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Test Report

Report Number:

F170297E6

Equipment under Test (EUT):

Wireless Communication System Module

NINA-W10 series

Applicant:

u-blox AG

Manufacturer:

u-blox AG

ilac-MRA
DAkkS Deutsche Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

[1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

[2] **FCC CFR 47 Part 15**, Radio Frequency Devices

[3] **RSS-247 Issue 2 (February 2017)**, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[4] **RSS-Gen Issue 4 (November 2014)**, General Requirements for Compliance of Radio Apparatus

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.

tested and written by:	Bernward ROHDE		26.02.2018
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		26.02.2018
	Name	Signature	Date

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 generalizations 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

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Applicant represented during the test by the following person:	-

1.2 Manufacturer

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Applicant represented during the test by the following person:	-

1.3 Test Laboratory

The tests were carried out by:

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Germany

Accredited by *Deutsche Akkreditierungsstelle GmbH* in compliance with DIN EN ISO/IEC 17025 under Reg. No. **< *D-PL-17186-01-02* >**.

1.4 EUT (Equipment Under Test)

Test object: *	**Wireless Communication System Module**
Model / PMN: *	**NINA-W101** and **NINA-W102**
FCC ID: *	XPYNINAW10
IC-Number: *	8595A-NINAW10
HVIN:*	**NINA-W101** and **NINA-W102**
HMN:*	N/A
Order number:*	-
Serial number: *	866D4CA6EB2B5390300 [marked #403] 867D4CA6EB2B9B20300 [marked #403]
PCB identifier: *	918130.05 918230.05
Hardware version: *	05
Software version / FVIN: *	NA

* Declared by the applicant

Frequency List WLAN (IEEE, 802.11b, 802.11g, 802.11n HT20)

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 12	RX:	2467 MHz	TX:	2467 MHz

Frequency List WLAN (IEEE, 802.11n HT40)

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

Ancillary Equipment:

Laptop PC:	Fujitsu LIFEBOOK S751

*Provided by the applicant

1.5 Technical Data of Equipment

Fulfills WLAN specification: *	IEEE, 802.11b, 802.11g, 802.11n HT20 + HT40, 802.11d					
Antenna type: *	See antenna list below					
Antenna name: *	See antenna list below					
Antenna gain: *	See antenna list below					
Antenna connector: *	U.FL (NINA-W101) None (NINA-W102)					
Evaluation board: *	EVK-NINA-W131/EVK-NINA-W132 (by u-blox AG)					
Supply voltage evaluation board:*	U_{nom} =	5.0 V DC	U_{min} =	5.0 V DC	U_{max} =	12.0 V DC
Supply voltage – EUT: *	U_{nom} =	3.3 V DC	U_{min} =	3.0 V DC	U_{max} =	3.6 V DC
Type of modulation (WLAN): *	802.11b: DSSS: DBPSK, DQPSK, CCK 802.11g/n HT20 + HT40: OFDM: BPSK, QPSK, 16-QAM, 64-QAM					
Operating frequency range:*	2412 MHz to 2467 MHz (WLAN)					
Channel spacing: *	5 MHz (WLAN)					
Number of channels: *	12 (WLAN IEEE, 802.11b, 802.11g, 802.11n HT20) 8 (WLAN IEEE, 802.11n HT40)					
Temperature range: *	-40 °C to +85 °C					
Lowest / highest internal clock frequency: *	40 MHz / 2480 MHz					

Antenna List:

Antenna name	Manufacturer	Type	Comment	Gain [dBi]
u-blox LILY Antenna	ProAnt	SMD PIFA	antenna on NINA-W102	3
FlatWhip-2400	ProAnt	Monopole	SMA/RSMA	3
InSide-2400	ProAnt	Patch	10cm cable/U.FL	3
Ex-IT 2400 -SMA 28-001 -RP-SMA 28-001 -MHF 28-001	ProAnt	Monopole	SMA RSMA 10 cm cable/U.FL	3
Ex-IT 2400 -SMA 70-002 -RP-SMA 70-002	ProAnt	Monopole	SMA RSMA	3
GW26.0111.HT	Taoglas	Single-band monopole	SMA	3
ANT-2.4-CW-RH-RPS ANT-2.4-CW-RH-SMA	Linx	Single-band monopole	RP-SMA connector SMA connector	-1
Ex-IT 2400 -MHF 70-001	ProAnt	Monopole	10cm cable/U.FL	3
Outside-2400	ProAnt	Patch	7 cm cable/U.FL 10 cm cable/U.FL 25 cm cable/U.FL	3
InSide-WLAN	ProAnt	Patch	dual band 10 cm cable/U.FL	3
InSide-WLAN Square	ProAnt	Patch	dual band 10 cm cable/U.FL	3
Ex-IT WLAN - SMA - RP-SMA - MHF	ProAnt	Monopole	dual band SMA RSMA 10cm cable/U.FL	3

1.6 Dates

Date of receipt of test sample:	22.08.2017
Start of test:	23.08.2017
End of test:	03.11.2017

2 Operational States

The EUT is a Wireless Communication System Module that is capable to operate WLAN, Bluetooth classic and Bluetooth Low Energy. It is intended for integration into various applications.
To put the module into a specific Operation Mode, a PC-software provided by the applicant named “s-center 1.0.0.5” was used.

The antenna port conducted tests were performed with the EUT marked #403 with the serial number 866D4CA6EB2B5390300.

The radiated tests were performed with the EUT marked #403 with the serial number 867D4CA6EB2B9B20300. Since this EUT has the maximum antenna gain of 3 dBi, the tests encompass both, antenna and housing emissions.

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

EUT in WLAN mode

Operation mode	Description of the operation mode	channel	mode	Data rate / Mbps
1	Continuous transmitting on 2412 MHz	1	802.11b	1 Mbps
2	Continuous transmitting on 2437 MHz	6	802.11b	1 Mbps
3	Continuous transmitting on 2462 MHz	11	802.11b	1 Mbps
4	Continuous transmitting on 2467 MHz	12	802.11b	1 Mbps
5	Continuous transmitting on 2412 MHz	1	802.11g	24 Mbps
6	Continuous transmitting on 2437 MHz	6	802.11g	24 Mbps
7	Continuous transmitting on 2462 MHz	11	802.11g	24 Mbps
8	Continuous transmitting on 2467 MHz	12	802.11g	24 Mbps
9	Continuous transmitting on 2412 MHz	1	802.11n HT20	MCS3
10	Continuous transmitting on 2437 MHz	6	802.11n HT20	MCS3
11	Continuous transmitting on 2462 MHz	11	802.11n HT20	MCS3
12	Continuous transmitting on 2467 MHz	12	802.11n HT20	MCS3
13	Continuous transmitting on 2422 MHz	3	802.11n HT40	MCS5
14	Continuous transmitting on 2437 MHz	6	802.11n HT40	MCS5
15	Continuous transmitting on 2452 MHz	9	802.11n HT40	MCS5
16	Continuous transmitting on 2457 MHz	10	802.11n HT40	MCS5

Power Settings WLAN for all measurements:

WLAN mode	Data rate [Mbps]	Channel	Power setting (reduction in ¼ dB)
802.11b	1 – 11	1 & 2	34
802.11b	1 – 11	3 – 5	26
802.11b	1 – 11	6 – 10	24
802.11b	1 – 11	11	22
802.11b	1 – 11	12	12
802.11g	6 – 12	1	24
802.11g	6 – 12	2 - 5	16
802.11g	6 – 12	6 - 10	12
802.11g	6 – 12	11	24
802.11g	6 – 12	12	32
802.11g	18	1	24
802.11g	18	2 – 5	16
802.11g	18	6 – 10	8
802.11g	18	11	24
802.11g	18	12	32
802.11g	24	1	22
802.11g	24	2 – 5	16
802.11g	24	6 – 10	8
802.11g	24	11	24
802.11g	24	12	32
802.11g	36	1	22
802.11g	36	2 – 5	12
802.11g	36	6 – 10	4
802.11g	36	11	22
802.11g	36	12	28
802.11g	48	1	12
802.11g	48	2 – 5	4
802.11g	48	6 – 10	0
802.11g	48	11	14
802.11g	48	12	20
802.11g	54	1	4
802.11g	54	2 – 5	0
802.11g	54	6 – 10	0
802.11g	54	11	4
802.11g	54	12	14
802.11n HT20	MCS0 – MCS2	1	24
802.11n HT20	MCS0 – MCS2	2 – 5	16
802.11n HT20	MCS0 – MCS2	6 – 10	12
802.11n HT20	MCS0 – MCS2	11	26
802.11n HT20	MCS0 – MCS2	12	34
802.11n HT20	MCS3 & MCS4	1	24
802.11n HT20	MCS3 & MCS4	2 – 5	16
802.11n HT20	MCS3 & MCS4	6 – 10	8

802.11n HT20	MCS3 & MCS4	11	26
802.11n HT20	MCS3 & MCS4	12	34
802.11n HT20	MCS5	1	5
802.11n HT20	MCS5	2 – 5	12
802.11n HT20	MCS5	6 – 10	4
802.11n HT20	MCS5	11	24
802.11n HT20	MCS5	12	30
802.11n HT20	MCS6	1	0
802.11n HT20	MCS6	2 – 5	4
802.11n HT20	MCS6	6 – 10	0
802.11n HT20	MCS6	11	16
802.11n HT20	MCS6	12	22
802.11n HT20	MCS7	1	0
802.11n HT20	MCS7	2 – 5	0
802.11n HT20	MCS7	6 – 10	0
802.11n HT20	MCS7	11	0
802.11n HT20	MCS7	12	8
802.11n HT40	MCS0 – MCS2	1	30
802.11n HT40	MCS0 – MCS2	2 – 5	28
802.11n HT40	MCS0 – MCS2	6 – 10	28
802.11n HT40	MCS0 – MCS2	11	32
802.11n HT40	MCS0 – MCS2	12	34
802.11n HT40	MCS3 & MCS4	1	30
802.11n HT40	MCS3 & MCS4	2 – 5	24
802.11n HT40	MCS3 & MCS4	6 – 10	24
802.11n HT40	MCS3 & MCS4	11	32
802.11n HT40	MCS3 & MCS4	12	34
802.11n HT40	MCS5	1	20
802.11n HT40	MCS5	2 – 5	20
802.11n HT40	MCS5	6 – 10	20
802.11n HT40	MCS5	11	30
802.11n HT40	MCS5	12	30
802.11n HT40	MCS6	1	14
802.11n HT40	MCS6	2 – 5	2
802.11n HT40	MCS6	6 – 10	4
802.11n HT40	MCS6	11	22
802.11n HT40	MCS6	12	22
802.11n HT40	MCS7	1	4
802.11n HT40	MCS7	2 – 5	2
802.11n HT40	MCS7	6 – 10	4
802.11n HT40	MCS7	11	6
802.11n HT40	MCS7	12	8

3 Additional Information

All tests were performed with unmodified samples.
The EUT was not labeled with the final label.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
Maximum Peak Output Power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (d) [3]	Passed	15 et seq
DTS Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (a) [3]	Passed	17 et seq
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (b) [3]	Passed	20 et seq
Band edge compliance	2400.0 - 2483.5	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	23 et seq.
Radiated emissions (transmitter)	0.009 – 26,500	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	31 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Passed	60 et seq.

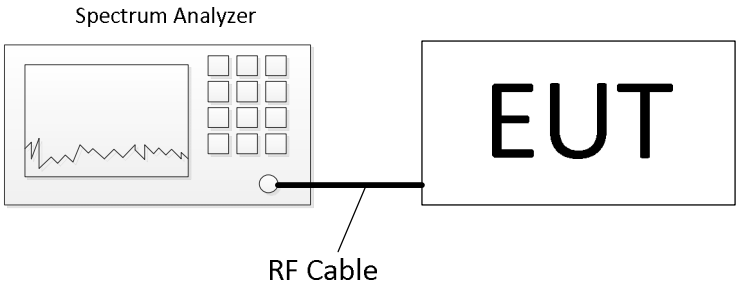
5 Results

5.1 Duty cycle

5.1.1 Method of measurement

The measurement was performed as an antenna port conducted measurement, as shown below.

Test Setup:



The method described in chapter 11.6 b) of document [1] was used to perform the following test.

Only the worst case plot for each mode was submitted below.

The following measurement technique was used:

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between two bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

- Set the center frequency of the instrument to the center frequency of the transmission.
- Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
- Set VBW ≥ RBW.
- Set detector = peak or average.
- The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

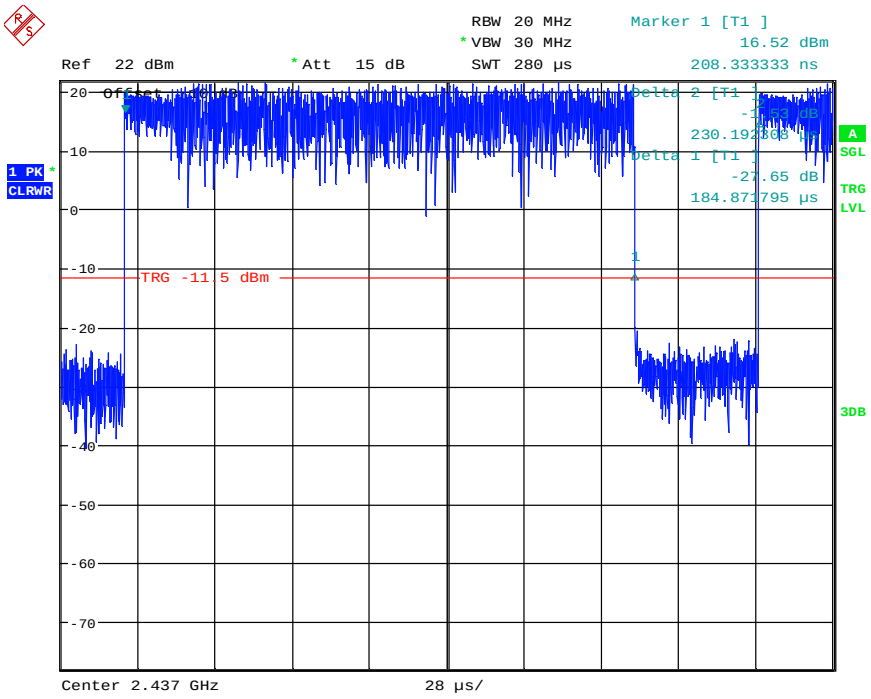
5.1.2 Test results

Ambient temperature	22 °C

Relative humidity	45 %

EUT in WLAN mode

170297_24Mbps_DutyCycle__g_6.wmf: Duty cycle measurement on channel 6 in g-mode



$$T_{TX\_On} = 184.9\,\mu s\,,\; T_{TX\_Period} = 230.2\,\mu s \qquad (1)$$

$$\frac{50}{T_{TX\_On}} = \frac{50}{184.9\,\mu s} = 270.416\,kHz \geq RBW \geq VBW \qquad (2)$$

Measurement Points 4001 for 280 µs à 184.9 µs = 2642 measurement points à Signal has 2642 measurement points (and fulfils the requirement of at least 100 Points resolution for the signal).

$$x = \frac{T_{TX\_On}}{T_{TX\_Period}} = \frac{184.9\,\mu s}{230.2\,\mu s} = 0.803 = 80.3\% \qquad (3)$$

Correction factor: $10 \times \log\left(\frac{1}{x}\right) = 10 \times \log\left(\frac{1}{0.803}\right) = 1.0\,dB$ (3)

Correction factor 802.11b: Tx_{On}: 592.0 ms; Tx_{Cycle}: 673.0 ms; Correction factor: 0.6 dB
Correction factor 802.11g: Tx_{On}: 184.9 ms; Tx_{Cycle}: 230.2 ms; Correction factor: 1.0 dB
Correction factor 802.11n HT20: Tx_{On}: 184.9 ms; Tx_{Cycle}: 229.7 ms; Correction factor: 0.9 dB
Correction factor 802.11n HT40: Tx_{On}: 200.3 ms; Tx_{Cycle}: 247.2 ms; Correction factor: 0.9 dB

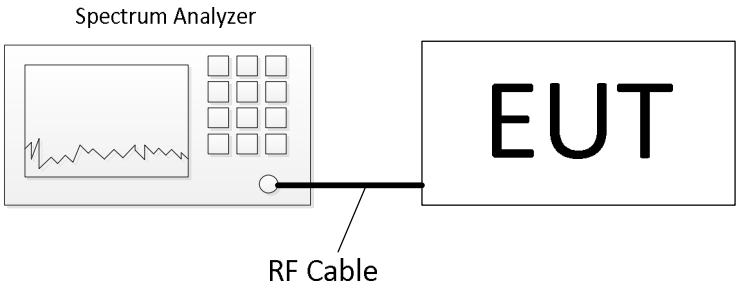
TEST EQUIPMENT USED FOR THE TEST:

30

5.2 Maximum conducted (average) output power

5.2.1 Method of measurement

The EUT was measured conducted at the antenna ports with the aid of a spectrum analyzer.



Acceptable measurement configurations

Procedure 11.9.2.2.4 in [1] was used for the following test.

Method AVGSA-2 uses trace averaging across ON and OFF times of the EUT transmissions, followed by duty cycle correction. The procedure for this method is as follows:

- - Measure the duty cycle D of the transmitter output signal as described in 11.6 [1].
- - Set span to at least 1.5 times the OBW.
- - Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz.
- - Set VBW ≥ [3 × RBW].
- Number of points in sweep ≥ [2 × span / RBW]. (This gives bin-to-bin spacing ≤ RBW / 2, so that narrowband signals are not lost between frequency bins.)
- Sweep time = auto.
- Detector = RMS (i.e., power averaging), if available. Otherwise, use the sample detector mode.
- Do not use sweep triggering. Allow the sweep to “free run.”
- Trace average at least 100 traces in power averaging (rms) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the ON and OFF periods of the transmitter.
- Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function with band limits set equal to the OBW band edges. If the instrument does not have a band power function, then sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.
- Add [10 log (1 / D)], where D is the duty cycle, to the measured power to compute the average power during the actual transmission times (because the measurement represents an average over both the ON and OFF times of the transmission). For example, add [10 log (1/0.25)] = 6 dB if the duty cycle is 25%.

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

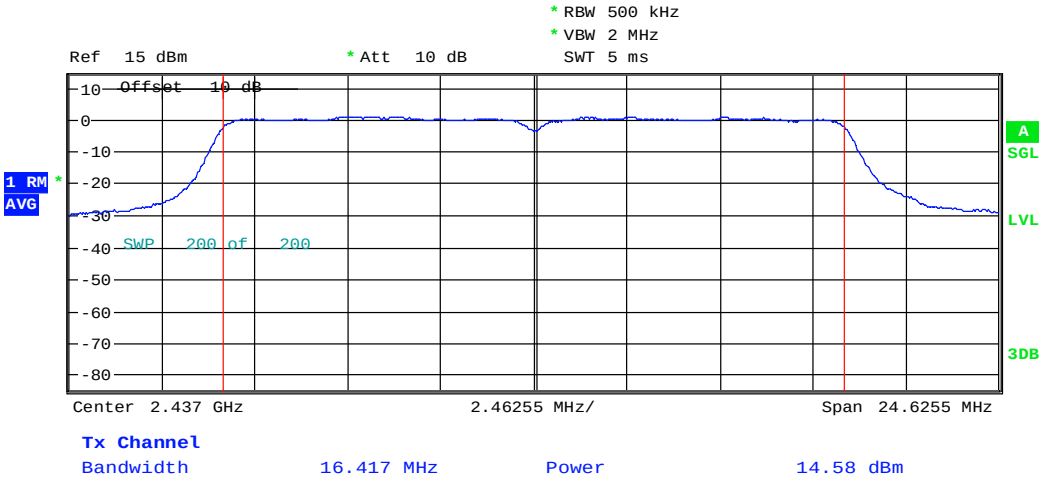
5.2.2 Test results

Ambient temperature	22 °C

Relative humidity	62 %

All antenna gains are below 6 dBi, therefore no conducted output limit reduction is necessary.

170279_AvOutpPwr_g_6.wmf: Maximum conducted (average) output power (operation mode 5):



Operation mode		Frequency [MHz]	Duty cycle correction [dB]	Conducted output power [dBm]	Limit [dBm]
1	b	2412	0.6	9.7	30
2	b	2437	0.6	12.3	30
3	b	2462	0.6	12.6	30
4	b	2467	0.6	15.1	30
5	g	2412	1.0	12.5	30
6	g	2437	1.0	15.6	30
7	g	2462	1.0	11.6	30
8	g	2467	1.0	10.3	30
9	n20	2412	0.9	11.9	30
10	n20	2437	0.9	15.4	30
11	n20	2462	0.9	11.1	30
12	n20	2467	0.9	9.0	30
13	n40	2422	0.9	10.4	30
14	n40	2437	0.9	10.5	30
15	n40	2452	0.9	8.0	30
16	n40	2457	0.9	8.2	30

Test: Passed

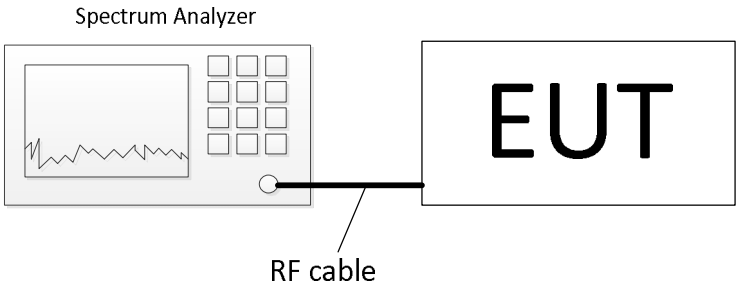
TEST EQUIPMENT USED FOR THE TEST:

30

5.3 DTS Bandwidth

5.3.1 Method of measurement

The EUT was tested with a spectrum analyzer connected directly to the EUT.



The measurement procedure refers to part 11.8.1 of document [1].

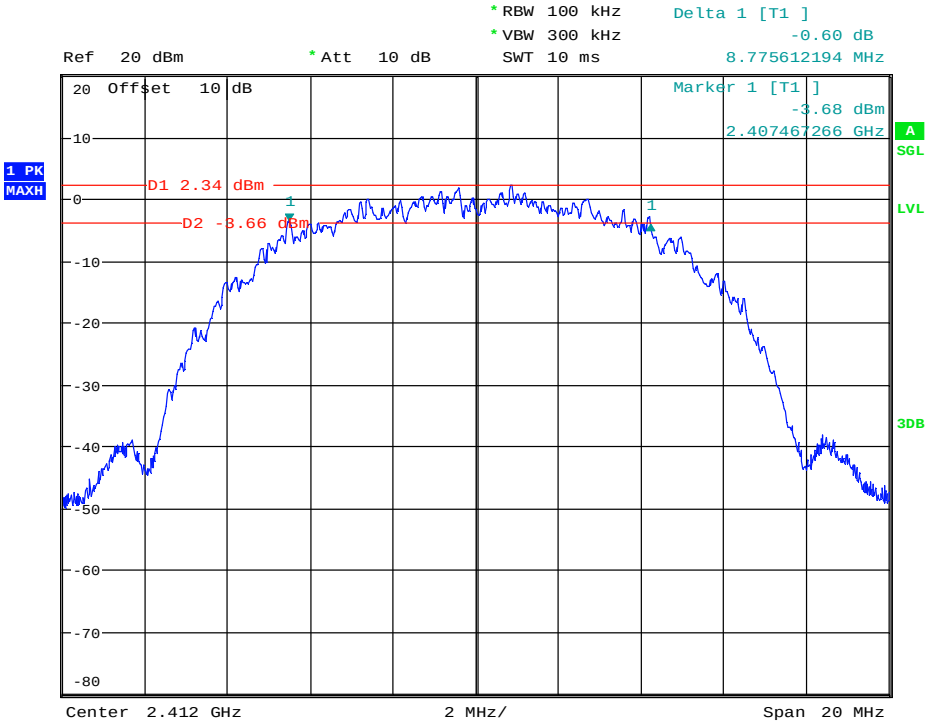
- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) ≥ 3 x RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

5.3.2 Test result

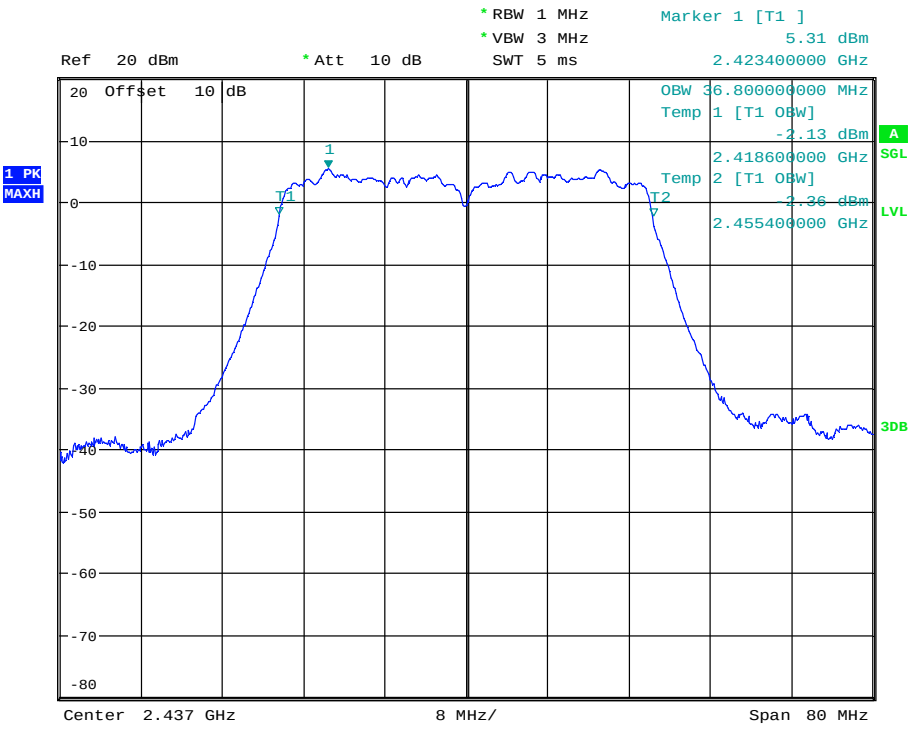
Ambient temperature	22 °C	Relative humidity	33 %

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

170279_6dB-BW_b_1.wmf: 6-dB Bandwidth (operation mode 1):



170297_99%BW_n40_6.wmf: 99% Bandwidth (operation mode 14):



Operation Mode		Center Frequency [MHz]	Minimum 6-dB Bandwidth Limit [MHz]	6 dB Bandwidth [MHz]	99 % Bandwidth [MHz]	Result
1	b	2412	0.5	8.776	11.220	Passed
2	b	2437	0.5	8.776	11.220	Passed
3	b	2462	0.5	8.776	11.187	Passed
4	b	2467	0.5	8.766	11.190	Passed
5	g	2412	0.5	16.432	16.650	Passed
6	g	2437	0.5	16.417	16.700	Passed
7	g	2462	0.5	16.447	16.425	Passed
8	g	2467	0.5	16.447	16.650	Passed
9	n20	2412	0.5	16.987	17.650	Passed
10	n20	2437	0.5	16.732	16.700	Passed
11	n20	2462	0.5	17.001	17.475	Passed
12	n20	2467	0.5	16.942	17.650	Passed
13	n40	2422	0.5	36.032	36.880	Passed
14	n40	2437	0.5	36.032	36.800	Passed
15	n40	2452	0.5	36.032	36.695	Passed
16	n40	2457	0.5	36.032	36.800	Passed

Test: Passed

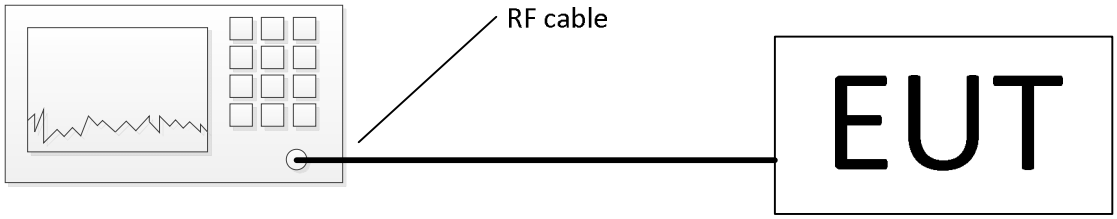
TEST EQUIPMENT USED FOR THE TEST:

30

5.4 Average Power Spectral Density

5.4.1 Method of measurement

The EUT was tested with a spectrum analyzer connected directly to the EUT.



The measurement procedure refers to part 11.10.5 of document [1].

Method AVGPSD-2 uses trace averaging across ON and OFF times of the EUT transmissions, followed by duty cycle correction.

The following procedure is applicable when the EUT cannot be configured to transmit continuously (i.e., D < 98%), when sweep triggering/signal gating cannot be used to measure only when the EUT is transmitting at its maximum power control level, and when the transmission duty cycle is constant (i.e., duty cycle variations are less than ±2%):

- Measure the duty cycle (D) of the transmitter output signal as described in 11.6.
- Set instrument center frequency to DTS channel center frequency.
- Set span to at least 1.5 times the OBW.
- Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
- Set VBW ≥ [3 × RBW].
- Detector = power averaging (rms) or sample detector (when rms not available).
- Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].
- Sweep time = auto couple.
- Do not use sweep triggering; allow sweep to “free run.”
- Employ trace averaging (rms) mode over a minimum of 100 traces.
- Use the peak marker function to determine the maximum amplitude level.
- Add [10 log (1 / D)], where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time.
- m) If measured value exceeds requirement specified by regulatory agency, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).

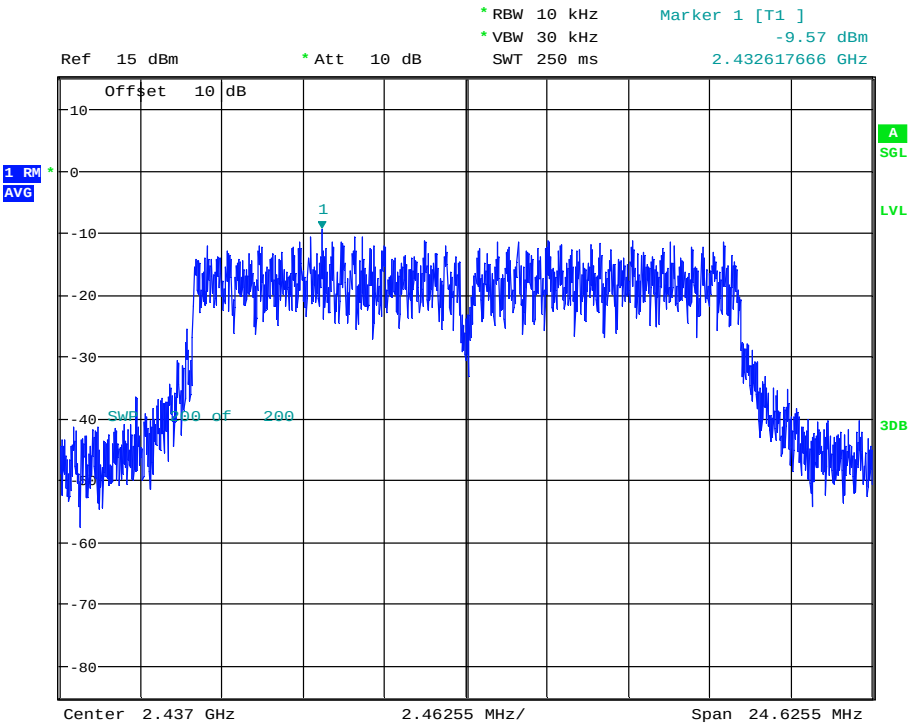
5.4.2 Test result

Ambient temperature	22 °C	Relative humidity	59 %

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

EUT in WLAN mode

170279_AVPwrSpecDens_g_6.wmf: Power Spectral Density (operation mode 6):



Operation Mode		Peak Frequency [MHz]	Power Spectral Density Limit [dBm/3kHz]	Duty cycle correction [dB]	Power Spectral Density Reading [dBm / 10 kHz]	Result
1	b	2412.197	8	0.6	-14.7	Passed
2	b	2437.203	8	0.6	-12.1	Passed
3	b	2463.195	8	0.6	-11.6	Passed
4	b	2467.203	8	0.6	-9.2	Passed
5	g	2419.822	8	1.0	-11.9	Passed
6	g	2444.825	8	1.0	-8.6	Passed
7	g	2457.620	8	1.0	-12.2	Passed
8	g	2474.824	8	1.0	-13.9	Passed
9	n20	2414.130	8	0.9	-13.7	Passed
10	n20	2439.129	8	0.9	-10.1	Passed
11	n20	2464.130	8	0.9	-9.5	Passed
12	n20	2460.751	8	0.9	-14.3	Passed
13	n40	2430.758	8	0.9	-14.0	Passed
14	n40	2445.758	8	0.9	-13.9	Passed
15	n40	2460.758	8	0.9	-19.0	Passed
16	n40	2465.758	8	0.9	-16.3	Passed

Test: Passed

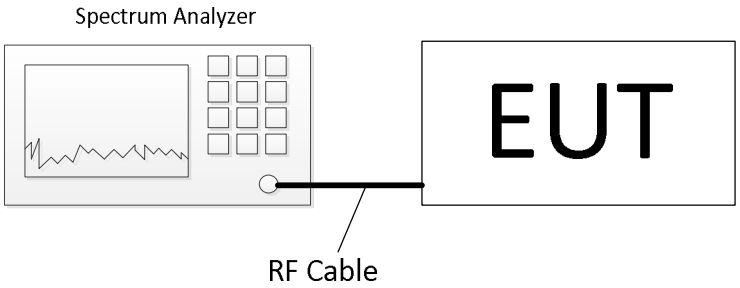
TEST EQUIPMENT USED FOR THE TEST:

30

5.5 Band-edge compliance

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

The EUT was tested with a spectrum analyzer connected directly to the EUT.



The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyzer. The measurement procedure refers to part 11.11.2 and 11.11.3 of document [1].

Measurement Procedure Reference – Reference Level:

- RBW = 100 kHz.
- VBW ≥ 300 kHz.
- Set the span to ≥ 1.5 times the DTS Bandwidth.
- Detector = Peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum PSD level.

Measurement Procedure – Unwanted Emissions

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

The measurement procedure at the band edges was simplified by performing the measurement in just one plot. Both, the in-band-emission and the unwanted emission were be encompassed by the span. After trace stabilization, the maximum peak was be determined by a peak detector and the value was marked by an appropriate limit line. The second limit line, which is 20 dB below the first, marks the limit for the emissions in the unrestricted band. A maximum-peak-detector marks the highest emission in the unrestricted band next to the band edge.

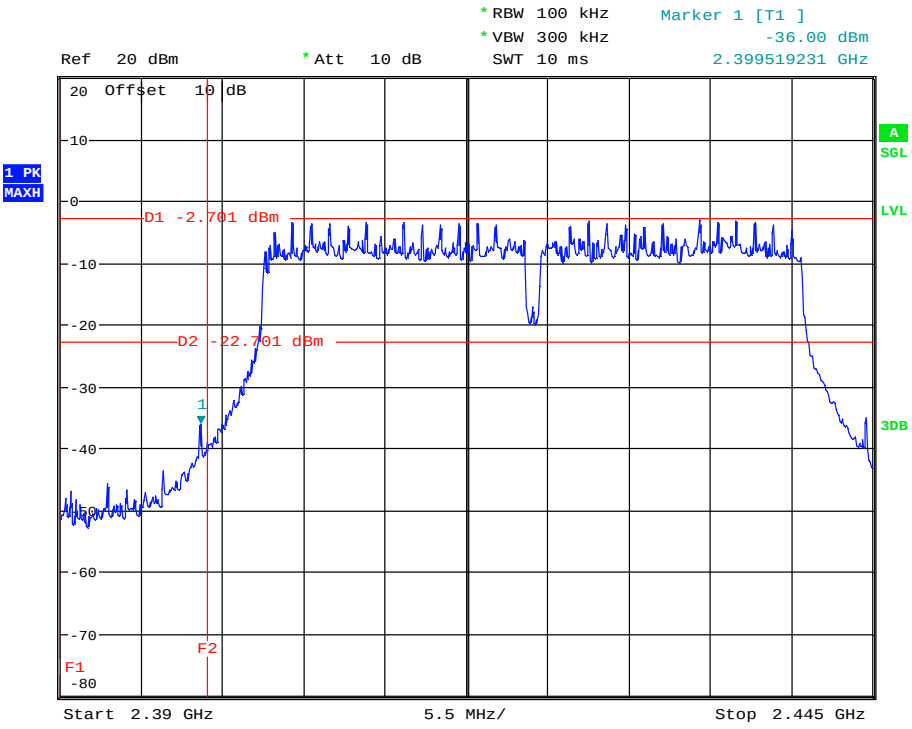
The measurements were performed at the lower end of the 2.4 GHz band.

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

Ambient temperature	22 °C	Relative humidity	40 %

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.

170279_MCS5_BandEdgeUnrestr_n40_3.wmf: conducted band-edge compliance (operation mode 13):



Operation mode		Emission Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emission Level [dBm]	Margin [dB]	Result
1	b	2398.397	2.8	-17.2	-51.5	34.3	Passed
5	g	2399.167	1.5	-18.5	-41.5	23.0	Passed
9	n20	2399.808	1.1	-18.9	-42.8	23.8	Passed
13	n40	2399.519	-2.7	-22.7	-35.7	13.0	Passed

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
30

5.5.3 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 sub-clause 5.6.1 of this test report).

After trace stabilization 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 general limits specified in § 15.205.

The measurement was performed at the lower and the upper end of the 2.4 GHz band.

The calculation was performed with the following formula as described in chapter 11.12.2.2 e) in [1]:

$$E\ [\mathrm{dB\mu V/m}] = EIRP\ [\mathrm{dBm}] - 20\log(d) + 104.8 + G_{\mathrm{Ant}}\ [\mathrm{dBi}] + G_{\mathrm{Array}}\ [\mathrm{dB}] + Att_{\mathrm{MeasCable}}\ [\mathrm{dB}] + Att_{\mathrm{RF\text{-}Switch}}\ [\mathrm{dB}]$$

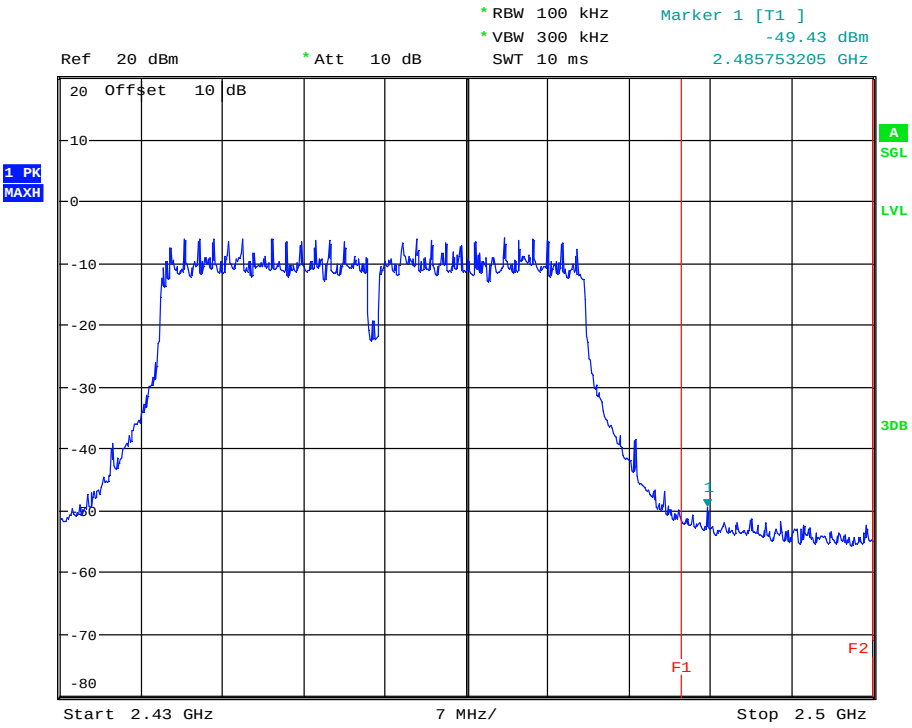
E [dBµV/m] = Field Strength [dBuV/m]
$EIRP$ [dBm] = Reading [dBm]
d = measurement distance in m
G_{Ant} [dBi] = Gain of the EUT antenna
G_{Array} [dB] = Array Gain [in case of multiple transmitting antenna port]
$Att_{\mathrm{MeasCable}}$ [dB] = Attenuation of the measurement cables
$Att_{\mathrm{RF\text{-}Switch}}$ [dB] = Attenuation of the RF Switch

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

Ambient temperature	22 °C	Relative humidity	40 %

The plots show an exemplary measurement result for the worst documented case. The other results are listed in the following tables.

170297_BandEdgeRestr_n40_10.wmf: conducted band-edge compliance (operation mode 16):



Band Edge Compliance, b-mode, channel 1, (Operation mode 1)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
1	2381.178	52.5	74.0	21.5	-45.7	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
1	2380.798	40.9	54.0	13.1	-57.3	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, b-mode, channel 11, (Operation mode 3)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
3	2487.176	54.6	74.0	19.4	-43.7	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
3	2487.441	42.5	54.0	11.5	-56.3	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, b-mode, channel 12, (Operation mode 4)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
4	2483.572	54.2	74.0	19.8	-44.1	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
4	2483.567	43.1	54.0	10.9	-55.2	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, g-mode, channel 1, (Operation mode 5)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
5	2389.660	62.5	74.0	11.5	-35.7	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
5	2389.915	46.7	54.0	7.3	-51.6	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, g-mode, channel 11, (Operation mode 7)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
7	2483.515	60.5	74.0	13.5	-37.8	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
7	2383.565	45.5	54.0	8.5	-53.7	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, g-mode, channel 12, (Operation mode 8)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
8	2483.600	60.3	74.0	13.7	-37.9	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
8	2483.690	45.2	54.0	8.8	-53.1	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, n20-mode, channel 1, (Operation mode 9)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
9	2389.449	58.5	74.0	15.5	-39.8	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
9	2389.869	44.6	54.0	9.4	-53.7	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, n20-mode, channel 11, (Operation mode 11)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
11	2484.005	60.6	74.0	13.4	-37.7	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
11	2483.665	44.6	54.0	9.4	-54.5	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, n20-mode, channel 12, (Operation mode 12)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
12	2485.025	55.4	74.0	18.6	-42.9	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
12	2483.535	43.9	54.0	10.1	-54.3	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, n40-mode, channel 3, (Operation mode 13)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
13	2387.567	59.5	74.0	14.5	-38.8	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
13	2389.372	46.5	54.0	7.5	-51.7	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, n40-mode, channel 9, (Operation mode 15)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
15	2483.844	57.2	74.0	16.8	41.1	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
15	2483.529	45.0	54.0	9.0	-54.1	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

Band Edge Compliance, n40-mode, channel 10, (Operation mode 16)							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
16	2483.553	61.8	74.0	12.2	-36.5	3.0	Passed
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
16	2483.498	47.2	54.0	6.8	-51.1	3.0	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB			

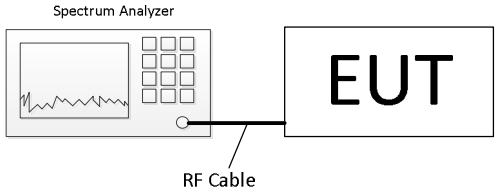
Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
30

5.6 Maximum unwanted emissions

5.6.1 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 analyzer.



The measurement procedure refers to part 11.12.2.2 in document [1].

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

Procedure for average measurement: 11.12.2.5.2 – Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction:

If continuous transmission of the EUT (D ≥ 98%) cannot be achieved and the duty cycle is constant (duty cycle variations are less than ±2%), then the following procedure shall be used:

- The EUT shall be configured to operate at the maximum achievable duty cycle.
- Measure the duty cycle D of the transmitter output signal as described in 11.6 in [1].
- Set the RBW = 1 MHz (unless otherwise specified).
- 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
- Sweep time = auto
- Perform a trace average of at least 100 traces
- Correct the resulting measurement value by adding the duty cycle correction value if applicable.

Peak measurement procedure: 11.12.2.4 in [1]

- Set the analyzer span to encompass the entire unwanted emission bandwidth.
- Set the RBW = specified in Table 1.
- Set the VBW ≥ 3 x 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 1 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

5.6.1.1 Limit calculations

The following general procedure is described in chapter 11.12.2.2 in [1].

a) Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 11.12.2.3 through 11.12.2.5 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP (see 11.12.2.6 for guidance on determining the applicable antenna gain).
c) Add the appropriate maximum ground reflection factor to the EIRP (6 dB for frequencies ≤ 30 MHz; 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and 0 dB for frequencies > 1000 MHz).
d) For MIMO devices, measure the power of each chain and sum the EIRP of all chains in linear terms (i.e., watts and mW).
e) Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

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

where

E is the electric field strength in dBµV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m

f) Compare the resultant electric field strength level with the applicable regulatory limit.
g) C Perform the radiated spurious emission test.

Chapter 14 in [1] states, that for transmitters with multiple outputs in the same band, summing of emissions and accounting for array gain have to be considered.

For the case that bot antenna ports transmit continuously, both results were summed as linear values as described in 14.3.2.2 in document [1].

To account for directional gain which might occur in case of N transmit antennas in the test mode spatial multiplexing, which is the mode the EUT uses, the directional has to be calculated as:

$$10log\left[\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{Ant}} g_{j,k}\right\}^2 \Big/ N_{Ant}\right]$$

Whereby

N_{SS} is the number of independent spatial streams of data.
N_{Ant} is the total number of antennas
$g_{j,k}$ is $10^{Gk/20}$ if the *k*th antenna is being fed by spatial stream j, or zero if it is not
G_k is the gain in dBi of the kth antenna

Since the EUT has only 1 antenna, no array gain is applicable here.

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

In any 100 kHz outside the authorized frequency band, the power shall be attenuated by 20 dB, compared to the highest in band power in any 100 kHz. This shall be demonstrated by using the peak power procedure. The reference level shall be measured using the procedure described in 5.6.2.1 and the emission level according to procedure 5.6.2.2. The procedures are based on chapter 11.11.2 and 11.11.3 in [1].

For the operation modes in which both antenna ports transmit simultaneously, the level of the both ports were summed in linear value for each frequency step. The applicable plots show the result of that sum.

5.6.2.1 Reference level measurement

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

5.6.2.2 Emission level measurement

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Ensure that the number of measurement points ≥ span/RBW
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level.

5.6.3 Test results (conducted emissions)

5.6.3.1 Emissions below 1 GHz

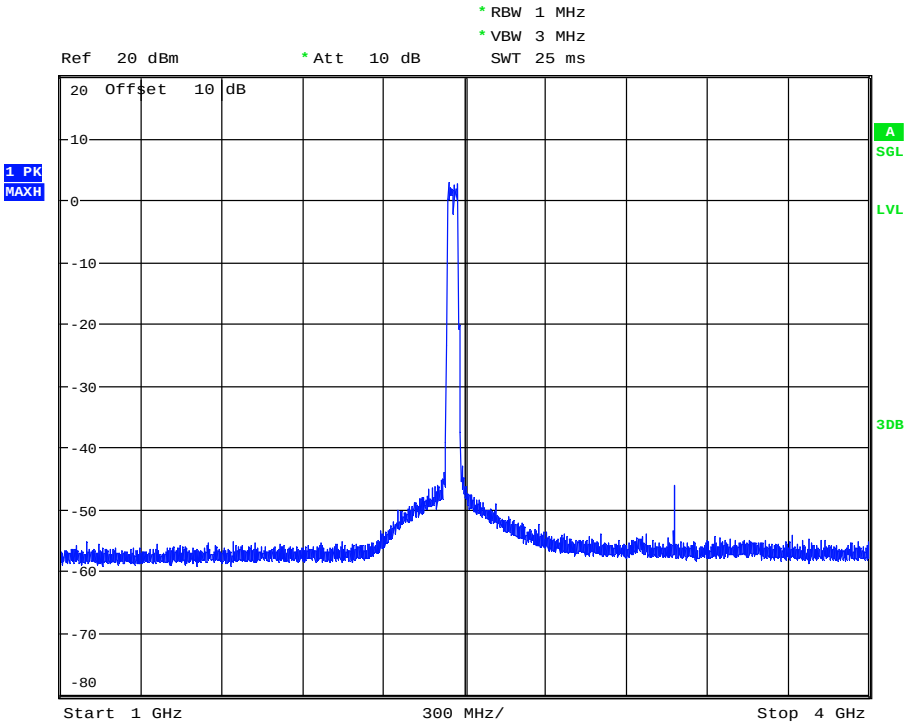
No significant emissions were found below 1 GHz, therefore no plots and result tables for this frequency range are submitted below.

5.6.3.2 Emissions above 1 GHz

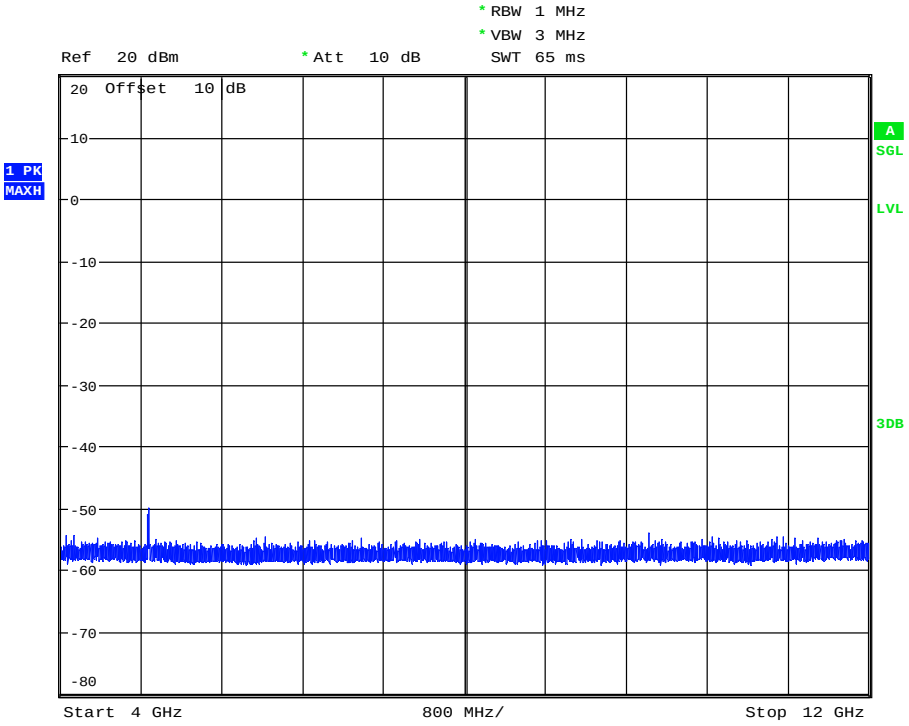
Ambient temperature	22 °C	Relative humidity	59 %

The following results were measured at antenna port of the EUT. Only the plots for the worst case emissions are submitted below.

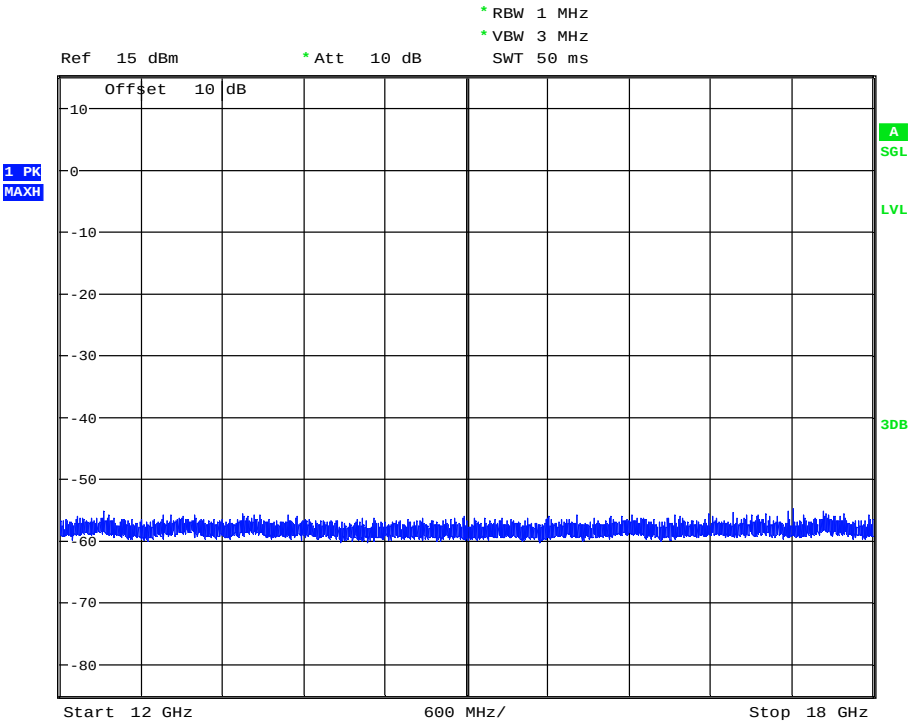
170297_SpurEmiss1-4G_n40_10.wmf: conducted spurious emissions (operation mode 16):



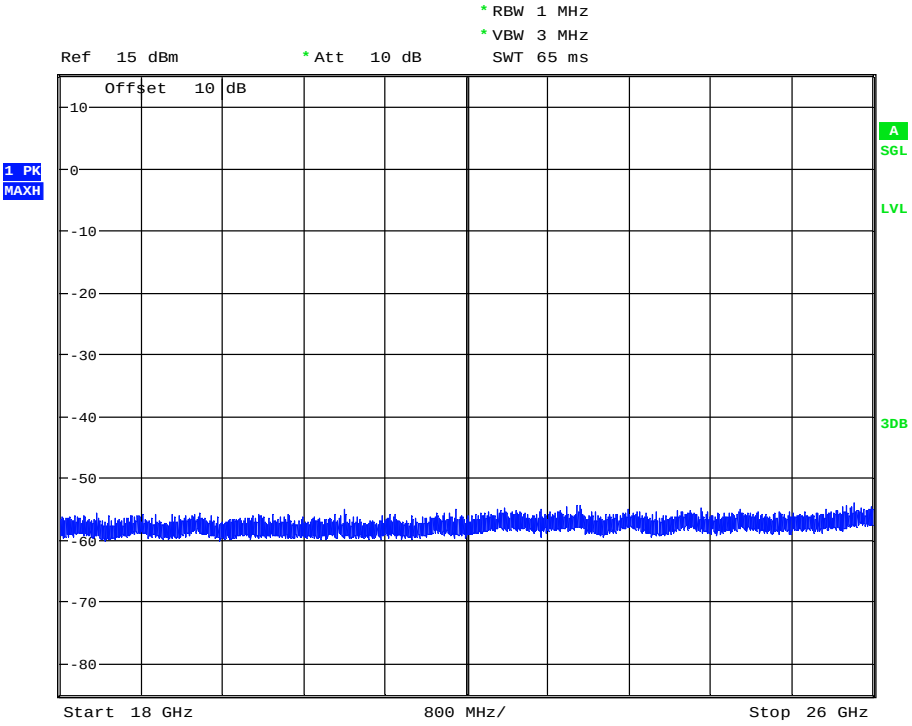
170297_SpurEmiss4-12G_b_6.wmf: conducted spurious emissions (operation mode 2):



170297_SpurEmiss12-18G_b_6.wmf: conducted spurious emissions (operation mode 2):



170297_SpurEmiss18-26G_b_6.wmf: conducted spurious emissions (operation mode 2):



Spurious Emissions, b-mode, channel 1, (Operation mode 1)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
1	4823.950	49.2	74.0	24.8	-49.1	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
1	4823.420	39.3	54.0	14.7	-58.9	3.0	
Emissions in the non-restricted Bands							
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result		
1	2412.860	2.8	-	-	-		
1	3216.000	-46.3	-17.2	29.2	Passed		
Measurement uncertainty			+0.66 dB / -0.72 dB				

Spurious Emissions, b-mode, channel 6, (Operation mode 2)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
2	4874.010	49.8	74.0	24.2	-48.4	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
2	4873.160	40.1	54.0	13.9	-58.2	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
2	2437.850	5.2	-	-	-
2	3249.340	-46.8	-14.8	32.0	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, b-mode, channel 11, (Operation mode 3)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
3	4924.11	49.7	74	24.3	-48.6	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
3	4923.34	40.6	54	13.4	-58.5	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
3	2462.86	5.3	-	-	-
3	3282.68	-46.5	-14.7	31.7	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, b-mode, channel 12, (Operation mode 4)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
4	4934.350	49.6	74.0	24.4	-48.6	3.0	Passed
4	7404.890	47.4	74.0	26.6	-50.9	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
4	4933.490	39.8	54.0	14.2	-58.5	3.0	Passed
4	7399.870	36.2	54.0	17.8	-62.1	3.0	Passed
Emissions in the non-restricted Bands							
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result		
4	2467.850	7.9	-	-	-		
4	3289.350	-47.0	-12.1	34.9	Passed		
Measurement uncertainty			+0.66 dB / -0.72 dB				

Spurious Emissions, g-mode, channel 1, (Operation mode 5)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
5	4821.080	48.9	74.0	25.1	-49.3	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
5	4825.190	37.7	54.0	16.3	-60.5	3.0	Passed
Emissions in the non-restricted Bands							
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result		
5	2417.000	1.5	-	-	-		
5	3216.010	-45.9	-18.5	27.5	Passed		
Measurement uncertainty			+0.66 dB / -0.72 dB				

Spurious Emissions, g-mode, channel 6, (Operation mode 6)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
6	4870.330	48.5	74.0	25.5	-49.8	3.0	Passed
6	7311.325	47.1	74.0	26.9	-51.1	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
6	4875.250	37.2	54.0	16.8	-61.1	3.0	Passed
6	7313.405	35.6	54.0	18.4	-62.7	3.0	Passed
Emissions in the non-restricted Bands							
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result		
6	2432.010	4.6	-	-	-		
6	3249.330	-46.2	-15.4	30.8	Passed		
Measurement uncertainty			+0.66 dB / -0.72 dB				

Spurious Emissions, g-mode, channel 11, (Operation mode 7)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
7	4900.06	47.1	74	26.9	-51.1	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
7	4905.24	36.9	54	17.1	-62.3	3.0	Passed
Emissions in the non-restricted Bands							
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result		
7	2459.51	0.3	-	-	-		
7	2628.33	-58.5	-19.7	38.8	Passed		
7	3282.68	-47.1	-19.7	27.4	Passed		
Measurement uncertainty			+0.66 dB / -0.72 dB				

Spurious Emissions, g-mode, channel 12, (Operation mode 8)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
8	4930.200	47.2	74.0	26.8	-51.1	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
8	4930.340	36.2	54.0	17.8	-62.0	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
8	2462.000	-0.8	-	-	-
8	3289.340	-46.7	-20.8	25.9	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n20-mode, channel 1, (Operation mode 9)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
9	4825.520	48.3	74.0	25.7	-50.0	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
9	4825.300	37.5	54.0	16.5	-60.7	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
9	2417.000	1.0	-	-	-
9	3216.010	-45.2	-19.0	26.2	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n20-mode, channel 6, (Operation mode 10)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
10	4868.910	48.2	74.0	25.8	-50.1	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
10	4872.660	37.2	54.0	16.8	-61.0	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
10	2432.010	4.5	-	-	-
10	3249.330	-46.3	-15.5	30.8	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n20-mode, channel 11, (Operation mode 11)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
11	4920.61	45.5	74	28.5	-52.7	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
11	4925.24	35.4	54	18.6	-63.8	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
11	2465.76	-3.3	-	-	-
11	2640.91	-58.1	-23.3	34.8	Passed
11	3282.68	-46.8	-23.3	23.5	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n20-mode, channel 12, (Operation mode 12)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
12	4932.950	46.8	74.0	27.2	-51.5	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
12	4935.240	36.0	54.0	18.0	-62.2	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
12	2462.000	-1.8	-	-	-
12	3289.360	-46.1	-21.8	24.3	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n40-mode, channel 3, (Operation mode 13)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
13	4840.470	47.2	74.0	26.8	-51.0	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
13	4842.680	36.0	54.0	18.0	-62.2	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
13	2425.760	-3.6	-	-	-
13	3229.340	-46.2	-23.6	22.6	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n40-mode, channel 6, (Operation mode 14)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
14	4870.310	46.9	74.0	27.1	-51.3	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
14	4872.770	36.0	54.0	18.0	-62.3	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
14	2440.760	-3.3	-	-	-
14	3249.340	-46.4	-23.3	23.0	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n40-mode, channel 11, (Operation mode 15)							
Peak Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
15	4900.79	44.8	74	29.2	-53.5	3.0	Passed
Average Emission – Restricted Band							
Operation Mode	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result
15	4902.84	34.2	54	19.8	-65	3.0	Passed

Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
15	2455.76	-6.2	-	-	-
15	3269.35	-46.8	-26.2	20.6	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Spurious Emissions, n40-mode, channel 12, (Operation mode 16)					
Peak Emission – Restricted Band					
No emissions found in the restricted band					
Average Emission – Restricted Band					
No emissions found in the restricted band					
Emissions in the non-restricted Bands					
Operation Mode	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result
16	2445.720	-5.8	-	-	-
16	3276.020	-46.6	-25.8	20.8	Passed
Measurement uncertainty			+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
30

5.6.4 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into five 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 heights 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 25 / 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 25 / 40 GHz.

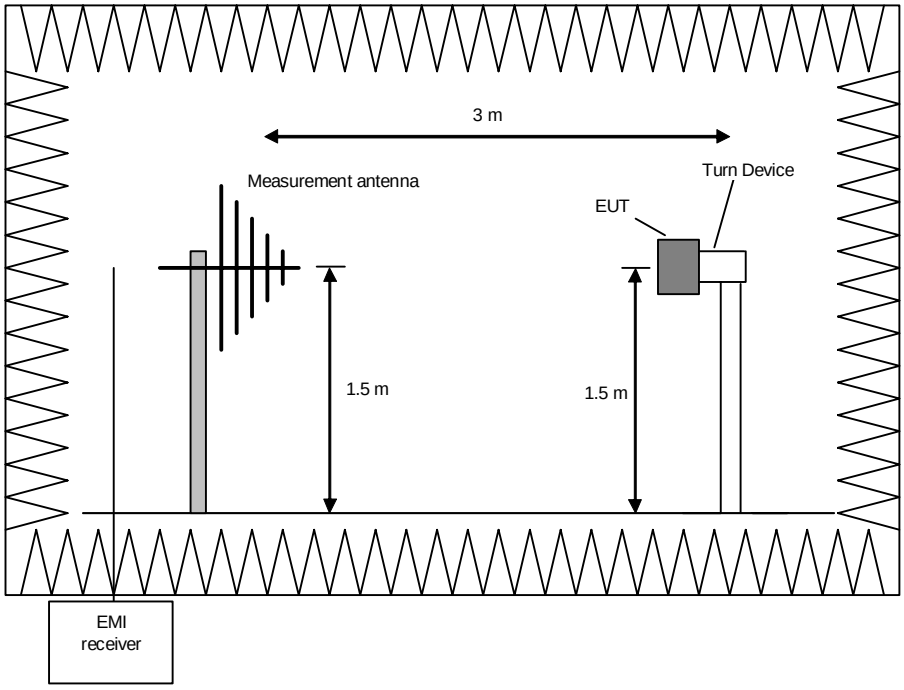
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Table top devices will set up on a non-conducting turn device on the height of 1.5m. Floor-standing devices will be placed directly on the turntable/ground plane. The set-up of the Equipment under test will be in accordance to [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

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

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Pre-scans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

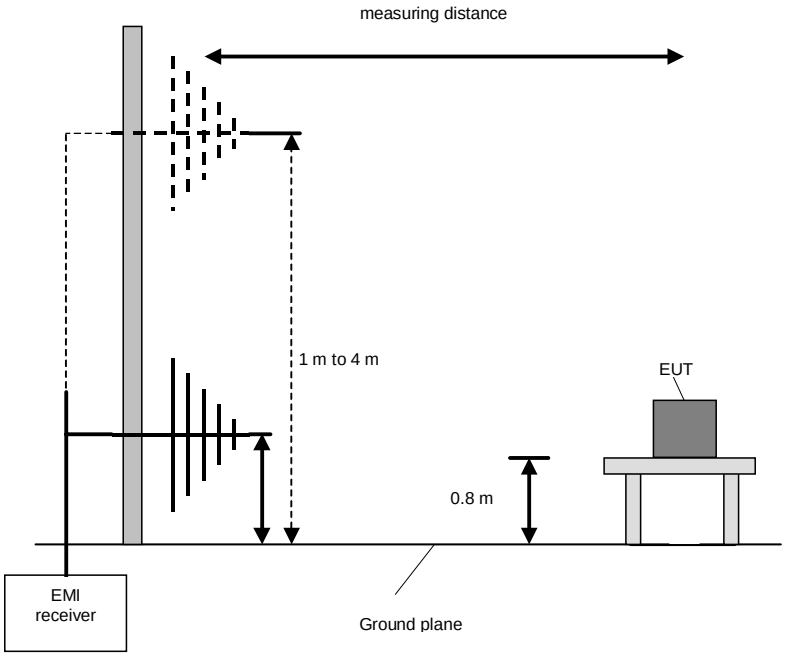
1. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarization of the measuring antenna.
5. Make a hardcopy of the spectrum.
6. Repeat 1) to 5) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
7. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of
0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarization and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
4) Repeat 1) to 3) for the other orthogonal antenna polarization.
5) Move the antenna and the turntable to the position where the maximum value is detected.
6) Measure while moving the antenna slowly +/- 1 m.
7) Set the antenna to the position where the maximum value is found.
8) Measure while moving the turntable +/- 45 °.
9) Set the turntable to the azimuth where the maximum value is found.
10) Measure with Final detector (QP and AV) and note the value.
11) Repeat 5) to 10) for each frequency.
12) Repeat 1) to 11) for each orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 40 GHz)

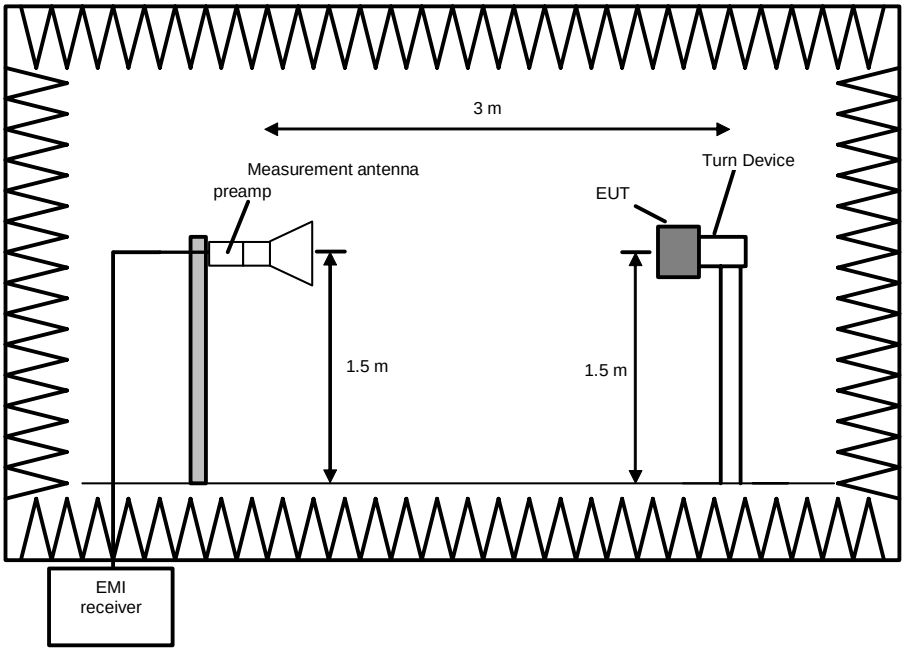
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyzer set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

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 25 / 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz



Procedure preliminary measurement:

Pre-scans were performed in the frequency range 1 to 40 GHz.
The following procedure will be used:

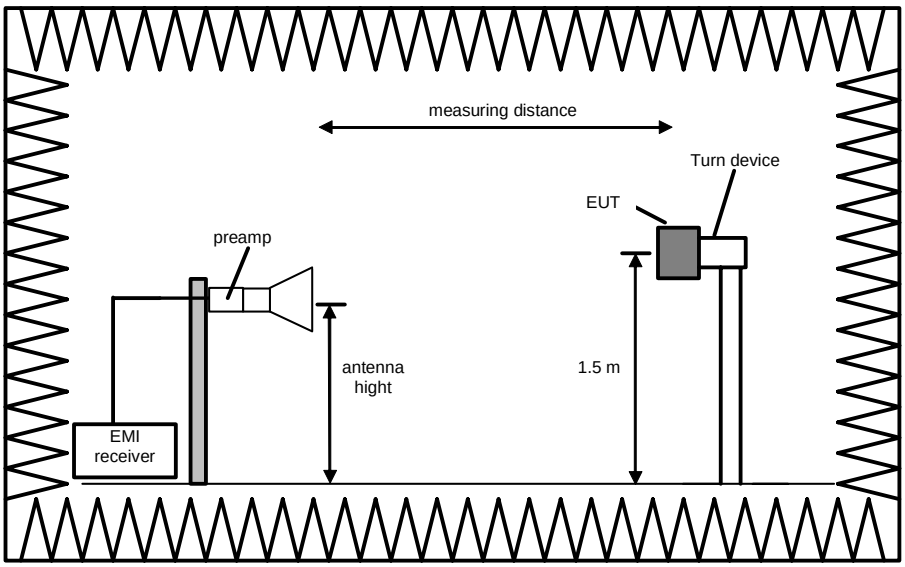
1. Monitor the frequency range at horizontal polarization and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarization of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarization, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 25 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 by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

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 25 / 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 GHz.
The following procedure will be used:

1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
2) Set the measurement antenna polarization to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
3) Set the spectrum analyzer to EMI mode with peak and average detector activated.
4) Rotate the turntable from 0° to 360° to find the EUT angle that produces the highest emissions.
5) Note the highest displayed peak and average values
6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.6.5 Test results (radiated emissions)

5.6.5.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	55 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m or an EUT turn device of a height of 1.5 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 Test setup Photo annex.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 5 V DC via an USB cable.

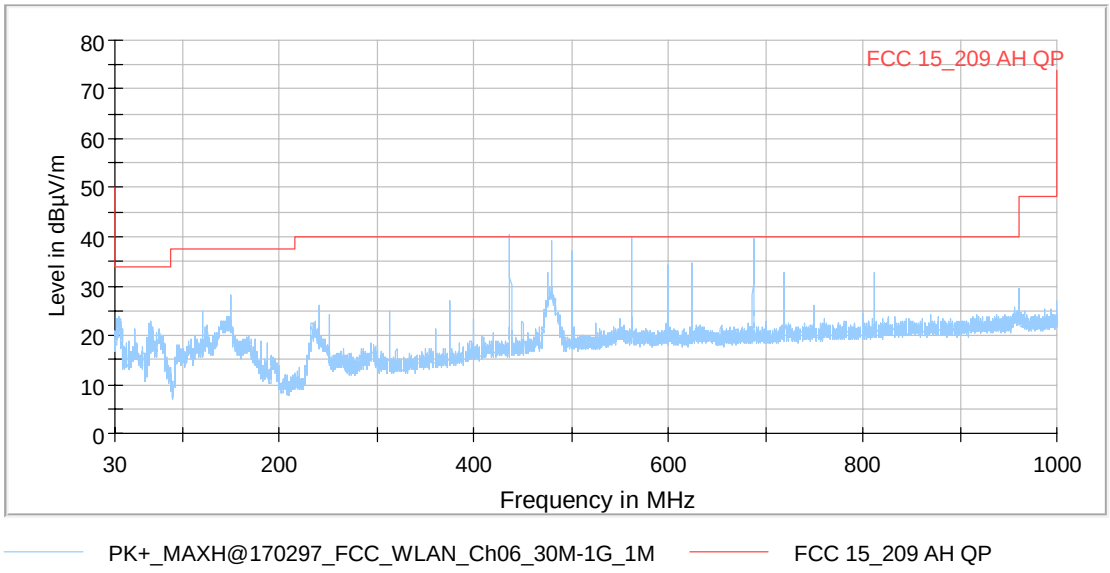
Remark: Document [1] states in 11.12.2.1, that in case of conducted measurements, additional radiated cabinet emission measurements must be performed. The measurements were performed at the worst case modulations for each frequency range.

Since the lowest internal clock frequency is 40 MHz, the radiated emissions were tested starting at 30 MHz.

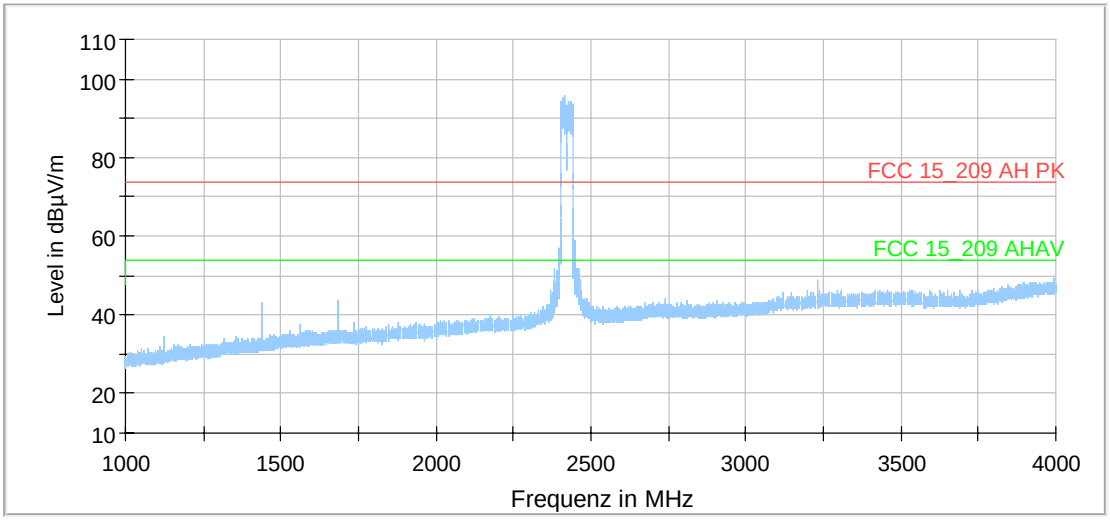
The Emissions below 1 GHz were equal for all antenna ports, transmit frequencies, modulation schemes and data rates. Therefore only the results of an exemplary test case are submitted below.

All modes (WLAN)

All modes.Rtf: Spurious emissions from 30 MHz to 1 GHz (all operation modes):

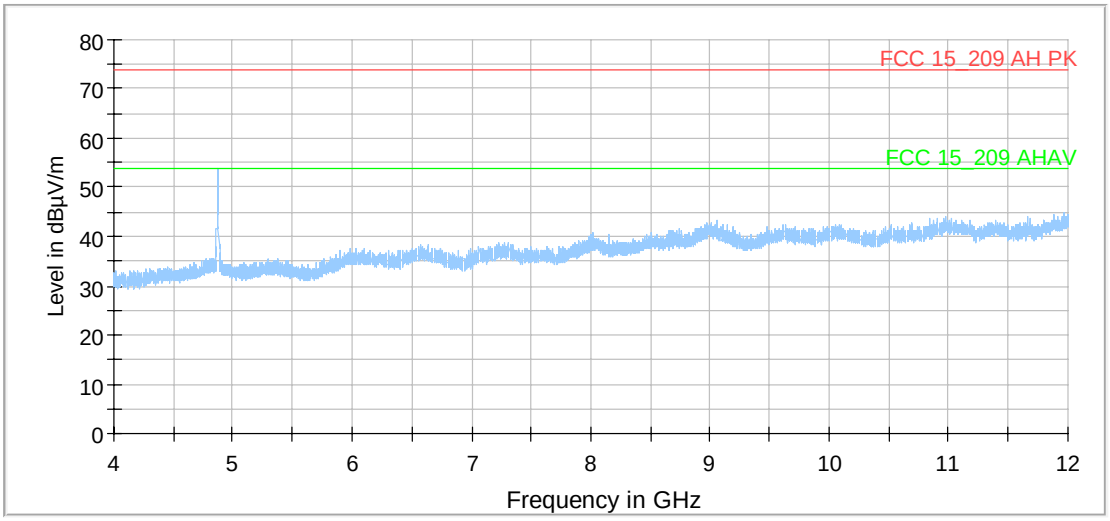


170297_FCC_WLAN_Ch03_1-4G.Rtf: Spurious emissions from 1 GHz to 4 GHz (operation mode 13, n40-mode):



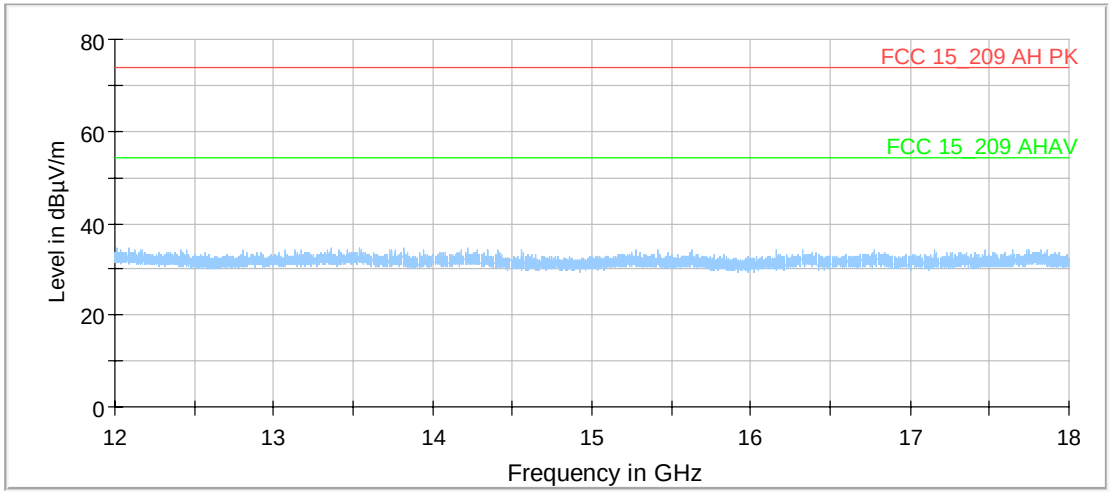
PK+_MAXH FCC 15_209 AH PK FCC 15_209 AHAV

170297_FCC_WLAN_Ch06_4-12G.Rtf: Spurious emissions from 4 GHz to 12 GHz (operation mode 2, b-mode):



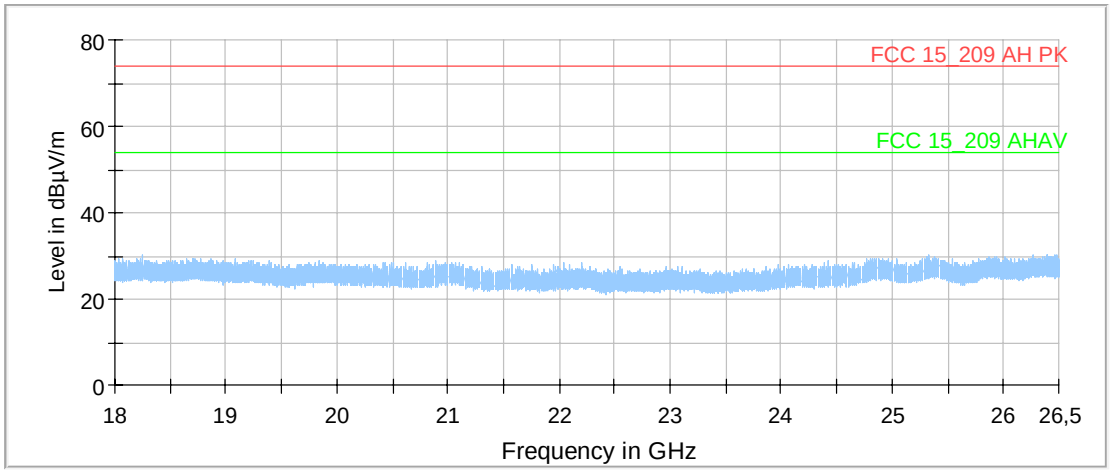
PK+_MAXH FCC 15_209 AH PK FCC 15_209 AHAV

170297_FCC_WLAN_Ch01_12-18G.Rtf: Spurious emissions from 12 to 18 GHz (operation mode 1, b-mode):



Preview Result 1-PK+
Final_Result PK+
FCC 15_209 AH PK
Final_Result CAV
FCC 15_209 AHAV

170297_FCC_WLAN_Ch01_18-26,5G.Rtf: Spurious emissions from 18 – 25 GHz (operation mode 1, b-mode):



PK+_MAXH@170297_FCC_WLAN_Ch01_18-26,5G
FCC 15_209 AH PK
FCC 15_209 AHAV

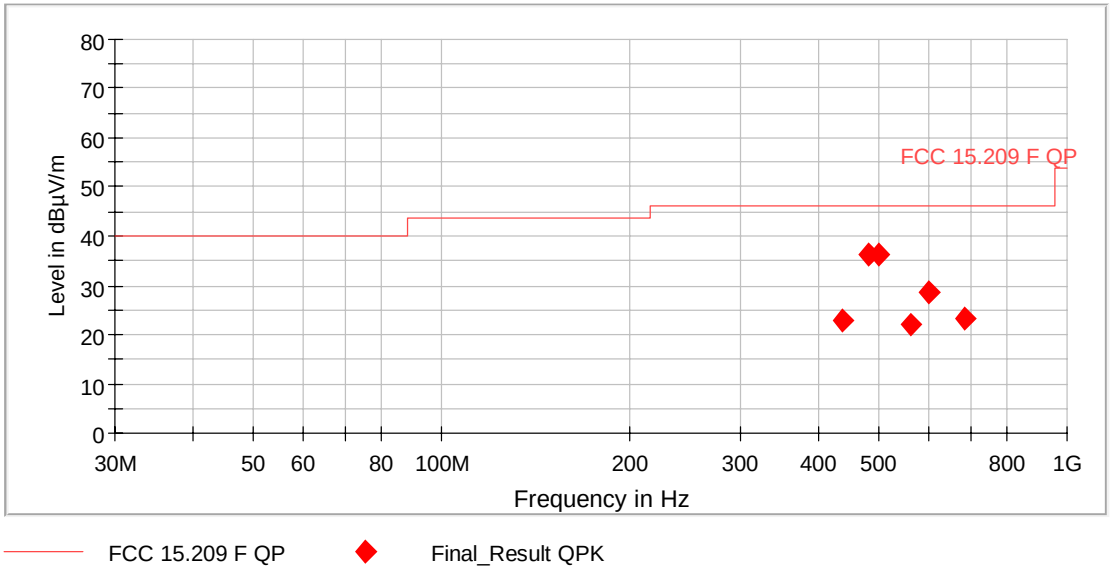
TEST EQUIPMENT USED FOR THE TEST:
7 - 29, 31 – 42, 44 – 51, 72

5.6.5.2 Final radiated emission measurement (30 MHz to 1 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 or a EUT turn device of a height of 1.5 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 test setup photos.
Test record:	All results are shown in the following.
Supply voltage:	During all measurements the host of the EUT was powered with 5 V DC via an USB cable.
Resolution bandwidth:	For all measurements a resolution bandwidth of 100 kHz was used.
Additional information:	Since the lowest internal clock frequency is 40 MHz, the radiated emissions were tested starting at 30 MHz. The correction factor is calculated as Antenna Factor [dB] + Cable Attenuation [dB] - Amplifier Gain[dB] The result Peak/Average is the result of Reading [dBµV/m] – Correction factor [dB]

170297 Nina 30M-1G FF.rtf: Spurious emissions from 30 MHz to 1 GHz (all operation modes)



Final Results

Frequency [MHz]	QuasiPeak [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Height [cm]	Pol	Azimuth [deg]	Corr. [dB]
437.448500	22.72	46.00	23.28	1000.0	120.000	232.0	H	290.0	25.3
479.983000	36.47	46.00	9.53	1000.0	120.000	175.0	H	58.0	26.2
499.965000	36.51	46.00	9.49	1000.0	120.000	184.0	H	55.0	26.4
562.481500	21.93	46.00	24.07	1000.0	120.000	357.0	V	357.0	27.9
600.020500	28.62	46.00	17.38	1000.0	120.000	103.0	V	262.0	28.0
687.466000	23.28	46.00	22.72	1000.0	120.000	120.0	H	61.0	28.3
Measurement uncertainty					+2.2 dB / -3.6 dB				

5.6.5.3 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 EUT turn device of a height of 1.5 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 test setup photos.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 5 V DC via an USB cable.

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.

EUT in WLAN mode (1 – 4 GHz)

The worst case operation mode found in the antenna port conducted tests, were repeated for each frequency range in the radiated measurements.

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

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
1124.920000	---	23.04	54	30.96	V	293.0	30.0	25.7	Passed
1124.920000	34.84	---	74	39.16	V	293.0	30.0	25.7	Passed
1437.400000	---	38.67	54	15.33	V	7.0	30.0	28.1	Passed
1437.400000	43.53	---	74	30.47	V	7.0	30.0	28.1	Passed
1687.480000	---	27.70	54	26.30	H	61.0	120.0	30.2	Passed
1687.480000	39.01	---	74	34.99	H	61.0	120.0	30.2	Passed
2414.500000	---	92.46	-	-	H	210.0	150.0	34.1	Fund.
2414.500000	101.89	---	-	-	H	210.0	150.0	34.1	Fund.
2431.060000	---	93.12	-	-	H	210.0	150.0	34.2	Fund.
2431.060000	102.76	---	-	-	H	210.0	150.0	34.2	Fund.
3229.300000	---	52.22	54	1.78	H	336.0	150.0	37.1	Passed
3229.300000	63.97	---	74	10.03	H	336.0	150.0	37.1	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

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

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
1437.460000	---	39.02	54	14.98	V	19.0	0.0	28.1	Passed
1437.460000	43.81	---	74	30.19	V	19.0	0.0	28.1	Passed
1687.480000	---	30.08	54	23.92	H	40.0	90.0	30.2	Passed
1687.480000	40.47	---	74	33.53	H	40.0	90.0	30.2	Passed
2424.460000	---	89.85	-	-	H	215.0	150.0	34.1	Fund.
2424.460000	99.06	---	-	-	H	215.0	150.0	34.1	Fund.
2448.220000	---	90.89	-	-	H	178.0	0.0	34.3	Fund.
2448.220000	100.59	---	-	-	H	178.0	0.0	34.3	Fund.
3249.340000	---	48.66	54	5.34	V	357.0	90.0	37.5	Passed
3249.340000	59.08	---	74	14.92	V	357.0	90.0	37.5	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

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

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
1437.460000	---	44.80	54	9.20	V	39.0	120.0	28.1	Passed
1437.460000	50.83	---	74	23.18	V	39.0	120.0	28.1	Passed
1687.420000	---	42.40	54	11.60	H	56.0	30.0	30.2	Passed
1687.420000	51.85	---	74	22.15	H	56.0	30.0	30.2	Passed
2444.500000	98.42	---	-	-	H	176.0	0.0	34.3	Fund.
2444.500000	---	89.01	-	-	H	176.0	0.0	34.3	Fund.
2468.260000	---	91.04	-	-	H	205.0	150.0	34.2	Fund.
2468.260000	100.42	---	-	-	H	205.0	150.0	34.2	Fund.
3275.980000	52.59	---	74	21.41	H	2.0	150.0	37.3	Passed
3275.980000	---	44.80	54	9.20	H	2.0	150.0	37.3	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

EUT in WLAN mode (4 - 25 GHz)

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
4823.150000	---	51.0	54	3.0	V	31	150	-1.1	Passed
4823.150000	58.9	---	74	15.1	V	31	150	-1.7	Passed
4824.700000	---	50.4	54	3.6	V	34	150	-1.1	Passed
4824.700000	59.2	---	74	14.8	V	34	150	-1.7	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

Transmitter operates at the middle of the assigned frequency band (operation mode 2)

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
4873.200000	---	53.0	54	1.0	V	20	150	-0.9	Passed
4873.200000	60.7	---	74	13.3	V	20	150	-1.5	Passed
4874.000000	---	52.0	54	2.0	V	19	150	-0.9	Passed
4874.000000	61.6	---	74	12.4	V	19	150	-1.5	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

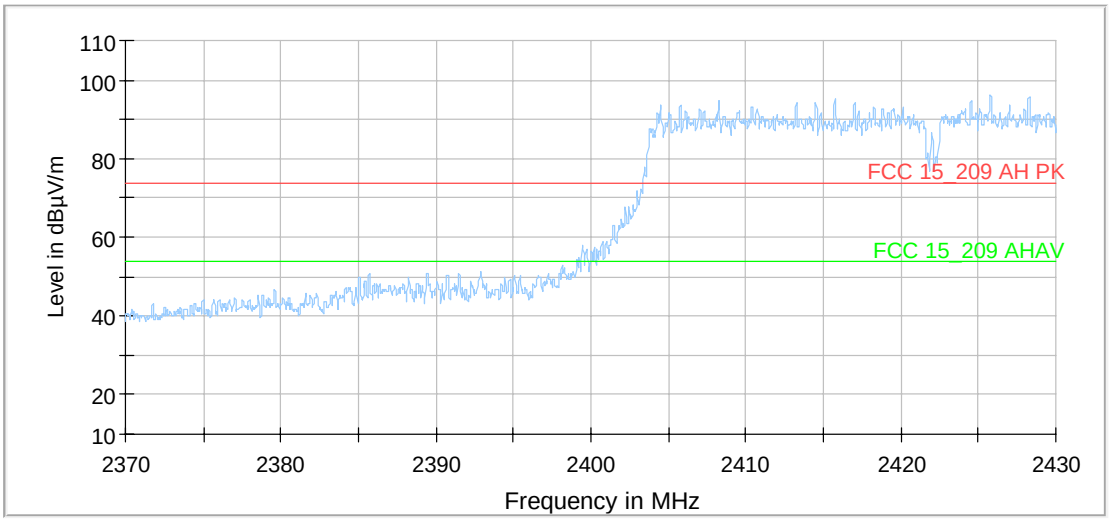
Transmitter operates at the upper end of the assigned frequency band (operation mode 4)

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
4933.200000	---	50.98	54	3.02	V	287.0	150.0	-1.0	Passed
4933.200000	59.06	---	74	14.94	V	287.0	150.0	-1.0	Passed
4934.700000	---	51.27	54	2.73	V	291.0	150.0	-0.9	Passed
4934.700000	60.14	---	74	13.86	V	291.0	150.0	-0.9	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

5.6.5.4 Band-edge-compliance (radiated)

Only the plot of the worst case emission is submitted below

170297_FCC_n40-MCS5_CH3_LowBE_Pwr20.rtf: Spurious emissions (operation mode 13):



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

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
2385.090000	---	46.57	54	7.43	H	177.0	0.0	34.0	Passed
2385.090000	60.52	---	74	13.48	H	177.0	0.0	34.0	Passed
2385.720000	---	47.53	54	6.47	H	180.0	150.0	34.0	Passed
2385.720000	62.92	---	74	11.08	H	180.0	150.0	34.0	Passed
2389.440000	---	47.92	54	6.08	H	178.0	0.0	34.0	Passed
2389.440000	60.81	---	74	13.19	H	178.0	0.0	34.0	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

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

Frequency (MHz)	Max Peak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Result
2488.275000	---	45.02	54	8.98	V	177.0	90.0	34.1	Passed
2488.275000	56.35	---	74	17.65	V	177.0	90.0	34.1	Passed
2489.500000	---	44.89	54	9.11	V	180.0	90.0	34.1	Passed
2489.500000	56.02	---	74	17.98	V	180.0	90.0	34.1	Passed
Measurement uncertainty			+2.2 dB / -3.6 dB						

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7 - 29, 31 – 42, 44 – 51, 72

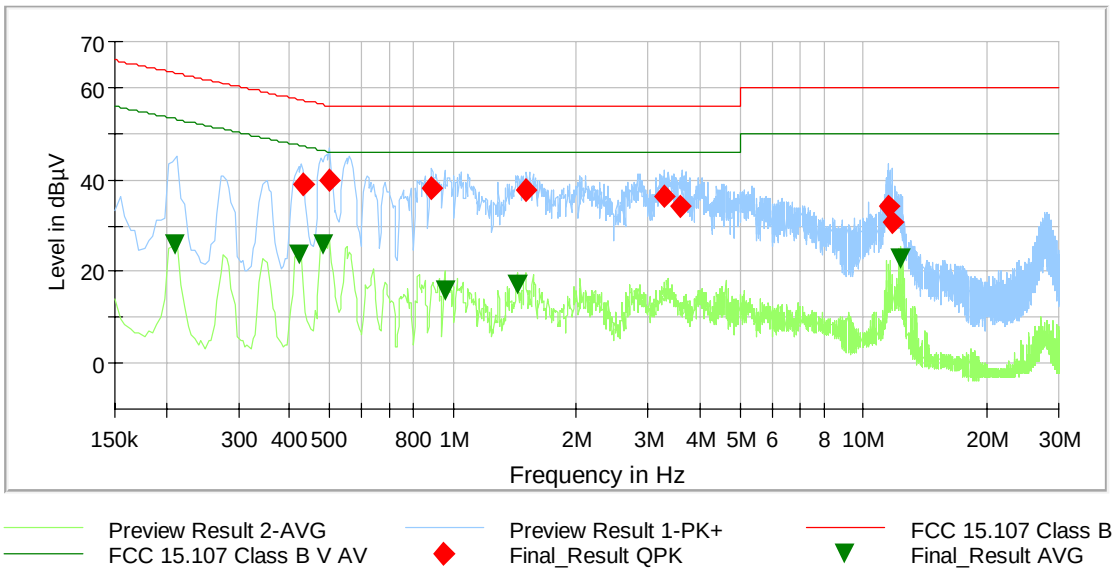
5.7 Conducted emissions on power supply lines (150 kHz to 30 MHz)

Ambient temperature	22 °C	Relative humidity	50 %

Position of EUT:	For this test, the EUT was connected to an ancillary device. The EUT was echoing packets, which were received from an ancillary device
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 “9820A-120090” by “NORDIC POWER“ was used. The power supply provided 12 V DC.

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 “◆” and the average measured points by “▼”.

EUT operating in WLAN mode:



Data record name: AC_powerline conducted FCC_WLAN.rtf

Final Results – EUT in WLAN mode

Frequency [MHz]	QuasiPeak [dBµV]	Average [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.210300	---	25.70	53.19	27.49	5000.0	9.000	N	GND	9.9
0.423600	---	23.50	47.38	23.88	5000.0	9.000	N	GND	9.9
0.431700	39.14	---	57.22	18.08	5000.0	9.000	N	GND	9.9
0.485700	---	25.94	46.24	20.30	5000.0	9.000	N	GND	9.9
0.501000	39.90	---	56.00	16.10	5000.0	9.000	L1	GND	9.9
0.885300	38.26	---	56.00	17.74	5000.0	9.000	L1	GND	9.9
0.957300	---	15.78	46.00	30.22	5000.0	9.000	N	GND	9.9
1.433400	---	17.05	46.00	28.95	5000.0	9.000	N	GND	9.9
1.509900	37.56	---	56.00	18.44	5000.0	9.000	L1	GND	9.9
3.255900	36.50	---	56.00	19.50	5000.0	9.000	L1	GND	10.2
3.596100	34.30	---	56.00	21.70	5000.0	9.000	L1	GND	10.3
11.531400	34.19	---	60.00	25.81	5000.0	9.000	L1	GND	10.7
11.748300	30.58	---	60.00	29.42	5000.0	9.000	L1	GND	10.7
12.354000	---	22.58	50.00	27.42	5000.0	9.000	L1	GND	10.7

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
1 – 6

6 Test Equipment

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262	480662	Calibration not necessary	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	15.02.2016	02.2018
3	LISN	NSLK8128	Schwarzbeck	8128155	480058	16.02.2016	02.2018
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Calibration not necessary	
5	EMI Software	ES-K1	Rohde & Schwarz	-	480111	Calibration not necessary	
6	Power supply AC	AC6803A AC Quelle 2000VA	Keysight	JPVJ002509	482350	Calibration not necessary	
7	EMI Software	EMC32	Rohde & Schwarz	100061	481022	Calibration not necessary	
8	HF-Cable	Sucoflex 104	Huber+Suhner	517406	482391	Annual verification (system cal.)	
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum Analyzer	FSU46	Rohde & Schwarz	200125	480956	07.03.2017	03.2018
31	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586	481720	24.02.2016	02.2018
32	Controller	MCU	Maturo	MCU/043/971107	480832	Calibration not necessary	
33	Turntable	DS420HE	Deisel	420/620/80	480315	Calibration not necessary	
34	Antenna support	AS615P	Deisel	615/310	480187	Calibration not necessary	
36	Antenna (Log.Per.)* 0.8 – 26.5 GHz	HL050	Rohde & Schwarz	100438	481170	09.10.2017	10.2020
37	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Calibration not necessary	
39	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Calibration not necessary	
41	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Calibration not necessary	
42	RF-cable No.38	Sucoflex 106B	Suhner	0709/6B / Kabel 38	481328	Calibration not necessary	
43	Loop antenna 9 – 30 MHz	HFH2-Z2	Rohde & Schwarz	832609/014	480059	29.02.2016	29.02.2018
44	Antenna (Bilog) 30 – 1000 MHz	CBL6112B	Schaffner EMV GmbH (-Chase)	2688	480328	19.06.2017	01.06.2020
46	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire	-	480302	Calibration not necessary	
47	RF-cable 36	Sucoflex 106B	Suhner	500003/6B / Kabel 36	481680	Calibration not necessary	
49	Preamplifier 100 MHz - 16 GHz	AFS6-00101600-10P-6-R	Narda MITEQ	-	482333	23.11.2016	11.2018
50	Preamplifier 1200 – 1800 MHz	JS3-12001800-16-5A	Miteq	571667	480343	18.02.2016	02.2018
51	Preamplifier 1800 – 2600 MHz	JS3-18002600-20-5A	Miteq	658697	480342	17.02.2016	02.2018
52	4 GHz High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments	1	480587	Calibration not necessary	

60	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	18.02.2016	02.2018
61	Peak Power Sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	18.02.2016	02.2018

* All tests with this antenna were performed in the time range when the antenna was calibrated.

7 Report History

Report Number	Date	Comment
F170297E6	26.02.2017	Initial Test Report

8 List of Annexes

ANNEX A TEST SETUP PHOTOS 7 pages

170297_E6_01.jpg Test setup – antenna port conducted measurements
170297_E6_02.jpg Test setup fully anechoic chamber
170297_E6_03.jpg Test setup fully anechoic chamber
170297_E6_04.jpg Test setup open area test site
170297_E6_05.jpg Test setup fully anechoic chamber
170297_E6_06.jpg Test setup fully anechoic chamber
170297_E6_07.jpg Test setup fully anechoic chamber

ANNEX B EXTERNAL PHOTOS 8 pages

170297_E8_13.jpg: EUT #403 (int ant) on not marketed eval board – top view
170297_E8_14.jpg: EUT #403 (onboard antenna) on not marketed eval board
170297_E8_15.jpg: EUT #403 (onboard antenna) on not marketed eval board – bottom view
170297_E8_23.jpg: EUT (onboard antenna) - bottom side
170297_E8_10.jpg: EUT #403 with antenna trace design on not marketed eval board – top view
170297_E8_11.jpg: EUT #403 with antenna trace design on not marketed eval board – close-up
170297_E8_12.jpg: EUT #403 with antenna trace design on not marketed eval board – bottom view
170297_E8_22.jpg: EUT #403 – bottom view

ANNEX C INTERNAL PHOTOS 2 pages

170297_E8_20.jpg: EUT with antenna trace design on not marketed eval board – without shielding
170297_E8_21.jpg: EUT (with onboard antenna removed) without shielding on not marketed eval board