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Test Report

Report Number: F123226E1 2nd version

Applicant:

IMST GmbH

Manufacturer:

IMST GmbH

Equipment under Test (EUT):

iM222A-int

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



REFERENCES

- [1] **ANSI C63.4-2009** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- [2] **FCC CFR 47 Part 15 (August 2011)** Radio Frequency Devices
- [3] **558074 D01 DTS Meas Guidance v02 (October 2012)** Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
- [4] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
- [5] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radiocommunication Equipment
- [6] **Publication Number 913591 (March 2007)** Measurement of radiated emissions at the edge of the band for a Part 15 RF Device

TEST RESULT

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

The complete test results are presented in the following.

| | | | |
|----------------------|----------------|--|------------------|
| Test engineer: | Manuel BASTERT |  | 19 December 2012 |
| | Name | Signature | Date |
| Authorized reviewer: | Bernd STEINER |  | 19 December 2012 |
| | Name | Signature | Date |

RESERVATION

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1 IDENTIFICATION

1.1 Applicant

| | |
|--|--|
| Name: | IMST GmbH |
| Address: | Carl-Friedrich-Gauss-Str. 2 47475 Kamp-Lintfort |
| Country: | Germany |
| Name for contact purposes: | Mr. Matthias SCHNEIDER |
| Phone: | + 49 (0) 2842-981-312 |
| Fax: | + 49 (0) 2842-981-399 |
| eMail Address: | schneider@imst.de |
| Applicant represented during the test by the following person: | - |

1.2 Manufacturer

| | |
|--|--|
| Name: | IMST GmbH |
| Address: | Carl-Friedrich-Gauss-Str. 2 47475 Kamp-Lintfort |
| Country: | Germany |
| Name for contact purposes: | Mr. Matthias SCHNEIDER |
| Phone: | + 49 (0) 2842-981-312 |
| Fax: | + 49 (0) 2842-981-399 |
| eMail Address: | schneider@imst.de |
| Applicant represented during the test by the following person: | - |

1.3 Test laboratory

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

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

1.4 EUT (Equipment Under Test)

| | |
|---------------------|---|
| Test object: * | Radio module |
| Type: * | iM222A-int |
| FCC ID: * | Q9BWIMOD404530 |
| IC: * | 10740A-WIMOD404530 |
| Serial number: * | 0000928 (for radiated measurements) 0000824 (for conducted measurements) |
| PCB identifier: * | WiMOD_AB_02 |
| Hardware version: * | v3.0 |
| Software version: * | AppRFTest_V1_2 |

1.5 Technical data of equipment

| | | | | |
|------------|-----|----------|-----|----------|
| Channel 0 | RX: | 2405 MHz | TX: | 2405 MHz |
| Channel 7 | RX: | 2440 MHz | TX: | 2440 MHz |
| Channel 15 | RX: | 2480 MHz | TX: | 2480 MHz |

| | | | | | |
|--|---|---------------------|--------------------|---------------------|--|
| Antenna type: * | Internal, PCB antenna | | | | |
| Antenna gain: * | -4.5 dBi | | | | |
| Antenna connector: * | SMA | | | | |
| Power supply: * | U _{nom} = | 3.0 V _{DC} | U _{min} = | 2.0 V _{DC} | U _{max} = 3.6 V _{DC} |
| Type of modulation: * | O-QPSK | | | | |
| Operating frequency range:* | 2405 MHz to 2480 MHz | | | | |
| Number of channels: * | 16 | | | | |
| Temperature range: * | -20 °C to +70 °C | | | | |
| Lowest / highest Internal clock frequency: * | 32.768 kHz crystal oscillator / 2.48 GHz ZigBee | | | | |

* declared by the applicant.

The following external I/O cables were used:

| Identification | Connector | | Length |
|----------------|---|-----------|--------|
| | EUT | Ancillary | |
| - | No cables are directly connectable to the EUT | | - |
| - | | | - |

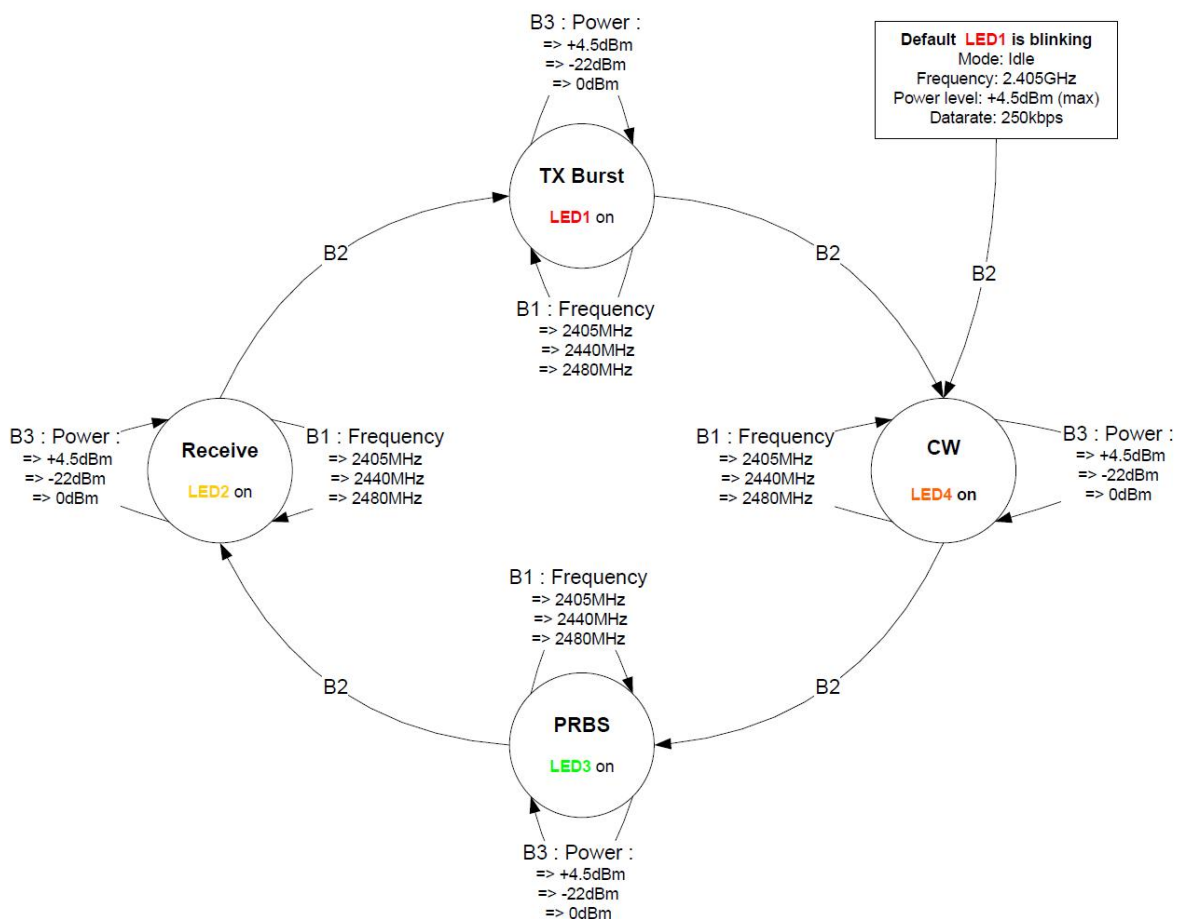
*: Length during the test if no other specified.

1.6 Dates

| | |
|---------------------------------|------------------|
| Date of receipt of test sample: | 30 October 2012 |
| Start of test: | 03 November 2012 |
| End of test: | 07 November 2012 |

2 OPERATIONAL STATES

The tests were carried out with two samples, one with an internal antenna and one with an antenna connector. On the device a test firmware (AppRFTTest_V1_2) was installed. The operation modes could be set by pressing the alignment buttons (see photo below) on the carrier board. The following state machine shows how to enable the needed operation modes:

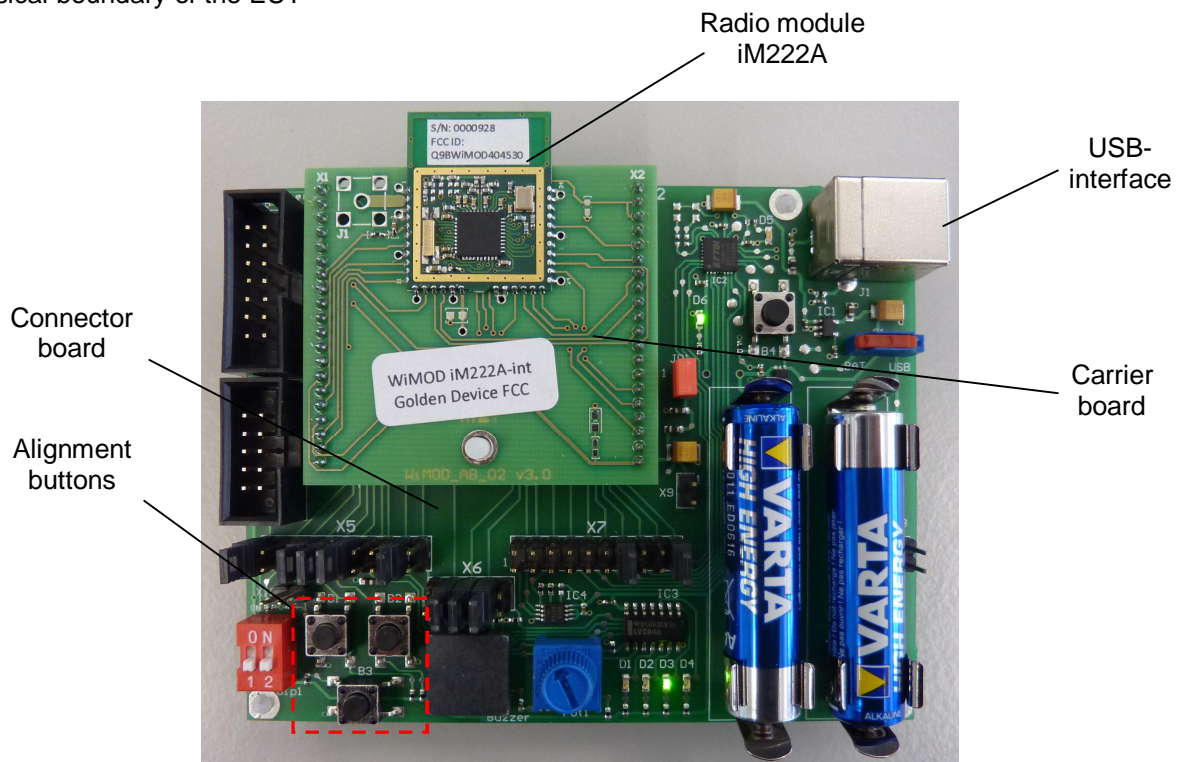


For the tests the PRBS mode with maximum output power was used. The data rate was set to 250 kbps.

During the tests (except the conducted emission test) the samples were powered with 3.0 V_{DC} by two type AAA batteries. The conducted measurement was performed using an AC / DC adapter type E-TEK ZDA 050050EU. The EUT was supplied over its USB interface.

| Operation mode | Description of the operation mode | Modulation | Data rate / kbps |
|----------------|-------------------------------------|------------|------------------|
| 1 | Continuous transmitting on 2405 MHz | O-PQSK | 250 |
| 2 | Continuous transmitting on 2440 MHz | O-PQSK | 250 |
| 3 | Continuous transmitting on 2480 MHz | O-PQSK | 250 |

Physical boundary of the EUT



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

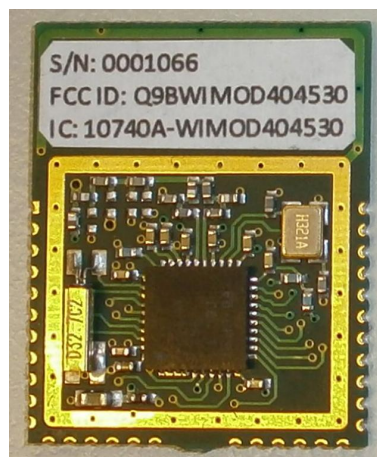
The 3 orthogonal axes were defined as Pos.1 EUT lying flat, Pos.2 EUT standing vertical and Pos. 3 EUT standing vertical. The measurements were carried out in Pos. 1.

The following test modes were adjusted during the tests:

| Test items | Operation mode |
|-------------------------------------|----------------|
| 6 dB bandwidth | 1, 2, 3 |
| Maximum peak conducted output power | 1, 2, 3 |
| Power spectral density | 1, 2, 3 |
| Band edge compliance | 1, 3 |
| Radiated emissions (transmitter) | 1, 2, 3 |

3 ADDITIONAL INFORMATION

The EUT was not labelled in correct form during the tests: Instead of Q9BWIMOD404530 the EUT was labeled with Q9BWiMOD404530 and the IC number was missing. The label was edited by the customer and is shown below.



4 OVERVIEW

| Application | Frequency range [MHz] | FCC 47 CFR Part 15 section [2] | RSS 210, Issue 8 [4] or RSS-Gen, Issue 3 [5] | Status | Refer page |
|------------------------------------|-----------------------|--------------------------------|--|--------|------------|
| 6 dB bandwidth | General | 15.247 (a) (2) | A8.2 (a) [4] | Passed | 9 et seq. |
| Maximum peak output power | General | 15.247 (b) (3), (4) | A8.4 (4) [4] | Passed | 12 et seq. |
| Power spectral density | 2400.0 - 2483.5 | 15.247 (e) | A8.2 (b) [4] | Passed | 13 et seq. |
| Band edge compliance | 2400.0 - 2483.5 | 15.247 (d) | A8.5 [4] | Passed | 16 et seq. |
| Radiated emissions (transmitter) | 0.009 - 25,000 | 15.205 (a) 15.209 (a) | 7.2.2 [5], 2.5 [4] | Passed | 19 et seq. |
| Conducted emissions on supply line | 0.15 - 30 | 15.207 (a) | 7.2.4 [5] | Passed | 35 et seq. |

5 TEST RESULTS

5.1 6 dB bandwidth

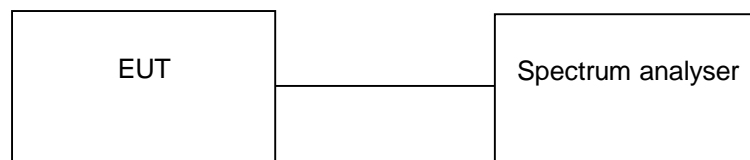
5.1.1 Method of measurement

Option 1 according to [3]:

1. Set resolution bandwidth (RBW) = 1-5% of DTS BW, not to exceed 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

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

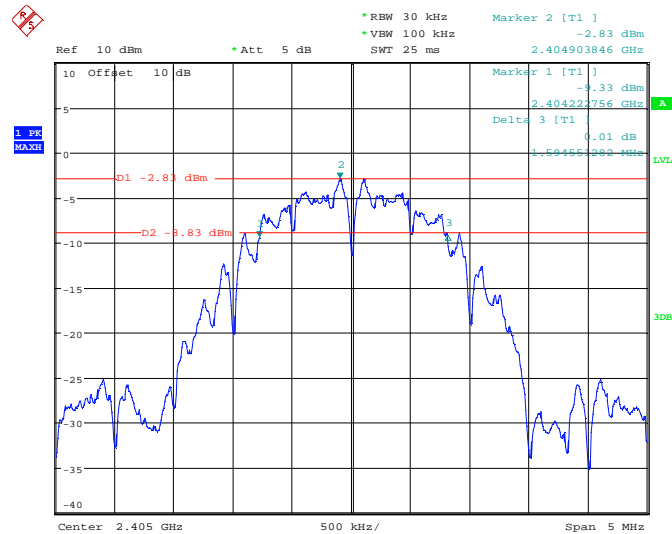
Test set-up:



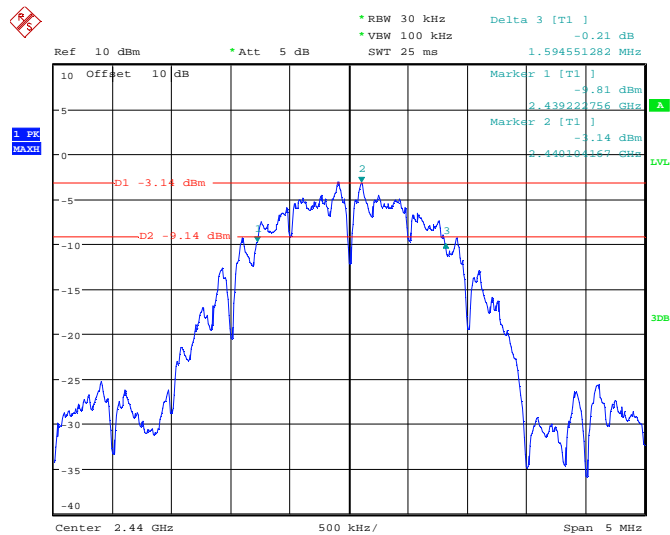
5.1.2 Test results

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 21 °C | Relative humidity | 45 % |
|---------------------|-------|-------------------|------|

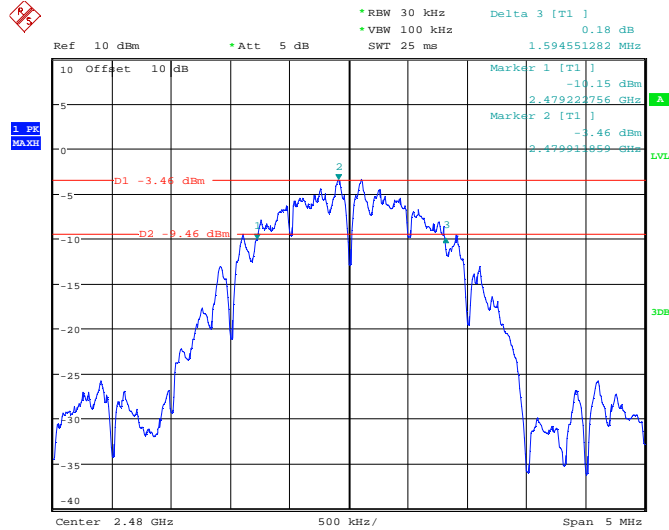
124226_20.wmf: 6 dB bandwidth at the lower end of the assigned frequency band:



124226_21.wmf: 6 dB bandwidth at the middle of the assigned frequency band:



124226_22.wmf: 6 dB bandwidth at the upper end of the assigned frequency band:



| Operation mode 1 to 3 | | | |
|-------------------------|-------------------------|-------------------------|-----------------------|
| Channel number | Channel frequency [MHz] | 6 dB bandwidth [kHz] | Bandwidth limit [kHz] |
| 0 | 2405 | 1594.551 | >500 kHz |
| 7 | 2440 | 1594.551 | >500 kHz |
| 15 | 2480 | 1594.551 | >500 kHz |
| Measurement uncertainty | | $< \pm 1 \cdot 10^{-7}$ | |

Test: Passed

| TEST EQUIPMENT USED FOR THE TEST: |
|-----------------------------------|
| 30, 168 |

5.2 Maximum peak conducted output power

5.2.1 Method of measurement

Option 3 (peak power meter method) according to [3]

The maximum peak conducted output power can be measured using a broadband peak RF power meter. The power meter must have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast, average-responding diode type sensor.

Test set-up:



5.2.2 Test results

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 21 °C | Relative humidity | 30 % |
|---------------------|-------|-------------------|------|

| Operation mode 1 to 3 | | | | |
|-------------------------|-------------------------|---|---------------------|------------------------|
| Channel number | Channel frequency [MHz] | Maximum peak conducted output power [dBm] | Antenna gain [dBi] | Peak power limit [dBm] |
| 0 | 2405 | 4.35 | -4.5 | 30.0 |
| 7 | 2440 | 4.09 | -4.5 | 30.0 |
| 15 | 2480 | 3.79 | -4.5 | 30.0 |
| Measurement uncertainty | | | +0.66 dB / -0.72 dB | |

Test: Passed

| |
|-----------------------------------|
| TEST EQUIPMENT USED FOR THE TEST: |
| 166, 167 |

5.3 Power spectral density

5.3.1 Method of measurement

A conducted power spectral density (PSD) limit of 8 dBm in any 3 kHz band segment within the DTS bandwidth is specified during any time interval of continuous transmission. By rule, the same method as used to determine the conducted output power shall be used to determine the power spectral density (*i.e.*, if maximum peak conducted output power was measured then the peak PSD procedure shall be used and if maximum conducted output power was measured then the average PSD procedure shall be used). If the average PSD is measured with a power averaging (RMS) detector or a sample detector, then the spectrum analyzer must be capable of utilizing a number of measurement points in each sweep that is greater than or equal to twice the span/RBW in order to ensure bin-to-bin spacing of $\leq RBW/2$ so that narrowband signals are not lost between frequency bins.

The following procedure was used to determine the DTS PSD.

Option 1

This procedure must be used if maximum peak conducted output power was used to demonstrate compliance to the fundamental output power limit, and is optional if the maximum (average) conducted output power was used to demonstrate compliance.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW ≥ 3 kHz.
4. Set the VBW $\geq 3 \times$ RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

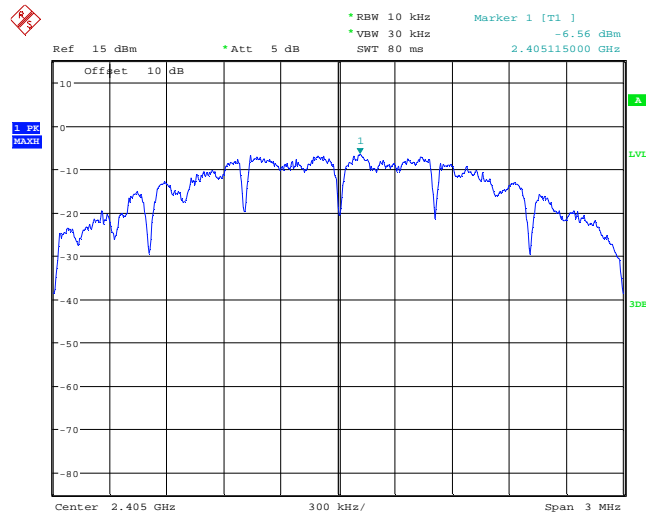
Test set-up:



5.3.2 Test results

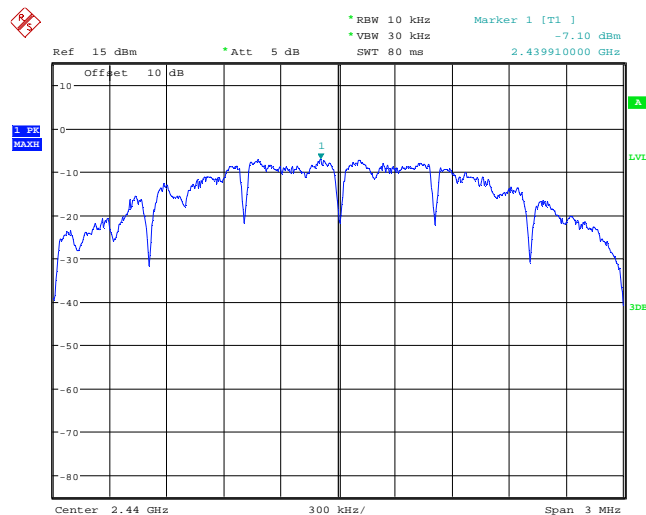
| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 21 °C | Relative humidity | 30 % |
|---------------------|-------|-------------------|------|

124226_ .wmf: Power spectral density at the lower end of the assigned frequency band:



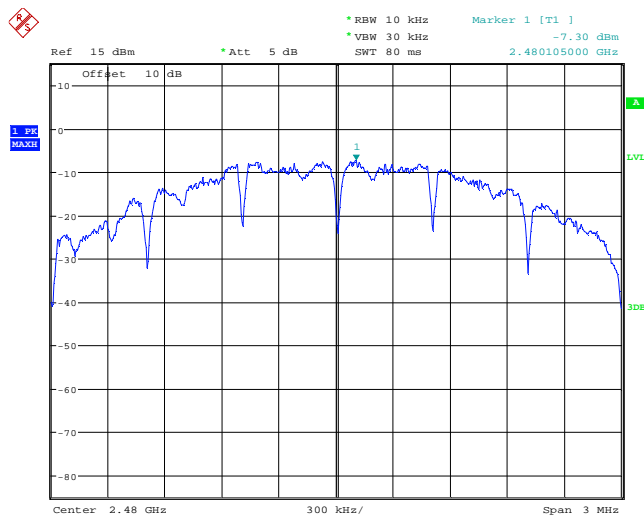
Date: 7.NOV.2012 12:40:47

124226_24.wmf: Power spectral density at the middle of the assigned frequency band:



Date: 7.NOV.2012 12:43:15

124226_25.wmf: Power spectral density at the upper end of the assigned frequency band:



Date: 7.NOV.2012 12:45:04

| Operation mode 1 to 3 | | | | | |
|-------------------------|-------------------------|--|--|--------------------|--|
| Channel number | Channel frequency [MHz] | measured Power spectral density [dBm / 10 kHz] | calculated Power spectral density [dBm / 3 kHz (-5.23 dB)] | Antenna gain [dBi] | Power spectral density limit [dBm / 3 kHz] |
| 0 | 2402 | -6.56 | -11.79 | -4.5 | 8.0 |
| 7 | 2442 | -7.10 | -12.33 | -4.5 | 8.0 |
| 15 | 2480 | -7.30 | -12.53 | -4.5 | 8.0 |
| Measurement uncertainty | | | | +1.1 dB / -1.5 dB | |

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30, 168

5.4 Band-edge compliance (radiated)

5.4.1 Method of measurement

The measurement of unwanted emissions at the edge of the authorized frequency bands can be complicated by the capture of RF energy from the fundamental emission within the RBW passband. The following techniques are permitted for use in performing a measurement of the unwanted emission level at the band edges.

Marker-Delta Method

The marker-delta method, as described in KDB 913591 and in C63.10, can be used to perform measurements of the unwanted emissions level at the band-edges.

Integrated Power Measurement

A narrower resolution bandwidth can be used at the band edge to improve the measurement accuracy provided that the measurement is subsequently integrated to the relevant bandwidth specification (e.g., 100 kHz within non-restricted bands and 1 MHz within restricted frequency bands).

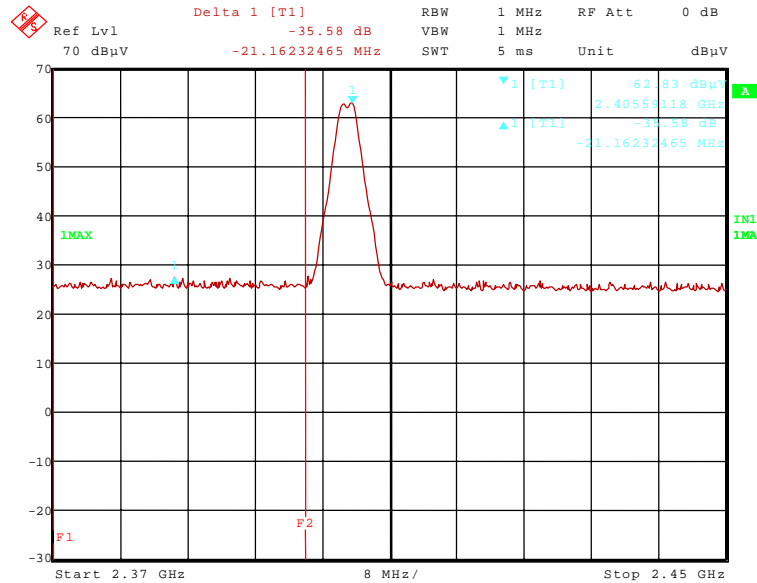
Used measurement procedure: Marker-Delta Method.

5.4.2 Test result

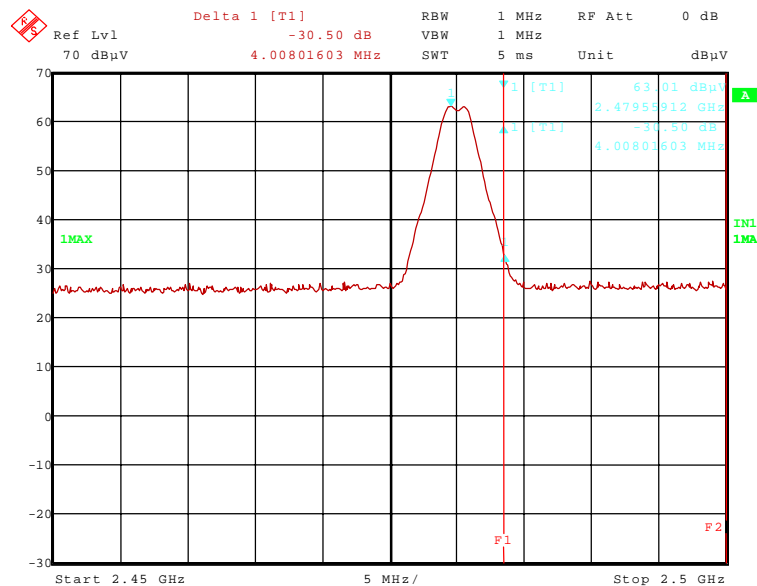
| | |
|---------------------|-------|
| Ambient temperature | 20 °C |
|---------------------|-------|

| | |
|-------------------|------|
| Relative humidity | 40 % |
|-------------------|------|

124226_3.wmf: Radiated band-edge compliance, lower band edge:



124226_2.wmf: Radiated band-edge compliance, upper band edge:



| Band-edge compliance (lower band edge) | | | | | | | | | | | |
|--|--------------------------------|-----------------------|--------------|-----------------------|--------------------------|--------------|---------------------|--------------|-------|----------------|------|
| Result measured with the peak detector: | | | | | | | | | | | |
| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Reading dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
| 2405.00 | 94.1 | - | - | 62.1 | 28.3 | 0.0 | 3.7 | 150 | Vert. | - | 1 |
| 2384.43 | 59.0 | 74.0 | 15.0 | 27.0 | 28.3 | 0.0 | 3.7 | 150 | Hor. | Yes | 1 |
| Result measured with the average detector: | | | | | | | | | | | |
| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Reading dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
| 2405.00 | 90.9 | - | - | 58.9 | 28.3 | 0.0 | 3.7 | 150 | Vert. | - | 1 |
| 2384.43 | 45.1 | 54.0 | 8.9 | 13.1 | 28.3 | 0.0 | 3.7 | 150 | Hor. | Yes | 1 |
| Measurement uncertainty | | | | | | | +2.2 dB / -3.6 dB | | | | |

| Band-edge compliance (upper band edge) | | | | | | | | | | | |
|--|--------------------------------|-----------------------|--------------|-----------------------|--------------------------|--------------|---------------------|--------------|-------|----------------|------|
| Result measured with the peak detector: | | | | | | | | | | | |
| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Reading dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
| 2480.00 | 94.8 | - | - | 62.5 | 28.5 | 0.0 | 3.8 | 150 | Vert. | - | 1 |
| 2483.57 | 64.3 | 74.0 | 9.7 | 32.0 | 28.5 | 0.0 | 3.8 | 150 | Hor. | Yes | 1 |
| Result measured with the average detector: | | | | | | | | | | | |
| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Reading dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
| 2480.00 | 91.7 | - | - | 59.4 | 28.5 | 0.0 | 3.8 | 150 | Vert. | - | 1 |
| 2483.57 | 53.0 | 54.0 | 1.0 | 20.7 | 28.5 | 0.0 | 3.8 | 150 | Hor. | Yes | 1 |
| Measurement uncertainty | | | | | | | +2.2 dB / -3.6 dB | | | | |

Test: Passed

| |
|-----------------------------------|
| TEST EQUIPMENT USED FOR THE TEST: |
| 29, 31 – 34, 36, 44 |

5.5 Radiated emissions

5.5.1 Method of measurement

The radiated emission measurement is subdivided into four stages.

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

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

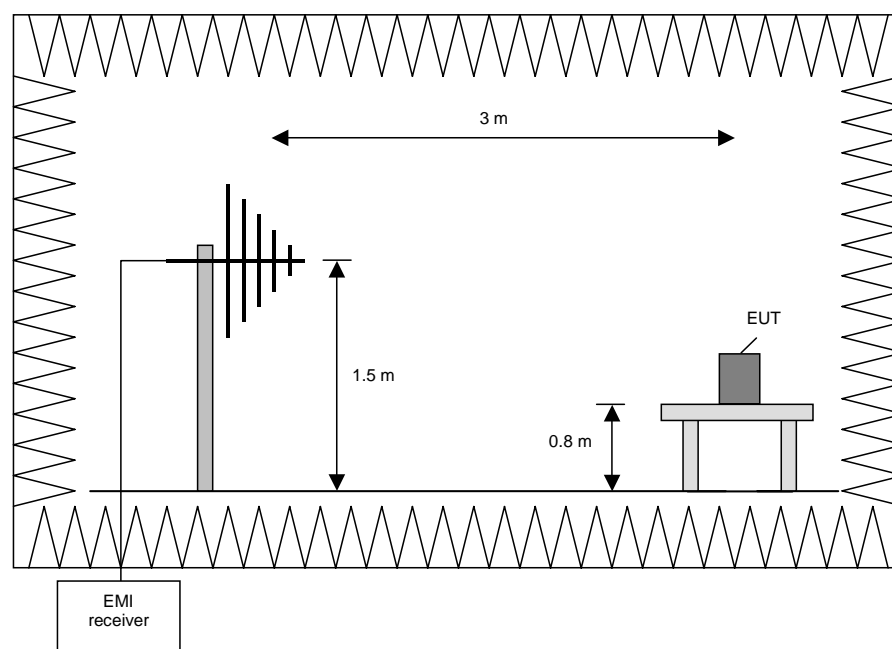
Preliminary measurement (30 MHz to 1 GHz)

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 set up 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 230 MHz and 230 MHz to 1 GHz.

The following procedure will be used:

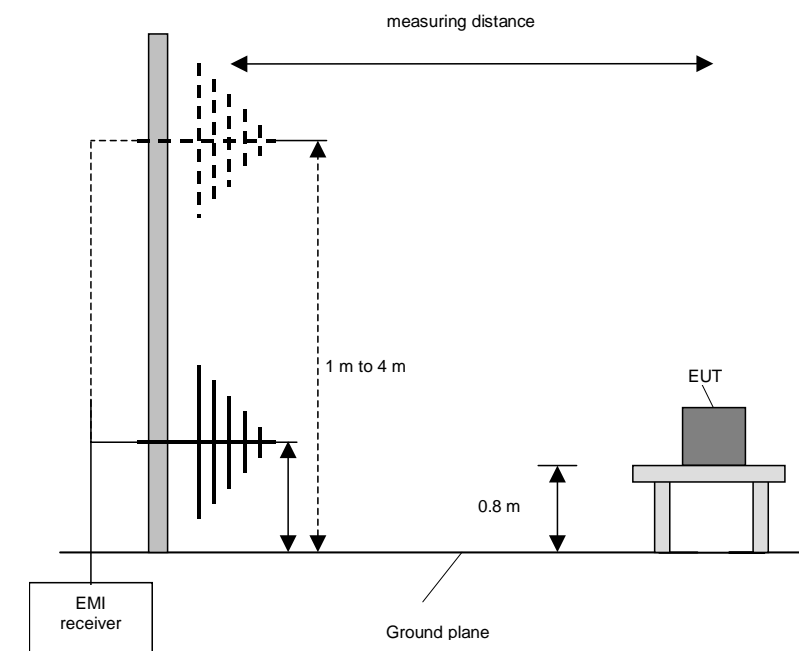
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the 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:

- 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 110 GHz)

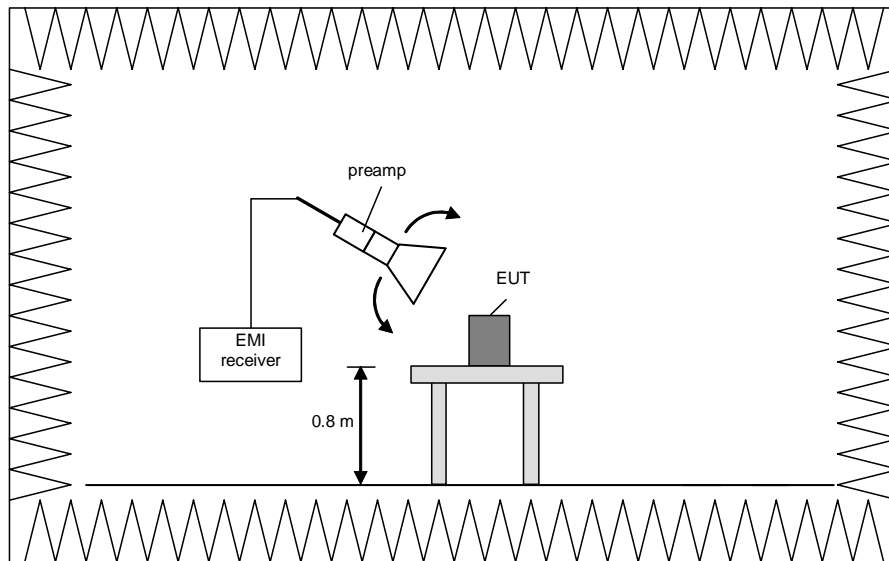
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance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

Preliminary measurement (1 GHz to 110 GHz)

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

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

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

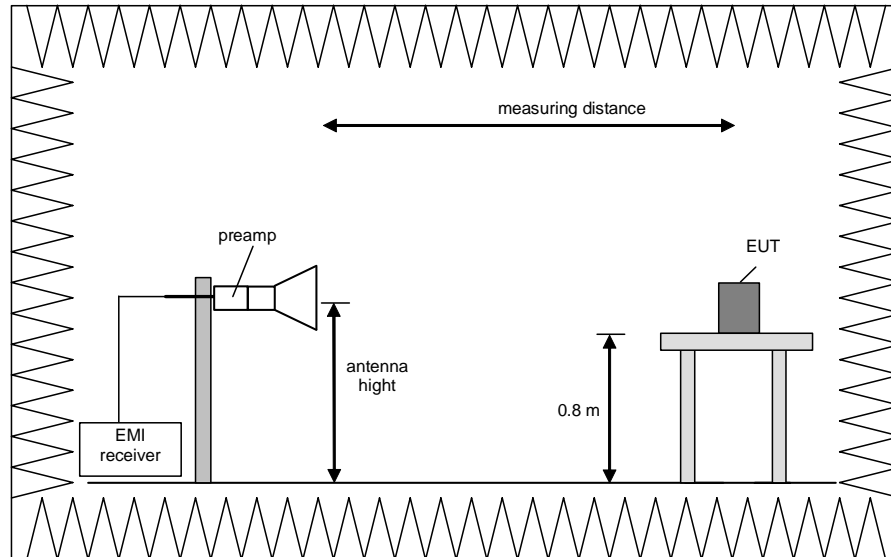


Final measurement (1 GHz to 110 GHz)

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

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

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



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 GHz.

The following procedure will be used:

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

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

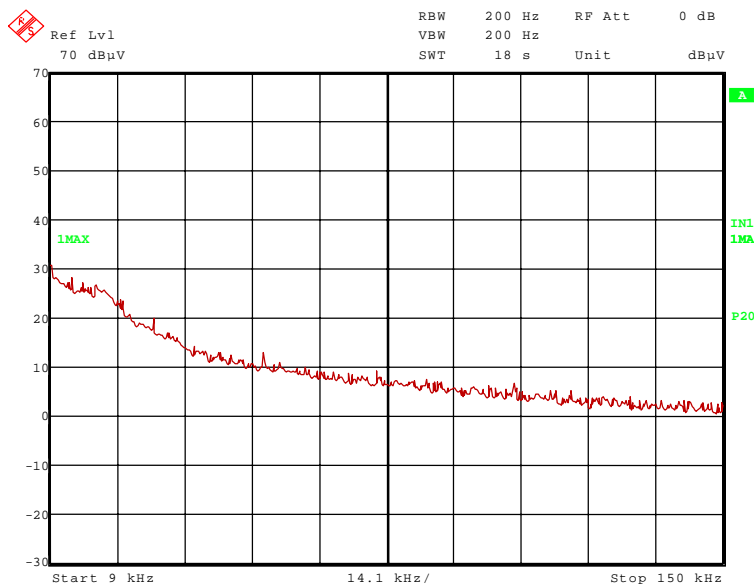
5.5.2 Test results

5.5.2.1 Preliminary radiated emission measurement

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 21 °C | Relative humidity | 28 % |
|---------------------|-------|-------------------|------|

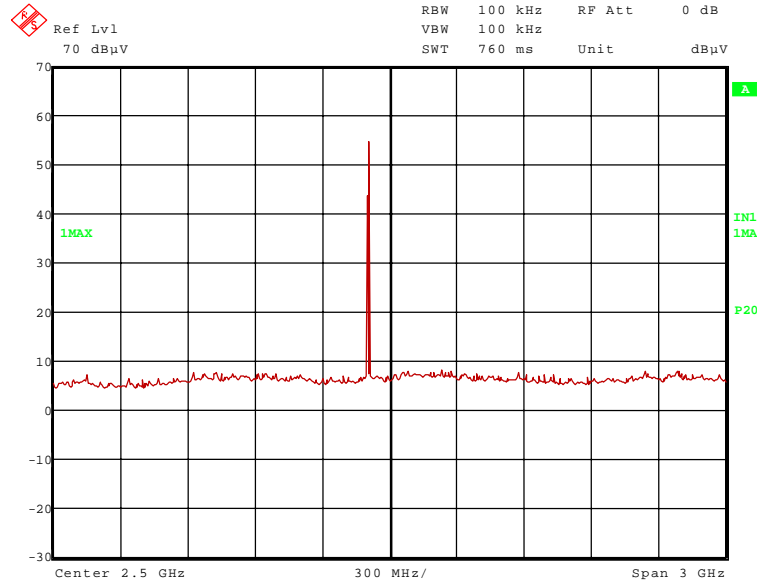
- Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.
- Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.
- Test record: All results are shown in the following.
- Supply voltage: During all measurements the EUT was supplied with 3.0 V_{DC} by two type AAA batteries.
- Remark: No emissions were emitted in the frequency range 9 kHz to 1 GHz independent of the transmitter operation mode. Therefore the emissions in this frequency range were documented only with the transmitter operates at channel 7 (2440 MHz).

124226_8.wmf: Spurious emissions from 9 kHz to 150 kHz:

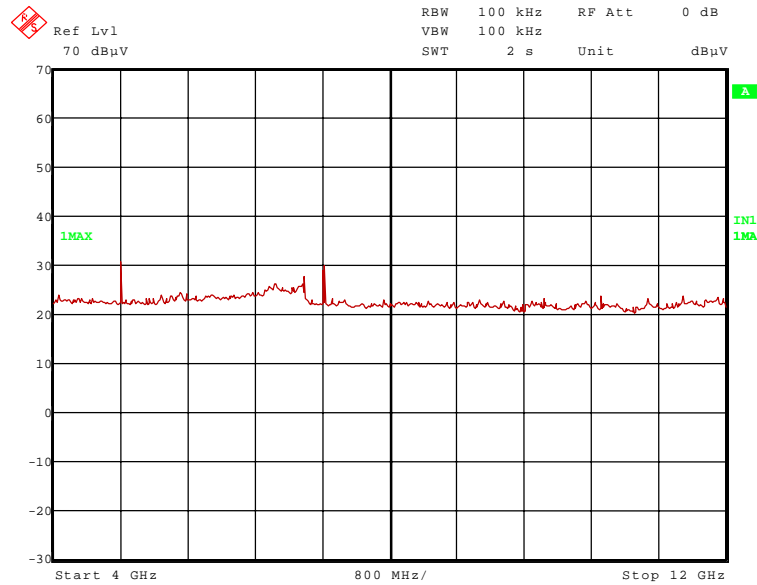


Transmitter operates at channel 0 (2405 MHz)

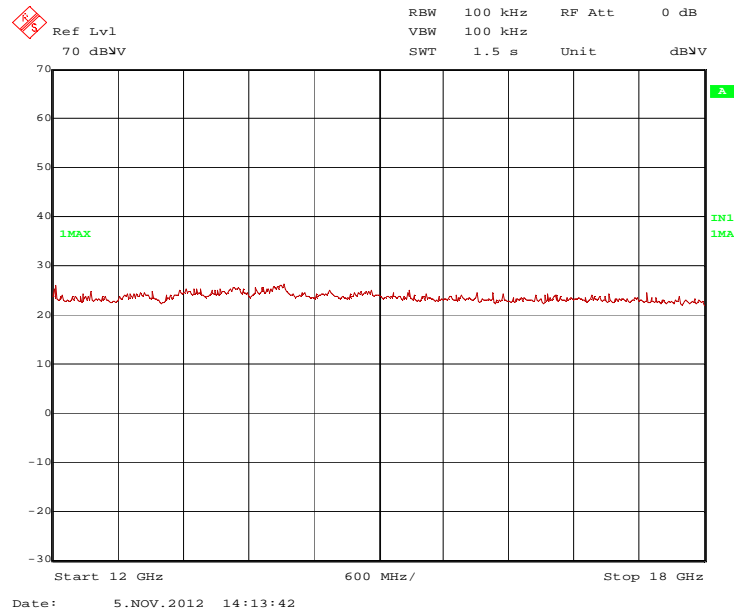
124226_1.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



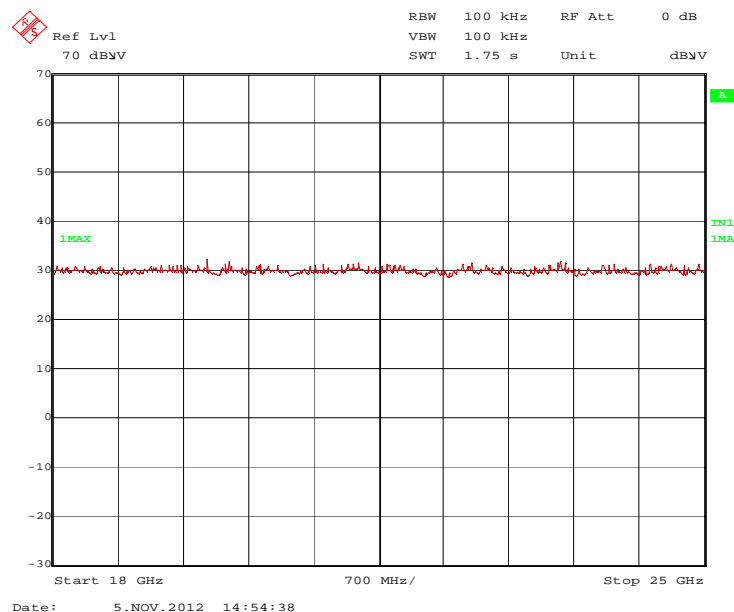
124226_11.wmf: Spurious emissions from 4 GHz to 12 GHz (operation mode 1):



124226_14.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 1):



124226_18.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 1):



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

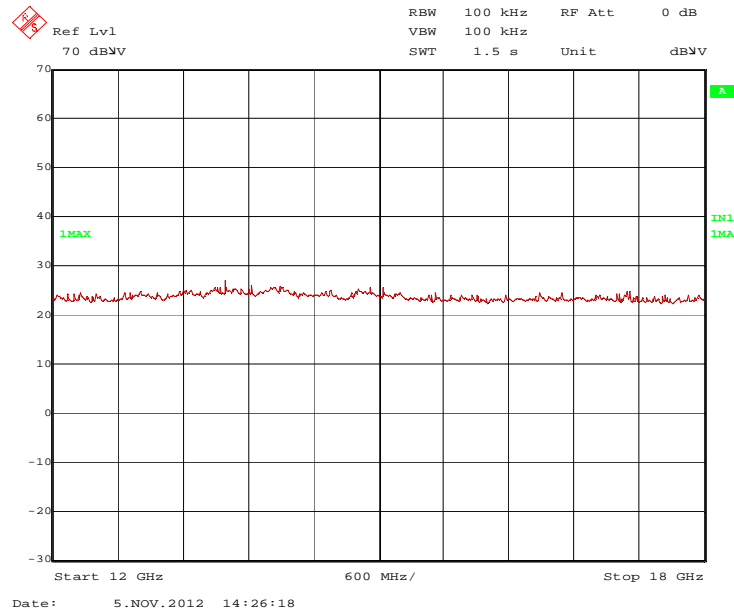
- 4.810 GHz and 7.215 GHz.

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

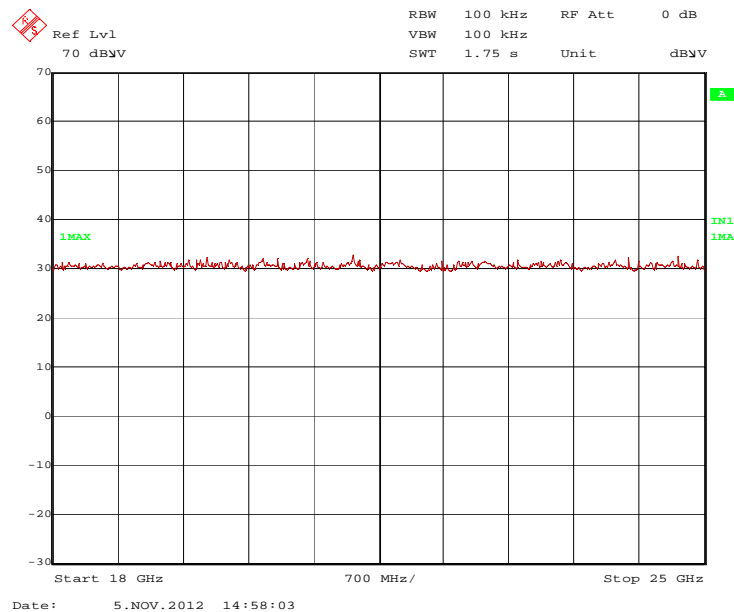
- 2.405 GHz.

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

124226_15.wmf: Spurious emissions from 12 GHz to 18 GHz (operation mode 2):



124226_19.wmf: Spurious emissions from 18 GHz to 25 GHz (operation mode 2):



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

- 4.880 GHz and 7.320 GHz.

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

- 2.440 GHz.

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

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

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 21 °C | Relative humidity | 32 % |
|---------------------|-------|-------------------|------|

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

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

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 3.0 V DC by two type AAA batteries.

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

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

Result measured with the peak detector:

| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Readings dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
|-------------------------|--------------------------------|-----------------------|--------------|------------------------|--------------------------|--------------|---------------------|--------------|------|----------------|------|
| 2405 | 94.1 | - | - | 62.1 | 28.3 | 0.0 | 3.7 | 150 | Hor. | - | 1 |
| 4810 | 47.9 | 74.0 | 26.1 | 35.7 | 32.6 | 25.7 | 5.3 | 150 | Hor. | Yes | 1 |
| 7215 | 50.4 | 74.1 | 23.7 | 32.5 | 35.7 | 24.6 | 6.8 | 150 | Hor. | No | 1 |
| Measurement uncertainty | | | | | | | +2.2 dB / -3.6 dB | | | | |

Result measured with the average detector:

| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Readings dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
|-------------------------|--------------------------------|-----------------------|--------------|------------------------|--------------------------|--------------|---------------------|--------------|------|----------------|------|
| 2405 | 90.9 | - | - | 58.9 | 28.3 | 0.0 | 3.7 | 150 | Hor. | - | 1 |
| 4810 | 41.4 | 54.0 | 12.6 | 29.2 | 32.6 | 25.7 | 5.3 | 150 | Hor. | Yes | 1 |
| 7215 | 37.0 | 70.9 | 33.9 | 19.1 | 35.7 | 24.6 | 6.8 | 150 | Hor. | No | 1 |
| Measurement uncertainty | | | | | | | +2.2 dB / -3.6 dB | | | | |

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

Result measured with the peak detector:

| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Readings dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
|-------------------------|--------------------------------|-----------------------|--------------|------------------------|--------------------------|-------------------|---------------------|--------------|------|----------------|------|
| 2440 | 92.1 | - | - | 60.0 | 28.4 | 0.0 | 3.7 | 150 | Hor. | - | 1 |
| 4880 | 48.4 | 74.0 | 25.6 | 36.0 | 32.8 | 25.7 | 5.3 | 150 | Hor. | Yes | 1 |
| 7320 | 51.0 | 74.0 | 23.0 | 32.6 | 36.2 | 24.6 | 6.8 | 150 | Hor. | Yes | 1 |
| Measurement uncertainty | | | | | | +2.2 dB / -3.6 dB | | | | | |

Result measured with the average detector:

| Frequency MHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Readings dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
|-------------------------|--------------------------------|-----------------------|--------------|------------------------|--------------------------|-------------------|---------------------|--------------|------|----------------|------|
| 2440 | 88.7 | - | - | 56.6 | 28.4 | 0.0 | 3.7 | 150 | Hor. | - | 1 |
| 4880 | 42.8 | 54.0 | 11.2 | 30.4 | 32.8 | 25.7 | 5.3 | 150 | Hor. | Yes | 1 |
| 7320 | 37.7 | 54.0 | 16.3 | 19.3 | 36.2 | 24.6 | 6.8 | 150 | Hor. | Yes | 1 |
| Measurement uncertainty | | | | | | +2.2 dB / -3.6 dB | | | | | |

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

Result measured with the peak detector:

| Frequency GHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Readings dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
|-------------------------|--------------------------------|-----------------------|--------------|------------------------|--------------------------|-------------------|---------------------|--------------|-------|----------------|------|
| 2480 | 94.8 | - | - | 62.5 | 28.5 | 0.0 | 3.8 | 150 | Vert. | - | 1 |
| 4960 | 48.7 | 74.0 | 25.3 | 36.1 | 32.9 | 25.6 | 5.3 | 150 | Hor. | Yes | 1 |
| 7440 | 51.5 | 74.0 | 22.5 | 32.9 | 36.3 | 24.5 | 6.8 | 150 | Vert. | Yes | 1 |
| Measurement uncertainty | | | | | | +2.2 dB / -3.6 dB | | | | | |

Result measured with the average detector:

| Frequency GHz | Corr. value dB μ V/m | Limit dB μ V/m | Margin dB | Readings dB μ V | Antenna factor 1/m | Preamp dB | Cable loss dB | Height cm | Pol. | Restr. Band | Pos. |
|-------------------------|--------------------------------|-----------------------|--------------|------------------------|--------------------------|-------------------|---------------------|--------------|-------|----------------|------|
| 2480 | 91.7 | - | - | 59.4 | 28.5 | 0.0 | 3.8 | 150 | Vert. | - | 1 |
| 4960 | 43.5 | 54.0 | 10.5 | 30.9 | 32.9 | 25.6 | 5.3 | 150 | Hor. | Yes | 1 |
| 7440 | 38.4 | 54.0 | 15.6 | 19.8 | 36.3 | 24.5 | 6.8 | 150 | Vert. | Yes | 1 |
| Measurement uncertainty | | | | | | +2.2 dB / -3.6 dB | | | | | |

Test: Passed

| |
|---|
| TEST EQUIPMENT USED FOR THE TEST: |
| 29, 31 –34, 36, 37, 39, 44, 46, 49 - 51, 72 |

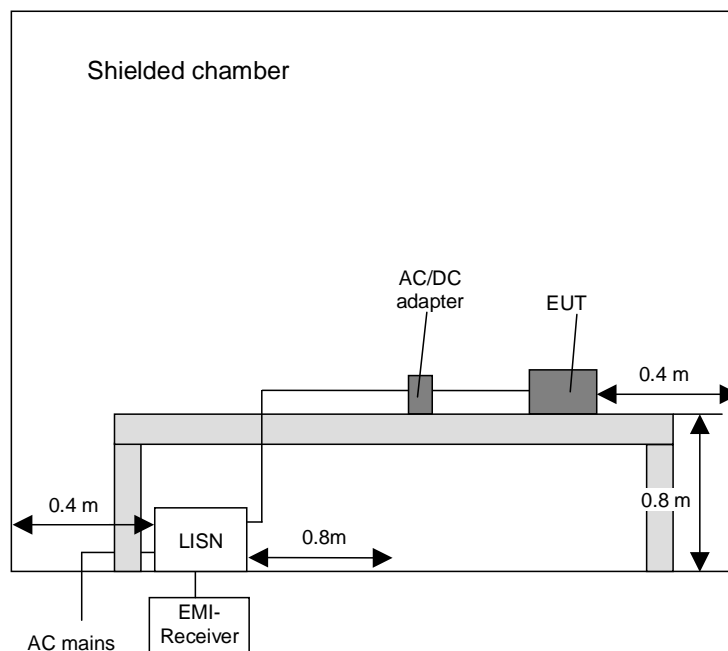
5.6 Conducted emissions on power supply lines

5.6.1 Method of measurement

This test will be carried out in a shielded chamber. Table top 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 |



5.6.2 Test results

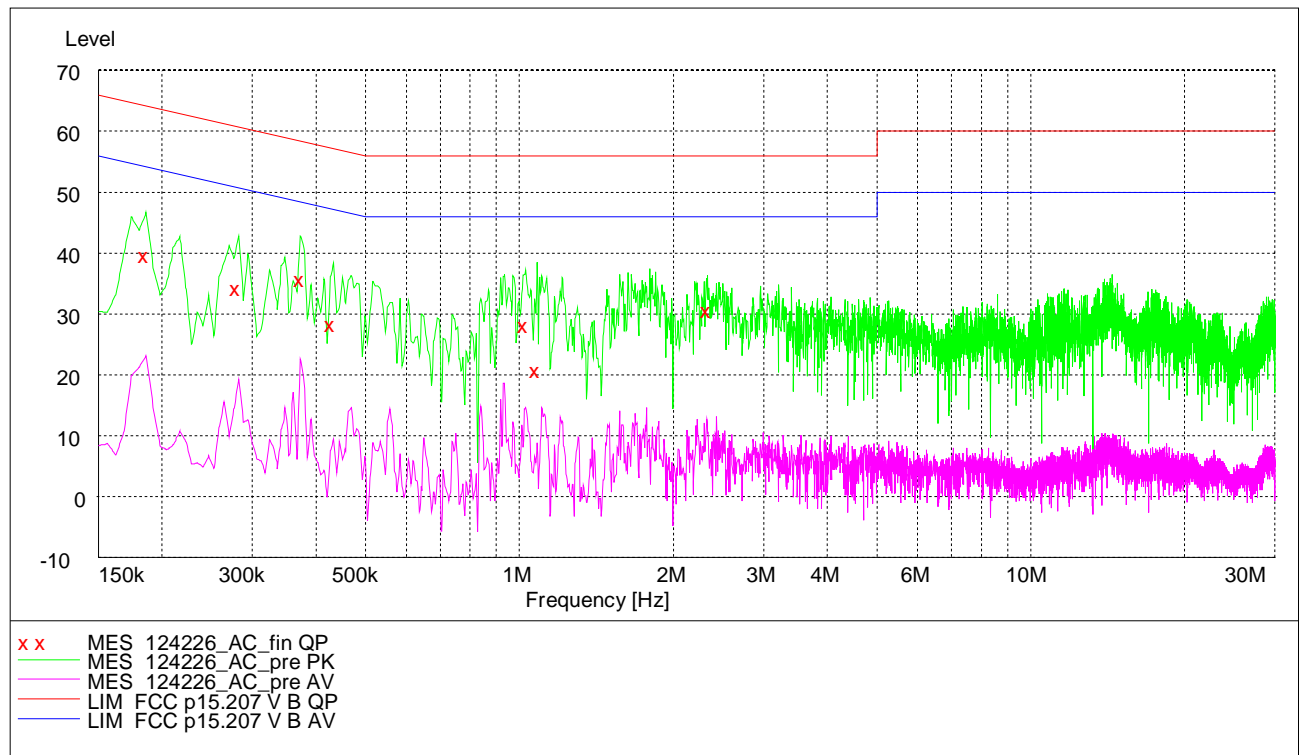
| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 20 °C | Relative humidity | 40 % |
|---------------------|-------|-------------------|------|

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

Cable guide: The cable of the EUT was 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: The EUT operates in operation mode 4. All results are shown in the following.

Supply voltage: During the measurement the EUT was supplied via the USB interface 5 V_{DC} by an AC / DC adaptor type E-TEK ZDA050050EU, which was supplied by 120 V_{AC} / 60 Hz.



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

| Frequency MHz | Level dB μ V | Transducer dB | Limit dB μ V | Margin dB | Line | PE |
|------------------|---------------------|------------------|---------------------|--------------|------|-----|
| 0.186000 | 40.10 | 1.2 | 64.2 | 24.2 | N | FLO |
| 0.280500 | 34.60 | 0.9 | 60.8 | 26.2 | L1 | FLO |
| 0.374100 | 36.20 | 0.9 | 58.4 | 22.2 | L1 | FLO |
| 0.429900 | 28.70 | 0.9 | 57.3 | 28.6 | L1 | FLO |
| 1.023900 | 28.60 | 0.7 | 56.0 | 27.4 | L1 | FLO |
| 1.082400 | 21.10 | 0.8 | 56.0 | 34.9 | L1 | FLO |
| 2.340600 | 31.00 | 0.7 | 56.0 | 25.0 | L1 | FLO |

Test: Passed

| |
|-----------------------------------|
| TEST EQUIPMENT USED FOR THE TEST: |
|-----------------------------------|

| |
|-----------|
| 1 – 4, 20 |
|-----------|

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

| No. | Test equipment | Type | Manufacturer | Serial No. | PM. No. | Cal. Date | Cal. due |
|-----|---|--------------------|--------------------|-------------------|---------|--------------------------------------|----------|
| 1 | Shielded chamber M4 | - | Albatross Projects | B83117-C6439-T262 | 480662 | Weekly verification (system cal.) | |
| 2 | EMI Receiver | ESIB 26 | Rohde & Schwarz | 1088.7490 | 481182 | 03/09/2012 | 03/2014 |
| 3 | LISN | NSLK8128 | Schwarzbeck | 8128161 | 480138 | 12/13/2011 | 12/2012 |
| 4 | High pass filter | HR 0.13-5ENN | FSY Microwave Inc. | DC 0109 SN 002 | 480340 | Weekly verification (system cal.) | |
| 14 | Open area test site | - | Phoenix Test-Lab | - | 480085 | Weekly verification (system cal.) | |
| 15 | Measuring receiver | ESIB7 | Rohde & Schwarz | 100304 | 480521 | 02/15/2012 | 02/2014 |
| 16 | Controller | HD100 | Deisel | 100/670 | 480139 | - | - |
| 17 | Turntable | DS420HE | Deisel | 420/620/80 | 480087 | - | - |
| 18 | Antenna support | 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.) | |
| 30 | Spectrum analyser | FSU | Rohde & Schwarz | 200125 | 480956 | 02/15/2012 | 02/2014 |
| 31 | Measuring receiver | ESI 40 | Rohde & Schwarz | 100064 | 480355 | 02/13/2012 | 02/2014 |
| 32 | Controller | MCU | Maturo | MCU/043/971107 | 480832 | - | - |
| 33 | Turntable | DS420HE | Deisel | 420/620/80 | 480315 | - | - |
| 34 | Antenna support | AS615P | Deisel | 615/310 | 480187 | - | - |
| 35 | Antenna | CBL6112 B | Chase | 2688 | 480328 | 04/21/2011 | 04/2014 |
| 36 | Antenna | 3115 A | EMCO | 9609-4918 | 480183 | 11/09/2011 | 11/2014 |
| 37 | Standard Gain Horn 11.9 GHz – 18 GHz | 18240-20 | Flann Microwave | 483 | 480294 | Six month verification (system cal.) | |
| 39 | Standard Gain Horn 17.9 GHz – 26.7 GHz | 20240-20 | Flann Microwave | 411 | 480297 | Six month verification (system cal.) | |
| 43 | RF-cable No. 30 | RTK 081 | Rosenberger | - | 410141 | Weekly verification (system cal.) | |
| 44 | RF-cable No. 31 | RTK 081 | Rosenberger | - | 410142 | Weekly verification (system cal.) | |
| 46 | RF-cable 1 m | KPS-1533-400-KPS | Insulated Wire | - | 480301 | Six month verification (system cal.) | |
| 49 | Preamplifier | JS3-00101200-23-5A | Miteq | 681851 | 480337 | Six month verification (system cal.) | |
| 50 | Preamplifier | JS3-12001800-16-5A | Miteq | 571667 | 480343 | Six month verification (system cal.) | |
| 51 | Preamplifier | JS3-18002600-20-5A | Miteq | 658697 | 480342 | Six month verification (system cal.) | |
| 55 | Loop antenna | HFH2-Z2 | Rohde & Schwarz | 832609/014 | 480059 | 02/16/2010 | 02/2014 |

