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Test Report

Report Number: F143563E1

Applicant:

OTT Hydromet GmbH

Manufacturer:

OTT Hydromet GmbH

Equipment under Test (EUT):

RLS

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

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

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 (July 2014)** Radio Frequency Devices

[3] **KDB publication 890966 D01** Measurement procedure for Level Probing Radars v01 (April 2014)

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 3) were fulfilled by the equipment under test.
The complete test results are presented in the following.

	Name	Signature	Date
Test engineer:	Thomas KÜHN		24 July 2014
Authorized reviewer:	Michael DINTER		24 July 2014

RESERVATION

This test report is only valid in its original form.

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

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1 Identification

1.1 Applicant

Name:	OTT Hydromet GmbH
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Country:	Germany
Name for contact purposes:	Mr. Martin KENNERKNECHT
Phone:	+49 831 56 17 - 310
Fax:	+49 831 56 17 - 309
eMail Address:	m.kennerknecht@ott.com
Applicant represented during the test by the following person:	Mr. Martin KENNERKNECHT

1.2 Manufacturer

Name:	OTT Hydromet GmbH
Address:	Ludwigstraße 16 87437 Kempten
Country:	Germany
Name for contact purposes:	Mr. Martin KENNERKNECHT
Phone:	+49 831 56 17 - 310
Fax:	+49 831 56 17 - 309
eMail Address:	m.kennerknecht@ott.com
Manufacturer represented during the test by the following person:	Mr. Martin KENNERKNECHT

1.3 Test laboratory

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

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

2 EUT (Equipment Under Test)

Test object: *	Radar level sensor
Model name: *	RLS
FCC ID: *	OA6RLS252
PCB identifier: *	63.107.100.3.2 B
Serial number: *	None (engineering sample)
Hardware version: *	B0
Software version: *	None
Lowest / highest internal frequency: *	3.57 MHz / transmit frequency

2.1 Technical data of equipment

Antenna type: *	Internal patch antenna (for details refer antenna specification)					
Antenna connector: *	None (not possible)					
Modulation: *	None					
Operation frequency: *	25.7 GHz					
Number of channels: *	Not applicable (one channel operation)					
Supply Voltage: *	U_{nom}=	12.0 V DC	U_{min}=	9.6 V DC	U_{max}=	28.0 V DC
Temperature range: *	-40 °C to +85 °C					
Ancillary used for test:	-					

* declared by the applicant.

The following external I/O cables were used:

An unshielded 4-pole connection cable with power supply and data in and out lines was connected to the EUT's connector. All wires were connected to the EUT (used and unused). A laptop computer could be used to read out the data from the data logger, it was not connected during the tests.

2.2 Dates

Date of receipt of test sample:	10 July 2014
Start of test:	10 July 2014
End of test:	14 July 2014

2.3 Operational states

All tests were carried out with an unmodified sample.

During all tests the EUT was supplied with a DC supply voltage, which was provided by an external power supply or an AC / DC adaptor type enercell (used only for the conducted emissions on AC-mains). For the conducted emission measurement on AC-mains the AC / DC adaptor was supplied with 120 V AC / 60 Hz.

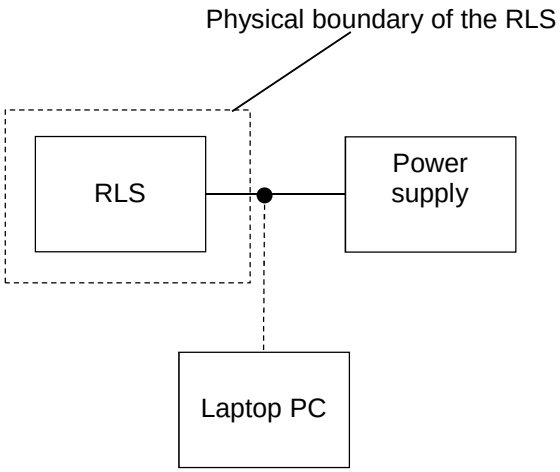
If a variation of the supply voltage was necessary, it was done in the range 9.6 V DC to 28 V DC. This range was declared by the applicant as extreme supply voltage range.

A variation of the environmental temperature was done in a wider range (85° C to -40 °C) as it is requested in the measurement procedure [3] because the applicant declares this range as the operational temperature range.

All emission tests were carried out in two positions of the EUT: Position 1 is the normal installation position (antenna shows downwards), for position 2 measurement the antenna shows sidewards (antenna boresight). For details of the positions refer also the photographs in annex A of this test report. The plots in the following showing the maximum results of both measurements. The measurements of the fundamental emission were carried out in position 2 in order to measure the maximum emission.

The tested sample was not labeled.

The physical boundaries of the Equipment Under Test are shown below.



3 Overview

Application	Frequency range	FCC 47 CFR Part 15 section [2]	Status	Refer page
Fundamental emission bandwidth	24.05 to 29.00 GHz	15.256 (f) (1)	Passed	8 et seq.
Fundamental emission	24.05 to 29.00 GHz	15.256 (g)	Passed	10 et seq.
Unwanted emissions	1 MHz to 100 GHz	15.256 (h) + (k), 15.209	Passed	13 et seq.
Frequency stability	24.05 to 29.00 GHz	15.256 (f) (2)	Passed	29 et seq.
Conducted emissions on power supply line	150 kHz to 30 MHz	15.207	Passed	31 et seq.
Antenna requirement	-	15.256 (b)	Passed	Integrated, refer photographs in annex B of this test report
Antenna beamwidth	Wanted frequency range	15.256 (i)	Passed	Refer antenna data sheet provided by the applicant
Antenna side lobe gain	Wanted frequency range	15.256 (j)	Passed	Refer antenna data sheet provided by the applicant

4 Test results

4.1 10 dB bandwidth

4.1.1 Method of measurement (10 dB bandwidth)

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. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed or a suitable antenna has to be used to couple the EUTs signal to the spectrum analyser. The EUT has to be switched on.

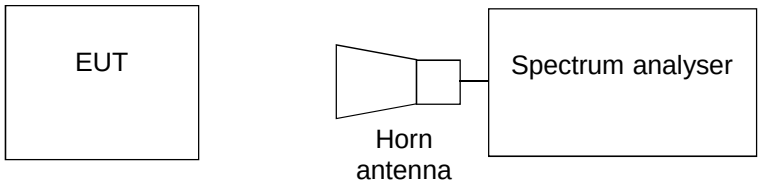
The following spectrum analyser settings shall be used:

- Span: Wide enough to capture emission bandwidth.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: 3 MHz.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The display line has to be set 10 dB below the peak marker. The second and third marker shall be set on the intersection points between the display line and the measured curve.

The measurement will be performed at the upper, the lower end and the middle of the assigned frequency band (if applicable).

Test set-up:

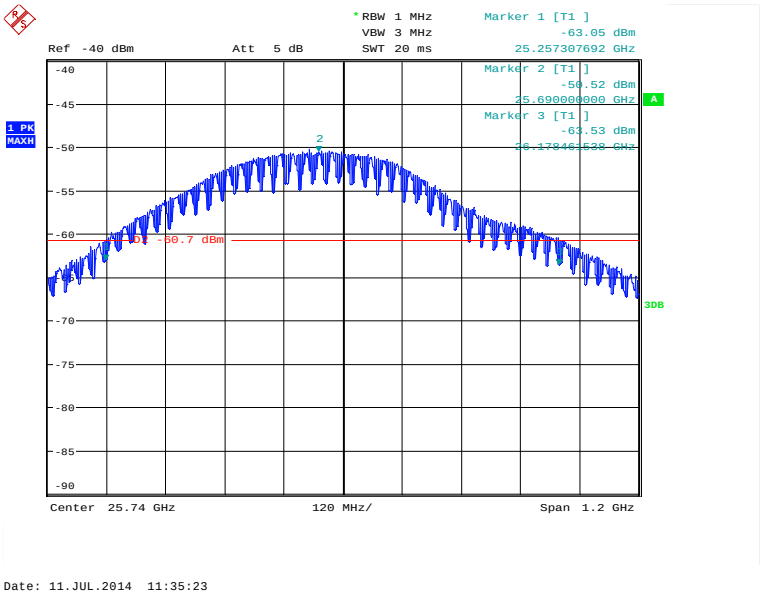


4.1.2 Test results (10 dB bandwidth)

Ambient temperature	22 °C

Relative humidity	68 %

142568_021.wmf: 10 dB bandwidth:



Lower 10 dB frequency	Upper 10 dB frequency	10 dB bandwidth	Limit
25.257308 GHz	26.178462 GHz	921.154 MHz	50 MHz (required minimum), furthermore the 10 dB bandwidth has to stay within the assigned frequency band (24.05 to 29.00 GHz)
Measurement uncertainty		+0.66 dB / -0.72 dB	

Test result Passed

Test equipment used (refer clause 5):

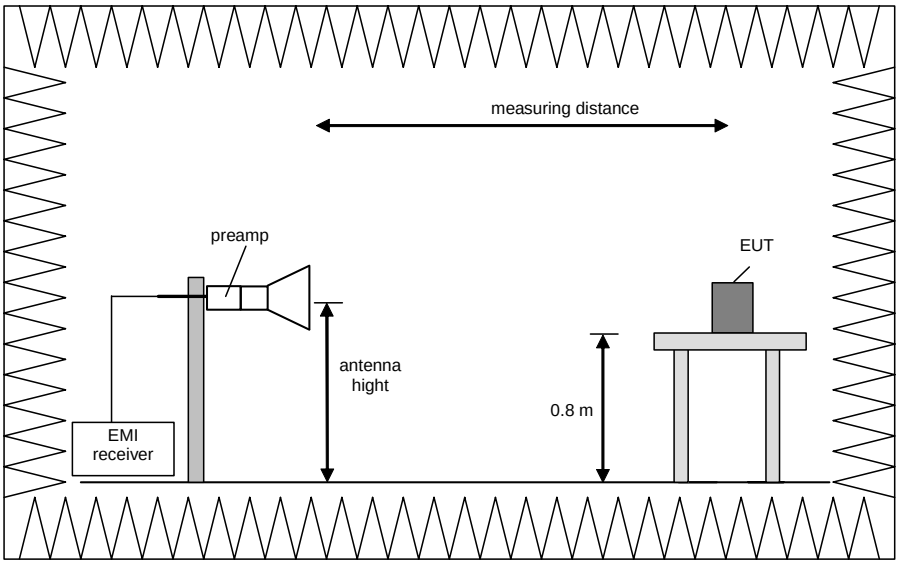
6, 8, 39, 60

4.2 Fundamental emission

4.2.1 Method of measurement (fundamental emission)

1) Locate the receive test antenna at a far field distance boresighted on the LPR transmit antenna. Adjust the LPR and the test antenna for maximum main beam coupling.
2) Set the spectrum analyzer for power averaging (RMS) detector and 1 MHz RBW.
3) Record the maximum level and frequency of the signal within the fundamental emission bandwidth, which must be contained entirely within the authorized frequency band.
4) Centered on the frequency of the maximum signal recorded in step 3, select peak detector, 50 MHz RBW and at least 50 MHz VBW.
    a. If 50 MHz RBW is not available on the spectrum analyzer, determine the maximum of the spectrum trace in a narrower RBW which is greater than or less than the PRF by a factor of 3, but not less than 1 MHz, and calculate the maximum signal level in 50 MHz by adding the appropriate correction factor shown below to the maximum measured signal level.
        i. For pulsed LPRs
        20 Log (50/RBW) dB, if PRF < RBW/3
        20 Log (50/PRF) dB, if PRF > 3*RBW
        ii. For FMCW, step or hopping LPRs
        20 Log (50/RBW) dB
    b. It may be necessary to offset the measurement frequency in order to ensure that the measurement is made within the fundamental emission bandwidth because the 3 dB bandwidth of the RBW is not entirely within the fundamental emission bandwidth. The measurement shall be made at the nearest frequency to the frequency identified in step 4 when the 3 dB point of the RBW closest to the fundamental emission band edge is at the frequency of the band edge.
    c. If the measurement must be performed with a RBW greater than 3 MHz because the PRF is between 1 MHz and 3 MHz or for any other reason, the test report must contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation used.
5) Determine the conducted power output of the EUT or the field strength produced by the EUT at a given distance from the measurements in steps 1 to 4 by calculation taking into account all attenuators, amplifier gains, antenna factor, measurement distance extrapolation, conversion loss, cable losses, etc. as applicable or the signal substitution method.
6) The EIRP is then calculated by applying the appropriate equation as follows:
EIRP (dBm) = E (dBµV/m) – 104.8 + 20 Log D
where E is the field strength at the far field distance D.

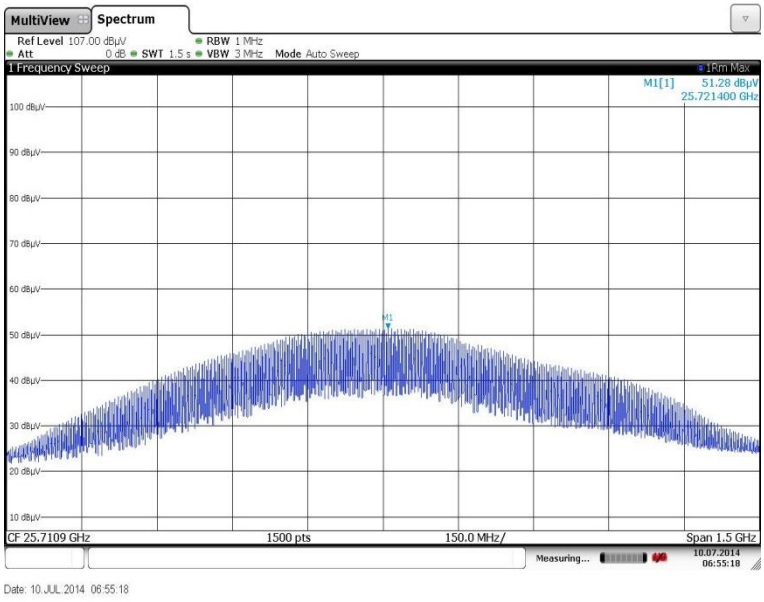
Test set-up:



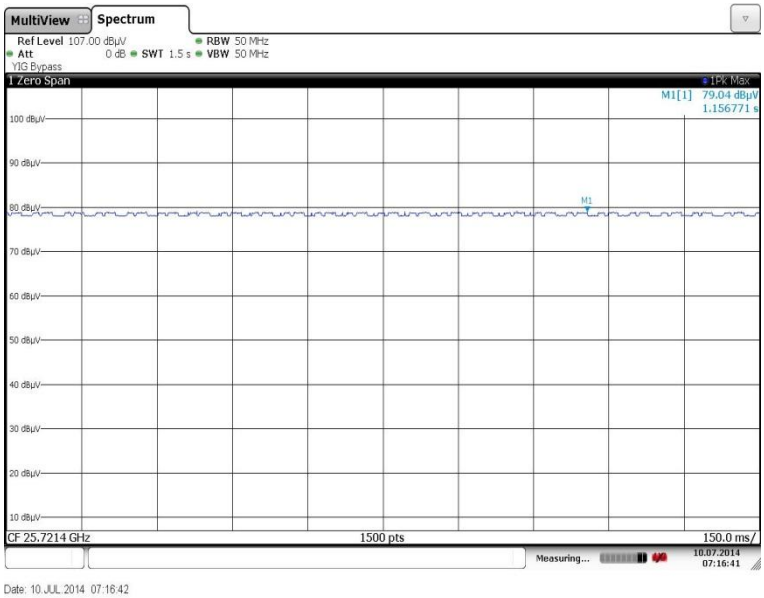
4.2.2 Test results (fundamental emission)

Ambient temperature	21 °C		Relative humidity	65 %

143563:001.jpg: Fundamental emission (average):



143563:002.jpg: Fundamental emission(peak):



Fundamental emission (average):

Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Measured field strength dBµV/m	Height cm	Pol.	Measuring distance m	Level fundamental (EIRP) dBm	Limit dBm	Margin dB
51.3	37.1	-	4.8	93.2	100	Hor.	0.5	-17.6	-14.0	3.6
Measurement uncertainty							+2.2 dB / -3.6 dB			

Fundamental emission (peak):

Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Measured field strength dBµV/m	Height cm	Pol.	Measuring distance m	Level fundamental (EIRP) dBm	Limit dBm	Margin dB
79.0	37.1	-	5.0	121.1	100	Hor.	0.5	10.3	26.0	15.7
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test result: Passed

Test equipment used (refer clause 5):

7, 8, 29, 39, 60

4.3 Radiated emissions

4.3.1 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 9 kHz to 110 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 heights in the frequency range 30 MHz to 1 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.

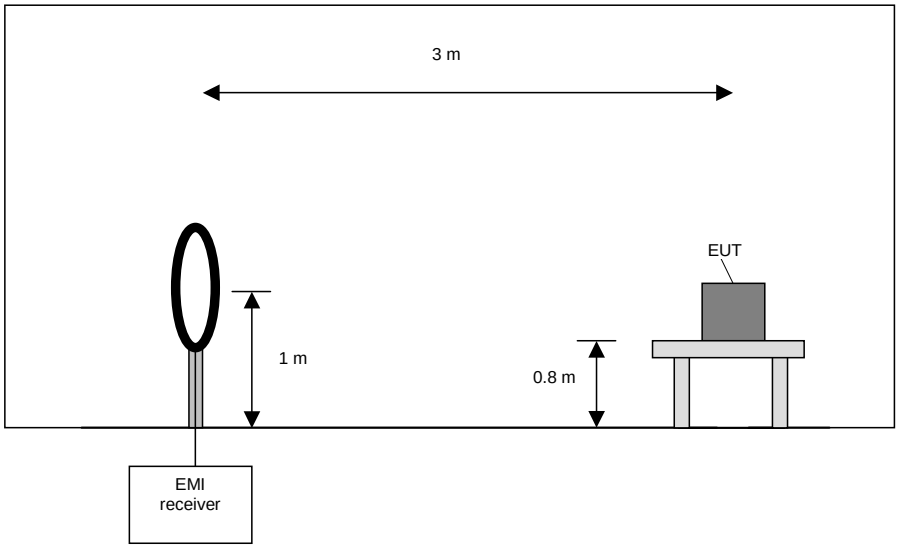
Preliminary measurement (9 kHz to 30 MHz):

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 ANSI C63.4-2009 [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, 150 kHz to 1 MHz and 1 MHz 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).

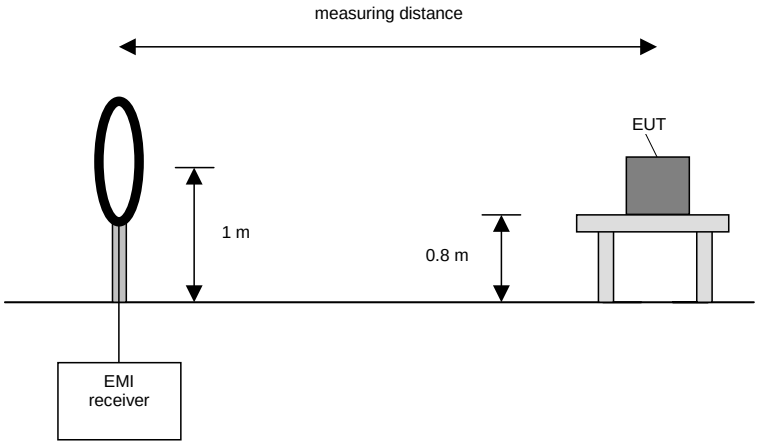
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane with 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 during the preliminary measurement detected frequencies 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	10 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 (because of EUT is a module and might be used in a handheld equipment application).

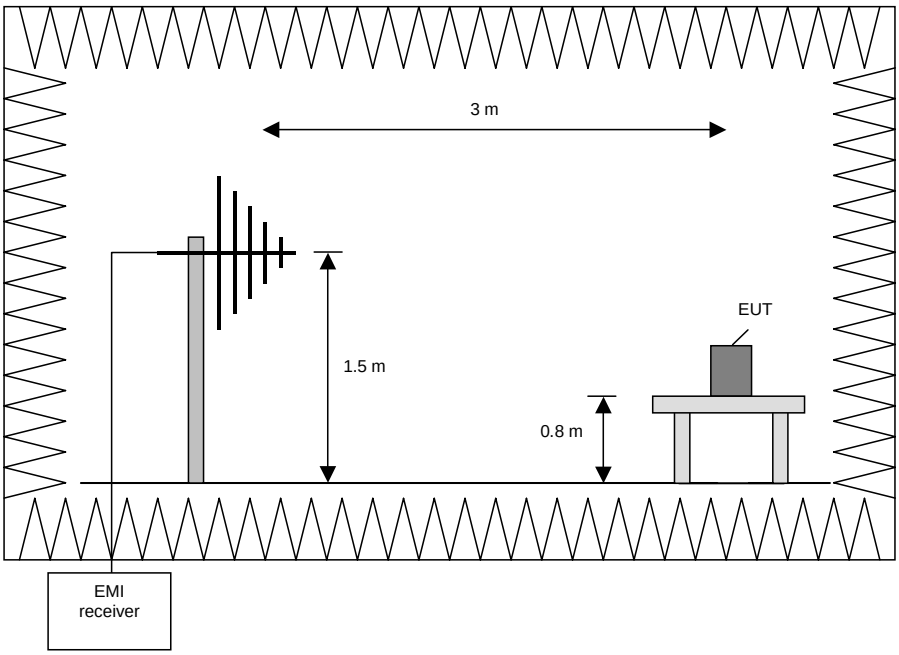
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

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 °.

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 200 MHz and 200 MHz to 1 GHz.
The following procedure will be used:

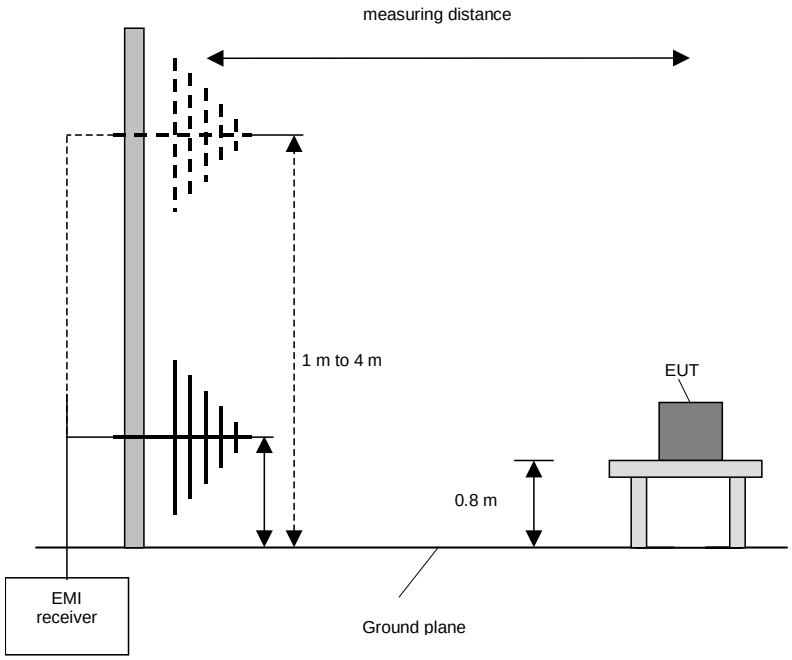
1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2) Manipulate the system cables within the range to produce the maximum level of emission.
3) Rotate the EUT by 360 ° to maximize the detected signals.
4) Make a hardcopy of the spectrum.
5) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6) Repeat 1) to 4) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
7) Repeat 1) to 5) with the vertical polarisation of the measuring antenna.

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:

7) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
8) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
9) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
10) Repeat 1) to 3) for the other orthogonal antenna polarization.
11) Move the antenna and the turntable to the position where the maximum value is detected.
12) Measure while moving the antenna slowly +/- 1 m.
13) Set the antenna to the position where the maximum value is found.
14) Measure while moving the turntable +/- 45 °.
15) Set the turntable to the azimuth where the maximum value is found.
16) Measure with Final detector (QP and AV) and note the value.
17) Repeat 5) to 10) for each frequency.
18) 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 110 GHz)

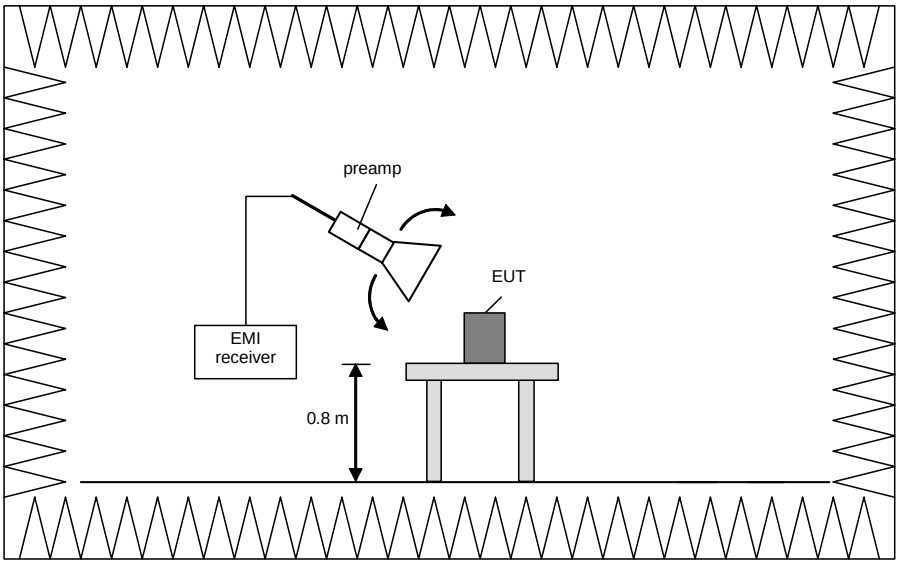
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance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

Preliminary measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 1 MHz. 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	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

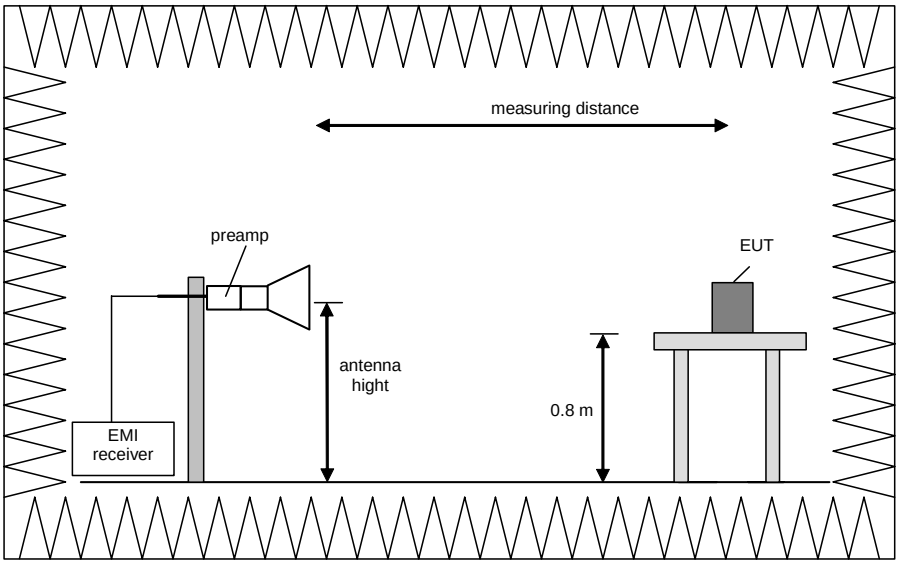


Final measurement (1 GHz to 110 GHz)

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.

4.3.2 Test results (radiated emissions)

4.3.2.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	65 %

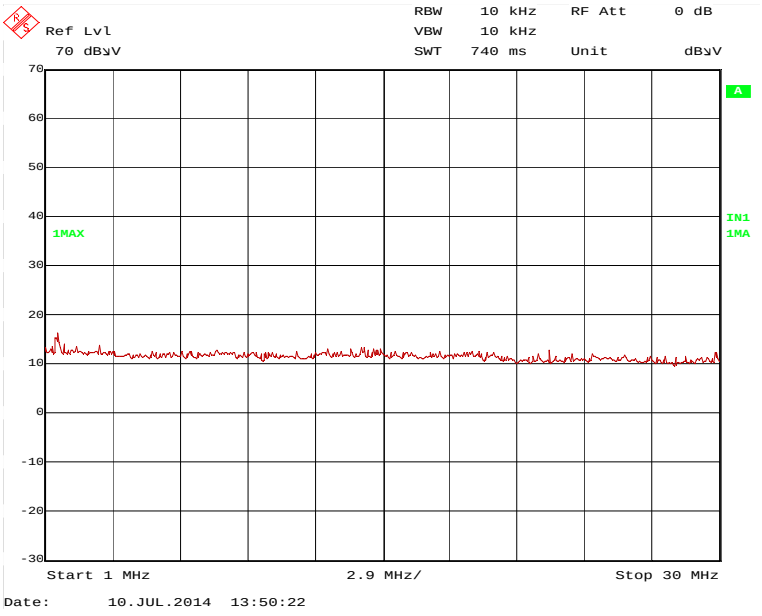
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 12 V DC by an external power supply.

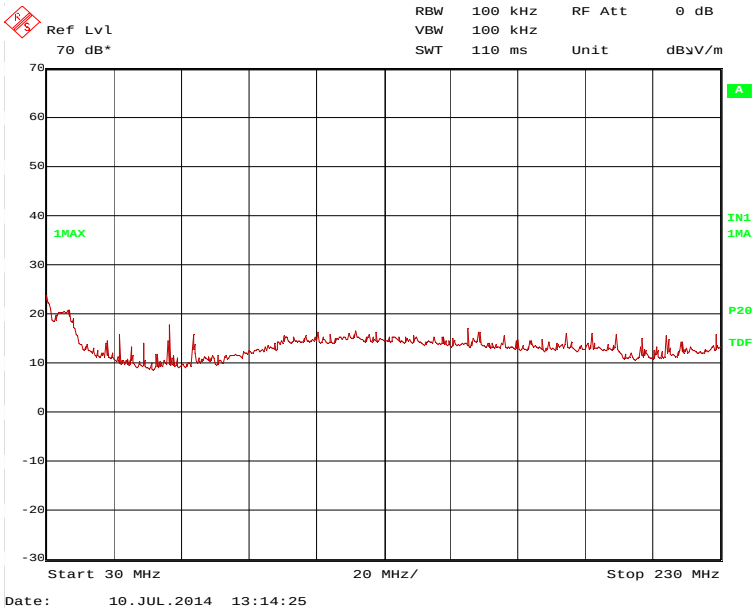
Remark: All emission tests were carried out in two positions of the EUT: Position 1 is the normal installation position (antenna shows downwards), for position 2 measurement the antenna shows sideward (anboresight view). For details of the positions refer also the photographs in annex A of this test report. The plots in the following showing the maximum results from both measurements.

143563_013.wmf: Spurious emissions from 1 MHz to 30 MHz:

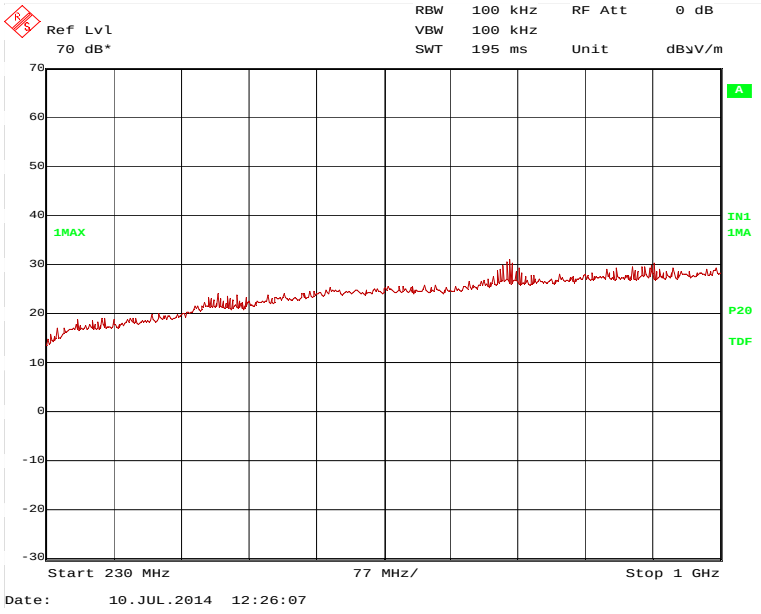


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

143563_012.wmf: Spurious emissions from 30 MHz to 230 MHz:



143563_11.wmf: Spurious emissions from 230 MHz to 1 GHz:



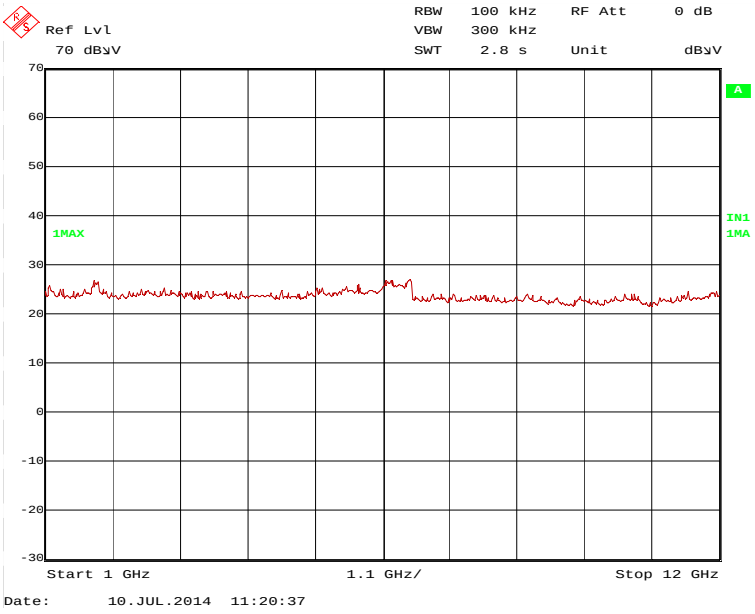
The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 35.300 MHz, 66.350 MHz, 154.822 MHz, 199.055 MHz and 742.406 MHz.

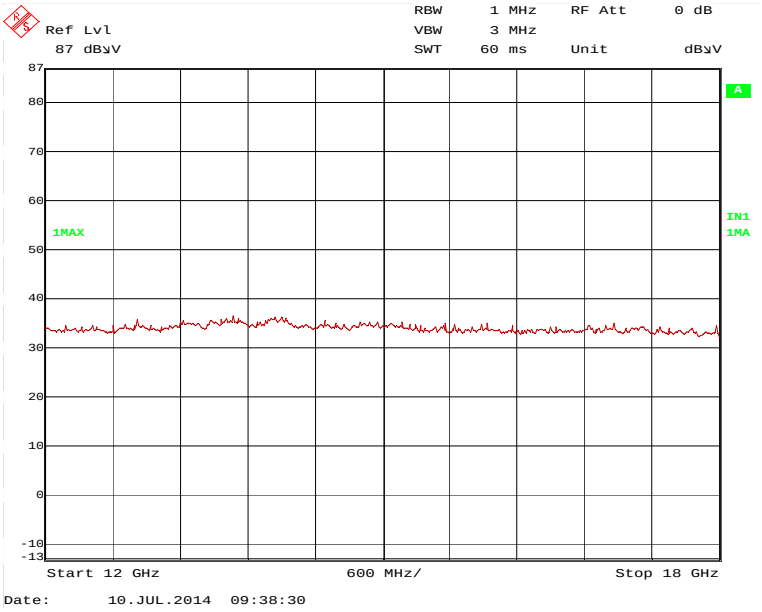
No frequencies were found inside the restricted bands during the preliminary radiated emission test.

These frequencies have to be measured on the open area test site. The result is presented in the following.

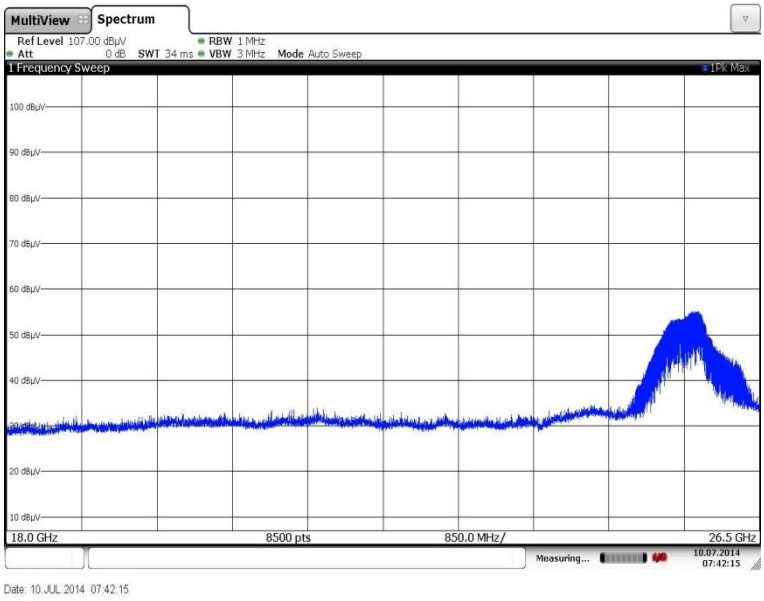
143563_009.wmf: Spurious emissions from 1 GHz to 12 GHz:



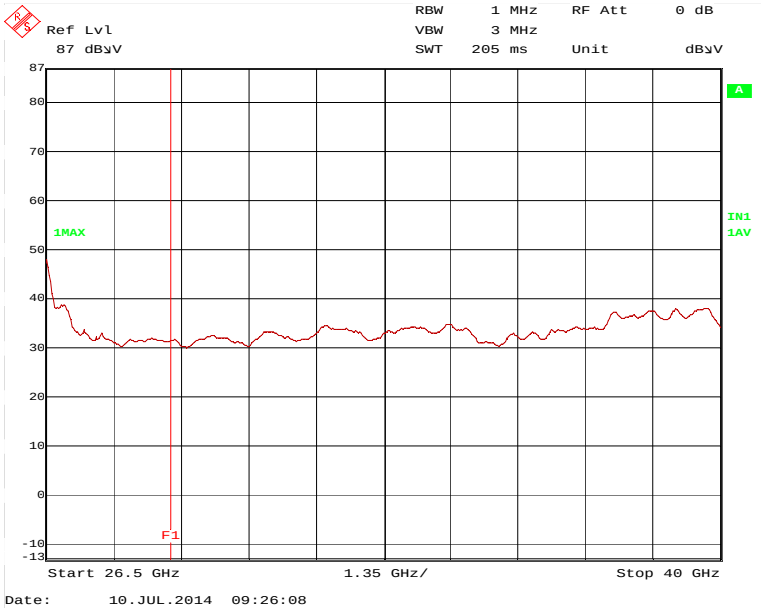
143568_005.wmf: Spurious emissions from 12 GHz to 18 GHz:



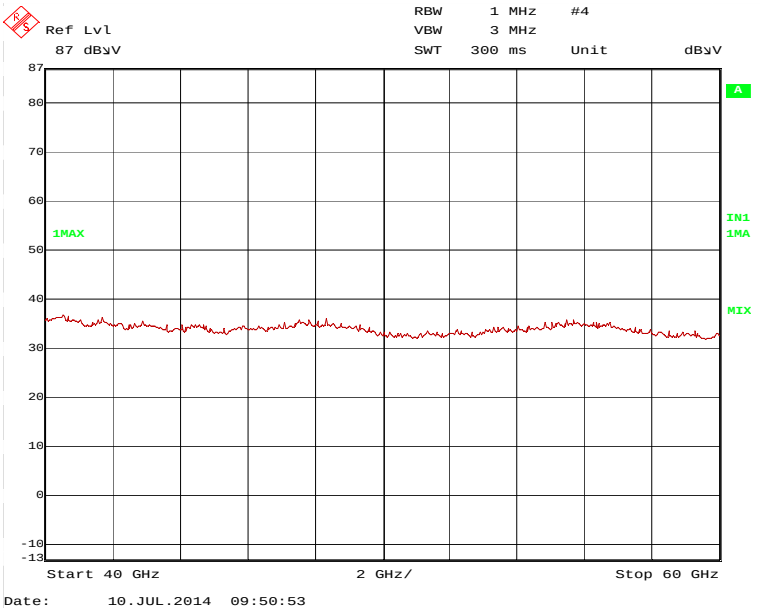
143568_003.jpg: Spurious emissions from 18 GHz to 26.5 GHz:



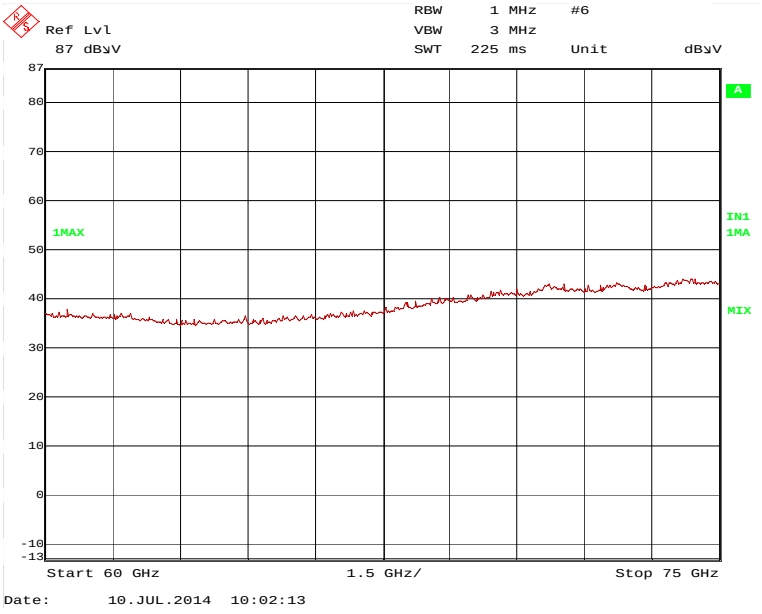
143568_004.wmf: Spurious emissions from 26.5 GHz to 40 GHz:



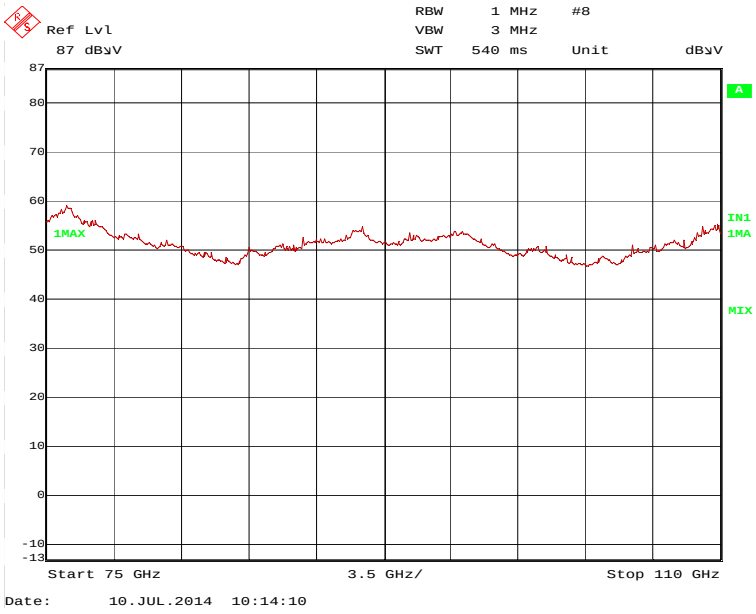
143568_006.wmf: Spurious emissions from 40 GHz to 60 GHz:



143568_007.wmf: Spurious emissions from 60 GHz to 75 GHz:



143568_008.wmf: Spurious emissions from 75 GHz to 110 GHz:



No emissions above the noise floor of the measurement system were found inside the restricted bands during the preliminary radiated emission test.

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

- 1.8434 GHz.

This frequency has to be measured in a final measurement. The results were presented in the following.

Test equipment used (refer clause 5):

7, 8, 29, 31 – 36, 39, 42 – 45, 49, 50, 52, 53, 56 – 58, 60

4.3.2.2 Final radiated emission measurement (30 MHz to 1 GHz)

Ambient temperature	22 °C	Relative humidity	60 %

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.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 12 V DC by an external power supply.

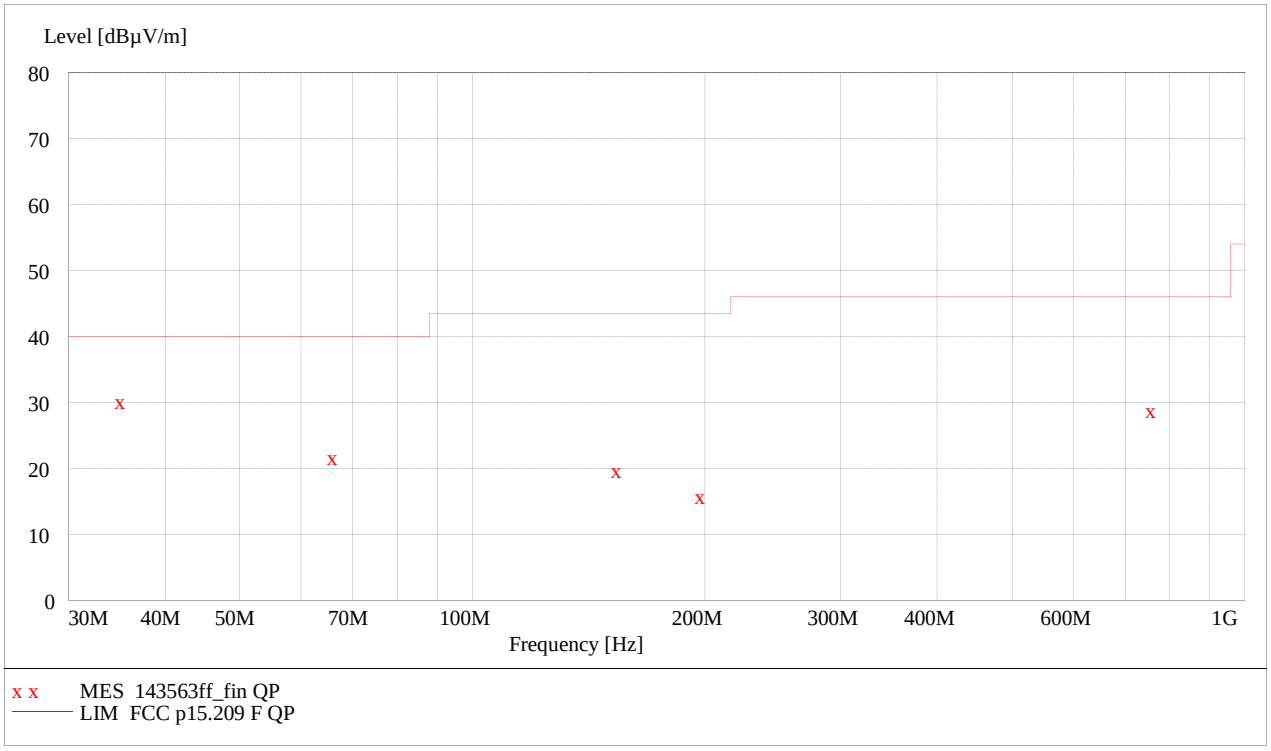
Test results: The test results were calculated with the following formula:

Result [dBµV/m] = reading [dBµV] + cable loss [dB] + antenna factor [dB/m]

The measured points and the limit line in the following diagrams refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with an x are the measured results of the standard final measurement on the open area test site.

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.

The measurement time with the quasi-peak measuring detector is 1 second.



Data record name: 143563ff

Spurious emissions outside restricted bands										
Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.	Pos.
35.300	30.3	40	9.7	12.2	17.5	0.6	100.0	180.0	Vert.	2
66.350	21.8	40	18.2	14.8	6.1	0.9	150.0	214.0	Vert.	2
154.822	19.8	43.5	23.7	6.8	11.6	1.4	100.0	1.0	Vert.	2
199.055	15.8	43.5	27.7	5.4	8.9	1.5	100.0	6.0	Vert.	2
762.406	28.9	46	17.1	4.0	21.7	3.2	185.0	167.0	Vert.	2
Measurement uncertainty				+2.2 dB / -3.6 dB						

Test: Passed

Test equipment used (refer clause 5):

8, 14 – 20

4.3.2.3 Final radiated emission measurement (1 GHz to 110 GHz)

Ambient temperature	21 °C	Relative humidity	65 %

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.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 12 V DC by an external power supply.

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

Result measured with the peak detector:

Frequency GHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
1.8434	36.5	74.0	37.5	32.9	26.9	25.9	2.6	150	Vert.	No	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

Result measured with the average detector:

Frequency GHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band	Pos.
1.8434	25.6	54.0	28.4	22.0	26.9	25.9	2.6	150	Vert.	No	2
Measurement uncertainty							+2.2 dB / -3.6 dB				

Test: Passed

Test equipment used (refer clause 5):

8, 29, 31 – 34, 36

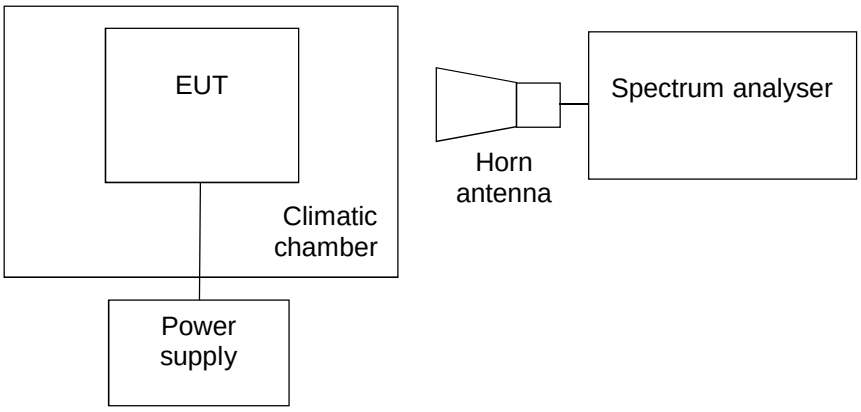
4.4 Frequency stability

4.4.1 Method of measurement (frequency stability)

The following procedure will be used:

1) Place the EUT in the climatic chamber.
2) Switch on the EUT and check the correct function and the settings of the spectrum analyser.
3) Switch off the EUT and tune the climatic chamber to a temperature of 50 °C or the highest temperature specified for the EUT. Wait until the thermal balance is obtained.
4) Switch the EUT on with nominal supply voltage and record the frequencies according to the procedure described under clause 4.1 of this test report within 1 minute after start-up. Switch the EUT off and wait for ten minutes.
5) Switch the EUT on with minimum supply voltage (85 %) and record the frequencies according to the procedure described under clause 4.1 of this test report within 1 minute after start-up. Switch the EUT off and wait for ten minutes.
6) Switch the EUT on with maximum supply voltage (115 %) and record the frequencies according to the procedure described under clause 4.1 of this test report within 1 minute after start-up.
7) Switch off the EUT and tune the climatic chamber to a temperature range of 50 °C (or the highest temperature specified for the EUT) to –20 °C (or the lowest temperature specified for the EUT) in ten-degree steps. Wait until the thermal balance is obtained for every step and repeat step 4) to 7) with the next temperature step until –20 °C or the lowest temperature specified for the EUT were reached.

Test set-up:



4.4.2 Test result (frequency stability)

Ambient temperature	22 °C	Relative humidity	68 %

Test set-up: For this test the EUT was fixed on a wooden table inside the climatic chamber.

Cable guide: For further information of the cable guide refer to the pictures in annex A of this test report.

Temperature	Supply voltage	Lower frequency	Upper frequency	10 dB bandwidth	Peak frequency	Result
85 °C	9.6 V DC (U_{min})	25.2380 GHz	26.1073 GHz	869.3 MHz	25.6669 GHz	Passed
	12 V DC (U_{nom})	25.2361 GHz	26.1611 GHz	925.0 MHz	25.7073 GHz	Passed
	28 V DC (U_{max})	25.2419 GHz	26.0919 GHz	850.0 MHz	25.6823 GHz	Passed
80 °C	9.6 V DC (U_{min})	25.2419 GHz	26.1246 GHz	882.7 MHz	25.6707 GHz	Passed
	12 V DC (U_{nom})	25.2265 GHz	26.1034 GHz	876.9 MHz	25.6823 GHz	Passed
	28 V DC (U_{max})	25.2400 GHz	26.1073 GHz	867.3 MHz	25.6784 GHz	Passed
70 °C	9.6 V DC (U_{min})	25.2457 GHz	26.1342 GHz	888.5 MHz	25.6784 GHz	Passed
	12 V DC (U_{nom})	25.2380 GHz	26.1130 GHz	875.0 MHz	25.6842 GHz	Passed
	28 V DC (U_{max})	25.2457 GHz	26.1457 GHz	900.0 MHz	25.6707 GHz	Passed
60 °C	9.6 V DC (U_{min})	25.2457 GHz	26.1323 GHz	886.6 MHz	25.6823 GHz	Passed
	12 V DC (U_{nom})	25.2457 GHz	26.1323 GHz	886.6 MHz	25.6823 GHz	Passed
	28 V DC (U_{max})	25.2534 GHz	26.1130 GHz	859.6 MHz	25.6840 GHz	Passed
50 °C	9.6 V DC (U_{min})	25.2496 GHz	26.1246 GHz	875.0 MHz	25.7111 GHz	Passed
	12 V DC (U_{nom})	25.2496 GHz	26.1246 GHz	875.0 MHz	25.7111 GHz	Passed
	28 V DC (U_{max})	25.2573 GHz	26.1457 GHz	888.4 MHz	25.6707 GHz	Passed
40 °C	9.6 V DC (U_{min})	25.2496 GHz	26.1496 GHz	900.0 MHz	25.6919 GHz	Passed
	12 V DC (U_{nom})	25.2496 GHz	26.1496 GHz	900.0 MHz	25.6919 GHz	Passed
	28 V DC (U_{max})	25.2630 GHz	26.1323 GHz	869.3 MHz	25.6669 GHz	Passed
30 °C	9.6 V DC (U_{min})	25.2573 GHz	26.1496 GHz	892.3 MHz	25.6784 GHz	Passed
	12 V DC (U_{nom})	25.2496 GHz	26.1650 GHz	915.4 MHz	25.6823 GHz	Passed
	28 V DC (U_{max})	25.2707 GHz	26.1534 GHz	882.7 MHz	25.7073 GHz	Passed
20 °C	9.6 V DC (U_{min})	25.2708 GHz	26.1612 GHz	890.4 MHz	25.6958 GHz	Passed
	12 V DC (U_{nom})	25.2650 GHz	26.1535 GHz	888.5 MHz	25.7188 GHz	Passed
	28 V DC (U_{max})	25.2670 GHz	26.1650 GHz	898.0 MHz	25.6912 GHz	Passed
10 °C	9.6 V DC (U_{min})	25.2669 GHz	26.1746 GHz	907.7 MHz	25.6919 GHz	Passed
	12 V DC (U_{nom})	25.2573 GHz	26.1784 GHz	921.1 MHz	25.6957 GHz	Passed
	28 V DC (U_{max})	25.2611 GHz	26.1900 GHz	928.9 MHz	25.7111 GHz	Passed
0 °C	9.6 V DC (U_{min})	25.2611 GHz	26.1823 GHz	921.2 MHz	25.6996 GHz	Passed
	12 V DC (U_{nom})	25.2611 GHz	26.1823 GHz	921.2 MHz	25.7038 GHz	Passed
	28 V DC (U_{max})	25.2611 GHz	26.1746 GHz	913.5 MHz	25.6996 GHz	Passed
-10 °C	9.6 V DC (U_{min})	25.2573 GHz	26.1823 GHz	925.0 MHz	25.6919 GHz	Passed
	12 V DC (U_{nom})	25.2573 GHz	26.1900 GHz	932.7 MHz	25.6900 GHz	Passed
	28 V DC (U_{max})	25.2611 GHz	26.1823 GHz	921.2 MHz	25.6957 GHz	Passed
- 20 °C	9.6 V DC (U_{min})	25.2688 GHz	26.1938 GHz	925.0 MHz	25.7150 GHz	Passed
	12 V DC (U_{nom})	25.2785 GHz	26.1862 GHz	907.7 MHz	25.7073 GHz	Passed
	28 V DC (U_{max})	25.2823 GHz	26.1862 GHz	903.9 MHz	25.7188 GHz	Passed
-30 °C	9.6 V DC (U_{min})	25.2669 GHz	26.2112 GHz	944.3 MHz	25.7169 GHz	Passed
	12 V DC (U_{nom})	25.2785 GHz	26.1938 GHz	915.3 MHz	25.7073 GHz	Passed
	28 V DC (U_{max})	25.2785 GHz	26.1996 GHz	921.1 MHz	25.7188 GHz	Passed
-40 °C	9.6 V DC (U_{min})	25.2746 GHz	26.2073 GHz	932.7 MHz	25.7112 GHz	Passed
	12 V DC (U_{nom})	25.2650 GHz	26.2112 GHz	946.2 MHz	25.7169 GHz	Passed
	28 V DC (U_{max})	25.2708 GHz	26.2112 GHz	940.4 MHz	25.7035 GHz	Passed
Measurement uncertainty				$< \pm 1*10^{-7}$		

Test result: Passed

Test equipment used (refer clause 5):

6, 8, 39, 60, 61

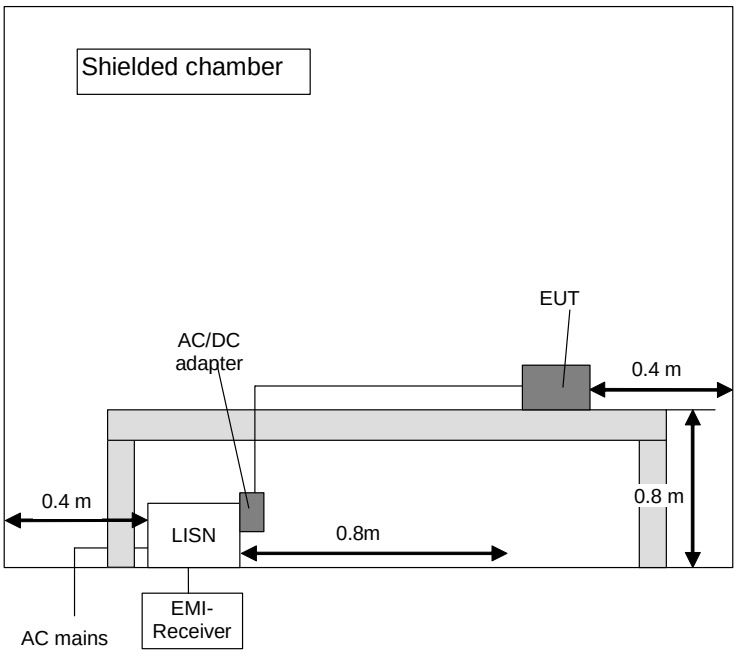
4.5 Conducted emissions on power supply lines (150 kHz to 30 MHz)

4.5.1 Method of measurement (conducted emissions on power supply lines)

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 set-up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

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

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



4.5.2 Test results (conducted emissions on power supply lines)

Ambient temperature	22 °C	Relative humidity	60 %

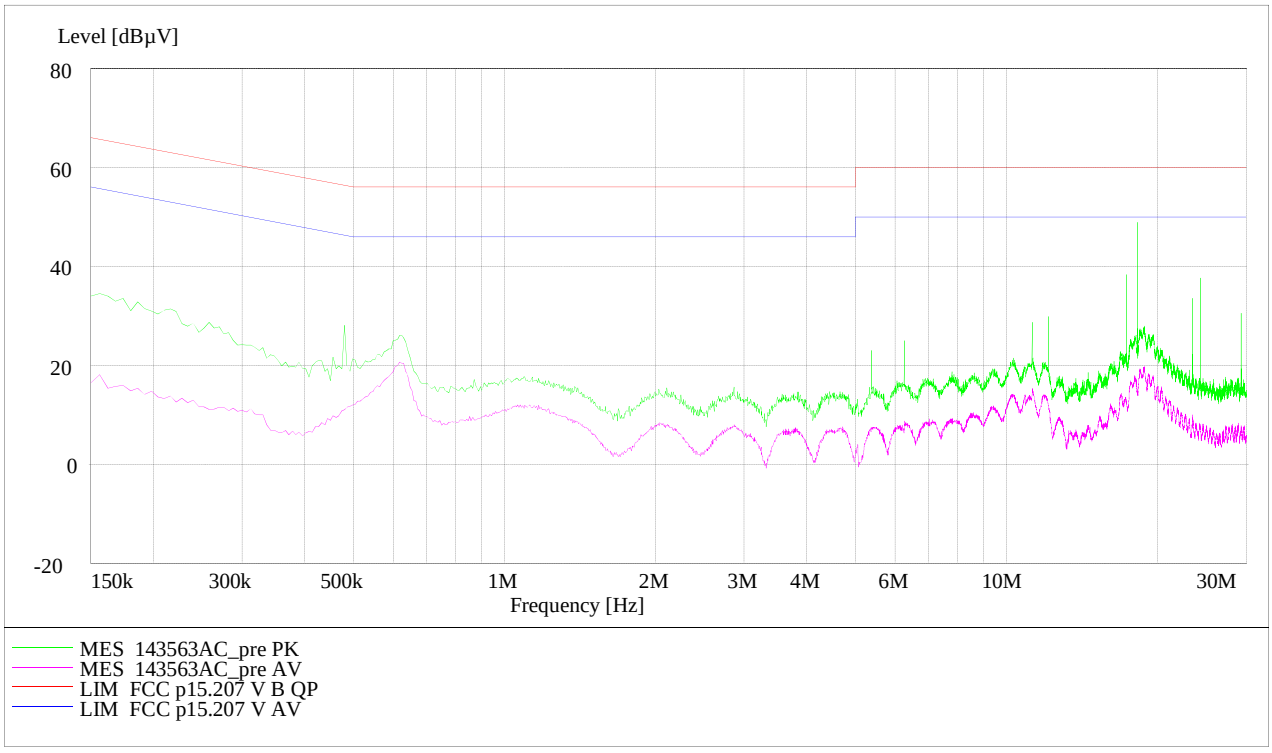
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following. This test was carried out in

Supply voltage: During all measurements the EUT was supplied with 12.0 V DC by an AC / DC adaptor type enercell, which was supplied by 120 V AC / 60 Hz.

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.



Data record name: 143563AC

Test: Passed

Test equipment used (refer clause 5):

1 – 4, 8

5 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Shielded chamber M4	-	Siemens	B83117-S1-X158	480088	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	12/20/2013	12/2014
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
6	Spectrum Analyzer	FSU	Rohde & Schwarz	200125	480956	02/24/2014	02/2015
7	Spectrum Analyzer	FSW	Rohde & Schwarz	100586	481720	02/27/2014	02/2016
8	Power supply	TOE8752-32	Toellner Electronic Inst.	31566	480010	-	-
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	AS615P	Deisel	615/310	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.)	
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/16/14	02/2016
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	04/14/2014	04/2017
36	Antenna	3115 B	EMCO	9609-4922	480184	09/28/2011	09/2014
37	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Annual verification (system cal.)	
39	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Annual verification (system cal.)	
40	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	410	480296	Annual verification (system cal.)	
42	Standard Gain Horn 26.4 GHz – 40.1 GHz	22240-20	Flann Microwave	468	480298	Annual verification (system cal.)	
43	RF-cable No. 36	Sucoflex 106B	Suhner	0522/6B	480571	Weekly verification (system cal.)	
44	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
45	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	06/11/2014	06/2015
50	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	06/11/2014	06/2015

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	06/11/2014	06/2015
52	Preamplifier	JS3-26004000-25-5A	Miteq	563593	480344	06/11/2014	06/2015
53	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/18/2014	02/2016
56	Standard Gain Horn 40 GHz – 60 GHz	24240-20	Flann Microwave	133313	480481	Annual verification (system cal.)	
	Harmonic Mixer 40…60 GHz	FS-Z60	Rohde&Schwarz	100071			
57	Standard Gain Horn 50 GHz – 75 GHz	25240-20	Flann Microwave	135181	480480	Annual verification (system cal.)	
	Harmonic Mixer 50…75 GHz	FS-Z75	Rohde&Schwarz	100045			
58	Standard Gain Horn 75 GHz – 110 GHz	27240-20	Flann Microwave	132148	480482	Annual verification (system cal.)	
	Harmonic Mixer 75…110 GHz	FS-Z110	Rohde&Schwarz	100049			
60	RF cable		Insulated Wire	KPS-1533-800-KPS	480302	Annual verification (system cal.)	
61	Climatic chamber	MK 240	BINDER	05-79022	480462	02/08/2014	02/2016

6 Report history

Report Number	Date	Comment
F143563E1	24 July 2014	Document created

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143563_5.JPG: RLS, test set-up fully anechoic chamber
143563_4.JPG: RLS, test set-up fully anechoic chamber
143563_3.JPG: RLS, test set-up fully anechoic chamber
143563_8.JPG: RLS, test set-up open area test site
143563_10.JPG: RLS, test set-up shielded chamber
143563_12.JPG: RLS, test set-up temperature chamber
143563_13.JPG: RLS, test set-up temperature chamber (isolation removed)

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143563_b.JPG: RLS, 3-D-view 2
143563_d.JPG: RLS, top view (cover removed)

142568_1.JPG: TN902-Q120L130-H1147, 3-D-view 2

ANNEX C INTERNAL PHOTOGRAPHS 8 pages

143563_f.JPG: RLS, internal view 1 (cover removed)
143563_h.JPG: RLS, internal view 2 (absorbing material for TX patch)
143563_i.JPG: RLS, PCB, top view
143563_n.JPG: RLS, PCB, top view (shielding cover removed)
143563_j.JPG: RLS, PCB, bottom view
143563_m.JPG: RLS, PCB, bottom view (shielding cover removed)
143563_k.JPG: RLS, detail view to TX patch and shielding cover
143563_l.JPG: RLS, detail view to RX patch and shielding cover