

Test Report

Report Number:

F151710E2

Equipment under Test (EUT):

**Electrosurgical device
VIO[®] 3**

Applicant:

ERBE Elektromedizin GmbH

Manufacturer:

ERBE Elektromedizin GmbH



References

- [1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15 (March 2016)**, Radio Frequency Devices
- [3] **RSS-247 (May 2015)**, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- [3] **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 0) were fulfilled by the equipment under test.

The complete test results are presented in the following.

Test engineer:	Paul NEUFELD		20.04.2016
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		20.04.2016
	Name	Signature	Date

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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** , FCC Test site registration number 90877 and
Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	Electrosurgical system			
Model / PMN: *	VIO® 3			
FCC ID: *	2AGEM-VIO3			
IC Company number / UPN: *	20687-VIO3			
HVIN	VIO® 3			
Serial number: *	11401470			
PCB identifier: *	Y5			
Hardware version: *	Y5			
Software version / FVIN: *	V1.0.0.E			
WLAN module	ELLA-W133-A			

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

1.5 Technical Data of Equipment

Fulfils WLAN specification: *	IEEE, 802.11b, 802.11g					
Antenna name: *	FXP73 Blue Diamond 2.4GHz					
Antenna type: *	Patch Antenna					
Antenna gain: *	3.0 dBi					
Antenna connector: *	U-FL					
Power supply Host	U _{nom} =	120 / 230 V AC	U _{min} =	100V AC	U _{max} =	240 V AC
Power supply module	U _{nom} =	3.3 V DC	U _{min} =	3.0 V DC	U _{max} =	3.6 V DC
Type of modulation: *	802.11b: CCK, DQPSK, DBPSK 802.11g: OFDM					
Operating frequency range: *	2412 MHz to 2462 MHz					
Number of channels: *	11					
Temperature range: *	-40 °C to +85 °C					
Lowest / highest internal clock frequency: *	8 MHz / 30 MHz					

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
Power Supply cable	Inlet connector	Socket outlet (120 V / 60 Hz)	2 m*
LAN cable	USB plug	Laptop PC	2 m*

*: Length during the test if not other specified.

1.6 Dates

Date of receipt of test sample:	07.10.2015
Start of test:	07.10.2015
End of test:	25.11.2015

2 Operational States

The equipment under test (EUT) is an electrosurgical device with a variety of ancillary equipment. The focus of this test is the combination of the EUT and the internal WLAN module. The WLAN module will only be used for maintenance purposes. . Due to the fact that the main focus of this test is on the WLAN function, the device under test was set into a mode with active WLAN testmode but with disabled surgery function. The operation mode surgery falls in the scope of other standards and is not part of this testreport.

For the test a special firmware named NK_OS05_BSP87.nb0 was loaded on the VIO® 3, which was enabling the setting of the test modes. During the test an external Laptop PC was connected via LAN to the VIO® 3. The communication was performed via telnet commands.

The module itself is capable to operate in IEEE 801.11 b, g, n20 and n40 but as declared by the application it is limited to IEEE 802.11b and 802.11g in the final firmware and as well to channel 1 – 11 only. So channel 12 and 13 are not used. The power setting were set to the values as indicated in the table in chapter 3.

Operation Modes representing the worst case

Operation Mode	Channel	Frequency	WLAN Mode	Datarate
1	1	2412	b	11 Mbps
2	6	2437	b	11 Mbps
3	11	2462	b	11 Mbps
4	1	2412	g	18 Mbps
5	6	2437	g	18 Mbps
6	11	2462	g	18 Mbps

3 Additional Information

Power Table [Power settings in the customer test software during the tests]

WLAN Mode	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10	Ch 11
b	18	18	18	18	18	18	18	18	18	18	18
g	16	16	16	16	16	16	16	16	16	16	16

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 3 [4]	Status	Refer page
Maximum Peak Output Power	2400.0 - 2483.5	15.247 (b) (3), (4)	5.4 (2) [3]	Passed	10 et seq
DTS Bandwidth	2400.0 - 2483.5	15.247 (a) (2)	5.2 (1) [3]	Passed	12 et seq
Peak Power Spectral Density	2400.0 - 2483.5	15.247 (e)	5.2 (2) [3]	Passed	14 et seq
Band edge compliance	2400.0 - 2483.5	15.247 (d)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	16 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	20 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Passed	45 et seq.

5 Results

5.1 Maximum peak output power

5.1.1 Method of measurement

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

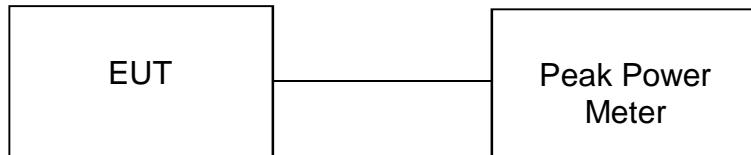
Acceptable measurement configurations

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

PKPM1 – Peak power meter method was used for this test. The procedure is described in chapter 11.9.1.3 of document [1].

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

Test set-up:



5.1.2 Test results

Ambient temperature	22 °C	Relative humidity	62 %
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The highest antenna array gain is 3.0 dBi for . Therefore no reduction of the Peak power limit is necessary.

Operation Mode	Antenna gain combined [dBi]	Maximum peak output power Port 1 [dBm]	Margin [dB]	Peak power limit [dBm]
1	3.0	17.4	12.6	30
2	3.0	17.3	12.7	30
3	3.0	17.5	12.5	30
4	3.0	20.7	9.3	30
5	3.0	20.4	9.6	30
6	3.0	20.7	9.3	30
Measurement uncertainty		+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

26, 27

5.2 DTS Bandwidth

5.2.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 11.8.1 of document [1].

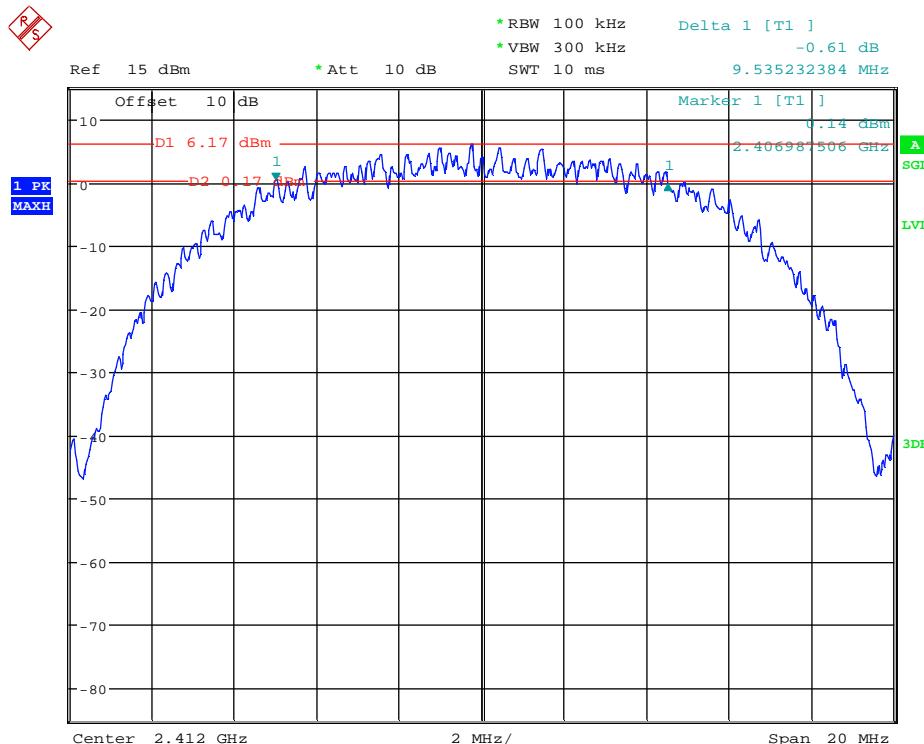
- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points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

5.2.2 Test result

Ambient temperature	22 °C	Relative humidity	59 %
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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.

Erbe 6dB-BW b 1.wmf: DTS Bandwidth (operation mode 1):



Operation Mode	Center Frequency [MHz]	Minimum 6-dB Bandwidth Limit [MHz]	6 dB Bandwidth [MHz]	Result
1	2412	0.5	9.535	Passed
2	2437	0.5	9.545	Passed
3	2462	0.5	9.535	Passed
4	2412	0.5	16.582	Passed
5	2437	0.5	16.567	Passed
6	2462	0.5	16.567	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

5.3 Peak Power Spectral Density

5.3.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 11.10.2 of document [1].

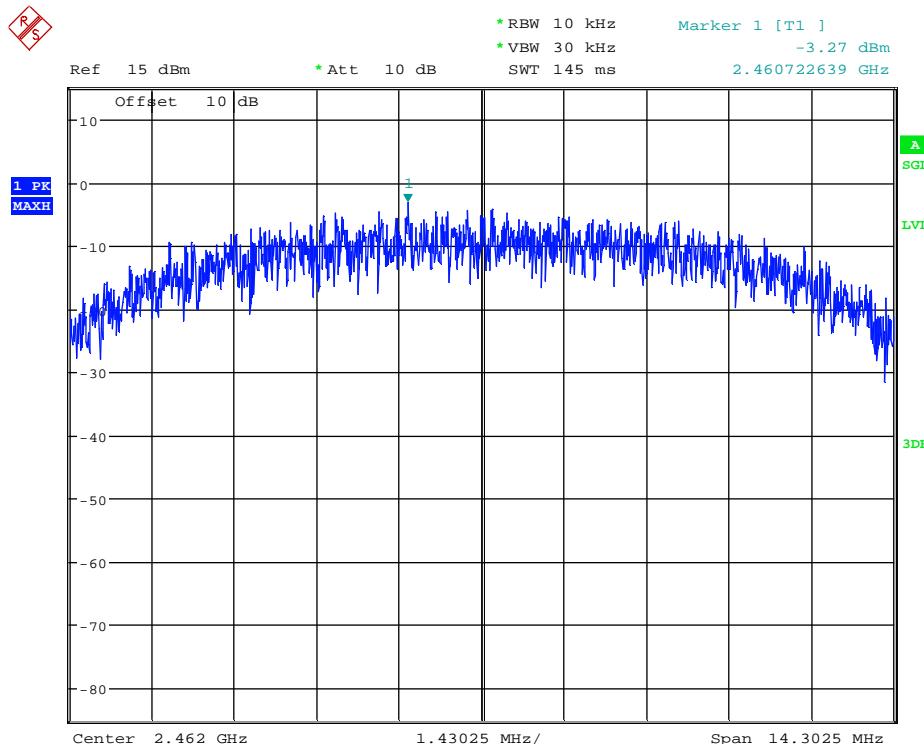
- Set analyser center frequency to DTS channel center frequency
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- Set the VBW $\geq 3 \times \text{RBW}$.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
- If measured value exceeds limit, reduce RBW (not less than 3 kHz) and repeat.

