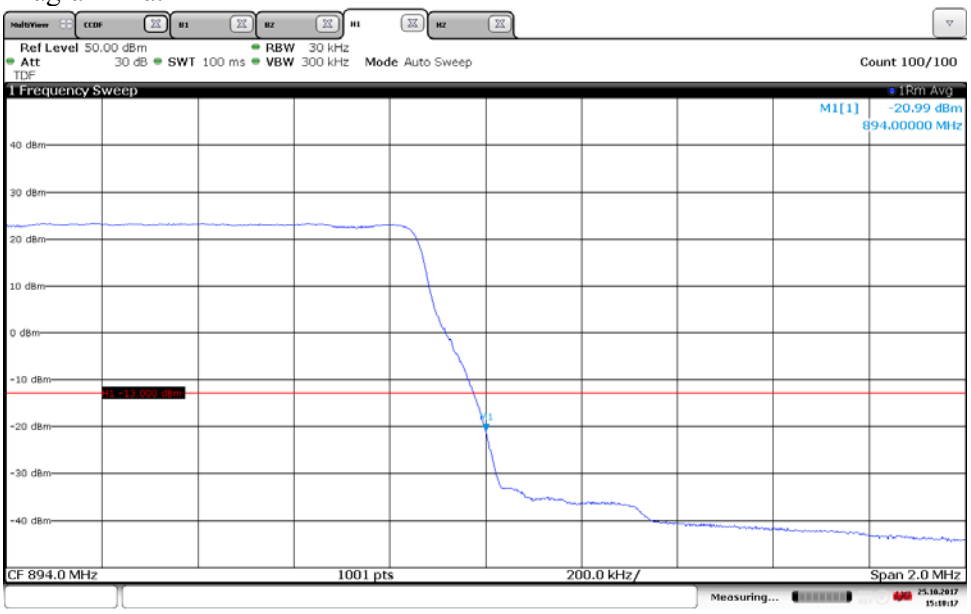


Diagram 14b:

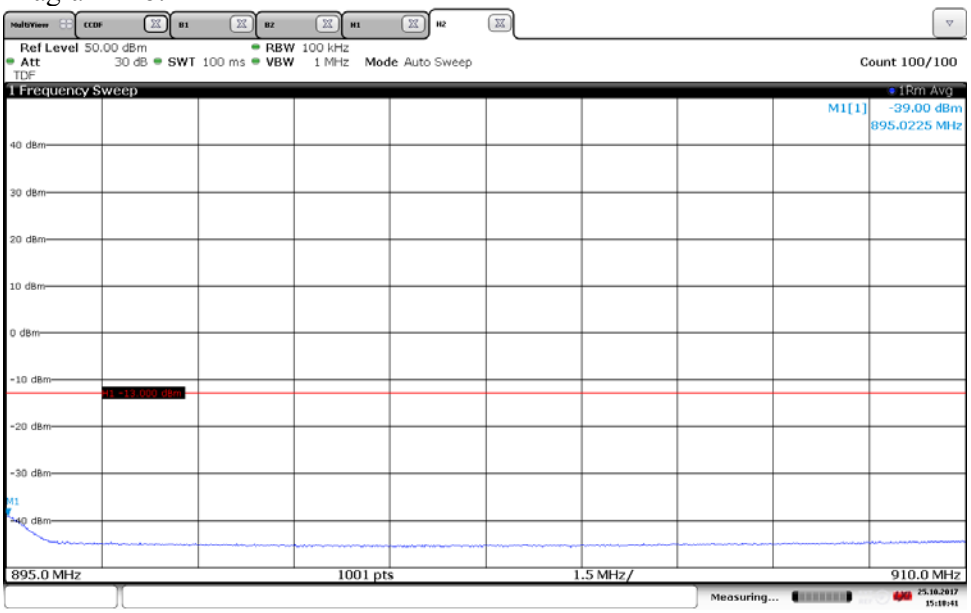


Diagram 15a:

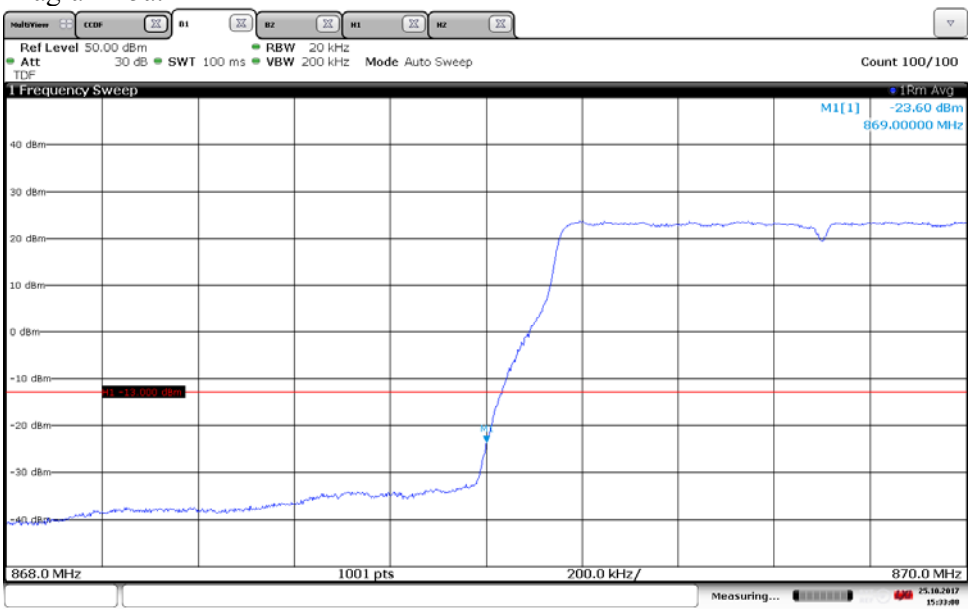


Diagram 15b:

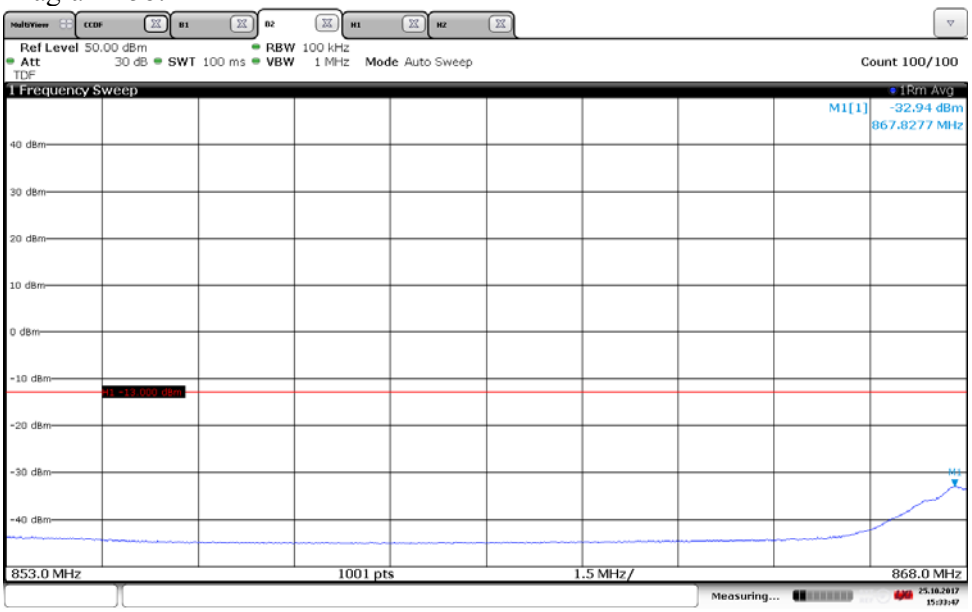


Diagram 16a:

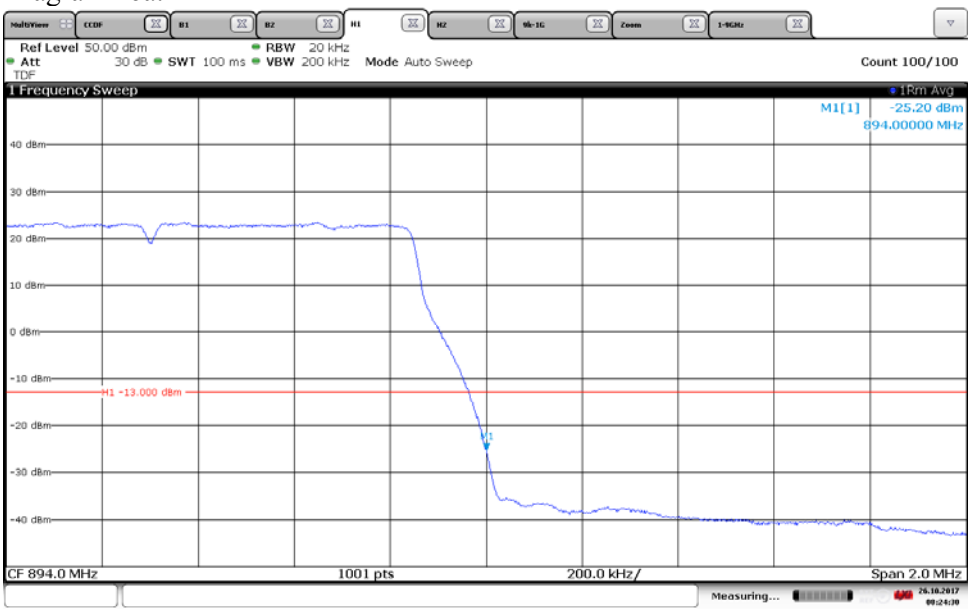


Diagram 16b:

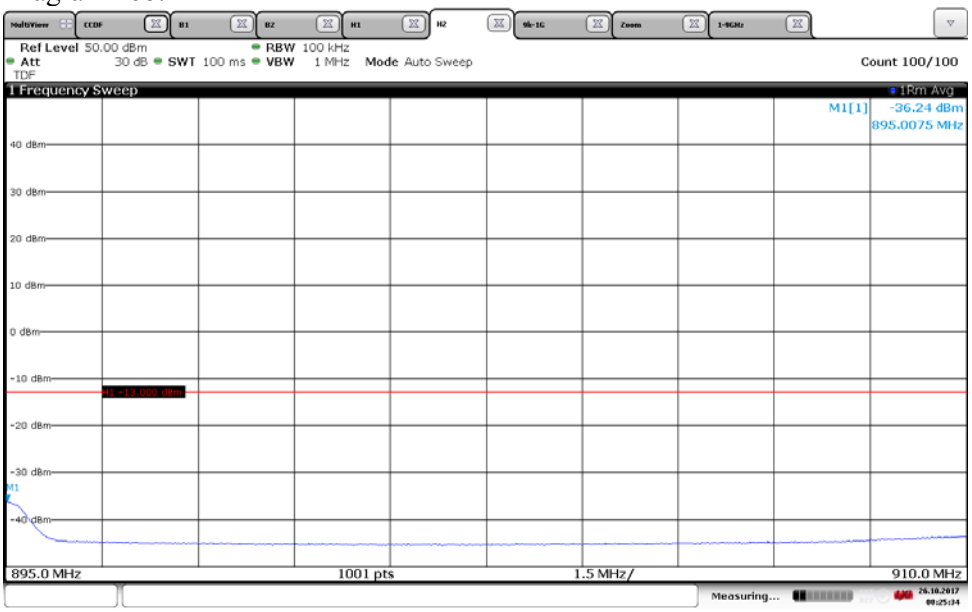


Diagram 17a:

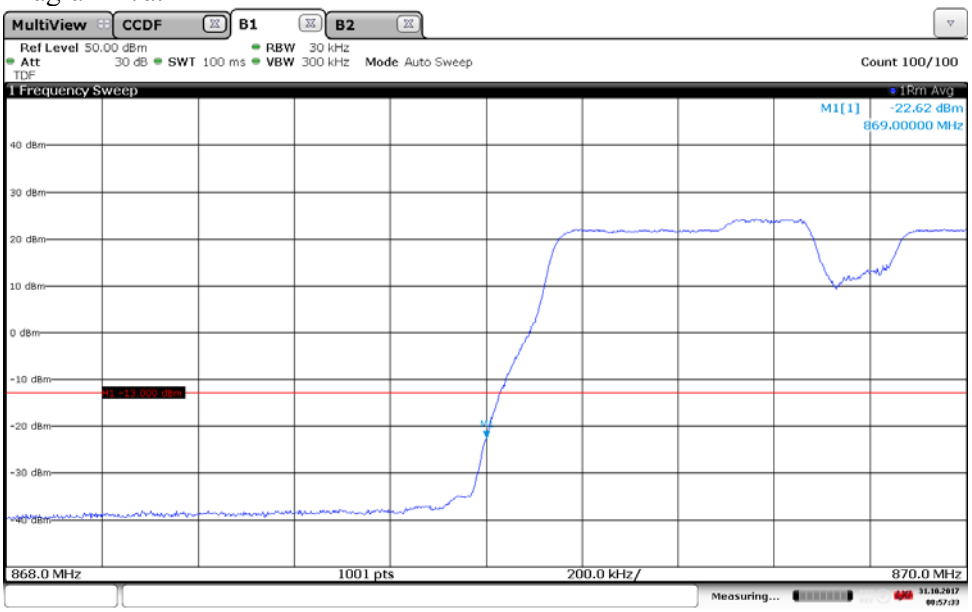


Diagram 17b:

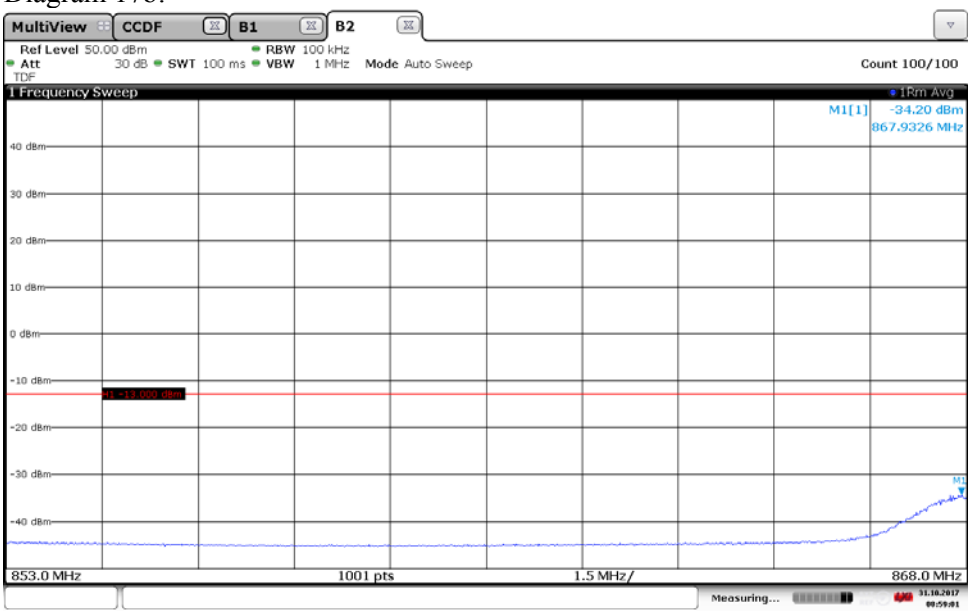


Diagram 18a:

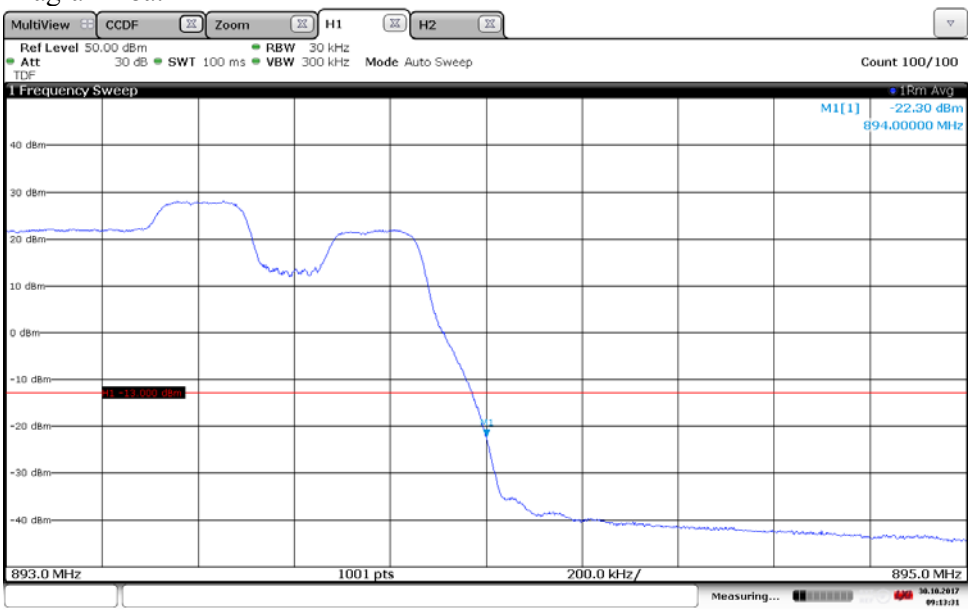
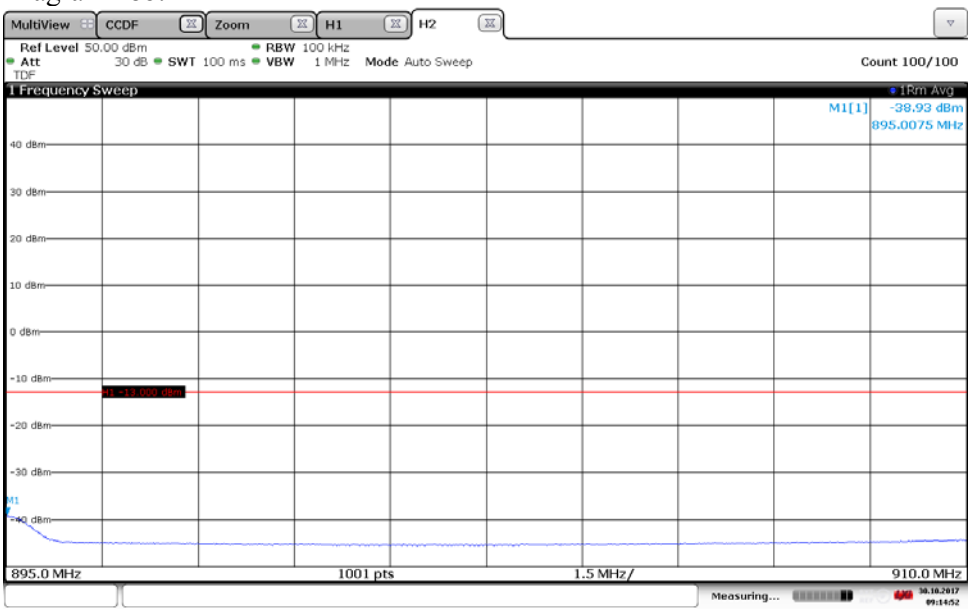


Diagram 18b:



Conducted spurious emission measurements according to CFR 47 2.1051 / IC RSS-132 5.5

Date	Temperature	Humidity
2017-10-25	24 °C ± 3 °C	29 % ± 5 %
2017-10-26	22 °C ± 3 °C	28 % ± 5 %
2017-10-30	24 °C ± 3 °C	10 % ± 5 %

Test set-up and procedure

The measurements were made per definition in § 22.917. The output 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.

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	901 373
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	B_5	RFA
2 a-b	T_5	RF A
3 a-b	B_5	RF B
4 a-b	M_5	RF B
5 a-b	$T_{1.4}$	RF B
6 a-b	T_3	RF B
7 a-b	T_5	RF B
8 a-b	T_{10}	RF B
9 a-b	T_5	RF C
10 a-b	T_5	RF D

Multi carrier E-TM 1.1

Diagram	Symbolic name	Tested Port
11 a-c	B2	RF B
12 a-c	B6	RF B
13 a-c	Bim	RF B
14 a-c	Tim	RF B

NB IoT-inband NTM

Diagram	Symbolic name	Tested Port
15 a-c	IoT_{3B}	RF B
16 a-c	IoT_{3T}	RF B
17 a-c	IoT_5	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 894 MHz. The measurements were made up to 9 GHz (10x894 MHz = 8.940 GHz).

Limits

CFR 47 § 22.917: 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 100 kHz RBW below 1 GHz and 1MHz RBW above 1 GHz.

IC RSS-132 5.5: 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 per any 100 kHz RBW.

Complies?	Yes

Diagram 1a:

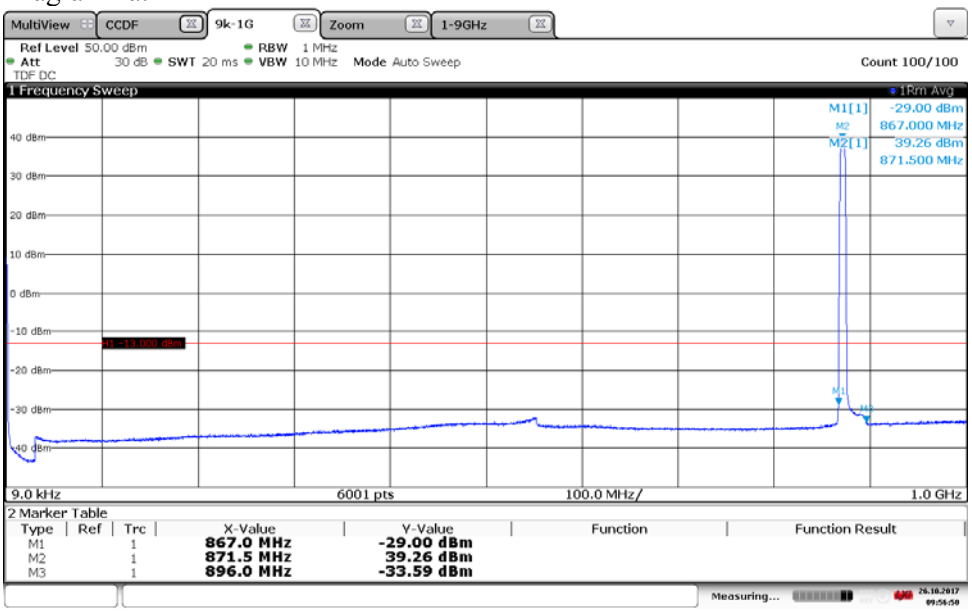


Diagram 1b:

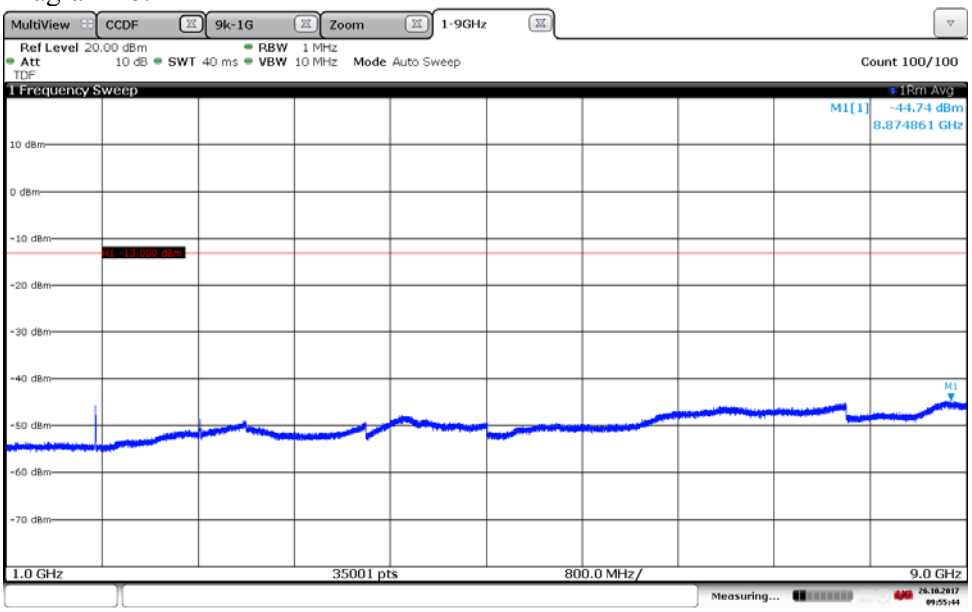


Diagram 2a:

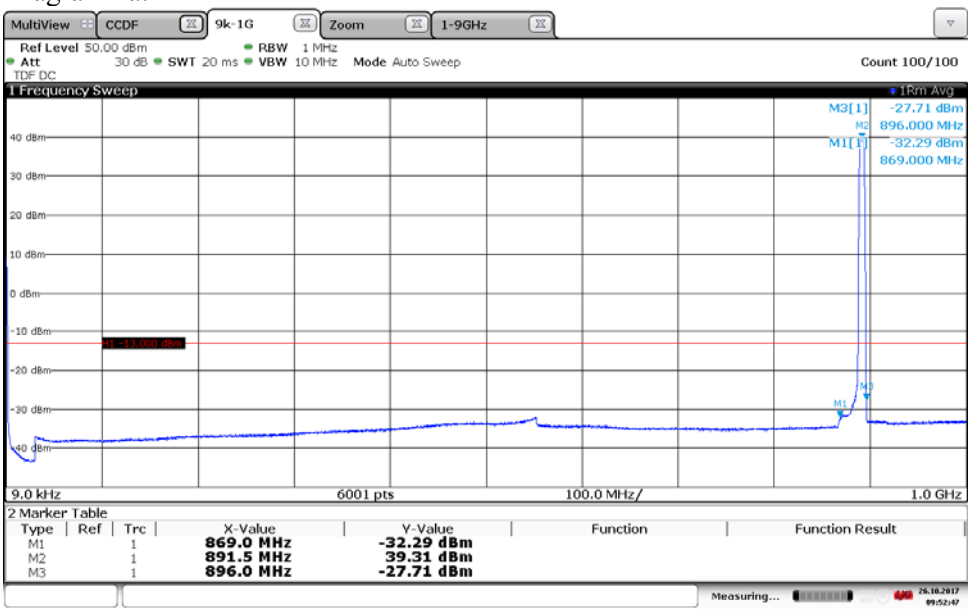


Diagram 2b:

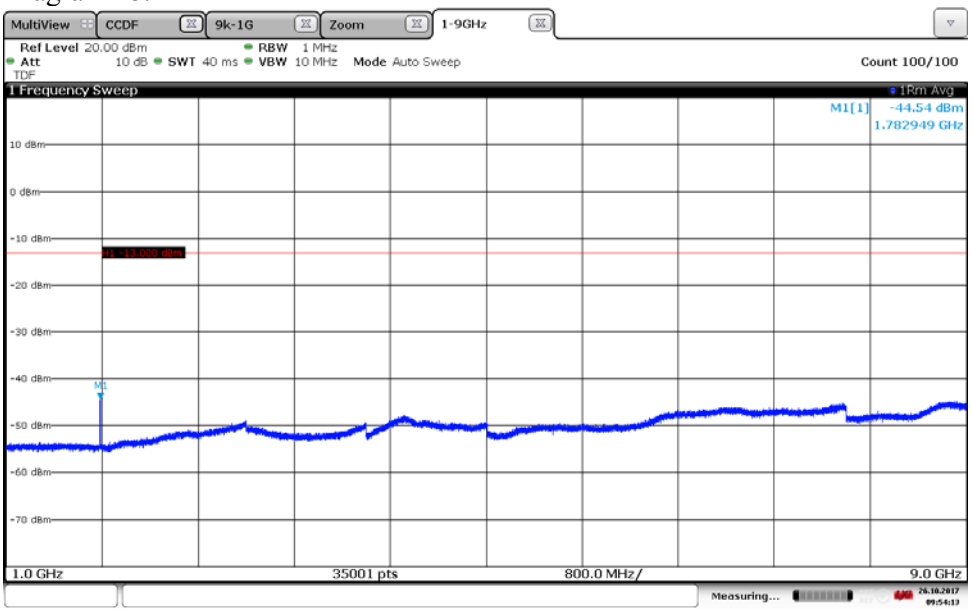


Diagram 3a:

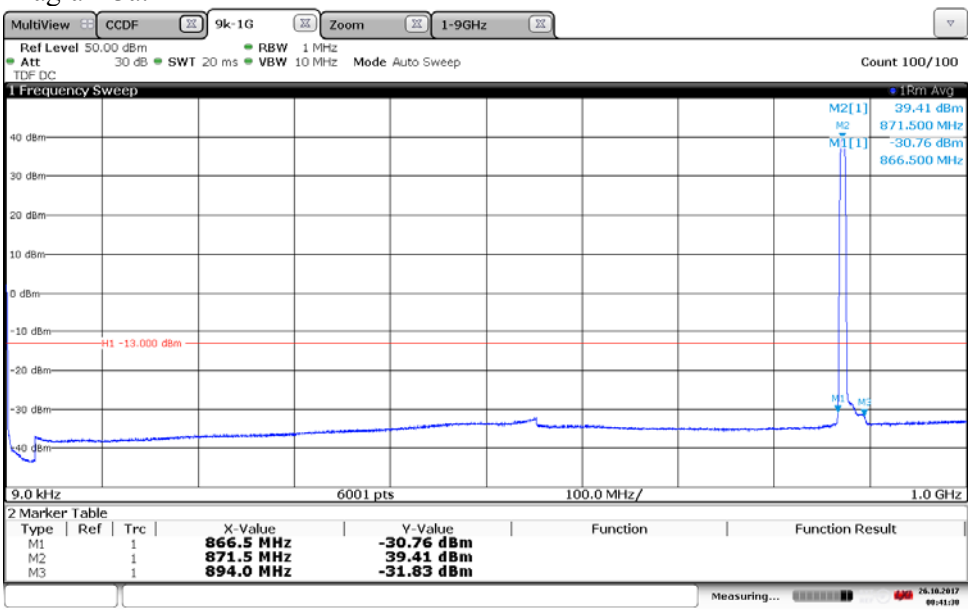


Diagram 3b:

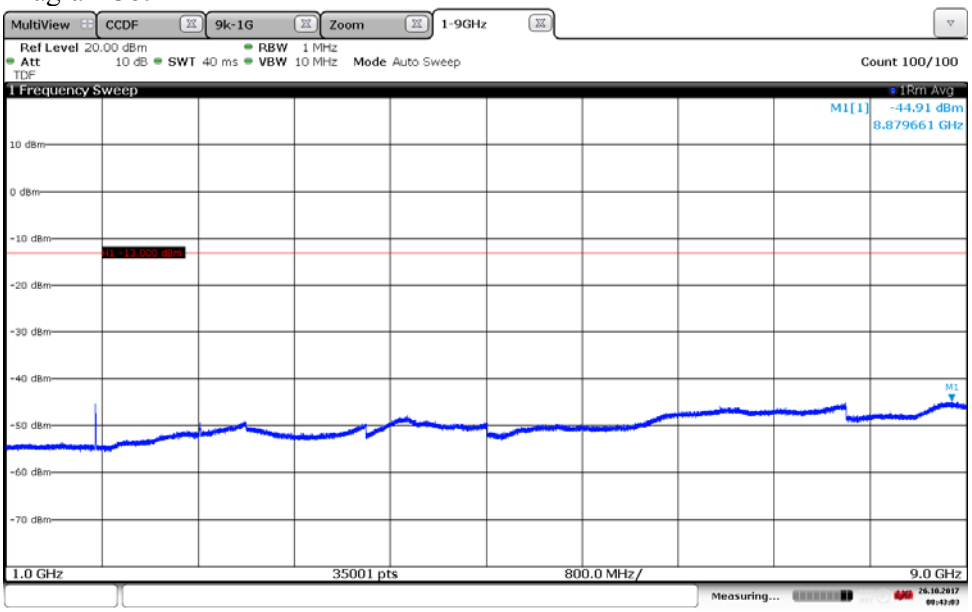


Diagram 4a:

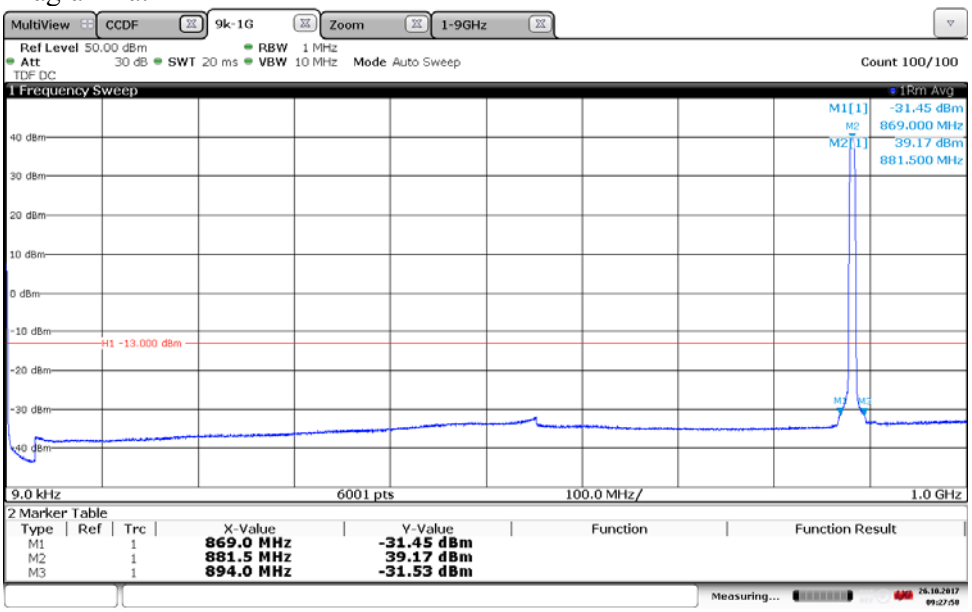


Diagram 4b:

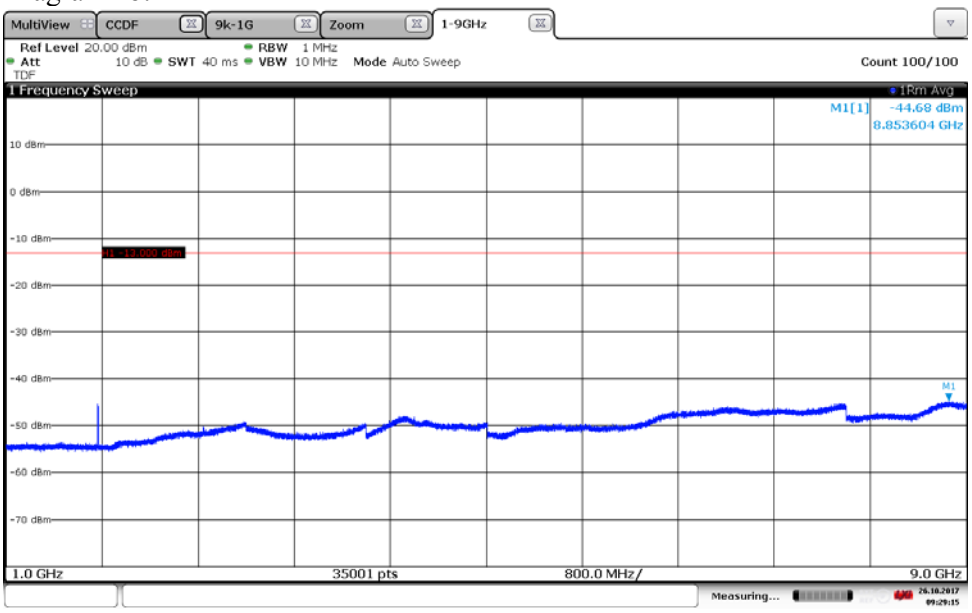


Diagram 5a:

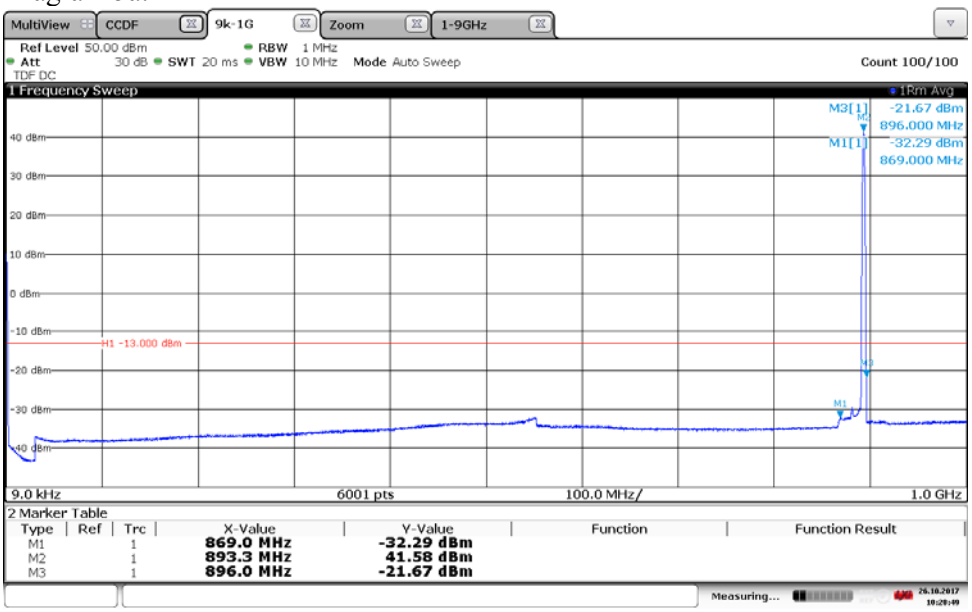


Diagram 5b:

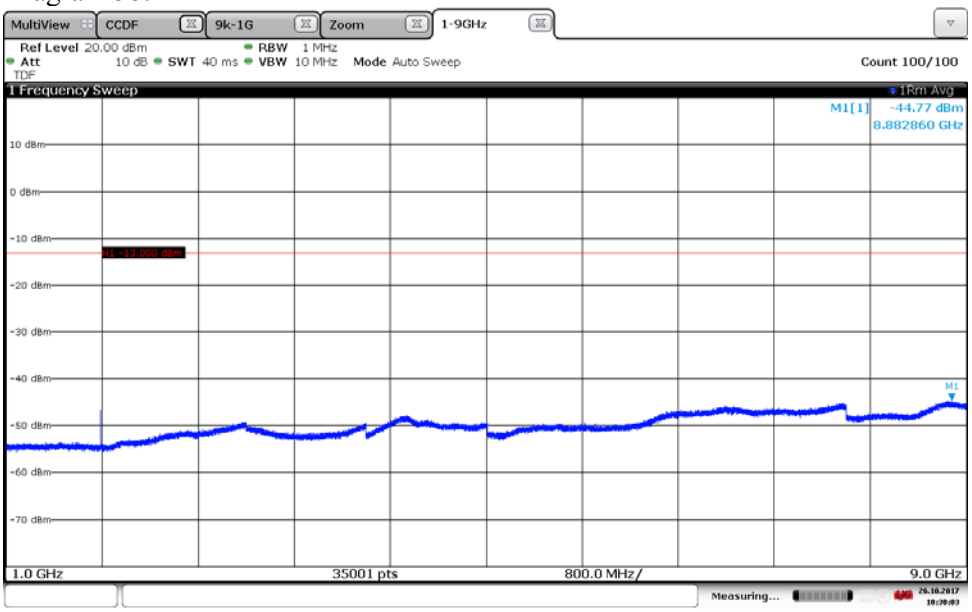


Diagram 6a:

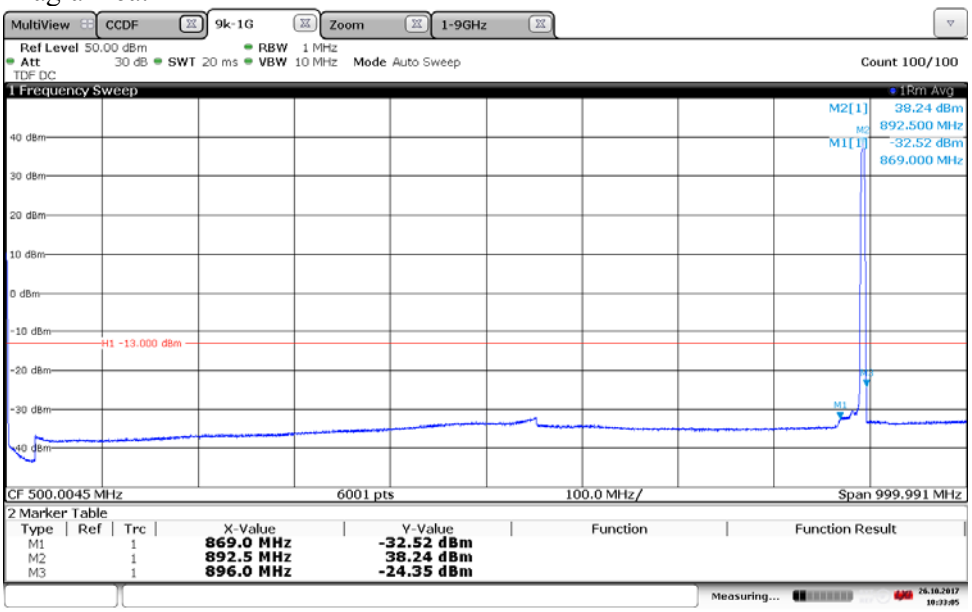


Diagram 6b:

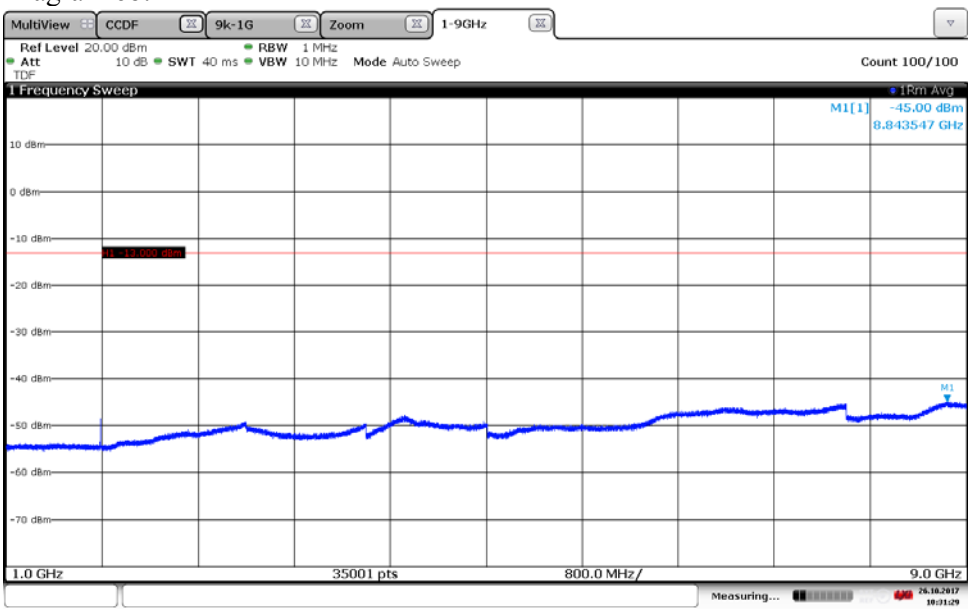


Diagram 7a:

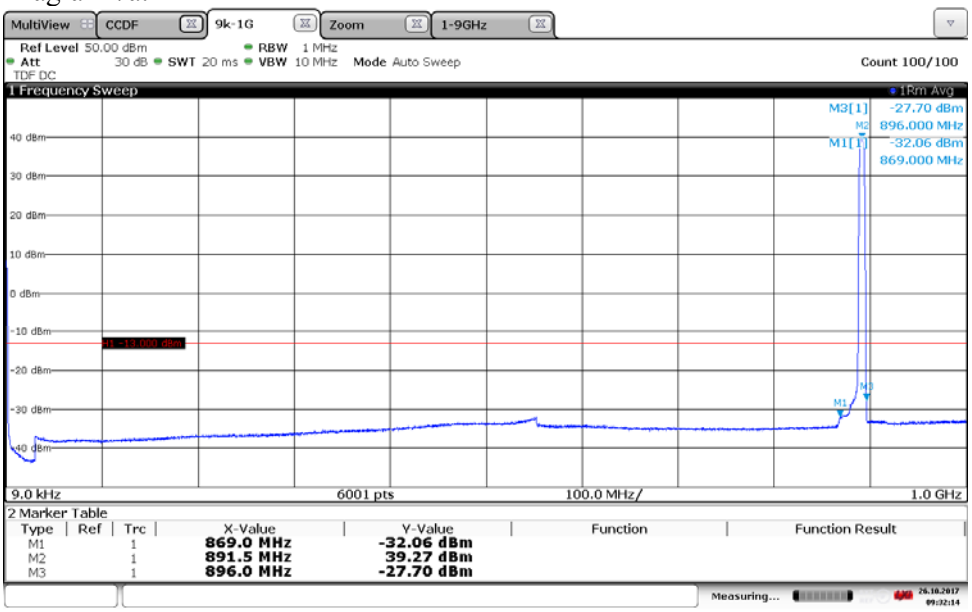


Diagram 7b:

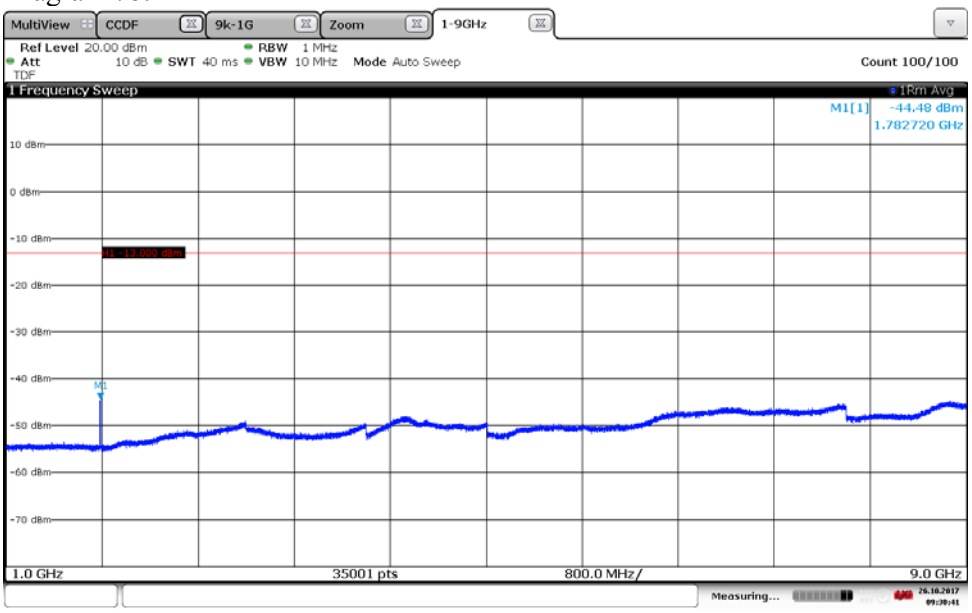


Diagram 8a:

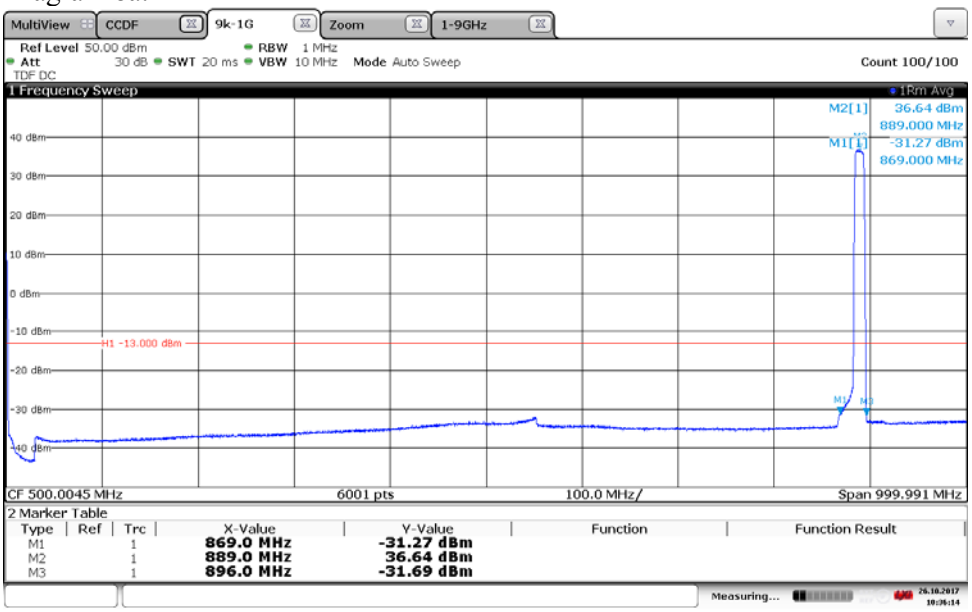


Diagram 8b:

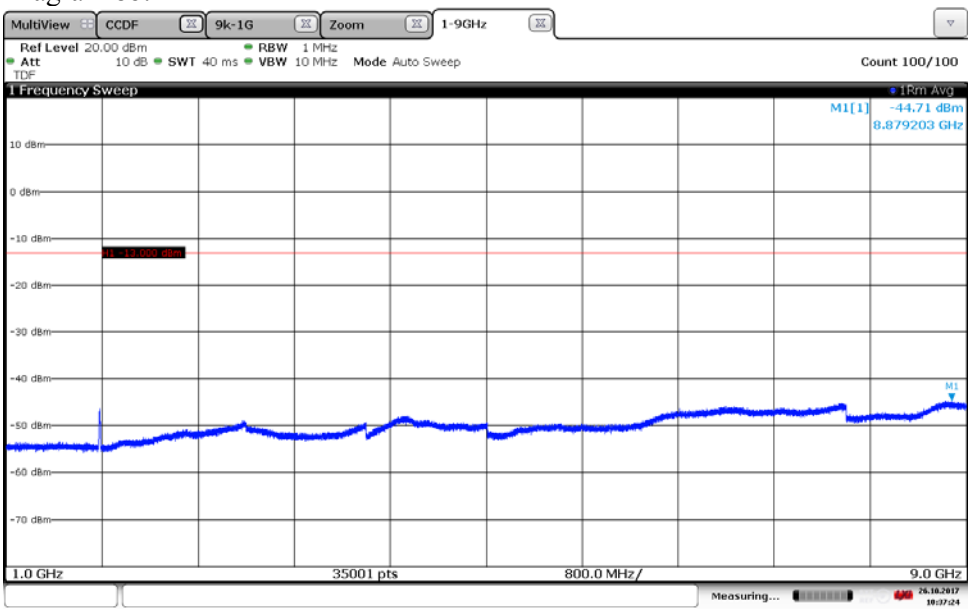


Diagram 9a:

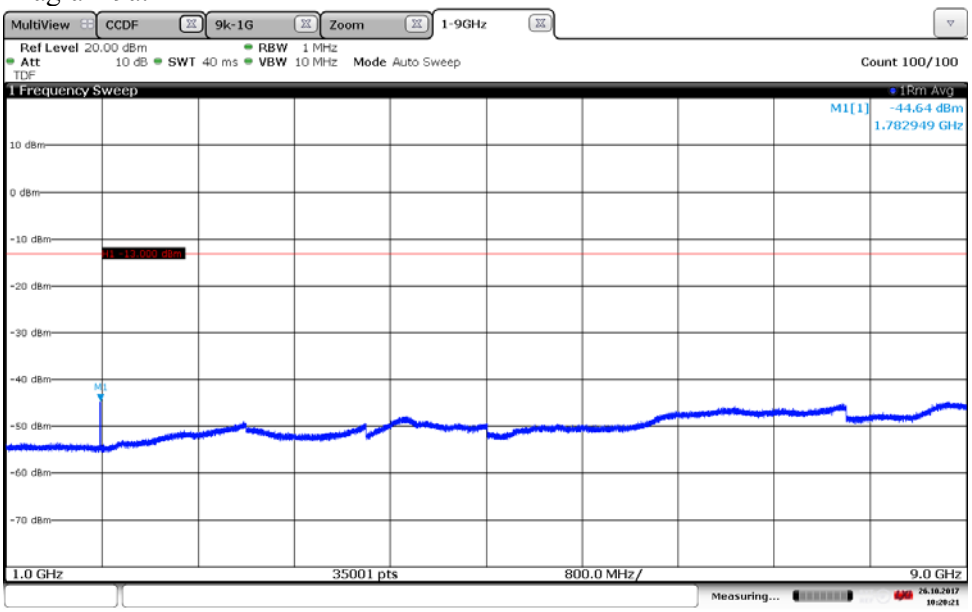


Diagram 9b:

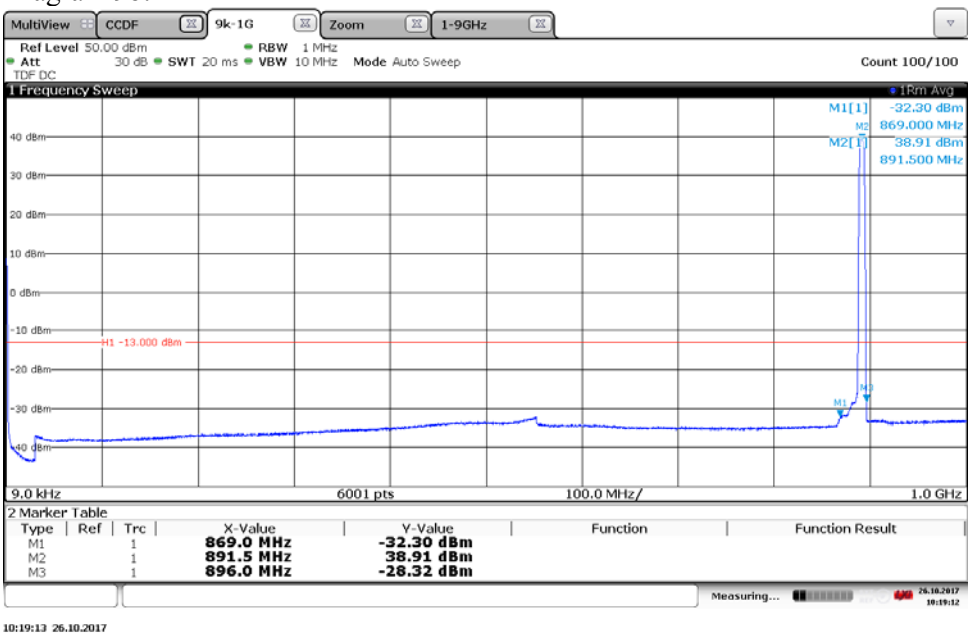
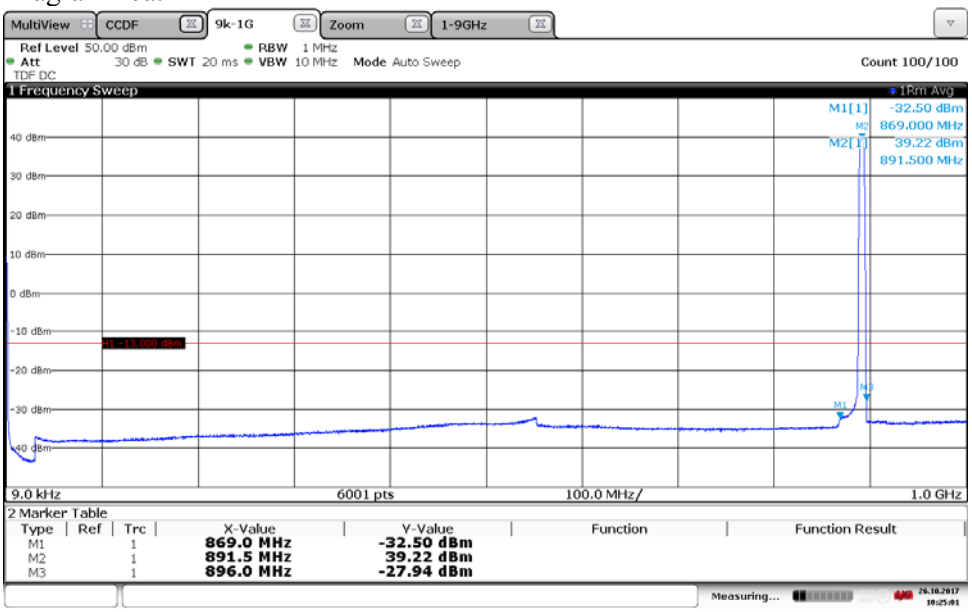
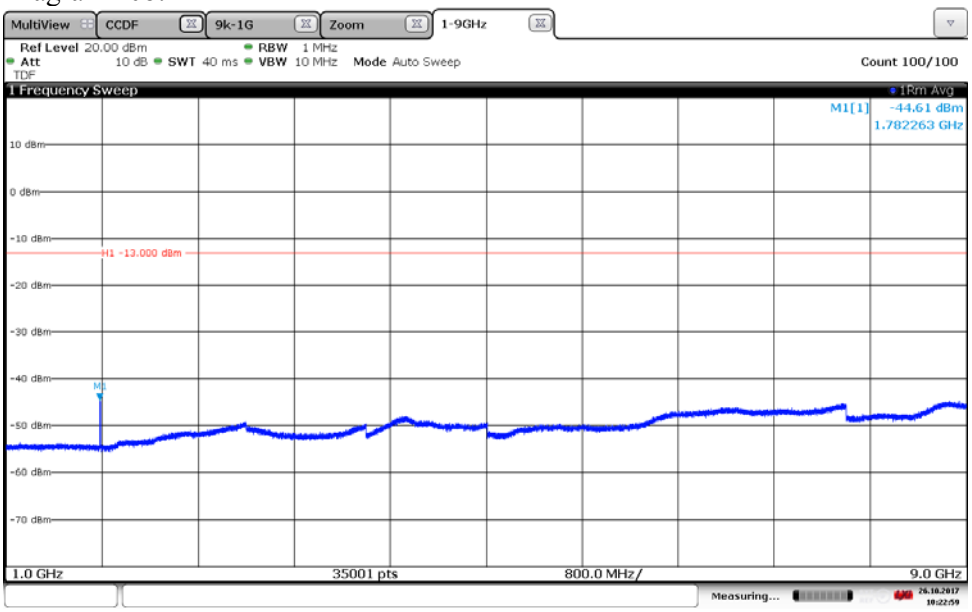


Diagram 10a:



10:25:02 26.10.2017

Diagram 10b:



10:22:59 26.10.2017

Diagram 11a:

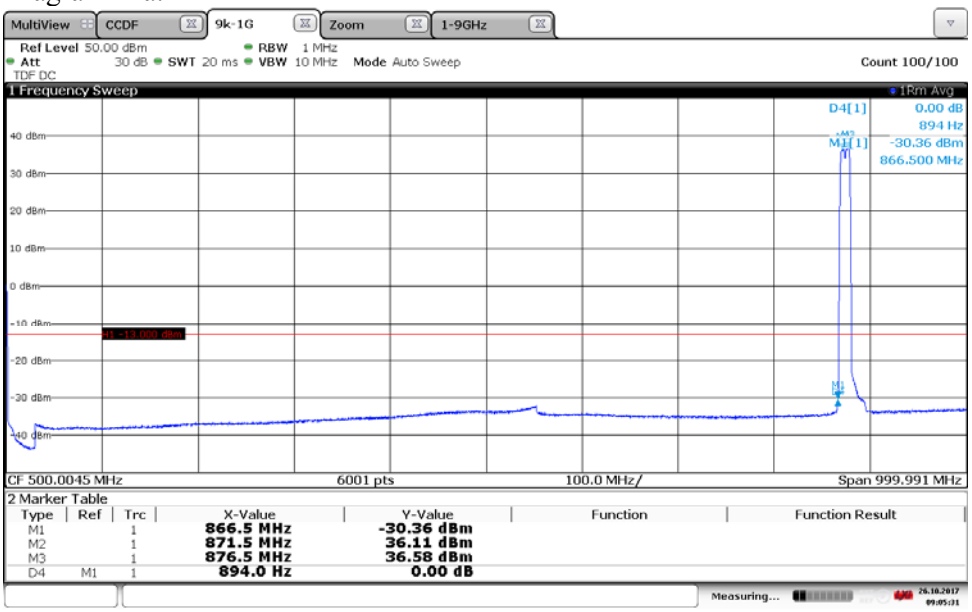
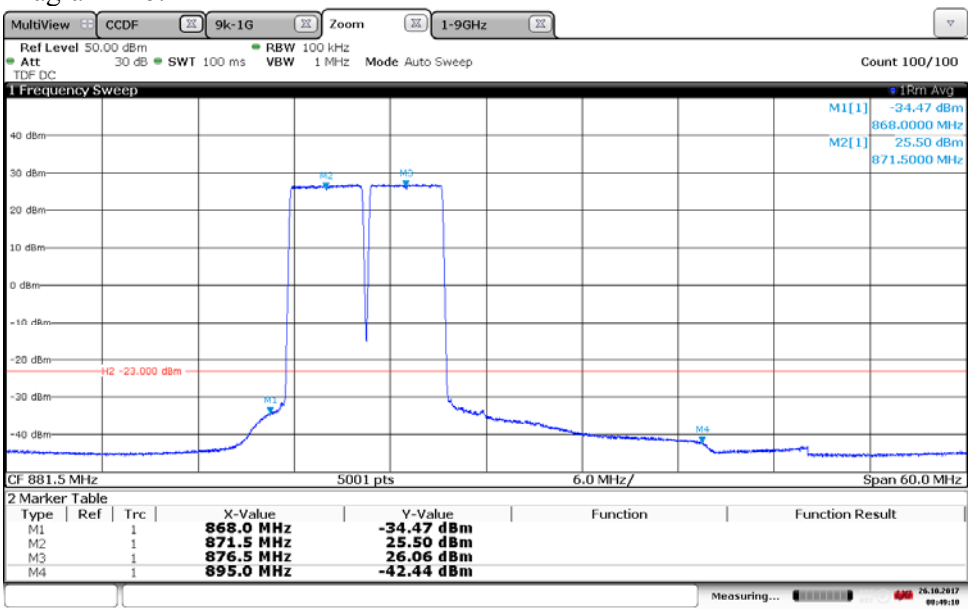


Diagram 11b:



Note: The limit in the diagram shall be -13 dBm instead of -23 dBm.

Diagram 11c:

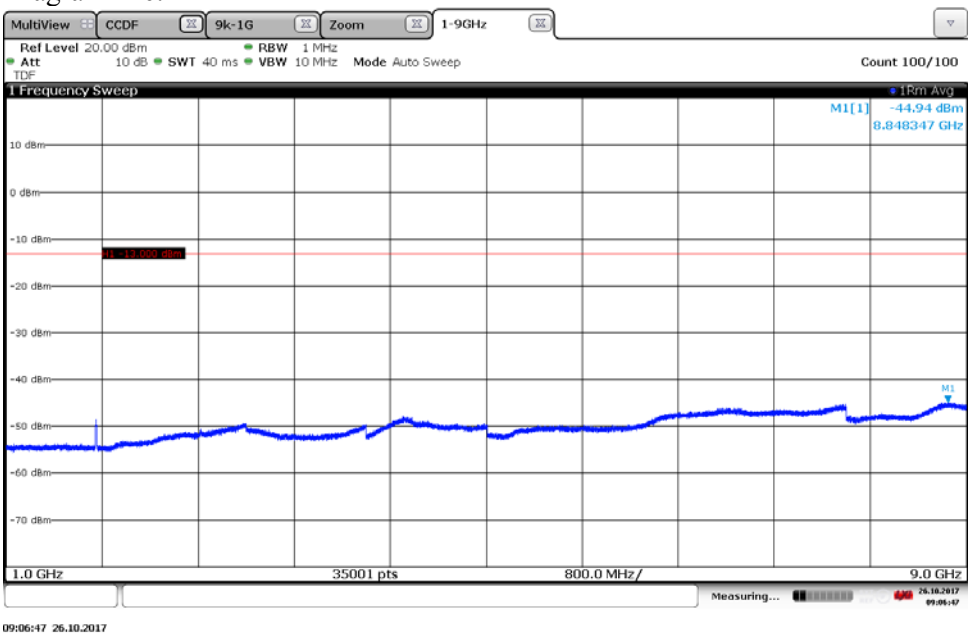

MultiView
CCDF
9k-1G
Zoom
1-9GHz
Ref Level 20.00 dBm
RBW 1 MHz
Att 10 dB SWT 40 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
TDF
1 Frequency Sweep
1Rm Avg
M1[1] -44.94 dBm
8.848347 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
1.0 GHz
35001 pts
800.0 MHz/
9.0 GHz
Measuring...
09:06:47 26.10.2017

Diagram 12a:

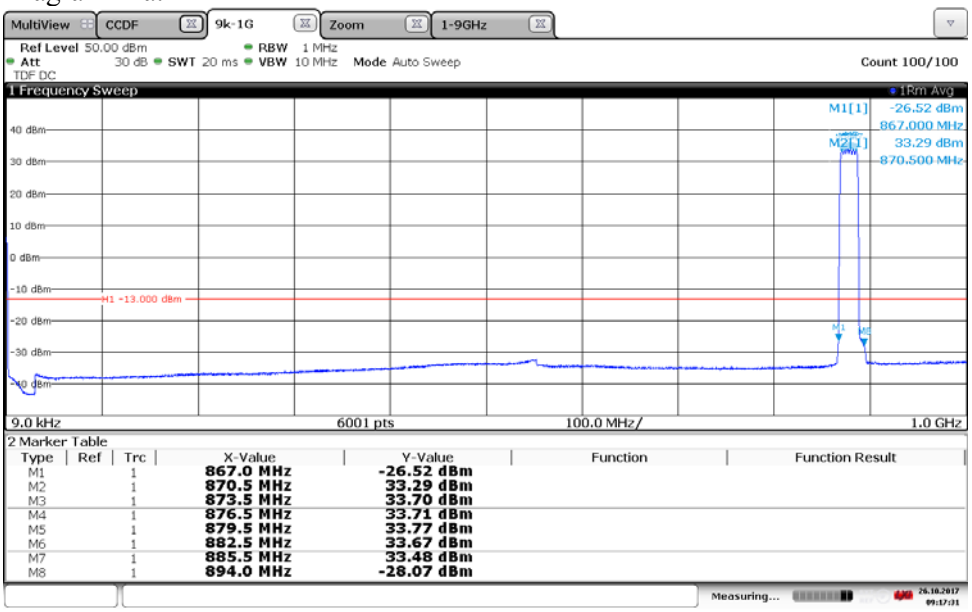
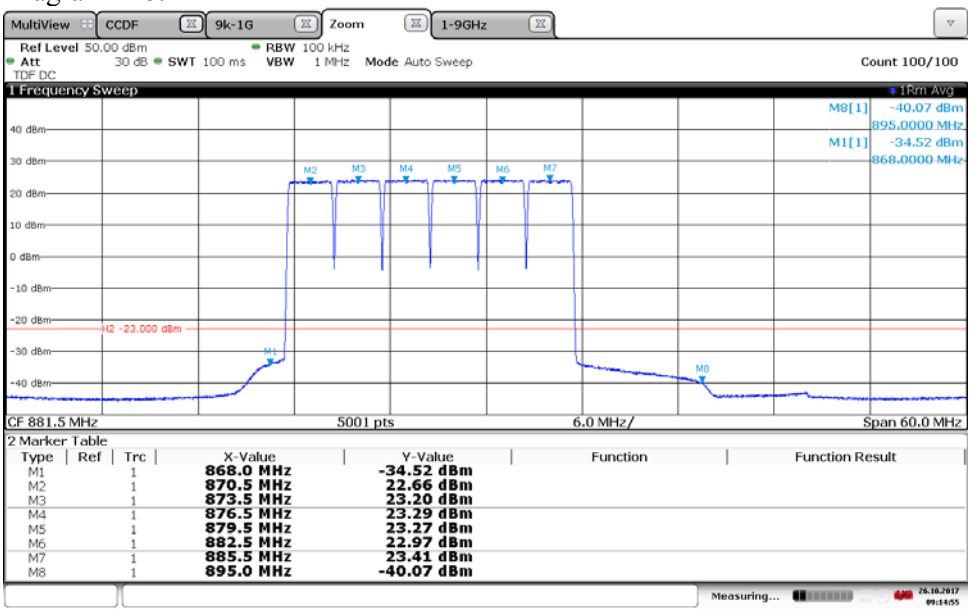


Diagram 12b:



Note: The limit in the diagram shall be -13 dBm instead of -23 dBm.

Diagram 12c:

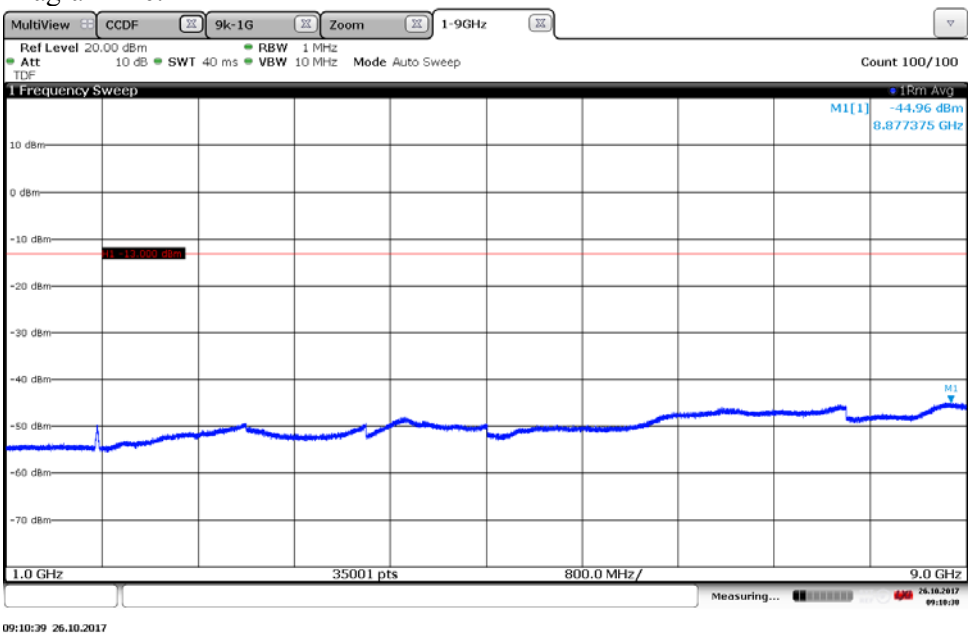
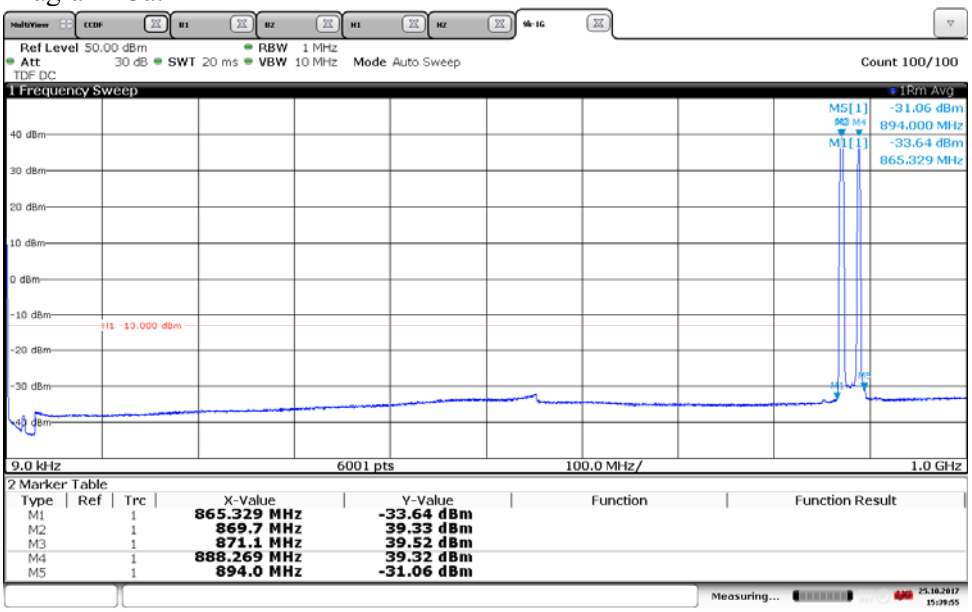
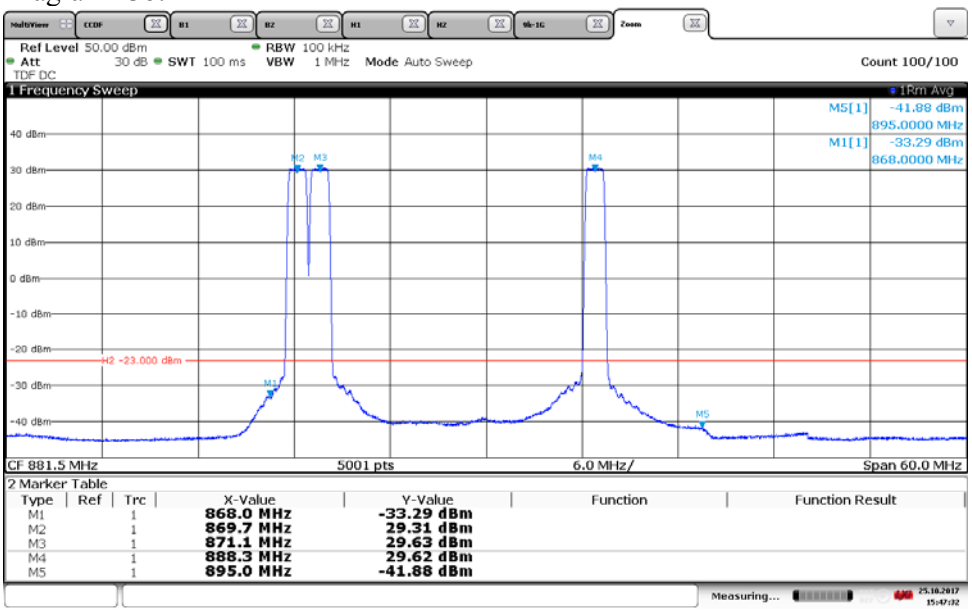

MultiView
CCDF
9k-1G
Zoom
1-9GHz
Ref Level 20.00 dBm
RBW 1 MHz
Att 10 dB SWT 40 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
TDF
1 Frequency Sweep
1Rm Avg
M1[1] -44.96 dBm
8.877375 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
1.0 GHz
35001 pts
800.0 MHz/
9.0 GHz
Measuring...
09:10:39 26.10.2017

Diagram 13a:



15:39:55 25.10.2017

Diagram 13b:



15:47:33 25.10.2017

Note: The limit in the diagram shall be -13 dBm instead of -23 dBm.

Diagram 13c:

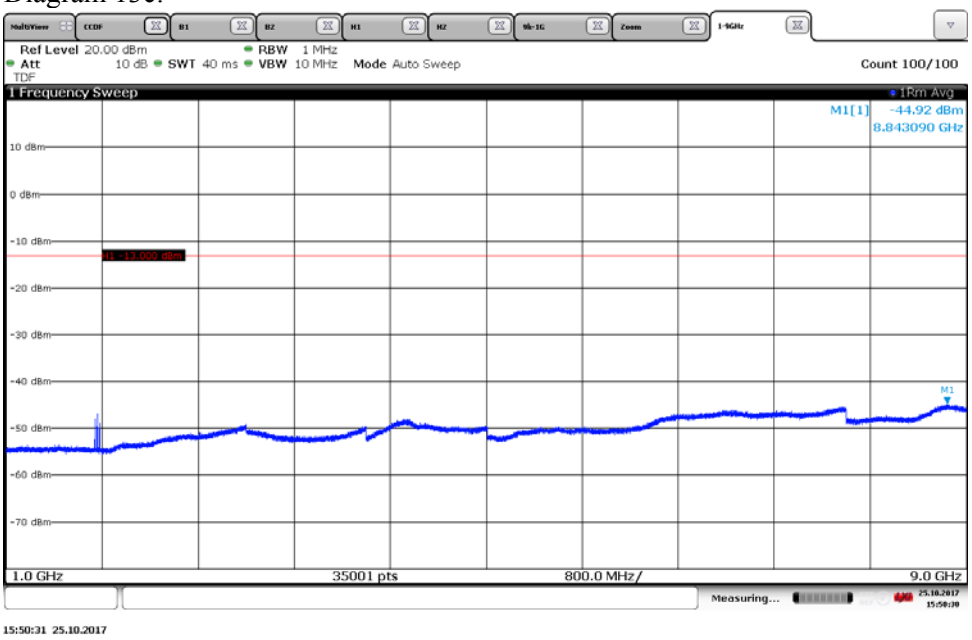

Ref Level 20.00 dBm
RBW 1 MHz
Att 10 dB SWT 40 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -44.92 dBm
8.843090 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
1.0 GHz
35001 pts
800.0 MHz/
9.0 GHz
Measuring...
15:50:31 25.10.2017

Diagram 14a:

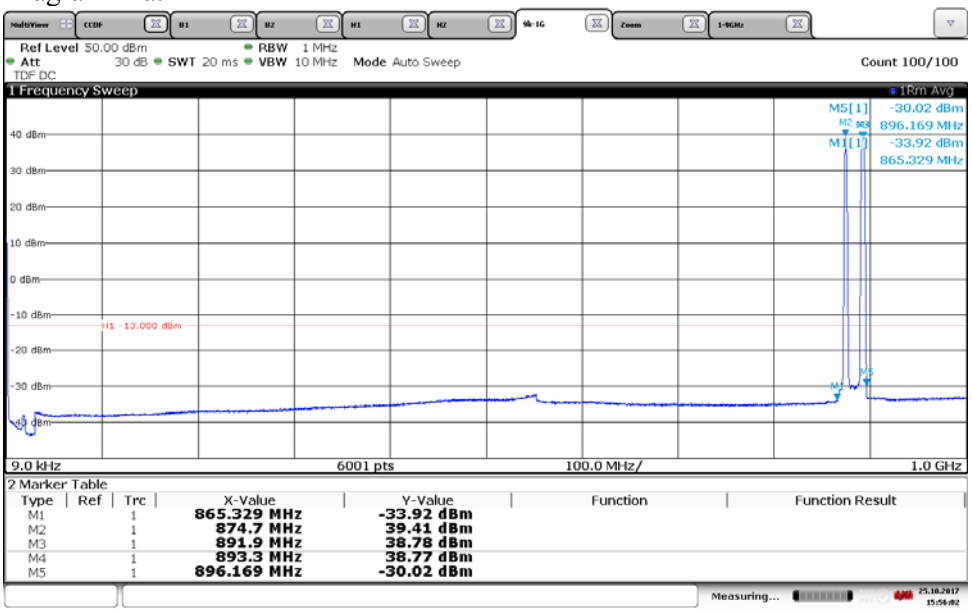
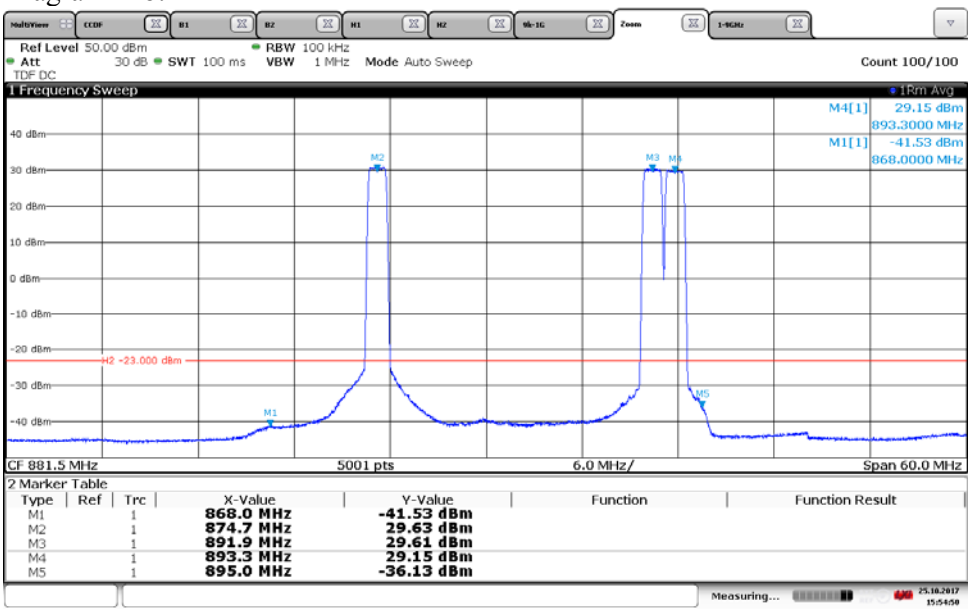


Diagram 14b:



Note: The limit in the diagram shall be -13 dBm instead of -23 dBm.

Diagram 14c:

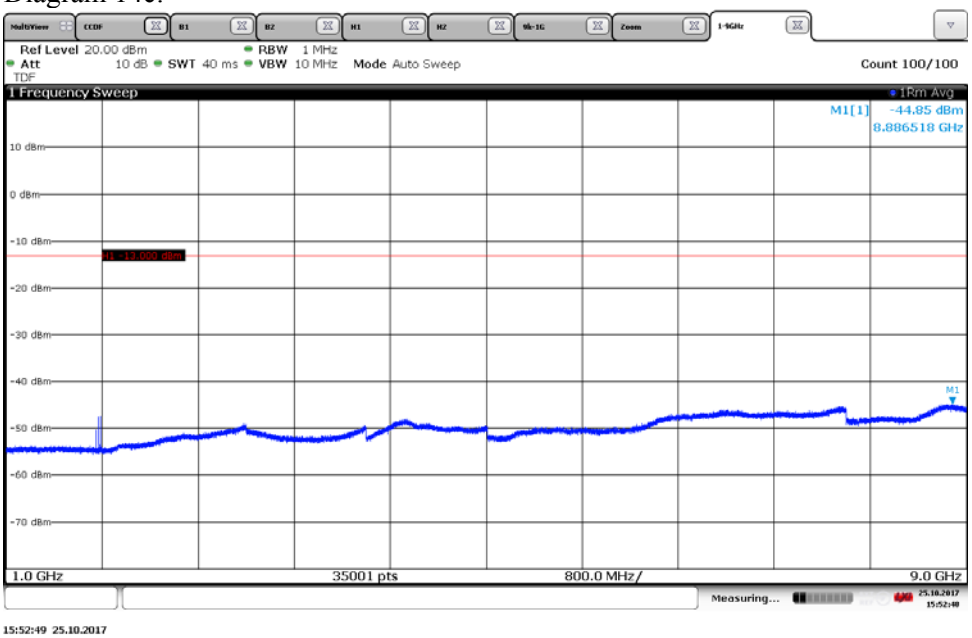

Ref Level 20.00 dBm
RBW 1 MHz
Att 10 dB SWT 40 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -44.85 dBm
8.886518 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
1.0 GHz
35001 pts
800.0 MHz/
9.0 GHz
Measuring...
15:52:49 25.10.2017

Diagram 15a:

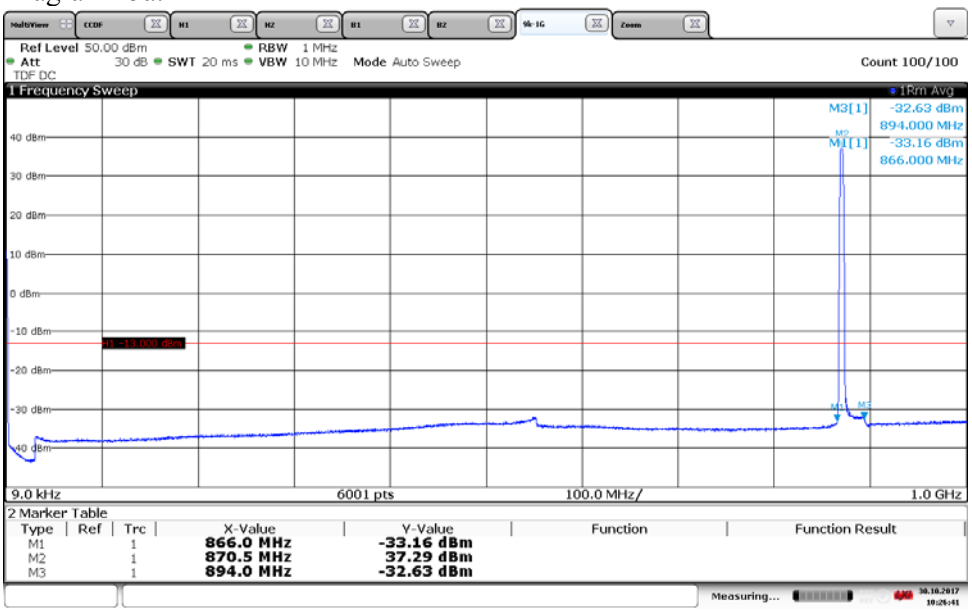
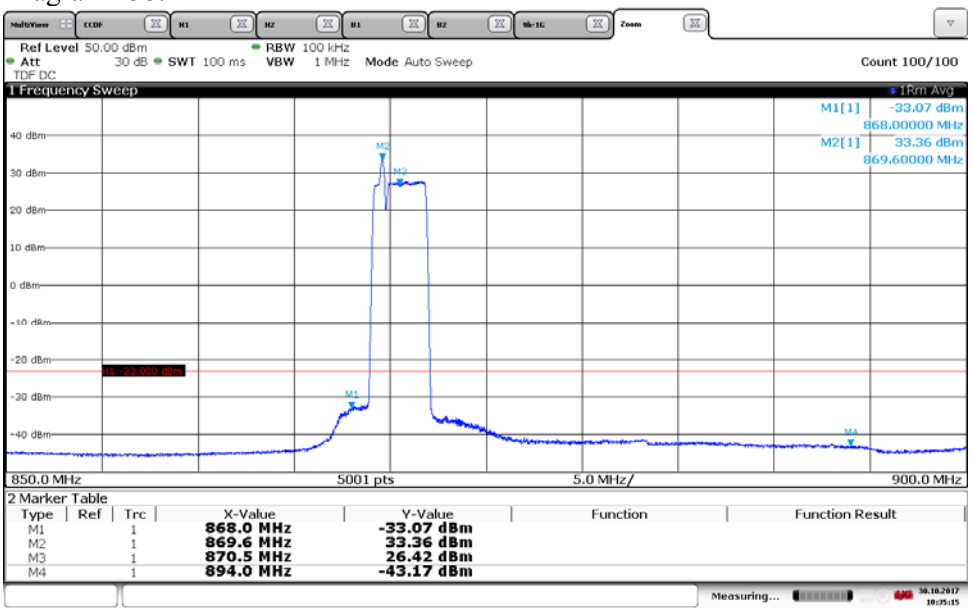


Diagram 15b:



Note: The limit in the diagram shall be -13 dBm instead of -23 dBm.

Diagram 15c:

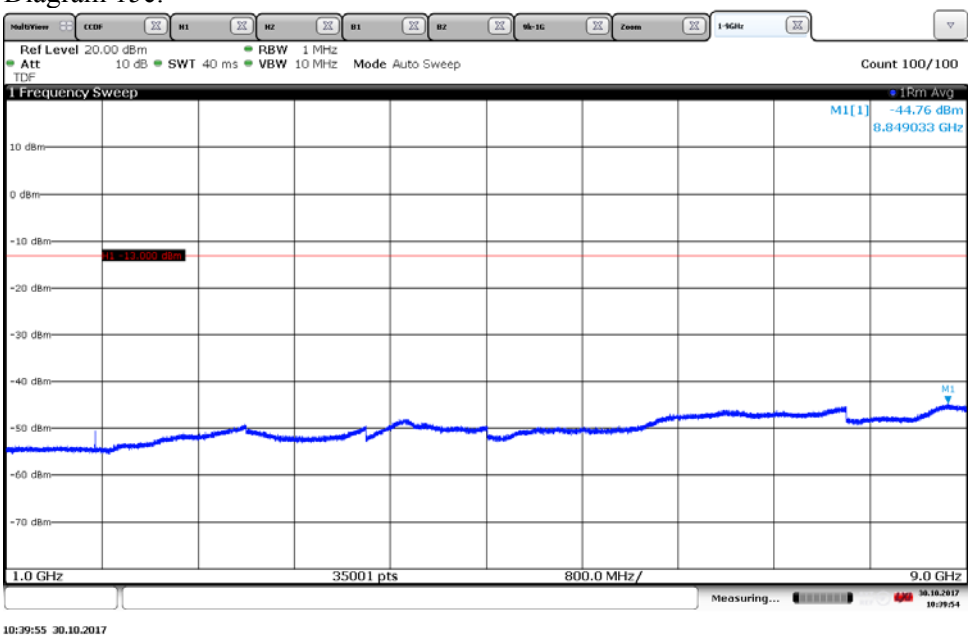

Ref Level 20.00 dBm
RBW 1 MHz
Att 10 dB SWT 40 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -44.76 dBm
8.849033 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
1.0 GHz
35001 pts
800.0 MHz/
9.0 GHz
Measuring...
10:39:55 30.10.2017

Diagram 16a:

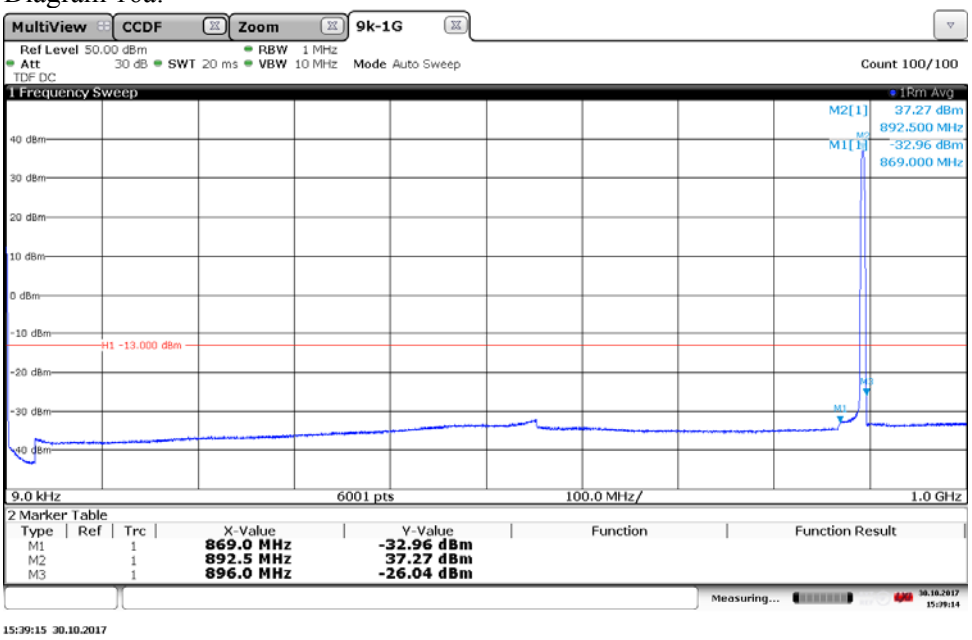
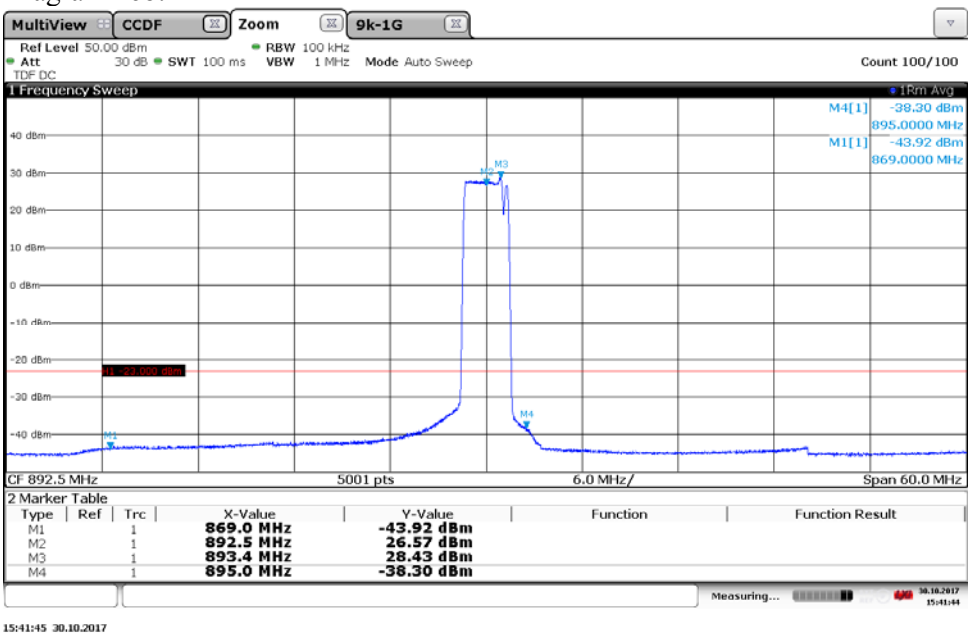


Diagram 16b:



Note: The limit in the diagram shall be -13 dBm instead of -23 dBm.

Diagram 16c:

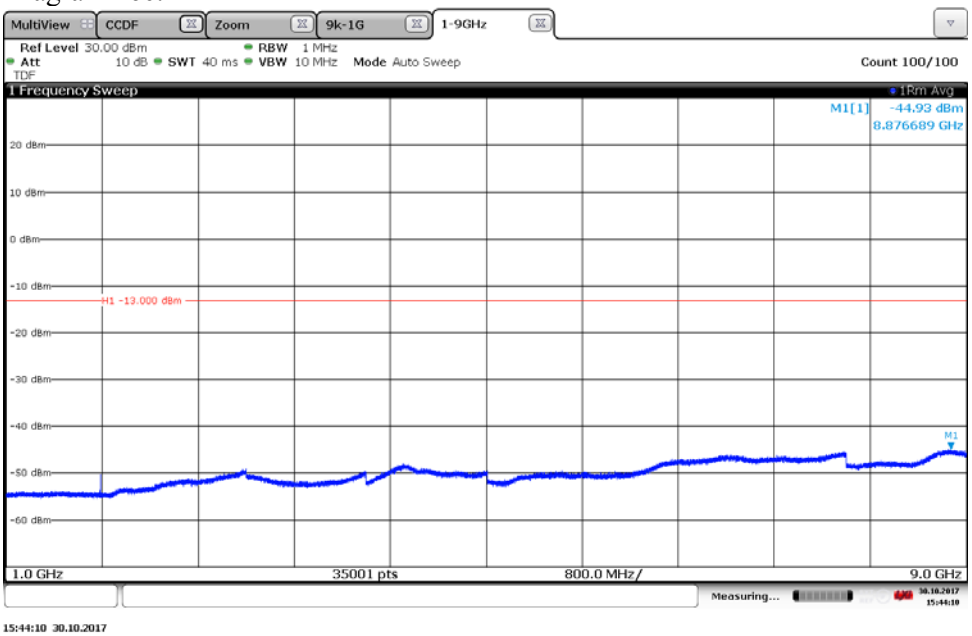

MultiView
CCDF
Zoom
9k-1G
1-9GHz
Ref Level 30.00 dBm
RBW 1 MHz
Att 10 dB SWT 40 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
TDF
1 Frequency Sweep
1Rm Avg
M1[1] -44.93 dBm
8.876689 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
H1 -13.000 dBm
M1
1.0 GHz
35001 pts
800.0 MHz/
9.0 GHz
Measuring...
15:44:10 30.10.2017

Diagram 17a:

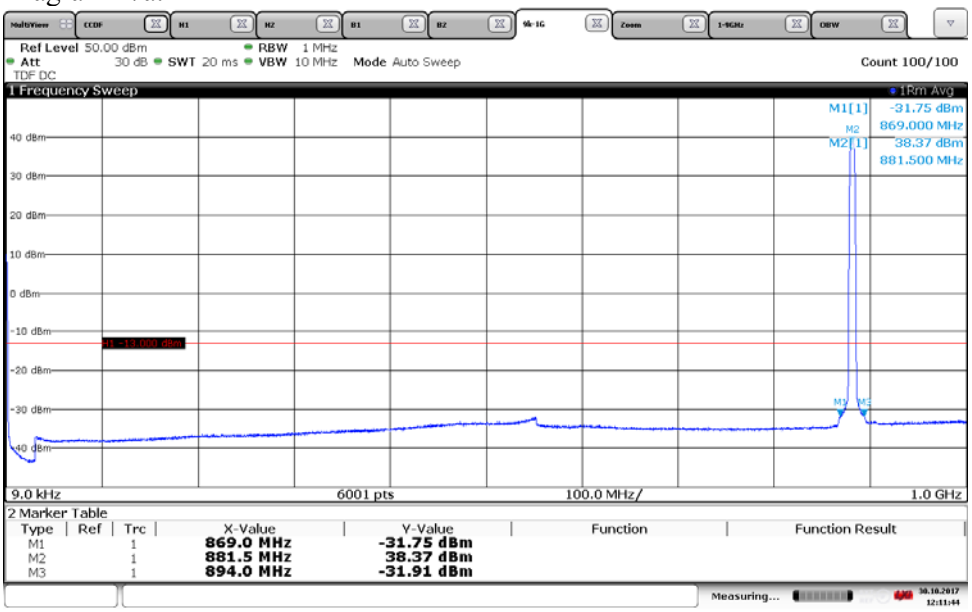
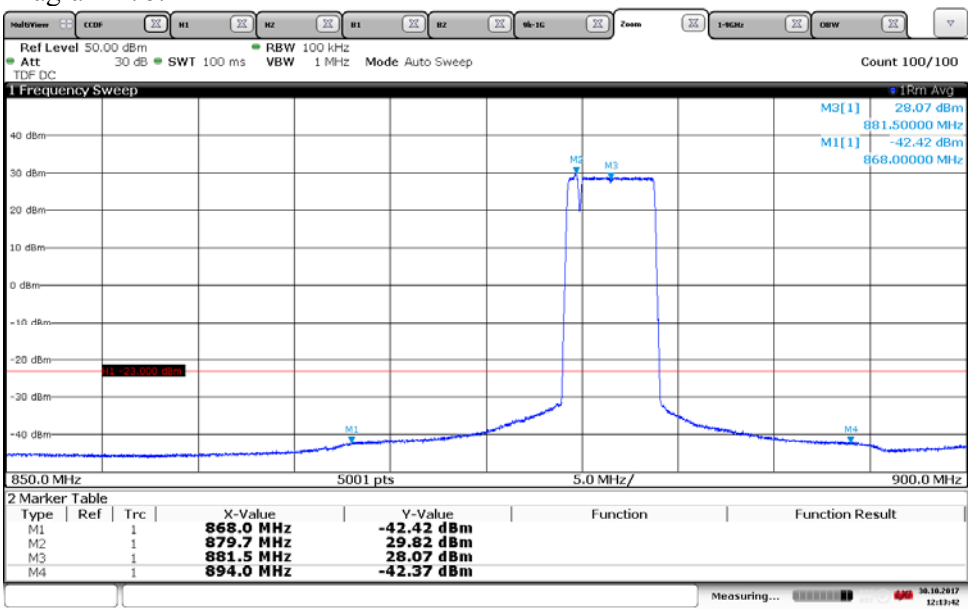
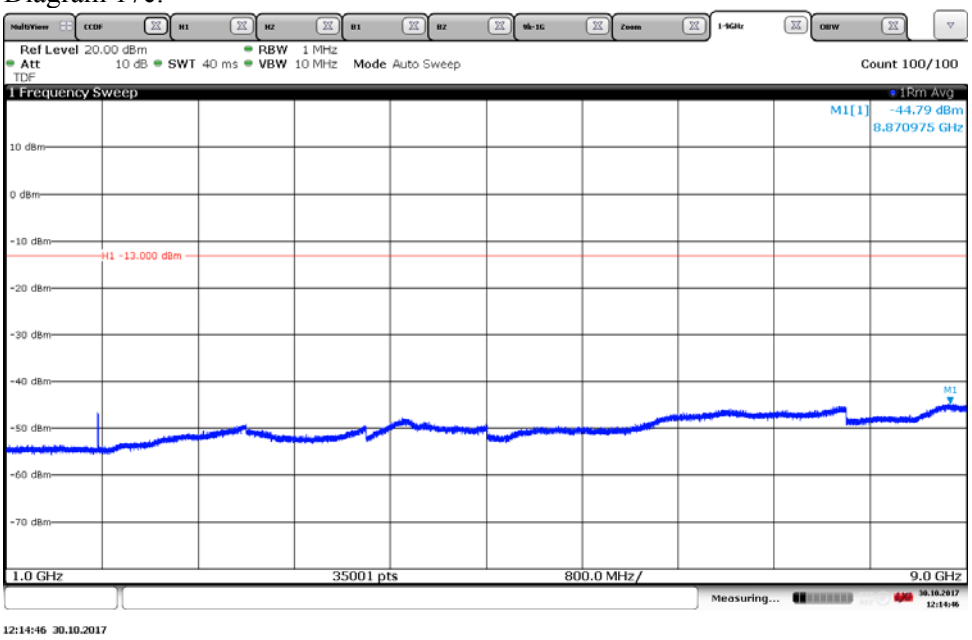


Diagram 17b:



Note: The limit in the diagram shall be -13 dBm instead of -23 dBm.

Diagram 17c:


Ref Level 20.00 dBm
RBW 1 MHz
Att 10 dB SWT 40 ms VBW 10 MHz Mode Auto Sweep
Count 100/100
1 Frequency Sweep
1Rm Avg
M1[1] -44.79 dBm
8.870975 GHz
10 dBm
0 dBm
-10 dBm
H1 -13.000 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
1.0 GHz
35001 pts
800.0 MHz/
9.0 GHz
Measuring...
12:14:46 30.10.2017

Field strength of spurious radiation measurements according to 47 CFR 2.1053 / IC RSS-133 5.5

Date	Temperature	Humidity
2017-10-18	22 °C ± 3 °C	42 % ± 5 %

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

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

The measurements were performed with both horizontal and vertical polarization of the antenna. The antenna distance was 3 m.

RF absorbers were covering a floor area in the frequency range 1 GHz – 9 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 – 9 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.

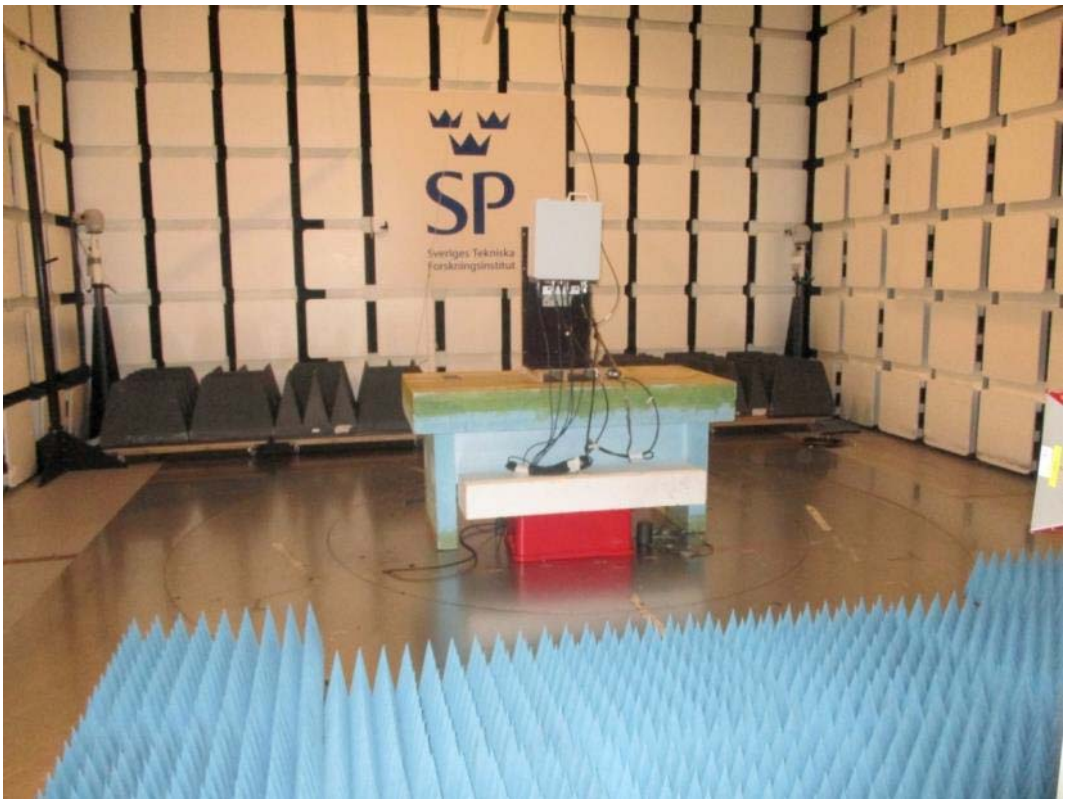
The measurement procedure was as the following:

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 and 1.5 m.
2. Spurious radiation on frequencies closer than 20 dB to the limit in the pre-measurement is scanned 0-360 degrees and the antenna is scanned 1- 4 m for maximum response. The emission is then measured with the RMS detector and the RMS value is reported. Frequencies closer than 10 dB to the limit when measured with the RMS detector were measured with the substitution method according to ANSI 63.26.

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

30-1000 MHz:

1-9 GHz:



Measurement equipment

Measurement equipment	RISE number
Semi anechoic chamber Tesla	503 881
R&S ESU 40	901 385
R&S software EMC32 version 10.20.01	BX62351
ETS Lindgren BiConiLog 3142E	BX61914
ETS Lindgren Horn Antenna 3115	502 175
µComp Nordic, Low Noise Amplifier	901 545
HP Filter 1-20 GHz	901 501
Temperature and humidity meter, Testo 625	504 188

Results

representing worst case:

Symbolic name M_5, TX mid frequency, BW 5 MHz, Diagram 1 a-b

Frequency (MHz)	Spurious emission level (dBm)	
	Vertical	Horizontal
30-9000	All emission > 20 dB below limit	All emission > 20 dB below limit

Measurement uncertainty: 3.1 dB

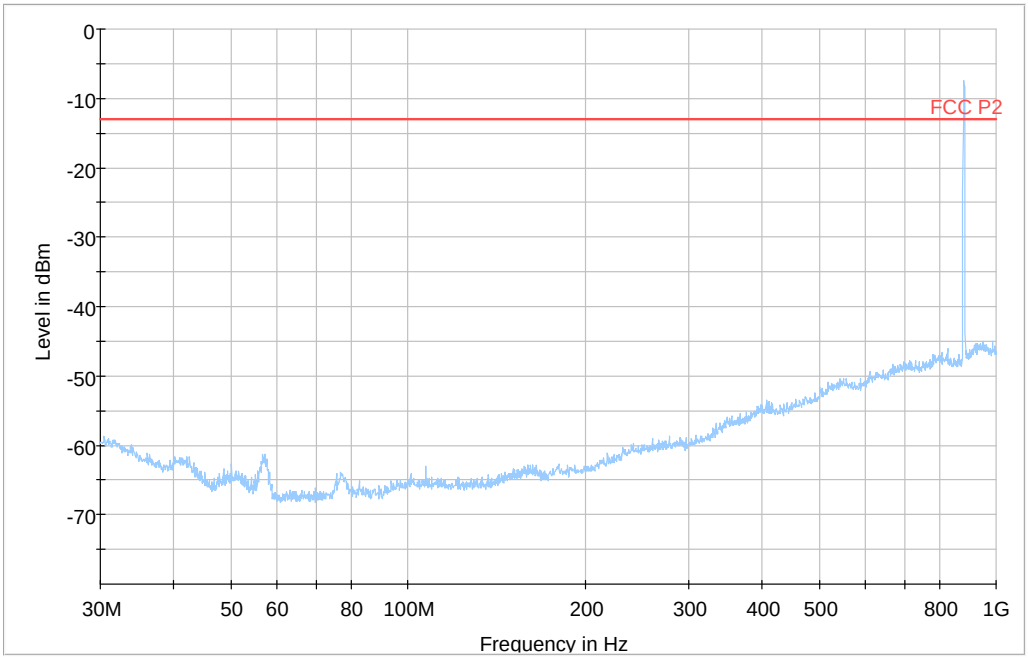
Limits

CFR 47 §22.917 and IC RSS-132 5.6

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.

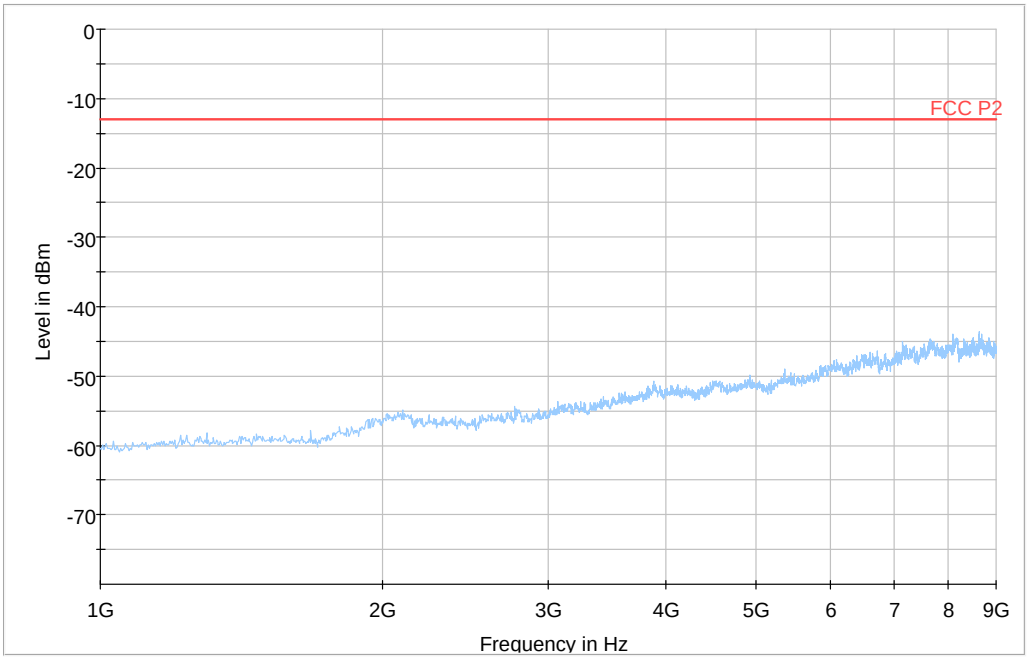
Complies?	Yes

Diagram 1a:



Note: The emission at 881.5 MHz is the carrier frequency and shall be ignored in the context.

Diagram 1b:



Frequency stability measurements according to CFR 47 §22.355 , 2.1055 / IC RSS 132 5.3

Date	Temperature (test equipment)	Humidity (test equipment)
2017-10-17	22 °C ± 3 °C	32 % ± 5 %
2017-10-18	22 °C ± 3 °C	39 % ± 5 %
2017-10-19	22 °C ± 3 °C	20 % ± 5 %
2017-10-26	22 °C ± 3 °C	28 % ± 5 %

Test set-up and procedure

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

Measurement equipment	RISE number
Rohde & Schwarz signal analyzer FSQ 40	504 143
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 881.5 MHz (M) 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	4
55.2	+20	3
48	+20	3
48	+30	4
48	+40	4
48	+50	5
48	+10	4
48	0	4
48	-10	4
48	-20	3
48	-30	4
Maximum freq. error (Hz)		5
Measurement uncertainty		$< \pm 1 \times 10^{-7}$

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

Limit according to:
3GPP TS 36.141:
The frequency error shall be within ± 0.05 PPM ± 12 Hz (± 44.075Hz).

§22.355
The frequency stability shall be within ± 1.5 ppm (± 1322.25 Hz).

RSS-132 5.3 Frequency:
The carrier frequency shall not depart from the reference frequency in excess of ± 1.5 ppm (± 1322.25 Hz) for base stations when tested to the temperature and supply voltage variations specified in RSS-Gen.

Complies?	Yes

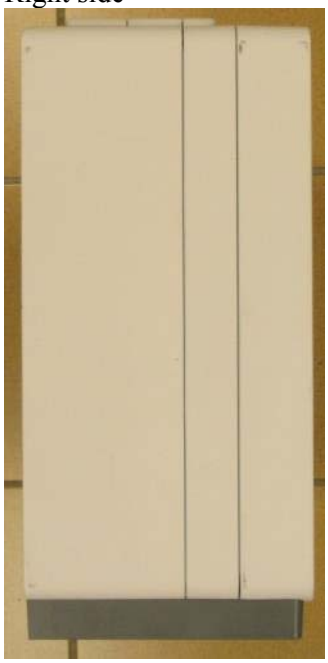
Photos of test object

Front side

Rear side

Left side

Right side



Bottom side

Top side

Labels:

Radiated measurements:

Test object label:

SFP module:

Conducted measurements:

Test object label:

SFP module: