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Test Report

Report Number: F136117E3

Applicant:

u-blox Malmö AB

Manufacturer:

u-blox Malmö AB

Equipment under Test (EUT):

ODIN-W160

Laboratory accredited by
Deutsche Akkreditierungsstelle GmbH (DAkkS)
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. D-PL-17186-01-02,
FCC Test site registration number 90877 and
Industry Canada Test site registration IC3469A-1

REFERENCES

[1] **ANSI C63.4-2009** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

[2] **FCC CFR 47 Part 15 (March 2014)** Radio Frequency Devices

[3] **Publication Number 789033 (April 2013)** UNII Meas Guidelines v01r03

[4] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

[5] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radiocommunication Equipment

[6] **Publication Number 662911 (May 2013)** Emission Testing of Transmitters with Multiple Outputs in the Same Band v02

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

Test engineer:	Paul NEUFELD		10 July 2014
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		10 July 2014
	Name	Signature	Date

RESERVATION

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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1 IDENTIFICATION

1.1 Applicant

Name:	u-blox Malmö AB
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Country:	Sweden
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Phone:	+ 46 40 63 07 100
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Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	u-blox Malmö AB
Address:	Norra Vallgatan 64 3V, SE-211 22 Malmö
Country:	Sweden
Name for contact purposes:	Mr. Mats Andersson
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	mats.andersson@u-blox.com
Manufacturer represented during the test by the following person:	None

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
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32825 Blomberg
Germany

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under the Reg. No. D-PL-17186-01-02, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	WLAN module
Type: *	ODIN-W160
FCC ID: *	**PVH0953**
IC: *	**5325A-0953**
Serial number: *	WLAN: 292006260218, 292006259621, 292006259601, 292006260221
PCB identifier: *	0953-03
Hardware version: *	3.1
Software version: *	cB-2282(wlan_pcti_release_1.0.13605)

Channel 01	RX:	2412 MHz	TX:	2412 MHz
Channel 02	RX:	2417 MHz	TX:	2417 MHz
Channel 03	RX:	2422 MHz	TX:	2422 MHz
Channel 04	RX:	2427 MHz	TX:	2427 MHz
Channel 05	RX:	2432 MHz	TX:	2432 MHz
Channel 06	RX:	2437 MHz	TX:	2437 MHz
Channel 07	RX:	2442 MHz	TX:	2442 MHz
Channel 08	RX:	2447 MHz	TX:	2447 MHz
Channel 09	RX:	2452 MHz	TX:	2452 MHz
Channel 10	RX:	2457 MHz	TX:	2457 MHz
Channel 11	RX:	2462 MHz	TX:	2462 MHz

Channel 36	RX:	5180 MHz	TX:	5180 MHz
Channel 40	RX:	5200 MHz	TX:	5200 MHz
Channel 44	RX:	5220 MHz	TX:	5220 MHz
Channel 48	RX:	5240 MHz	TX:	5240 MHz

Channel 52	RX:	5260 MHz	TX:	5260 MHz
Channel 56	RX:	5280 MHz	TX:	5280 MHz
Channel 60	RX:	5300 MHz	TX:	5300 MHz
Channel 64	RX:	5320 MHz	TX:	5320 MHz

Channel 100	RX:	5500 MHz	TX:	5500 MHz
Channel 104	RX:	5520 MHz	TX:	5520 MHz
Channel 108	RX:	5540 MHz	TX:	5540 MHz
Channel 112	RX:	5560 MHz	TX:	5560 MHz
Channel 116	RX:	5580 MHz	TX:	5580 MHz

Channel 132	RX:	5660 MHz	TX:	5660 MHz
Channel 136	RX:	5680 MHz	TX:	5680 MHz
Channel 140	RX:	5700 MHz	TX:	5700 MHz

Channel 149	RX:	5745 MHz	TX:	5745 MHz
Channel 153	RX:	5765 MHz	TX:	5765 MHz
Channel 157	RX:	5785 MHz	TX:	5785 MHz
Channel 161	RX:	5805 MHz	TX:	5805 MHz
Channel 165	RX:	5825 MHz	TX:	5825 MHz

Fulfills WLAN specification: *	IEEE, 802.11b, 802.11g, 802.11n, 802.11a					
Antenna type: *	See Table 1					
Antenna gain: *	See Table 1					
Antenna connector: *	See Table 1					
Power supply - EUT	3.3 V DC					
Power supply Host	U_{nom}=	5 V DC	U_{min}=	3.6 V DC	U_{max}=	6 V DC
Type of modulation: *	802.11a:OFDM 802.11b: CCK, DQPSK, DBPSK 802.11g: OFDM 802.11n: OFDM					
Operating frequency range:*	2412 MHz to 2462 MHz, 5180 MHz to 5240 MHz, 5260 MHz to 5320 MHz, 5500 MHz to 5700 MHz, 5745 to 5825 MHz					
Number of channels: *	32					
Temperature range: *	-40 °C to +85 °C					
Lowest / highest Internal clock frequency: *	32768 Hz / 26.000 MHz					

* declared by the applicant.

Table 1 Antenna specifications

Antenna name	Manufacturer	Type	Comment	Gain [dBi]
WCR-2400 -IP04 -IP10 -SMA -SMRP	Centurion	Monopole	10cm flying lead U.FL 25cm flying lead U.FL SMA RSMA	2 dBi @ 2.4 GHz
SDM2-2400/1575	Mobile Mark	Patch	flying lead U.FL	2 dBi @ 2.4 GHz
PSTG0-2400HS	Mobile Mark	Monopole	SMA/RSMA	0 dBi @ 2.4 GHz
FlatWhip-2400	ProAnt	Monopole	SMA/RSMA	3 dBi @ 2.4 GHz
“InSide-EPA 2400”	ProAnt	Patch	circular polarization	3 dBi @ 2.4 GHz
“InSide-EPA-WLAN”	ProAnt	Patch	circular polarization	3 dBi @ 5 GHz
InSide-2400	ProAnt	Patch	10cm flying lead U.FL	3 dBi @ 2.4 GHz
InSide-WLAN	ProAnt	Patch	dual band 10cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
Outside-2400	ProAnt	Patch	10 cm flying lead U.FL 25 cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT 2400 -SMA 28-001 -RP-SMA 28-001 - MHF 28-001	ProAnt	Monopole	SMA RSMA 10 cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT WLAN - SMA - RP-SMA -MHF	ProAnt	Monopole	dual band SMA RSMA 10cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
Ex-IT 2400 -MHF 70-001	ProAnt	Monopole	10cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT 2400 -SMA 70-002 -RP-SMA 70-002	ProAnt	Monopole	SMA RSMA	3 dBi @ 2.4 GHz
InSide Fold-2400	ProAnt	Patch	10 cm flying lead U.FL	3 dBi @ 2.4 GHz
InSide Fold-WLAN	ProAnt	Patch	10 cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
InSide-WLAN Square	ProAnt	Patch	10 cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz

The following external I/O cables were used:

Identification	Length
DC power cable	2 m *
RS232 cable	2 m *

*: Length during the test if not other specified.

1.5 Dates

Date of receipt of test sample:	21 January 2014
Start of test:	21 January 2014
End of test:	04 April 2014

2 OPERATIONAL STATES

The equipment under test (EUT) is a WLAN dual band and Bluetooth dual mode module soldered on to a carrier board. The WLAN / Bluetooth module is equipped with an U.FL. antenna connector.
A RS232 connector and the power supply connector are located at the carrier board.

The tests were carried out with an unmodified sample of the EUT. Parts of the tests were carried out conducted at the antenna port. If the conducted tests did not pass, the measurements were repeated as radiated tests with the dedicated antennas attached.
Additionally a radiated measurement of the housing emission was performed while the antenna port is terminated by a 50 Ω resistor.

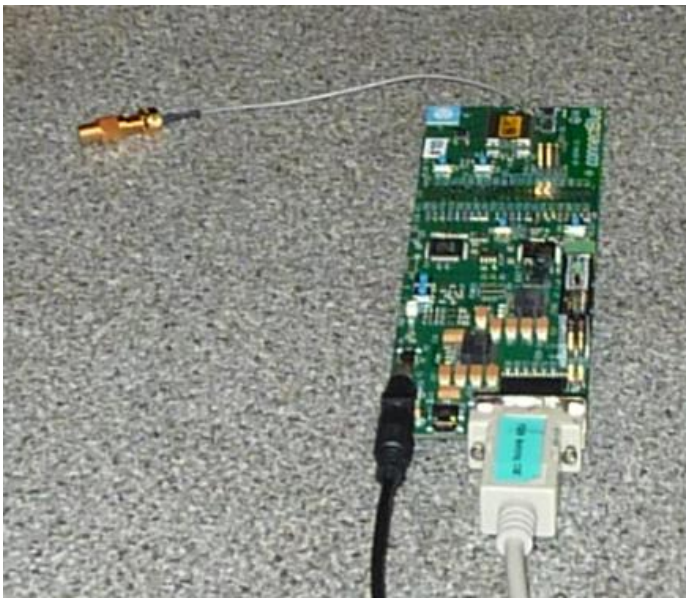
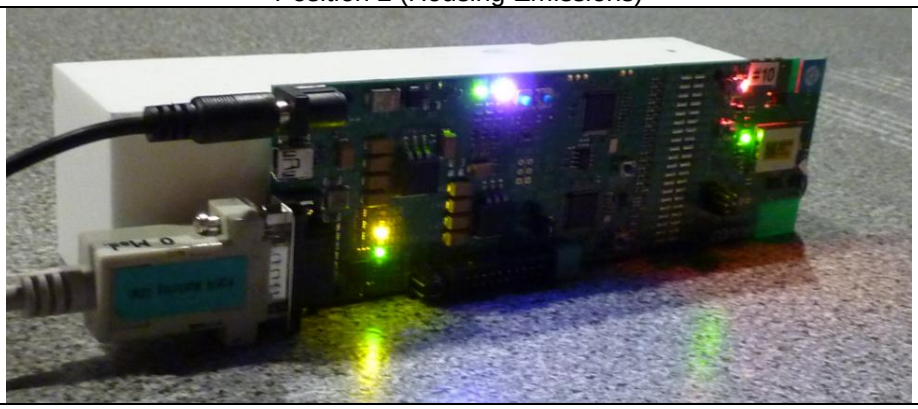
The carrier board was connected via a RS232 connection to a laptop computer. With a testsoftware running on the laptop the operation mode as seen in the table below could be chosen.

During the tests, the test samples were powered with 5 V via the power supply connection of the carrier board from a laboratory power supply.

The following operation modes were identified as worst case condition and used during the tests:

Operation mode	Description of the operation mode	WLAN mode	WLAN channel	Modulation	Data rate / Mbps
1	Continuous transmitting on 5180 MHz	a	36	OFDM	6 MBit/s
2	Continuous transmitting on 5200 MHz	a	40	OFDM	6 MBit/s
3	Continuous transmitting on 5240 MHz	a	48	OFDM	6 MBit/s
4	Continuous transmitting on 5260 MHz	a	52	OFDM	6 MBit/s
5	Continuous transmitting on 5300 MHz	a	60	OFDM	6 MBit/s
6	Continuous transmitting on 5320 MHz	a	64	OFDM	6 MBit/s
7	Continuous transmitting on 5500 MHz	a	100	OFDM	6 MBit/s
8	Continuous transmitting on 5580 MHz	a	116	OFDM	6 MBit/s
9	Continuous transmitting on 5700 MHz	a	140	OFDM	6 MBit/s
10	Continuous transmitting on 5180 MHz	n20	36	OFDM	6 MBit/s
11	Continuous transmitting on 5200 MHz	n20	40	OFDM	6.5 MBit/s
12	Continuous transmitting on 5240 MHz	n20	48	OFDM	6.5 MBit/s
13	Continuous transmitting on 5260 MHz	n20	52	OFDM	6.5 MBit/s
14	Continuous transmitting on 5300 MHz	n20	60	OFDM	6.5 MBit/s
15	Continuous transmitting on 5320 MHz	n20	64	OFDM	6.5 MBit/s
16	Continuous transmitting on 5500 MHz	n20	100	OFDM	6.5 MBit/s
17	Continuous transmitting on 5580 MHz	n20	116	OFDM	6.5 MBit/s
18	Continuous transmitting on 5700 MHz	n20	140	OFDM	6.5 MBit/s

Table 2 Worst case test setup

Position 1 (Housing Emissions)	Position 3 (Housing Emissions)
	
Position 2 (Housing Emissions)	
	

Preliminary tests were performed to find worst-case configuration and position. The radiated emission measurements were carried out in the orthogonal direction that emits the highest spurious emission levels.

The following test modes were adjusted during the tests:

Test items	Operation mode
Maximum Peak Output Power	1 - 18
DTS Bandwidth	1 - 18
Peak Power Spectral Density	1 - 18
Band Edge Compliance	1, 3, 4, 6, 7, 9, 10, 12, 13, 15, 16, 18
Maximum Unwanted Emissions	1 - 18

3 ADDITIONAL INFORMATION

The power was set to the values shown in the table below.

Channel	36 - 48	52 - 64	100	104 - 136	140	149 - 165
Power a/n20 modes (for 5 GHz)	13.5	16.0	15.0	14.5	13.0	18.0

This report contains the results of the EUT operating in the 5 GHz UNII band only.

4 OVERVIEW

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 8 [4] or RSS-Gen, Issue 3 [5]	Status	Refer page
Maximum Peak Output Power	5150 – 5250 5250 – 5350 5470 - 5725	15.407 (a)	A9.2 [4]	Passed	12 et seq
UNII Bandwidth	5150 – 5250 5250 – 5350 5470 - 5725	15.403 (i)	A9.2 [4]	Passed	14 et seq
Peak Power Spectral Density	5150 – 5250 5250 – 5350 5470 - 5725	15.407 (a)(5)	A9.2 [4]	Passed	16 et seq
Peak Excursion	5150 – 5250 5250 – 5350 5470 - 5725	15.407 (b)	A9.3 [4]	Passed	19 et seq
Frequency Stability	5150 – 5250	15.407 (g)	A9.5 [4]	Passed	22 et seq
Band edge compliance	5150 – 5250 5250 – 5350 5470 - 5725	15.407 (b)	A8.5 [4]	Passed	24 et seq.
Radiated emissions (transmitter)	0.009 - 40,000	15.407 (b) 15.205 (a) 15.209 (a)	7.2.2 [5], 2.5 [4]	Passed	29 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.4 [5]	Passed	63 et seq.

5 TEST RESULTS

5.1 Maximum conducted output power

5.1.1 Method of measurement

The EUT has to be connected to the power meter via a low loss cable.

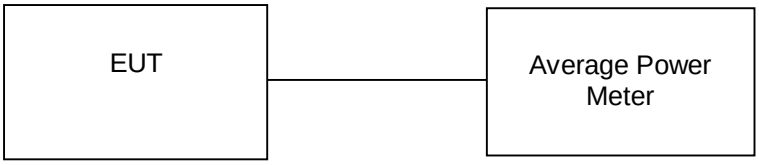
Acceptable measurement configurations

The measurement procedures described herein are based on the use of an antenna-port conducted test configuration.

“Measurement using a power meter (PM)” was used for this test. The procedure is described in chapter E)3)a) of document [3].

The measurement will be performed at the upper and lower end and the middle of the assigned frequency band.

Test set-up:



5.1.2 Test results

Ambient temperature	22 °C

Relative humidity	62 %

The highest antenna gain is 3 dBi. Therefore no reduction of the power limit is necessary.

Operation Mode	Nominal Channel frequency	Antenna gain combined [dBi]	Maximum output power [dBm]	Margin [dB]	power limit [dBm]	Power limit calculated from 26 dB Bandwidth
1	5180 MHz	3	12.3	4.7	17	18.00
2	5200 MHz	3	13.1	3.9	17	18.25
3	5240 MHz	3	12.9	4.1	17	18.15
4	5260 MHz	3	15.2	8.8	24	26.48
5	5300 MHz	3	15.1	8.9	24	26.45
6	5320 MHz	3	13.8	10.2	24	25.67
7	5500 MHz	3	15.1	8.9	24	25.70
8	5580 MHz	3	14.6	9.4	24	26.63
9	5700 MHz	3	13.0	11.0	24	24.82
10	5180 MHz	3	12.2	4.8	17	18.20
11	5200 MHz	3	12.9	4.1	17	18.59
12	5240 MHz	3	12.9	4.1	17	18.53
13	5260 MHz	3	15.1	8.9	24	26.74
14	5300 MHz	3	15.1	8.9	24	26.65
15	5320 MHz	3	13.7	10.3	24	25.93
16	5500 MHz	3	14.5	9.5	24	25.67
17	5580 MHz	3	14.5	9.5	24	26.90
18	5700 MHz	3	12.8	11.2	24	25.05
Measurement uncertainty			+0.66 dB / -0.72 dB			

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

26, 27

5.2 UNII Bandwidth

5.2.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part C) of document [3].

- Set RBW = approximately 1% of the emission bandwidth.
- Set the VBW > RBW.
- Detector = Peak.
- Trace mode = max hold.
- Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyser. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

The measurements were carried out at each antenna port separately.

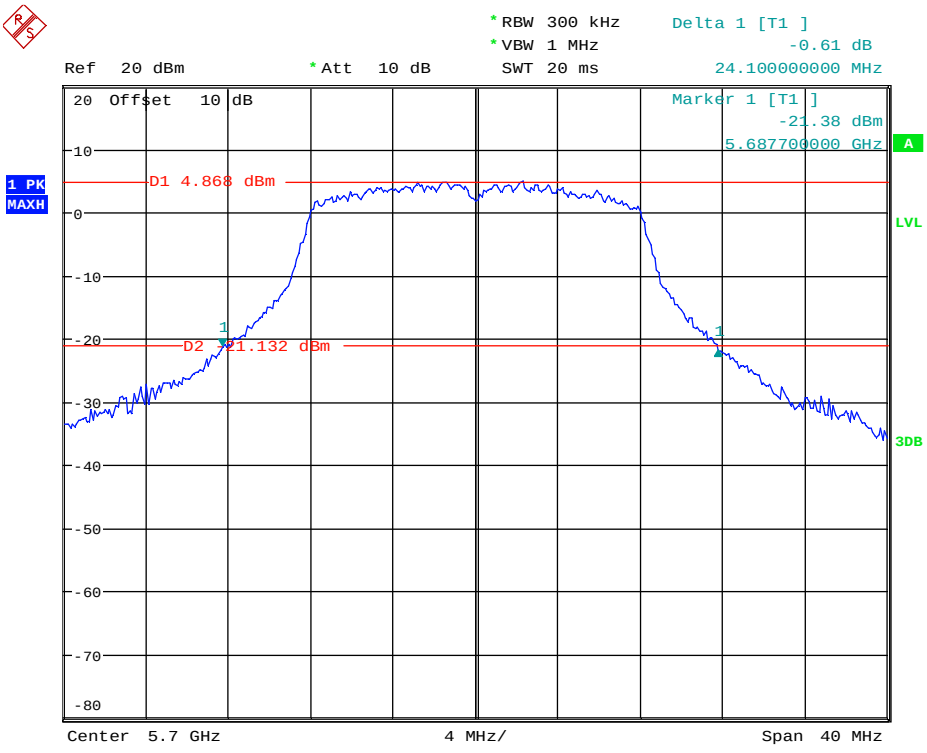
5.2.2 Test result

Ambient temperature	22 °C

Relative humidity	59 %

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

137117_26dB-BW_a_140: DTS Bandwidth (operation mode 9):



Operation Mode	Nominal Channel frequency [MHz]	99% Bandwidth [MHz]	26 dB Bandwidth [MHz]	Result
1	5180	0.5	25.100	Passed
2	5200	0.5	26.600	Passed
3	5240	0.5	26.000	Passed
4	5260	0.5	35.300	Passed
5	5300	0.5	35.100	Passed
6	5320	0.5	29.300	Passed
7	5500	0.5	28.300	Passed
8	5580	0.5	26.000	Passed
9	5700	0.5	24.100	Passed
10	5180	0.5	26.300	Passed
11	5200	0.5	28.800	Passed
12	5240	0.5	28.400	Passed
13	5260	0.5	37.500	Passed
14	5300	0.5	36.700	Passed
15	5320	0.5	31.100	Passed
16	5500	0.5	29.200	Passed
17	5580	0.5	27.600	Passed
18	5700	0.5	25.400	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

5.3 Peak Power Spectral Density

5.3.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part F) of document [3].

Method SA-1 was used for this measurement.

- Set span to encompass the entire 26-dB emission bandwidth (EBW) (or, alternatively, the entire 99% occupied bandwidth) of the signal.
- Set RBW = 1 MHz.
- Set VBW ≥ 3 MHz.
- Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
- Sweep time = auto.
- Detector = RMS (i.e., power averaging).
- Trace average at least 100 traces in power averaging (i.e., RMS) mode.
- The result is the PPSD.
- Set Marker to the peak of the spectrum.
- If duty cycle < 100 % add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.

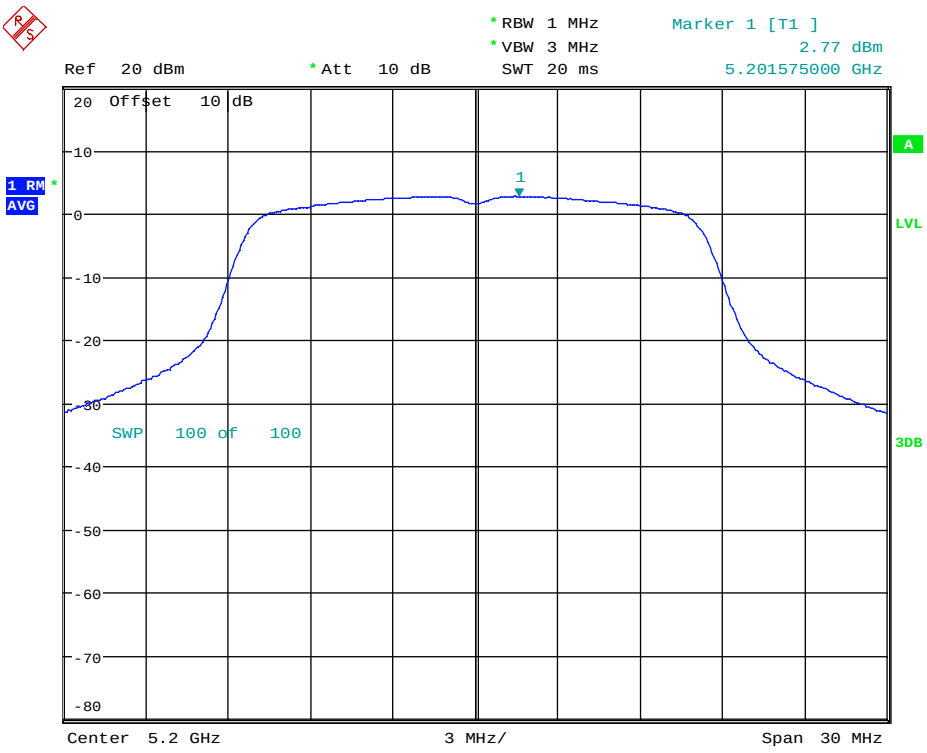
The measurements were carried out at each antenna port separately.

5.3.2 Test result

Ambient temperature	22 °C	Relative humidity	59 %

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

136117_PeakPwrSpecDens_a_40.wmf: Power Spectral Density (operation mode 2):



Operation Mode	Nominal Channel frequency [MHz]	Peak Frequency [MHz]	Power Spectral Density Reading [dBm / MHz]	Array Gain [dB]	Power Spectral Density Limit [dBm / MHz]	Margin [dB]	Result
1	5180	5181.650	1.91	0.00	4	2.09	Passed
2	5200	5201.575	2.78	0.00	4	1.22	Passed
3	5240	5238.350	2.56	0.00	4	1.44	Passed
4	5260	5261.500	4.63	0.00	11	6.37	Passed
5	5300	5298.575	4.31	0.00	11	6.69	Passed
6	5320	5318.575	3.04	0.00	11	7.96	Passed
7	5500	5498.575	3.84	0.00	11	7.16	Passed
8	5580	5578.575	4.39	0.00	11	6.61	Passed
9	5700	5698.500	1.70	0.00	11	9.30	Passed
10	5180	5181.400	1.55	0.00	4	2.45	Passed
11	5200	5198.700	2.49	0.00	4	1.51	Passed
12	5240	5238.600	2.35	0.00	4	1.65	Passed
13	5260	5258.600	4.51	0.00	11	6.49	Passed
14	5300	5298.400	4.16	0.00	11	6.84	Passed
15	5320	5321.600	2.87	0.00	11	8.13	Passed
16	5500	5498.500	4.11	0.00	11	6.98	Passed
17	5580	5578.300	4.16	0.00	11	6.84	Passed
18	5700	5698.500	1.34	0.00	11	9.66	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB				

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

5.4 Peak Excursion

5.4.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part G) of document [3].

Testing each modulation mode on a single channel in a single operating band is sufficient to demonstrate compliance with the peak excursion requirement. (If all modulation modes are not available on a single channel in a single band, then testing must be extended to other channels and bands as needed to ensure that all modulation modes are tested.)

Tests must include all variations in signal structure, such as:

(i) All signal types (e.g., direct sequence spread spectrum (DSSS) and OFDM);
(ii) All modulation types (e.g., BPSK, QPSK, 16-QAM, 64-QAM, and 256-QAM);
(iii) All bandwidth modes;
(iv) All variations in signal parameters (e.g., changes in subcarrier spacing or number of subcarriers).

For a given signal structure, testing of multiple error-correction coding rates is not required (e.g., 1/2, 2/3, and 3/4 rate codes).

For MIMO devices, testing of a single output port is sufficient to demonstrate compliance with the peak excursion requirement. If a given signal structure can be exercised with various combinations of spatial multiplexing (such as different numbers of spatial streams), beamforming, and cyclic delay diversity, peak excursion tests are not required to include those variations.

Set the spectrum analyser or EMI receiver span to view the entire emission bandwidth.

Find the maximum of the peak-max-hold spectrum.

Set RBW = 1 MHz.
VBW ≥ 3 MHz.
Detector = peak.
Trace mode = max-hold.
Allow the sweeps to continue until the trace stabilizes.
Use the peak search function to find the peak of the spectrum.

Use the procedure found under 5.3.1 to measure the PPSD. For this measurement the procedure SA-1 was used

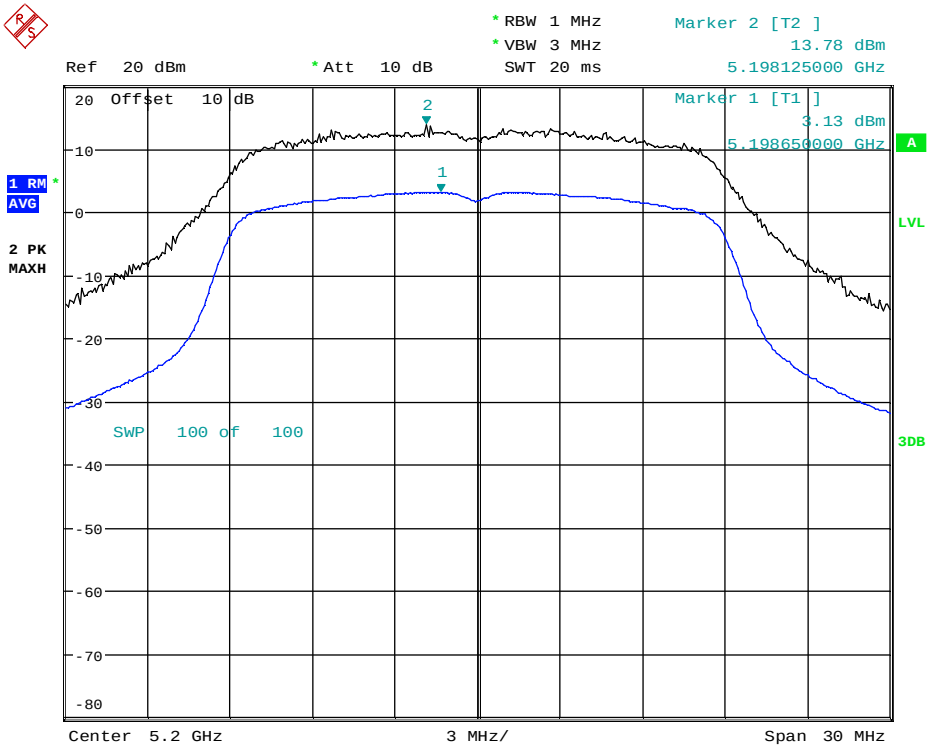
Compute the ratio of the maximum of the peak-max-hold spectrum to the PPSD.

5.4.2 Test result

Ambient temperature	22 °C	Relative humidity	60 %

The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

137117_PeakExc_n20-16QAM_40.wmf: peak excursion (operation mode 5)



WLAN channel	Signal type	Modulation	Peak Excursion [dB]	Limit [dB]	Margin [dB]	Result
40	a-mode	BPSK	9.65	13	3.35	Passed
40	a-mode	QPSK	9.54	13	3.46	Passed
40	a-mode	16-QAM	9.62	13	3.38	Passed
40	a-mode	64-QAM	9.86	13	3.14	Passed
40	n20	BPSK	9.07	13	3.93	Passed
40	n20	QPSK	10.08	13	2.92	Passed
40	n20	16-QAM	10.64	13	2.36	Passed
40	n20	64-QAM	10.37	13	2.63	Passed
60	a-mode	BPSK	9.30	13	3.70	Passed
60	a-mode	QPSK	9.55	13	3.45	Passed
60	a-mode	16-QAM	9.78	13	3.22	Passed
60	a-mode	64-QAM	9.81	13	3.19	Passed
60	n20	BPSK	9.35	13	3.65	Passed
60	n20	QPSK	10.01	13	2.99	Passed
60	n20	16-QAM	9.94	13	3.06	Passed
60	n20	64-QAM	10.22	13	2.78	Passed
116	a-mode	BPSK	9.12	13	3.88	Passed
116	a-mode	QPSK	9.60	13	3.40	Passed
116	a-mode	16-QAM	9.62	13	3.38	Passed
116	a-mode	64-QAM	9.79	13	3.21	Passed
116	n20	BPSK	9.38	13	3.62	Passed
116	n20	QPSK	9.77	13	3.23	Passed
116	n20	16-QAM	10.11	13	2.89	Passed
116	n20	64-QAM	9.84	13	3.16	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB			

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

5.5 Frequency Stability

5.5.1 Method of measurement

The EUT is placed in a climatic chamber, which is able to adjust the temperature over the desired temperature range.

After reaching the desired temperature and an after an appropriate acclimatisation time, the EUT is turned on.

The nominal channel frequency is the measurement result with nominal supply power at 20 °C.

Spectrum analyzer settings:

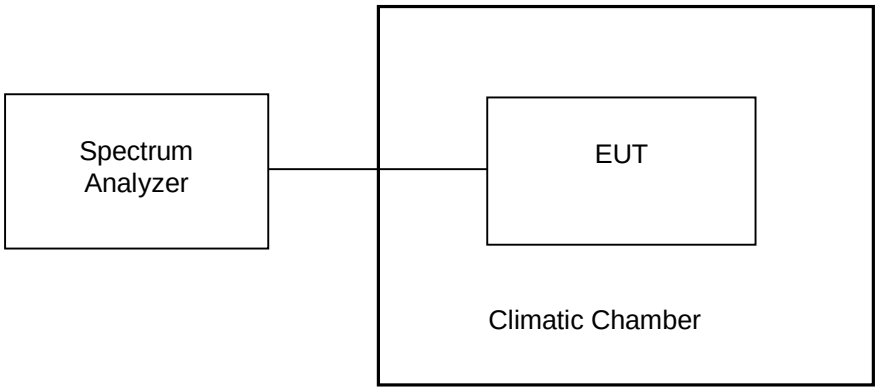
- Attenuation: Auto
- Center Frequency: channel frequency
- Span: 2 MHz
- RWB=VBW: 10 kHz
- Sweep Time: Auto

The frequency stability is testet at the minimum and maximum voltage, which is permitted by the manufacturer.

The frequency stability is testet at the minimum and maximum temperature, which is permitted by the manufacturer. But at least a temperature span from -30 °C – + 50 °C shall be covered.

The temperature is measured in 10 °C steps.

Test set-up:



5.5.2 Test result

The changes made from the original device (as described in the previous report) are not such, that the frequency stability is altered (It only would get better). The host device which handles the power supply is also the same. Therefore the tests are not repeated and the previous results are submitted below.

The EUT was set to transmit continuously in operation mode 4. The frequency was derived by observing a characteristic dip in the centre of the OFDM signal.

Voltage [V]	Measurement Frequency [MHz]	Frequency Deviation |d| [ppm]	Limit [ppm]	Result
3 V	5199.997596	0.31	20	Passed
3.3 V	5199.995994	Reference	20	-
3.6 V	5199.998397	0.46	20	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB		

Temperature [°C]	Measurement Frequency [MHz]	Frequency Deviation [ppm]	Limit [ppm]	Result
-40 °C	5200.002430	0.44	20	Passed
-30 °C	5200.003220	0.59	20	Passed
-20 °C	5200.003190	0.59	20	Passed
-10 °C	5200.002520	0.46	20	Passed
0 °C	5200.000080	-0.01	20	Passed
10 °C	5200.000530	0.08	20	Passed
20 °C	5200.000130	Reference	-	-
30 °C	5200.000080	-0.01	20	Passed
40 °C	5200.000930	0.15	20	Passed
50 °C	5200.000040	-0.02	20	Passed
60 °C	5199.999470	-0.13	20	Passed
70 °C	5199.999200	-0.18	20	Passed
80 °C	5200.001870	0.33	20	Passed
85 °C	5199.994110	-1.16	20	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB		

TEST EQUIPMENT USED FOR THE TEST:
7, 31

5.6 Band-edge compliance

5.6.1 Method of measurement (band edges next to unrestricted bands (conducted))

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part H2 and H5 of document [3].

Measurement Procedure – Unwanted Emissions

- Set the center frequency and span to encompass the frequency range to be measured.
- RBW = 1 MHz. (100 kHz for frequencies below 1 GHz)
- VBW ≥ 3 MHz. (300 kHz for frequencies below 1 GHz)
- Detector = Peak.
- Ensure that the number of measurement points ≥ span/RBW.
- Sweep time = auto couple.
- Trace Mode = max hold.
- Allow the trace to stabilise.
- Use the peak marker function to determine the maximum amplitude level.

Section H3d states, that unwanted Emissions within 2 MHz of the band edge may be measured using special band-edge techniques (the marker delta method or integration methods), provided that the 99% occupied bandwidth falls within the 2 MHz of the band edge. Otherwise all unwanted emissions measurements shall be performed using the standard methods.

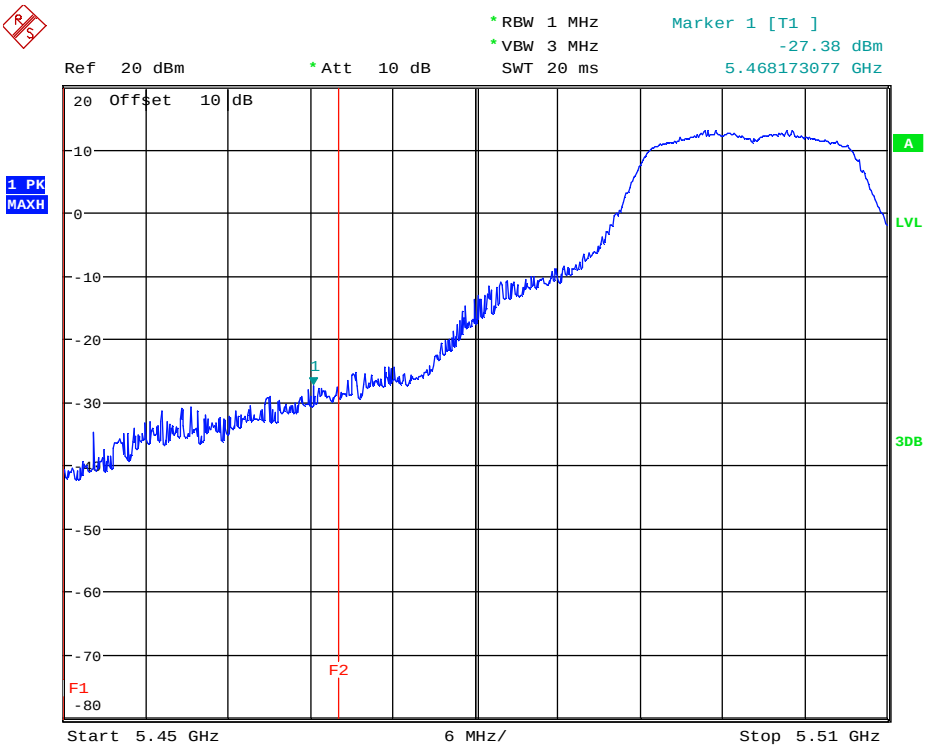
The measurements were performed at the lower end of the 5 GHz band.

5.6.2 Test result (band edges next to unrestricted bands (conducted))

Ambient temperature	22 °C	Relative humidity	59 %

The following results were measured at antenna port 1 of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

136117_BandEdgeUnrestr_a_100.wmf: conducted band-edge compliance (operation mode 7):



Operation Mode	WLAN channel	WLAN mode	Band-Edge	Unwanted Emission Frequency MHz	Unwanted Emission Value dBm	Limit dBm	Margin dB	Result
7	100	a	low	5.468.173	-27.00	-27.38	0.38	Passed
9	140	a	high	5.725.962	-27.00	-30.38	3.38	Passed
16	100	n20	low	5.469.231	-27.00	-27.93	0.93	Passed
18	140	n20	high	5.725.385	-27.00	-28.72	1.72	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB				

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7

5.6.3 Method of measurement (band edges next to restricted bands (conducted))

The same test set-up as used for the final conducted emission measurement shall be used (refer also subclause 5.7.1 of this test report).

After trace stabilisation the marker shall be set on the signal peak. The frequency line shall be set on the edge of the assigned frequency band. Now set the second marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge. The level of the measured field strength shall be compared to the the general limits specified in § 15.205.

The measurement was performed at the lower end of the 5.15 – 5.25 GHz band.

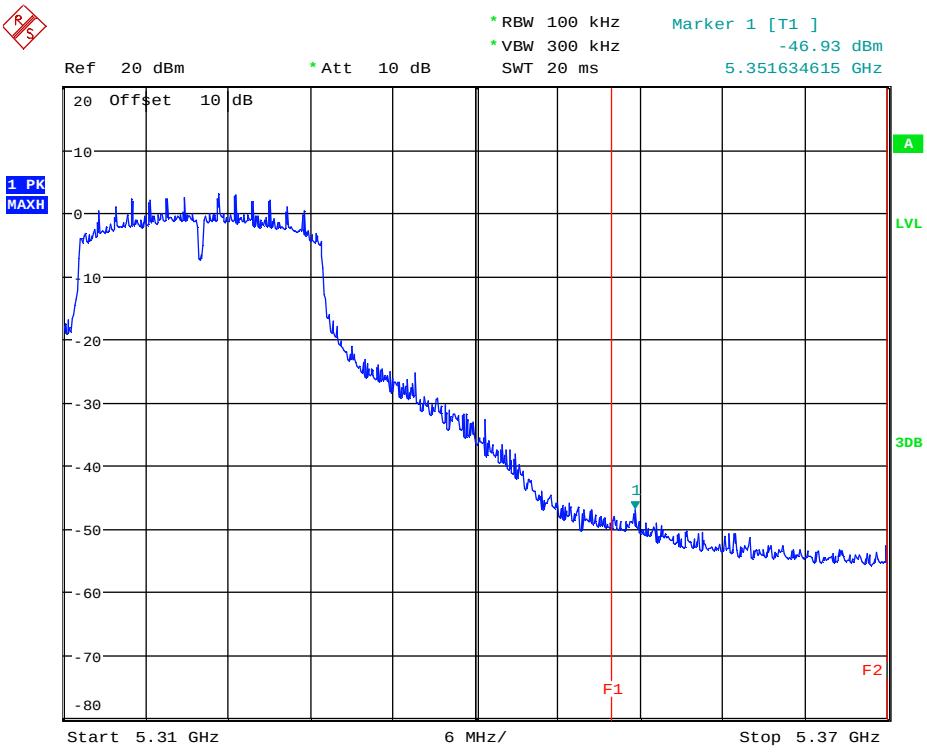
If an emission fails the conducted test, the measurement will be repeated in a radiated manner.

5.6.4 Test result (band edges next to restricted bands (conducted))

Ambient temperature	22 °C	Relative humidity	59 %

The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

136117_BandEdgeRestr_n20_64.wmf: conducted band-edge compliance (operation mode 6):



Band Edge Compliance, a-mode, channel 36 (Operation mode 1)									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	36	5148.715	60.87	74.00	13.13	-37.39	3.0	Passed	Y
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	36	5149.615	44.85	54.00	9.15	-53.41	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, n20-mode, channel 36 (Operation mode 10)									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	36	5147.175	60.39	74.00	13.61	-37.86	3.0	Passed	Y
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	36	5149.275	45.05	54.00	8.95	-53.21	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, a-mode, channel 64 (Operation mode 6)									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	64	5353.175	65.13	74.00	8.87	-33.12	3.0	Passed	Y
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	64	5350.175	46.84	54.00	7.16	-51.42	3.4	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, n20-mode, channel 64 (Operation mode 15)									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	64	5350.285	67.91	74.00	6.09	-30.35	3.0	Passed	Y
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	64	5349.985	47.59	54.00	6.41	-50.67	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7

5.7 Maximum unwanted emissions

5.7.1 Method of measurement (conducted emissions in the restricted bands)

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly mounted to a spectrum analyser. The measurement procedure refers to part H in [3].

If emissions were detected during the preliminary measurements, they were measured using the following measurement procedures:

Procedure for average measurement: H)6) – Trace averaging with continuous EUT transmission at full power:

The following method is valid if the EUT transmits continuously (duty cycle ≥ 98%)

- Set the RBW = 1 MHz.
- Set the VBW ≥ 3 x RBW.
- Detector = power average (RMS).
- Ensure that the number of measurement points in the sweep to ≥ 2 x (span/RBW).
- Averaging type = power (i.e., RMS)
- Sweep time = auto
- Perform a trace average of at least 100 traces

Peak measurement procedure: H5

- Set the analyzer span to encompass the entire unwanted emission bandwidth.
- Set the RBW = specified in Table 3.
- Set the VBW ≥ RBW.
- Set sweep time = auto.
- Detector = peak.
- Trace mode = max hold.
- Allow the trace to stabilize.
- Use the peak marker function to determine the peak power over the emission bandwidth.

Table 3 RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

The measurements were carried out at each antenna port.

If an emission fails the conducted test, the measurement will be repeated in a radiated manner.

5.7.1.1 Limit calculations

The following general procedure is described in chapter H)1)d) of [3].

a) Measure the conducted output power (in dBm) using the procedures described in 5.7.1.
b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level
c) Add the appropriate maximum ground reflections factor to the EIRP level (6 dB for frequencies ≤, 30 MHz, 4.7 for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz)
d) For devices with multiple antenna ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW)
e) Convert the resultant level to an equivalent electric field strength using the following relationships:

$$E. = EIRP - 20\log(d) + 104.8 \quad (1)$$

Where:

E. = electric field strength, in dBμV/m
EIRP = equivalent isotropic radiated power, in dBm
d = specified measurement distance, in meters

f) Compare the resultant electric field strength to the applicable limit

Document [6] state, that for transmitters with multiple outputs in the same band, summing of emissions and accounting for array gain have to be considered.

For combining emissions from multiple outputs, the spurious emissions at each output have to be measured and 10 log (N) has to be added to the resulting value, whereby N refers to the number of outputs.

To account for directional gain which might occur in case of N transmit antennas, the directional gain has to be calculated as

$$G_{Dir} = G_{Ant} + 10\log(N)dBi\,,$$

whereby N is the number of antennas.

The actual EUT only has one antenna port. Therefore only the antenna gain is added to the values which were measured conducted.

5.7.2 Method of measurement (conducted emissions in the unrestricted bands)

The measurement was performed as described in H)2) in document [3].

5.7.2.1 Emission level measurement

a) Set the center frequency and span to encompass frequency range to be measured.
b) RBW = 1 MHz.
c) VBW ≥ 3 MHz.
d) Detector = Peak.
e) Sweep time = auto.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.

The limit of -27 dBm/MHz was specified in 15.407 (b) (1)

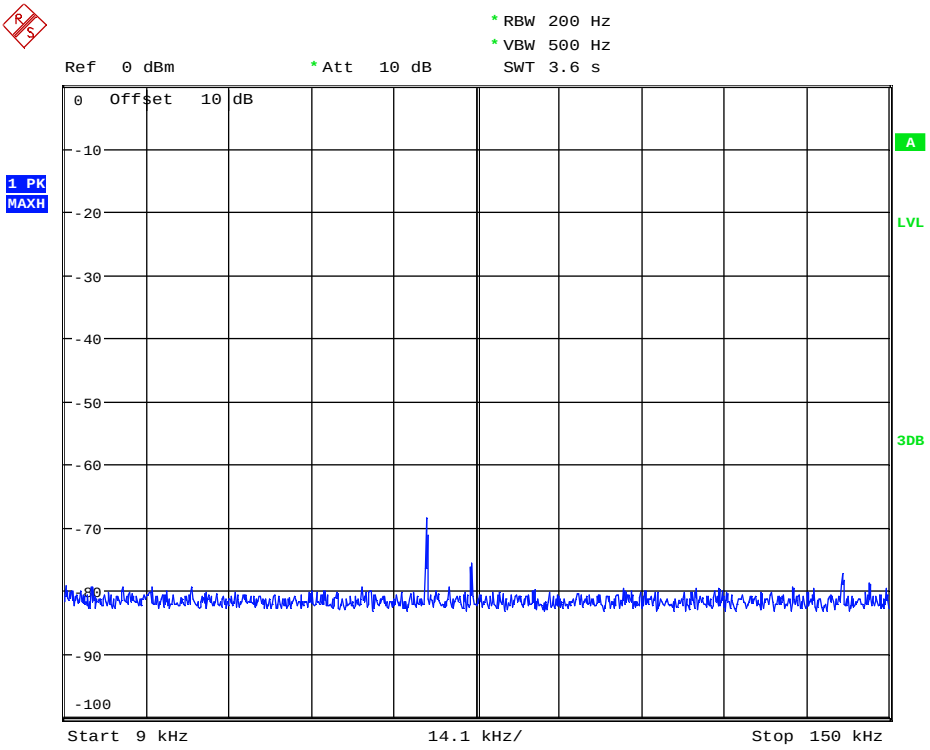
5.7.3 Test results (conducted emissions)

5.7.3.1 Emissions below 1 GHz

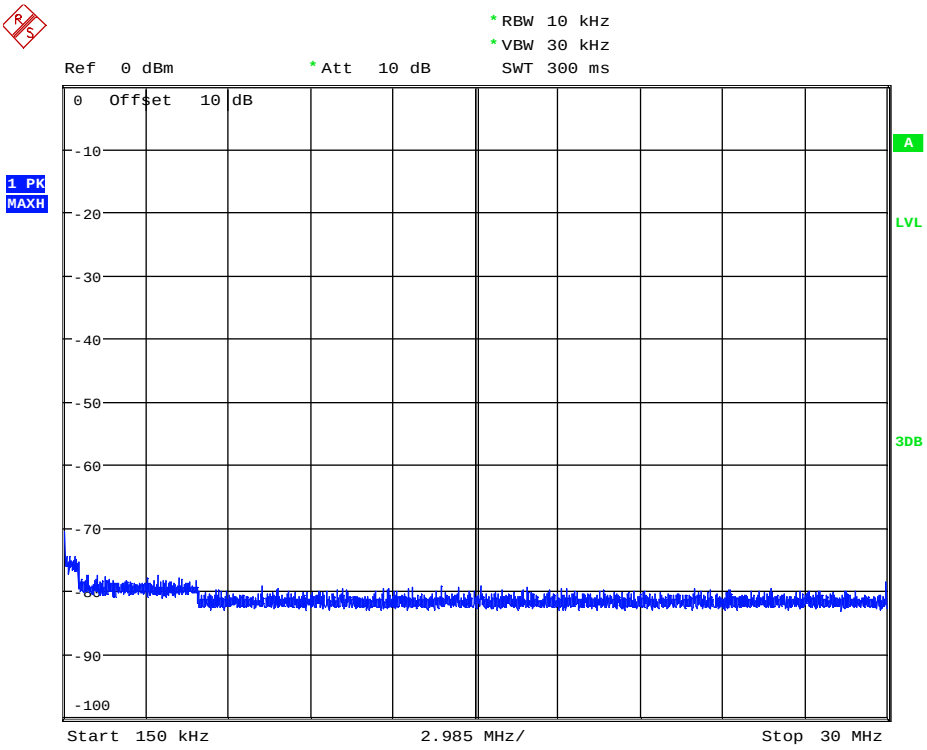
Ambient temperature	22 °C	Relative humidity	59 %

The Emissions below 1 GHz were equal for all channels, modulations and data rates. Therefore only the results of an exemplary test case are submitted below.

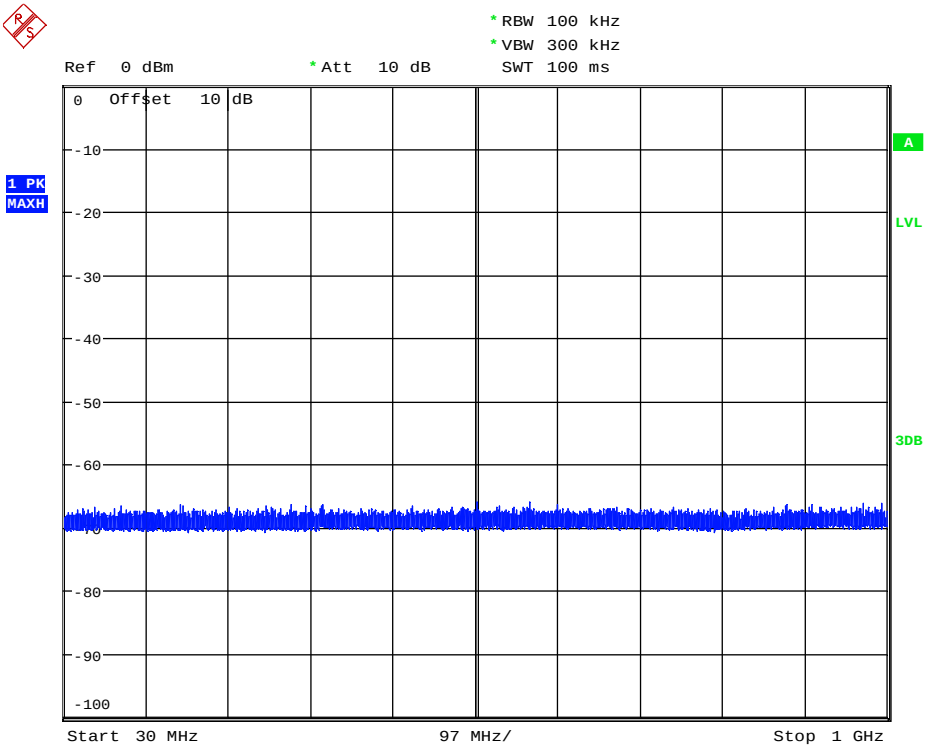
136117_9-150k_allModesWLAN.wmf: conducted spurious emissions (all operation modes):



136117_150k-30M_allModesWLAN.wmf: conducted spurious emissions (all operation modes):



136117_30M-1G_allModesWLAN.wmf: conducted spurious emissions (all operation modes):



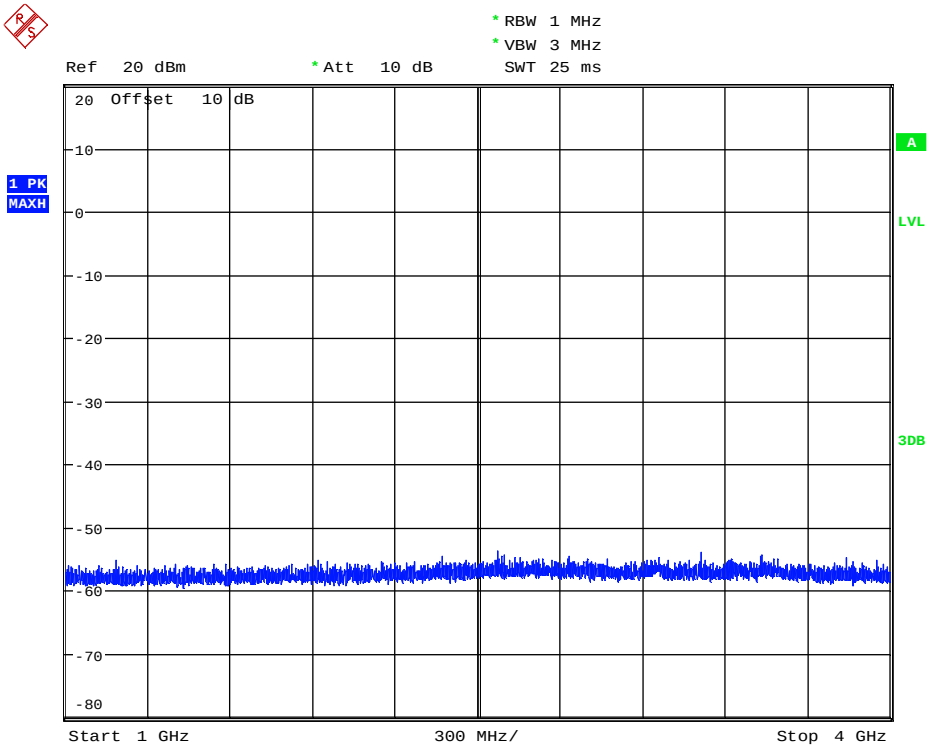
Spurious Emissions f < 1 GHz						
Peak Emission – Restricted Band						
Frequency [MHz]	Meas. Result [dBµV/m]	Max Peak Limit [dBµV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
0.071	-4.69	30.59	35.28	-68.95	3.0	Passed
0.079	-11.12	29.71	40.83	-75.38	3.0	Passed

5.7.3.2 Emissions above 1 GHz

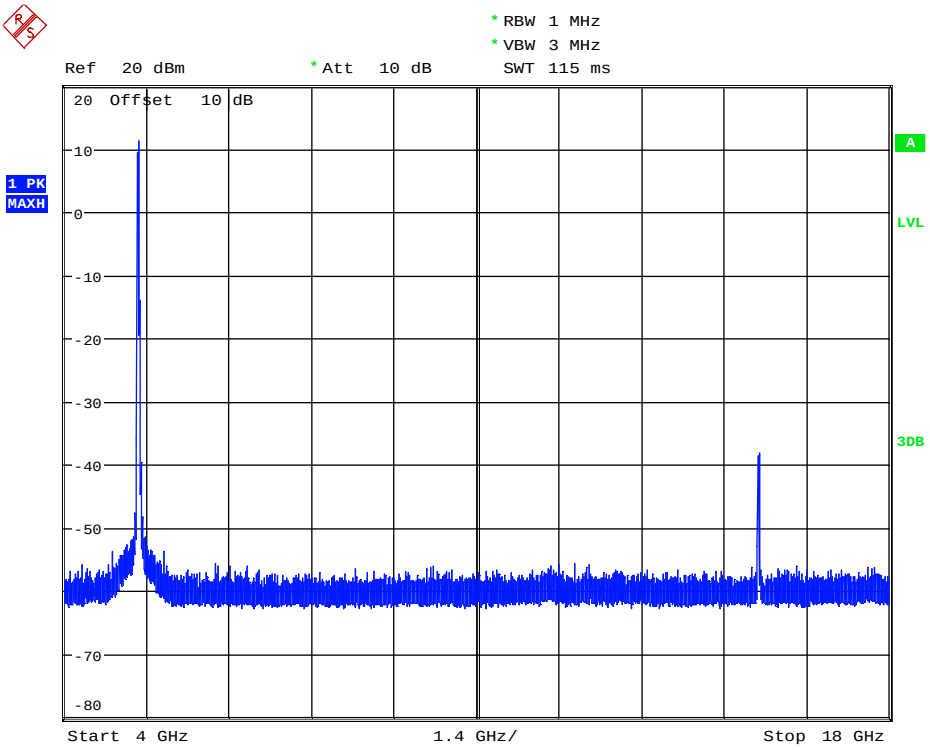
Ambient temperature	22 °C	Relative humidity	59 %

The following results were measured at antenna port of the EUT. The plots show exemplary measurement results for the worst documented case. The other results are listed in the following tables.