5.3.2 Test result

Ambient temperature	22 °C	Relative humidity	59 %
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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.

Erbe PwrSpecDens b_11.wmf: Power Spectral Density (operation mode 3):



Operation Mode	Peak Frequency [MHz]	Power Spectral Density Limit [dBm/3kHz]	Power Spectral Density Reading [dBm / 10 kHz]	Array Gain [dB]	Power Spectral Density Level [dBm / 10kHz]	Result
1	2410.723	8	-3.9	0.0	-3.9	Passed
2	2435.721	8	-3.5	0.0	-3.5	Passed
3	2460.723	8	-3.3	0.0	-3.3	Passed
4	2412.925	8	-6.2	0.0	-6.2	Passed
5	2437.924	8	-6.3	0.0	-6.3	Passed
6	2462.924	8	-6.2	0.0	-6.2	Passed
Measurement uncertainty				+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

5.4 Band-edge compliance

5.4.1 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 11.11.2 and 11.11.3 of document [1].

Measurement Procedure Reference – Reference Level:

- RBW = 100 kHz.
- VBW \geq 300 kHz.
- Set the span to \geq 1.5 times the DTS Bandwidth.
- Detector = Peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilise.
- Use the peak marker function to determine the 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 \geq 300 kHz.
- Detector = Peak.
- Ensure that the number of measurement points \geq span/RBW.
- Sweep time = auto couple.
- Trace Mode = max hold.
- Allow the trace to stabilise.
- Use the peak marker function to determine the maximum amplitude level.

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.

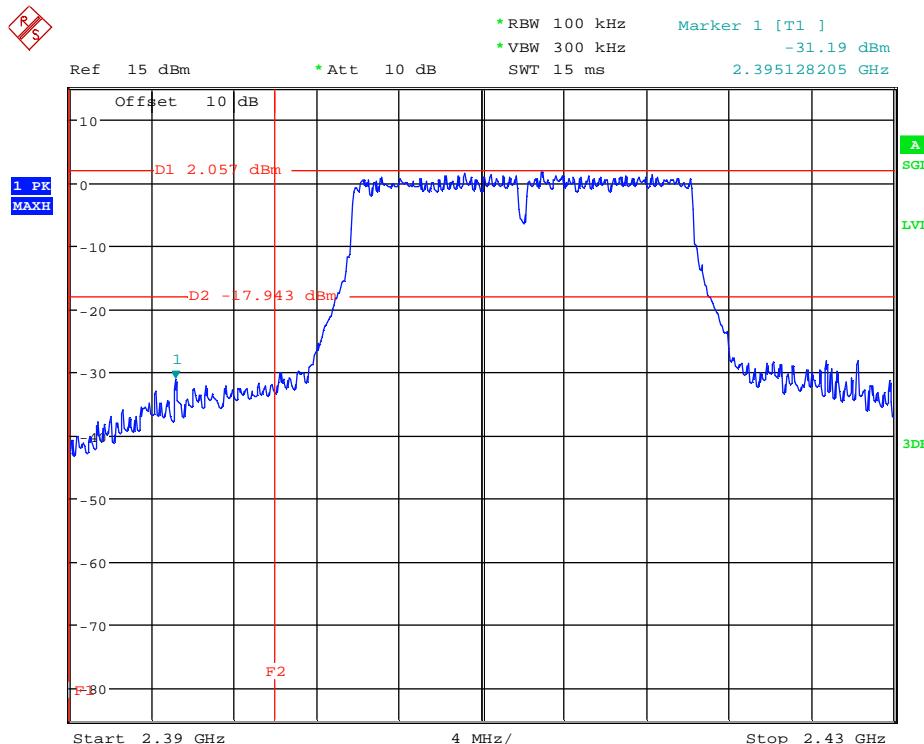
The measurements were performed at the lower end of the 2.4 GHz band.

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

Ambient temperature	22 °C	Relative humidity	59 %
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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.

Erbe BandEdgeUnrestr g_1.wmf: conducted band-edge compliance (operation mode 4):



WLAN Mode	WLAN Channel	Antenna port	Emission Frequency [MHz]	Reference Level [dBm]	Limit [dBm]	Emission Level [dBm]	Margin [dB]	Result
b	1	1	2398.526	6.4	-13.6	-41.5	27.9	Passed
g	1	1	2395.128	2.1	-17.9	-30.9	13.0	Passed

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

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

The same test set-up as used for the final conducted emission measurement shall be used (refer also subclause 5.5.1 of this test report).

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

$$E [\text{dB}\mu\text{V/m}] = E/\text{RP} [\text{dBm}] - 20\log(d) + 104.8$$

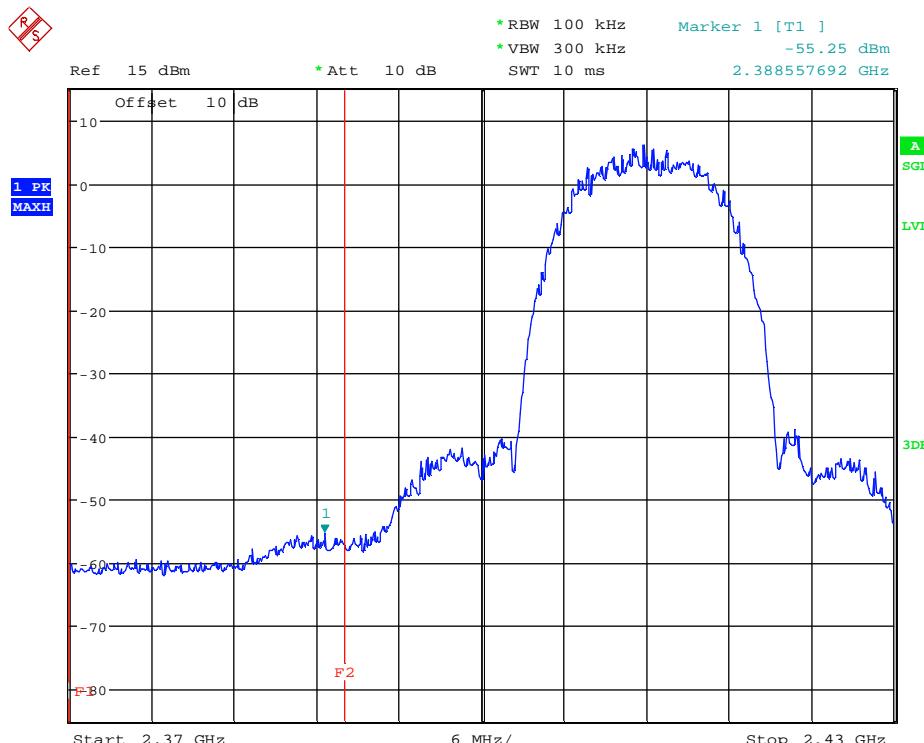
5.4.4 Test result (band edges next to restricted bands (conducted))

Ambient temperature	22 °C	Relative humidity	59 %
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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.

The results in g-mode were failed during the conducted measurement. Therefore the band-edge compliance in g-mode was performed as radiated measurements.

Erbe BandEdgeRestr_b_1.wmf: conducted band-edge compliance (operation mode 1):



Band Edge Compliance, b-mode, channel 1 (Operation mode 1)									
WLAN Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
b	1	2386.758	53.3	74.0	20.7	-45.3	3.0	Passed	Y
WLAN Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
b	1	2387.233	42.4	54.0	11.6	-56.1	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

Band Edge Compliance, b-mode, channel 11 (Operation mode 3)									
WLAN Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
b	11	2486.179	52.4	74.0	21.6	-46.2	3.0	Passed	Y
WLAN Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Average Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
b	11	2483.642	41.4	54.0	12.6	-57.2	3.0	Passed	Y
Measurement uncertainty				+0.66 dB / -0.72 dB					

For the results in g-mode refer to chapter 5.4.6.

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

7

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

The same test set-up as used for the radiated spurious emission measurement shall be used (refer also subclause 5.5.4 of this test report).

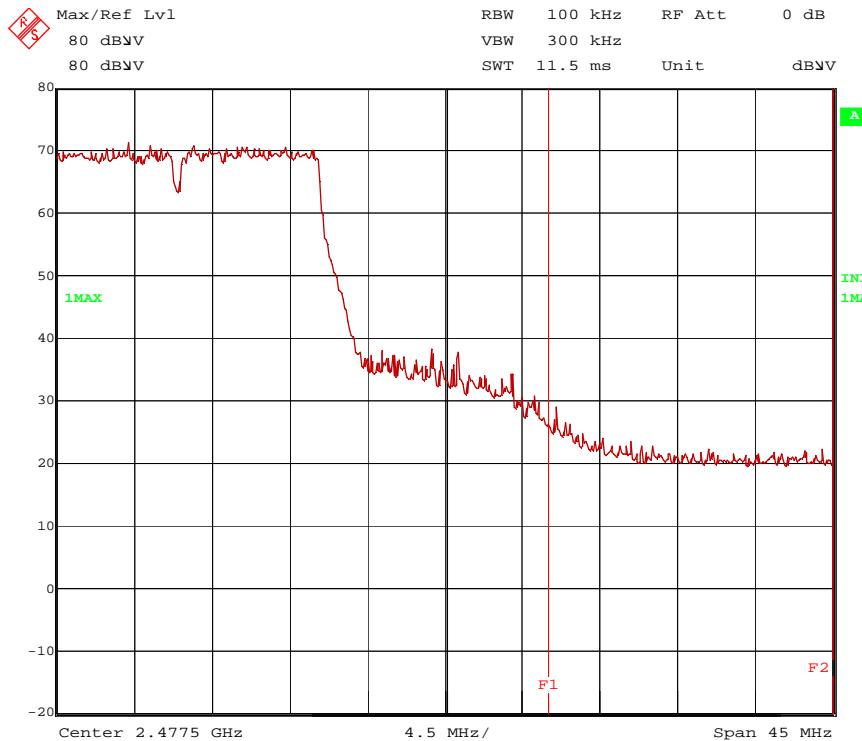
The measurement was performed at the lower and the upper end of the 2.4 GHz band.

