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Test Report

Report Number: F122165E1

Applicant:

Lancom Systems GmbH

Manufacturer:

Atheros Communications, Inc.

Equipment under Test (EUT):

DNXA-116 2x2 802.11n PCIe module

Laboratory (CAB) accredited by
Deutsche Gesellschaft für Akkreditierung mbH
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. DGA-PL-105/99-22,
FCC Test site registration number 90877 and
Industry Canada Test site registration IC3469A-1

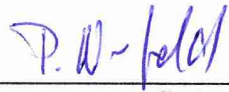
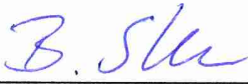
REFERENCES

- [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 (August 2011)** Radio Frequency Devices
- [3] **Publication Number 558074 (January 2012)** DTS Meas Guidance v01
- [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 913591 (March 2007)** Measurement of radiated emissions at the edge of the band for a Part 15 RF Device
- [7] **Publication Number 662911 (October 2011)** Emission Testing of Transmitters with Multiple Outputs in the Same Band.

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		26 September 2012
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		26 September 2012
	Name	Signature	Date

RESERVATION

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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

Name:	Atheros Communications, Inc.
Address:	1700 Technology Drive San Jose, CA 95110
Country:	USA
Name for contact purposes:	-
Phone:	-
Fax:	-
eMail Address:	-
Applicant represented during the test by the following person:	-

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by DGA Deutsche Gesellschaft für Akkreditierung mbH in compliance with DIN EN ISO/IEC 17025 under Reg. No. DGA-PL-105/99-22, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	DNXA-116 2x2 802.11n PCIe module
Type: *	DNXA-116
FCC ID: *	NKR-DNXA116
IC: *	4441A-DNXA116
Serial number: *	C140099BX01
PCB identifier: *	2011.02.23 G 48DNXXA0B.0GA
Hardware version: *	-
Software version: *	-

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 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, 802.11a, 802.11b, 802.11g, 802.11n
Antenna type: *	Swivel Type, Replacement Antenna
Antenna gain: *	3dBi @2.4 GHz; 5 dBi @5.x GHz
Antenna connector: *	SMA Reverse / UFL
Power supply	Powered by an 12 V AC/DC adapter
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, 5745 to 5825 MHz
Number of channels: *	20
Temperature range: *	0 °C to +40 °C
Lowest / highest Internal clock frequency: *	400 MHz / 5825 GHz

* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
AC/DC Adapter	DC plug	-	2 m *
Ethernet cable	Ethernet plug	-	-

*: Length during the test if no other specified.

1.5 Dates

Date of receipt of test sample:	20 June 2012
Start of test:	22 June 2012
End of test:	25 September 2012

2 OPERATIONAL STATES

The tested EUT is the RF-module as identified in 1.4, not the entire "LANCOM L-322agn dual Wireless" access point. Two of these RF-modules are implemented in the access point. The module was implemented in the access-point to get it into operation.

The tests were carried out with an unmodified sample of the EUT. Parts of the tests were carried out conducted by connected directly to the antenna ports. For the radiated tests, the antenna ports were terminated symmetrically by 50 Ω resistors. If tests did not pass during conducted measurements, the measurements were repeated as radiated tests, with the dedicated antennas attached.

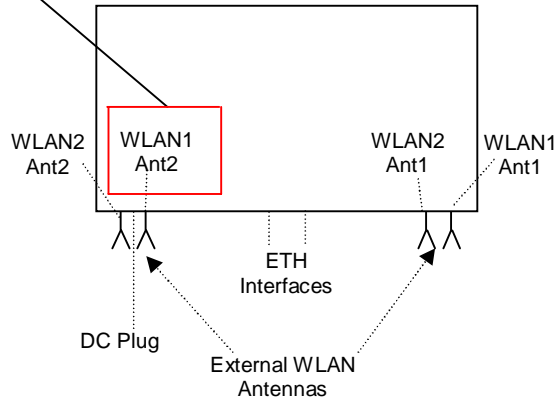
The operational states of the EUT were controlled by software. This software was provided by the applicant and installed on a laptop PC, which was connected to the EUT via an Ethernet cable. After adjusting the operation mode the Ethernet cable was removed.

During the tests the test samples were powered with 12 V, provided by a 100-240 V AC/DC adapter, which was provided by the applicant.

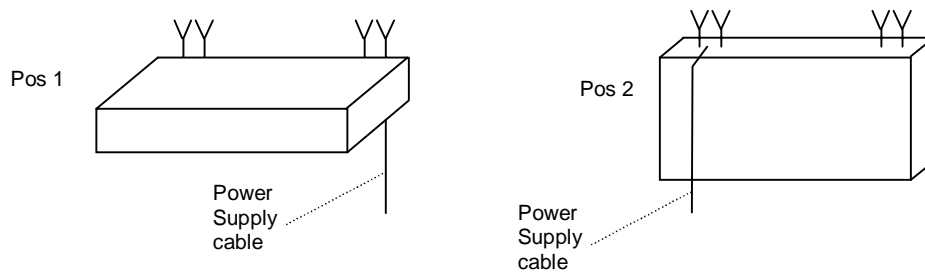
The following operation modes were used during the tests:

Operation mode	Description of the operation mode	WLAN mode	WLAN channel	Modulation	Data rate / Mbps
1	Continuous transmitting on 2412 MHz	b	1	DSSS	1 MBit/s
2	Continuous transmitting on 2437 MHz	b	6	DSSS	1 MBit/s
3	Continuous transmitting on 2462 MHz	b	11	DSSS	1 MBit/s
4	Continuous transmitting on 2412 MHz	g	1	OFDM	6 MBit/s
5	Continuous transmitting on 2437 MHz	g	6	OFDM	6 MBit/s
6	Continuous transmitting on 2462 MHz	g	11	OFDM	6 MBit/s
7	Continuous transmitting on 2412 MHz	n 20 MHz	1	OFDM	6.5 MBit/s
8	Continuous transmitting on 2437 MHz	n 20 MHz	6	OFDM	6.5 MBit/s
9	Continuous transmitting on 2462 MHz	n 20 MHz	11	OFDM	6.5 MBit/s
10	Continuous transmitting on 2422 MHz	n 40 MHz	3	OFDM	6.5 MBit/s
11	Continuous transmitting on 2437 MHz	n 40 MHz	6	OFDM	6.5 MBit/s
12	Continuous transmitting on 2452 MHz	n 40 MHz	9	OFDM	6.5 MBit/s
13	Continuous transmitting on 5745 MHz	a	149	OFDM	6 MBit/s
14	Continuous transmitting on 5785 MHz	a	157	OFDM	6 MBit/s
15	Continuous transmitting on 5825 MHz	a	165	OFDM	6 MBit/s
16	Continuous transmitting on 5745 MHz	n 20 MHz	149	OFDM	6.5 MBit/s
17	Continuous transmitting on 5785 MHz	n 20 MHz	157	OFDM	6.5 MBit/s
18	Continuous transmitting on 5825 MHz	n 20 MHz	165	OFDM	6.5 MBit/s
19	Continuous transmitting on 5755 MHz	n 40 MHz	151	OFDM	6.5 MBit/s
20	Continuous transmitting on 5795 MHz	n 40 MHz	159	OFDM	6.5 MBit/s

Physical boundary of the EUT



For the radiated tests, the worst case positioning of the EUT was investigated through measurements. The WLAN router has two possible operating positions:



Position 1: Device lying horizontally
Position 2: Device mounted vertically

Preliminary tests were in the two positions, 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. This was found to be Position 2.

The following test modes were adjusted during the tests:

Test items	Operation mode
Band edge compliance	1, 3, 4, 6, 7, 9, 10, 12, 13, 15, 16, 18, 19, 20
Radiated emissions (transmitter)	1 - 20

3 ADDITIONAL INFORMATION

To be compliant to the applying regulatory standards, the transmission power was adjusted for several WLAN channels. The power setting refer to the transmit power, as shown in the test software provided by the applicant. Figure 1 depicts the GUI of the test software.

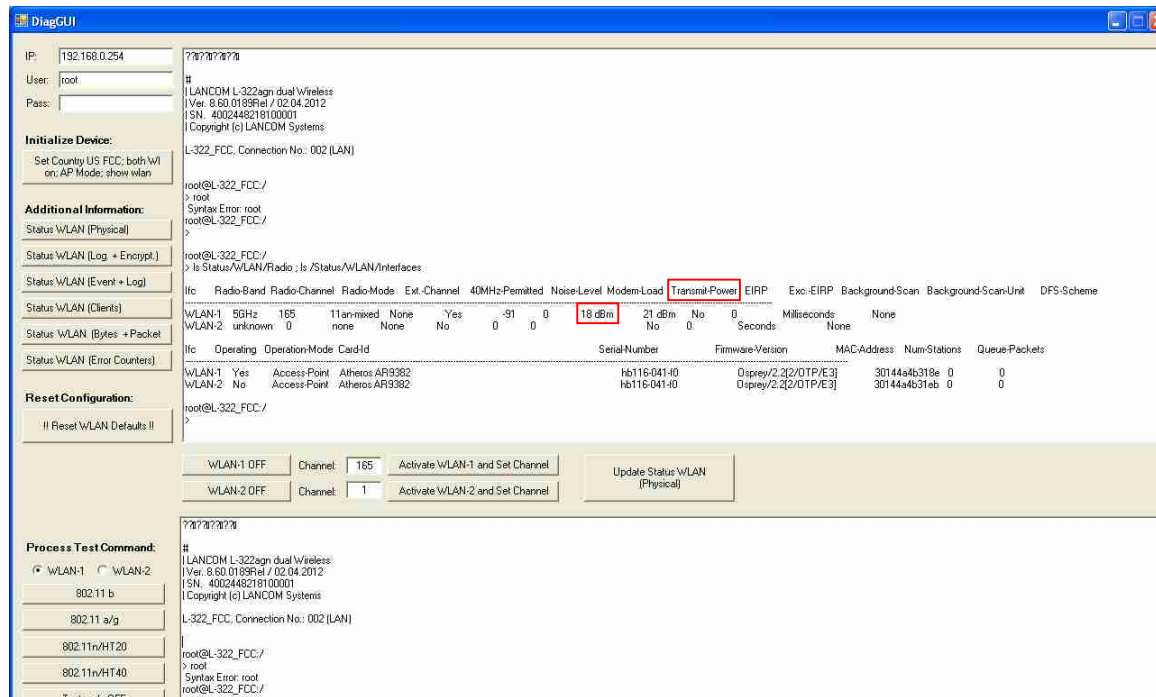


Figure 1 GUI Test Software provided by the applicant

The power reduction for test purposes was performed by a telnet command, which was described by the applicant. For this a telnet connection to the EUT was established using the command “telnet 192.168.0.254” in the windows command console. The submenu was at “/Setup/Interfaces/WLAN/Radio-Settings”. The Reduction was performed by the command "set WLAN-1 {Tx-Power-Reduction} X", whereby X is an integer which represents the value of power reduction in dB.

The standard power settings as displayed in the applicant-test-software, are shown in Table 1. The changes that were made for selected channels can be seen in Table 2. All other WLAN channels were passed with the original settings. The power reduction affected all WLAN modes and data rates for the regarding WLAN channel.

Table 1 Original transmission power for all WLAN modes&channels

WLAN channel*	1 – 12	36 -48	149 - 165
Transmit power	20 dBm	17 dBm	18 dBm

*all modulations / data rates / WLAN modes

Table 2 Adjusted transmission power for selected WLAN channels

WLAN channel*	8 - 10	11	36
Transmit power	17 dBm	13 dBm	18 dBm

*all modulations / data rates / WLAN modes

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
Band edge compliance	2400.0 - 2483.5 5725 - 5825	15.247 (d)	A8.5 [4]	Passed	13 et seq.
Radiated emissions (transmitter)	1000 - 40,000	15.205 (a) 15.209 (a)	7.2.2 [5], 2.5 [4]	Passed	19 et seq.

5 TEST RESULTS

5.1 Maximum peak output power

5.1.1 Method of measurement (maximum peak output power)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser 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.

The testing was performed according to the procedure in the original test report, namely power measurement with a peak power meter.

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 (maximum peak output power)

Ambient temperature	21 °C	Relative humidity	40 %
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Operation Mode	Channel frequency [MHz]	Antenna gain combined [dBi]	Maximum peak output power – chain0 [dBm]	Maximum peak output power - port2 [dBm]	Maximum peak output power – sum (both ports) [dBm]	Margin [dB]	Peak power limit [dBm]
1	2412	6.01	14.01	13.15	16.61	13.38	29.99
2	2437	6.01	14.46	12.25	16.50	13.49	29.99
3	2462	6.01	9.76	7.25	11.69	18.30	29.99
4	2412	6.01	16.41	15.72	19.09	10.90	29.99
5	2437	6.01	21.87	20.33	24.18	5.81	29.99
6	2462	6.01	15.34	13.45	17.51	12.48	29.99
7	2412	6.01	16.73	15.49	19.16	10.83	29.99
8	2437	6.01	21.35	19.88	23.69	6.30	29.99
9	2462	6.01	15.19	13.48	17.43	12.56	29.99
10	2422	6.01	13.93	13.25	16.61	13.38	29.99
11	2437	6.01	18.00	16.44	20.30	9.69	29.99
12	2452	6.01	13.73	12.31	16.09	13.90	29.99
13	5745	8.01	16.93	17.75	20.37	7.62	27.99
14	5785	8.01	17.69	17.20	20.46	7.53	27.99
15	5825	8.01	17.71	16.87	20.32	7.67	27.99
16	5745	8.01	16.96	17.49	20.24	7.75	27.99
17	5785	8.01	17.79	17.22	20.52	7.47	27.99
18	5825	8.01	17.38	17.02	20.21	7.78	27.99
19	5755	8.01	13.34	13.92	16.65	11.34	27.99
20	5795	8.01	12.90	13.86	16.42	11.57	27.99
Measurement uncertainty			+0.66 dB / -0.72 dB				

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

60

5.2 Band-edge compliance

5.2.1 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 5.4.1 of the 558074 D01 DTS Meas Guidance v.01.

Measurement Procedure Reference – Reference Level:

- RBW = 100 kHz.
- VBW \geq 300 kHz.
- Set the span to 5-30 % greater than the EBW.
- Detector = Peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize
- Use the peak marker function to determine the the maximum power level in any 100 kHz frequency band segment within the fundamental EBW.

Measurement Procedure – Unwanted Emissions

- RBW = 100 kHz.
- VBW \geq 300 kHz.
- Set the span to encompass the spectrum to be examined.
- Detector = Peak.
- Sweep time = auto couple.
- Trace Mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize (This may take some time, depending on the extend of the span)

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 and the lower and upper end of the 5 GHz band.

The measurements were carried out at each antenna port separately.

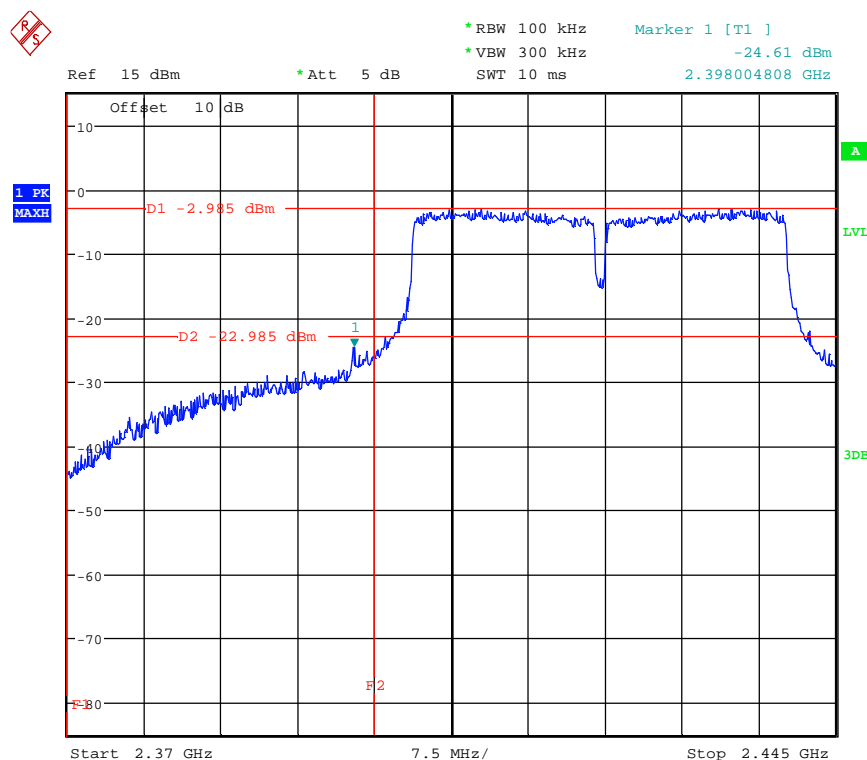
5.2.2 Test result (band edges next to unrestricted bands (conducted))

5.2.2.1 Antenna port 1

Ambient temperature	21 °C	Relative humidity	60 %
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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.

122165_LowBandEdge_40_low.wmf: conducted band-edge compliance (operation mode 10):



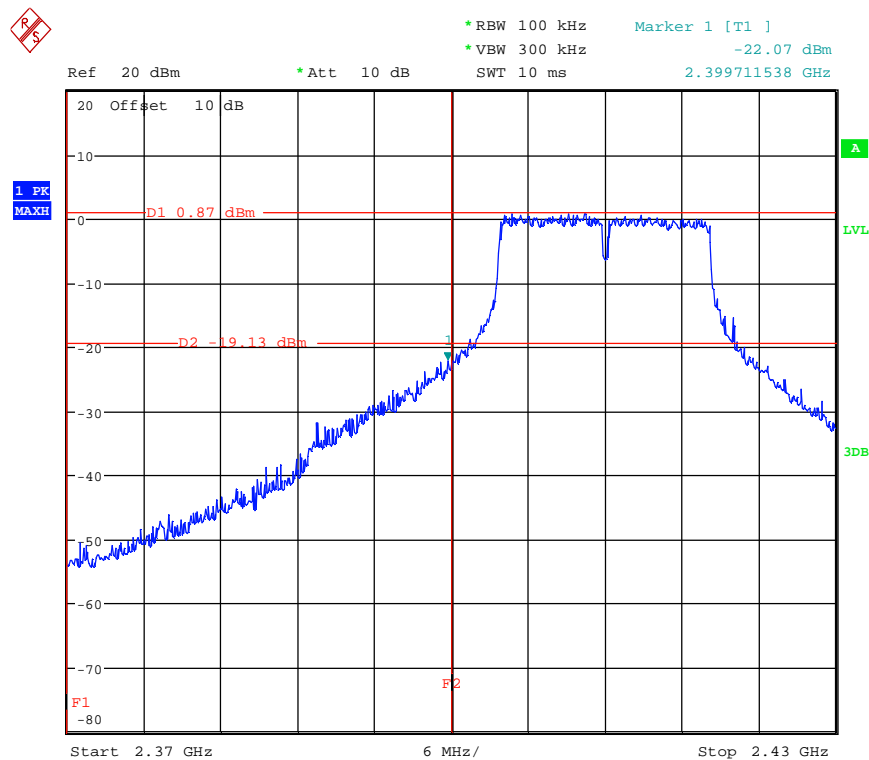
Operation mode	WLAN channel	WLAN mode	Band-Edge	Reference Level dBm	Limit dBm	Unwanted Emission Frequency MHz	Unwanted Emission Value dBm	Margin dB
1	1	b	low	1.5	-18.5	2397.019	-42.0	23.5
4	1	g	low	0.9	-19.1	2399.712	-22.1	3.0
7	1	n20	low	0.5	-19.5	2399.808	-21.3	1.8
10	1	n40	low	-3.0	-23.0	2398.005	-24.6	1.6
13	149	a	low	0.8	-19.2	5723.654	-30.1	10.9
15	165	a	up	-1.4	-21.4	5802.724	-43.7	22.3
16	149	n20	low	0.3	-19.7	5724.327	-29.0	9.3
18	165	n20	up	-1.1	-21.1	5800.481	-44.5	23.4
19	151	n40	low	-5.6	-25.6	5725.000	-33.5	7.9
20	159	n40	up	-6.2	-26.2	5855.417	-57.7	31.5

5.2.2.2 Antenna port 2

Ambient temperature	21 °C	Relative humidity	52 %
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The following results were measured at antenna port 2 of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

122165 LowBandEdge g low.wmf: conducted band-edge compliance (operation mode 4):



Operation mode	WLAN channel	WLAN mode	Band-Edge	Reference Level dBm	Limit dBm	Unwanted Emission Frequency MHz	Unwanted Emission Value dBm	Margin dB
1	1	b	low	1.6	-18.4	2398.462	-36.0	2.3
4	1	g	low	0.8	-19.2	2399.423	-21.5	0.6
7	1	n20	low	-0.5	-20.5	2400.000	-21.1	1.8
10	1	n40	low	-5.1	-25.1	2399.207	-26.9	10.9
13	149	a	low	0.1	-19.9	5724.327	-30.8	25.6
15	165	a	up	-3.4	-23.4	5800.481	-49.0	9.7
16	149	n20	low	-0.5	-20.5	5724.904	-30.2	23.5
18	165	n20	up	-2.6	-22.6	5850.274	-46.1	7.8
19	151	n40	low	-7.1	-27.1	5722.756	-34.9	25.0
20	159	n40	up	-7.7	-27.7	5853.774	-52.7	2.3

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
30

5.2.3 Method of measurement (band edges next to restricted bands (radiated))

The same test set-up as used for the final radiated emission measurement shall be used (refer also subclause 5.3.3 of this test report).

The preliminary measurements are performed using the following settings:

- Span: Wide enough to capture the peak level of the emission on the channel closest to the band-edge, as well as any modulation products, which fall outside the authorized band of operation.
- Resolution bandwidth: = 100 kHz
- Video bandwidth: = 300 kHz
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

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. This frequency shall be measured with the EMI receiver as described in subclause 5.3.3 of this test report. The level of the measured field strength shall be compared to the the general limits specified in § 15.205.

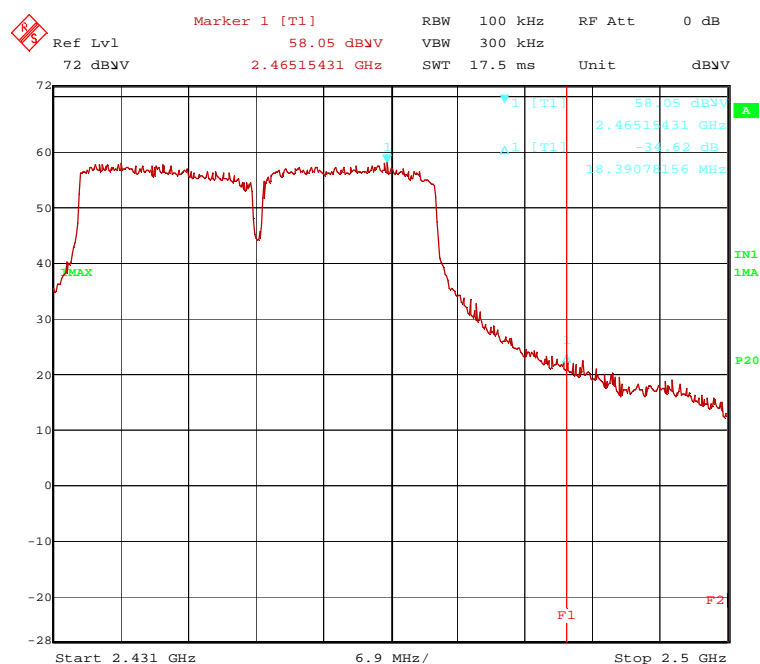
The measurement was performed at the upper end of the 2.4 GHz band.

5.2.4 Test result (band edges next to restricted bands (radiated))

Ambient temperature	21 °C	Relative humidity	55 %
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The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

2165_139.wmf: Radiated band-edge compliance (operation mode 12):



Band-edge compliance (upper band edge. Mode 3, Tx-Power adjusted to 13 dBm)											
Result measured with the peak detector:											
Frequency	Corr. value	Limit	Margin	Reading	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band	Pos.
MHz	dBµV/m	dBµV/m	dB	dBµV	1/m	dB	dB	cm			
2460	97.3	-	-	65.1	28.5	0.0	3.7	150	Vert.	carrier	2
2499	56.2	74.0	17.8	23.9	28.5	0.0	3.8	150	Vert.	Yes	2
Result measured with the average detector:											
Frequency	Corr. value	Limit	Margin	Reading	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band	Pos.
GHz	dBµV/m	dBµV/m	dB	dBµV	1/m	dB	dB	cm			
2460	93.6	-	-	61.4	28.5	0.0	3.7	150	Vert.	carrier	2
2499	39.5	54.0	14.5	7.2	28.5	0.0	3.8	150	Vert.	Yes	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (upper band edge. Mode 6, Tx-Power adjusted to 13 dBm)											
Result measured with the peak detector:											
Frequency	Corr. value	Limit	Margin	Reading	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band	Pos.
MHz	dBµV/m	dBµV/m	dB	dBµV	1/m	dB	dB	cm			
2469	95.5	-	-	63.3	28.5	0.0	3.7	150	Vert.	carrier	2
2484	58.2	74.0	15.8	25.9	28.5	0.0	3.8	150	Vert.	Yes	2
Result measured with the average detector:											
Frequency	Corr. value	Limit	Margin	Reading	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band	Pos.
MHz	dBµV/m	dBµV/m	dB	dBµV	1/m	dB	dB	cm			
2469	86.3	-	-	54.1	28.5	0.0	3.7	150	Vert.	carrier	2
2484	40.0	54.0	14.0	7.7	28.5	0.0	3.8	150	Vert.	Yes	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (upper band edge. Mode 9, Tx-Power adjusted to 13 dBm)											
Result measured with the peak detector:											
Frequency	Corr. value	Limit	Margin	Reading	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band	Pos.
MHz	dBµV/m	dBµV/m	dB	dBµV	1/m	dB	dB	cm			
2466	103.9	-	-	71.7	28.5	0.0	3.7	150	Vert.	carrier	2
2484	67.0	74.0	7.0	34.7	28.5	0.0	3.8	150	Vert.	Yes	2
Result measured with the average detector:											
Frequency	Corr. value	Limit	Margin	Reading	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band	Pos.
MHz	dBµV/m	dBµV/m	dB	dBµV	1/m	dB	dB	cm			
2466	94.0	-	-	61.8	28.5	0.0	3.7	150	Vert.	carrier	2
2484	47.2	54.0	6.8	14.9	28.5	0.0	3.8	150	Vert.	Yes	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

Band-edge compliance (upper band edge. Mode 12, Tx-Power adjusted to 13 dBm)											
Result measured with the peak detector:											
Frequency MHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Reading dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2465	99.6	-	-	67.4	28.5	0.0	3.7	150	Vert.	carrier	2
2484	69.8	74.0	4.2	37.5	28.5	0.0	3.8	150	Vert.	Yes	2
Result measured with the average detector:											
Frequency MHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Reading dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2465	89.4	-	-	57.2	28.5	0.0	3.7	150	Vert.	carrier	2
2484	51.4	54.0	2.6	19.1	28.5	0.0	3.8	150	Vert.	Yes	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 34, 36, 40, 41

5.3 Maximum unwanted emissions

5.3.1 Method of measurement (conducted emissions)

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 5.4.2.2.2 in the 558074 D01 DTS Meas Guidance v.01.

In 5.4.1 it states, that attenuation below the general emission limits specified in §15.209(a) limits is not required. Therefore to simplify measurements, all emissions are compared to that limit.

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

Procedure for average measurement: 5.4.2.2.1 – Power Averaging:

- Set the analyzer span to encompass the entire unwanted emission bandwidth.
- Set the RBW = 1 MHz.
- Set the VBW \geq 3 MHz.
- Detector = power average (RMS).
- Ensure that the number of measurement points in the sweep to \geq 2 x (span/RBW).
- Manually set the sweep time to: \geq 10 x (number of measurement points in sweep) x (transmission symbol period).
- Perform the measurement over a single sweep.
- Use the peak marker function to determine the maximum average power level in any 1 MHz of the unwanted emission.

Peak Measurement – Applicability of §15.35 (b),(c): Procedure in 5.4.2.2.3 – Peak Measurement

- Set the analyzer span to encompass the entire unwanted emission bandwidth.
- Set the RBW = span.
- Set the VBW \geq RBW.
- Set sweep time = auto couple.
- Detector = peak.
- Allow the trace to stabilize.
- Use the peak marker function to determine the peak power over the emission bandwidth.

The measurements were carried out at each antenna port.

5.3.1.1 Limit calculations

Chapter 5.4.2.2.1 provides the following formula for converting EIRP to equivalent electric field strength:

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

Where:

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

With the aid of this formula and the appropriate parts of [2], the EIRP limits in Table 3 were calculated.

Table 3 EIRP Limit calculations from Radiated Limits

Frequency MHz	Field strength μ V/m	Meas Distance m	RBW	EIRP Limit dBm
0.009 – 0.490	2400/F (kHz)	300	200 – 300 Hz	6.3 – 20logF (kHz)
0.490 – 1.705	24000/F (kHz)	30	200 – 300 Hz	6.3 – 20logF (kHz)
1.705 - 30	30	30	9 – 10 kHz	-51.7
30 – 88	100	3	100 kHz	-60
88 – 216	150	3	100 kHz	-56.4
216 - 960	200	3	100 kHz	-54
960 - 1000	500	3	100 kHz	-46
\geq 1000	500	3	1 MHz	-41.3

Document [7] states, 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 10log(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 has to be calculated as

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

whereby N is the number of antennas.

For the actual EUT with two antenna ports, a value of 8.15 dB has to be added to spurious emission values of which 3 dB result from the combined output from two outputs and 5.15 dBi is the directional gain.

To simplify the measurement, the EIRP limits were reduced for the aforementioned value. These results in an adjusted EIRP Limit table as shown in

Table 4 Adjusted EIRP Limits

Frequency MHz	EIRP Limit dBm
0.009 – 0.490	-1.85 – 20logF (kHz)
0.490 – 1.705	-1.85 – 20logF (kHz)
1.705 - 30	-59.85
30 – 88	-68.15
88 – 216	-64.55
216 - 960	-62.12
960 - 1000	-54.15
\geq 1000	-49.45

5.3.2 Test results (conducted emissions)

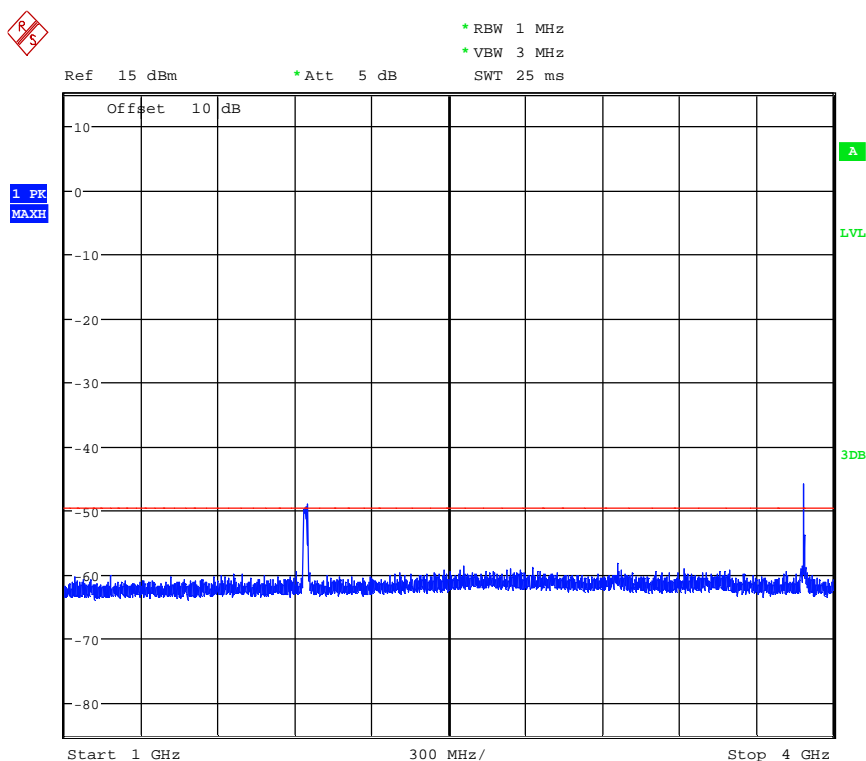
The measurements were only performed for frequencies above 1 GHz, because the device was already tested according to 15.109.

5.3.2.1 Antenna port 1

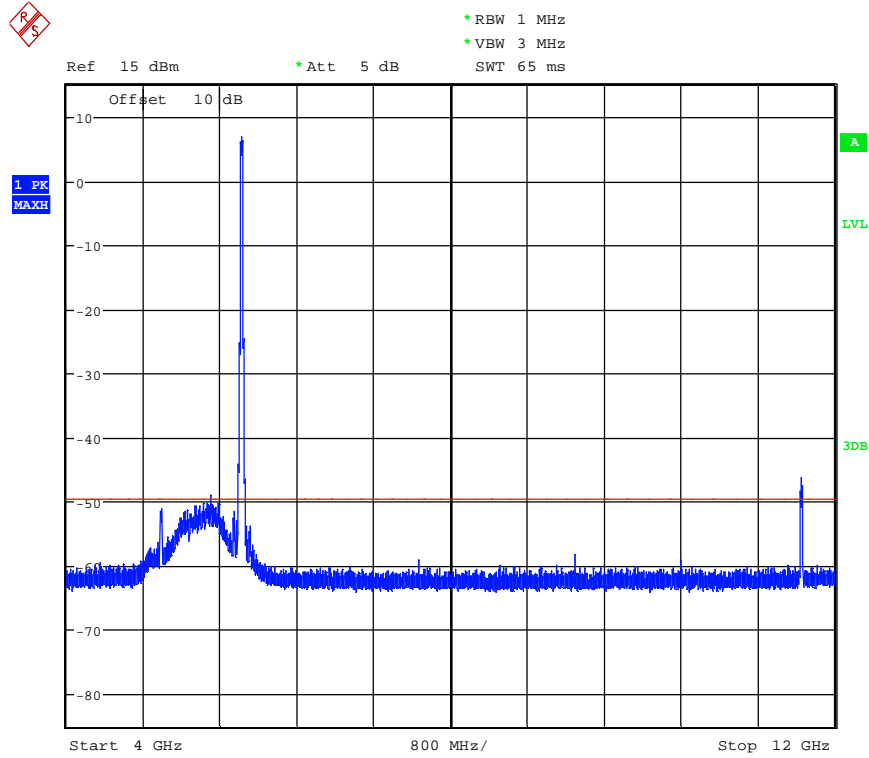
Ambient temperature	22 °C	Relative humidity	57 %
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The following results were measured at antenna port 1 of the EUT. The plots shows exemplary measurement results for the worst documented case. The other results are listed in the following table.

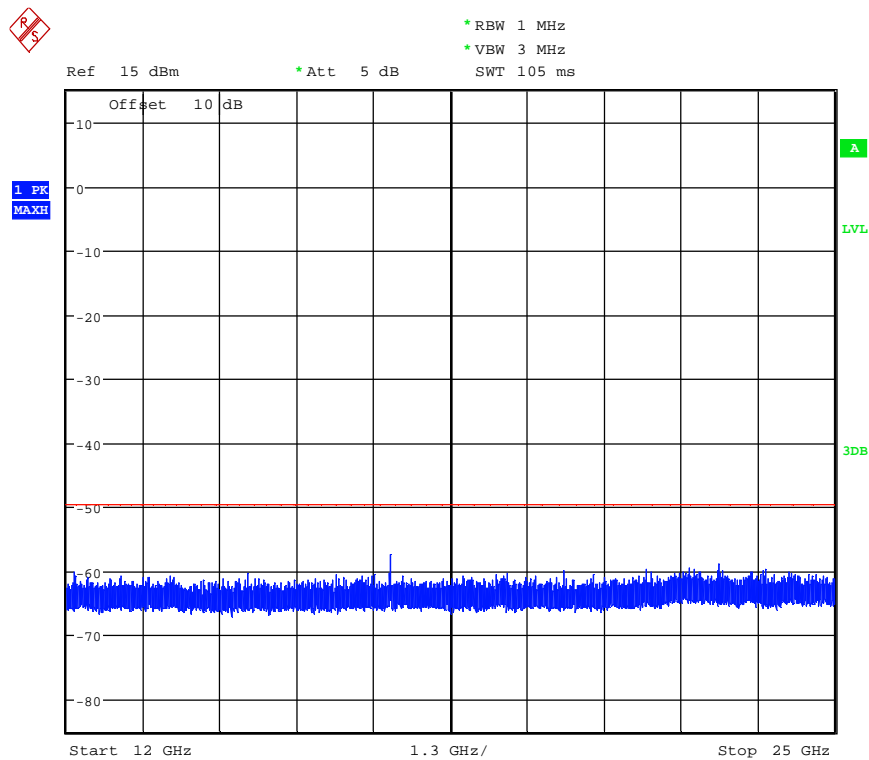
122165 Em1-4G a up.wmf: conducted spurious emissions (operation mode 15):



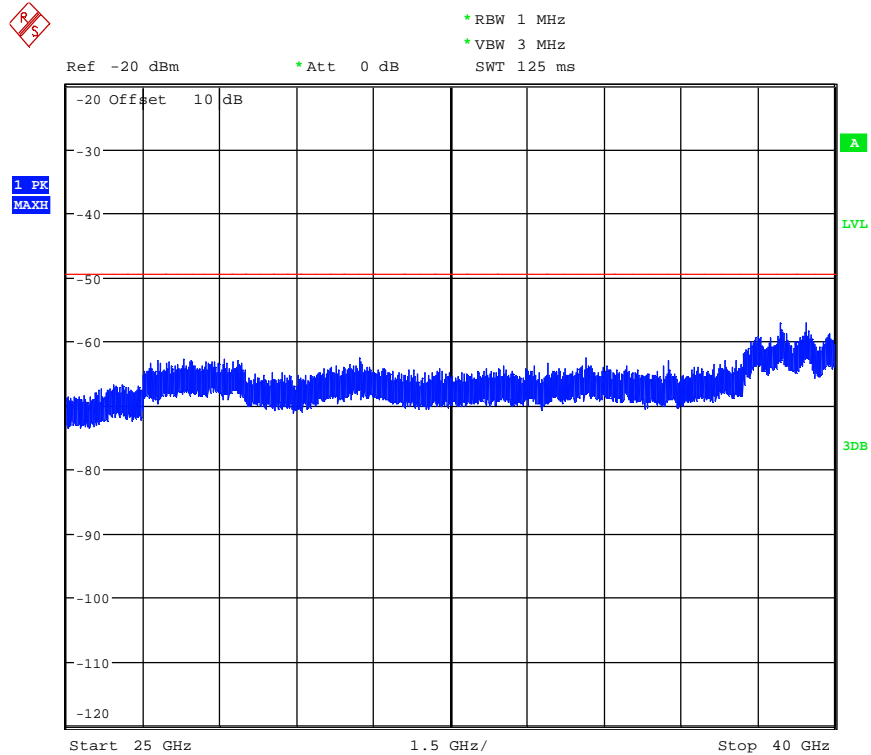
122165_Em4-12G_a_up.wmf: conducted spurious emissions (operation mode 15):



122165_Em12G-25G_a_up.wmf: conducted spurious emissions (operation mode 15):



122165 SpurEm25G-40G a up.wmf: conducted spurious emissions (operation mode 15):



Spurious Emissions, b-mode, channel 1 (Operation mode 1)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1614	-29.5	-49.5	-46.8	-56.5	17.3	7.0
2581	-29.5	-49.5	-38.0	-58.4	8.5	8.9
3229	-29.5	-49.5	-46.9	-52.6	17.4	3.1
4823	-29.5	-49.5	-49.5	-57.9	20.0	8.4

Spurious Emissions, b-mode, channel 6 (Operation mode 2)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1618	-29.5	-49.5	-50.8	-58.9	21.3	9.4
2288	-29.5	-49.5	-41.8	-54.9	12.3	5.4
2524	-29.5	-49.5	-40.0	-59.7	10.5	10.2
3236	-29.5	-49.5	-47.7	-53.7	18.2	4.2

Spurious Emissions, b-mode, channel 11 (Operation mode 3)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
2288	-29.5	-49.5	-46.0	-57.5	8.5	8.0
2551	-29.5	-49.5	-45.5	-64.1	1.4	14.6
3269	-29.5	-49.5	-49.8	-58.6	11.2	9.1
4874	-29.5	-49.5	-49.4	-57.4	12.0	7.9

Spurious Emissions, g-mode, channel 1 (Operation mode 4)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-50.1	-57.3	20.6	7.8
1937	-29.5	-49.5	-51.1	-63.2	21.6	13.7
2592	-29.5	-49.5	-41.4	-60.2	11.9	10.7
3229	-29.5	-49.5	-47.6	-53.6	18.1	4.1
4825	-29.5	-49.5	-39.5	-61.3	10.0	11.8

Spurious Emissions, g-mode, channel 6 (Operation mode 5)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1618	-29.5	-49.5	-49.9	-58.7	20.4	9.2
2524	-29.5	-49.5	-38.9	-59.8	9.4	10.3
3236	-29.5	-49.5	-47.3	-53.2	17.8	3.7
4876	-29.5	-49.5	-39.7	-61.0	10.2	11.5

Spurious Emissions, g-mode, channel 11 (Operation mode 6)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1635	-29.5	-49.5	-50.2	-57.5	20.7	8.0
2496	-29.5	-49.5	-35.0	-60.6	5.5	11.1
3269	-29.5	-49.5	-47.8	-53.7	18.3	4.2

Spurious Emissions, n20-mode, channel 1 (Operation mode 7)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-49.0	-56.2	19.5	6.7
2585	-29.5	-49.5	-38.7	-58.5	9.2	9.0
3229	-29.5	-49.5	-46.8	-52.3	17.3	2.8
4826	-29.5	-49.5	-39.4	-62.5	9.9	13.0

Spurious Emissions, n20-mode, channel 6 (Operation mode 8)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1618	-29.5	-49.5	-48.9	-56.4	19.4	6.9
2502	-29.5	-49.5	-31.5	-58.9	2.0	9.4
3236	-29.5	-49.5	-46.6	-52.2	17.1	2.7
4878	-29.5	-49.5	-40.7	-62.6	11.2	13.1

Spurious Emissions, n20-mode, channel 11 (Operation mode 9)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1635	-29.5	-49.5	-50.5	-57.9	21.0	8.4
2288	-29.5	-49.5	-43.1	-58.6	13.6	9.1
2505	-29.5	-49.5	-40.9	-61.7	11.4	12.2
3270	-29.5	-49.5	-47.2	-54.2	17.7	4.7

Spurious Emissions, n40-mode, channel 1 (Operation mode 10)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-50.0	-58.0	20.5	8.5
2505	-29.5	-49.5	-33.4	-58.8	3.9	9.3
3229	-29.5	-49.5	-47.5	-53.1	18.0	3.6
4846	-29.5	-49.5	-44.0	-65.3	14.5	15.8

Spurious Emissions, n40-mode, channel 6 (Operation mode 11)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1618	-29.5	-49.5	-49.2	-55.9	19.7	6.4
2502	-29.5	-49.5	-31.3	-56.6	1.8	7.1
3236	-29.5	-49.5	-46.7	-52.1	17.2	2.6
4856	-29.5	-49.5	-44.2	-65.4	14.7	15.9

Spurious Emissions, n40-mode, channel 11 (Operation mode 12)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1635	-29.5	-49.5	-50.6	-57.7	21.1	8.2
2500	-29.5	-49.5	-31.2	-59.8	1.7	10.3
3269	-29.5	-49.5	-47.8	-54.1	18.3	4.6

Spurious Emissions, a-mode, channel 149 (Operation mode 13)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1902	-29.5	-49.5	-42.5	-58.6	13.0	9.1
3837	-29.5	-49.5	-42.8	-50.0	13.3	0.5
4997	-29.5	-49.5	-45.2	-65.3	15.7	15.8
5499	-29.5	-49.5	-36.7	-59.5	7.2	10.0
11489	-29.5	-49.5	-32.9	-57.9	3.4	8.4
17234	-29.5	-49.5	-35.0	-62.1	5.5	12.6

Spurious Emissions, a-mode, channel 157 (Operation mode 14)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1915	-29.5	-49.5	-43.1	-59.4	13.6	9.9
3862	-29.5	-49.5	-45.3	-49.8	15.8	0.3
4993	-29.5	-49.5	-46.1	-65.4	16.6	15.9
5458	-29.5	-49.5	-40.5	-61.1	11.0	11.6
11567	-29.5	-49.5	-39.1	-59.6	9.6	10.1
17348	-29.5	-49.5	-34.5	-66.5	5.0	17.0

Spurious Emissions, a-mode, channel 165 (Operation mode 15)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1935	-29.5	-49.5	-41.4	-58.5	11.9	9.0
3883	-29.5	-49.5	-43.9	-49.6	14.4	0.1
4996	-29.5	-49.5	-46.2	-65.9	16.7	16.4
5395	-29.5	-49.5	-41.4	-61.9	11.9	12.4
11651	-29.5	-49.5	-38.6	-58.7	9.1	9.2
17490	-29.5	-49.5	-44.6	-68.2	15.1	18.7

Spurious Emissions, n20-mode, channel 149 (Operation mode 16)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1906	-29.5	-49.5	-42.8	-59.1	13.3	9.6
3837	-29.5	-49.5	-42.9	-50.1	13.4	0.6
4985	-29.5	-49.5	-45.0	-65.2	15.5	15.7
5430	-29.5	-49.5	-39.5	-60.3	10.0	10.8
11486	-29.5	-49.5	-33.6	-58.8	4.1	9.3
17238	-29.5	-49.5	-35.6	-63.2	6.1	13.7

Spurious Emissions, n20-mode, channel 157 (Operation mode 17)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1915	-29.5	-49.5	-43.1	-59.5	13.6	10.0
3863	-29.5	-49.5	-45.6	-49.9	16.1	0.4
4984	-29.5	-49.5	-46.4	-65.9	16.9	16.4
5496	-29.5	-49.5	-41.4	-62.1	11.9	12.6
11569	-29.5	-49.5	-39.3	-59.1	9.8	9.6
17352	-29.5	-49.5	-36.2	-66.3	6.7	16.8

Spurious Emissions, n20-mode, channel 165 (Operation mode 18)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1937	-29.5	-49.5	-43.5	-61.5	14.0	12.0
3883	-29.5	-49.5	-44.9	-49.7	15.4	0.2
4989	-29.5	-49.5	-47.4	-66.4	17.9	16.9
5433	-29.5	-49.5	-42.4	-62.8	12.9	13.3
11650	-29.5	-49.5	-39.0	-60.8	9.5	11.3

Spurious Emissions, n40-mode, channel 151 (Operation mode 19)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1717	-29.5	-49.5	-47.3	-66.4	17.8	16.9
3460	-29.5	-49.5	-46.5	-51.4	17.0	1.9
4994	-29.5	-49.5	-47.3	-66.4	17.8	16.9
6920	-29.5	-49.5	-50.1	-57.6	20.6	8.1

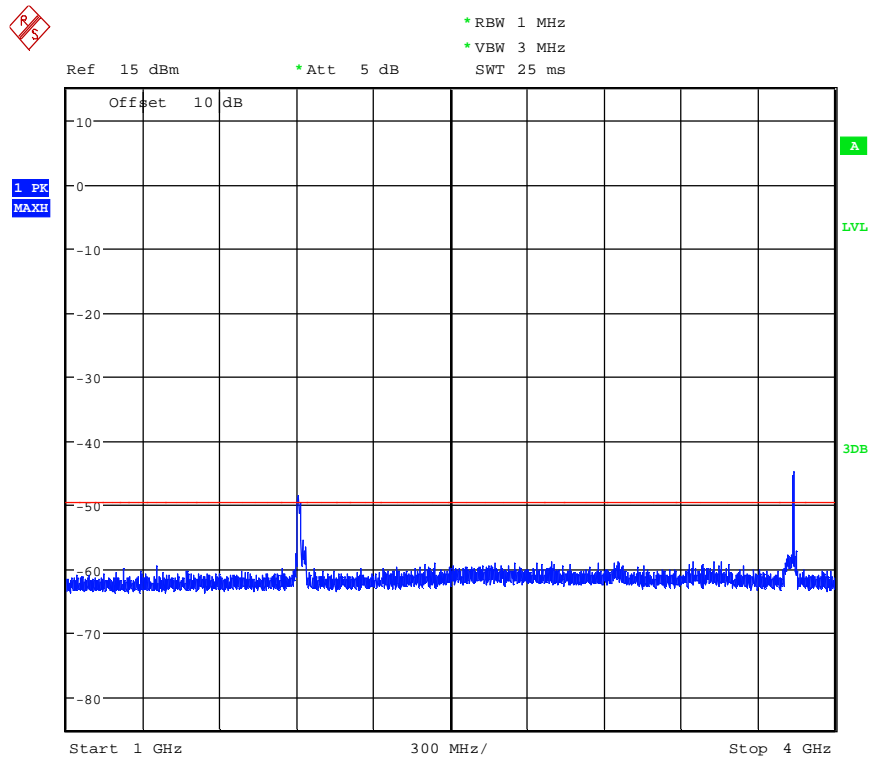
Spurious Emissions, n40-mode, channel 159 (Operation mode 20)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1730	-29.5	-49.5	-46.3	-65.3	16.8	15.8
3448z	-29.5	-49.5	-47.1	-52.6	17.6	3.1
4983	-29.5	-49.5	-47.6	-66.3	18.1	16.8
6973	-29.5	-49.5	-50	-58.5	20.5	9.0

5.3.2.2 Antenna port 2

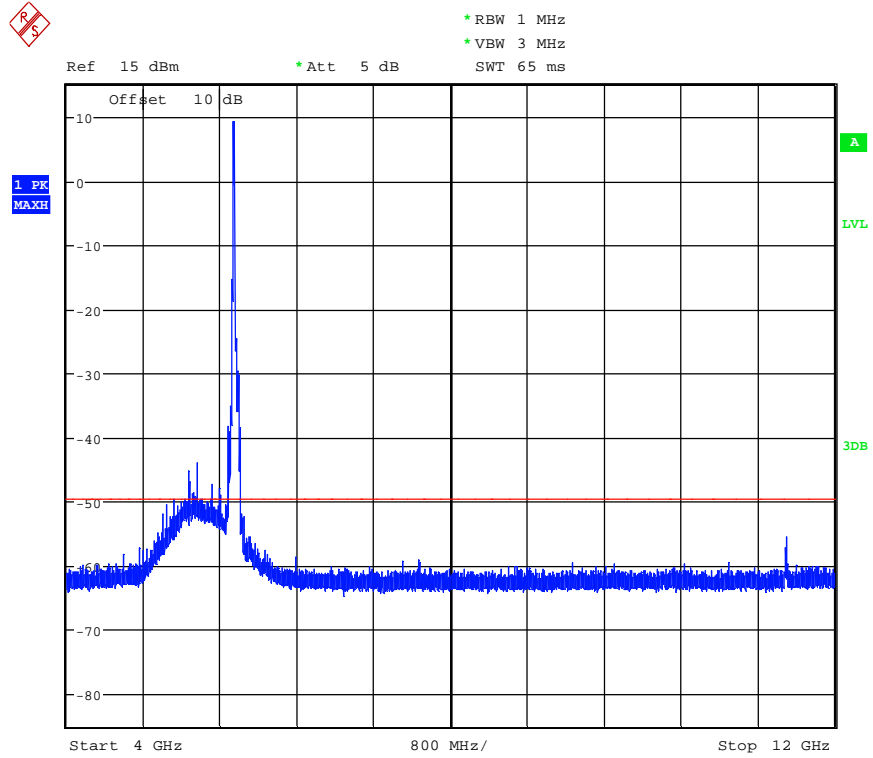
Ambient temperature	21 °C	Relative humidity	46 %
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The following results were measured at antenna port 2 of the EUT. The plots shows exemplary measurement results for the worst documented case. The other results are listed in the following table.

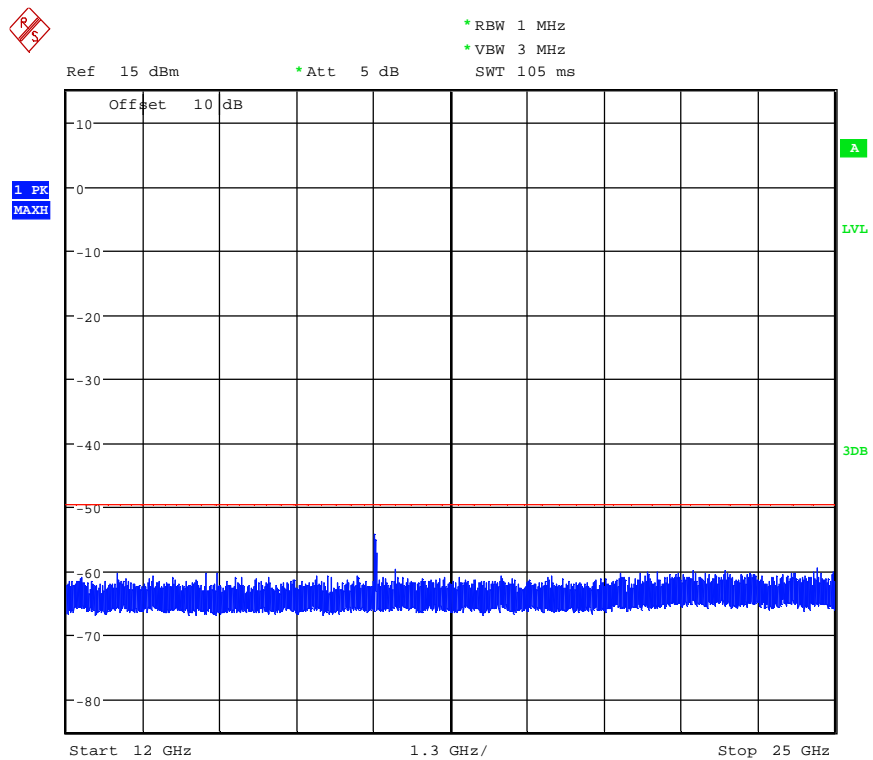
122165 Em1-4G a low.wmf: conducted spurious emissions (operation mode 13):



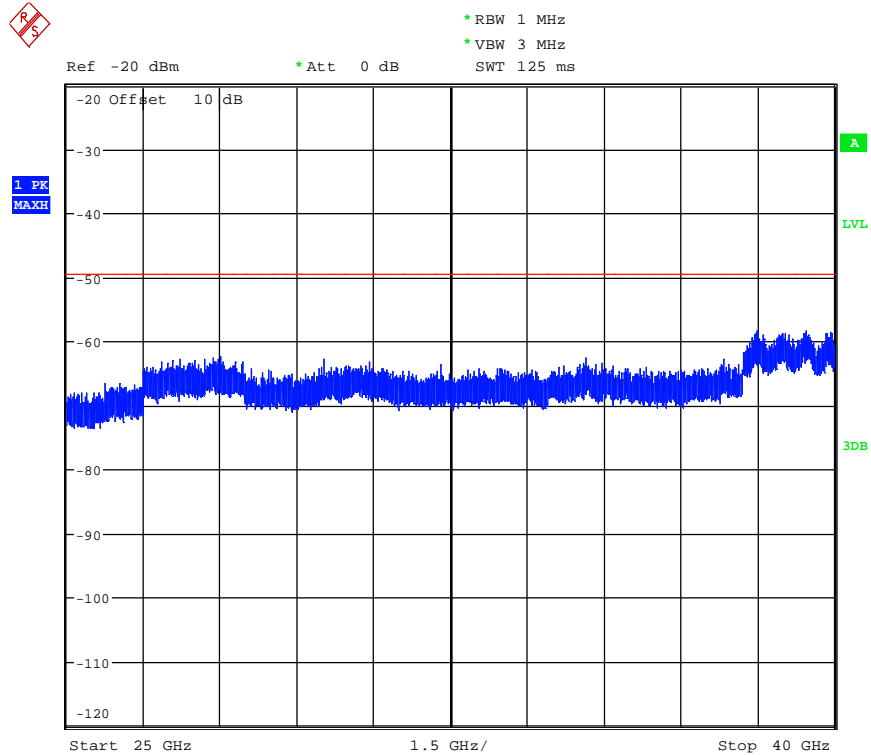
122165 Em4-12G a low.wmf: conducted spurious emissions (operation mode 13):



122165 Em12G-25G a low.wmf: conducted spurious emissions (operation mode 13):



122165 SpurEm25G-40G a up.wmf: conducted spurious emissions (operation mode 13):



Spurious Emissions, b-mode, channel 1 (Operation mode 1)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-50.38	-58.5	20.9	9.0
1883	-29.5	-49.5	-46.1	-68.7	16.6	19.2
3229	-29.5	-49.5	-46.2	-50.9	16.7	1.6
4824	-29.5	-49.5	-49.9	-58.2	20.4	8.7

Spurious Emissions, b-mode, channel 6 (Operation mode 2)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1618	-29.5	-49.5	-47.6	-56.7	18.1	7.2
1882	-29.5	-49.5	-46.5	-68.4	17.0	18.9
3238	-29.5	-49.5	-46.2	-50.7	16.7	1.2
4874	-29.5	-49.5	-53.4	-68.2	23.9	18.7

Spurious Emissions, b-mode, channel 11 (Operation mode 3)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1634	-29.5	-49.5	-52.8	-63.7	23.3	14.2
1885	-29.5	-49.5	-47.4	-68.7	17.9	19.2
3270	-29.5	-49.5	-47.5	-53.4	18.0	3.9

Spurious Emissions, g-mode, channel 1 (Operation mode 4)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-48.7	-56.4	19.2	6.91
3229	-29.5	-49.5	-45.8	-50.4	16.3	0.9
4822	-29.5	-49.5	-35.6	-60.8	6.1	11.3
7237	-29.5	-49.5	-41.3	-64.4	11.8	14.9

Spurious Emissions, g-mode, channel 6 (Operation mode 5)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1618	-29.5	-49.5	-48.5	-56.0	19.0	6.5
3237	-29.5	-49.5	-45.5	-49.8	16.0	0.3
4887	-29.5	-49.5	-37.1	-63.9	7.6	14.4
7311	-29.5	-49.5	-41.6	-64.1	12.1	14.6

Spurious Emissions, g-mode, channel 11 (Operation mode 6)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1634	-29.5	-49.5	-49.2	-55.1	19.7	5.6
1885	-29.5	-49.5	-48.3	-68.8	18.8	19.3
3269	-29.5	-49.5	-45.5	-49.6	16.0	0.1

Spurious Emissions, n20-mode, channel 1 (Operation mode 7)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-48.9	-56.3	19.4	6.8
2485	-29.5	-49.5	-44.0	-60.1	14.5	10.6
3229	-29.5	-49.5	-46.0	-50.4	16.5	0.9
4825	-29.5	-49.5	-37.3	-62.8	7.8	13.3
7235	-29.5	-49.5	-39.4	-65.7	9.9	16.2

Spurious Emissions, n20-mode, channel 6 (Operation mode 8)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1620	-29.5	-49.5	-48.6	-55.5	19.1	6.0
3237	-29.5	-49.5	-45.8	-49.9	16.3	0.4
4883	-29.5	-49.5	-38.8	-64.8	9.3	15.3
7312	-29.5	-49.5	-40.8	-65.4	11.3	15.9

Spurious Emissions, n20-mode, channel 11 (Operation mode 9)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1635	-29.5	-49.5	-49.8	-56.4	20.3	6.9
1887	-29.5	-49.5	-46.9	-68.3	17.4	18.8
3268	-29.5	-49.5	-45.8	-50.1	16.3	0.6

Spurious Emissions, n40-mode, channel 1 (Operation mode 10)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-49.1	-56.5	19.6	7.0
3229	-29.5	-49.5	-46.0	-50.4	16.5	0.9
4883	-29.5	-49.5	-43.1	-66.7	13.6	17.2

Spurious Emissions, n40-mode, channel 6 (Operation mode 11)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1618	-29.5	-49.5	-49.1	-55.6	13.5	6.1
3237	-29.5	-49.5	-45.2	-50.0	15.2	0.5
4884	-29.5	-49.5	-45.3	-68.0	-2.8	18.5

Spurious Emissions, n40-mode, channel 11 (Operation mode 12)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1635	-29.5	-49.5	-50.2	-57.0	20.7	7.5
1887	-29.5	-49.5	-47.4	-68.3	17.9	18.8
3269	-29.5	-49.5	-46.2	-50.5	16.7	1.0

Spurious Emissions, a-mode, channel 149 (Operation mode 13)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1888	-29.5	-49.5	-47.4	-69.0	17.9	19.5
1891	-29.5	-49.5	-49.5	-68.8	20.0	19.3
5350	-29.5	-49.5	-38.7	-51.2	9.2	1.7
11490	-29.5	-49.5	-45.8	-66.2	16.3	16.7
17235	-29.5	-49.5	-41.8	-65.9	12.3	16.4

Spurious Emissions, a-mode, channel 157 (Operation mode 14)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
5320	-29.5	-49.5	-38.8	-51.1	9.3	1.6
17358	-29.5	-49.5	-42.3	-66.5	12.8	17.0

Spurious Emissions, a-mode, channel 165 (Operation mode 15)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1936	-29.5	-49.5	-46.3	-66.1	16.8	16.6
1946	-29.5	-49.5	-46.1	-66.2	16.6	16.7
3885	-29.5	-49.5	-54.4	-58.9	24.9	9.4
5320	-29.5	-49.5	-40.0	-54.4	10.5	4.9

Spurious Emissions, n20-mode, channel 149 (Operation mode 16)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1615	-29.5	-49.5	-48.9	-56.3	19.4	6.8
2485	-29.5	-49.5	-44.0	-60.1	14.5	10.6
3229	-29.5	-49.5	-46.0	-50.4	16.5	0.9
4825	-29.5	-49.5	-37.3	-62.8	7.8	13.3
7235	-29.5	-49.5	-39.4	-65.7	9.9	16.2

Spurious Emissions, n20-mode, channel 157 (Operation mode 17)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1620	-29.5	-49.5	-48.6	-55.5	19.1	5.6
3237	-29.5	-49.5	-45.8	-49.9	16.3	0.4
4883	-29.5	-49.5	-38.8	-64.8	9.31	15.3
7312	-29.5	-49.5	-40.8	-65.4	11.3	15.9

Spurious Emissions, n20-mode, channel 165 (Operation mode 18)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1635	-29.5	-49.5	-49.8	-56.4	20.3	6.9
1887	-29.5	-49.5	-46.9	-68.3	17.4	18.8
3268	-29.5	-49.5	-45.8	-50.1	16.3	0.6

Spurious Emissions, n40-mode, channel 151 (Operation mode 19)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1.615	-29.5	-49.5	-49.1	-56.5	19.6	7.0
3229	-29.5	-49.5	-46.0	-50.4	16.5	0.9
4883	-29.5	-49.5	-43.1	-66.7	13.6	17.2

Spurious Emissions, n40-mode, channel 159 (Operation mode 20)						
Unwanted Emission Frequency MHz	Max Peak Limit dBm	Average Limit dBm	Max Peak Emission dBm	Average Emission dBm	Peak Margin dB	Average Margin dB
1635	-29.5	-49.5	-50.2	-57.0	20.7	7.5
1887	-29.5	-49.5	-47.4	-68.3	17.9	18.8
3269	-29.5	-49.5	-46.2	-50.5	16.7	1.0

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30, 80

5.3.3 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 site 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)

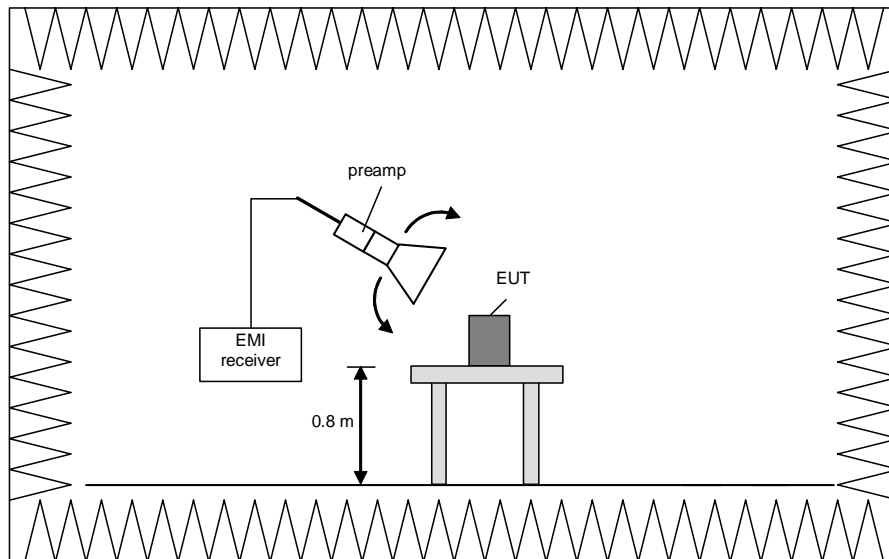
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance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

Preliminary measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of 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

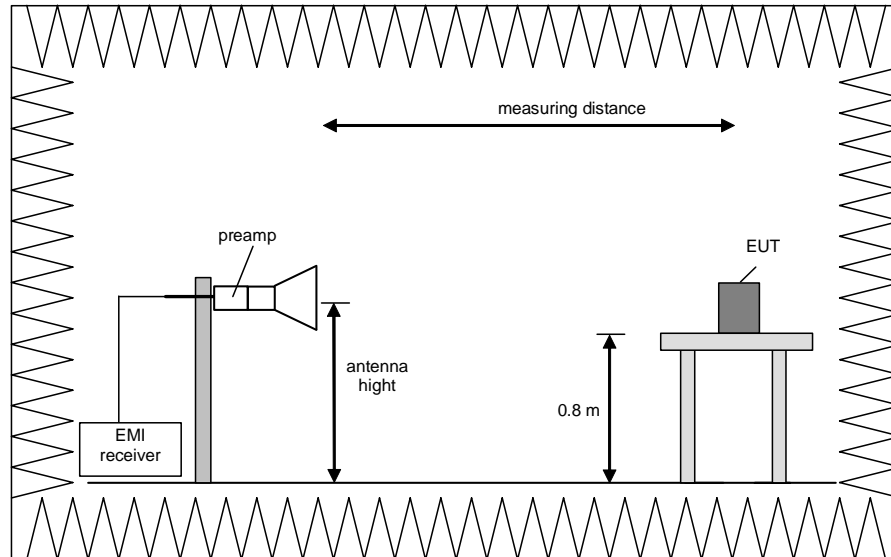


Final measurement (1 GHz to 110 GHz)

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.

5.3.4 Test results (radiated emissions) – cabinet emissions

5.3.4.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	51 %
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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 EUT with 12 V via an AC/DC Adapter.

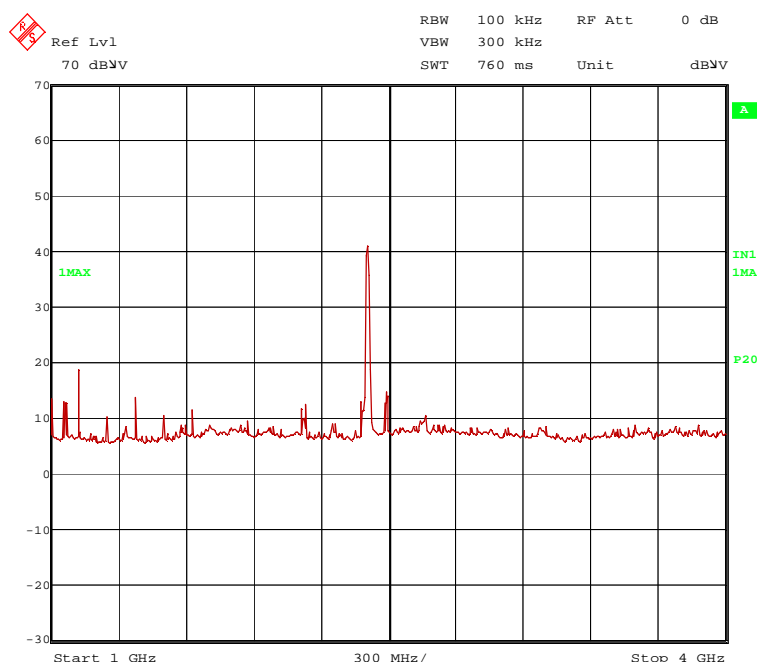
Remark: Document [3] states in 5.4.2.1, that in case of conducted measurements, additional radiated cabinet emission measurements must be performed. The measurements were performed at the worst case modulation, namely 802.11n mode with 20 MHz at channel 1, 6 and 11.

The measurements were only performed for frequencies above 1 GHz, because the device was already tested according to 15.109.

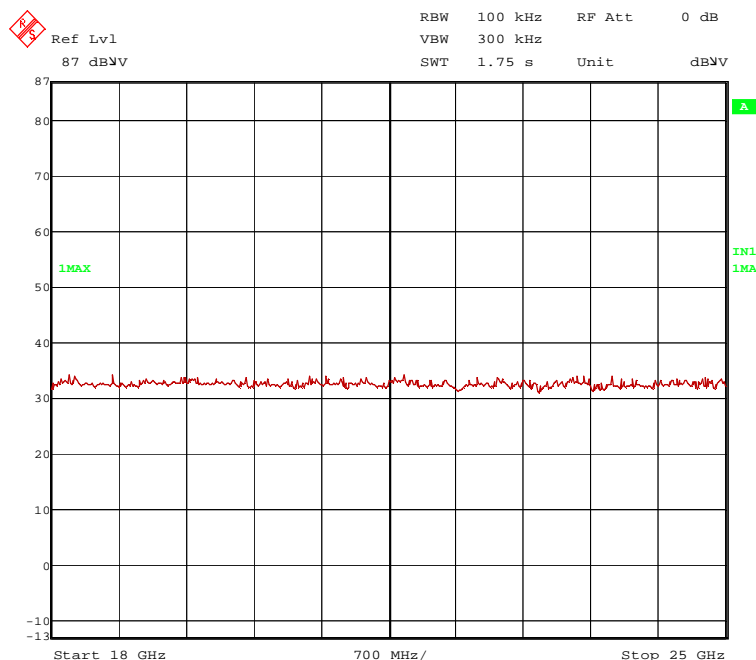
Only the plots of the worst case emissions are submitted for every frequency range above 1 GHz in the preliminary results.

Transmitter operates at the lower end of the assigned frequency band (n20-mode)

122165_145.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 7):



122165_168.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 7):



The following frequency was found inside the restricted bands during the preliminary radiated emission test:

- 1125 MHz, 1375 MHz, 2499 MHz, 4825 MHz, 12502 MHz

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

- 2408 MHz and 7227 MHz.

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

TEST EQUIPMENT USED FOR THE TEST:
29, 31 – 37, 39 - 44, 46, 49 – 51, 55, 72, 73

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

Ambient temperature	20 °C	Relative humidity	30 %
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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 EUT with 12 V via an AC/DC Adapter.

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

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

Result measured with the peak detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	83.6	-	-	51.6	28.3	0.0	3.7	150	Hor.	-	2
1125	49.2	74.0	24.8	22.1	24.6	0.0	2.5	150	Vert.	Yes	2
1375	44.6	74.0	29.4	16.7	25.0	0.0	2.9	150	Hor.	Yes	2
2499	56.4	74.0	17.6	24.1	28.5	0.0	3.8	150	Vert.	Yes	2
4825	59.7	74.0	14.3	47.5	32.6	25.7	5.3	150	Vert.	Yes	2
7227	63.3	74.0	10.7	45.3	35.8	24.6	6.8	150	Vert.	No	2
12052	50.2	74.0	23.8	40.0	33.6	25.9	2.5	150	Hor.	Yes	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2402	78.1	-	-	46.1	28.3	0.0	3.7	150	Hor.	-	2
1125	43.8	54.0	10.2	16.7	24.6	0.0	2.5	150	Vert.	Yes	2
1375	33.9	54.0	20.1	6.0	25.0	0.0	2.9	150	Hor.	Yes	2
2499	40.0	54.0	14.0	7.7	28.5	0.0	3.8	150	Vert.	Yes	2
4825	46.3	54.0	7.7	34.1	32.6	25.7	5.3	150	Vert.	Yes	2
7227	44.0	54.0	10.1	26.0	35.8	24.6	6.8	150	Vert.	No	2
12052	35.0	54.0	19.0	24.8	33.6	25.9	2.5	150	Hor.	Yes	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

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

Result measured with the peak detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2442	79.6			47.5	28.4	0.0	3.7	150	Vert.	Carrier	2
1125	50.5	74.0	23.5	23.4	24.6	0.0	2.5	150	Vert.	Yes	2
1375	19.6	74.0	54.4	18.2	25.0	26.5	2.9	150	Vert.	Yes	2
2499	29.9	74.0	44.1	24.1	28.5	26.5	3.8	150	Hor.	Yes	2
4876	58.0	74.0	16.0	45.6	32.8	25.7	5.3	150	Vert.	Yes	2
7319	61.7	74.0	12.3	43.3	36.2	24.6	6.8	150	Vert.	Yes	2
9753	58.2	74.0	15.8	36.9	37.3	23.9	7.9	150	Hor.	No	2
12200	50.3	74.0	23.7	40.1	33.6	25.9	2.5	150	Hor.	Yes	2
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2442	70.1			38.0	28.4	0.0	3.7	150	Vert.	Carrier	2
1125	43.8	54.0	10.2	16.7	24.6	0.0	2.5	150	Vert.	Yes	2
1375	7.8	54.0	46.2	6.4	25.0	26.5	2.9	150	Vert.	Yes	2
2499	12.7	54.0	41.3	6.9	28.5	26.5	3.8	150	Hor.	Yes	2
4876	44.2	54.0	9.8	31.8	32.8	25.7	5.3	150	Vert.	Yes	2
7319	44.6	54.0	9.4	26.2	36.2	24.6	6.8	150	Vert.	Yes	2
9753	44.2	54.0	9.8	22.9	37.3	23.9	7.9	150	Hor.	No	2
12200	35.9	54.0	18.1	25.7	33.6	25.9	2.5	150	Hor.	Yes	2
Measurement uncertainty						+2.2 dB / -3.6 dB					

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

Result measured with the peak detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2467	70.6			38.4	28.5	0.0	3.7	150	Vert.	Carrier	2
1125	50.1	74.0	23.9	23.0	24.6	0.0	2.5	150	Vert.	Yes	2
1375	45.7	74.0	28.3	17.8	25.0	0.0	2.9	150	Hor.	Yes	2
2496	56.7	74.0	17.3	24.4	28.5	0.0	3.8	150	Vert.	Yes	2
4924	50.1	74.0	23.9	37.5	32.9	25.6	5.3	150	Vert.	Yes	2
Measurement uncertainty						+2.2 dB / -3.6 dB					

Result measured with the average detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
2467	61.1			28.9	28.5	0.0	3.7	150	Vert.	Carrier	2
1125	44.3	54.0	9.7	17.2	24.6	0.0	2.5	150	Vert.	Yes	2
1375	34.2	54.0	19.8	6.3	25.0	0.0	2.9	150	Hor.	Yes	2
2496	40.0	54.0	14.0	7.7	28.5	0.0	3.8	150	Vert.	Yes	2
4924	36.1	54.0	17.9	23.5	32.9	25.6	5.3	150	Vert.	Yes	2
Measurement uncertainty						+2.2 dB / -3.6 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 37, 39 - 44, 46, 49 – 51, 55, 72, 73

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	03/09/2012	03/2014
4	High pass filter	HR 0.13- 5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	02/15/2012	02/2014
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	MA240-0	Inn-Co GmbH	MA240- 0/030/6600603	480086	-	-
19	Antenna	CBL6111 D	Chase	25761	480894	09/28/2011	09/2014
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	02/15/2012	02/2014
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/13/2012	02/2014
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS615P	Deisel	615/310	480187	-	-
35	Antenna	CBL6112 B	Chase	2688	480328	04/21/2011	04/2014
36	Antenna	3115 A	EMCO	9609-4918	480183	11/09/2011	11/2014
37	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
39	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
40	Standard Gain Horn Antenne 26.4 – 40.1 GHz	22240-20	Flann Microwave	469	480229	Six month verification (system cal.)	
41	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
42	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141	Weekly verification (system cal.)	
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142	Weekly verification (system cal.)	
46	RF-cable 1 m	KPS-1533- 400-KPS	Insulated Wire	-	480301	Six month verification (system cal.)	
49	Preamplifier	JS3- 00101200- 23-5A	Miteq	681851	480337	Six month verification (system cal.)	
50	Preamplifier	JS3- 12001800- 16-5A	Miteq	571667	480343	Six month verification (system cal.)	

51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
55	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/16/2012	02/2014
60	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	02/15/2012	02/2014
72	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	
73	Single Control Unit	SCU	Maturo GmbH	SCU/006/971107	480831	Calibration not necessary	
80	High-pass Filter	H26G40G1	Microwave Circuits, Inc.	33471	480593	Six month verification (system cal.)	