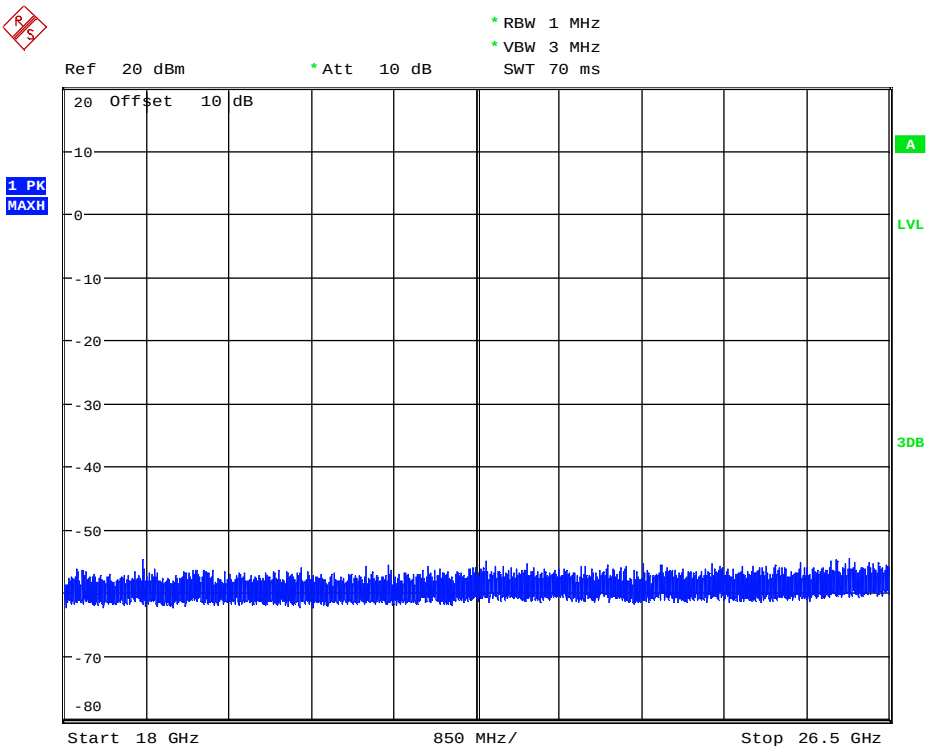
136117_SpurEmiss1-4G_n20_52.wmf: conducted spurious emissions (operation mode 13):



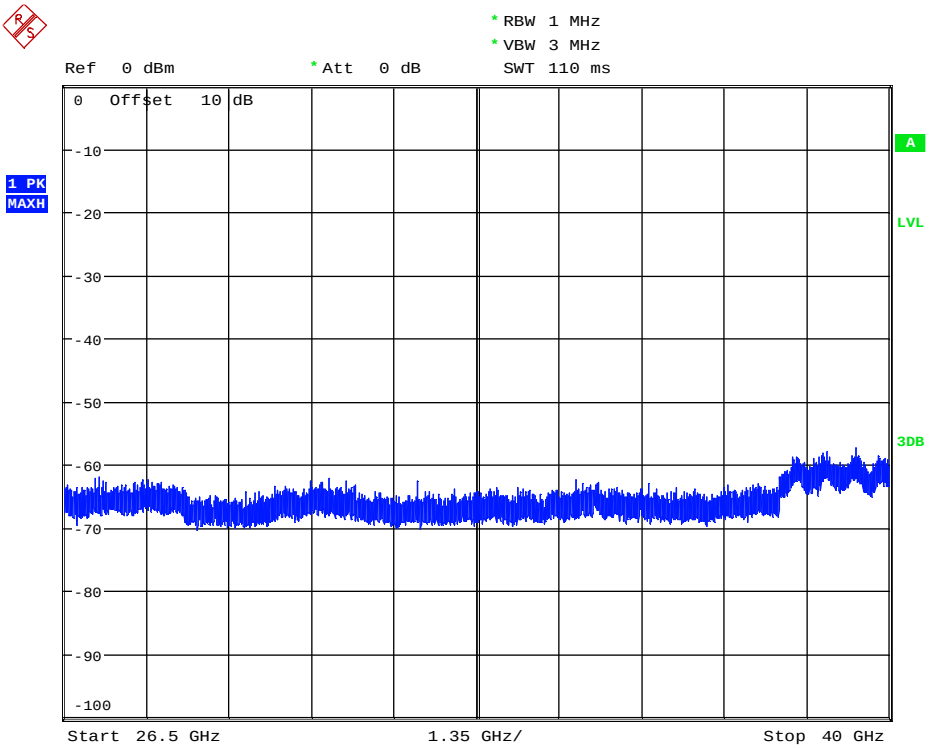
136117_SpurEmiss4-18G_n20_52.wmf: conducted spurious emissions (operation mode 13):



136117_SpurEmiss18-26,5G_n20_52.wmf: conducted spurious emissions (operation mode 13):



137117_SpurEmiss26,5-40G_n20_52.wmf: conducted spurious emissions (operation mode 13):



Spurious Emissions, a-mode, channel 36 (Operation mode 1)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	36	5020.750	56.62	74.00	17.38	-41.64	3.0	Passed	Y
a	36	5379.375	52.00	74.00	22.00	-46.26	3.0	Passed	Y
a	36	15540.975	57.86	74.00	16.14	-40.40	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	36	5020.825	36.82	54.00	17.18	-61.43	3.0	Passed	Y
a	36	5378.425	37.45	54.00	16.55	-60.81	3.0	Passed	Y
a	36	15539.900	38.87	54.00	15.23	-59.49	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
a	36								
No emissions were found									

Spurious Emissions, a-mode, channel 40 (Operation mode 2)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	40	5000.100	50.51	74.00	23.49	-47.75	3.0	Passed	Y
a	40	5035.600	54.22	74.00	19.78	-44.04	3.0	Passed	Y
a	40	5146.700	55.14	74.00	18.86	-43.12	3.0	Passed	Y
a	40	15600.700	60.50	74.00	13.50	-37.76	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	40	5003.325	36.07	54.00	17.93	-62.19	3.0	Passed	Y
a	40	5036.225	36.45	54.00	17.55	-61.81	3.0	Passed	Y
a	40	5149.775	41.31	54.00	12.69	-56.95	3.0	Passed	Y
a	40	15598.725	42.07	54.00	11.93	-56.19	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
a	40	5633.325	-41.06	-27.00	14.06	Passed	No		
a	40	5513.700	-45.70	-27.00	18.70	Passed	No		

Spurious Emissions, a-mode, channel 48 (Operation mode 3)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	48	5142.750	50.72	74.00	23.28	-47.54	3.0	Passed	Y
a	48	5399.525	61.75	74.00	12.25	-36.51	3.0	Passed	Y
a	48	5359.525	57.03	74.00	16.97	-41.22	3.0	Passed	Y
a	48	15721.350	60.98	74.00	13.02	-37.27	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	48	5148.475	38.96	54.00	15.04	-59.30	3.0	Passed	Y
a	48	5400.075	37.24	54.00	16.76	-61.02	3.0	Passed	Y
a	48	5359.800	37.86	54.00	16.14	-60.39	3.0	Passed	Y
a	48	15718.450	42.22	54.00	11.78	-56.03	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
a	48	5676.650	-41.31	-27.00	14.31	Passed	No		

Spurious Emissions, a-mode, channel 52 (Operation mode 4)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	52	5076.450	48.75	74.00	25.25	-49.51	3.0	Passed	Y
a	52	5354.775	49.98	74.00	24.02	-48.28	3.0	Passed	Y
a	52	5419.675	63.06	74.00	10.94	-35.20	3.0	Passed	Y
a	52	15777.825	64.48	74.00	9.52	-33.78	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	52	5076.400	36.92	54.00	17.08	-61.33	3.0	Passed	Y
a	52	5351.000	38.21	54.00	15.79	-60.05	3.0	Passed	Y
a	52	5418.475	37.39	54.00	16.61	-60.86	3.0	Passed	Y
a	52	15779.525	48.43	54.00	5.57	-49.83	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
a	52	5698.325	-49.28	-27.00	22.28	Passed	No		

Spurious Emissions, a-mode, channel 60 (Operation mode 5)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	60	5140.725	59.57	74.00	14.43	-39.09	3.0	Passed	Y
a	60	5379.225	57.50	74.00	16.50	-41.16	3.0	Passed	Y
a	60	5419.500	58.30	74.00	15.70	-40.36	3.0	Passed	Y
a	60	5454.000	60.28	74.00	13.72	-38.38	3.0	Passed	Y
a	60	15897.675	62.40	74.00	11.60	-36.26	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	60	5142.300	37.62	54.00	16.38	-60.64	3.0	Passed	Y
a	60	5376.625	38.75	54.00	15.25	-59.40	3.0	Passed	Y
a	60	5414.350	37.34	54.00	16.66	-60.91	3.0	Passed	Y
a	60	5455.850	37.38	54.00	16.62	-60.88	3.0	Passed	Y
a	60	15899.700	45.88	54.00	8.12	-52.38	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
a	60	5346.675	-35.85	-27.00	8.85	Passed	No		

Spurious Emissions, a-mode, channel 64 (Operation mode 6)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	64	5442.179	55.02	74.00	18.98	-43.23	3.0	Passed	Y
a	64	15954.000	57.33	74.00	16.77	-41.03	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
a	64	5443.454	37.35	54.00	16.65	-60.91	3.0	Passed	Y
a	64	15959.975	39.79	54.00	14.21	-58.47	3.0	Passed	Y

Emissions in the non-restricted Bands							
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
a	64	5239.975	-43.80	-27.00	16.80	Passed	No
a	64	5474.058	-40.14	-27.00	13.14	Passed	No
a	64	5479.771	-36.42	-27.00	9.42	Passed	No

Spurious Emissions, a-mode, channel 100 (Operation mode 7)							
No Emissions found in the Restricted Bands							
Emissions in the non-restricted Bands							
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
a	100	5340.675	-36.52	-27.00	9.52	Passed	No
a	100	5155.950	-44.89	-27.00	17.89	Passed	No
a	100	5843.525	-47.19	-27.00	20.19	Passed	No
a	100	16504.100	-42.71	-27.00	15.71	Passed	No

Spurious Emissions, a-mode, channel 116 (Operation mode 8)							
No Emissions found in the Restricted Bands							
Emissions in the non-restricted Bands							
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
a	116	5231.425	-45.11	-27.00	18.11	Passed	No
a	116	5928.700	-48.30	-27.00	21.30	Passed	No
a	116	5740.100	-35.20	-27.00	8.20	Passed	No
a	116	16741.325	-37.26	-27.00	10.26	Passed	No

Spurious Emissions, a-mode, channel 140 (Operation mode 9)							
No Emissions found in the Restricted Bands							
Emissions in the non-restricted Bands							
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
a	140	5343.512	-47.84	-27.00	20.84	Passed	No
a	140	5726.858	-30.98	-27.00	3.98	Passed	No
a	140	17097.675	-41.65	-27.00	14.65	Passed	No

Spurious Emissions, n20-mode, channel 36 (Operation mode 10)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	36	5379.300	52.98	74.00	21.02	-45.28	3.0	Passed	Y
n20	36	15548.975	57.53	74.00	16.47	-40.73	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	36	5377.900	36.91	54.00	17.09	-61.34	3.0	Passed	Y
n20	36	15542.375	38.58	54.00	15.42	-59.68	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
n20	36	5611.625	-48.72	-27.00	21.72	Passed	No		

Spurious Emissions, n20-mode, channel 40 (Operation mode 11)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	40	5149.600	54.16	74.00	19.84	-44.10	3.0	Passed	Y
n20	40	5399.450	52.12	74.00	21.88	-46.14	3.0	Passed	Y
n20	40	15604.675	61.31	74.00	12.69	-36.95	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	40	5149.575	41.26	54.00	12.74	-56.99	3.0	Passed	Y
n20	40	5396.275	36.91	54.00	17.09	-61.35	3.0	Passed	Y
n20	40	15600.475	41.64	54.00	12.36	-56.62	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
n20	40	5633.225	-48.53	-27.00	21.53	Passed	No		

Spurious Emissions, n20-mode, channel 48 (Operation mode 12)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	48	5079.750	57.82	74.00	16.18	-40.44	3.0	Passed	Y
n20	48	4803.350	48.00	74.00	26.00	-50.25	3.0	Passed	Y
n20	48	5359.800	56.42	74.00	17.58	-41.84	3.0	Passed	Y
n20	48	15724.400	61.04	74.00	12.96	-37.22	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	48	5083.675	37.18	54.00	16.82	-61.08	3.0	Passed	Y
n20	48	4803.275	40.72	54.00	13.28	-57.54	3.0	Passed	Y
n20	48	5359.525	37.91	54.00	16.09	-60.35	3.0	Passed	Y
n20	48	15720.200	41.71	54.00	12.29	-56.55	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
n20	48	5676.650	-41.54	-27.00	14.54	Passed	No		

Spurious Emissions, n20-mode, channel 52 (Operation mode 13)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	52	15778.500	64.20	74.00	9.80	-34.06	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	52	15778.600	48.06	54.00	5.94	-50.20	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
n20	52	5698.375	-49.58	-27.00	22.58	Passed	No		

Spurious Emissions, n20-mode, channel 60 (Operation mode 14)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	60	5350.500	61.70	74.00	12.30	-36.56	3.0	Passed	Y
n20	60	15900.150	62.00	74.00	12.00	-36.25	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	60	5350.300	42.46	54.00	11.54	-55.79	3.0	Passed	Y
n20	60	15900.175	45.20	54.00	8.80	-53.06	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
n20	60	5741.325	-49.89	-27.00	22.89	Passed	No		

Spurious Emissions, n20-mode, channel 64 (Operation mode 15)									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	64	5351.000	67.58	74.00	6.42	-30.68	3.0	Passed	Y
n20	64	15959.900	57.34	74.00	16.66	-40.91	3.0	Passed	Y
Average Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Cor. Value [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
n20	64	5350.025	47.53	54.00	6.47	-50.73	3.0	Passed	Y
n20	64	15960.550	39.59	54.00	14.41	-58.66	3.0	Passed	Y
Emissions in the non-restricted Bands									
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?		
n20	64	5763.375	-50.19	-27.00	23.19	Passed	No		

Spurious Emissions, n20-mode, channel 100 (Operation mode 16)							
No Emissions found in the Restricted Bands							
Emissions in the non-restricted Bands							
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
n20	100	5156.200	-47.20	-27.00	20.20	Passed	No
n20	100	5843.725	-50.01	-27.00	23.01	Passed	No
n20	100	16496.325	-42.62	-27.00	15.62	Passed	No

Spurious Emissions, n20-mode, channel 116 (Operation mode 17)							
No Emissions found in the Restricted Bands							
Emissions in the non-restricted Bands							
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
n20	116	5231.275	-45.29	-27.00	18.29	Passed	No
n20	116	5742.475	-36.30	-27.00	9.30	Passed	No
n20	116	5928.800	-48.54	-27.00	21.54	Passed	No
n20	116	16737.925	-37.63	-27.00	10.63	Passed	No
n20	116	16736.325	-38.45	-27.00	11.45	Passed	No

Spurious Emissions, n20-mode, channel 140 (Operation mode 18)							
No Emissions found in the Restricted Bands							
Emissions in the non-restricted Bands							
WLAN Mode	Channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
n20	140	5459.875	-47.62	-27.00	20.62	Passed	No
n20	140	5343.875	-47.87	-27.00	20.87	Passed	No
n20	140	17100.650	-50.45	-27.00	23.45	Passed	No

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7, 30,

5.7.4 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into four stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 110 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 110 GHz.

All measurements will be carried out with the EUT working on the middle of the assigned frequency band.

Preliminary and final measurement (1 GHz to 110 GHz)

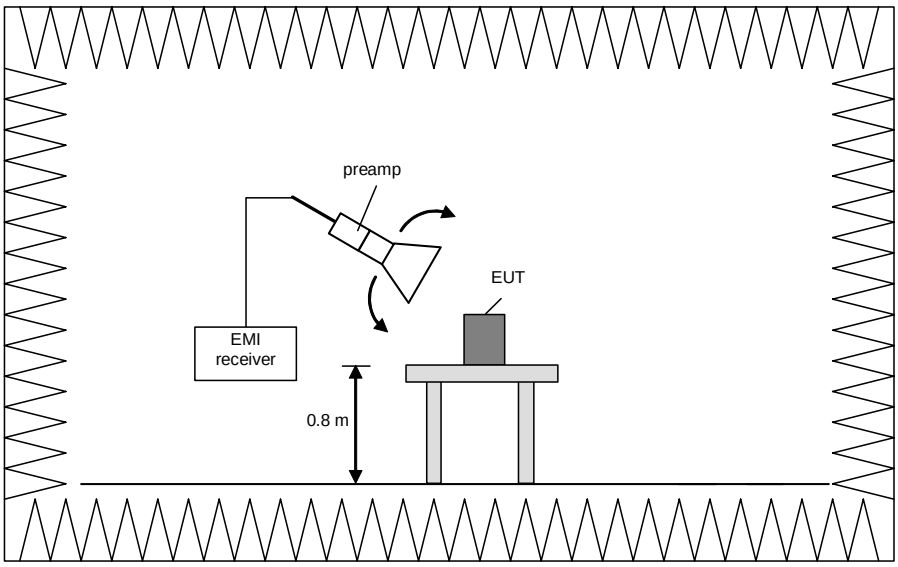
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

Preliminary measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending on the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna, the antenna close to the EUT and while moving the antenna over all sides of the EUT. With the spectrum analyser in CLEAR / WRITE mode the cone of the emission should be found and than the measuring distance will be set to 3 m with the receiving antenna moving in this cone of emission. At this position the final measurement will be carried out.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz
40 GHz to 60 GHz	100 kHz
50 GHz to 75 GHz	100 kHz
75 GHz to 110 GHz	100 kHz

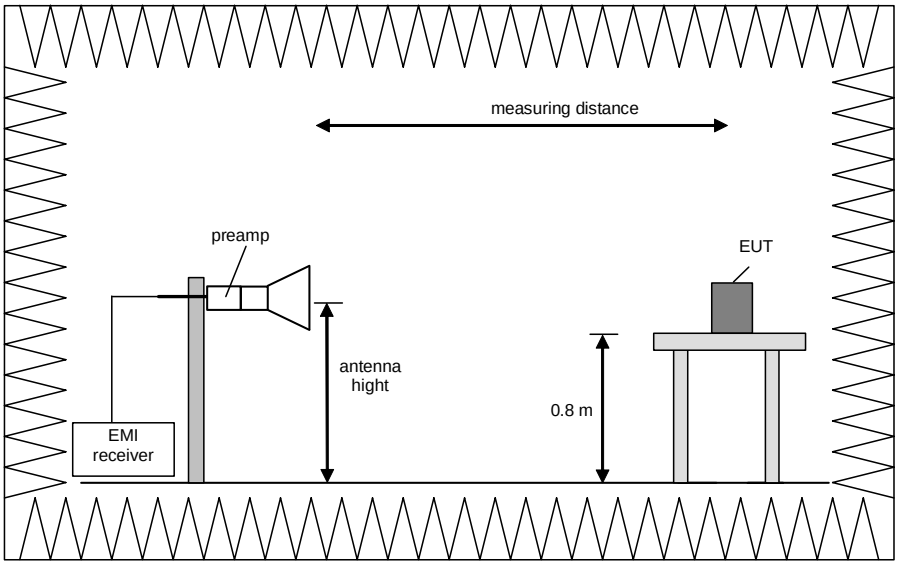


Final measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 ° in order to have the antenna inside the cone of radiation.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 GHz.
The following procedure will be used:

1) Monitor the frequency range at horizontal polarisation and move the antenna over all sides of the EUT (if necessary move the EUT to another orthogonal axis).
2) Change the antenna polarisation and repeat 1) with vertical polarisation.
3) Make a hardcopy of the spectrum.
4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
5) Change the analyser mode to Clear / Write and found the cone of emission.
6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3 m and the antenna will be still inside the cone of emission.
7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarisation and azimuth and the peak and average detector, which causes the maximum emission.
8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

Step 1) to 6) are defined as preliminary measurement.

5.7.5 Test results (radiated emissions) – cabinet emissions

5.7.5.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	51 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in Table 2.

Test record: All results are shown in the following.

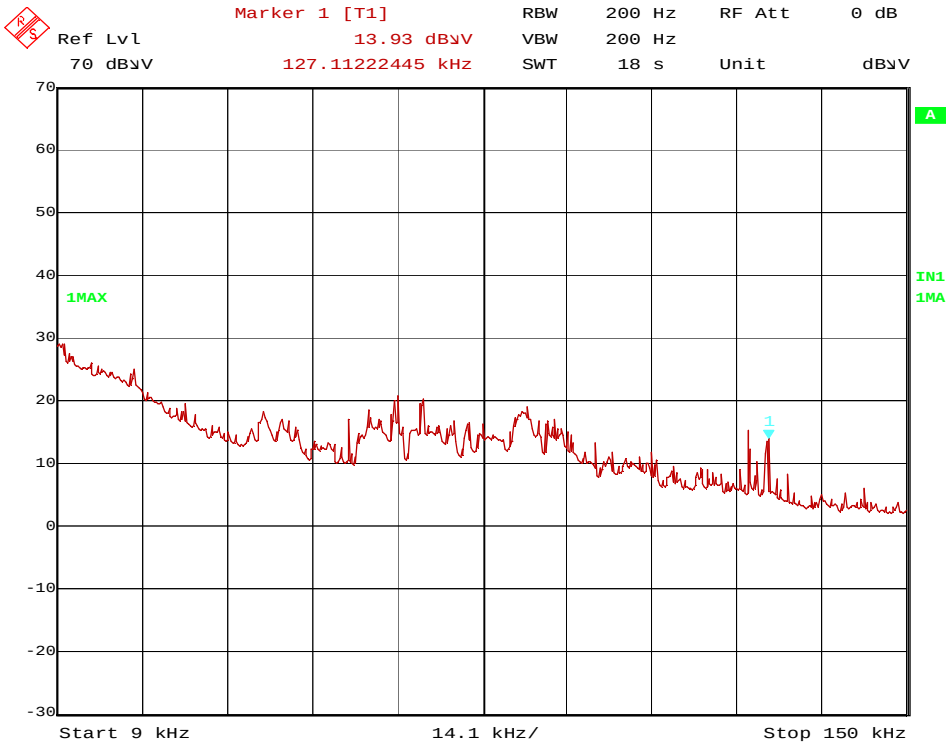
Supply voltage: During all measurements the host of the EUT was powered with 5 V via an AC/DC Adapter.

Remark: Document [3] states in 12.2.1, that in case of conducted measurements, additional radiated cabinet emission measurements must be performed. The measurements were performed at the worst case modulation, namely 802.11n mode at channel 36, 40, 48, 52, 60, 64, 100, 116 and 140.

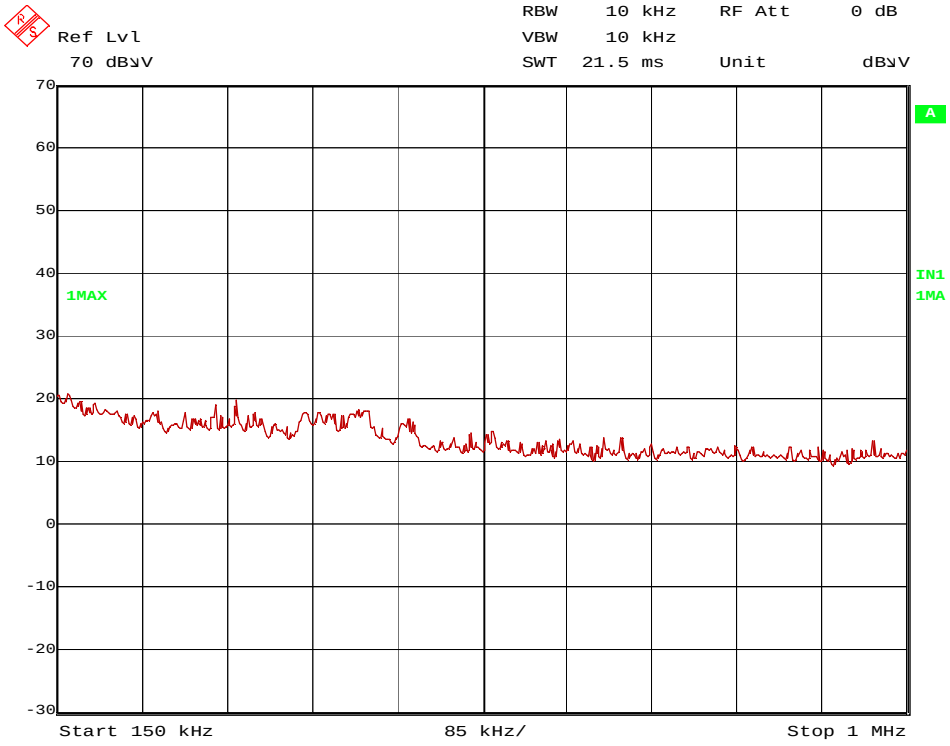
Only the plots of the worst case emissions are submitted for every frequency range above 1 GHz in the preliminary results.

The Emissions below 1 GHz were equal for all antenna ports, transmit frequencies, modulation schemes and data rates. Therefore only the results of an exemplary test case are submitted below.

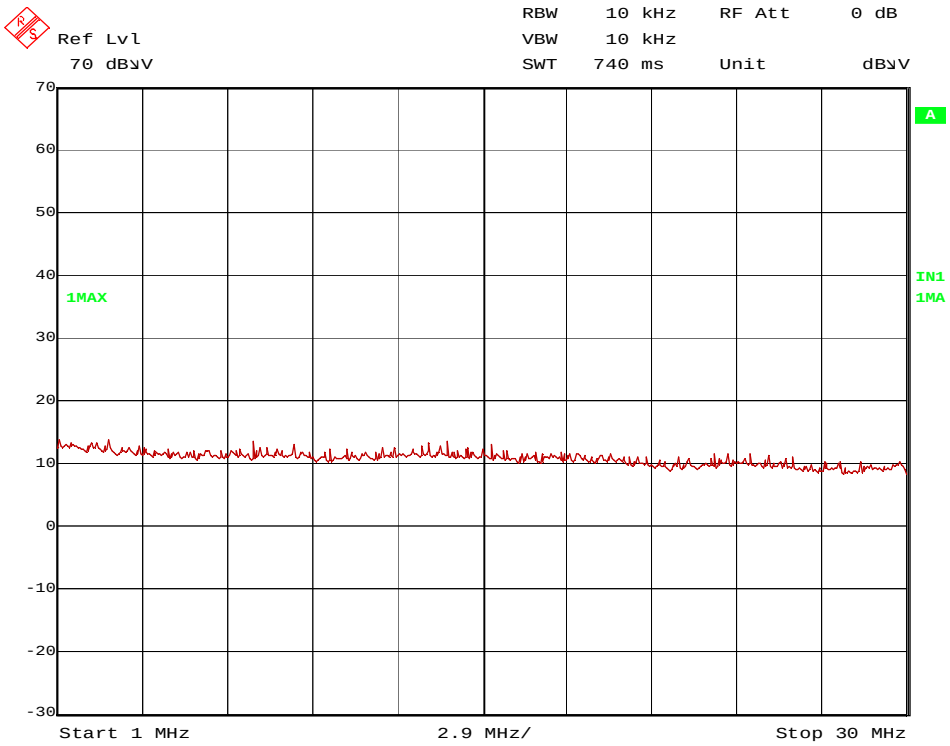
117_W26.wmf: Spurious emissions from 9 kHz to 150 kHz:



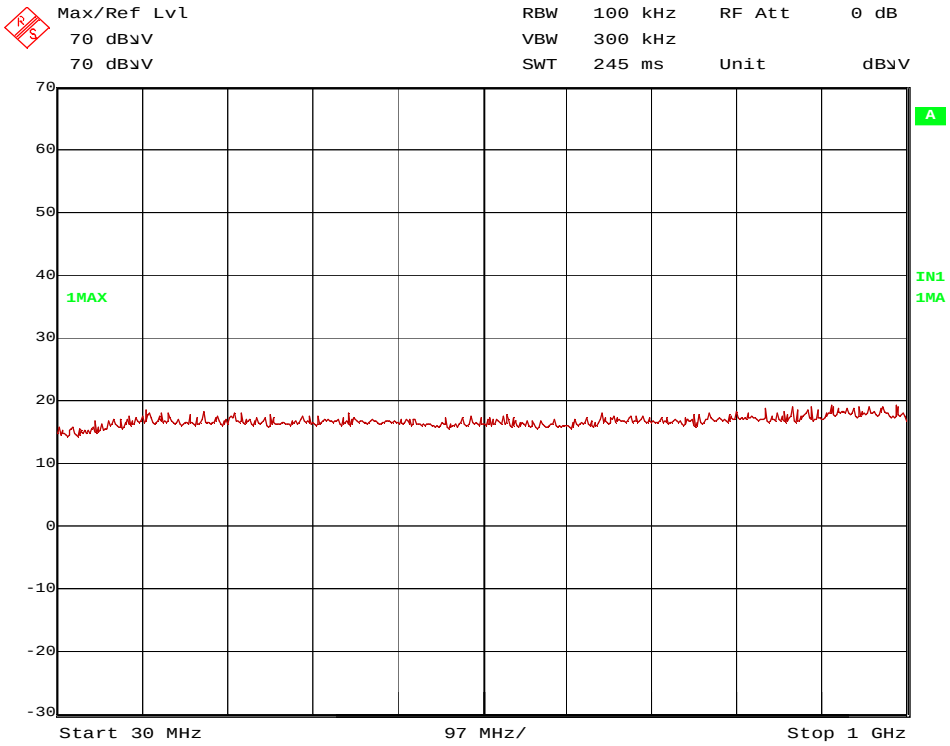
117_W27.wmf: Spurious emissions from 150 kHz to 1 MHz:



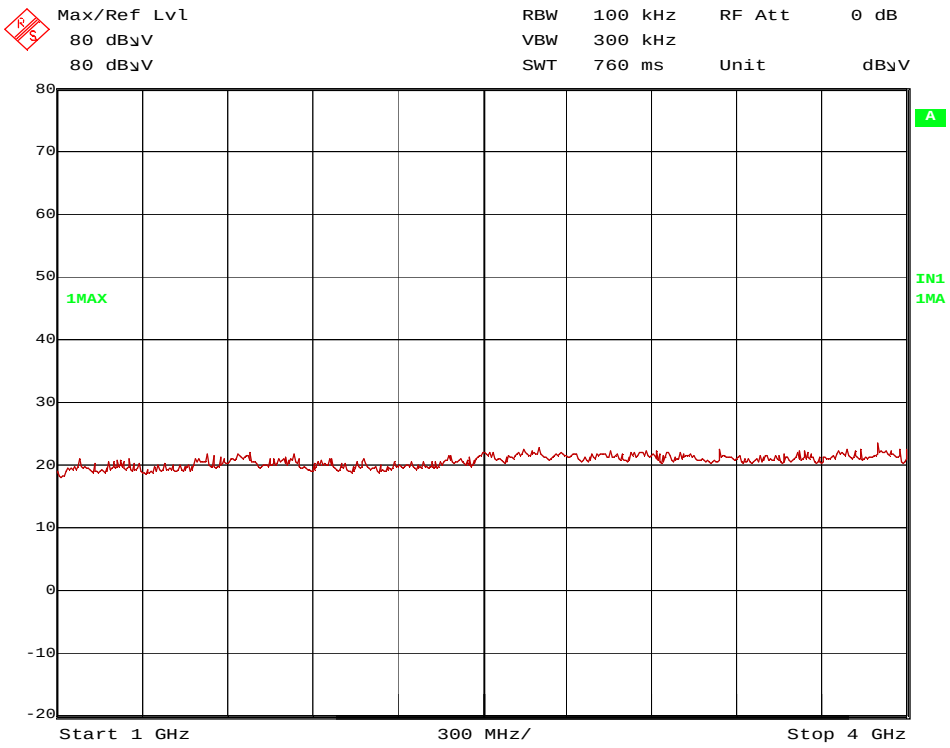
117_W28.wmf: Spurious emissions from 1 MHz to 30 MHz:



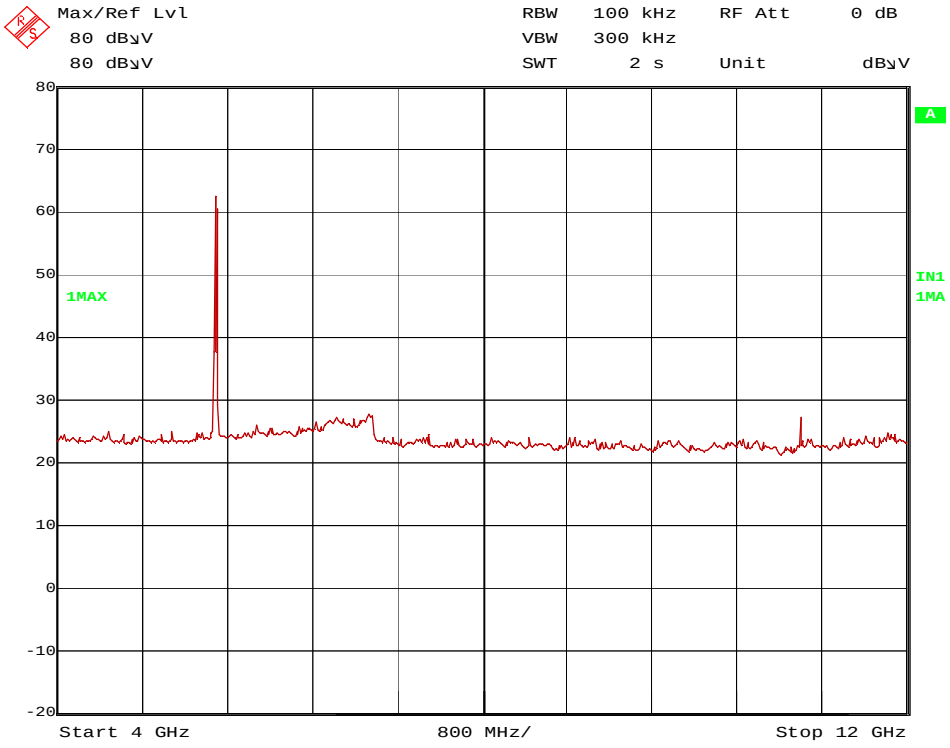
136117_all-modes_pos2_30M-1G_1.wmf: Spurious emissions from 30 MHz to 1 GHz:



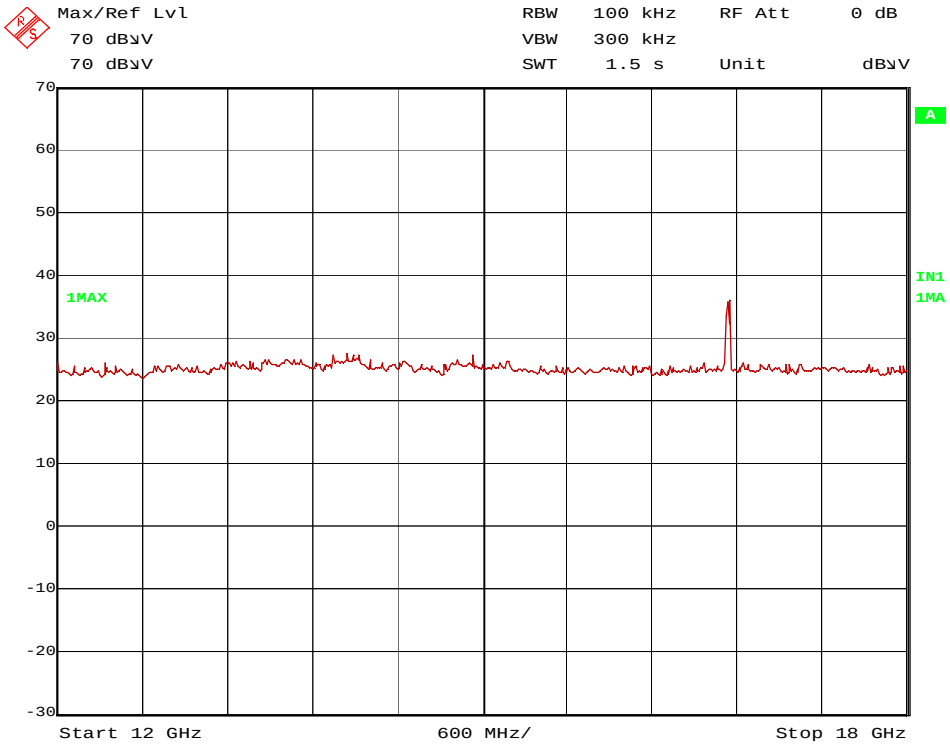
136117_ch116_n20_6.5M_Pwr18_pos2_1-4GHz_new.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 17):



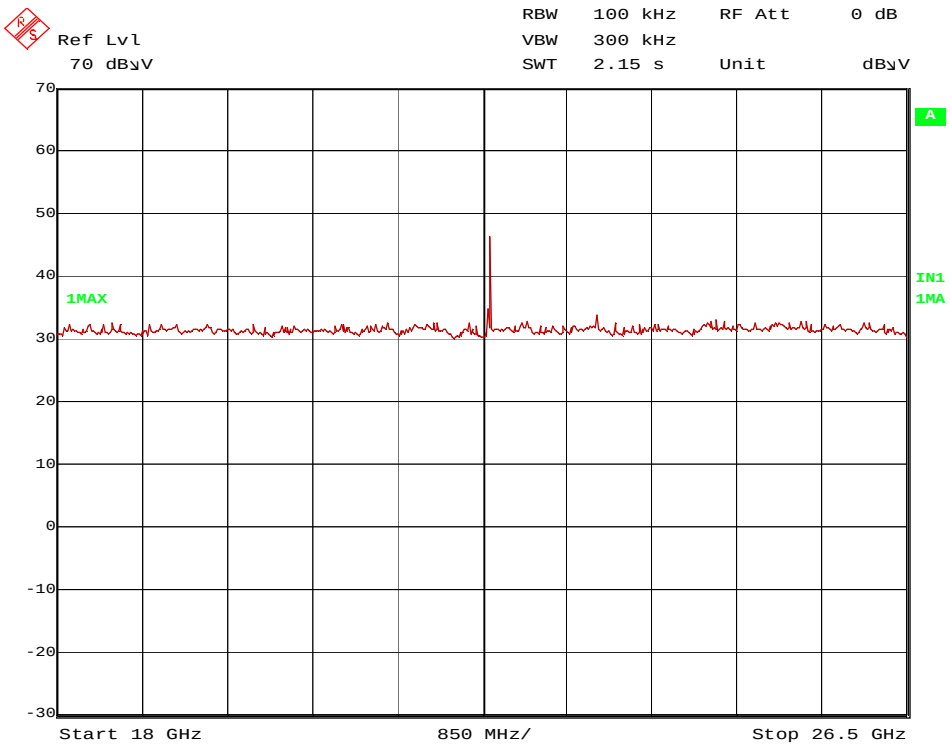
136117_ch100_n20_6.5M_Pwr18_4-12G_Pos2.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 16):



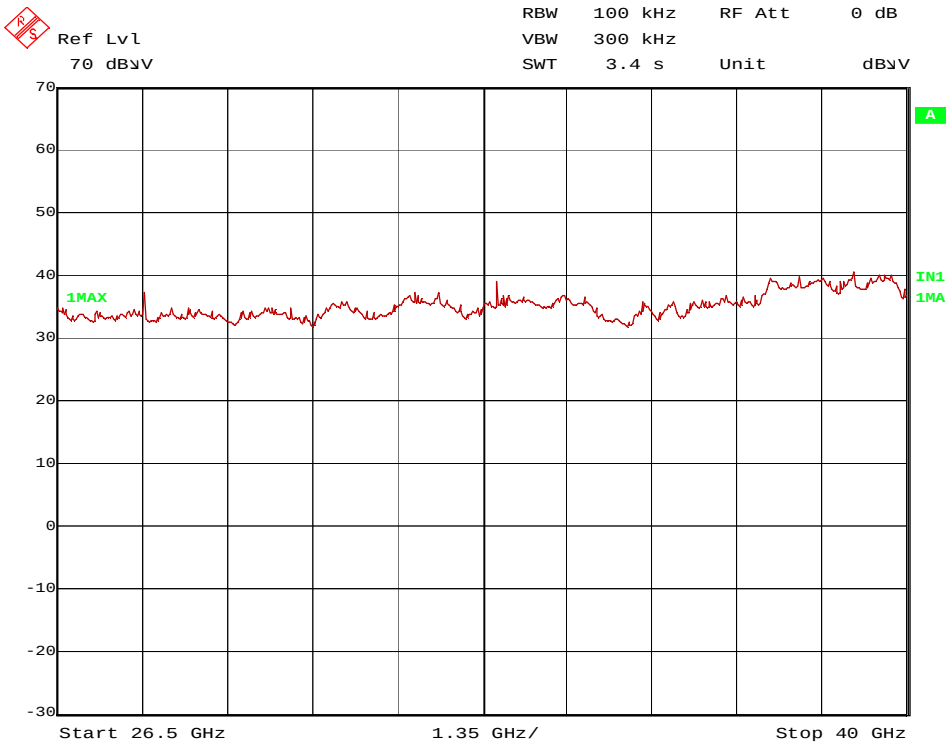
136117_ch116_n20_12-18G: Spurious emissions from 12 to 18 GHz (operation mode 17):



136117_ch116_n20_18-26,5G_pos2.wmf: Spurious emissions from 18 – 26.5 GHz (operation mode 17):



136117_ch116_26,5-40G_pos2.wmf: Spurious emissions from 26.5 – 40 GHz (operation mode 17):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 11000, 11160, 11400, 13250, 13300, 15540, 15600, 15720, 15780, 15900, 15960, 20720, 20800, 20960, 21040, 21200, 21280, 22320, 22800, 31200, 31440 and 31560 MHz.

The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 12950, 13000, 13100, 13150, 16500, 16740,17100, 22000, 25920, 26000, 26300, 26200, 26500, 26600, 27500,.27900, 28500, 31080, 31800, 31920, 33000, 33480, and 34200 MHz.

These frequencies have to be measured in a final measurement. The results are presented in the following.

TEST EQUIPMENT USED FOR THE TEST:
5, 6, 8 - 29

5.7.5.2 Final radiated emission measurement (9 kHz to 1 GHz)

No emissions could be found in the final measurement on the open area test site, therefore no results for the final measurements are submitted.

5.7.5.3 Final radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	22 °C	Relative humidity	55 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 5 V via an laboratory power supply..

Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.

Additional information: For simplification, all values were compared to the restricted band limits.

Position 2 was found to have the worst case spurious emissions.

Transmitter operates at the lower end of the assigned frequency band (operation mode 10)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
12950.0	40.1	74.0	33.9	31.3	33.6	26.4	1.7	150	Vert.	2
15540.0	39.8	74.0	34.2	31.9	33.7	27.8	2.0	150	Hor.	2
20720.0	53.8	74.0	20.2	49.9	37.1	37.7	4.4	150	Hor.	2
25920.0	41.5	74.0	32.5	38.2	37.2	38.7	4.9	150	Hor.	2
31080.0	46.5	74.0	27.5	31.7	40.7	28.8	2.9	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
12950	36.3	54.0	17.7	27.5	33.6	26.4	1.7	150	Vert.	2
15540	30.3	54.0	23.7	22.4	33.7	27.8	2.0	150	Hor.	2
20720	50.4	54.0	3.6	46.5	37.1	37.7	4.4	150	Hor.	2
25920	30.2	54.0	23.8	26.9	37.2	38.7	4.9	150	Hor.	2
31080	42.8	54.0	11.2	28.0	40.7	28.8	2.9	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the lower end of the assigned frequency band (operation mode 13)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13150.0	44.6	74.0	29.4	35.8	33.6	26.6	1.7	150	Vert.	2
15780.0	58.9	74.0	15.1	49.1	33.8	27.7	3.7	150	Hor.	2
21040.0	54.5	74.0	19.5	51.1	37.1	37.9	4.3	150	Hor.	2
26300.0	54.2	74.0	19.8	42.7	37.3	30.9	5.0	150	Hor.	2
31560.0	46.5	74.0	27.5	30.5	40.6	27.6	3.0	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13150	35.5	54.0	18.5	26.7	33.6	26.6	1.7	150	Vert.	2
15780	43.5	54.0	10.5	33.7	33.8	27.7	3.7	150	Hor.	2
21040	49.2	54.0	4.8	45.8	37.1	37.9	4.3	150	Hor.	2
26300	45.3	54.0	8.7	33.8	37.3	30.9	5.0	150	Hor.	2
31560	42.5	54.0	11.5	26.5	40.6	27.6	3.0	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the lower end of the assigned frequency band (operation mode 16)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
11000.0	62.2	74.0	11.8	40.5	38.2	23.4	6.9	150	Vert.	2
16500.0	52.3	74.0	21.7	42.8	33.8	28.1	3.8	150	Hor.	2
22000.0	50.0	74.0	24.0	46.1	37.2	37.8	4.5	150	Hor.	2
27500.0	46.7	74.0	27.3	33.9	40.7	30.3	2.4	150	Hor.	2
33000.0	53.4	74.0	20.6	35.8	40.7	26.4	3.3	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
11000	49.8	54.0	4.2	28.1	38.2	23.4	6.9	150	Vert.	2
16500	38.8	54.0	15.2	29.3	33.8	28.1	3.8	150	Hor.	2
22000	53.4	54.0	0.6	49.5	37.2	37.8	4.5	150	Hor.	2
27500	36.8	54.0	17.2	24.0	40.7	30.3	2.4	150	Hor.	2
33000	46.5	54.0	7.5	28.9	40.7	26.4	3.3	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the middle of the assigned frequency band (operation mode 11)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13000.0	39.5	74.0	34.5	30.6	33.6	26.5	1.8	150	Hor.	2
15600.0	41.7	74.0	32.3	32.1	33.7	27.9	3.8	150	Vert.	2
20800.0	53.4	74.0	20.6	49.7	37.1	37.7	4.3	150	Vert.	2
26000.0	53.4	74.0	20.6	41.9	37.2	30.7	5.0	150	Vert.	2
31200.0	46.3	74.0	27.7	31.4	40.7	28.4	2.7	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13000	35.3	54.0	18.7	26.4	33.6	26.5	1.8	150	Hor.	2
15600	32.5	54.0	21.5	22.9	33.7	27.9	3.8	150	Vert.	2
20800	49.9	54.0	4.1	46.2	37.1	37.7	4.3	150	Vert.	2
26000	44.7	54.0	9.3	33.2	37.2	30.7	5.0	150	Vert.	2
31200	42.4	54.0	11.6	27.5	40.7	28.4	2.7	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the middle of the assigned frequency band (operation mode 14)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13250.0	50.4	74.0	23.6	35.8	33.6	26.5	7.4	150	Vert.	2
15900.0	57.9	74.0	16.1	48.1	33.8	27.6	3.6	150	Hor.	2
21200.0	54.8	74.0	19.2	51.1	37.1	37.8	4.4	150	Hor.	2
26500.0	41.3	74.0	32.7	28.7	40.6	30.8	2.8	150	Hor.	2
31800.0	45.7	74.0	28.3	29.7	40.6	27.5	2.9	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13250	41.1	54.0	12.9	26.5	33.6	26.5	7.4	150	Vert.	2
15900	42.2	54.0	11.8	32.4	33.8	27.6	3.6	150	Hor.	2
21200	50.2	54.0	3.8	46.5	37.1	37.8	4.4	150	Hor.	2
26500	37.8	54.0	16.2	25.2	40.6	30.8	2.8	150	Hor.	2
31800	41.8	54.0	12.2	25.8	40.6	27.5	2.9	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the middle of the assigned frequency band (operation mode 17)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
11160.0	62.7	74.0	11.3	41.08	38.4	23.8	7	150	Vert.	2
16740.0	55.3	74.0	18.7	46.2	33.8	28.6	3.9	150	Hor.	2
22320.0	54.1	74.0	19.9	50.1	37.2	37.7	4.5	150	Hor.	2
27900.0	47.4	74.0	26.6	34.1	40.6	30.1	2.8	150	Hor.	2
33480.0	53.8	74.0	20.2	35.8	40.7	26	3.3	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
11160	50.6	54.0	3.4	29.09	38.4	23.8	7.0	150	Vert.	2
16740	42.7	54.0	11.3	33.7	33.8	28.6	3.9	150	Hor.	2
22320	50.3	54.0	3.7	46.3	37.2	37.7	4.5	150	Hor.	2
27900	37.9	54.0	16.1	24.6	40.6	30.1	2.8	150	Hor.	2
33480	45.0	54.0	9.0	27.0	40.7	26.0	3.3	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the upper end of the assigned frequency band (operation mode 12)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13100.0	39.7	74.0	34.3	30.6	33.6	26.3	1.8	150	Vert.	2
15720.0	39.4	74.0	34.6	31.6	33.7	27.8	1.9	150	Vert.	2
20960.0	53.4	74.0	20.6	49.7	37.1	37.8	4.4	150	Vert.	2
26200.0	53.2	74.0	20.8	42.1	37.2	30.9	4.8	150	Vert.	2
31440.0	46.7	74.0	27.3	30.8	40.7	27.7	2.9	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13100	35.0	54.0	19.0	25.9	33.6	26.3	1.8	150	Vert.	2
15720	30.8	54.0	23.2	23.0	33.7	27.8	1.9	150	Vert.	2
20960	49.8	54.0	4.2	46.1	37.1	37.8	4.4	150	Vert.	2
26200	44.7	54.0	9.3	33.6	37.2	30.9	4.8	150	Hor.	2
31440	43.2	54.0	10.8	27.3	40.7	27.7	2.9	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the upper end of the assigned frequency band (operation mode 15)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13300.0	46.5	74.0	27.5	36.1	33.6	26.3	3.2	150	Vert.	2
15960.0	52.4	74.0	21.6	42.6	33.8	27.7	3.7	150	Hor.	2
21280.0	53.9	74.0	20.1	50.1	37.2	37.8	4.4	150	Hor.	2
26600.0	57.4	74.0	16.6	44.9	40.6	30.7	2.6	150	Hor.	2
31920.0	47.3	74.0	26.7	30.5	40.6	26.9	3.1	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
13300	37.2	54.0	16.8	26.8	33.6	26.3	3.2	150	Vert.	2
15960	37.4	54.0	16.6	27.6	33.8	27.7	3.7	150	Hor.	2
21280	50.8	54.0	3.2	47.0	37.2	37.8	4.4	150	Hor.	2
26600	46.5	54.0	7.5	34.0	40.6	30.7	2.6	150	Hor.	2
31920	42.9	54.0	11.1	26.1	40.6	26.9	3.1	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Transmitter operates at the upper end of the assigned frequency band (operation mode 18)

Result measured with the peak detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
11400.0	63.2	74.0	10.8	41.32	38.6	23.6	6.9	150	Vert.	2
17100.0	53.2	74.0	20.8	43.8	33.8	28.3	3.9	150	Hor.	2
22800.0	52.2	74.0	21.8	48.1	37.2	37.8	4.7	150	Hor.	2
28500.0	48.4	74.0	25.6	35.3	40.6	30.3	2.8	150	Hor.	2
34200.0	53.5	74.0	20.5	35.6	40.7	26	3.2	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Pos.
11400	51.9	54.0	2.1	29.98	38.6	23.6	6.9	150	Vert.	2
17100	39.1	54.0	14.9	29.7	33.8	28.3	3.9	150	Hor.	2
22800	48.2	54.0	5.8	44.1	37.2	37.8	4.7	150	Hor.	2
28500	40.5	54.0	13.5	27.4	40.6	30.3	2.8	150	Hor.	2
34200	44.1	54.0	9.9	26.2	40.7	26.0	3.2	150	Hor.	2
Measurement uncertainty				+0.66 dB / -0.72 dB						

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
5, 6, 8 - 29

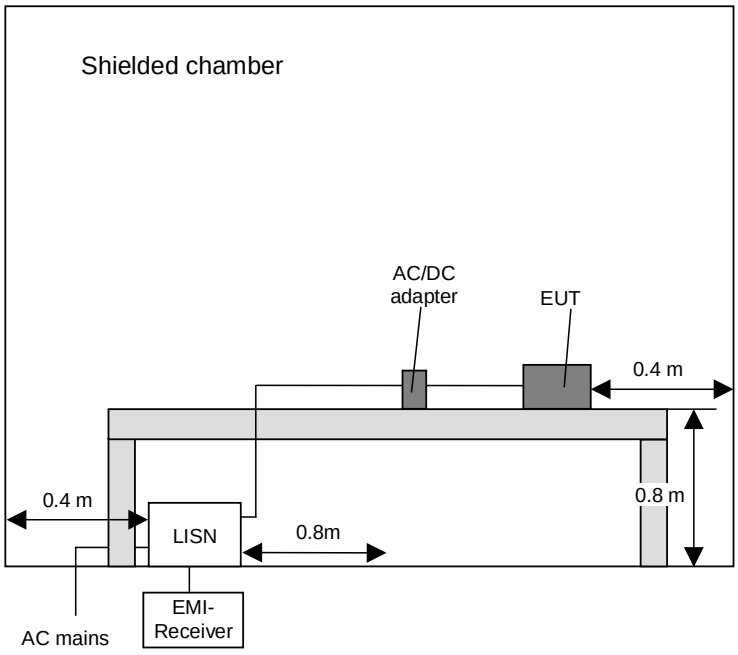
5.8 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.8.1 Method of measurement

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. The setup of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.8.2 Test results (conducted emissions on power supply lines)

Ambient temperature	20 °C	Relative humidity	52 %

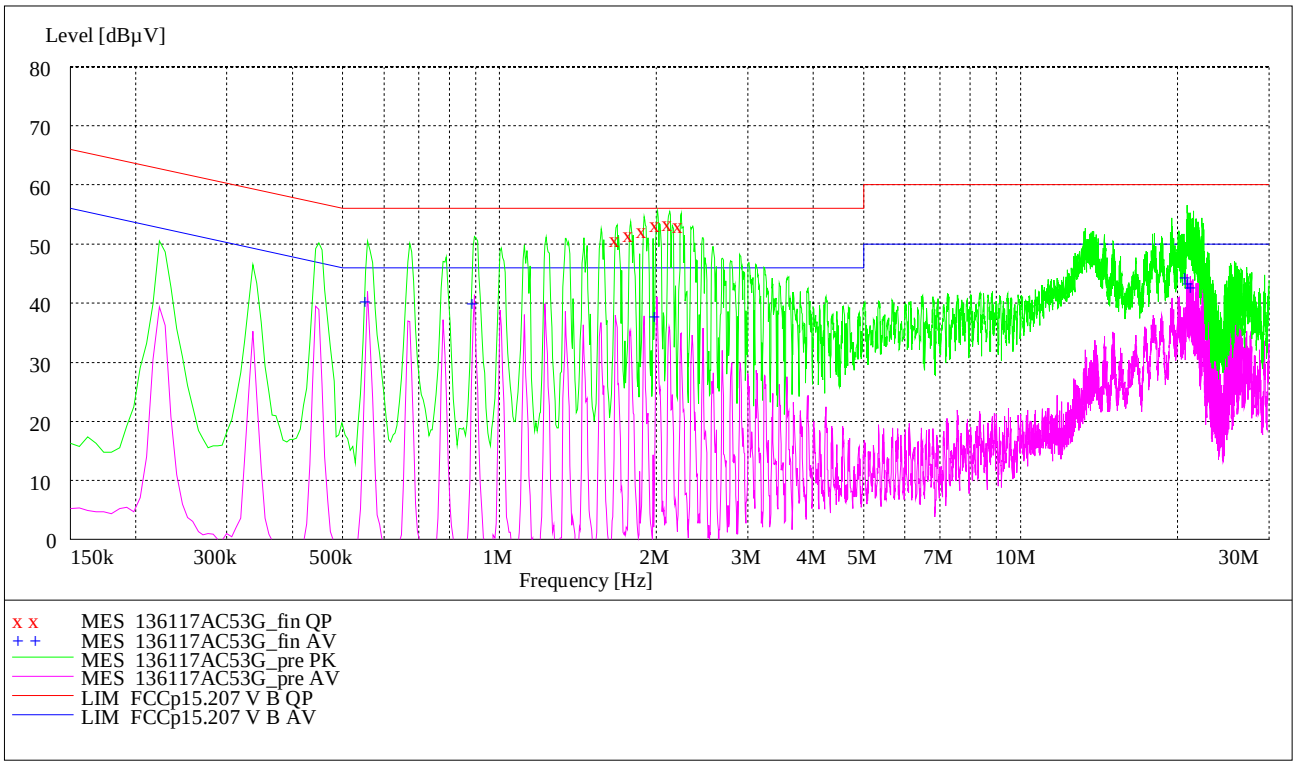
Position of EUT: For the test the EUT were plugged into a laptop PC via a RS232 cable. The EUT was set to continuous transmission on channel 60 (n20 mode, 6.5 Mbps, PWR: 16 dBm, operation mode 14) by the laptop PC.
The laptop PC with the inserted EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: Measurement performed with US 120V/60Hz. For the test a power supply type 2121 from Mascot was used.

The curves in the diagram only represent for each frequency point the maximum measured value of all preliminary measurements, which were made for each power supply line. The top-measured curve represents the peak measurement and the bottom-measured curve the average measurement. The quasi-peak measured points are marked by an x and the average measured points by an +.



Data record name: 136117AC24G

Result measured with the quasipeak detector (marked by an x):

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
1.680000	51.00	0.7	56.0	5.0	L1	GND
1.788000	51.90	0.7	56.0	4.1	L1	FLO
1.896000	52.70	0.7	56.0	3.3	L1	FLO
2.010000	53.70	0.8	56.0	2.3	L1	GND
2.124000	53.80	0.8	56.0	2.2	L1	FLO
2.232000	53.30	0.8	56.0	2.7	L1	FLO

Result measured with the average detector (marked by a +):

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.558000	40.70	0.9	46.0	5.3	L1	GND
0.894000	40.10	0.7	46.0	5.9	L1	GND
2.004000	38.00	0.8	46.0	8.0	L1	GND
20.916000	44.50	2.5	50.0	5.5	N	FLO
21.174000	43.70	2.5	50.0	6.3	L1	GND
21.420000	42.80	2.5	50.0	7.2	L1	GND

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
1 – 5

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
3	LISN	NSLK8128	Schwarzbeck	8128155	480058	04/05/2012	05/2014
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
5	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
6	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
7	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	07/15/2013	07/2015
8	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/26/2014	02/2016
9	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
10	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
11	Antenna support	AS615P	Deisel	615/310	480187	-	-
12	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
13	Antenna	3115 A	EMCO	9609-4918	480183	11/09/2011	11/2014
14	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
15	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
16	Standard Gain Horn Antenne 26.4 – 40.1 GHz	22240-20	Flann Microwave	469	480229	Six month verification (system cal.)	
17	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
18	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
19	RF-cable No. 36	Sucoflex 106B	Huber&Suhner	500003/6B / Kabel 36-	481680	Weekly verification (system cal.)	
20	RF-cable 1 m	KPS-1533-400-KPS	Insulated Wire	-	480300	Six month verification (system cal.)	
21	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire		480302	Six month verification (system cal.)	
22	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
23	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	Six month verification (system cal.)	
24	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
25	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/2014	02/2016
26	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	07/2013	07/2015
27	Peak Power Sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	07/2013	07/2015
28	4 GHz High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

29	Single Control Unit	SCU	Maturo GmbH	SCU/006/971107	480831	Calibration not necessary	
30	High-pass Filter	H26G40G1	Microwave Circuits, Inc.	33471	480593	Six month verification (system cal.)	
31	Temperature Test Chamber	MK 240	Binder	05-79022	480462	02/18/2014	08/2015

7 REPORT HISTORY

Report Number	Date	Comment
F136117E3	10 July 2014	Document created

8 LIST OF ANNEXES

ANNEX A TEST SET-UP PHOTOS 7 pages

136117_01: Test setup - Radiated emission, Antennas terminated (fully anechoic chamber)
136117_02: Test setup - Radiated emission, Antennas terminated (fully anechoic chamber)
136117_03: Test setup - Radiated emission, Antennas terminated (fully anechoic chamber)
136117_07: Test setup – conducted measurements at the antenna port
136117_04: Test setup – conducted emissions on power supply lines

ANNEX B EXTERNAL PHOTOGRAPHS 3 pages

136117_08.JPG: EUT + Carrier Board – Top View
136117_10.JPG: EUT + Carrier Board – Bottom View
136117_10.JPG: EUT + Carrier Board – Connectors

ANNEX C INTERNAL PHOTOGRAPHS 3 pages

133448_13.JPG: EUT - top view, with shielding
136117_14.JPG: EUT - top view, shielding removed
136117_12.JPG: EUT – bottom view