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

Ambient temperature	22 °C	Relative humidity	59 %
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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.

BandEdge ch11_18M_18dBm_Ver_1m.wmf: conducted band-edge compliance (operation mode 6):



Transmitter operates at the lower end of the assigned frequency band operation mode 4 (g-mode)

Result measured with the peak detector:

Frequency MHz	Meas. Result dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	EUT Height cm	Pol.	Antenna Height cm
2389	70.8	78.0	7.2	37.3	30.1	0.0	3.4	150	Vert.	100
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	EUT Height cm	Pol.	Antenna Height cm
2389	57.4	58.0	0.6	23.9	30.1	0.0	3.4	150	Vert.	100
Measurement uncertainty				+2.2 dB / -3.6 dB						

Transmitter operates at the upper end of the assigned frequency band operation mode 6 (g-mode)

Result measured with the peak detector:

Frequency MHz	Meas. Result dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	EUT Height cm	Pol.	Antenna Height cm
2484	73.6	78.0	4.4	40.0	30.2	0.0	3.4	200	Vert	100
Measurement uncertainty				+2.2 dB / -3.6 dB						

Result measured with the average detector:

Frequency MHz	Meas. Result dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	EUT Height cm	Pol.	Antenna Height cm
2484	57.8	58.0	0.2	24.2	30.2	0.0	3.4	150	Vert	100
Measurement uncertainty				+2.2 dB / -3.6 dB						

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

6, 8 - 14, 17, 18

5.5 Maximum unwanted emissions

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

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly mounted to a spectrum analyser. The measurement procedure refers to part 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 ($D \geq 98\%$) cannot be achieved and the duty cycle is constant (duty cycle variations are less than $\pm 2\%$), 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 $\geq 3 \times$ RBW.
- Detector = power average (RMS).
- Ensure that the number of measurement points in the sweep to $\geq 2 \times$ (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 \geq 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

5.5.1.1 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 \leq 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:

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

where

E is the electric field strength in $\text{dB}\mu\text{V}/\text{m}$

$EIRP$ 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 this test report no summing was necessary, because the EUT has only one internal antenna.

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

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

whereby N is the number of antennas.

For the actual EUT the highest combination of antenna gain and used number of ports results in an additional value, added to the conducted spurious emission level, of 2.5 dB. Whereby the antenna has a gain of 2.5 dBi and the number of used ports is 1.

5.5.2 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 5.5.2.1 and the emission level according to procedure 5.5.2.2. The procedures are based on chapter 11.11.2 and 11.11.3 in [1].

For the 802.11n 20 MHz MIMO mode the level of the both ports were summed in linear value for each frequency step. The applicable plots show the result of that sum.

5.5.2.1 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 $\geq 3 \times$ 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.

5.5.2.2 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 $\geq 3 \times$ RBW.
- d) Detector = peak.
- e) Ensure that the number of measurement points \geq 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.

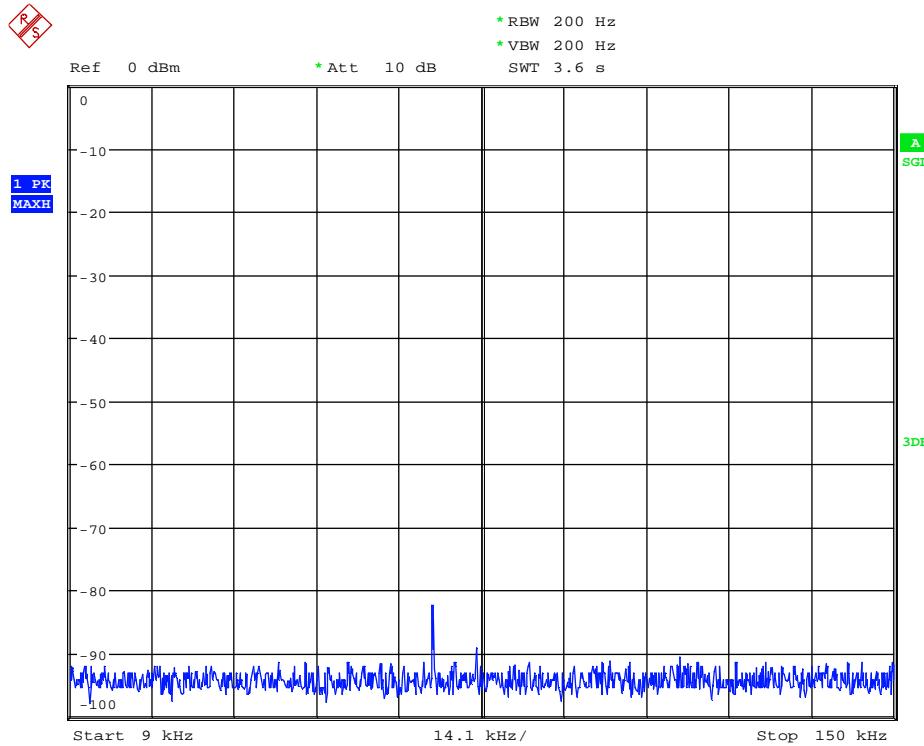
5.5.3 Test results (conducted emissions)

5.5.3.1 Emissions below 1 GHz

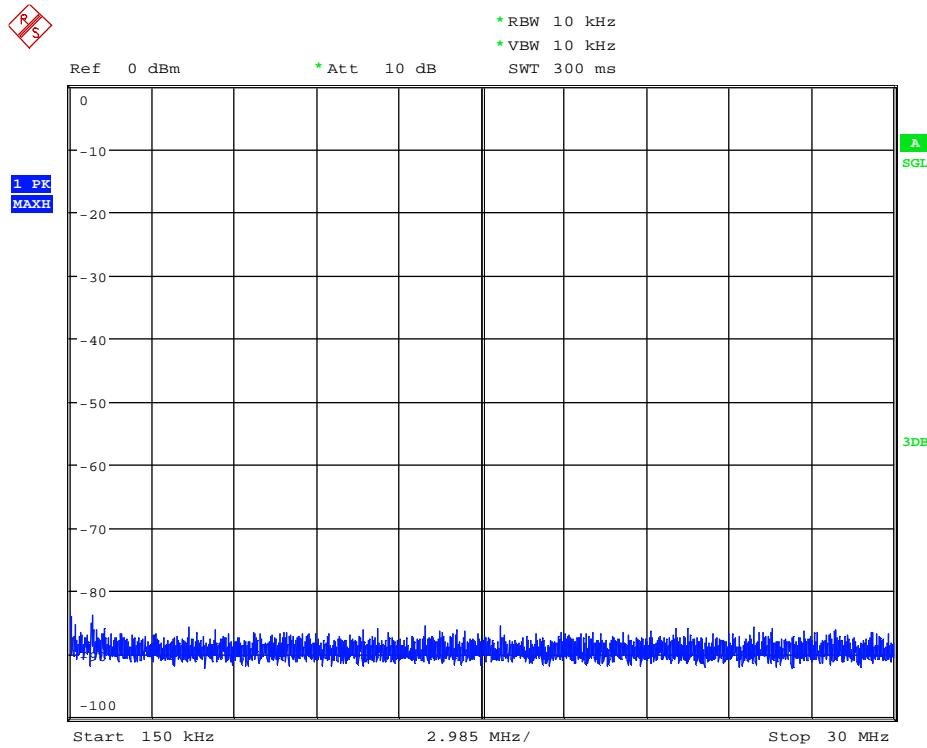
Ambient temperature	22 °C	Relative humidity	59 %
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The Emissions below 1 GHz were similar for all channels, modulations and data rates. Therefore only the results of an exemplary test case are submitted below.

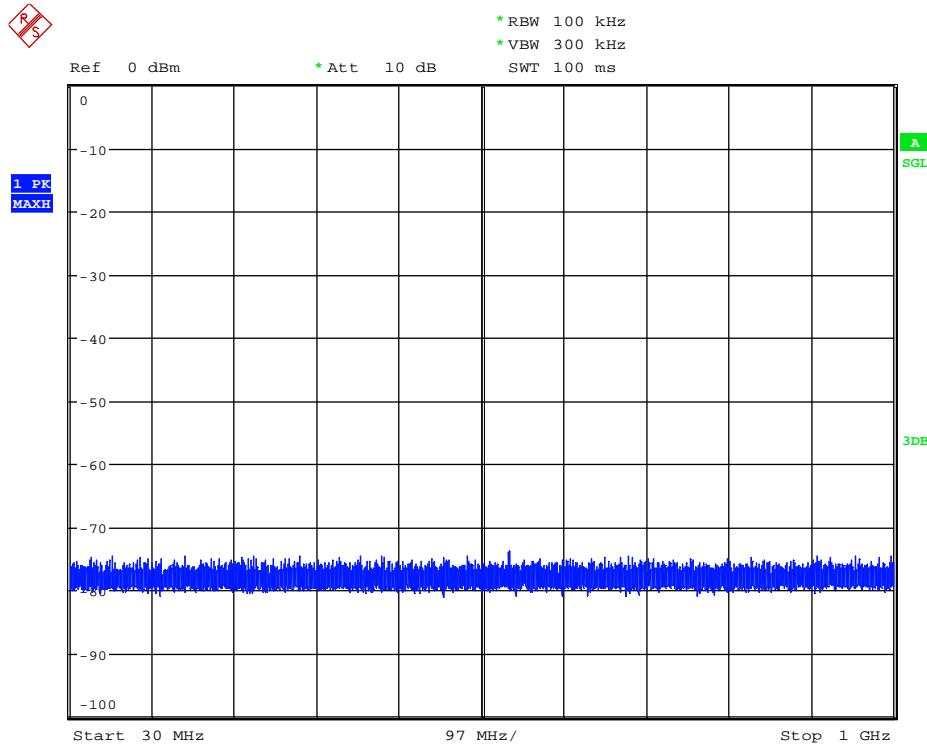
Erbe_SpurEmiss9-150k_b_1.wmf: conducted spurious emissions (operation mode 1):



Erbe_SpurEmiss150k-30M_b_1.wmf: conducted spurious emissions (operation mode 1):



Erbe_SpurEmiss0.03-1G_b_1.wmf: conducted spurious emissions (operation mode 1):



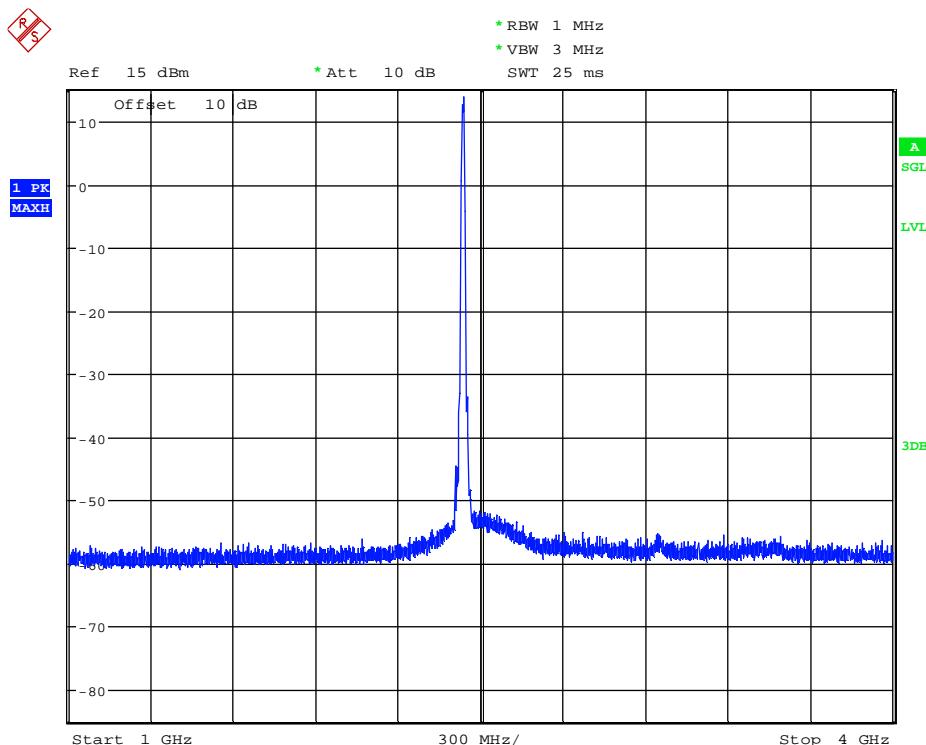
Spurious Emissions f < 1 GHz									
Peak Emission – Restricted Band									
WLAN Mode	Channel	Frequency [MHz]	Field Strength [dBuV/m]	Max Peak Limit [dBuV/m]	Margin [dB]	Reading [dBm]	Antenna Gain + Array Gain [dBi]	Result	Restricted Band?
b	1	0.071	-16.5	30.6	48.6	-81.8	3.0	Passed	Y

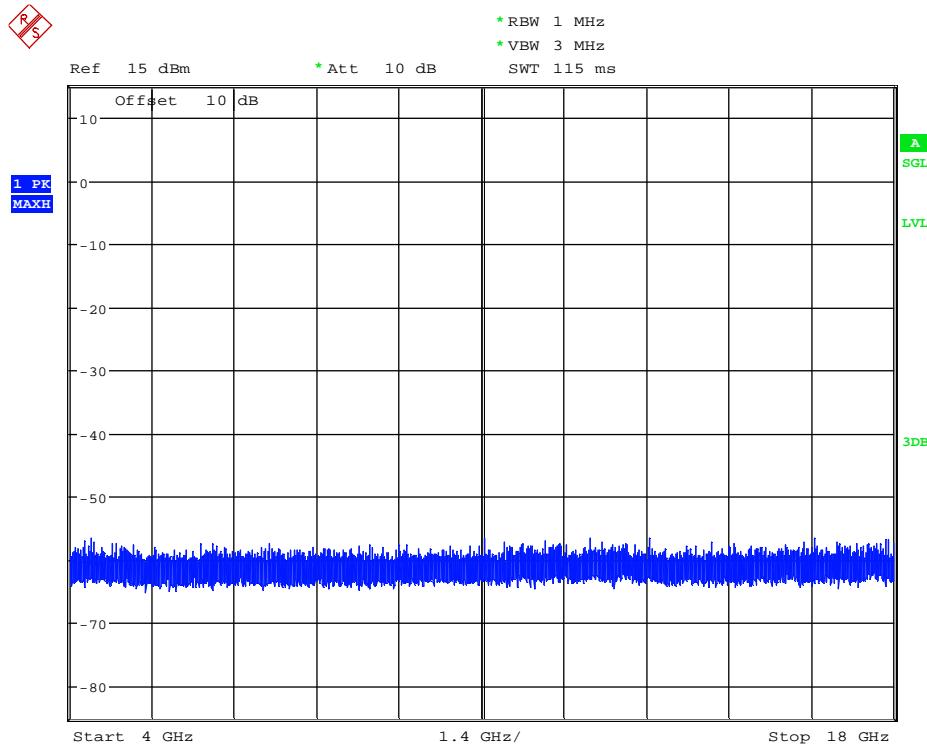
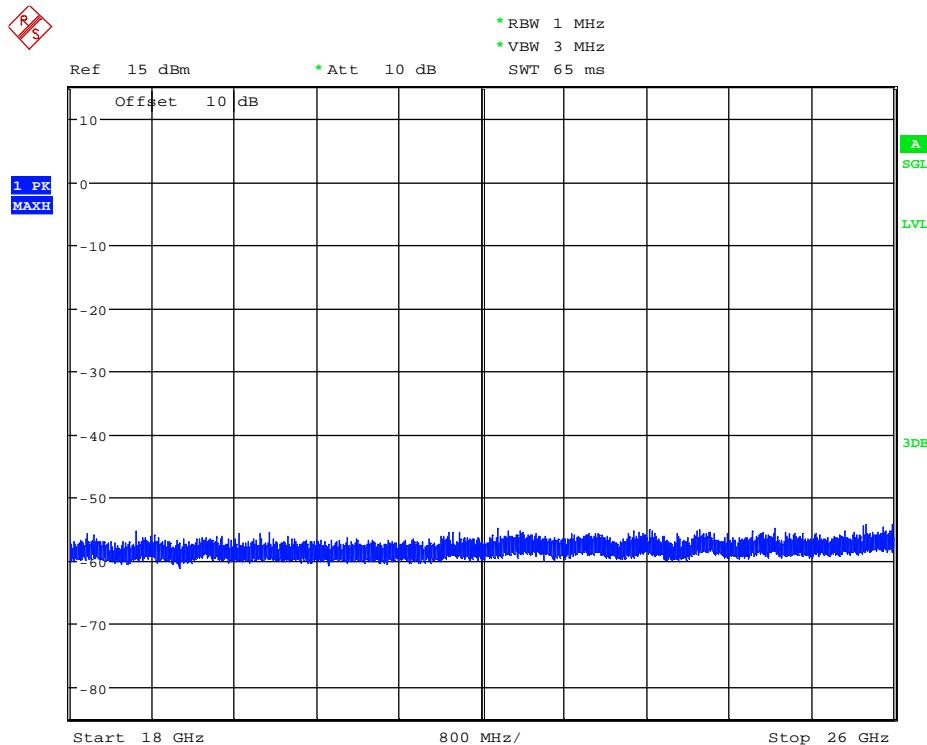
5.5.3.2 Emissions above 1 GHz

Ambient temperature	22 °C	Relative humidity	59 %
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The following results were measured at antenna port of the EUT. Since no spurious emissions were found during the preliminary measurements, and therefore no worst case mode exists, only the results in 802.11b mode on channel 6 are submitted below.

Erbe_SpurEmiss1-4G_b_6.wmf: conducted spurious emissions (operation mode 2):



Erbe_SpurEmiss4-18G_b_6.wmf: conducted spurious emissions (operation mode 2):

Erbe_SpurEmiss18-26G_b_6.wmf: conducted spurious emissions (operation mode 2):


No Spurious Emissions were found during the preliminary measurement, therefore no final results are submitted.

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
7, 28, 32

5.5.4 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 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test side without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 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.

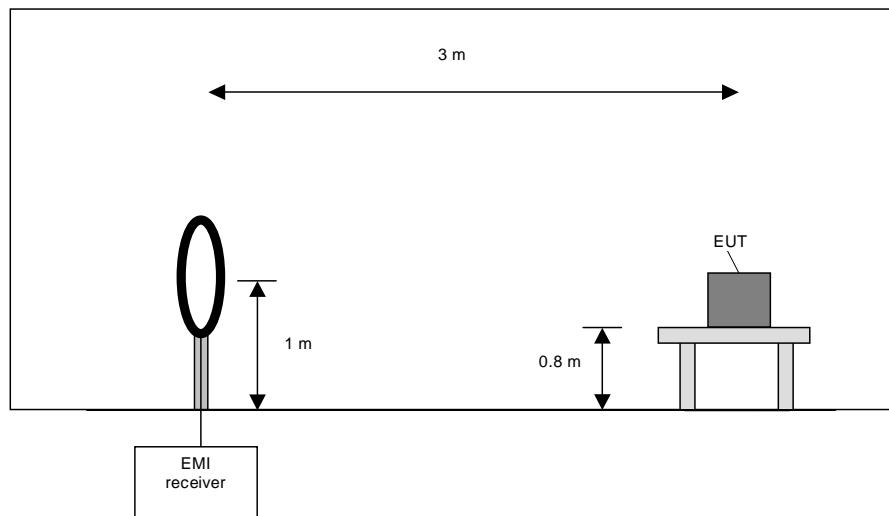
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. 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 [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation 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) Make a hardcopy of the spectrum.
- 5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
- 7) Rotate the measuring antenna and repeat steps 1) to 5).

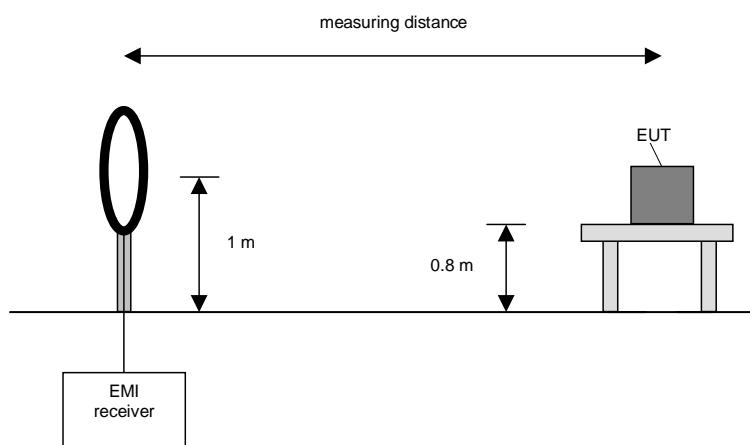
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the frequencies, which were detected during the preliminary measurements, the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

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

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Final measurement procedure:

The following procedure will be used:

- 1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
- 3) Rotate the measuring antenna to find the maximum and note the value.
- 4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
- 5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT (if the EUT is a module and might be used in a handheld equipment application).

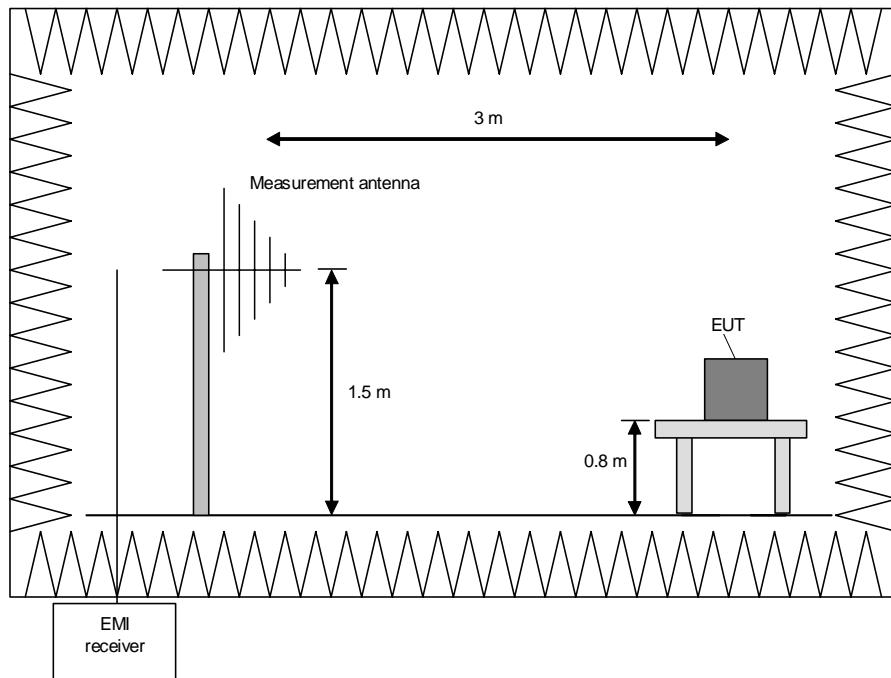
Preliminary measurement (30 MHz to 1 GHz)

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 table with the height of 0.8 m. 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 polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated in all 3 orthogonal axis of the EUT.

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:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.

The following procedure will be used:

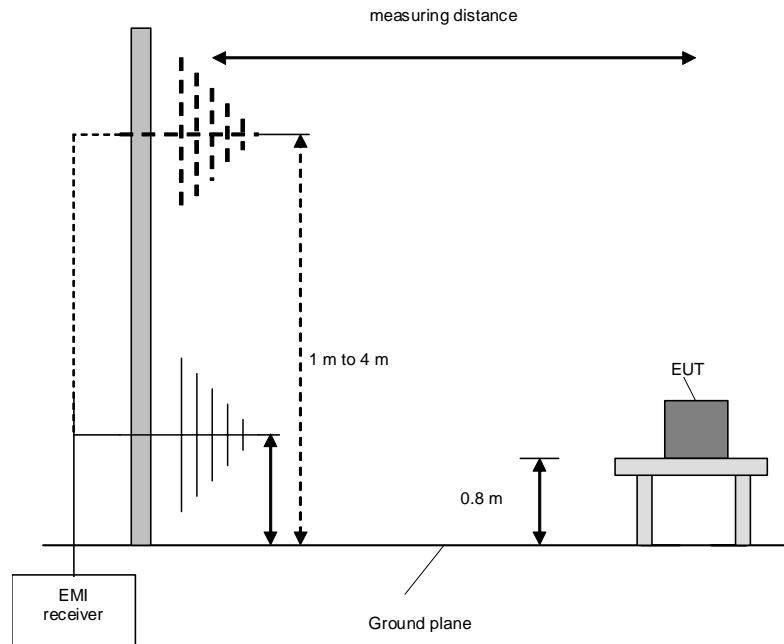
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarisation of the measuring antenna.
5. Make a hardcopy of the spectrum.
6. Repeat 1) to 5) with the EUT in the two other possible orthogonal positions compared to the position during the first run of the measurement.
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 polarisation 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 25 GHz)

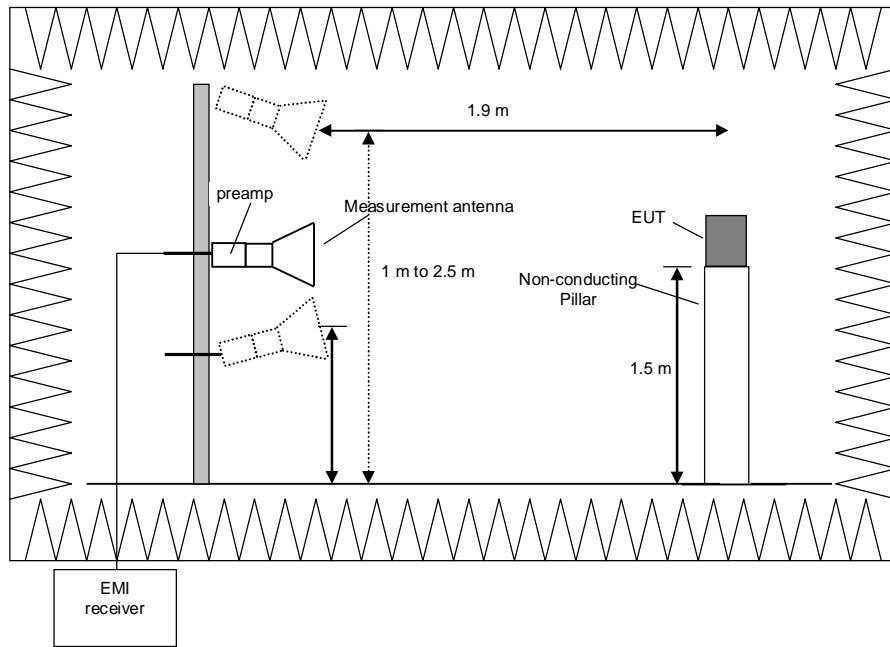
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 25 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 and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. The measurement is repeated after height scans of the measurement antenna as described in 6.6.3.1 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	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 25 GHz.

The following procedure will be used:

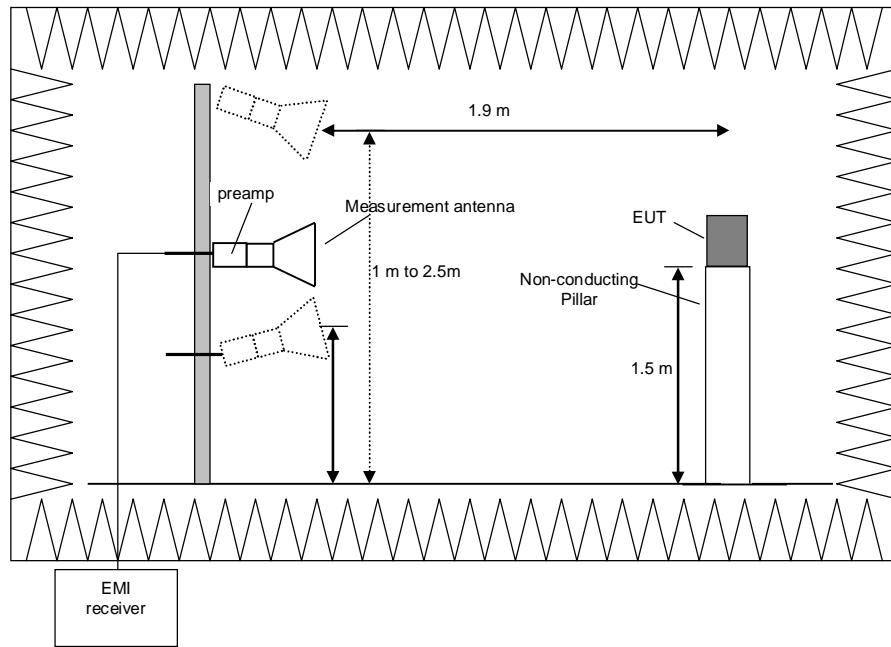
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by moving the measurement antenna from 1 – 2.5 m while aiming the EUT as shown in the image above to find the position with the highest emission.
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 polarisation, with the according EUT position (Turntable) and the antenna height 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 polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser 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.

5.5.5 Test results (radiated emissions) – emissions from the cabinet and the internal antenna (FXP73 Blue Diamond 2.4GHz)

5.5.5.1 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 or a non-conducting pole of a height of 1.5 m. The distance between EUT and antenna was 1.9 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 120 V via an laboratory power supply.

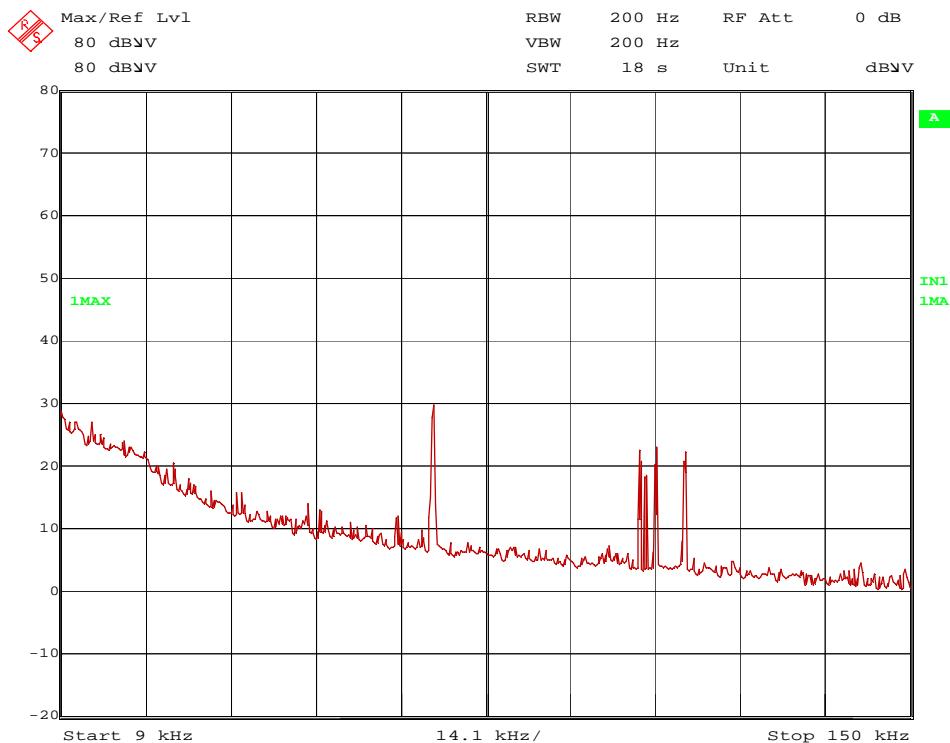
Remark: Document [1] states in 11.12.2.1, that in case of conducted measurements, additional radiated cabinet emission measurements must be performed.

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

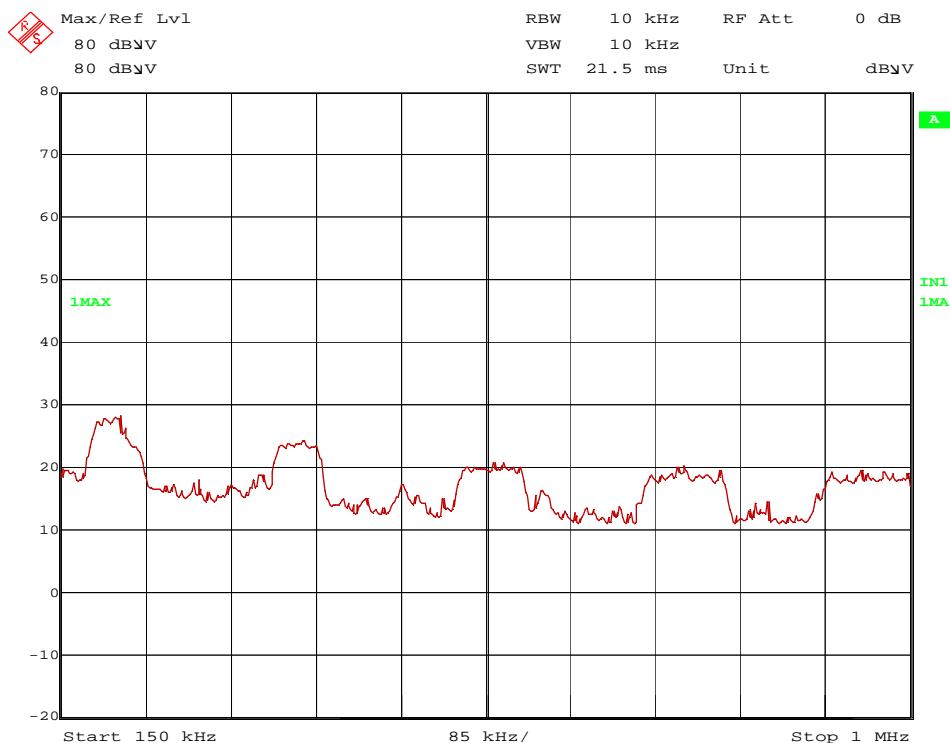
The emissions below 1 GHz were equal for all modulation, channels and data rates. Therefore only exemplary results with the EUT transmitting with 11 Mbit/s on channel 6 are submitted below.

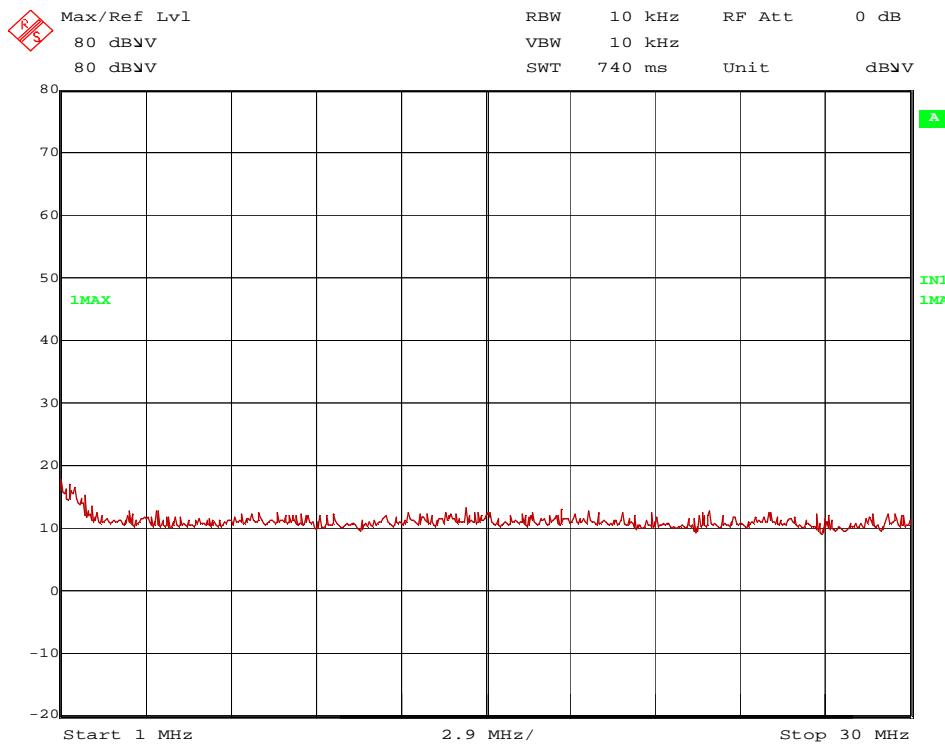
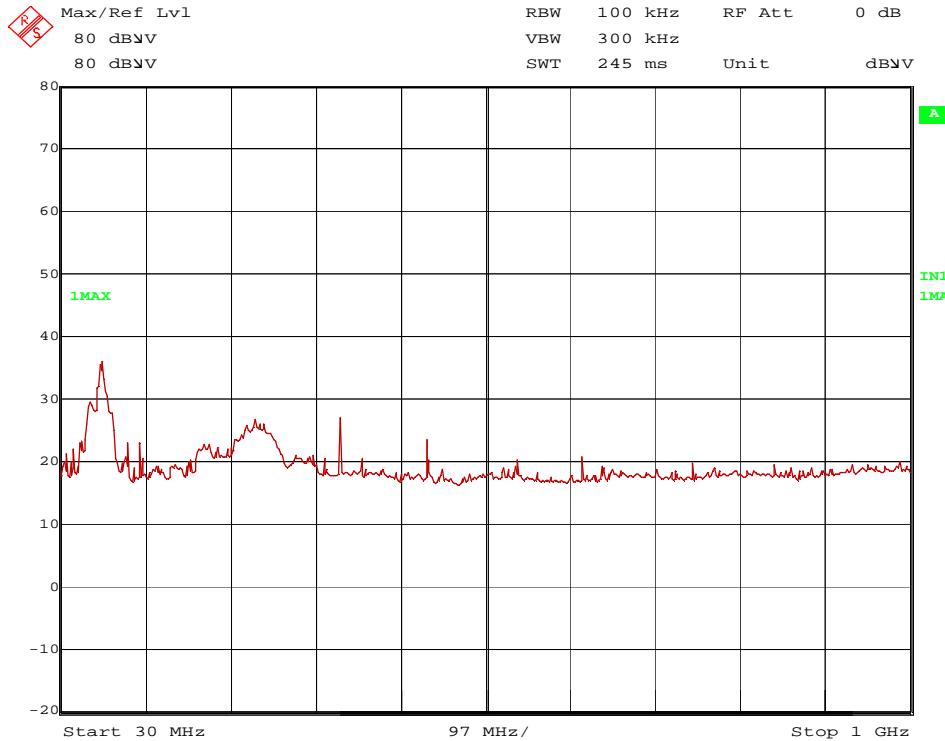
Transmitter operates at the middle of the assigned frequency band (operation mode 2)

ch6_11Mpbs_Pos1.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



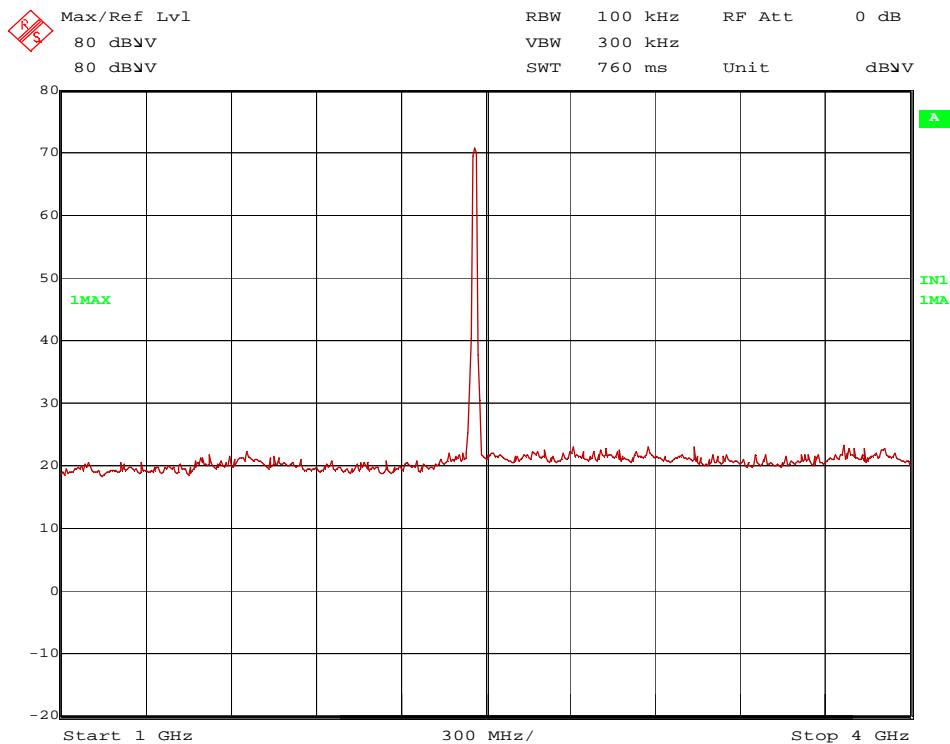
ch6_11Mpbs_Pos1_120VDC.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):



ch6_11Mpbs_Pos1_120VDC.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

SpurEm30M-1G_ch6_11M_18dBm_Pos1.wmf: Spurious emissions from 30 MHz to 1 GHz (operation mode 2):


Transmitter operates at the upper end of the assigned frequency band (operation mode 6)

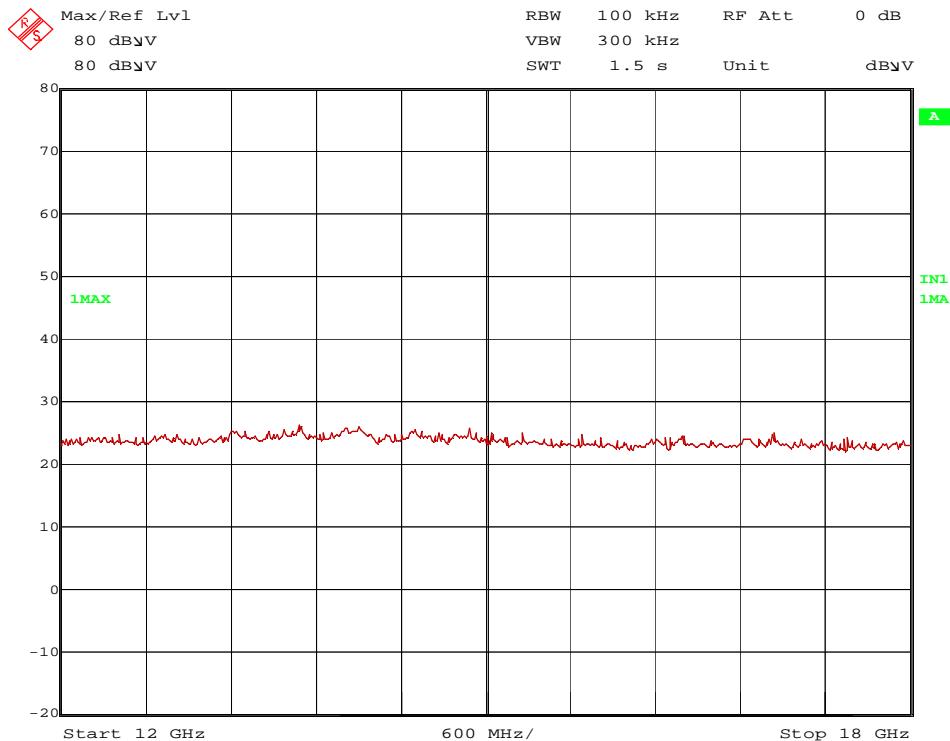
SpurEm1-4G_ch11_18M_18dBm_Ver_1m.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 6):



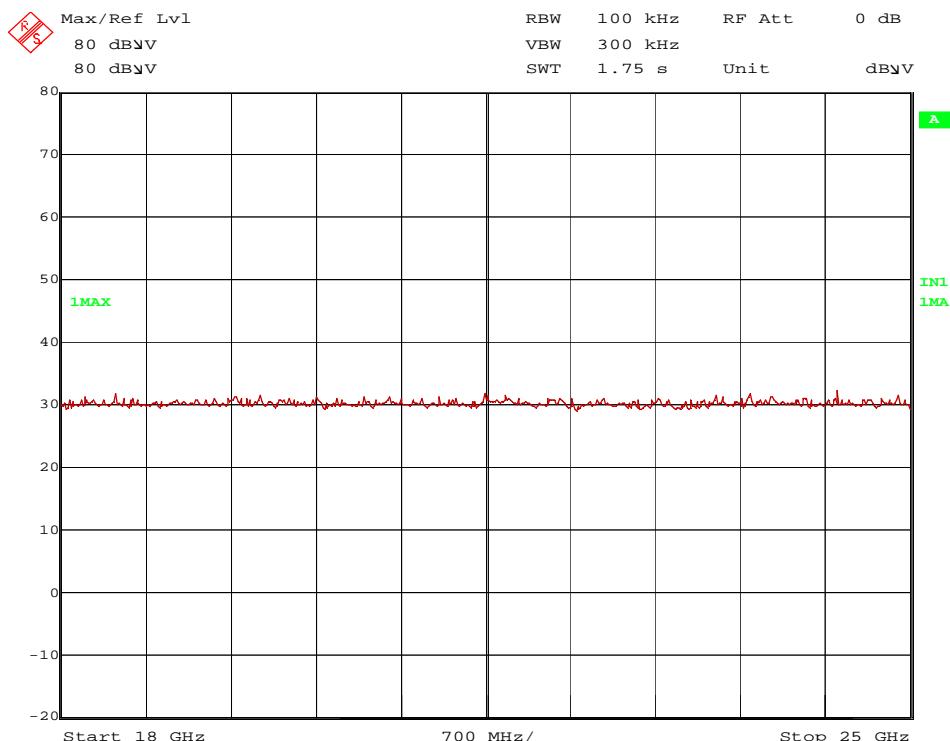
SpurEm4-12G_ch11_18M_18dBm_Ver_1,5m.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 6):



SpurEm12-18G ch11 18M 18dBm Ver 1.5m.wmf: Spurious emissions from 12 to 18 GHz (operation mode 6):



SpurEm18-25G ch11 18M 18dBm Ver 1.5m.wmf: Spurious emissions from 18 – 25 GHz (operation mode 6):



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

- 70 kHz, 253.541 MHz, 349.128 MHz,.

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

- 105 kHz, 108 kHz, 112 kHz, 204.5 kHz, 405.5 kHz, 563.9 kHz, 77.221 MHz and 106.743 MHz.

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

TEST EQUIPMENT USED FOR THE TEST:
6, 8 - 15, 17-20, 22 - 25, 28, 33

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

Ambient temperature	22 °C	Relative humidity	55 %
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Position of EUT: The EUT was set-up on an EUT turn table with a height of 1 m. The distance between EUT and antenna was 1.9 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.

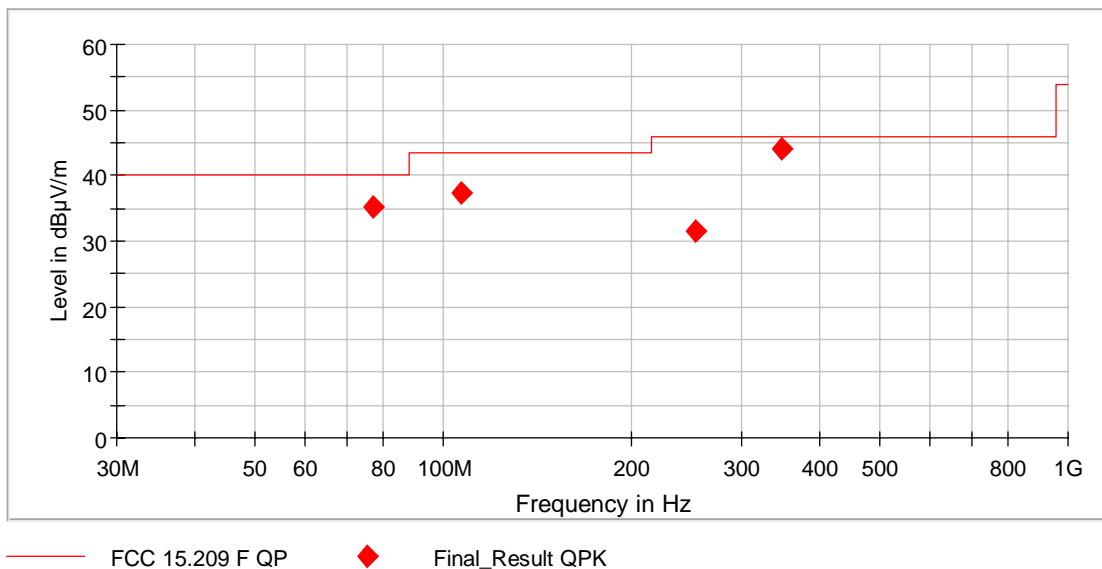
Supply voltage: During all measurements the host of the EUT was powered with 120 V AC via a laboratory power supply.

Resolution bandwidth: For measurements below 150 kHz a resolution bandwidth of 200 Hz was used. For measurements between 150 kHz and 30 MHz a resolution bandwidth of 10 kHz was used and for measurements between 30 MHz and 1 GHz a resolution bandwidth of 100 kHz was used.

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

Result measured with the QP detector:

Frequency MHz	Meas. Result 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.
0.07	49.7	130.7	81.0	29.5	20.0	0.0	0.2	150	Vert.
0.105	42.5	127.2	84.7	22.3	20.0	0.0	0.2	150	Vert.
0.108	43.4	126.9	83.5	23.2	20.0	0.0	0.2	150	Vert.
0.112	42.3	126.6	84.3	22.1	20.0	0.0	0.2	150	Vert.
0.2045	48.5	121.4	72.9	28.2	20.0	0.0	0.3	150	Vert.
0.4055	44.8	115.4	70.6	24.5	20.0	0.0	0.3	150	Vert.
0.56	41.2	92.6	51.4	20.9	20.0	0.0	0.3	150	Vert.
Measurement uncertainty				+2.2 dB / -3.6 dB					



The results of the standard subsequent measurement on the open area test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Final_Result

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
77.221000	35.23	40.00	4.77	1000.0	120.000	228.0	H	102.0	15.5
106.743000	37.42	43.50	6.08	1000.0	120.000	396.0	H	46.0	19.6
253.514000	31.57	46.00	14.43	1000.0	120.000	169.0	V	208.0	21.5
349.128000	44.13	46.00	1.87	1000.0	120.000	139.0	V	180.0	24.0

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

No spurious emissions were found besides the emissions on the band edges. These emissions are documented in 5.4.6.

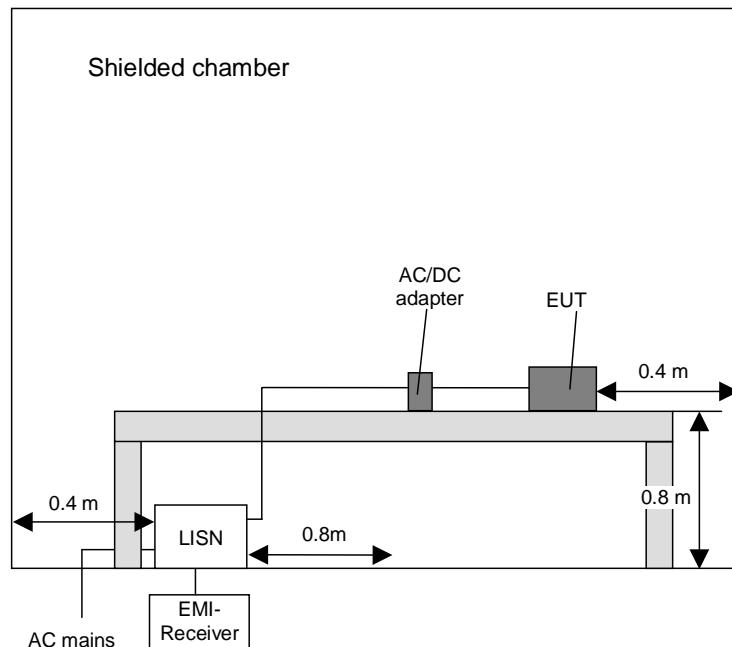
5.6 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.7 Method of measurement

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

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

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.7.1 Test results (conducted emissions on power supply lines)

Ambient temperature	20 °C	Relative humidity	52 %
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Position of EUT: The EUT was set to continuous transmit data in 802.11b mode with 11 MBPS on channel 6 in test mode.

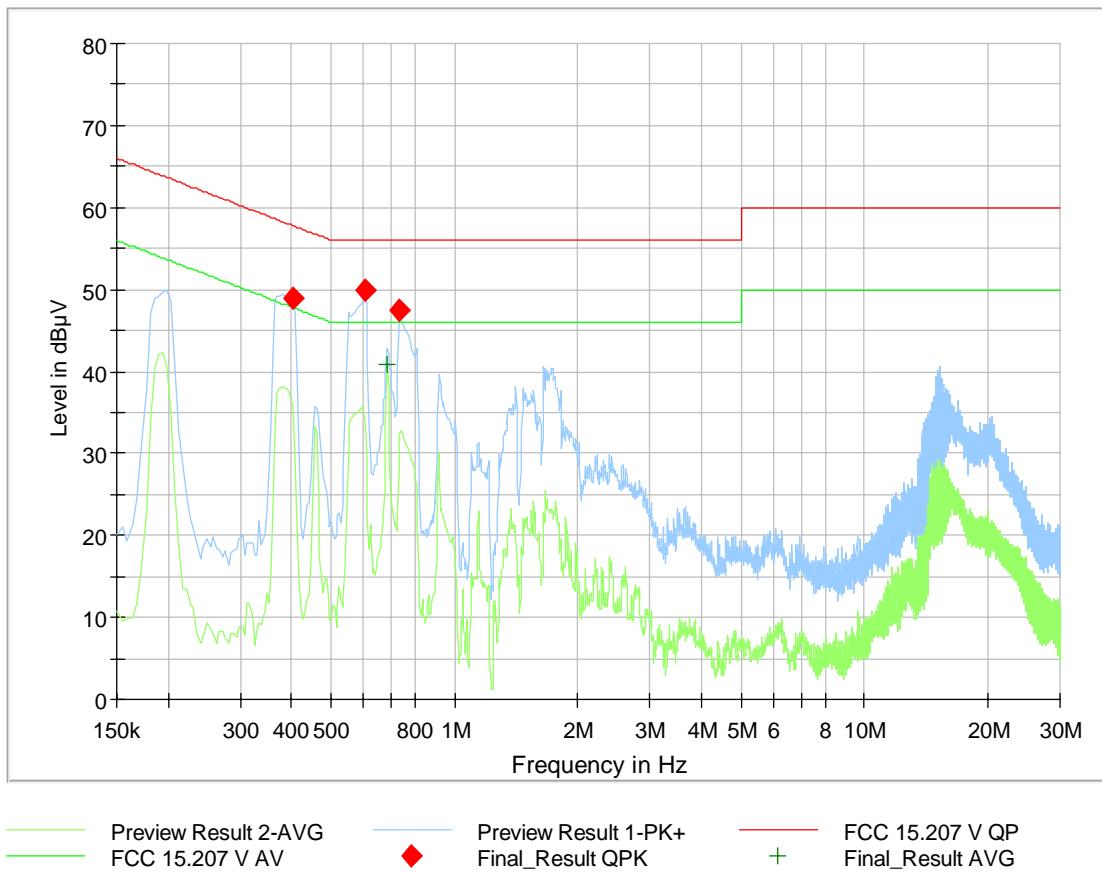
The EUT was set-up on a non-conducting table of a height of 0.8 m.

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

Test record: All results are shown in the following.

Supply voltage: Measurement performed with US 120V/60Hz.

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 "+".



Data record name: 151710 FCC ACMains

Final_Result

Frequency (MHz)	QuasiPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.402900	48.90	---	57.79	8.89	5000.0	9.000	N	FLO	9.9
0.604500	49.83	---	56.00	6.17	5000.0	9.000	N	FLO	9.9
0.686400	---	40.78	46.00	5.22	5000.0	9.000	L1	GND	9.9
0.735000	47.58	---	56.00	8.42	5000.0	9.000	L1	GND	9.9

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

1 – 5

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
3	LISN	NSLK8128	Schwarzbeck	8128155	480058	02/16/2016	02/2018
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
5	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
6	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
7	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	02/17/2016	02/2018
8	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/16/2016	02/2018
9	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
10	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
11	Antenna support	AS615P	Deisel	615/310	480187	-	-
12	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
13	Antenna	3115 A	EMCO	9609-4918	480183	10/11/2014	11/2017
14	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
15	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
16	Standard Gain Horn Antenne 26.4 – 40.1 GHz	22240-20	Flann Microwave	469	480229	Six month verification (system cal.)	
17	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
18	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
19	RF-cable No. 36	Sucoflex 106B	Huber&Suhner	500003/6B / Kabel 36-	481680	Weekly verification (system cal.)	
20	RF-cable 1 m	KPS-1533-400-KPS	Insulated Wire	-	480300	Six month verification (system cal.)	
21	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire		480302	Six month verification (system cal.)	
22	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
23	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	Six month verification (system cal.)	
24	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	Six month verification (system cal.)	
25	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/2016	02/2018
26	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	02/2016	02/2018
27	Peak Power Sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	02/2016	02/2018
28	4 GHz High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	

29	Single Control Unit	SCU	Maturo GmbH	SCU/006/971107	480831	Calibration not necessary	
30	High-pass Filter	H26G40G1	Microwave Circuits, Inc.	33471	480593	Six month verification (system cal.)	
31	Temperature Test Chamber	MK 240	Binder	05-79022	480462	08/2015	02/2017
32	Low Pass Filter	WLJ1.0G-5EE-300W	Wainwright Instruments GmbH	6	481298	Yearly verification (system cal.)	
33	Turn Device	TDF 1.5-10Kg	Maturo	-	482034	-	

7 Report History

Report Number	Date	Comment
F151710E2	20.04.2016	Initial Test Report

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 151710_03.jpg: Test setup - Radiated emission < 1 GHz (outdoor test site)
 151710_04.jpg: Test setup - Radiated emission < 1 GHz (fully anechoic chamber)
 151710_05.jpg: Test setup - Radiated emission < 1 GHz (open area test site)
 151710_06.jpg: Test setup - Radiated emission >1 GHz (fully anechoic chamber)
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