REPORT

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The test site complies with RSS-Gen, IC file no. 3482A-1

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Reference
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Accred. No. 1002
Testing
ISO/IEC 17025

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Radio measurements on Radio 2219 B5 radio equipment with FCC ID TA8AKRC161678-1 and IC: 287AB-AS1616781

(8 appendices)

Test object

Product name: Radio 2219 B5
Product number: KRC 161 678/1

Summary

See appendix 1 for details.

Standard		Compliant	Appendix
FCC CFR 47 / IC RSS-132 ISSUE 3			
2.1046 / RSS-132 5.4	RF power output	Yes	2
2.1049 / RSS-Gen 4.6.1	Occupied bandwidth	Yes	3
2.1051 / RSS-132 5.5	Band edge	Yes	4
2.1051 / RSS-132 5.5	Spurious emission at antenna terminals	Yes	5
2.1053 / RSS-132 5.5	Field strength of spurious radiation	Yes	6
2.1055 / RSS-132 5.3	Frequency stability	Yes	7

SP Technical Research Institute of Sweden

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Description of the test object related to single RAT LTE mode

Equipment:	Radio equipment Radio 2219 B5. Product number KRC 161 678/1 FCC ID TA8AKRC161678-1 IC: 287AB-AS1616781
HVIN:	AS1616781
Hardware revision state:	R1A
Frequency range:	TX: 869 - 894 MHz RX: 824 - 849 MHz
IBW:	25 MHz, ≥5 MHz channel bandwidth 20 MHz, ≤3 MHz channel bandwidth
Output power:	Max 80 W/ carrier for channel bandwidth ≥5 MHz Max 20 W/ carrier for channel bandwidth ≤3 MHz Max 80 W/ carrier for channel bandwidth ≥5 MHz with NB IoT in-band operation. Power dynamic range of the NB IoT carrier is +6 dB Max output power 80 W/ antenna port
Antenna ports:	2 TX/RX ports
RF configurations:	Single and multi carrier, 1-4 carriers/ port (2x 10 MHz, 1x 15 MHz) TX Diversity, 2x2 MIMO, 4x4 MIMO[1] and NB IoT in-band operation, Contiguous Spectrum (CS), Non-Contiguous Spectrum (NCS) and Carrier Aggregation (CA) intra-band and inter-band[2] supported
RF power Tolerance:	+0.6/ - 2.0 dB
CPRI Speed	9.8 Gbit/s
Channel bandwidths:	1.4 MHz, 3 MHz, 5 MHz, 10 MHz and 15 MHz NB IoT in-band: (channel bandwidth ≥3 MHz): 1 Resource Block (RB)
Modulations:	LTE: QPSK, 16QAM, 64QAM and 256QAM NB-IoT: QPSK
Nominal power voltage:	-48VDC

[1] 4x4 MIMO requires an additional unit.
[2] Carrier Aggregation (CA) inter-band requires an additional unit operating on the other band.

The information above is supplied by the manufacturer.

Operation mode during measurements

Measurements were performed with the test object transmitting test models as defined in 3GPP TS 36.141. 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 test model E-TM3.1A to represent 256QAM modulation. For NB-IoT test model N-TM was used as defined in TS 36.141.

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.

Purpose of test

The purpose of the tests is to verify compliance to the performance characteristics specified in applicable items of FCC CFR 47 and Industry Canada RSS-132 and RSS-Gen. Test scope limited to single RAT LTE mode

References

Measurements were done according to relevant parts of the following standards:
ANSI 63.4-2014
ANSI/TIA/EIA-603-D-2010
CFR 47 part 2, April, 2017
CFR 47 part 22, April, 2017
KDB 662911 D01 Multiple Transmitter Output v02r02
KDB 971168 D01 Power Meas License Digital Systems v02r02
KDB 971168 D03 IM Emission Repeater Amp v01
RSS-Gen Issue 4
RSS-132 Issue 3
3GPP TS 36.141 V13.6.0
3GPP TS 37.141 V13.5.0

Appendix 1

Test frequencies used for conducted and radiated measurements

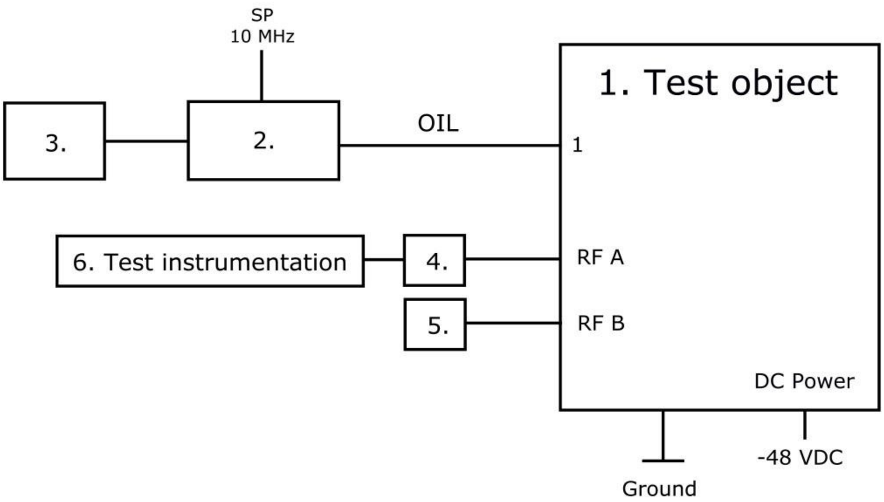
TX test frequencies:

EARFCN Downlink	Frequency [MHz]	Symbolic name	Comment
2407	869.7	$B_{L1.4}$	TX bottom frequency in 1.4 MHz BW configuration
2415	870.5	B_{L3}	TX bottom frequency in 3 MHz BW configuration
2425	871.5	B_{L5}	TX bottom frequency in 5 MHz BW configuration
2425	871.5	B_{L5+IoT}	TX bottom frequency in 5 MHz BW configuration with NB IoT in-band operation at resours block 2 (RB 2) in LTE carrier
2450	874.0	B_{L10}	TX bottom frequency in 10 MHz BW configuration
2475	876.5	B_{L15}	TX bottom frequency in 15 MHz BW configuration
2407 2421 2593	869.7 871.1 888.3	$BIM_{L1.4}$	3 carrier TX 1.4 MHz BW bottom constellation according to KDB 971168 D03
2425 2475 2625	871.5 876.5 891.5	BIM_{L5}	3 carrier TX 5 MHz BW bottom constellation according to KDB 971168 D03
2525	881.5	$M_{L1.4}$	TX mid frequency in 1.4 MHz BW configuration
2525	881.5	M_{L3}	TX mid frequency in 3 MHz BW configuration
2525	881.5	M_{L5}	TX mid frequency in 5 MHz BW configuration
2525	881.5	M_{L10}	TX mid frequency in 10 MHz BW configuration
2525	881.5	M_{L15}	TX mid frequency in 15 MHz BW configuration
2525	881.5	M_{L5+IoT}	TX mid frequency in 5 MHz BW configuration with NB IoT in-band operation at resours block 2 (RB 2) in LTE carrier
2475 2550	876.5 884.0	$M2_{L5+L10}$	2 carrier aggregation TX mid constellation 5 MHz and 10MHz BW configuration
2475 2575	876.5 886.5	$M2_{L10+L10}$	2 carrier aggregation TX mid constellation 10MHz BW configuration
2500 2550	879.0 884.0	$M2_{L5}$	2 carrier TX mid constellation 5 MHz BW configuration
2450 2500 2550 2600	874.0 879.0 884.0 889.0	$M4_{L5CON}$	4 carrier TX mid constellation 5 MHz BW configuration
2440 2470 2580 2610	871.5 876.5 886.5 891.5	$M4_{L5RAD}$	4 carrier TX 5 MHz BW mid constellation
2643	893.3	$T_{L1.4}$	TX top frequency in 1.4 MHz BW configuration
2635	892.5	T_{L3}	TX top frequency in 3 MHz BW configuration
2625	891.5	T_{L5}	TX top frequency in 5 MHz BW configuration
2600	889.0	T_{L10}	TX top frequency in 10 MHz BW configuration
2575	886.5	T_{L15}	TX top frequency in 15 MHz BW configuration
2425 2575 2625	871.5 886.5 891.5	TIM_{L5}	3 carrier TX 5 MHz BW top constellation according to KDB 971168 D03

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

Appendix 1

Test setup: Conducted measurements



Test object:

1.	Radio 2219 B5, KRC 161 678/1, rev. R1A, s/n: D825138266 With Radio Software: CXP 901 7316/2, rev. R64HS. FCC ID TA8AKRC161678-1 and IC: 287AB-AS1616781

Associated equipment:

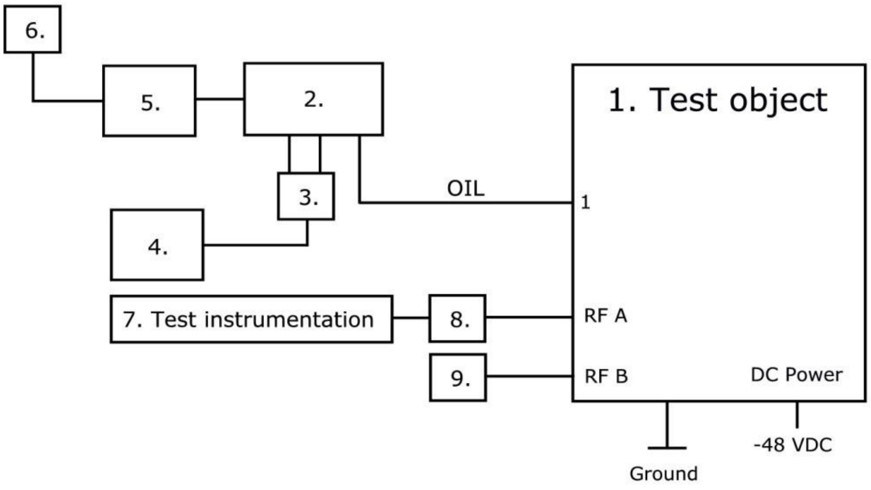
2.	Testing Equipment: CT10, LPC 102 487/1, rev. R1C, s/n: T01F265031, BAMS – 1000797753 with software CXA 104 446/1, rev. R8U

Functional test equipment:

3.	HP EliteBook 8560w, BAMS – 1001236850
4.	RF Attenuator: SP number: 902 282
5.	Terminator, 50 ohm
6.	SP Test Instrumentation according to measurement equipment list for each test. The signal analyzer was connected to the SP 10 MHz reference standard during all measurements.

Appendix 1

Test setup: Conducted measurements with IoT



Test object:

1.	Radio 2219 B5, KRC 161 678/1, rev. R1A, s/n: D825138266 With Radio Software: CXP 901 7316/2, rev. R64HS. FCC ID TA8AKRC161678-1 and IC: 287AB-AS1616781

Associated equipment:

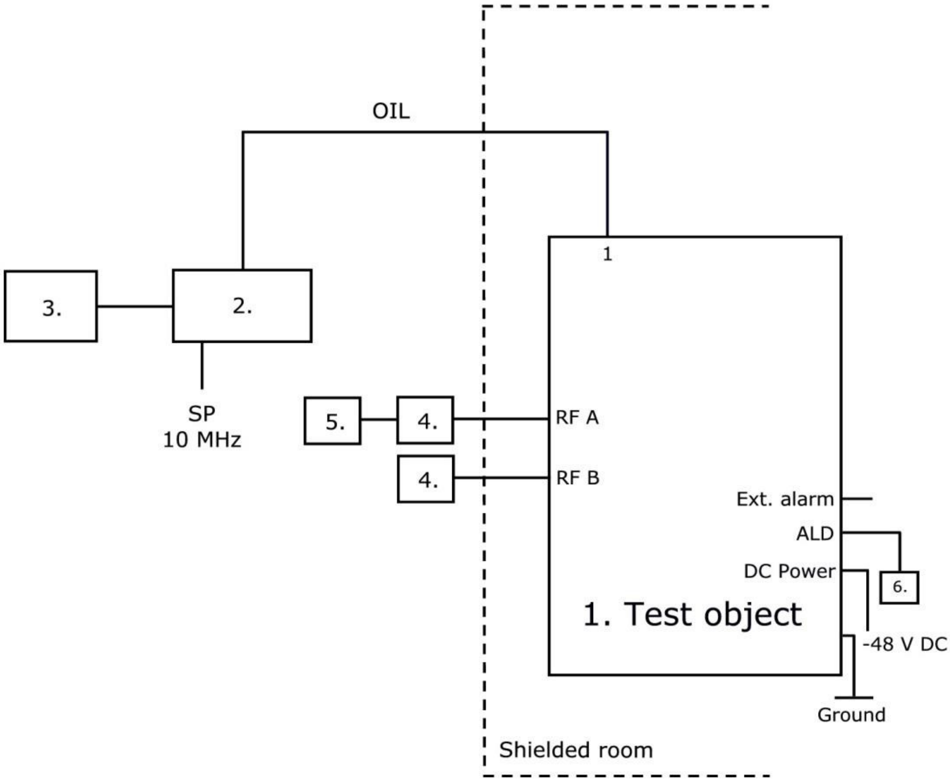
2.	RBS 6601 Main Unit: SUP 6601, 1/BFL 901 009/4, rev. R1E, s/n: BR82691785 DUS 41 01, KDU 137 624/1, rev. R5A/A, s/n: D169766593 With software: CXP 102 051/26, rev: R23NC
3.	Switch Netgear GS108E
4.	Computer, HP EliteBook 8560w, BAMS - 1001236850
5.	Sync Box, LPC 107 043/1 s/n: A402704701
6.	GPS Active Antenna, KRE 101 2082/1

Functional test equipment:

7.	SP Test Instrumentation according to measurement equipment list for each test. The signal analyzer was connected to the SP 10 MHz reference standard during all measurements.
8.	RF Attenuator: SP number: 902 282
9.	Terminator

Appendix 1

Test setup: Radiated measurements



Test object:

1.	Radio 2219 B5, KRC 161 678/1, rev. R1A, s/n: D825138266 With Radio Software: CXP 901 7316/2, rev. R64HS. FCC ID TA8AKRC161678-1 and IC: 287AB-AS1616781

Associated equipment:

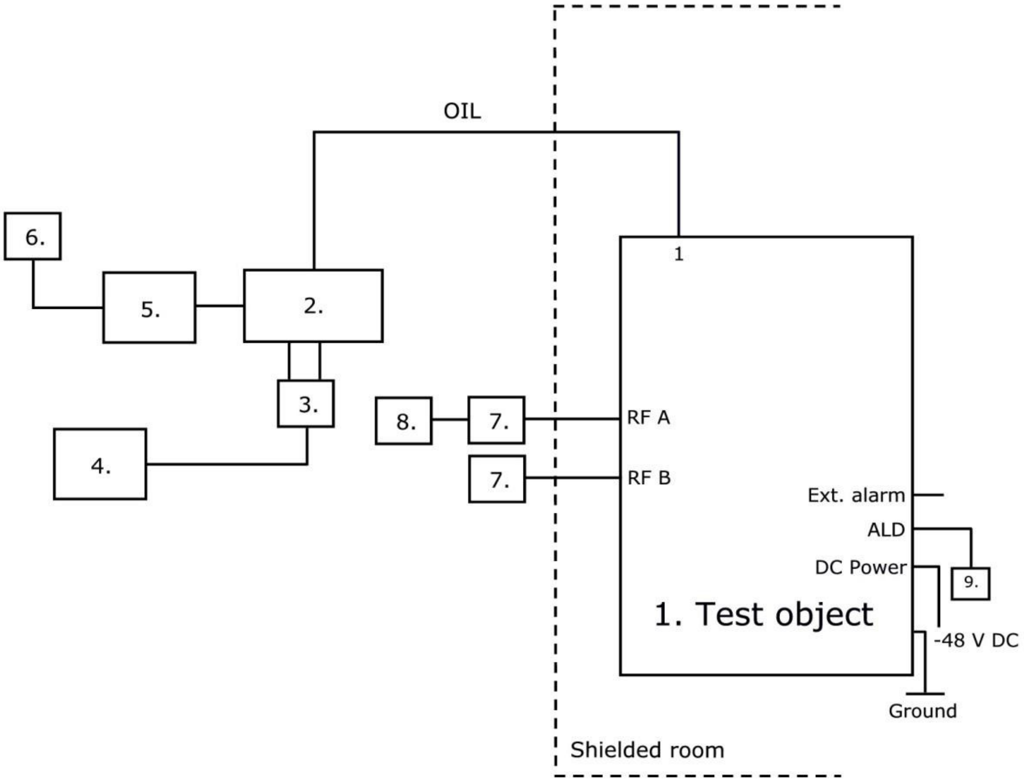
2.	Testing Equipment: CT10, LPC 102 467/1, rev. R1C, s/n: T01F375047, BAMS – 1001466801 with software CXA 104 446/1, rev. R8U

Functional test equipment:

3.	HP EliteBook 8560w, BAMS – 1001236850
4.	Attenuator/ Terminator
5.	R&S ESIB 26, SP no: 503 292, for supervision purpose only

Appendix 1

Test setup: Radiated measurements with IoT



Test object:

1.	Radio 2219 B5, KRC 161 678/1, rev. R1A, s/n: D825138266 With Radio Software: CXP 901 7316/2, rev. R64HS. FCC ID TA8AKRC161678-1 and IC: 287AB-AS1616781

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. R5A/A, s/n: D169766593 With software: CXP 102 051/26, rev: R23NC
3.	Switch Netgear GS108E
4.	Computer, HP EliteBook 8560w, BAMS - 1001236850
5.	Sync Box, LPC 107 043/1 s/n: A402704701
6.	GPS Active Antenna, KRE 101 2082/1
9.	Remote Control Unit, KRY 121 68/1, s/n: CSE0850824

Functional test equipment:

7.	Attenuator/ Terminator
8.	R&S ESIB 26, SP number: 503 292, for supervision purpose only

Appendix 1

Interfaces:	Type of port:
Power: -48VDC	DC Power
RF port A, 4.3-10 connector, combined TX/RX	Antenna
RF port B, 4.3-10 connector, combined TX/RX	Antenna
1, optical interface	Signal
2, optical interface, not used in this configuration	Signal
EXT Alarm, shielded multi-wire	Signal
ALD, shielded multi-wire	Signal
Ground wire	Ground

Measurement equipment

	Calibration Due	SP number
Test site Tesla	2019-12	503 881
R&S ESU 40	2017-07	901 385
R&S FSQ 40	2017-07	504 143
R&S FSW 43	2017-08	902 073
Control computer with R&S software EMC32 version 9.15.0	-	503 899
High pass filter 1-18 GHz	2017-06	901 501
High pass filter 1-20 GHz	2017-06	901 373
RF attenuator Weinschel 6905-40-11-LIM	2018-03	902 282
Coaxial cable Sucoflex 102EA	2018-03	BX50191
Coaxial cable Sucoflex 102EA	2018-03	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	2017-05	504 023
Temperature and humidity meter, Testo 625	2017-06	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 2017-02-14.

Manufacturer's representative

Mikael Jansson, Ericsson AB.

Test engineers

Tomas Lennhager, Tomas Isbring and Andreas Johnson, RISE.

Test participant

None.

Appendix 2

RF power output measurements according to CFR 47 2.1046 / IC RSS-132 5.4

Date	Temperature	Humidity
2017-03-27	21 °C ± 3 °C	30% ± 5 %
2017-03-28	22 °C ± 3 °C	32% ± 5 %
2017-04-12	22 °C ± 3 °C	39% ± 5 %
2017-04-27	21 °C ± 3 °C	20% ± 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 RBW of 80 MHz was used.

Measurement equipment	SP number
Rohde & Schwarz signal analyser FSW 43	902 073
RF attenuator Weinschel 6905-40-11-LIM	902 282
Testo 635 temperature and humidity meter	504 203

Measurement uncertainty: 1.1 dB

Results

Single carrier E-TM1.1

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

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
$B_{L1.4}$	43.09/ 8.32	43.14/ 8.26	46.13/49.13[2]
$M_{L1.4}$	42.94/ 8.32	42.93/ 8.26	45.95/48.95[2]
$T_{L1.4}$	42.97/ 8.32	42.93/ 8.26	45.96/48.96[2]
B_{L3}	43.10/ 8.32	43.11/ 8.22	46.12/49.12[2]
M_{L3}	42.97/ 8.32	42.92/ 8.20	45.96/48.96[2]
T_{L3}	43.03/ 8.34	42.95/ 8.20	46.00/49.00[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Appendix 2

Rated output power level at RF connector 1x 49 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
B_{L5}	48.64/ 7.08	48.75/ 7.06	51.71/54.71[2]
M_{L5}	48.82/ 7.04	48.75/ 7.06	51.80/54.80[2]
T_{L5}	48.76/ 7.06	48.68/ 7.08	51.73/54.73[2]
B_{L10}	48.74/ 7.18	48.80/ 7.18	51.78/54.78[2]
M_{L10}	48.81/ 7.06	48.81/ 7.08	51.82/54.82[2]
T_{L10}	48.80/ 7.08	48.75/ 7.10	51.79/54.79[2]
B_{L15}	48.78/ 7.26	48.81/ 7.28	51.81/54.81[2]
M_{L15}	48.81/ 7.08	48.79/ 7.12	51.81/54.81[2]
T_{L15}	48.78/ 7.08	48.73/7.10	51.77/54.77[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Single carrier E-TM3.2

Rated output power level at RF connector 1x 49 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
B_{L5}	48.63/ 7.08	48.70/ 7.10	51.68/54.68[2]
M_{L5}	48.80/ 7.04	48.78/ 7.06	51.80/54.80[2]
T_{L5}	48.75 7.08	48.68/ 7.08	51.73/54.73[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Single carrier E-TM3.1

Rated output power level at RF connector 1x 49 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
B_{L5}	48.63/ 7.10	48.69/ 7.10	51.67/54.67[2]
M_{L5}	48.78/ 7.04	48.79/ 7.06	51.80/54.80[2]
T_{L5}	48.77/ 7.06	48.68/ 7.08	51.74/54.74[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Appendix 2

Single carrier E-TM3.1A

Rated output power level at RF connector 1x 49 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
B_{L5}	48.59/ 7.10	48.66/ 7.10	51.64/54.64[2]
M_{L5}	48.77/ 7.06	48.77/ 7.06	51.78/54.78[2]
T_{L5}	48.73/ 7.10	48.66/ 7.10	51.71/54.71[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Single carrier E-TM1.1 with NB-IoT

Rated output power level at RF connector 1x 49 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
M_{L5+IoT}	48.34/ 7.38	48.37/ 7.36	51.37/54.37[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Multi carrier E-TM1.1

Rated output power 2 x 46 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
$M2_{L5}$	48.72/ 7.08	48.77/ 7.08	51.76/54.72[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Rated output power 4 x 43 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
$M4_{L5CON}$	47.73/ 7.12	47.78/ 7.12	50.77/53.77[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Appendix 2

Carrier Aggregation E-TM1.1

Rated output power 2 x 46 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
$M2_{L5+L10}$	48.66/ 6.78	48.68/ 6.78	51.68/54.68[2]
$M2_{L10+L10}$	48.65/ 7.10	48.68/ 7.10	51.68/54.68[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Carrier Aggregation E-TM3.1

Rated output power 2 x 46 dBm/ port.

Symbolic name	Port RFA [RMS dBm/ dB PAR]	Port RFB [RMS dBm/ dB PAR]	Total power[1)] [RMS dBm]
$M2_{L5+L10}$	48.65/ 6.78	48.70/ 6.78	51.69/54.69[2]
$M2_{L10+L10}$	48.63/ 7.10	48.69/ 7.08	51.67/54.67[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Power Spectrum Density E-TM1.1

Rated output power 1 x 43 dBm/ port.

	Output power per 1 MHz [RMS dBm]		
Symbolic name	Port RFA	Port RFB	Total power[1)]
$B_{L1.4}$	42.15	42.28	45.23/ 48.23[2]
B_{L3}	39.13	39.12	42.14/ 45.14[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

Rated output power 1 x 49 dBm/ port.

	Output power per 1 MHz [RMS dBm]		
Symbolic name	Port RFA	Port RFB	Total power[1)]
M_{L5}	42.82	42.79	45.82/ 48.82[2]
M_{L10}	39.87	39.84	42.87/ 45.87[2]
M_{L15}	38.16	38.13	41.16/ 44.16[2]

[1)]: summed output power according to FCC KDB662911 Multiple transmitter output.
[2)]: 3 dB added to the total power for the case when the device are used in a 4x4 MIMO configuration together with an additional unit.

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

Appendix 3

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

Date	Temperature	Humidity
2017-03-28	22 °C ± 3 °C	32% ± 5 %
2017-03-29	22 °C ± 3 °C	31% ± 5 %
2017-04-12	22 °C ± 3 °C	39% ± 5 %
2017-04-27	21 °C ± 3 °C	20% ± 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 RMS detector activated. The signal analyzer was connected to an external 10 MHz reference standard during the measurements.

Measurement equipment	SP number
Rohde & Schwarz signal analyser FSW 43	902 073
RF attenuator Weinschel 6905-40-11-LIM	902 282
Testo 635 temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier E-TM1.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
1	M_{L5}	RF A	4.478

Single carrier E-TM3.2

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
2	M_{L5}	RF A	4.478

Single carrier E-TM3.1A

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
3	M_{L5}	RF A	4.486

Appendix 3

Single carrier E-TM3.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
4	$B_{L1.4}$	RF A	1.100
5	B_{L15}	RF A	13.456
6	$M_{L1.4}$	RF A	1.101
7	$M_{L1.4}$	RF B	1.101
8	M_{L3}	RF A	2.694
9	M_{L5}	RF A	4.495
10	M_{L10}	RF A	8.978
11	M_{L15}	RF A	13.461
12	M_{L15}	RF B	13.446
13	$T_{L1.4}$	RF A	1.101
14	T_{L15}	RF A	13.460

Single carrier E-TM1.1 with NB-IoT

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
15	M_{L5+IoT}	RF A	4.482

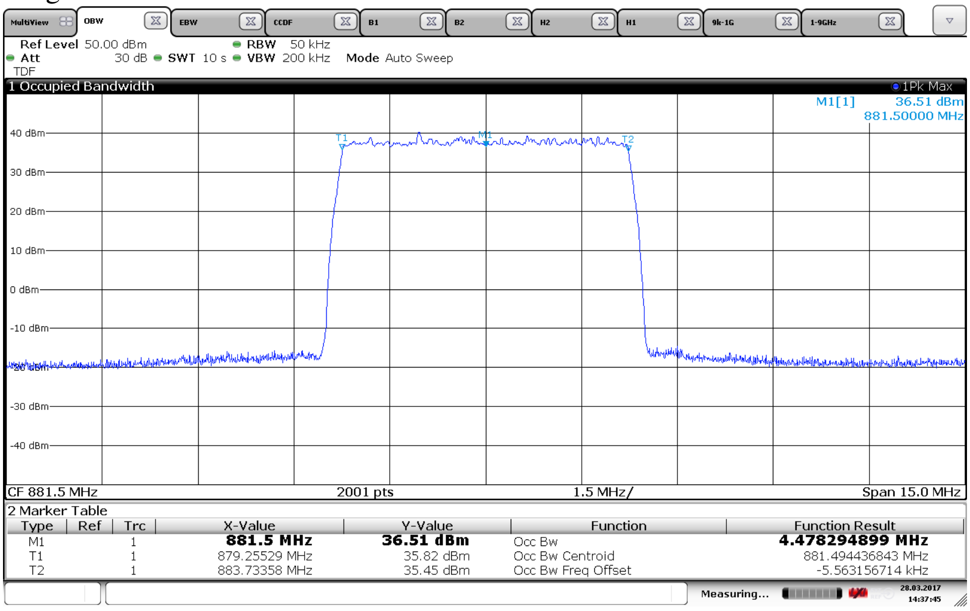
Carrier aggrigation E-TM3.1

Diagram	Symbolic name	Tested Port	Occupied BW (99%) [MHz]
16	M_{L5+L10}	RF A	14.155
17	$M_{L10+L10}$	RF A	18.887

The diagrams are shown on the following pages.

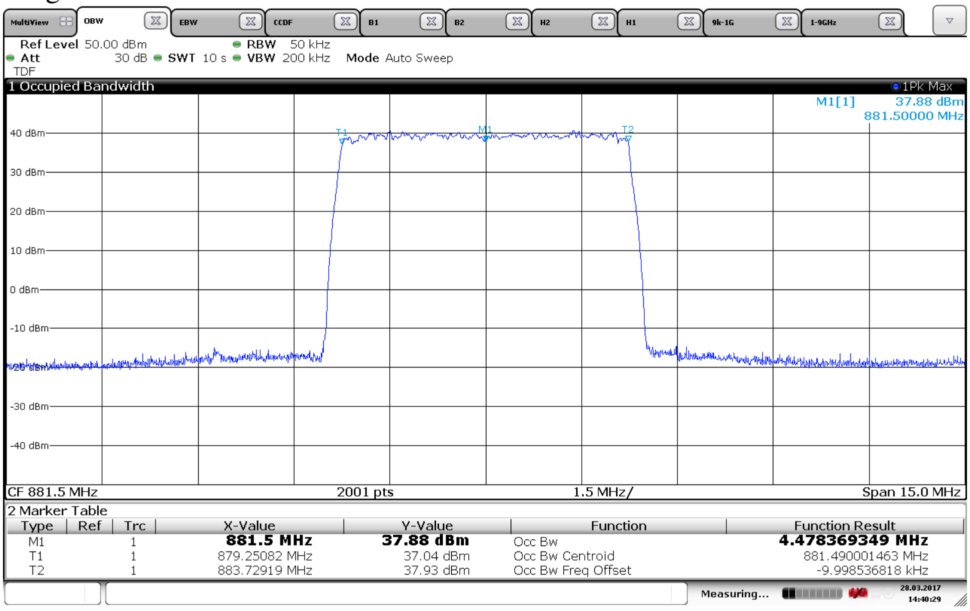
Appendix 3

Diagram 1:



14:37:46 28.03.2017

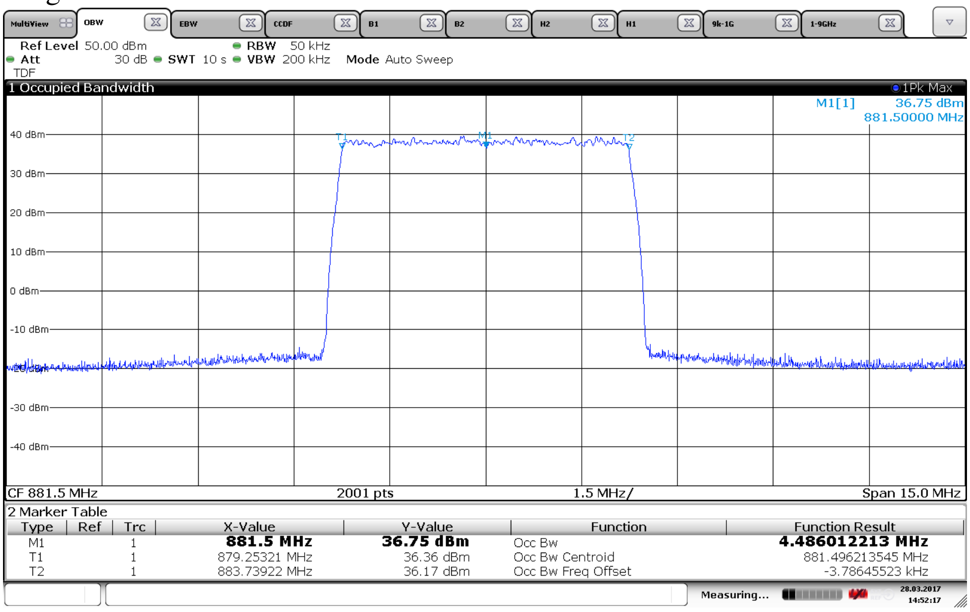
Diagram 2:



14:40:30 28.03.2017

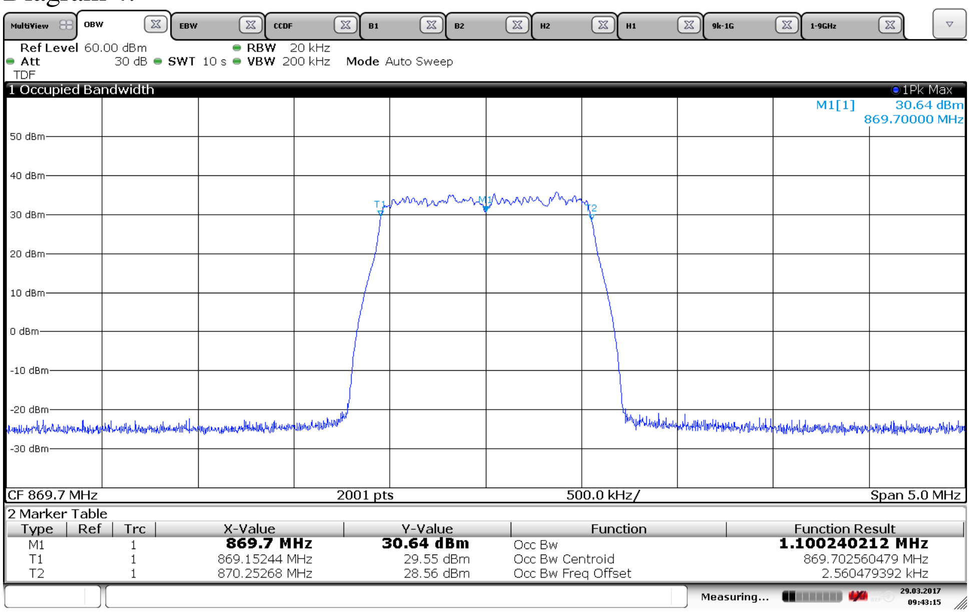
Appendix 3

Diagram 3:



14:52:17 28.03.2017

Diagram 4:



09:43:16 29.03.2017

Appendix 3

Diagram 5:

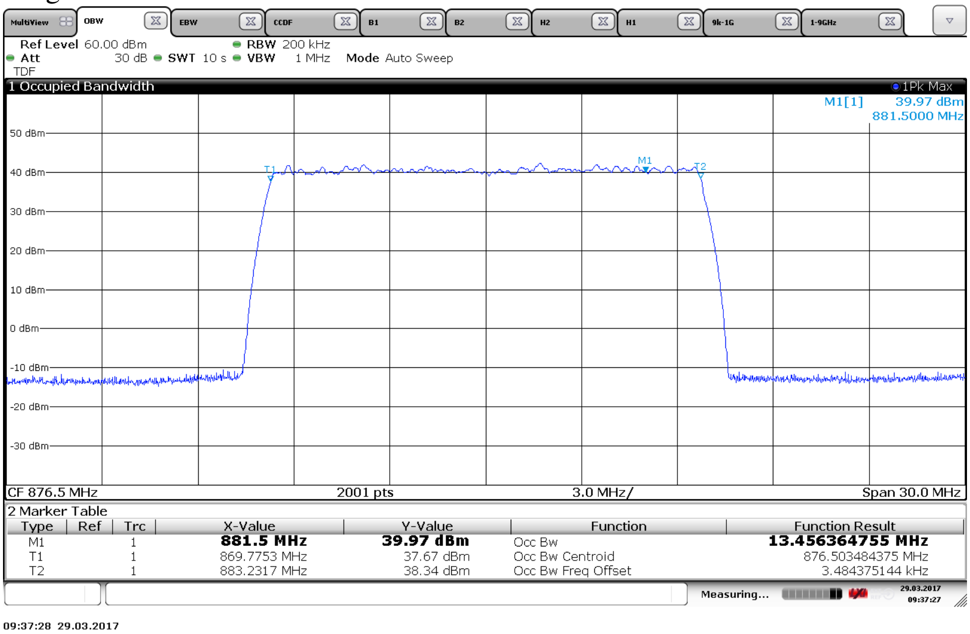
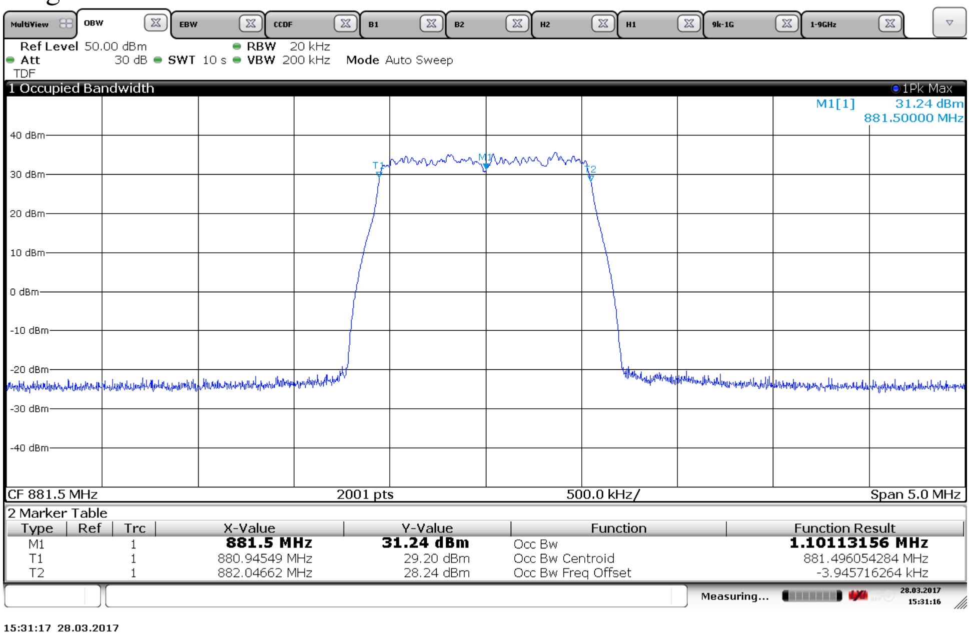
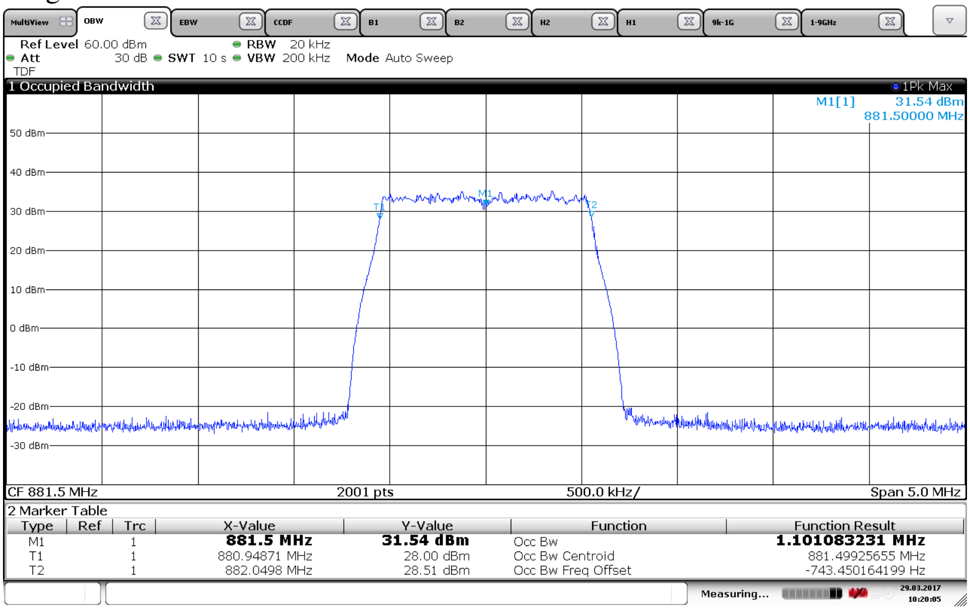


Diagram 6:



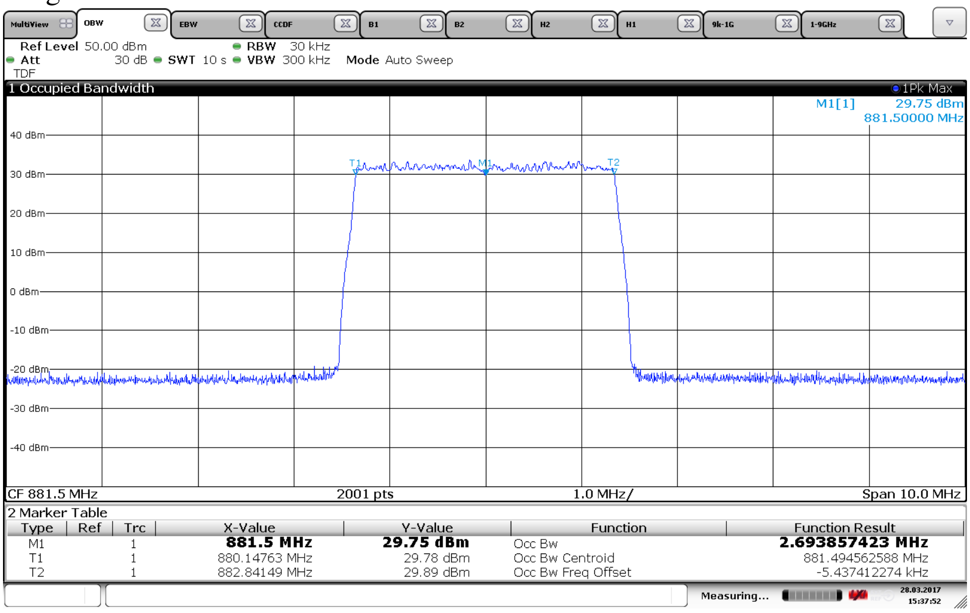
Appendix 3

Diagram 7:



10:20:06 29.03.2017

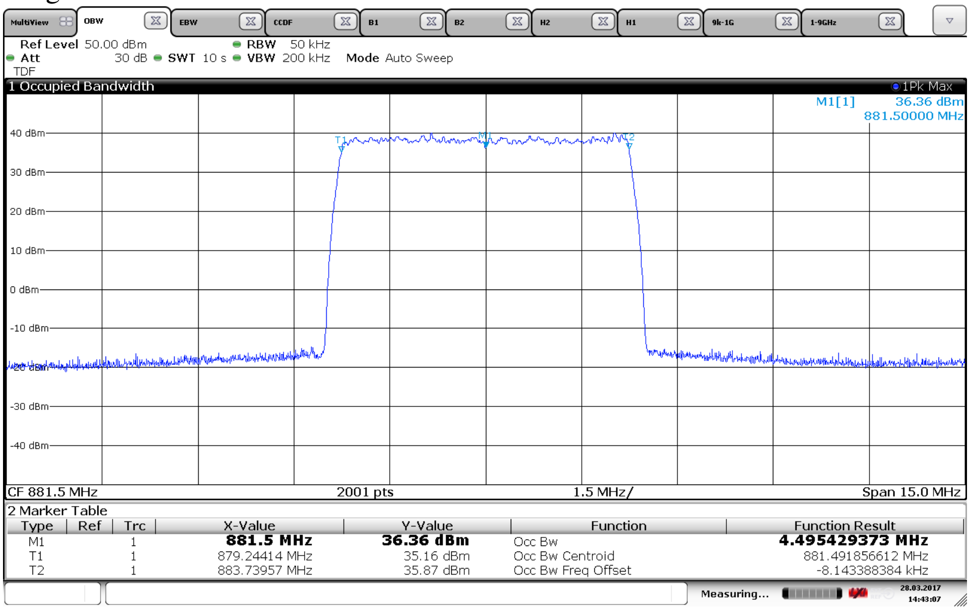
Diagram 8:



15:37:52 28.03.2017

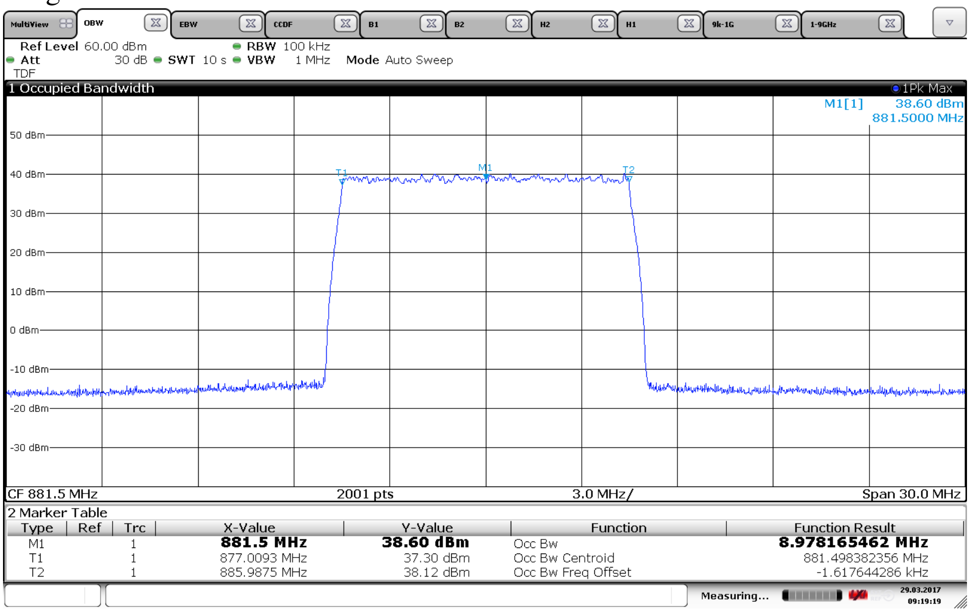
Appendix 3

Diagram 9:



14:43:07 28.03.2017

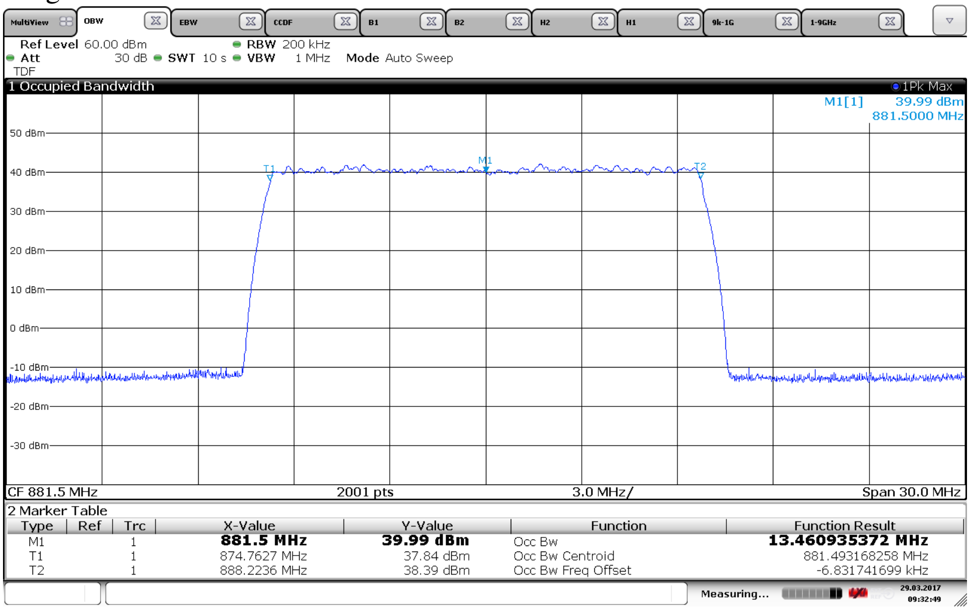
Diagram 10:



09:19:20 29.03.2017

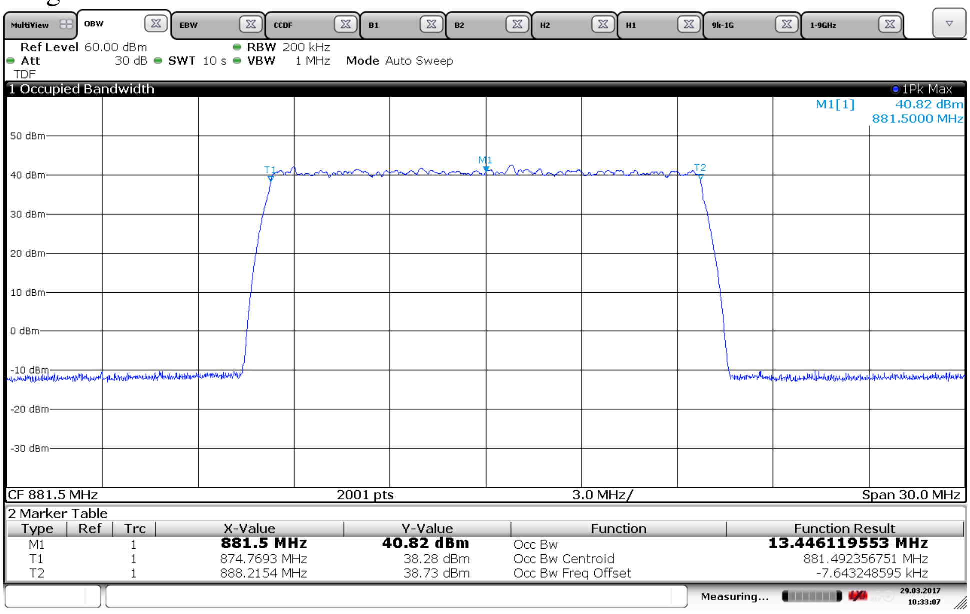
Appendix 3

Diagram 11:



09:32:49 29.03.2017

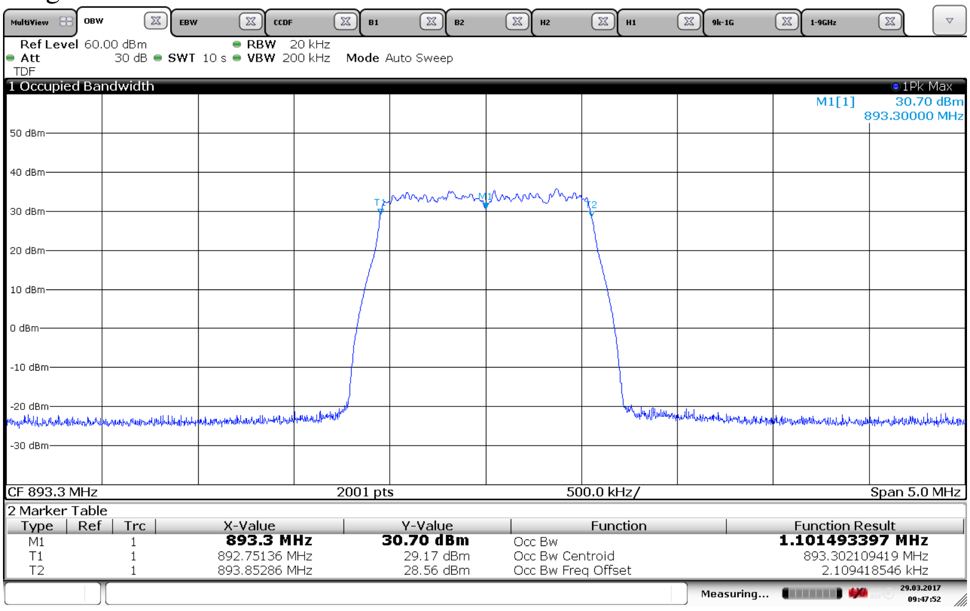
Diagram 12:



10:33:07 29.03.2017

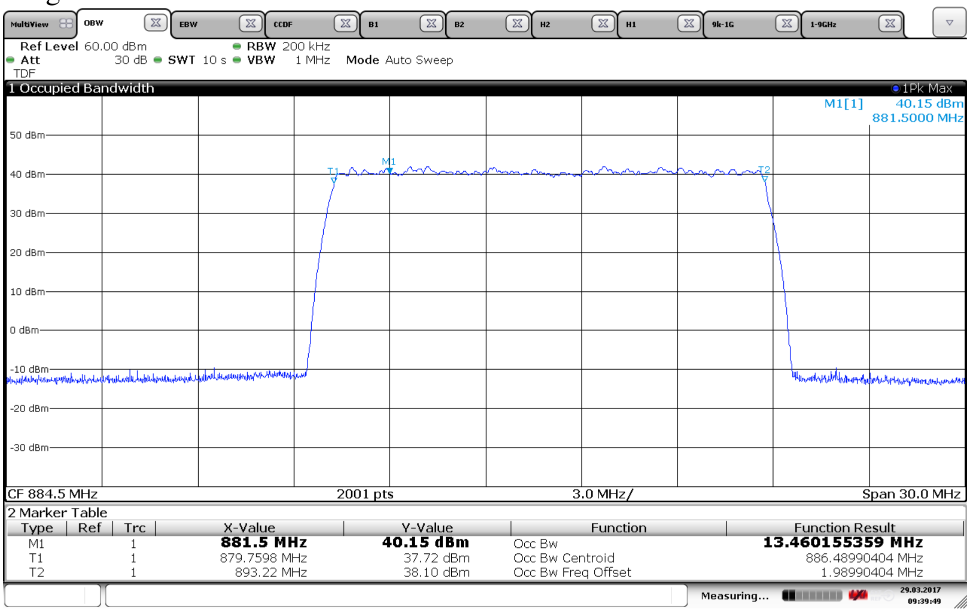
Appendix 3

Diagram 13:



09:47:52 29.03.2017

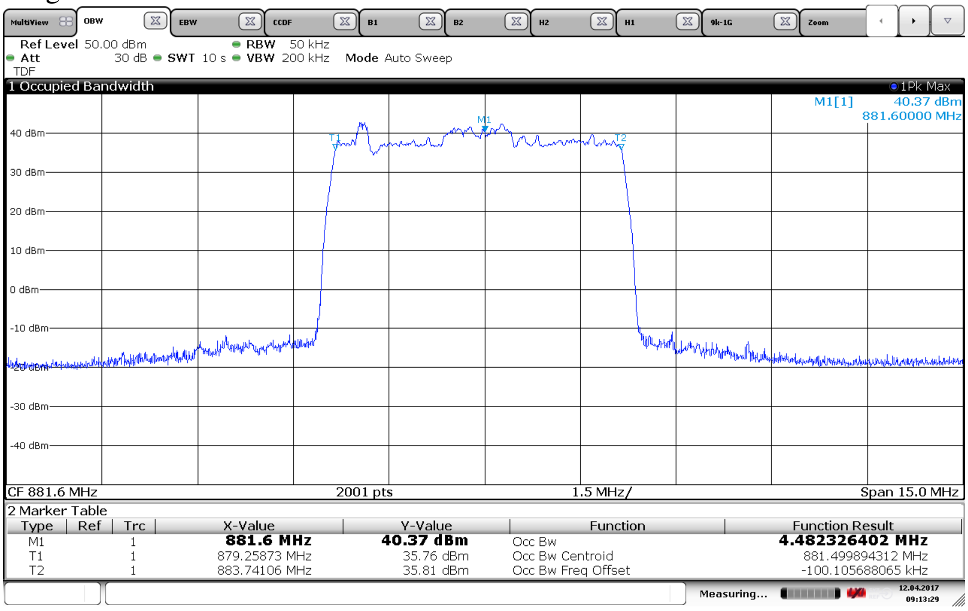
Diagram 14:



09:39:50 29.03.2017

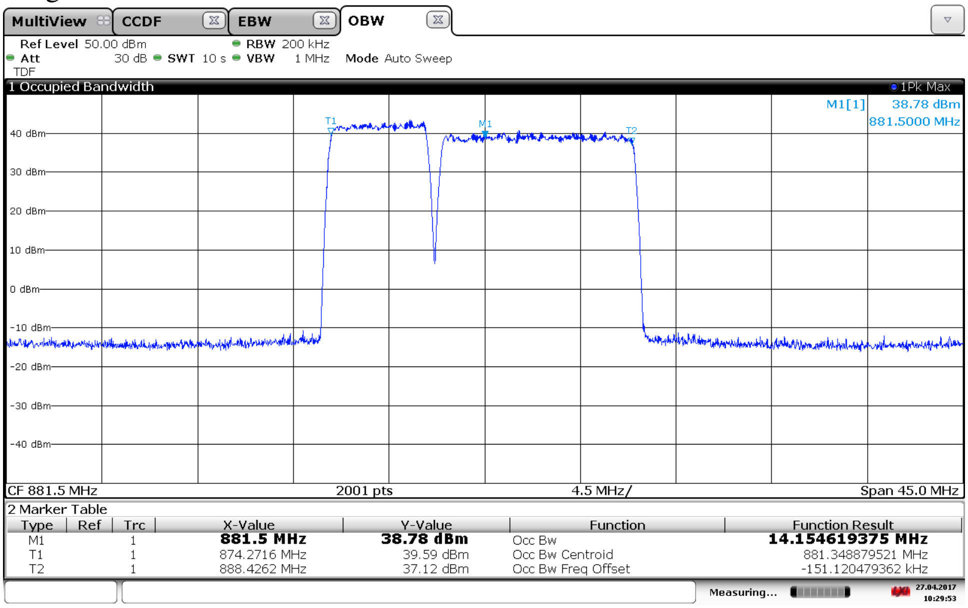
Appendix 3

Diagram 15:



09:13:29 12.04.2017

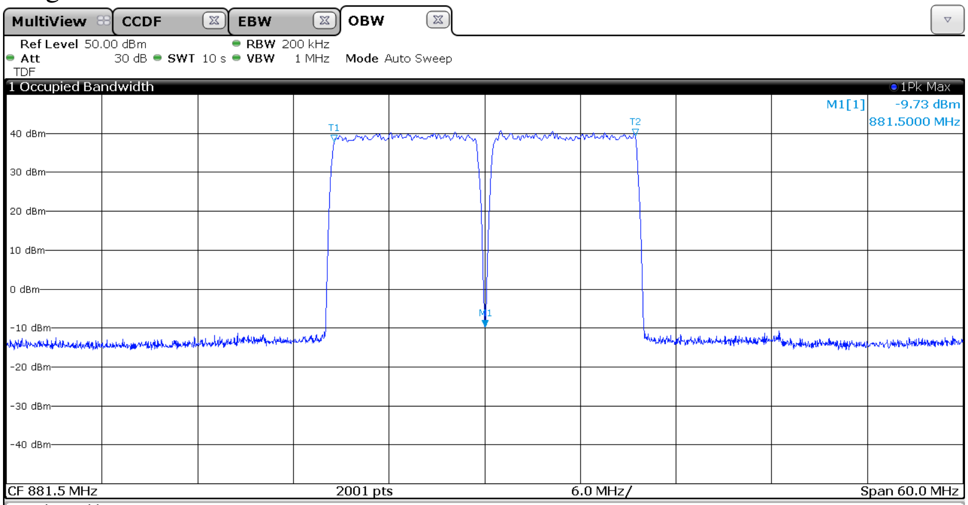
Diagram 16:



10:29:54 27.04.2017

Appendix 3

Diagram 17:



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**881.5 MHz**	**-9.73 dBm**	Occ Bw	**18.88657359 MHz**
T1		1	872.0616 MHz	37.80 dBm	Occ Bw Centroid	881.50490039 MHz
T2		1	890.9482 MHz	39.30 dBm	Occ Bw Freq Offset	4.900389542 kHz

10:47:18 27.04.2017

Appendix 4

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

Date	Temperature	Humidity
2017-03-29	22 °C ± 3 °C	31% ± 5 %
2017-04-12	22 °C ± 3 °C	39% ± 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.

FCC rules specify a RBW of at least 1% of the fundamental emission bandwidth (EBW) for offsets up to 1 MHz from the band edge and a RBW of 100 kHz for measurements of emissions more than 1 MHz away from the band edges.
Where a smaller RBW was used as compared to the rules the limit in the plot is adjusted by 10*log(RBWused/RBW1%EBW) [dB].

BW configuration	Emission BW [MHz]	RBW used	Adjusted limit [dBm]
1.4 MHz	1.12	10 kHz	-14.00
3 MHz	2.73	10 kHz	-17.62

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	SP number
Rohde & Schwarz signal analyser FSW 43	902 073
RF attenuator Weinschel 6905-40-11-LIM	902 282
Testo 635 temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier E-TM3.1

Diagram	Symbolic name	Tested Port
1 a-b	$B_{L1.4}$	RF A
2 a-b	B_{L3}	RF A
3 a-b	B_{L5}	RF A
4 a-b	B_{L5+IoT}	RF A
5 a-b	B_{L5}	RF B
6 a-b	B_{L10}	RF A
7 a-b	B_{L15}	RF A
8 a-b	$T_{L1.4}$	RF A
9 a-b	T_{L3}	RF A
10 a-b	T_{L5}	RF A
11 a-b	T_{L5}	RF B
12 a-b	T_{L10}	RF A
13 a-b	T_{L15}	RF A

Multi carrier E-TM3.1

Diagram	Symbolic name	Tested Port
14 a-b	BIM_{L5}	RF A
15 a-b	TIM_{L5}	RF A

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

The diagrams are shown on the following pages.

Remark

Where multiple requirements apply, the most stringent requirement is considered for compliance assessment.

Limits

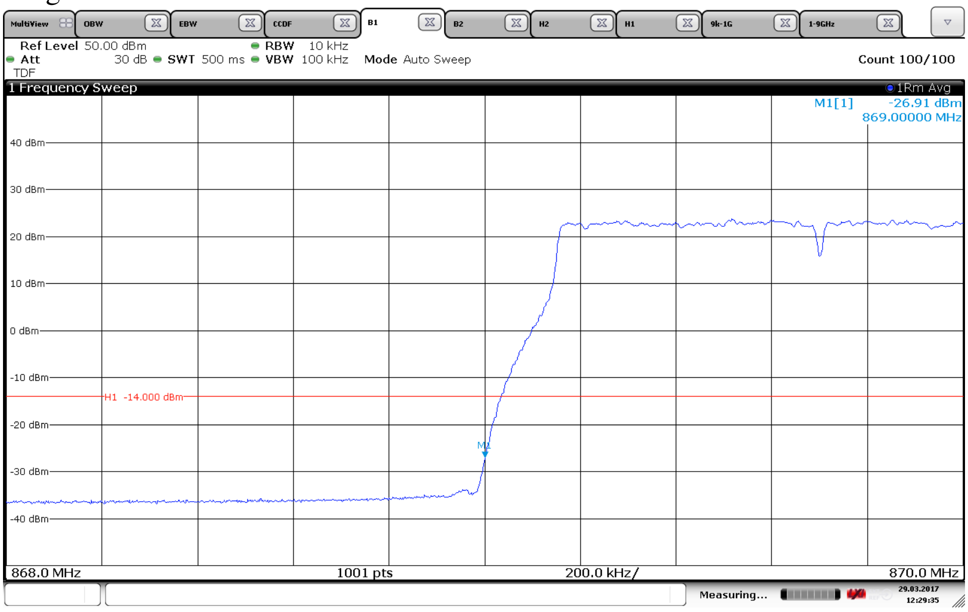
CFR 47 § 22.917: Outside a licensee's frequency band(s) of operation the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB, resulting in a limit of -13 dBm per 100 kHz RBW below 1 GHz and 1MHz RBW above 1 GHz.

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

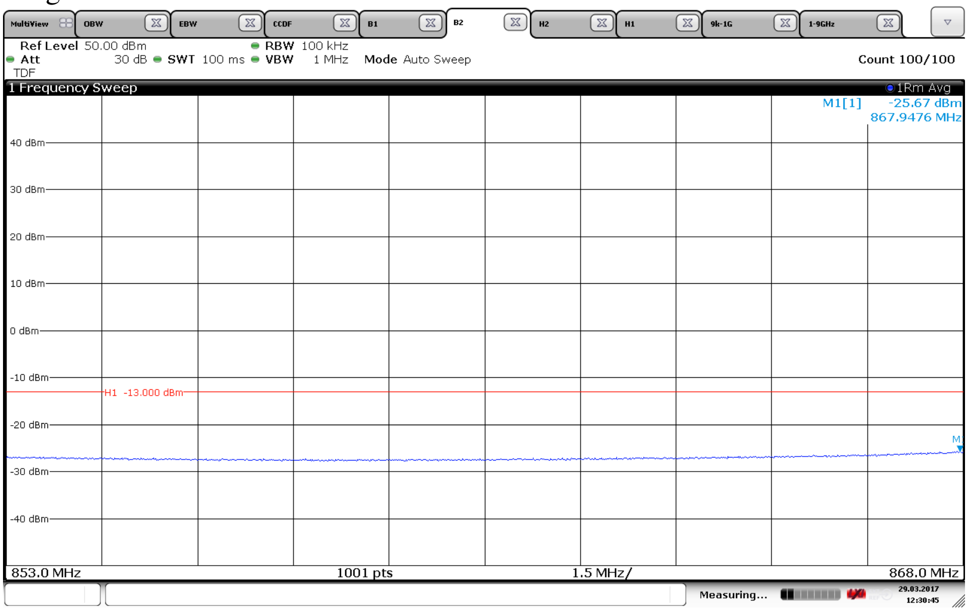
Appendix 4

Diagram 1 a:



12:29:36 29.03.2017

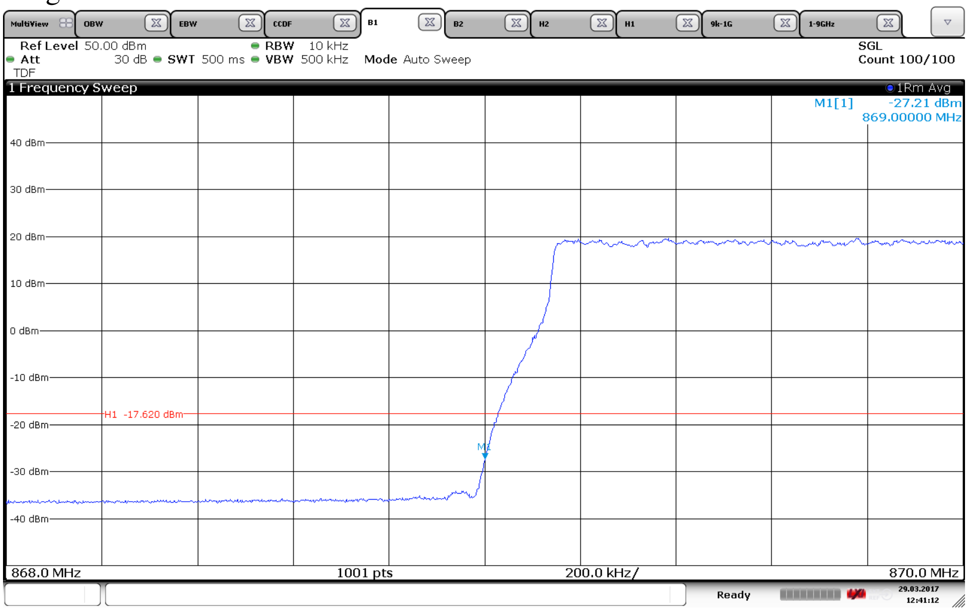
Diagram 1 b:



12:30:45 29.03.2017

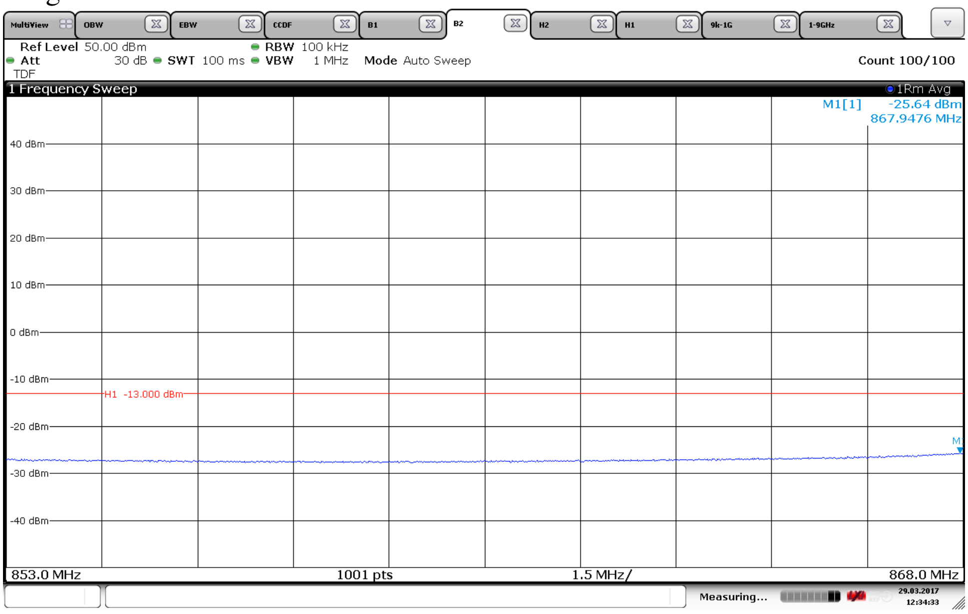
Appendix 4

Diagram 2 a:



12:41:13 29.03.2017

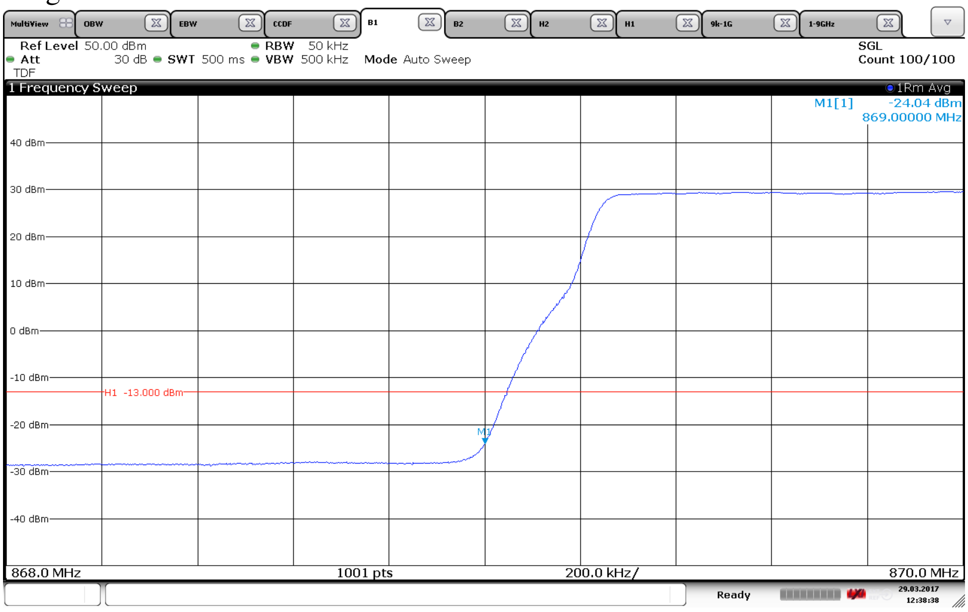
Diagram 2 b:



12:34:34 29.03.2017

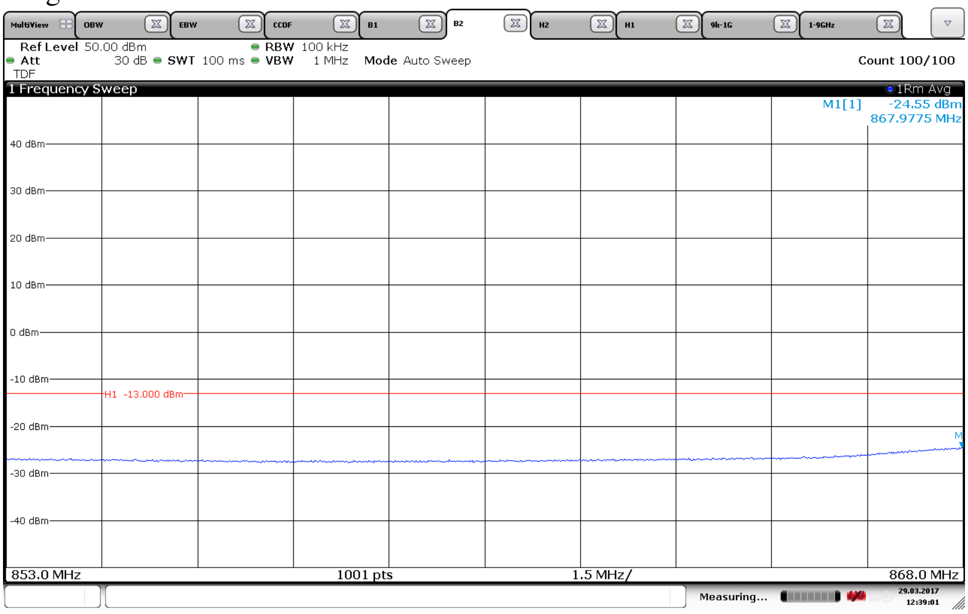
Appendix 4

Diagram 3 a:



12:38:38 29.03.2017

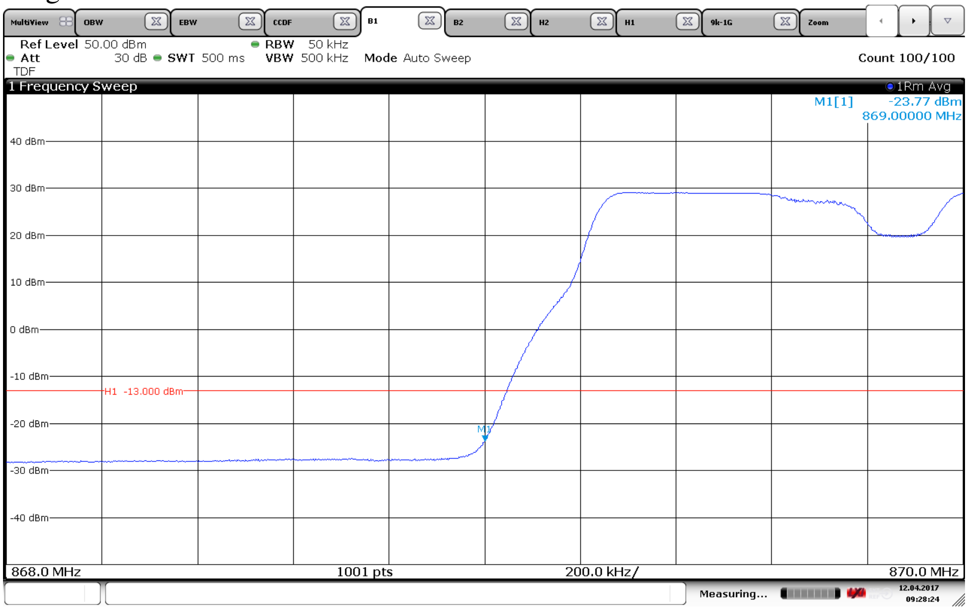
Diagram 3 b:



12:39:01 29.03.2017

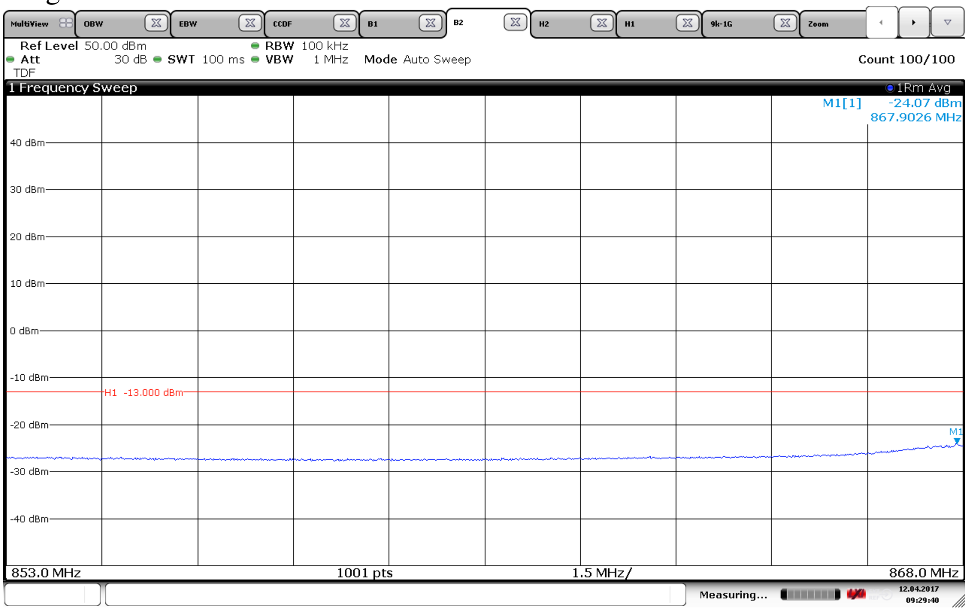
Appendix 4

Diagram 4 a:



09:28:24 12.04.2017

Diagram 4 b:



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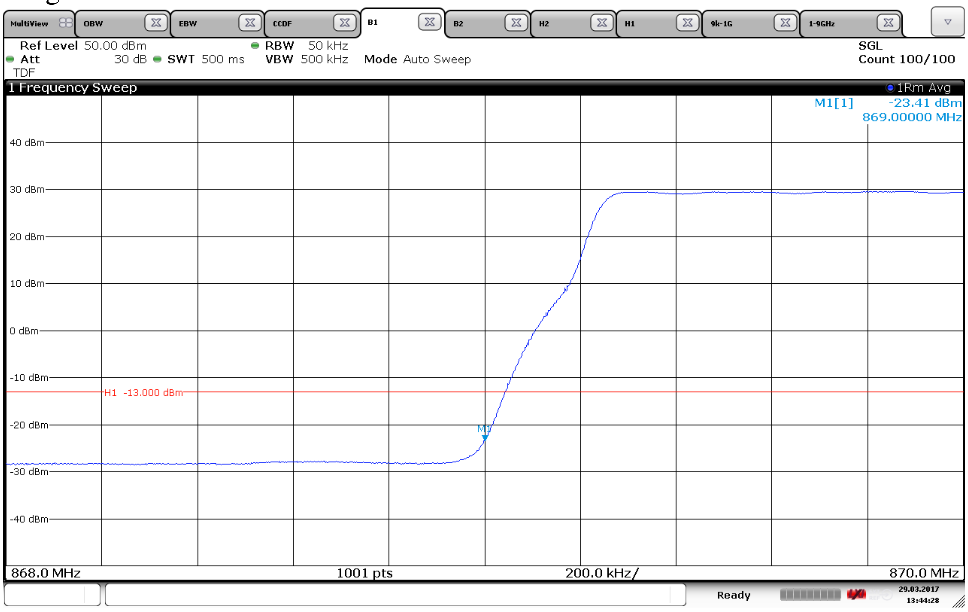
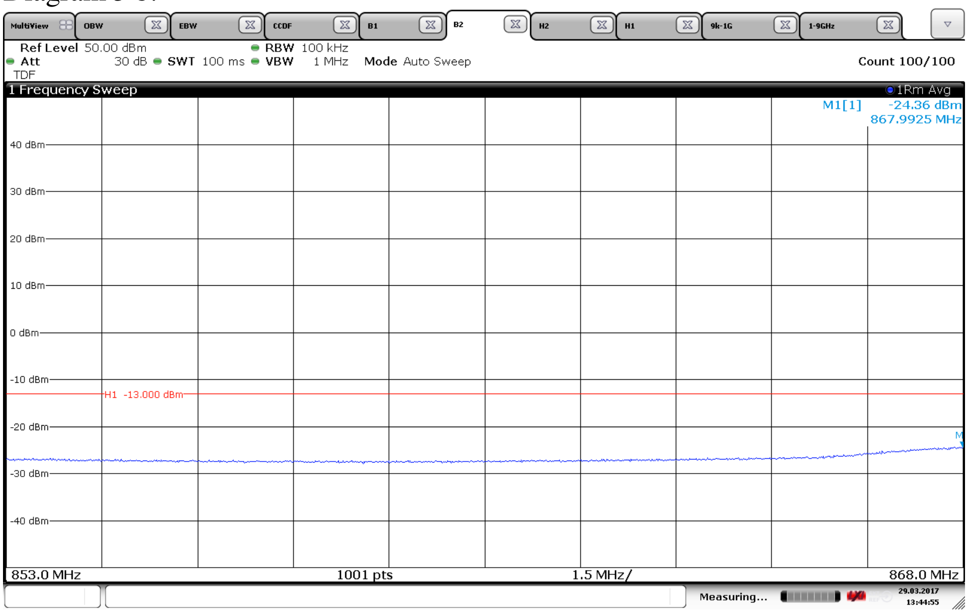
Appendix 4

Diagram 5 a:



13:44:29 29.03.2017

Diagram 5 b:



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Appendix 4

Diagram 6 a:

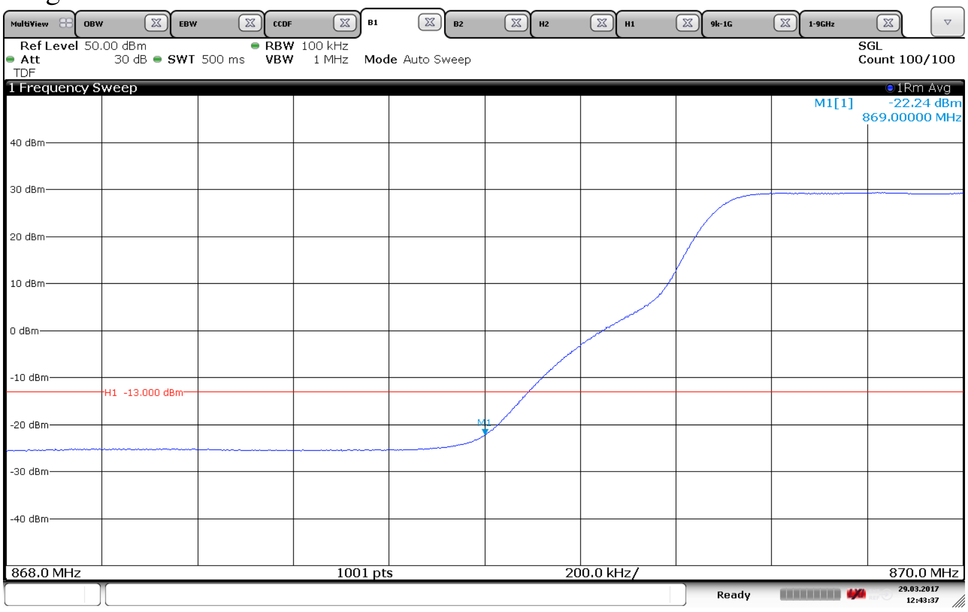

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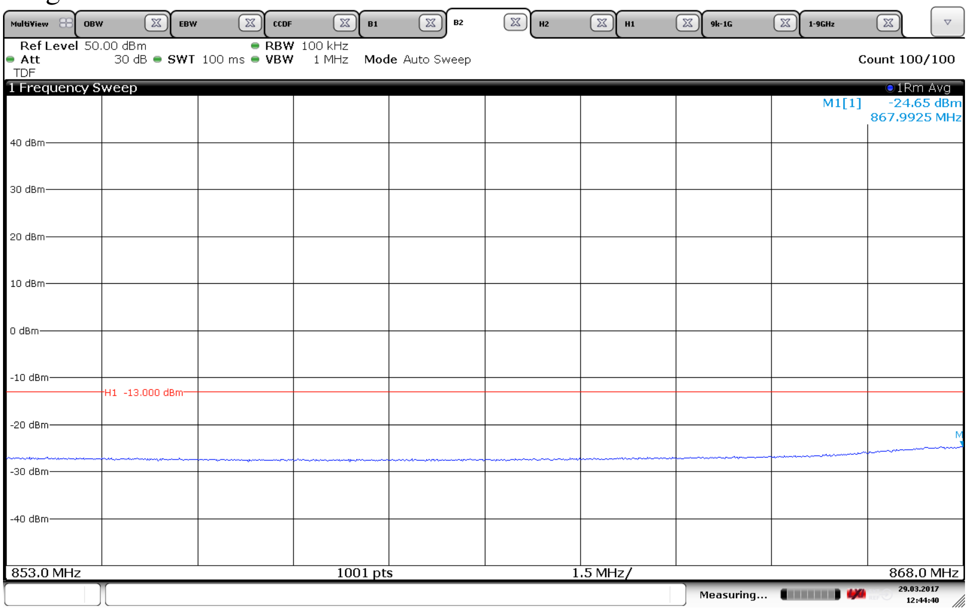
Diagram 6 b:



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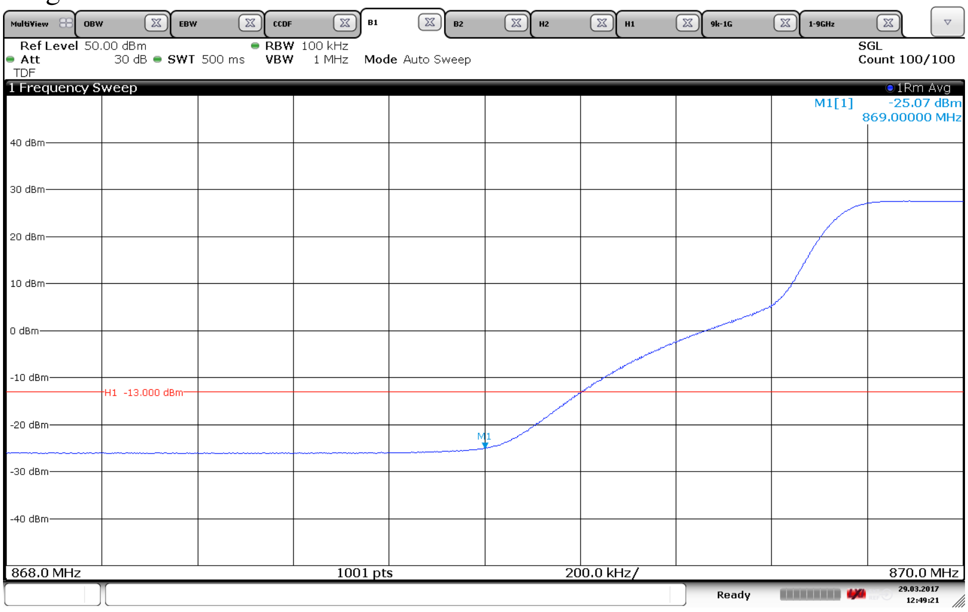
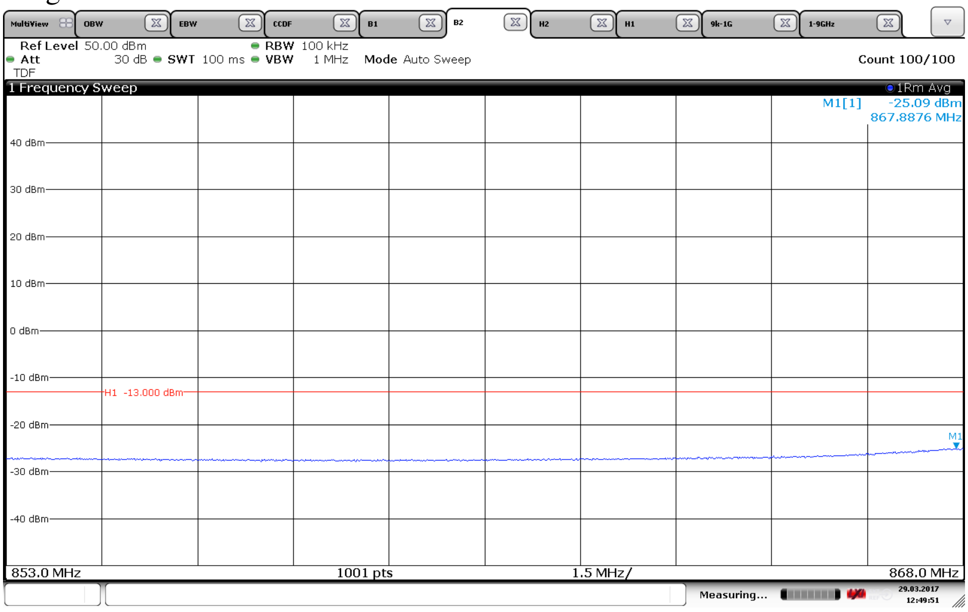
Appendix 4

Diagram 7 a:



12:49:21 29.03.2017

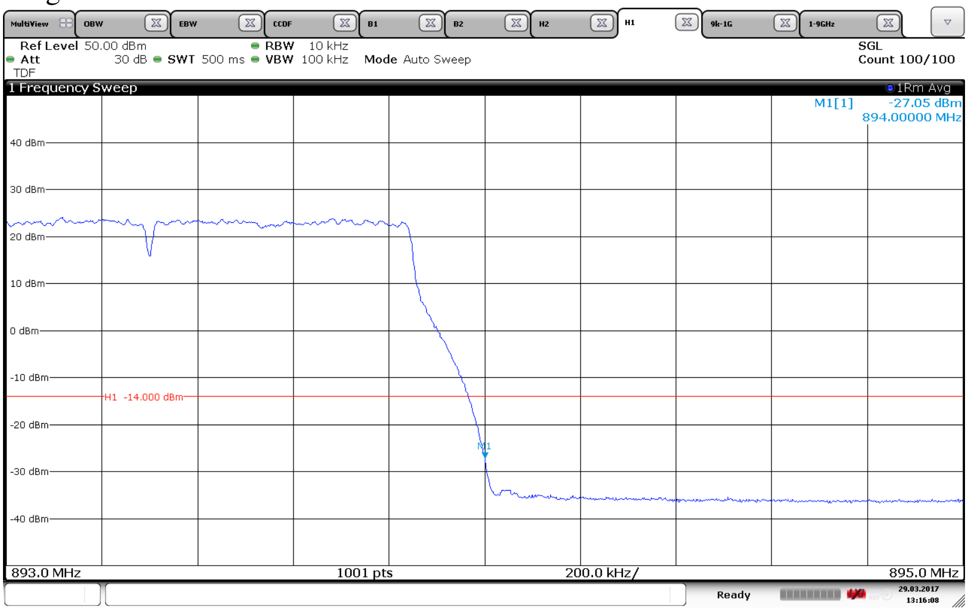
Diagram 7 b:



12:49:51 29.03.2017

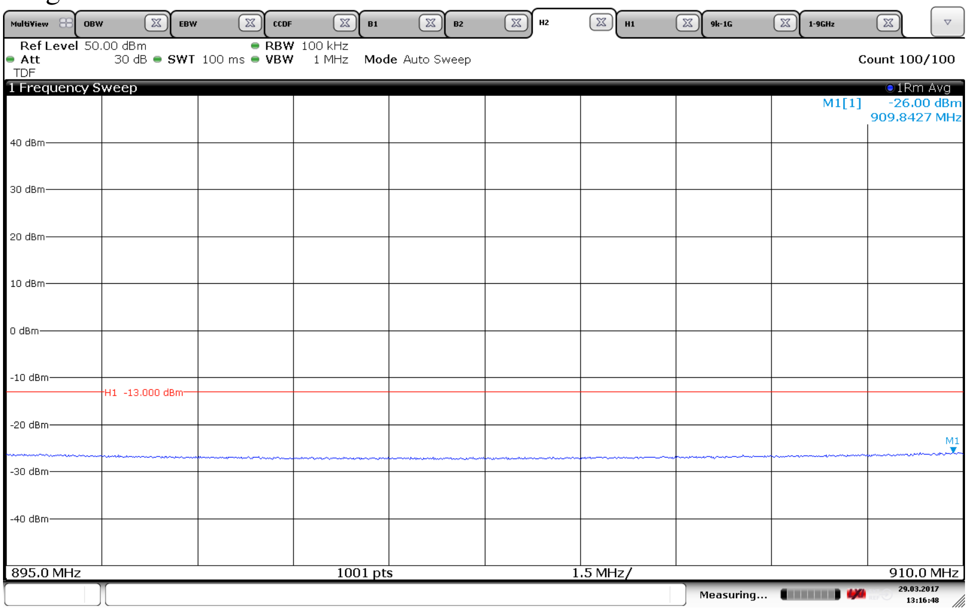
Appendix 4

Diagram 8 a:



13:16:08 29.03.2017

Diagram 8 b:



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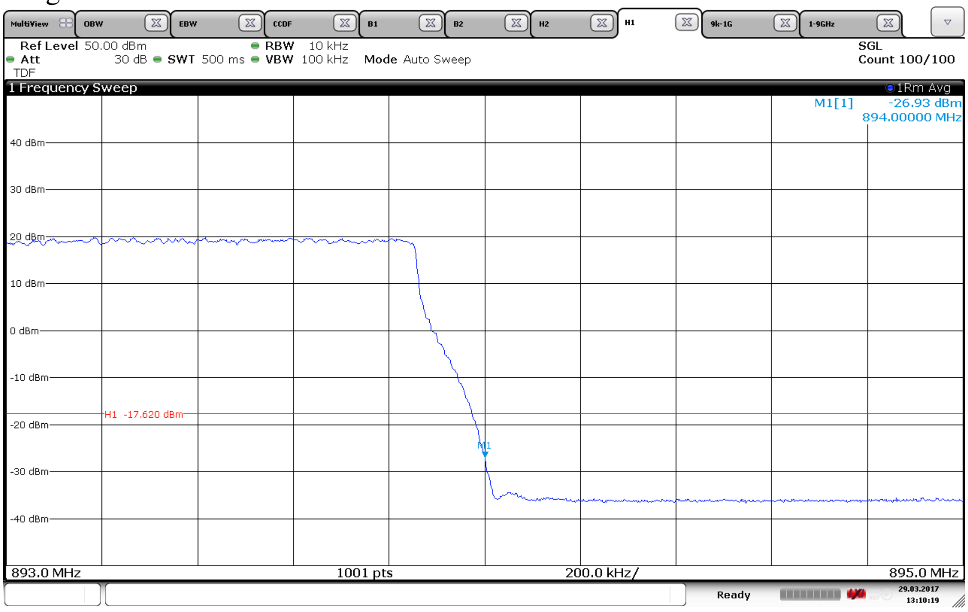
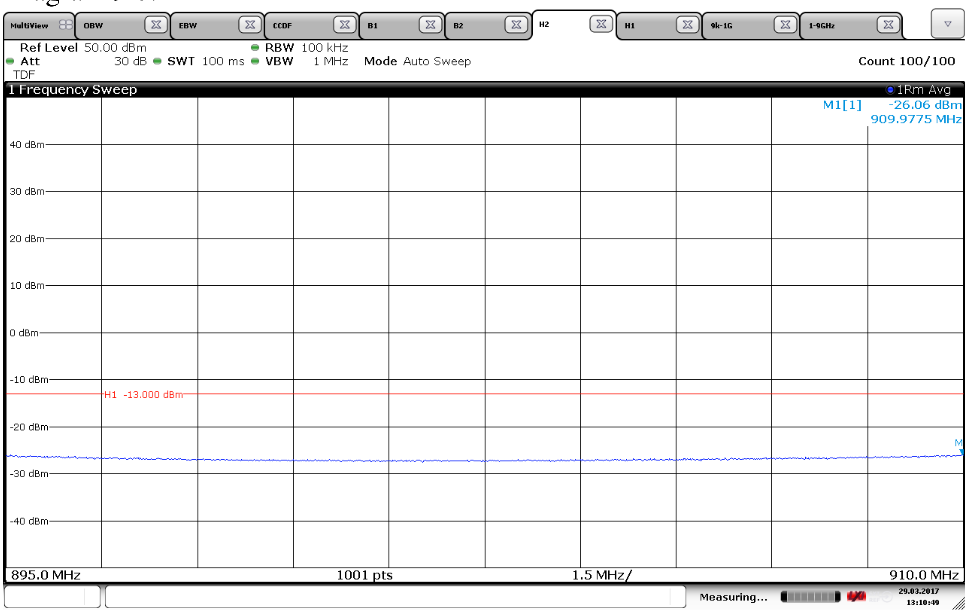
Appendix 4

Diagram 9 a:



13:10:20 29.03.2017

Diagram 9 b:



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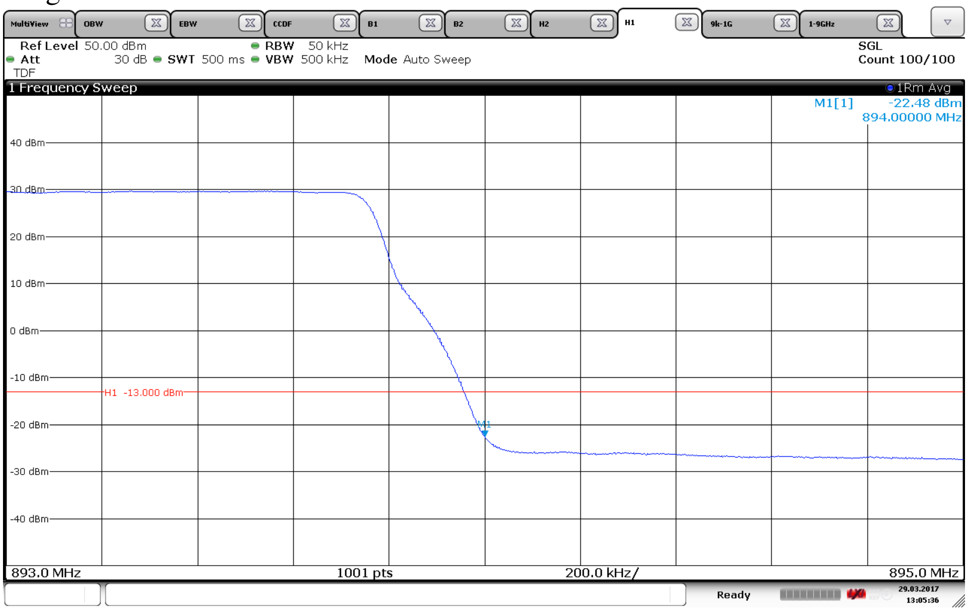
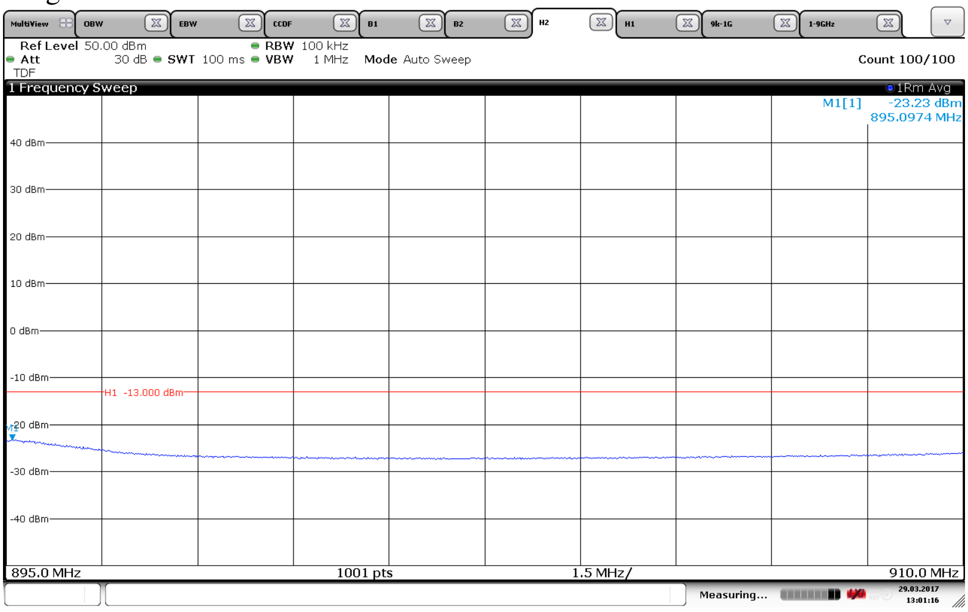
Appendix 4

Diagram 10 a:



13:05:37 29.03.2017

Diagram 10 b:



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Appendix 4

Diagram 11 a:

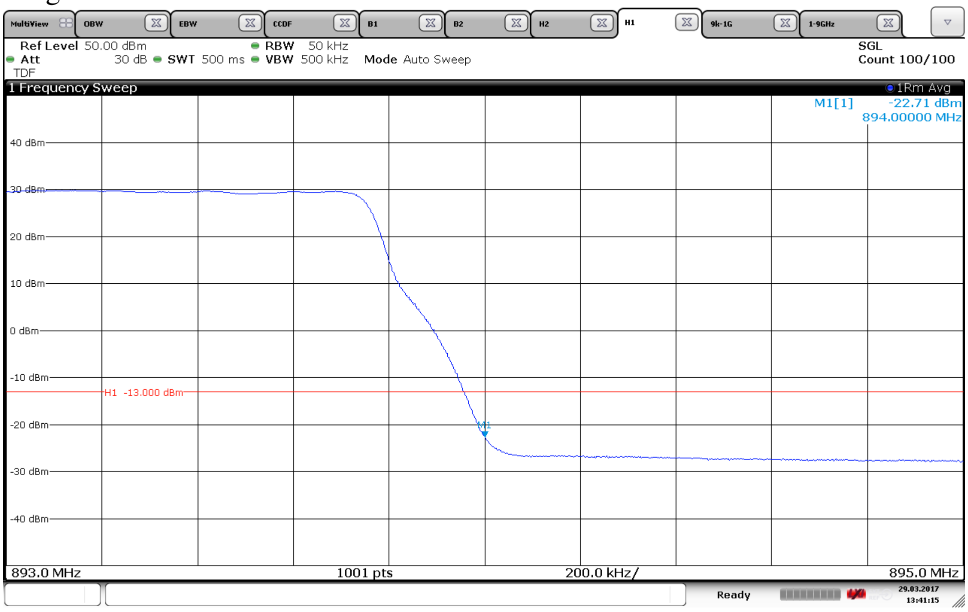

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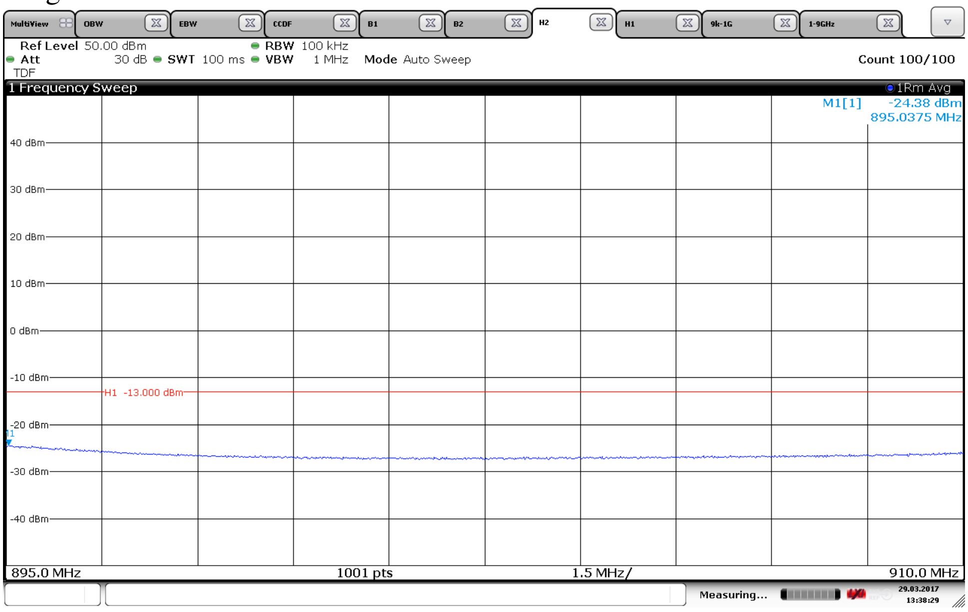
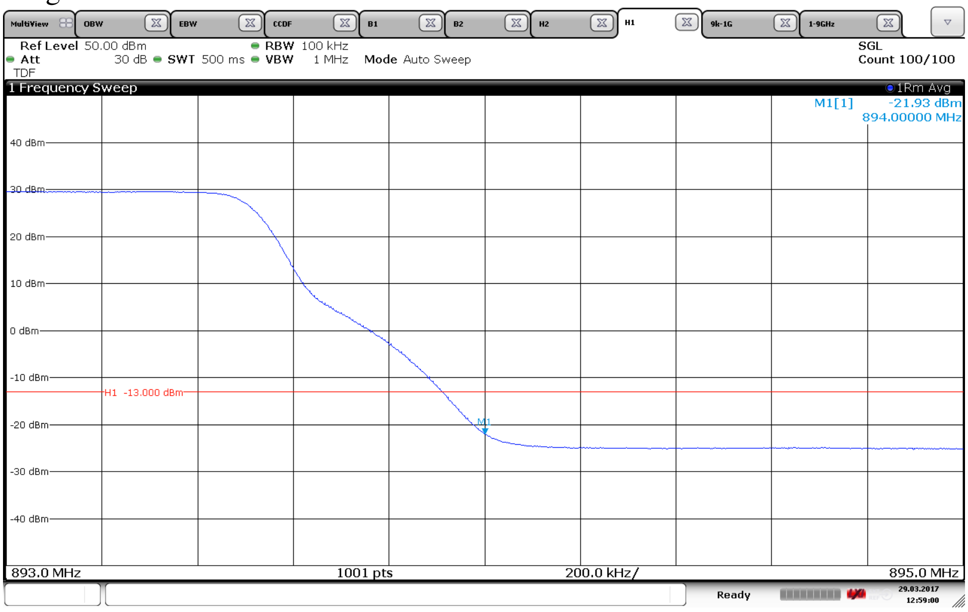
Diagram 11 b:



13:38:30 29.03.2017

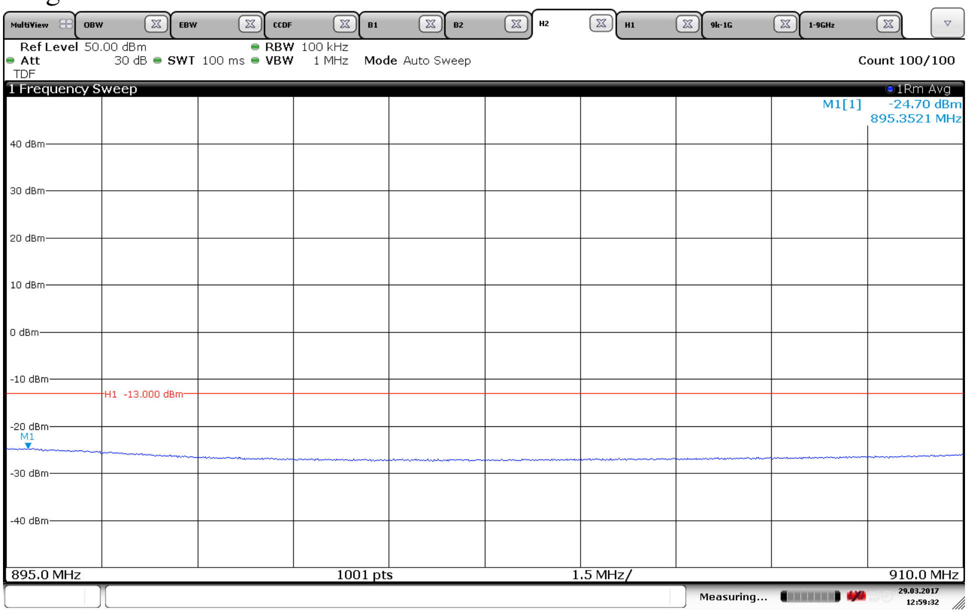
Appendix 4

Diagram 12 a:



12:59:00 29.03.2017

Diagram 12 b:



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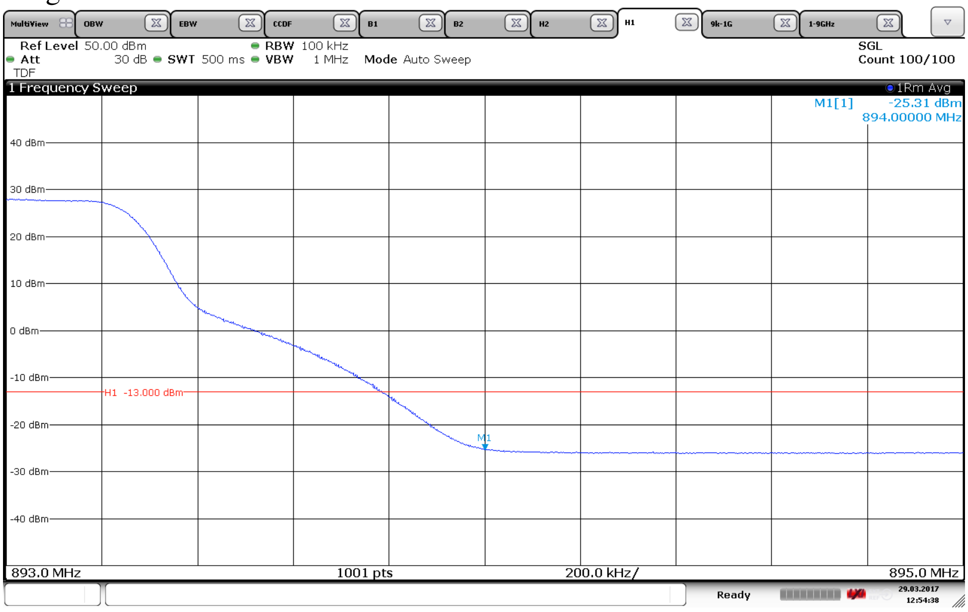
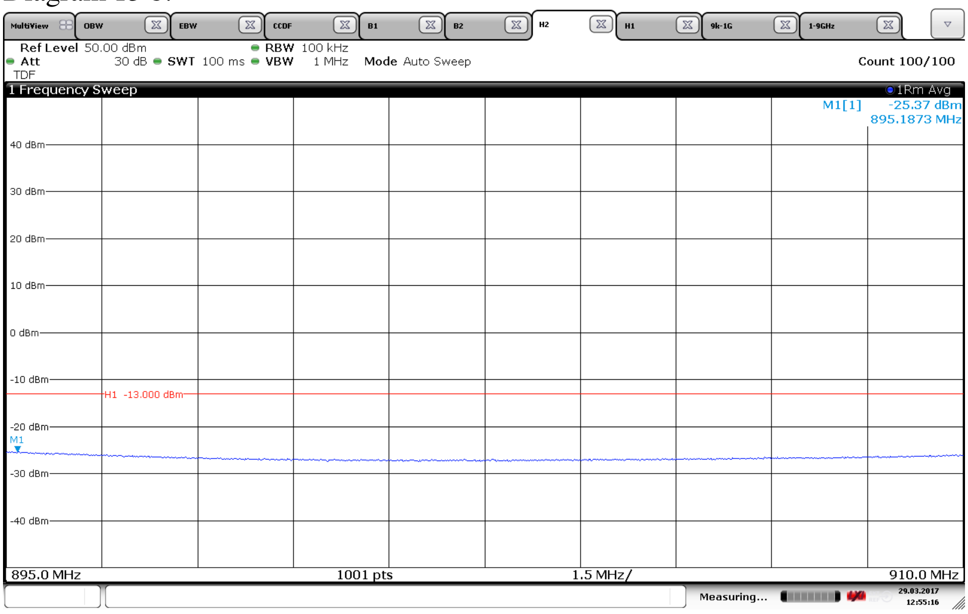
Appendix 4

Diagram 13 a:



12:54:39 29.03.2017

Diagram 13 b:



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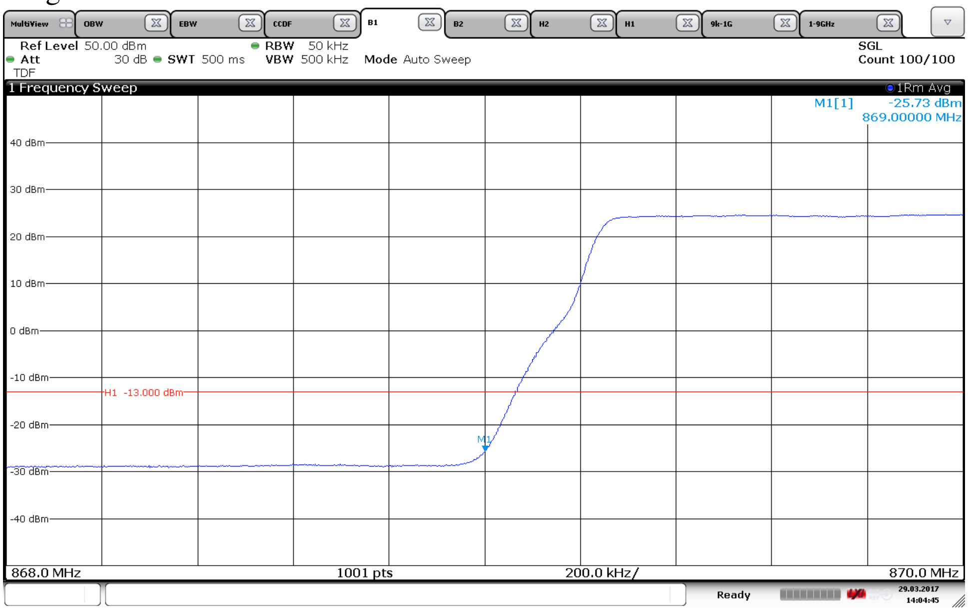
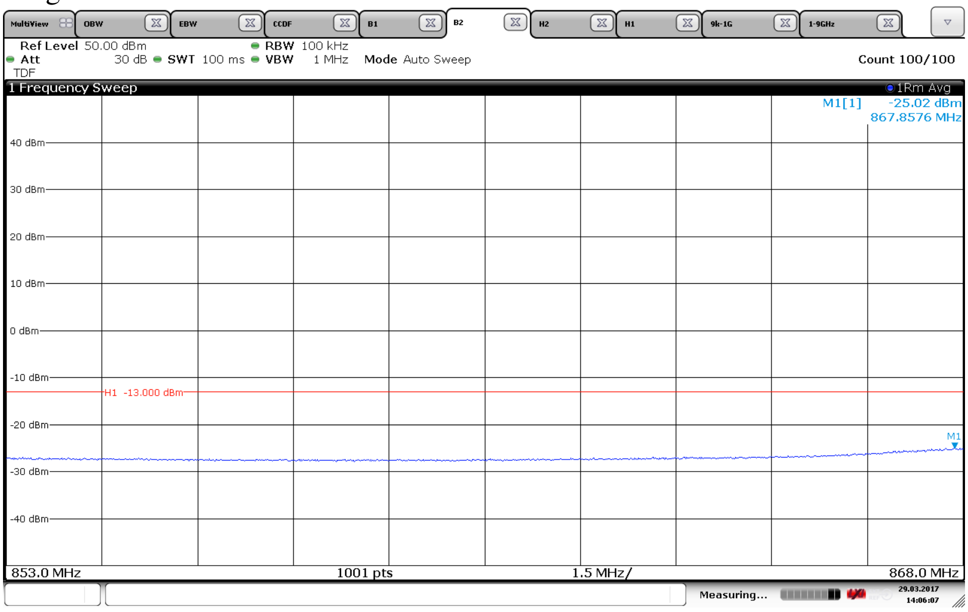
Appendix 4

Diagram 14 a:



14:04:45 29.03.2017

Diagram 14 b:



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Appendix 4

Diagram 15 a:

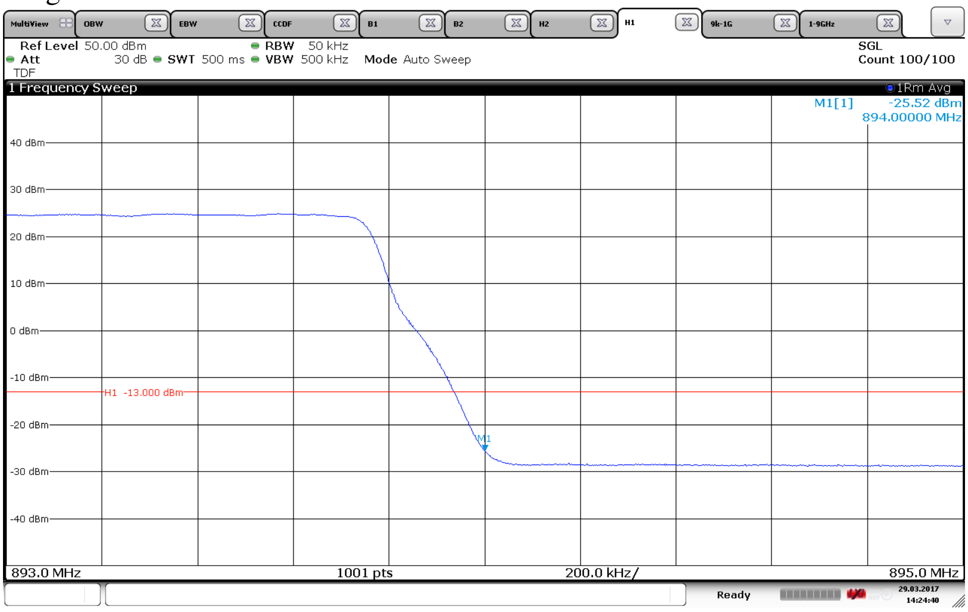

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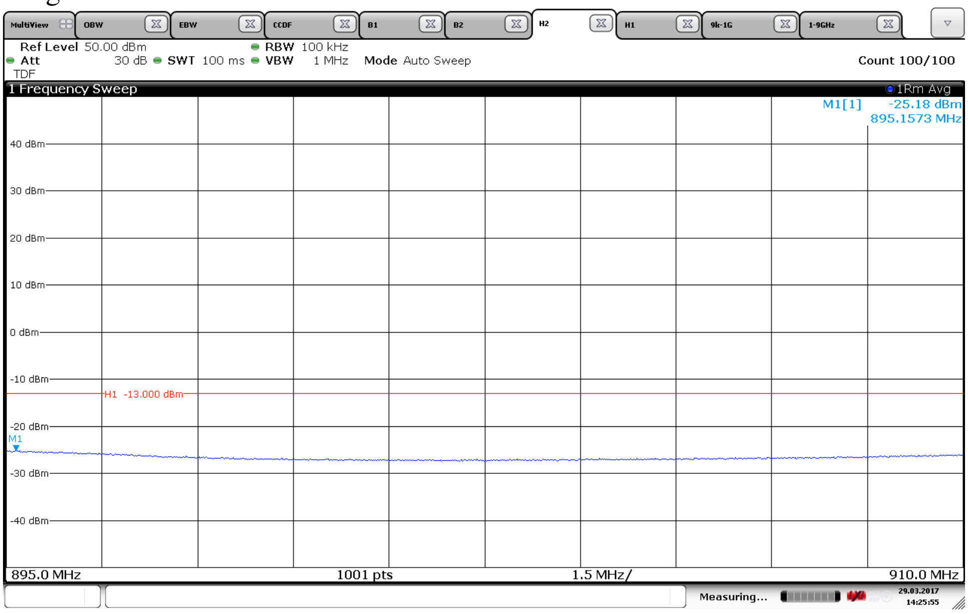
Diagram 15 b:



14:25:55 29.03.2017

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

Date	Temperature	Humidity
2017-03-29	22 °C ± 3 °C	31% ± 5 %
2017-03-30	22 °C ± 3 °C	31% ± 5 %
2017-04-12	22 °C ± 3 °C	39% ± 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	SP number
Rohde & Schwarz signal analyser FSW 43	902 073
RF attenuator Weinschel 6905-40-11-LIM	902 282
High pass filter	901 373
Testo 635 temperature and humidity meter	504 203

Measurement uncertainty: 3.7 dB

Results

Single carrier E-TM3.1

Diagram	Symbolic name	Tested Port
1 a+b	$B_{L1.4}$	RF A
2 a+b	B_{L15}	RF A
3 a+b	$M_{L1.4}$	RF A
4 a+b	$M_{L1.4}$	RF B
5 a+b	M_{L5+IoT}	RF A
6 a+b	M_{L15}	RF A
7 a+b	M_{L15}	RF B
8 a+b	$T_{L1.4}$	RF A
9 a+b	T_{L15}	RF A

Multi carrier E-TM3.1

Diagram	Symbolic name	Tested Port
10 a+b+c	BIM_{L5}	RF A
11 a+b+c	$M4_{L5CON}$	RF A
12 a+b+c	TIM_{L5}	RF A

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

Remarks

The upper frequency boundary covers 10x the highest TX fundamental frequency.
The highest fundamental frequency is 894MHz. The measurements were made up to 9 GHz (10x894 MHz = 8.94 GHz).

Limits

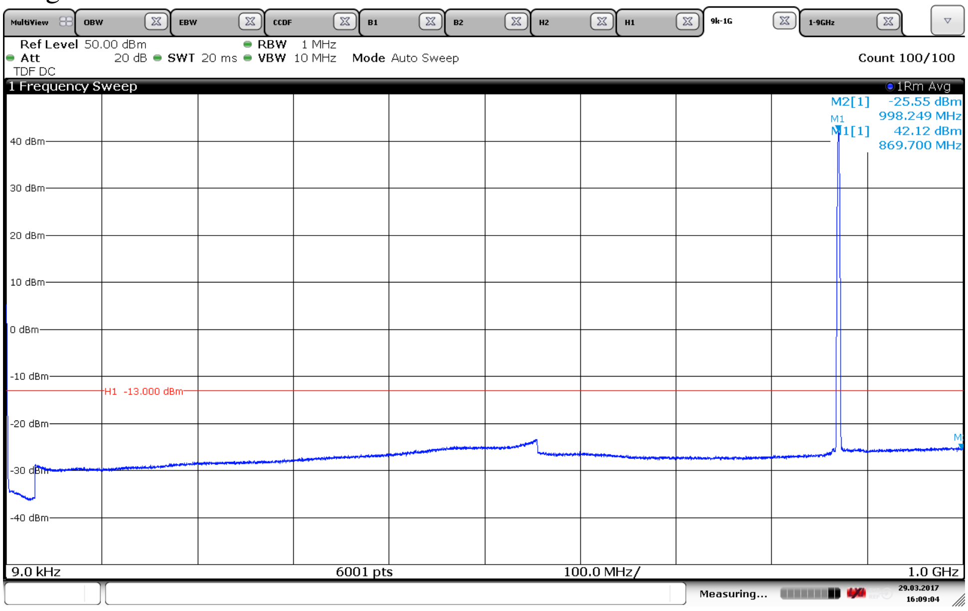
CFR 47 § 22.917: Outside a licensee's frequency band(s) of operation the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB, resulting in a limit of -13 dBm per 100 kHz RBW below 1 GHz and 1MHz RBW above 1 GHz.

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

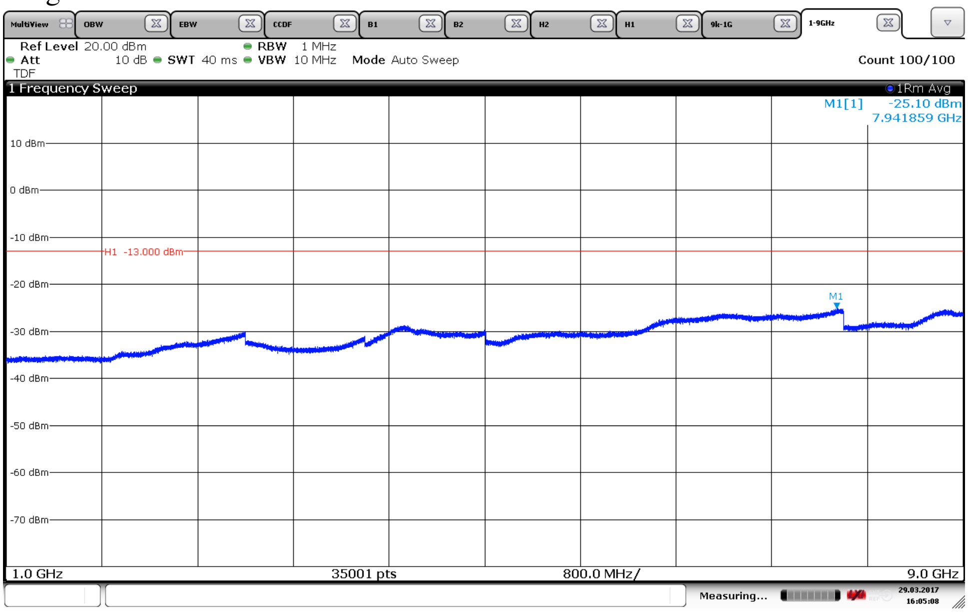
Appendix 5

Diagram 1a:



16:09:05 29.03.2017

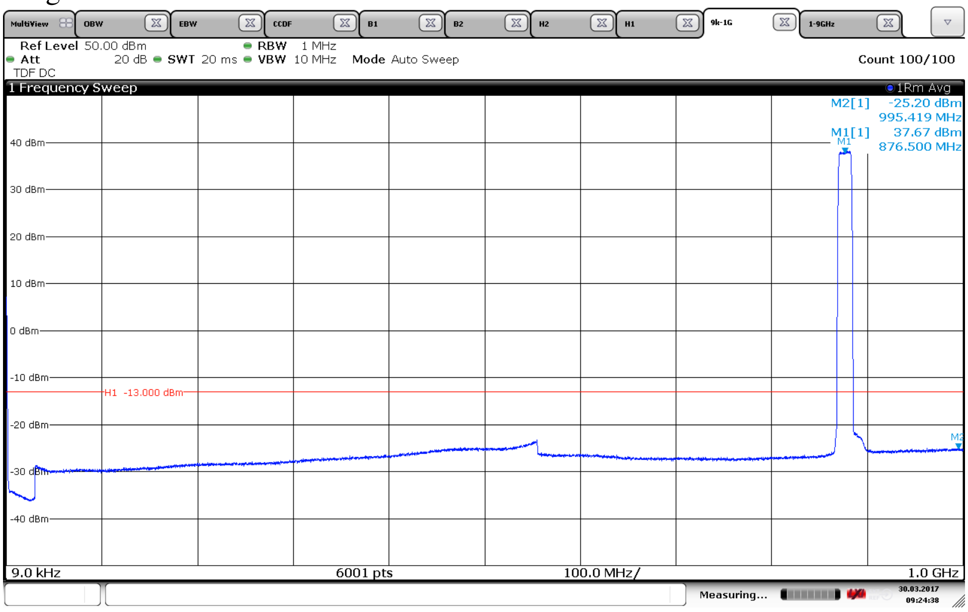
Diagram 1b:



16:05:08 29.03.2017

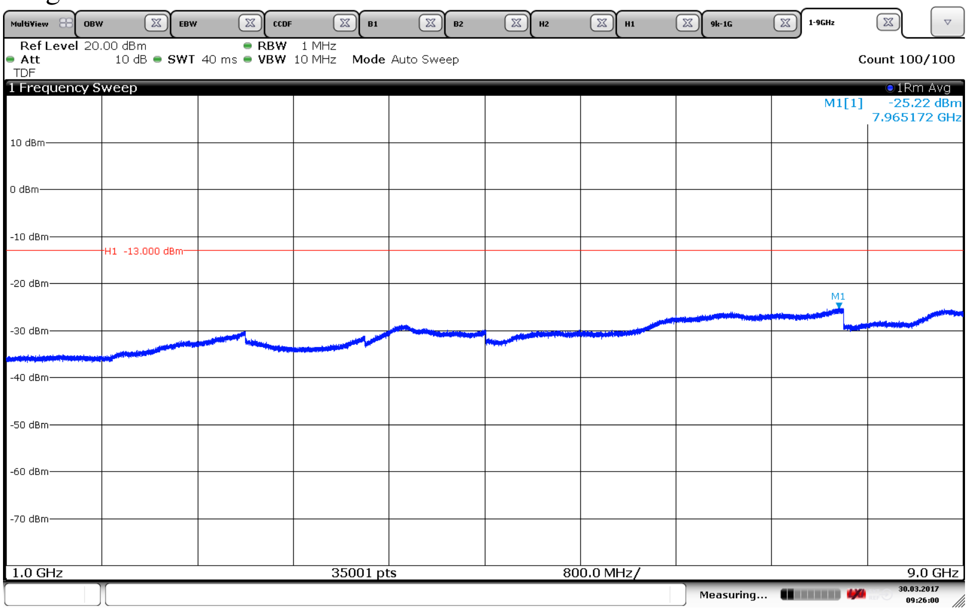
Appendix 5

Diagram 2a:



09:24:39 30.03.2017

Diagram 2b:



09:26:01 30.03.2017

Appendix 5

Diagram 3a:

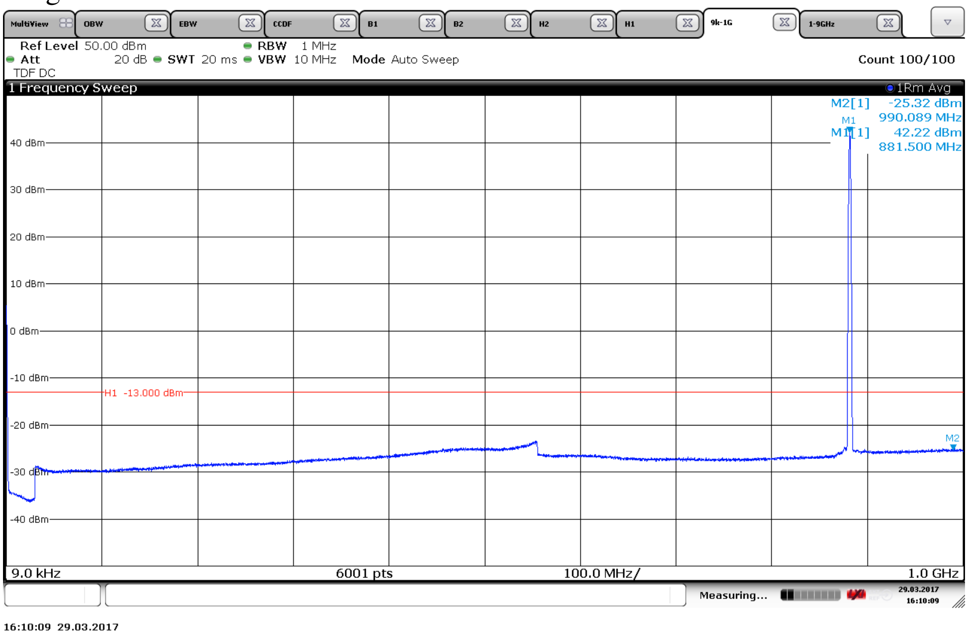
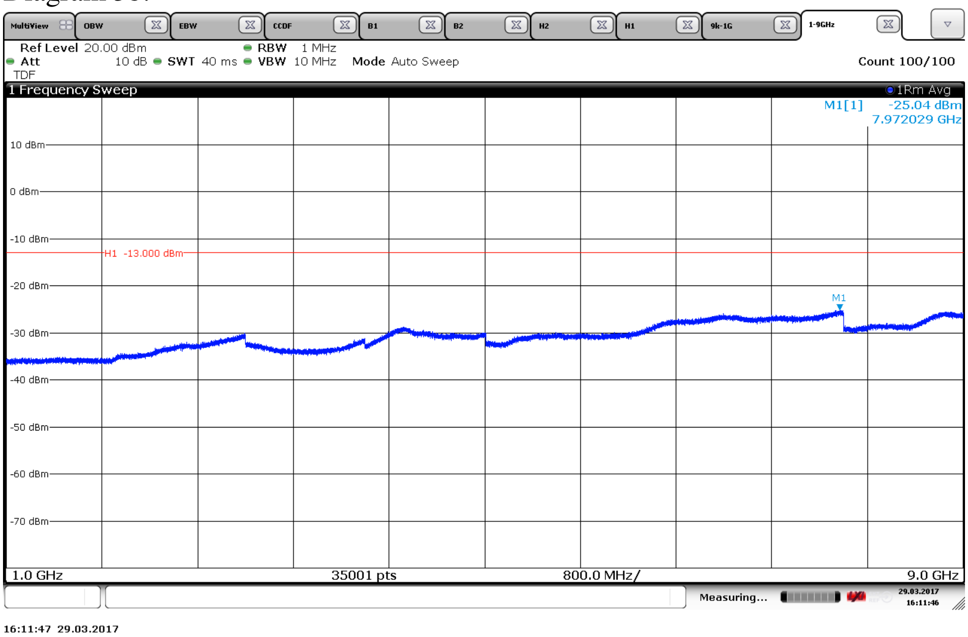
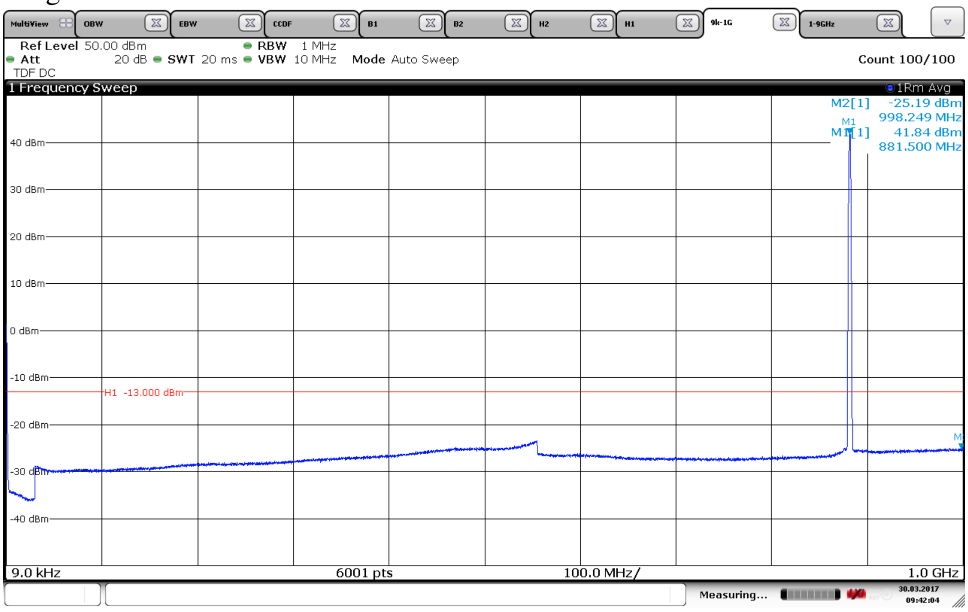


Diagram 3b:



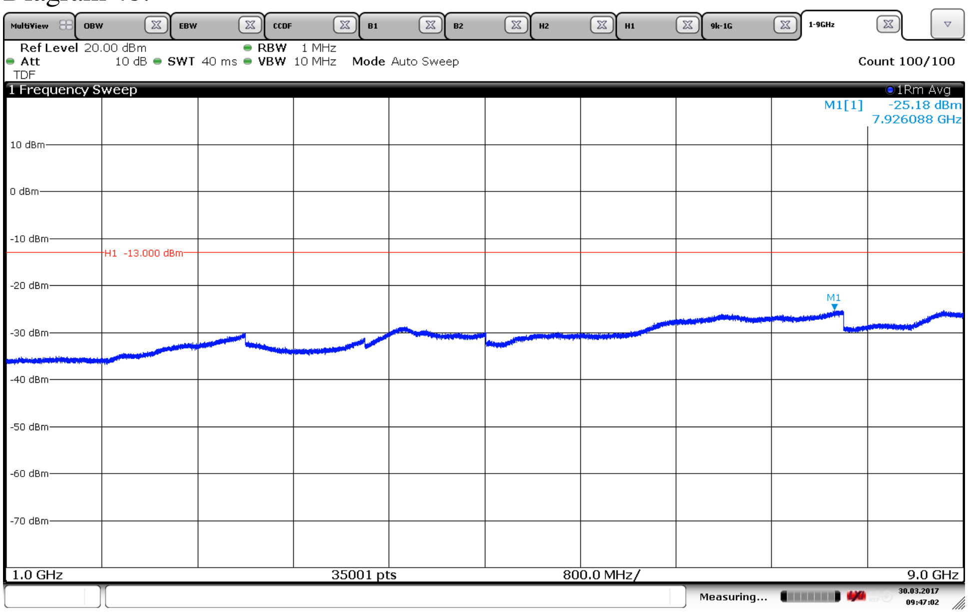
Appendix 5

Diagram 4a:



09:42:04 30.03.2017

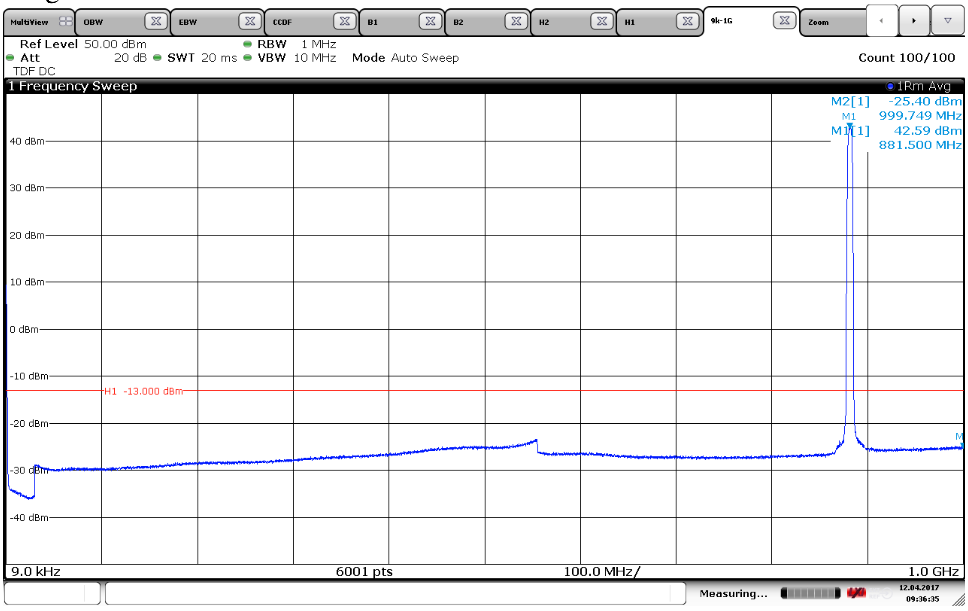
Diagram 4b:



09:47:03 30.03.2017

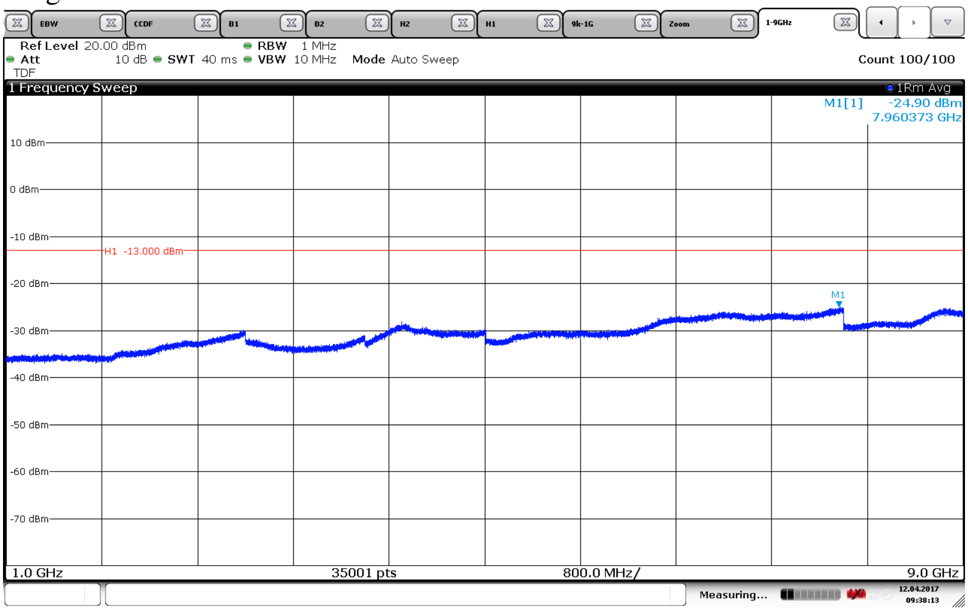
Appendix 5

Diagram 5a:



09:36:35 12.04.2017

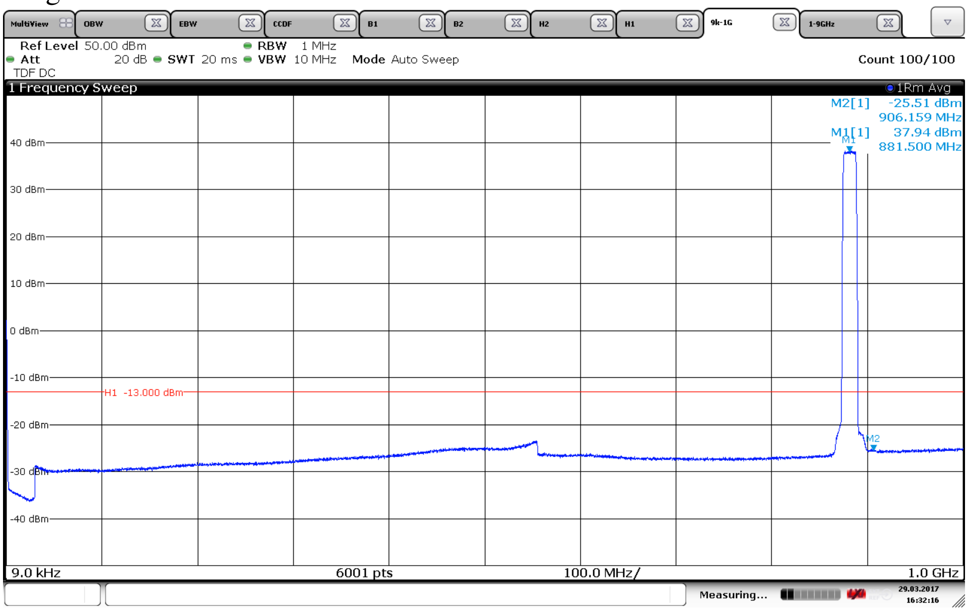
Diagram 5b:



09:38:14 12.04.2017

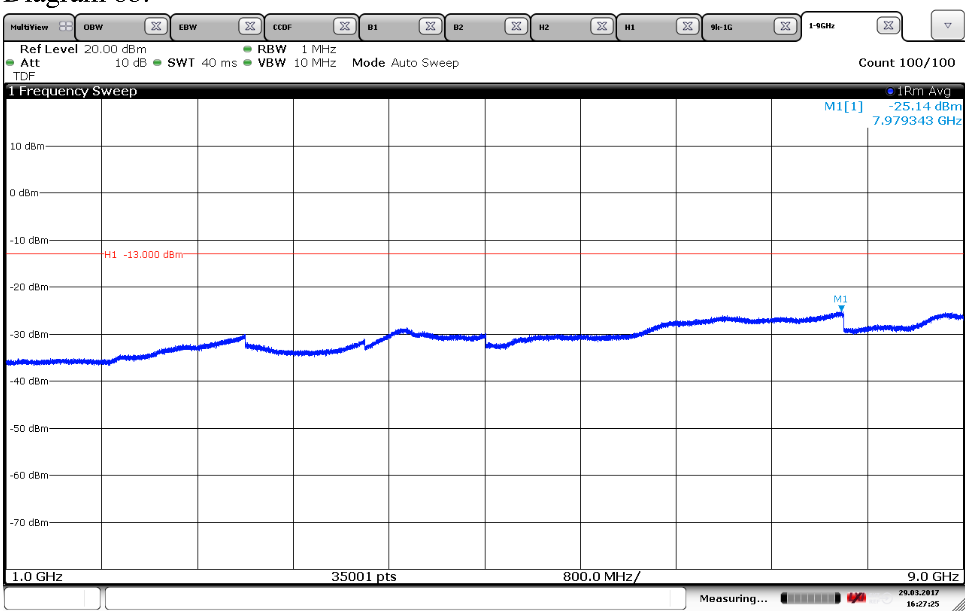
Appendix 5

Diagram 6a:



16:32:16 29.03.2017

Diagram 6b:



16:27:26 29.03.2017

Appendix 5

Diagram 7a:

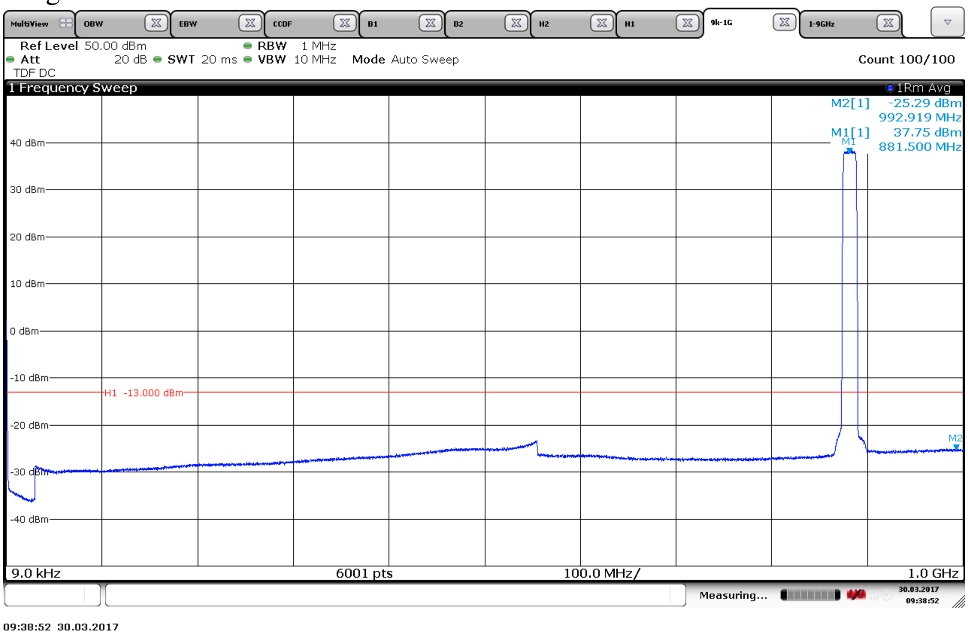
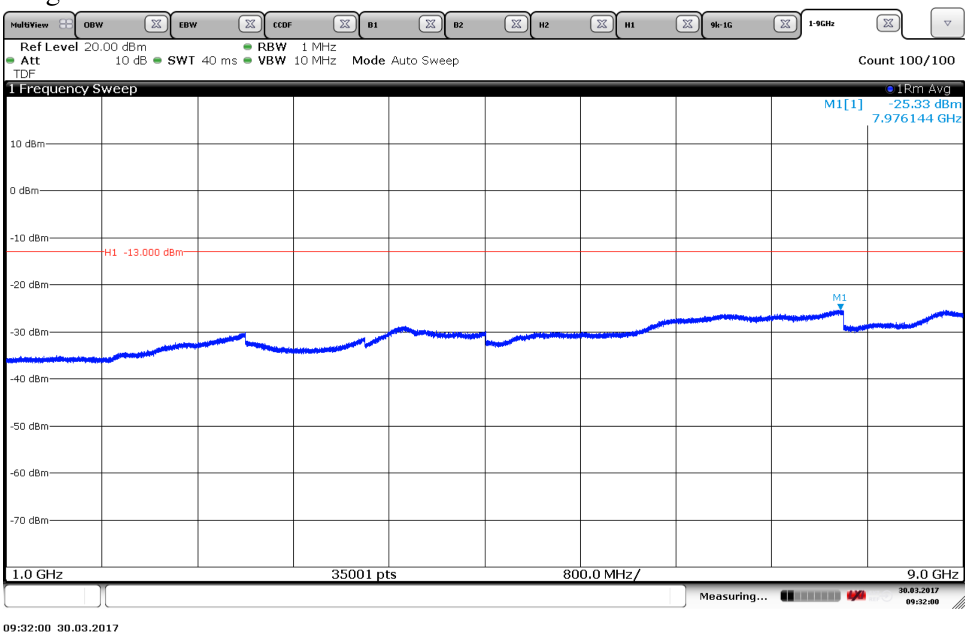


Diagram 7b:



Appendix 5

Diagram 8a:

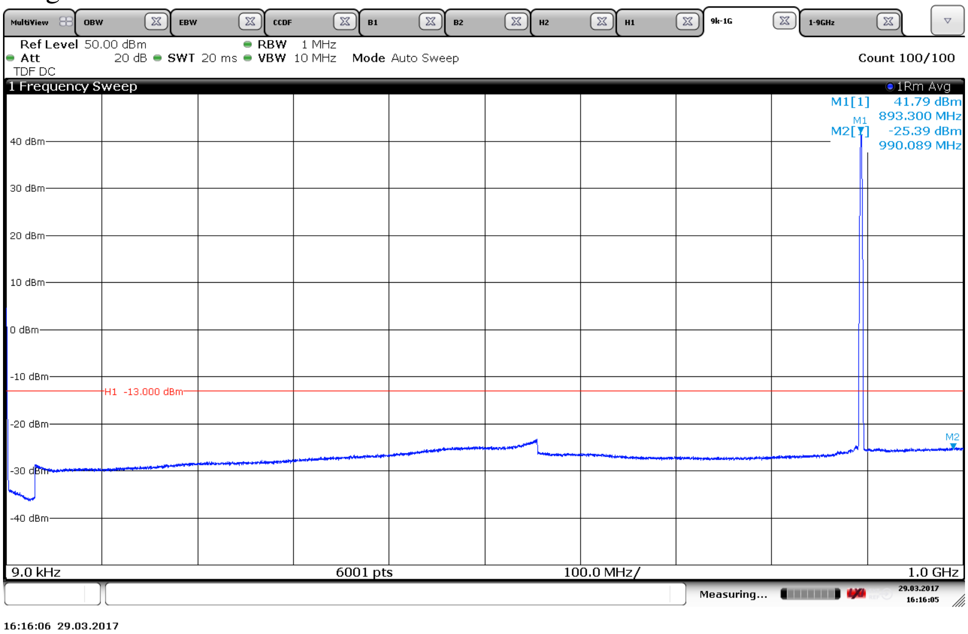
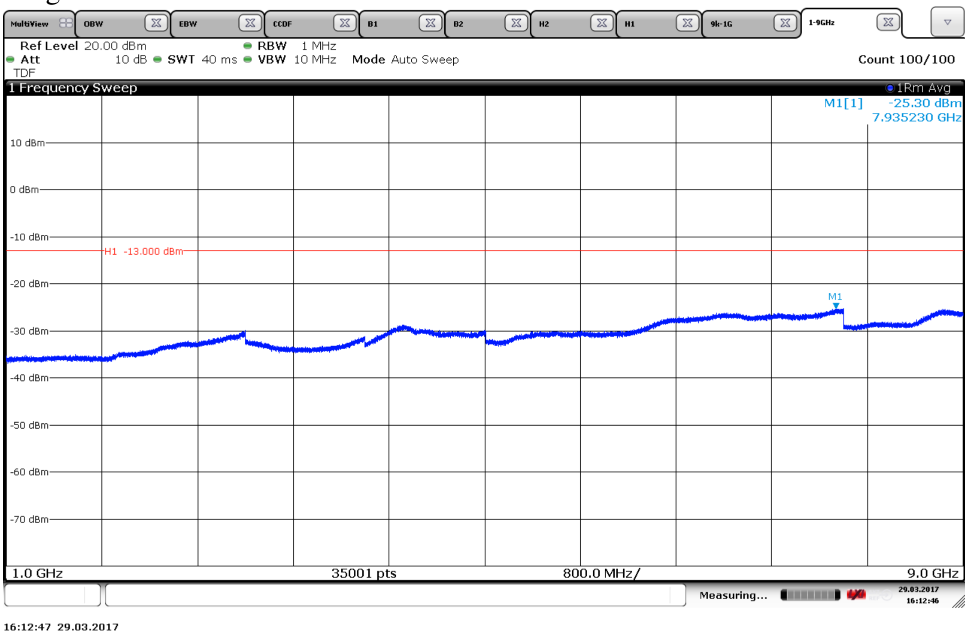
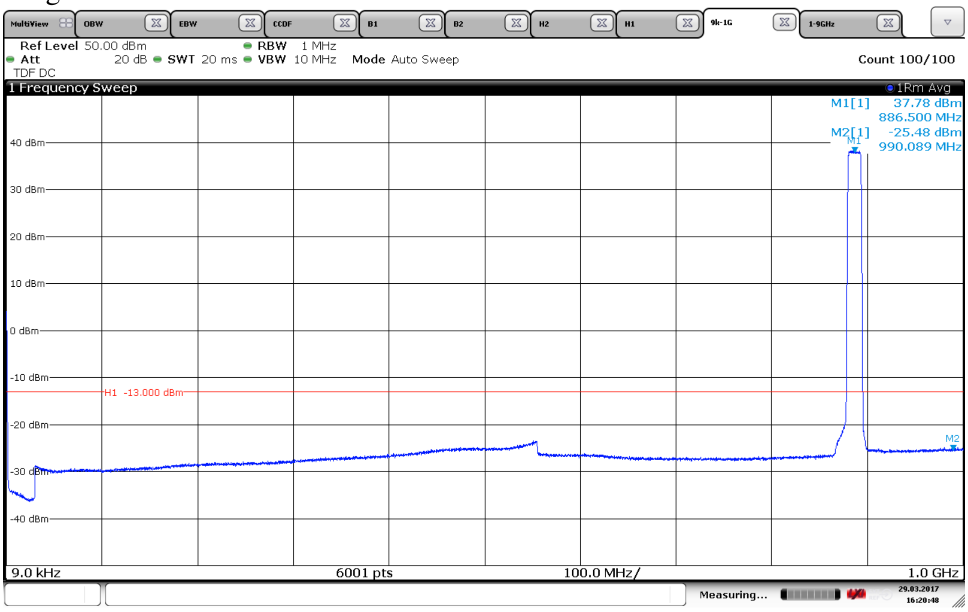


Diagram 8b:



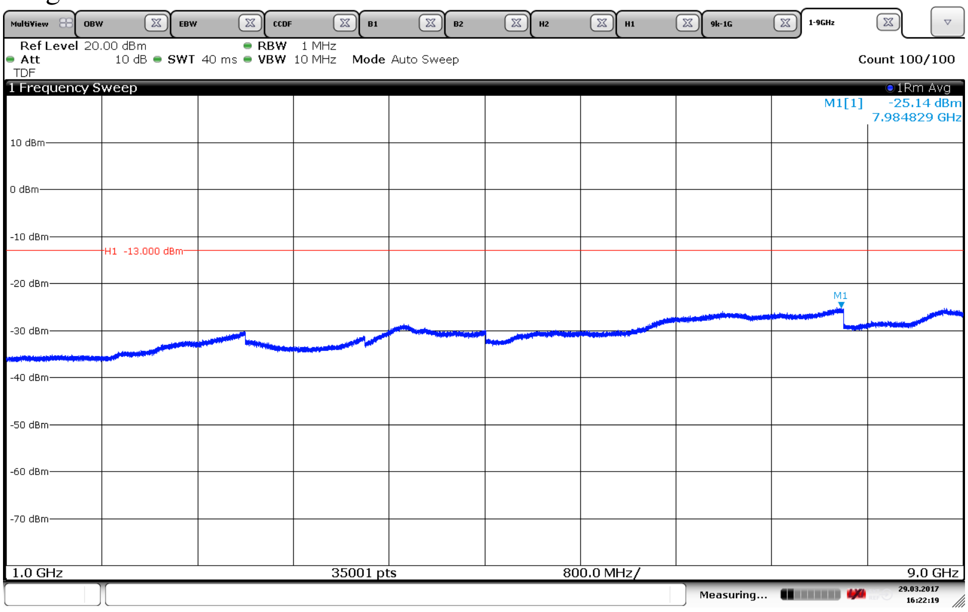
Appendix 5

Diagram 9a:



16:20:48 29.03.2017

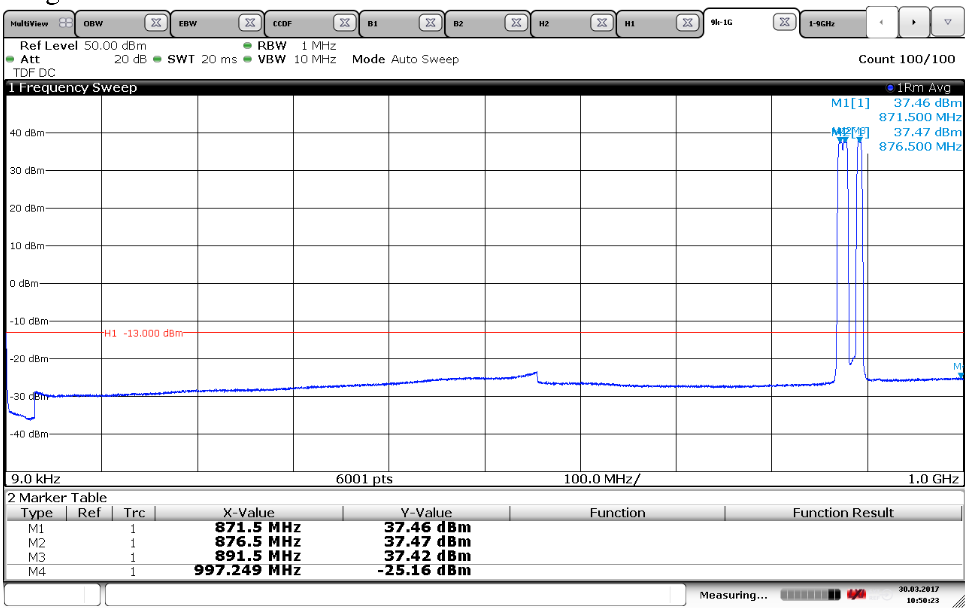
Diagram 9b:



16:22:20 29.03.2017

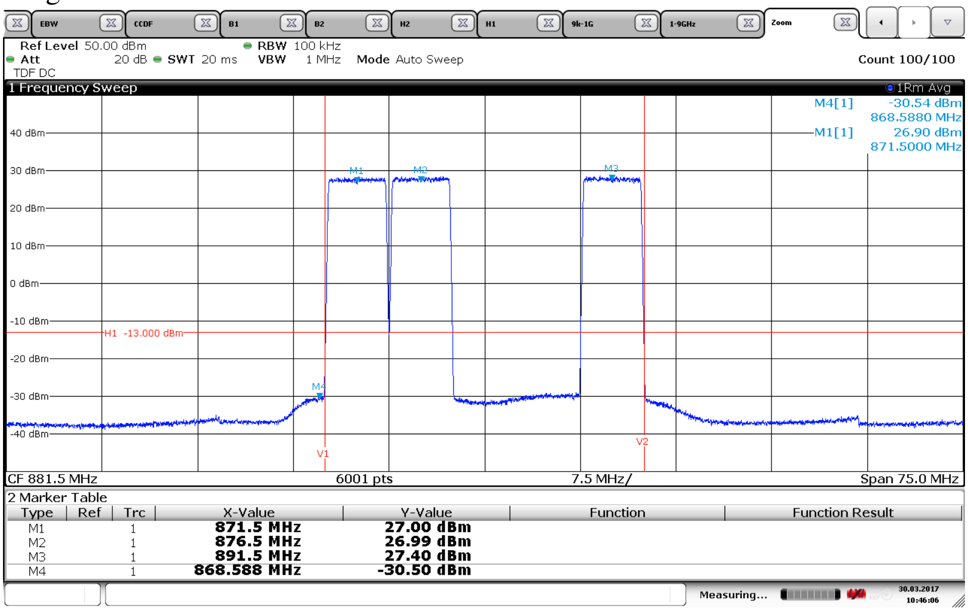
Appendix 5

Diagram 10a:



10:50:23 30.03.2017

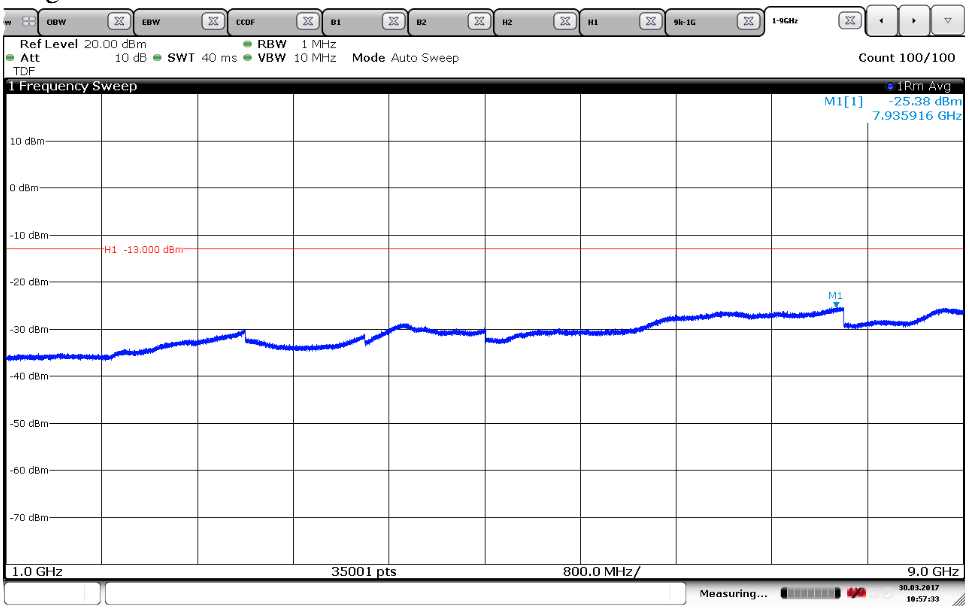
Diagram 10b:



10:46:07 30.03.2017

Appendix 5

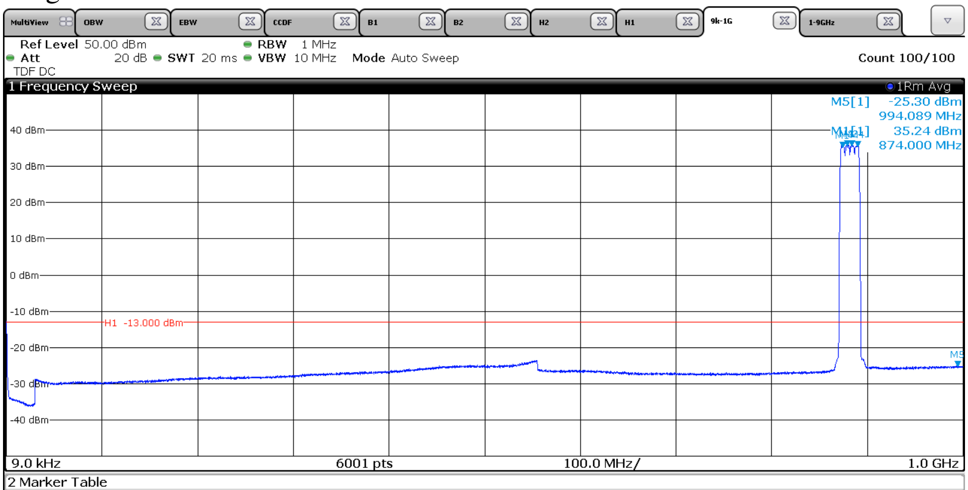
Diagram 10c:



10:57:34 30.03.2017

Appendix 5

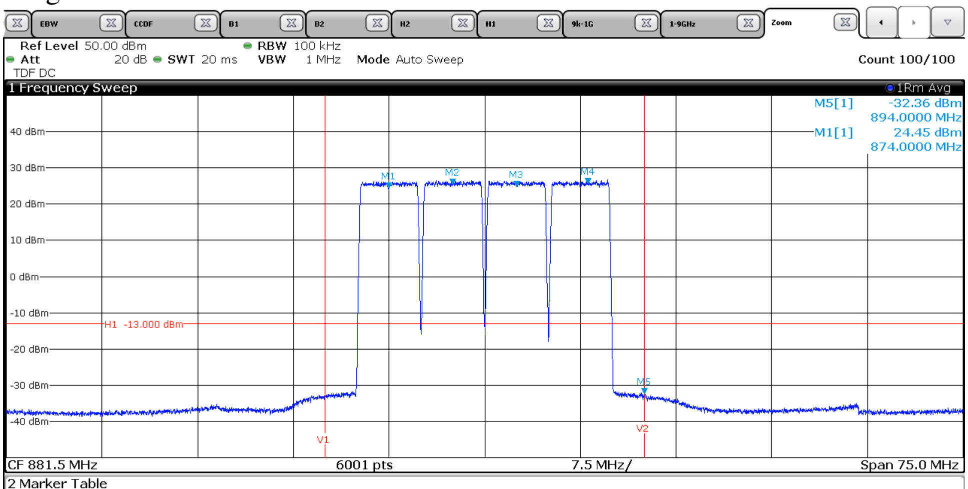
Diagram 11a:



Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	874.0 MHz	35.27 dBm		
M2		1	879.0 MHz	35.55 dBm		
M3		1	884.0 MHz	35.73 dBm		
M4		1	889.599 MHz	35.47 dBm		
M5		1	994.089 MHz	-25.26 dBm		

10:08:18 30.03.2017

Diagram 11b:

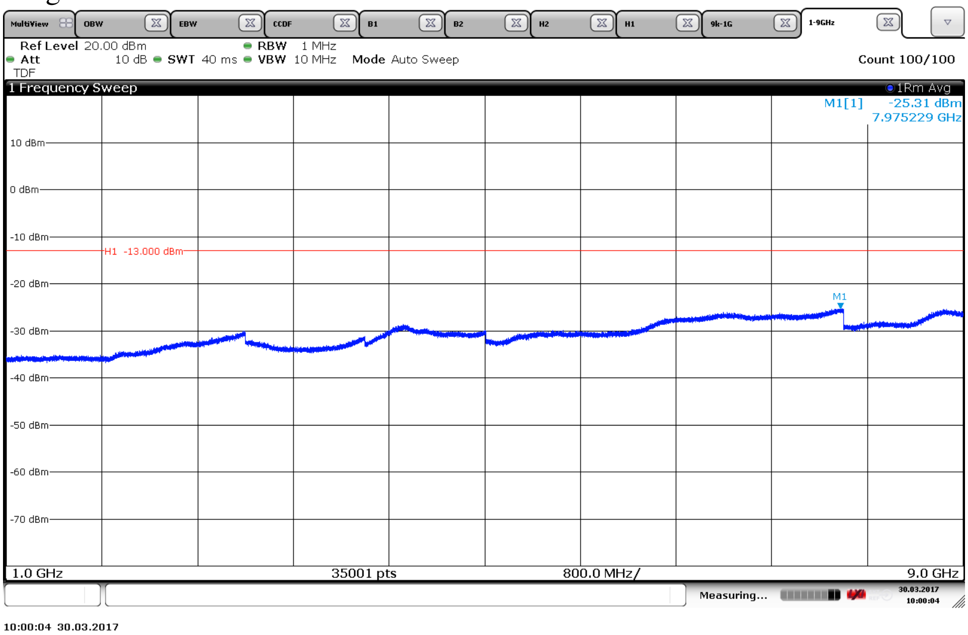


Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	874.0 MHz	24.45 dBm		
M2		1	879.0 MHz	25.48 dBm		
M3		1	884.0 MHz	24.89 dBm		
M4		1	889.6027 MHz	25.69 dBm		
M5		1	894.0 MHz	-32.41 dBm		

10:20:55 30.03.2017

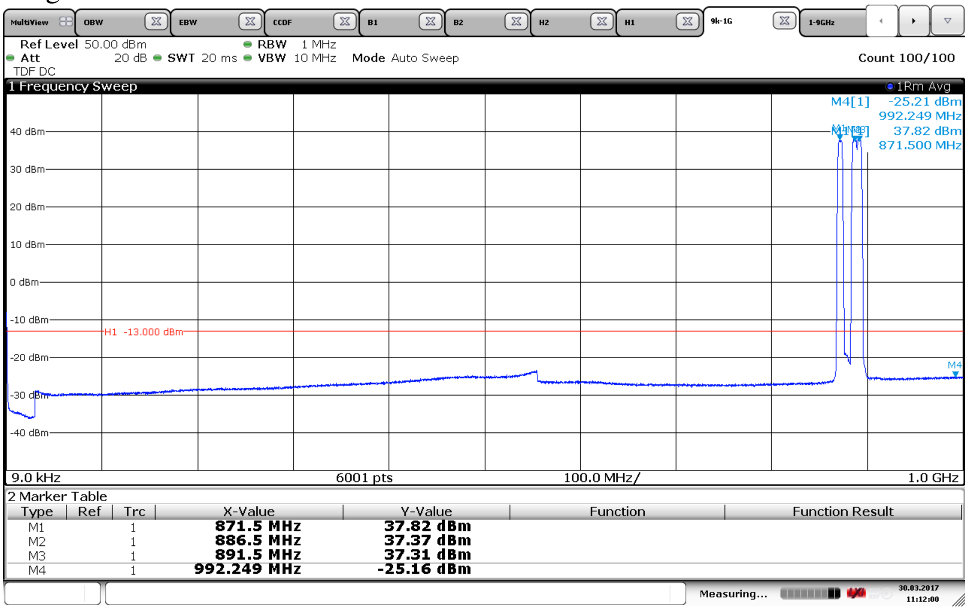
Appendix 5

Diagram 11c:



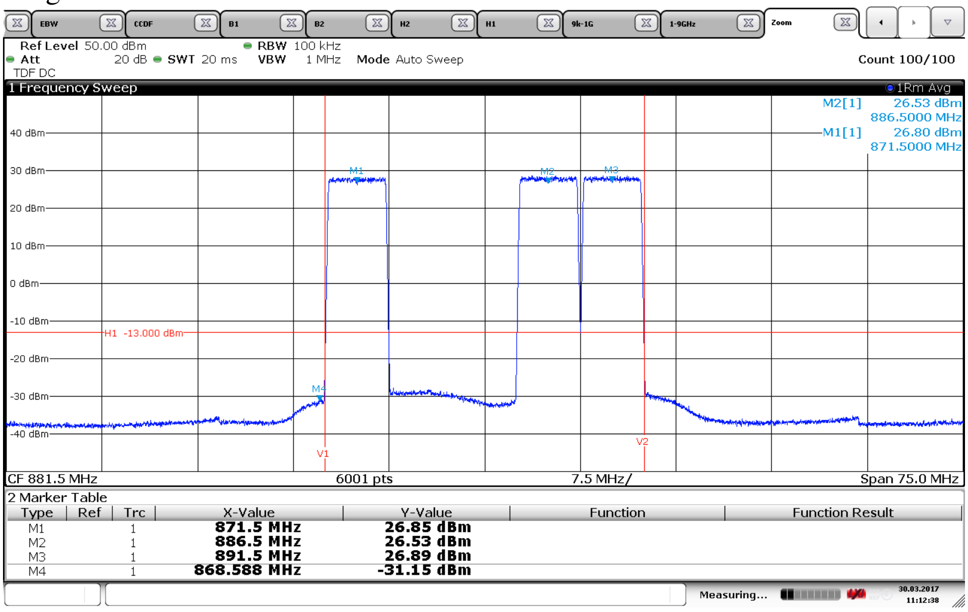
Appendix 5

Diagram 12a:



11:12:00 30.03.2017

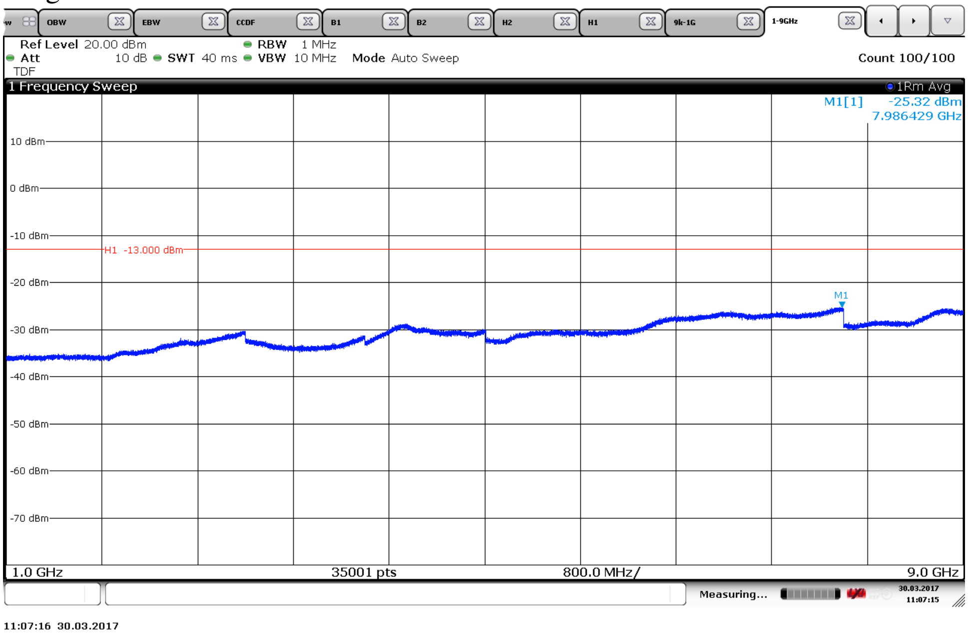
Diagram 12b:



11:12:38 30.03.2017

Appendix 5

Diagram 12c



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

Date	Temperature	Humidity
2017-02-21	22 °C ± 3 °C	31 % ± 5 %
2017-02-24	22 °C ± 3 °C	25 % ± 5 %
2017-01-27	22 °C ± 3 °C	34 % ± 5 %

The test sites are listed at FCC, Columbia with registration number: 93866. 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 – 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.

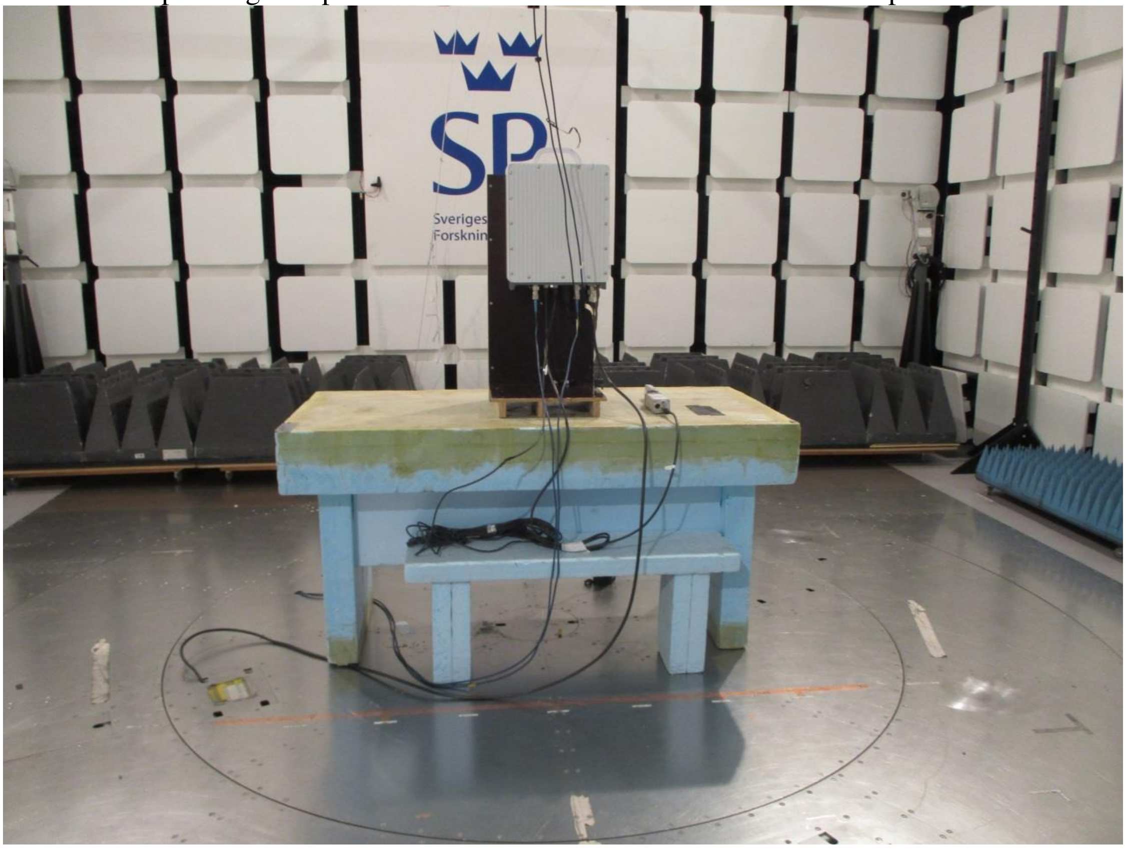
The measurement procedure was as the following:

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. For measurements > 1 GHz the test object was measured in seventeen directions with the antenna at 1.0 m height.
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/TIA/-603-D-2010.

Before comparing the results to the limit, 3 dB [10 log (2)] 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.

Appendix 6

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



Measurement equipment

Measurement equipment	SP number
Semi anechoic chamber Tesla	503 881
R&S ESU 40	901 385
EMC 32 ver. 9.15.0	503 899
ETS Lindgren BiConiLog 3142E	BX61914
ETS Lindgren Horn Antenna 3115	502 175
µComp Nordic, Low Noise Amplifier	901 545
HP Filter 1-18 GHz	901 501
Temperature and humidity meter, Testo 625	504 188

Appendix 6

Test frequencies

Symbolic name
B_{L5}
$M_{L1.4}$
M_{L3}
M_{L5}
M_{L10}
M_{L15}
T_{L5}
M_{L5+IoT}
$BIM_{L1.4}$
TIM_{L5}
$M4_{L5RAD}$

Results

Representing worst case:

Single RAT LTE, symbolic name M_{L5}, Test Model: E-TM1.1, 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

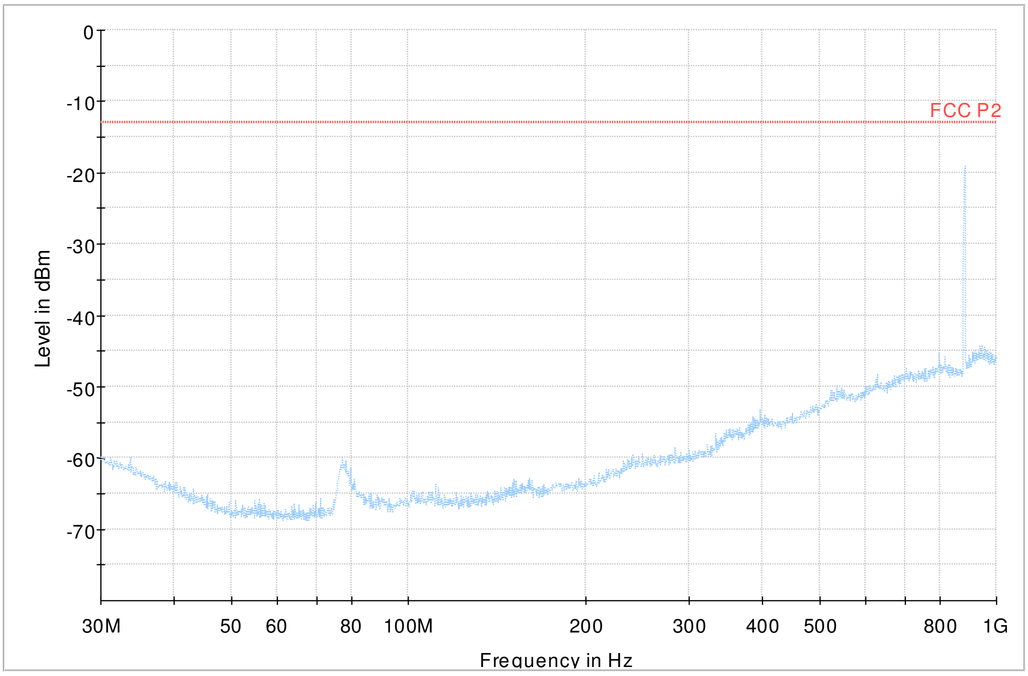
CFR 47 §22.917 and IC RSS-132 5.6

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

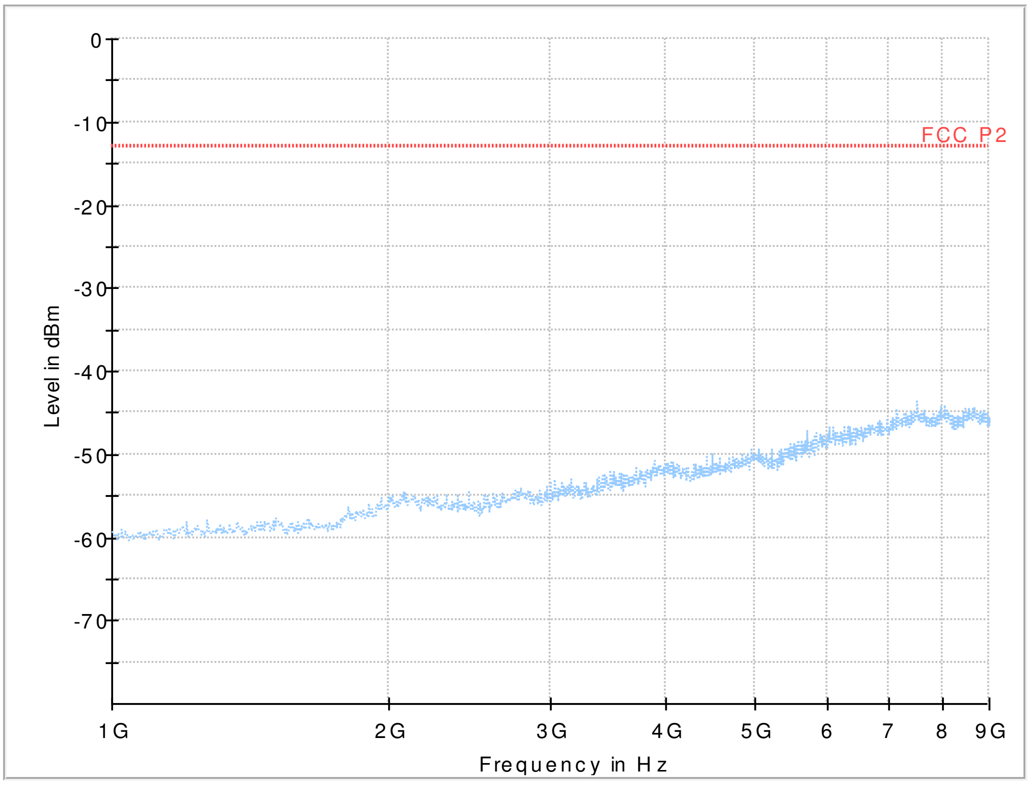
Appendix 6

Diagram 1a:



Note: The emission at 880 MHz to 883 MHz are the carrier frequencies and shall be ignored in the context.

Diagram 1b:



Appendix 7

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

Date	Temperature	Humidity
2017-04-06	22 °C ± 3 °C	24 % ± 5 %
2017-04-07	24 °C ± 3 °C	29 % ± 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.

Measurement equipment	SP number
R&S FSQ	504 143
EAB RF attenuator	-
Temperature Chamber	501 031
Testo 635, temperature and humidity meter	504 203
Multimeter Fluke 87	502 190

Results

Nominal Voltage: -48 V DC

Maximum output power at mid channel (M_{L5})

Channel Bandwidth: 5MHz

Test conditions		Frequency error (Hz)
Supply voltage DC (V)	T (°C)	Test model E-TM3.1A
-48.0	+20	3
-55.2	+20	4
-40.8	+20	4
-48.0	+30	5
-48.0	+40	3
-48.0	+50	6
-48.0	+10	5
-48.0	0	5
-48.0	-10	4
-48.0	-20	3
-48.0	-30	4
Maximum freq. error (Hz)		6
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 from which the TX frequency derives.

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

Appendix 8

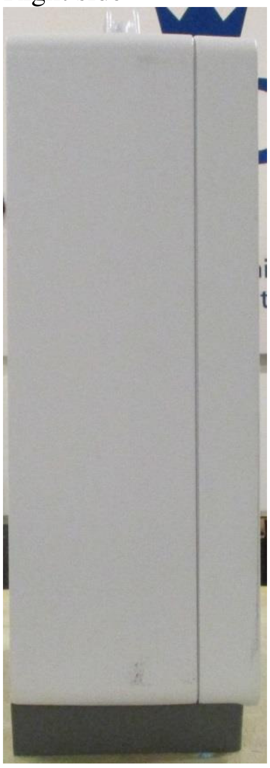
External photos

Front side

Rear side

Left side

Right side

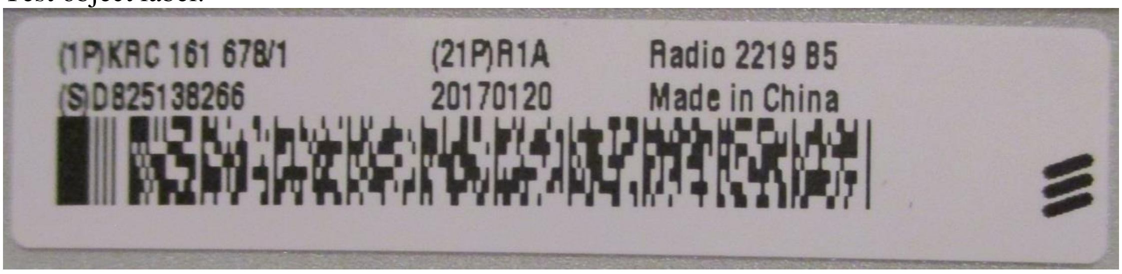


Appendix 8

Top side

Bottom side

Test object label:



SFP module: