



July 8, 2013

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## Prüfbericht / Test Report

**Nr. / No. 69557-18434-3 (Edition 3)**

Applicant: Brooks Automation (Germany) GmbH  
RFID Division

Type of equipment: RFID TIRIS Reader

Type designation: LF60 Solid

Order No.: Order of 30.01.13

Test standards: FCC Code of Federal Regulations,  
CFR 47, Part 15,  
Sections 15.205, 15.207 and 15.209

### **Note:**

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## 1 Description of the Equipment Under Test (EUT)

| General data of EUT             |  |
|---------------------------------|--|
| Type designation <sup>1</sup> : | LF60 Solid   |
| Parts <sup>2</sup> :            | Reader LF60<br>Mini Antenna ANT-7K15                       |
| Serial number(s):               | 4812 0004  |
| Manufacturer:                   | Brooks Automation GmbH                                     |
| Type of equipment:              | RFID TIRIS Reader  |
| Version:                        | With modifications according to documentation of applicant |
| FCC ID:                         | N5GLF60C   |
| Additional parts/accessories:   |  |

<sup>1</sup> Type designation of the system if EUT consists of more than one part.

<sup>2</sup> Type designations of the parts of the system, if applicable.

| <b>Technical data of EUT</b>            |  |
|---|--|
| Application frequency range:            | 134.2 kHz  |
| Frequency range:                        | 134.2 kHz  |
| Operating frequency:                    | 134.2 kHz  |
| Type of modulation:                     | AM / FM  |
| Pulse train:                            | ---  |
| Pulse width:                            | ---  |
| Number of RF-channels:                  | 1  |
| Channel spacing:                        | ---  |
| Designation of emissions <sup>3</sup> : | 1K80A1D  |
| Type of antenna:                        | Dedicated antenna  |
| Size/length of antenna:                 | Ø 1 x 7 cm   |
| Connection of antenna:                  | <input checked="" type="checkbox"/> detachable <input type="checkbox"/> not detachable |
| Type of power supply:                   | DC supply  |
| Specifications for power supply:        | nominal voltage: 24 V<br>minimum voltage: 18 V<br>maximum voltage: 30 V                |
| Specifications for AC power supply:     | nominal voltage: 110 V<br>nominal frequency: 60 Hz                                     |

<sup>3</sup> Also known as "Class of Emission".

## 2 Administrative Data

### Application details

|                           |   |
|---------------------------|---|
| Applicant (full address): | Brooks Automation (Germany) GmbH<br>RFID Division<br>Gartenstraße 19<br>D-95490 Mistelgau |
| Contact person:           | Mr. Lothar Düngfelder   |
| Order number:             | Order of 30.01.13   |
| Receipt of EUT:           | 2013-01-22  |
| Date(s) of test:          | 2013-02-01 to 2013-02-25  |
| Note(s):                  |   |

### Report details

|                |               |
|----------------|---------------|
| Report number: | 69557-18434-3 |
| Edition:       | 3             |
| Issue date:    | 2013-07-08    |

### 3 Identification of the Test Laboratory

| Details of the Test Laboratory          |  |
|---|--|
| Company name:                           | TÜV SÜD Product Service GmbH                                 |
| Address:                                | Aeussere Fruehlingstrasse 45<br>D-94315 Straubing<br>Germany |
| FCC test site registration number       | 90926  |
| Industry Canada test site registration: | 3050A-2  |
| Contact person:                         | Mr. Johann Roidt   |
|   | Phone: +49 9421 5522-0<br>Fax: +49 9421 5522-99              |

## 4 Summary

### Summary of test results

The tested sample complies with the requirements set forth in the  
**Code of Federal Regulations CFR 47, Part 15, Sections 15.205, 15.207 and 15.209**  
of the Federal Communication Commission (FCC).

### Personnel involved in this report

Laboratory Manager:



Mr. Johann Roidt

Responsible for testing:



Mr. Martin Steindl

Responsible for test report:

Mr. Martin Steindl

## 5 Operation Mode and Configuration of EUT

### Operation Mode(s)

Reading tag continuously

### Configuration(s) of EUT

The EUT was configured in stand alone configuration. For conducted power line emissions the antenna was replaced by a 50 Ohms termination resistor.

### List of ports and cables

| Port | Description             | Classification <sup>4</sup> | Cable type | Cable length |
|------|-------------------------|-----------------------------|------------|--------------|
| 1    | DC supply of EUT        | dc power                    | Unshielded | 2 m          |
| 2    | Ethernet                | signal/control port         | Shielded   | 2 m          |
| 3    | RS-232                  | signal/control port         | Shielded   | 2 m          |
| 4    | Remote I/O <sup>5</sup> | signal/control port         | Shielded   | ---          |
| 5    | Antenna                 | signal/control port         | Shielded   | 1 m          |

### List of devices connected to EUT

| Item | Description | Type Designation | Serial no. or ID | Manufacturer |
|------|-------------|------------------|------------------|--------------|
| 1    | Antenna     | ANT-7K15         | ---              | Brooks       |

### List of support devices

| Item | Description | Type Designation | Serial no. or ID | Manufacturer |
|------|-------------|------------------|------------------|--------------|
|      | ---         |                  |                  |              |

<sup>4</sup> Ports shall be classified as ac power, dc power or signal/control port

<sup>5</sup> This port was excluded from testing by the applicant. No cable was attached.

## 6 Measurement Procedures

### 6.1 Conducted Output Power

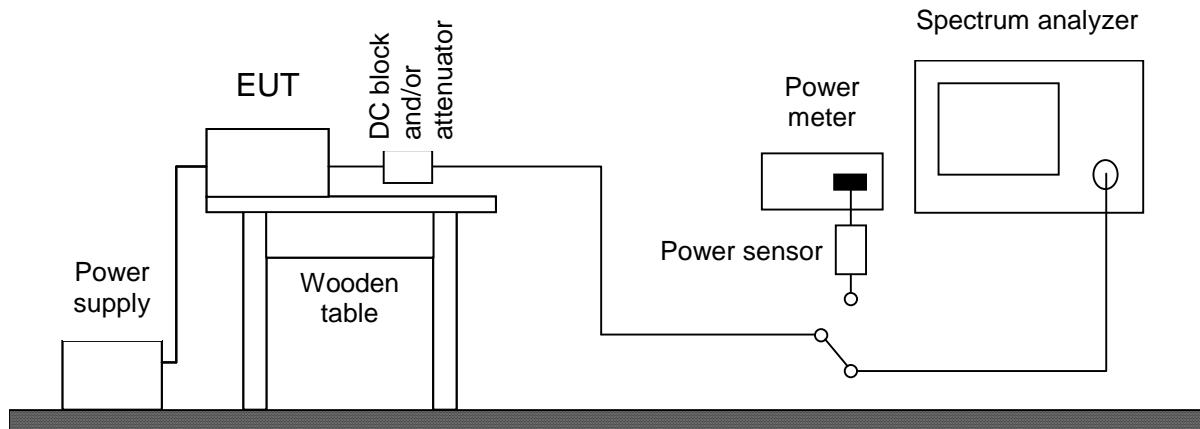
#### Measurement Procedure:

Rules and specifications: CFR 47 Part 2, section 2.1046(a)

Guide: CFR 47 Part 2, section 2.1046

Conducted output power is measured at the RF output terminals (e.g. antenna connector if antenna is detachable) when the transmitter is adjusted in accordance with the tune-up procedure, if applicable. The RF output terminals are connected to a spectrum analyzer and/or a power meter with appropriate sensor. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as dc block and appropriate attenuators (50 Ohms). The electrical characteristics of the radio frequency load attached to the output terminals shall be stated, if applicable.

If a spectrum analyzer is used and no other settings are specified resolution bandwidth shall be selected according to the carrier frequency  $f_c$  and set to 10 kHz ( $150 \text{ kHz} \leq f_c < 30 \text{ MHz}$ ), 100 kHz ( $30 \text{ MHz} \leq f_c < 1 \text{ GHz}$ ) or 1 MHz ( $f_c \geq 1 \text{ GHz}$ ). The video bandwidth shall be at least three times greater than the resolution bandwidth. The settings used have to be indicated within the appropriate test record(s).



Test instruments used:

| Type  | Designation | Inv.-no. | Serial No. or ID         | Manufacturer    |
|---|-------------|----------|--------------------------|-----------------|
| <input type="checkbox"/> Spectrum analyzer            | FSP30       | 1666     | 100063                   | Rohde & Schwarz |
| <input checked="" type="checkbox"/> EMI test receiver | ESPI7       | 1711     | 836914/0002              | Rohde & Schwarz |
| <input type="checkbox"/> EMI test receiver            | ESMI        | 1569     | 839379/013<br>839587/006 | Rohde & Schwarz |
| <input type="checkbox"/> Power meter                  | NRVS        | 1264     | 836856/015               | Rohde & Schwarz |
| <input type="checkbox"/> Peak power sensor            | NRV-Z31     | 1701     | 8579604.03               | Rohde & Schwarz |
| <input type="checkbox"/> Power sensor                 | NRV-Z52     | 1499     | 837901/030               | Rohde & Schwarz |
| <input type="checkbox"/> Power sensor                 | NRV-Z4      | 1034     | 863828/015               | Rohde & Schwarz |
| <input type="checkbox"/> DC-block                     | 7006        | 1636     | A2798                    | Weinschel       |
| <input checked="" type="checkbox"/> Attenuator        | 4776-10     | 1638     | 9412                     | Narda           |
| <input type="checkbox"/> Attenuator                   | 4776-20     | 1639     | 9503                     | Narda           |

## 6.2 Bandwidth Measurements

| <b>Measurement Procedure:</b>  |   |
|--|---|
| Rules and specifications:  | CFR 47 Part 2, section 2.202(a)<br>CFR 47 Part 15, section 15.215(c)<br>IC RSS-Gen Issue 3, sections 4.6.1 and 4.6.2<br>IC RSS-210 Issue 8, section A1.1.3<br>ANSI C63.4, annex H.6 |
| Guide:   | ANSI C63.4 / IC RSS-Gen Issue 3, sections 4.6.1 and 4.6.2   |
| Measurement setup:   | <input type="checkbox"/> Conducted: See below<br><input checked="" type="checkbox"/> Radiated: Radiated Emission Measurement 9 kHz to 30 MHz (6.4)                                  |
| <p>If antenna is detachable bandwidth measurements shall be performed at the antenna connector (conducted measurement) when the transmitter is adjusted in accordance with the tune-up procedure, if applicable. The RF output terminals are connected to a spectrum analyzer. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as dc block and appropriate attenuators (50 Ohms). The electrical characteristics of the radio frequency load attached to the output terminals shall be stated, if applicable.</p> <p>If radiated measurements are performed the same test setups and instruments are used as with radiated emission measurements for the appropriate frequency range.</p> <p>The analyzer settings are specified by the test description of the appropriate test record(s).</p> |   |

### 6.3 Conducted AC Powerline Emission

#### Measurement Procedure:

|                           |   |
|---------------------------|---|
| Rules and specifications: | CFR 47 Part 15, section 15.207<br>IC RSS-GEN Issue 3, section 7.2.4 |
| Guide:                    | ANSI C63.4 / CISPR 22   |

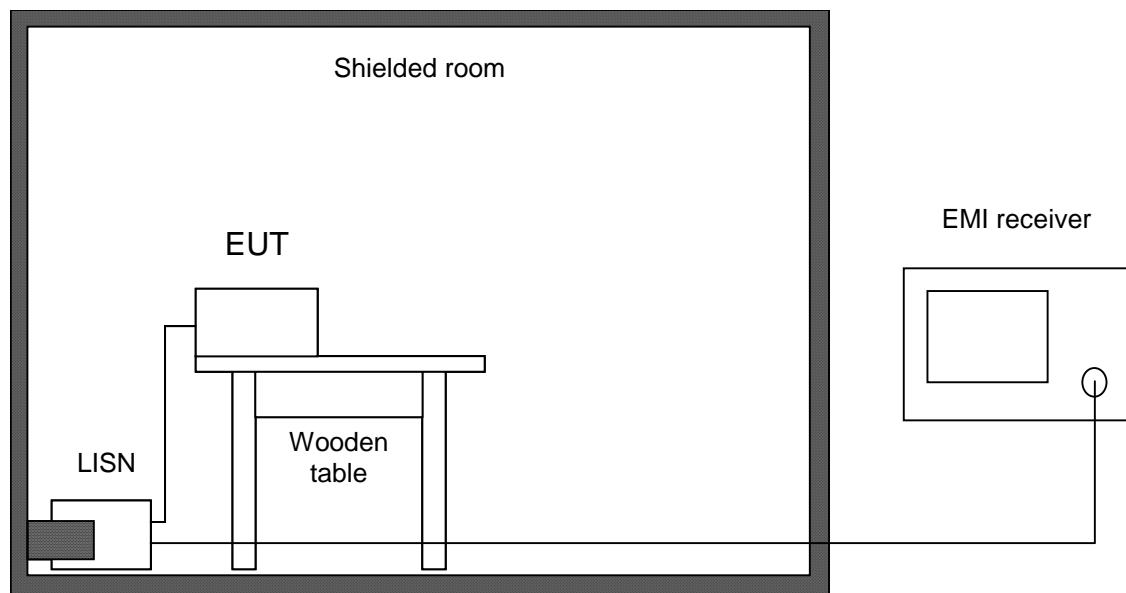
Conducted emission tests in the frequency range 150 kHz to 30 MHz are performed using Line Impedance Stabilization Networks (LISNs). To simplify testing with quasi-peak and average detector the following procedure is used:

First the whole spectrum of emission caused by the equipment under test (EUT) is recorded with detector set to peak using CISPR bandwidth of 10 kHz. After that all emission levels having less margin than 10 dB to or exceeding the average limit are retested with detector set to quasi-peak.

If average limit is kept with quasi-peak levels no additional scan with average detector is necessary. In cases of emission levels between quasi-peak and average limit an additional scan with detector set to average is performed.

According to ANSI C63.4, section 13.1.3.1, testing of intentional radiators with detachable antenna shall be performed using a suitable dummy load connected to the antenna output terminals. Otherwise, the tests shall be made with the antenna connected and, if adjustable, fully extended.

Testing with dummy load may be necessary to distinguish (unintentional) conducted emissions on the supply lines from (intentional) emissions radiated by the antenna and coupling directly to supply lines and/or LISN. Usage of dummy load has to be stated in the appropriate test record(s) and notes should be added to clarify the test setup.



Test instruments used:

| Type  | Designation | Inv.-no. | Serial No. or ID | Manufacturer    |
|---|-------------|----------|------------------|-----------------|
| <input checked="" type="checkbox"/> Test receiver | ESHS 10     | 1028     | 860043/016       | Rohde & Schwarz |
| <input checked="" type="checkbox"/> V-network     | ESH 3-Z5    | 1059     | 894785/005       | Rohde & Schwarz |
| <input checked="" type="checkbox"/> V-network     | ESH 3-Z5    | 1218     | 830952/025       | Rohde & Schwarz |
| <input type="checkbox"/> Artificial mains network | ESH 2-Z5    | 1536     | 842966/004       | Rohde & Schwarz |
| <input type="checkbox"/> Shielded room            | No. 1       | 1451     | ---              | Albatross       |
| <input checked="" type="checkbox"/> Shielded room | No. 4       | 1454     | 3FD 100 544      | Euroshield      |

## 6.4 Radiated Emission Measurement 9 kHz to 30 MHz

### Measurement Procedure:

|                           |  |
|---------------------------|--|
| Rules and specifications: | CFR 47 Part 15, sections 15.205 and 15.209<br>IC RSS-GEN Issue 3, sections 7.2.2 and 7.2.5 |
| Guide:                    | ANSI C63.4   |

Radiated emission in the frequency range 9 kHz to 30 MHz is measured using an active loop antenna. First the whole spectrum of emission caused by the equipment is recorded at a distance of 3 meters in a fully or semi anechoic room with the detector of the spectrum analyzer or EMI receiver set to peak. This configuration is also used for recording the spectrum of intentional radiators.

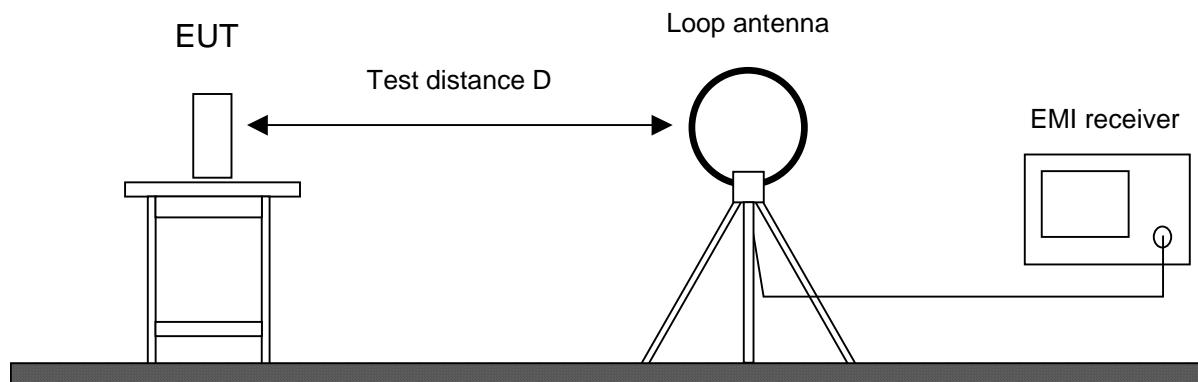
Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

EUT is rotated all around to find the maximum levels of emissions. Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

If worst case emission of the EUT cannot be recorded with EUT in standard position and loop antenna in vertical polarization the EUT (or the radiating part of the EUT) is rotated by 90 degrees instead of changing the loop antenna to horizontal polarization. This procedure is selected to minimize the influence of the environment (e.g. effects caused by the floor especially with longer distances).

Final measurement is performed at a test distance D of 30 meters using an open field test site. In case the regulation requires testing at other distances, the result is extrapolated by either making measurements at an additional distance D of 10 meters to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). In cases of very low emissions measurements are performed at shorter distances and results are extrapolated to the required distance. The provisions of CFR 47 Part 15 sections 15.31(d) and (f)(2) apply. According to CFR 47 Part 15 section 15.209(d) final measurement is performed with detector function set to quasi-peak except for the frequency bands 9 to 90 kHz and 110 to 490 kHz where, for non-pulsed operation, average detector is employed.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.



Test instruments used:

| Type   | Designation | Inv.-no. | Serial No. or ID         | Manufacturer    |
|--|-------------|----------|--------------------------|-----------------|
| <input type="checkbox"/> Spectrum analyzer             | FSP30       | 1666     | 100036                   | Rohde & Schwarz |
| <input type="checkbox"/> EMI test receiver             | ESMI        | 1569     | 839379/013<br>839587/006 | Rohde & Schwarz |
| <input type="checkbox"/> Test receiver                 | ESHS 10     | 1028     | 860043/016               | Rohde & Schwarz |
| <input checked="" type="checkbox"/> EMI test receiver  | ESU8        | 2044     | 100232                   | Rohde & Schwarz |
| <input type="checkbox"/> Preamplifier                  | Cabin no. 2 | CPA9231A | 1716                     | Schaffner       |
| <input checked="" type="checkbox"/> Loop antenna       |             | HFH2-Z2  | 1016                     | Rohde & Schwarz |
| <input type="checkbox"/> Fully anechoic room           | No. 2       | 1452     | ---                      | Albatross       |
| <input type="checkbox"/> Semi anechoic room            | No. 3       | 1453     | ---                      | Siemens         |
| <input checked="" type="checkbox"/> Semi anechoic room | No. 8       | 2057     | ---                      | Albatross       |

## 6.5 Radiated Emission at Alternative Test Site

### Measurement Procedure:

|                           |   |
|---------------------------|---|
| Rules and specifications: | CFR 47 Part 15, section 15.209<br>IC RSS-GEN Issue 3, section 7.2.5 |
| Guide:                    | ANSI C63.4  |

Radiated emission in the frequency range 30 MHz to 1 GHz is measured within a semi-anechoic room with groundplane complying with the NSA requirements of ANSI C63.4 for alternative test sites. A linear polarized logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna") is used. The measurement bandwidth of the test receiver is set to 120 kHz with quasi-peak detector selected.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.

Hand-held or body-worn devices are tested in the position producing the highest emission relative to the limit as verified by prescans in fully anechoic room.

If no prescan in a fully anechoic room is used first a peak scan is performed in four positions to get the whole spectrum of emission caused by EUT with the measuring antenna raised and lowered from 1 to 4 m to find table position, antenna height and antenna polarization for the maximum emission levels.

Data reduction is applied to these results to select those levels having less margin than 10 dB to or exceeding the limit using subranges and limited number of maximums. Further maximization is following.

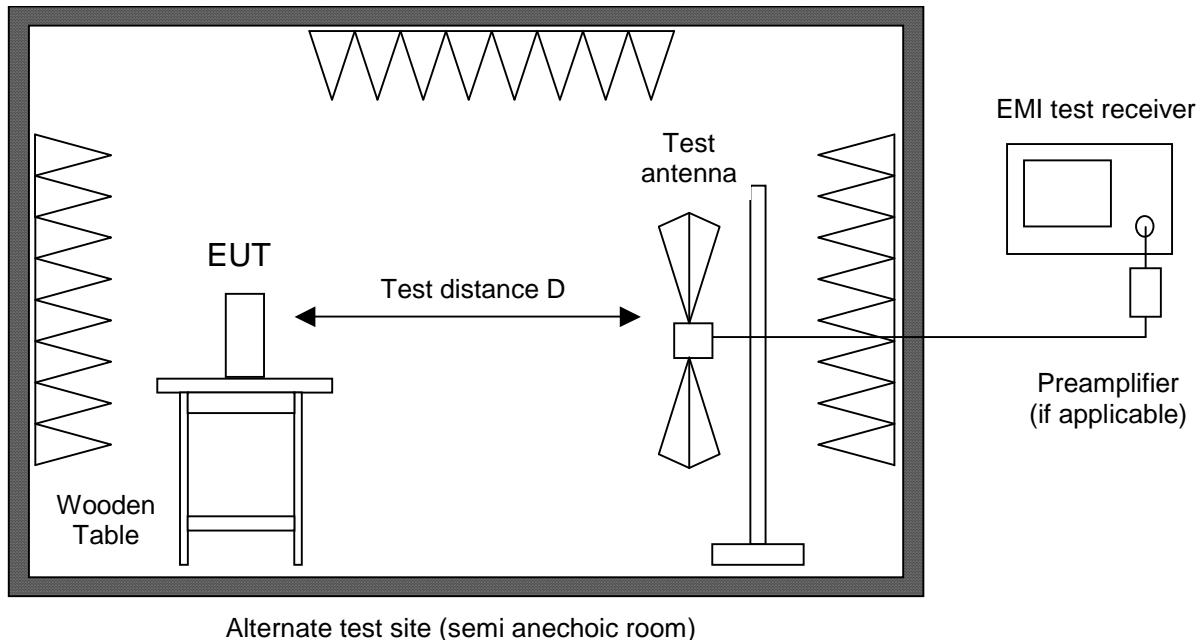
With detector of the test receiver set to quasi-peak final measurements are performed immediately after frequency zoom (for drifting disturbances) and maximum adjustment.

Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

In cases where prescans in a fully anechoic room are taken (e. g. if EUT is operating for a short time only or battery is discharged quickly) final measurements with quasi-peak detector are performed manually at frequencies indicated by prescan with EUT rotating all around and receiving antenna raising and lowering within 1 meter to 4 meters to find the maximum levels of emission.

Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

For measuring emissions of intentional radiators and receivers a test distance D of 3 meters is selected. Testing of unintentional radiators is performed at a distance of 10 meters. If limits specified for 3 meters shall be used for measurements performed at 10 meters distance the limits are calculated according to CFR 47 Part 15 section 15.31(d) and (f)(1) using an inverse linear-distance extrapolation factor of 20 dB/decade.



Alternate test site (semi anechoic room)

Test instruments used:

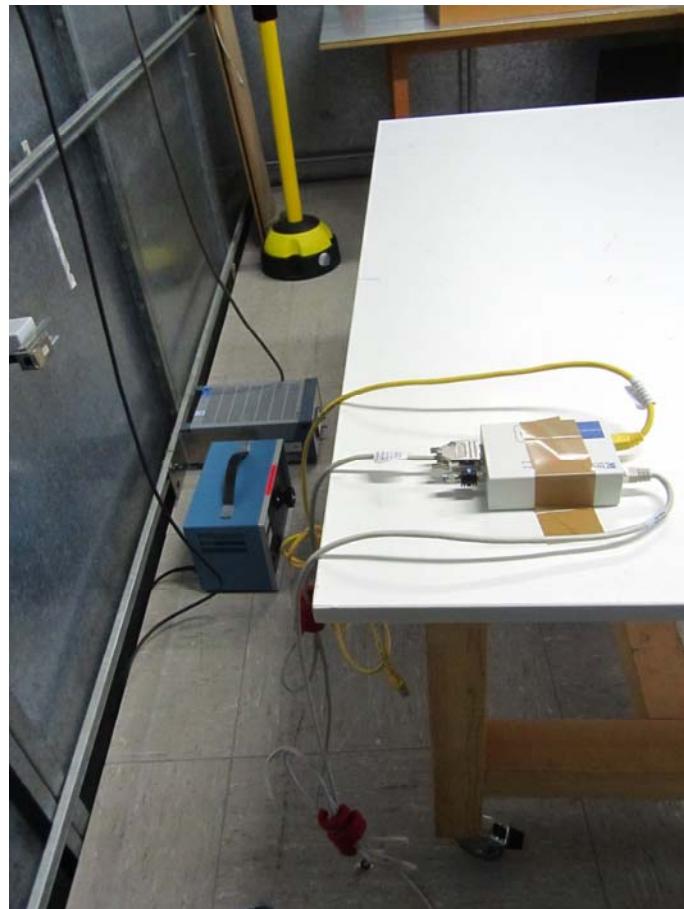
| Type   | Designation | Inv.-no. | Serial No. or ID | Manufacturer    |
|--|-------------|----------|------------------|-----------------|
| <input checked="" type="checkbox"/> EMI test receiver          | ESU8        | 2044     | 100232           | Rohde & Schwarz |
| <input checked="" type="checkbox"/> Trilog antenna Cabin no. 8 | VULB 9163   | 2058     | 9163-408         | Schwarzbeck     |
| <input checked="" type="checkbox"/> Semi anechoic room         | No. 8       | 2057     | ---              | Albatross       |

## 7 Photographs Taken During Testing

## Test setup for conducted DC powerline emission measurement



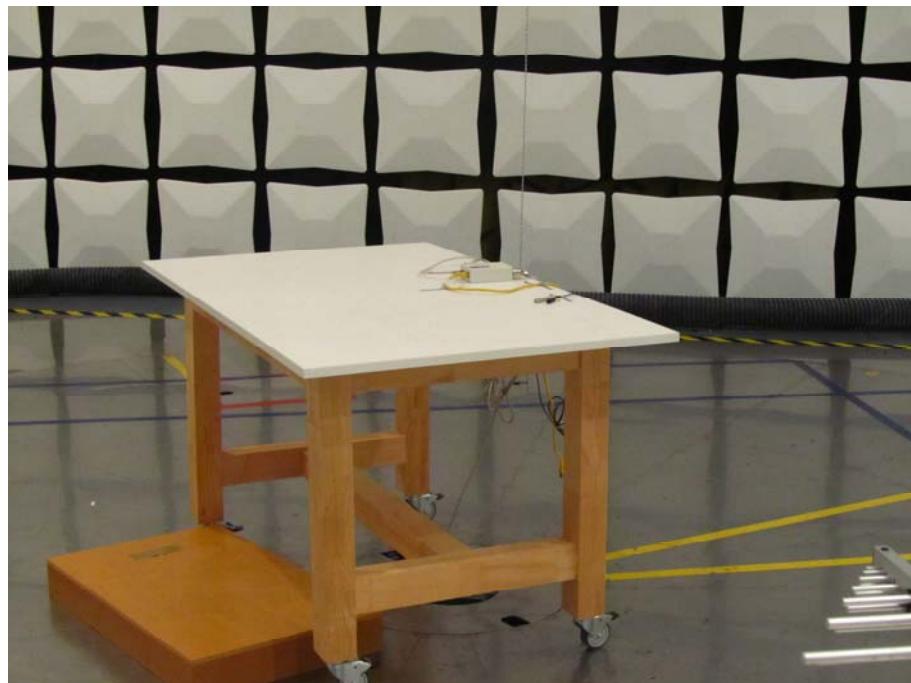
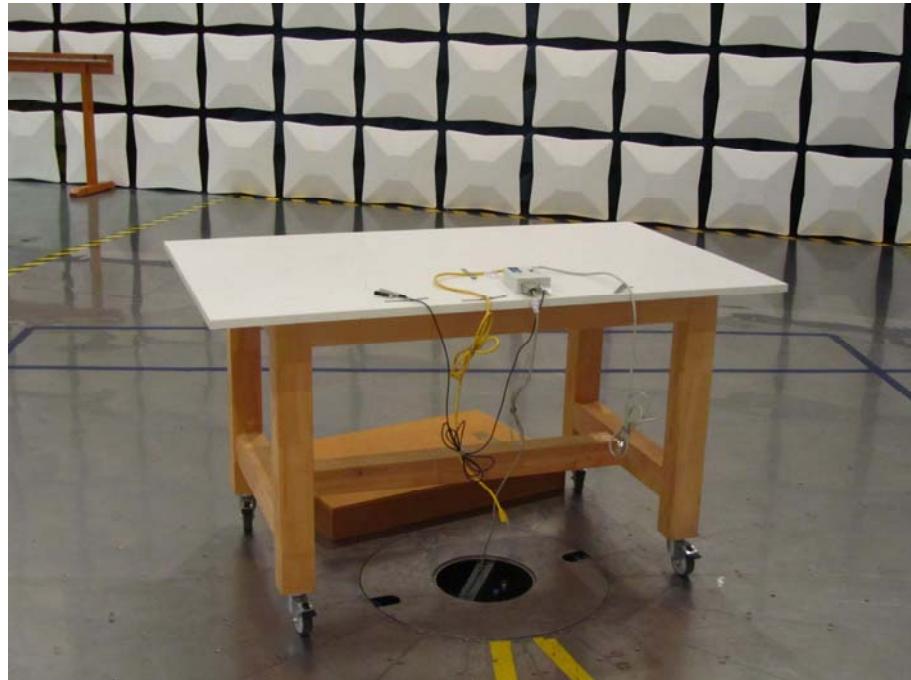
**Test setup for conducted DC powerline emission measurement**  
**- continued -**



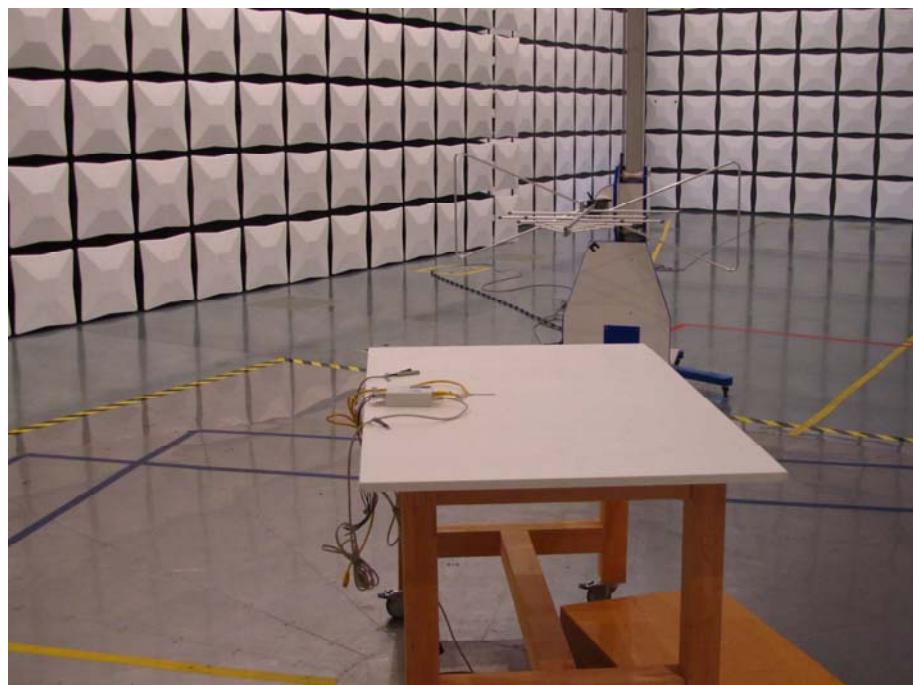
### Test setup for radiated emission measurement 9 kHz – 30 MHz



## Test setup for radiated emission measurement (alternate test site)



**Test setup for radiated emission measurement  
(alternate test site) - continued -**



## 8 Test Results

| <b>FCC CFR 47 Parts 2 and 15</b> |  |             |                |
|----------------------------------|--|-------------|----------------|
| <i>Section(s)</i>                | <i>Test</i>  | <i>Page</i> | <i>Result</i>  |
| 2.1046(a)                        | Conducted output power                               | 25          | Recorded       |
| 2.202(a)                         | Occupied bandwidth                                   | 27          | Recorded       |
| 2.201, 2.202                     | Class of emission                                    | 31          | Calculated     |
| 15.35(c)                         | Pulse train measurement for pulsed operation         | ---         | Not applicable |
| 15.205(a)                        | Restricted bands of operation                        | 32          | Test passed    |
| 15.207                           | Conducted AC powerline emission<br>150 kHz to 30 MHz | ---         | Not applicable |
| 15.207                           | Conducted DC powerline emission<br>150 kHz to 30 MHz | 33          | Test passed    |
| 15.205(b)<br>15.209              | Radiated emission<br>9 kHz to 30 MHz                 | 35          | Test passed    |
| 15.205(b)<br>15.209              | Radiated emission<br>30 MHz to 1 GHz                 | 36          | Test passed    |

## 8.1 Conducted Output Power

|                           |   |
|---------------------------|---|
| Rules and specifications: | CFR 47 Part 2, section 2.1046(a)  |
| Guide:                    | CFR 47 Part 2, section 2.1046   |
| Description:              | Conducted output power shall be measured at the RF output terminals (e.g. antenna connector if antenna is detachable) when the transmitter is adjusted in accordance with the tune-up procedure, if applicable. The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated. |
| Measurement procedure:    | Conducted Output Power (6.1)  |

|               |                 |
|---------------|-----------------|
| Comment:      |                 |
| Date of test: | 2013-02-25      |
| Test site:    | Unshielded room |

|              |             |
|--------------|-------------|
| Test Result: | Test passed |
|--------------|-------------|

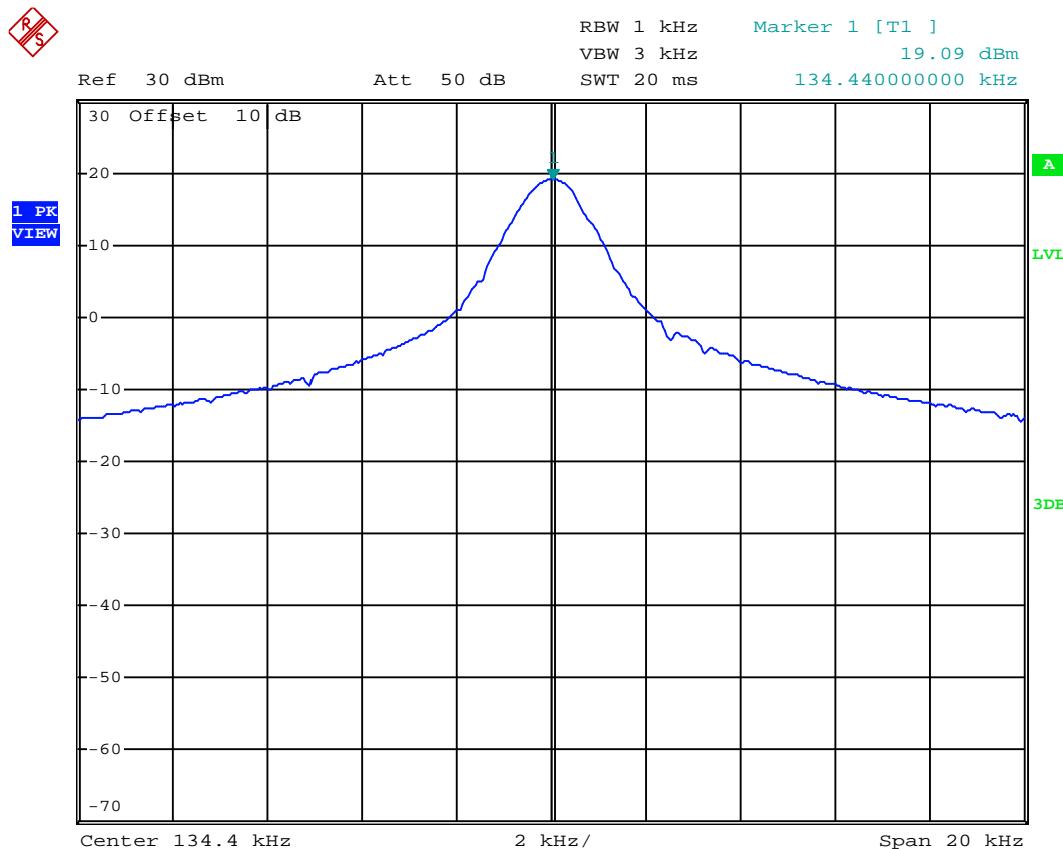
| Antenna gain: | dBi             |            |               |                 |                    |             |             |
|---------------|-----------------|------------|---------------|-----------------|--------------------|-------------|-------------|
| Mode          | Frequency (MHz) | Power Type | Reading (dBm) | Correction (dB) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
| Transmitting  | 0,1             | Peak       | 19,1          | 0,0             | 19,1               |             |             |

**Note 1:** If applicable, PEP (peak envelope power) and RMS values are measured using a power meter with appropriate sensor.

**Note 2:** If applicable, peak or average values are measured using a spectrum analyzer with resolution and video bandwidth set to: RBW = 1 kHz, VBW = 3 kHz

**Note 3:** If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power limit is reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### Conducted Output Power:



Date: 25.FEB.2013 12:56:14

## 8.2 Occupied Bandwidth

| Rules and specifications: | CFR 47 Part 2, section 2.202(a)<br>ANSI C63.4, annex H.6  |                       |                              |                 |       |                    |        |                    |         |
|---------------------------|---|-----------------------|------------------------------|-----------------|-------|--------------------|--------|--------------------|---------|
| Guide:                    | ANSI C63.4  |                       |                              |                 |       |                    |        |                    |         |
| Description:              | <p>The occupied bandwidth according to CFR 47 Part 2, section 2.202(a), is measured as the 99% emission bandwidth, i.e. below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5% of the total mean power radiated by a given emission.</p> <p>The occupied bandwidth according to ANSI C63.4, annex H.6; is measured as the frequency range defined by the points that are 26 dB down relative to the maximum level of the modulated carrier.</p> <p>The resolution bandwidth of the spectrum analyzer shall be set to a value greater than 5.0% of the allowed bandwidth. If no bandwidth specifications are given, the following guidelines are used:</p> <table border="1"><thead><tr><th>Fundamental frequency</th><th>Minimum resolution bandwidth</th></tr></thead><tbody><tr><td>9 kHz to 30 MHz</td><td>1 kHz</td></tr><tr><td>30 MHz to 1000 MHz</td><td>10 kHz</td></tr><tr><td>1000 MHz to 40 GHz</td><td>100 kHz</td></tr></tbody></table> <p>The video bandwidth shall be at least three times greater than the resolution bandwidth.</p> | Fundamental frequency | Minimum resolution bandwidth | 9 kHz to 30 MHz | 1 kHz | 30 MHz to 1000 MHz | 10 kHz | 1000 MHz to 40 GHz | 100 kHz |
| Fundamental frequency     | Minimum resolution bandwidth  |                       |                              |                 |       |                    |        |                    |         |
| 9 kHz to 30 MHz           | 1 kHz   |                       |                              |                 |       |                    |        |                    |         |
| 30 MHz to 1000 MHz        | 10 kHz  |                       |                              |                 |       |                    |        |                    |         |
| 1000 MHz to 40 GHz        | 100 kHz   |                       |                              |                 |       |                    |        |                    |         |
| Measurement procedure:    | Bandwidth Measurements (6.2)  |                       |                              |                 |       |                    |        |                    |         |

|               |                                  |
|---------------|----------------------------------|
| Comment:      |                                  |
| Date of test: | 2013-02-06                       |
| Test site:    | Fully anechoic room, cabin no. 8 |

### Occupied Bandwidth (99 %):



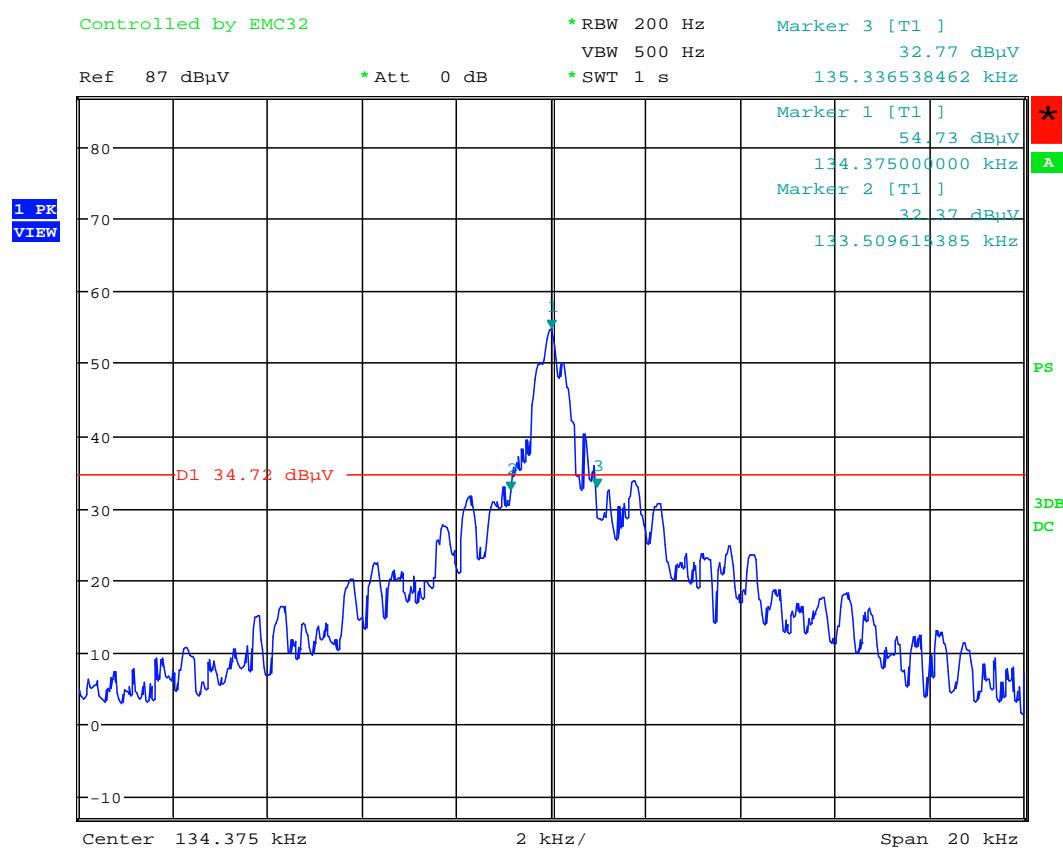
Date: 6.FEB.2013 15:11:21

Occupied Bandwidth (99 %): **3.878 kHz**

### 8.3 Bandwidth of the Emission

| Rules and specifications: | CFR 47 Part 15, section 15.209   |                       |                              |                 |       |                    |        |                    |         |
|---------------------------|--|-----------------------|------------------------------|-----------------|-------|--------------------|--------|--------------------|---------|
| Guide:                    | ANSI C63.4   |                       |                              |                 |       |                    |        |                    |         |
| Description:              | <p>The 20 dB bandwidth of the emission is measured as the frequency range defined by the points that are 20 dB down relative to the maximum level of the modulated carrier.</p> <p>For intentional radiators operating under the alternative provisions to the general emission limits the requirement to contain the 20 dB bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.</p> <p>The resolution bandwidth of the spectrum analyzer shall be set to a value greater than 5.0% of the allowed bandwidth. If no bandwidth specifications are given, the following guidelines are used:</p> <table border="1"><thead><tr><th>Fundamental frequency</th><th>Minimum resolution bandwidth</th></tr></thead><tbody><tr><td>9 kHz to 30 MHz</td><td>1 kHz</td></tr><tr><td>30 MHz to 1000 MHz</td><td>10 kHz</td></tr><tr><td>1000 MHz to 40 GHz</td><td>100 kHz</td></tr></tbody></table> <p>The video bandwidth shall be at least three times greater than the resolution bandwidth.</p> | Fundamental frequency | Minimum resolution bandwidth | 9 kHz to 30 MHz | 1 kHz | 30 MHz to 1000 MHz | 10 kHz | 1000 MHz to 40 GHz | 100 kHz |
| Fundamental frequency     | Minimum resolution bandwidth   |                       |                              |                 |       |                    |        |                    |         |
| 9 kHz to 30 MHz           | 1 kHz  |                       |                              |                 |       |                    |        |                    |         |
| 30 MHz to 1000 MHz        | 10 kHz   |                       |                              |                 |       |                    |        |                    |         |
| 1000 MHz to 40 GHz        | 100 kHz  |                       |                              |                 |       |                    |        |                    |         |
| Measurement procedure:    | Bandwidth Measurements (6.2)   |                       |                              |                 |       |                    |        |                    |         |

|               |                                  |
|---------------|----------------------------------|
| Comment:      |                                  |
| Date of test: | 2013-02-06                       |
| Test site:    | Fully anechoic room, cabin no. 8 |



Date: 6.FEB.2013 15:14:25

Bandwidth of the emission: **1.827 kHz**

## 8.4 Designation of Emissions

|                           |   |
|---------------------------|---|
| Rules and specifications: | CFR 47 Part 2, sections 2.201 and 2.202 |
| Guide:                    | ANSI C63.4 / TRC-43                     |

|                     |                      |
|---------------------|----------------------|
| Type of modulation: | Amplitude Modulation |
|---------------------|----------------------|

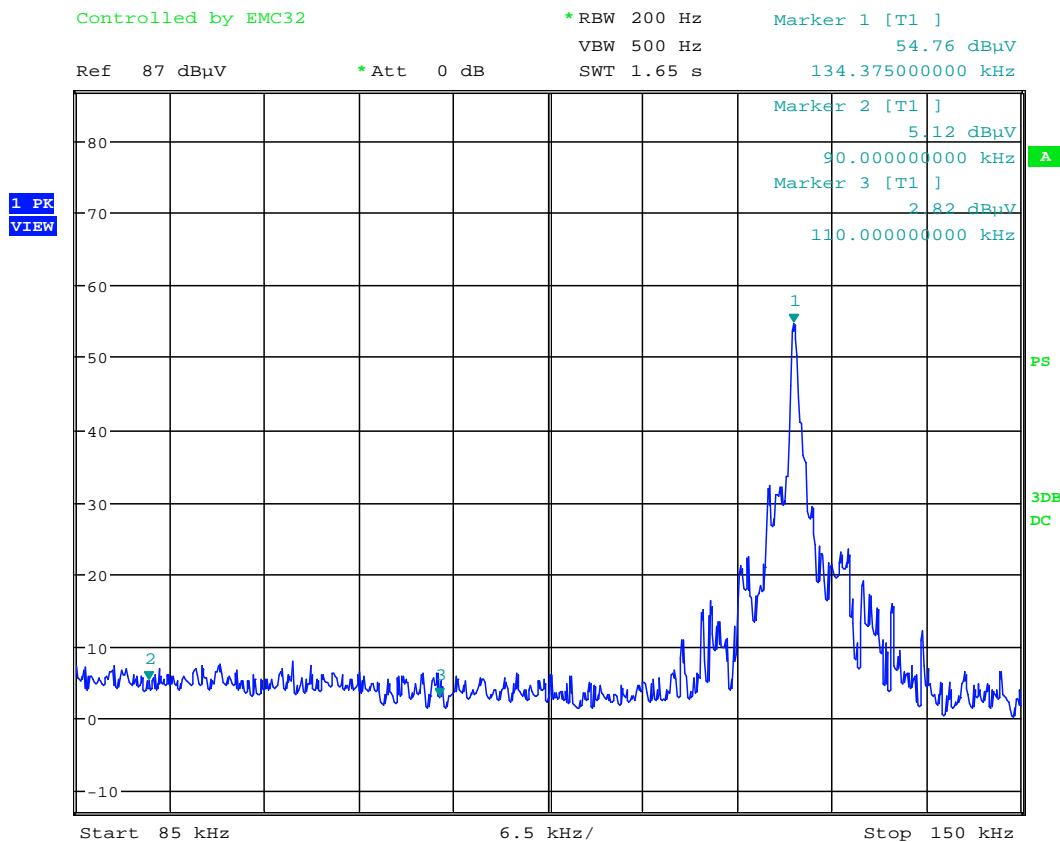
|                                       |   |
|---------------------------------------|---|
| $B_n = \text{Necessary Bandwidth}$    | $B_n = 2BK$   |
| $B = \text{Modulation rate}$          | $B = 0.9 \text{ kHz}$                                       |
| $K = \text{Overall numerical factor}$ | $K = 1$   |
| Calculation:                          | $B_n = 2 \cdot (0.9 \text{ kHz}) \cdot 1 = 1.8 \text{ kHz}$ |

|                           |                |
|---------------------------|----------------|
| Designation of Emissions: | <b>1K80A1D</b> |
|---------------------------|----------------|

## 8.5 Restricted Bands of Operation

|                           |  |
|---------------------------|--|
| Rules and specifications: | CFR 47 Part 15, section 15.205(a)  |
| Guide:                    | ANSI C63.4   |
| Limit:                    | Only spurious emissions are permitted in any of the frequency bands listed in CFR 47 Part 15, section 15.205(a). |
| Measurement procedure:    | Radiated Emission Measurement 9 kHz to 30 MHz (6.4)  |

|                |                                  |
|----------------|----------------------------------|
| Comment:       |                                  |
| Date of test:  | 2013-02-06                       |
| Test site:     | Fully anechoic room, cabin no. 8 |
| Test distance: | 10 meters                        |



Date: 6.FEB.2013 15:09:02

|              |             |
|--------------|-------------|
| Test Result: | Test passed |
|--------------|-------------|

## 8.6 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

|                           |                                       |                                 |  |
|---------------------------|---------------------------------------|---------------------------------|--|
| Rules and specifications: | CFR 47 Part 15, section 15.207        |                                 |  |
| Guide:                    | ANSI C63.4 / CISPR 22                 |                                 |  |
| Limit:                    | Frequency of Emission (MHz)           | Conducted Limit (dB $\mu$ V)    |  |
|                           |                                       | Quasi-peak                      | Average                                      |
|                           |                                       | 0.15 - 0.5<br>0.5 - 5<br>5 - 30 | 66 to 56<br>56<br>60<br>56 to 46<br>46<br>50 |
| Measurement procedure:    | Conducted AC Powerline Emission (6.3) |                                 |  |

|               |  |
|---------------|--|
| Comment:      | Since the applicant does not provide an appropriate AC/DC adapter the conducted emissions were tested on the DC supply of the EUT. |
| Date of test: | 2013-02-25   |
| Test site:    | Shielded room, cabin no. 4   |

|              |             |
|--------------|-------------|
| Test Result: | Test passed |
|--------------|-------------|

|            |      |
|------------|------|
| Tested on: | Plus |
|------------|------|

| Frequency (MHz) | Detector   | Reading Value (dB $\mu$ V) | Correction Factor (dB) | Final Value (dB $\mu$ V) | Limit (dB $\mu$ V) | Margin (dB) |
|-----------------|------------|----------------------------|------------------------|--------------------------|--------------------|-------------|
| 0,285           | Quasi-Peak | 54,4                       | 0,0                    | 54,4                     | 60,7               | 6,3         |
| 0,285           | Average    | 50,6                       | 0,0                    | 50,6                     | 50,7               | 0,1         |
| 1,140           | Average    | 27,4                       | 0,0                    | 27,4                     | 46,0               | 18,6        |
| 19,439          | Average    | 31,5                       | 0,0                    | 31,5                     | 50,0               | 18,5        |
| 21,725          | Average    | 38,2                       | 0,0                    | 38,2                     | 50,0               | 11,8        |
| 25,899          | Quasi-Peak | 40,0                       | 0,0                    | 40,0                     | 60,0               | 20,0        |
| 28,877          | Average    | 40,4                       | 0,0                    | 40,4                     | 50,0               | 9,6         |

|            |       |
|------------|-------|
| Tested on: | Minus |
|------------|-------|

| Frequency<br>(MHz) | Detector   | Reading<br>Value<br>(dB $\mu$ V) | Correction<br>Factor<br>(dB) | Final<br>Value<br>(dB $\mu$ V) | Limit<br>(dB $\mu$ V) | Margin<br>(dB) |
|--------------------|------------|----------------------------------|------------------------------|--------------------------------|-----------------------|----------------|
| 0,285              | Quasi-Peak | 51,7                             | 0,0                          | 51,7                           | 60,7                  | 9,0            |
| 22,205             | Quasi-Peak | 40,7                             | 0,0                          | 40,7                           | 60,0                  | 19,3           |
| 24,484             | Quasi-Peak | 42,4                             | 0,0                          | 42,4                           | 60,0                  | 17,6           |
| 0,285              | Average    | 50,6                             | 0,0                          | 50,6                           | 50,7                  | 0,1            |
| 0,570              | Average    | 28,8                             | 0,0                          | 28,8                           | 46,0                  | 17,2           |
| 1,140              | Average    | 28,4                             | 0,0                          | 28,4                           | 46,0                  | 17,6           |
| 1,710              | Average    | 27,1                             | 0,0                          | 27,1                           | 46,0                  | 18,9           |
| 3,990              | Average    | 26,0                             | 0,0                          | 26,0                           | 46,0                  | 20,0           |
| 19,390             | Average    | 33,9                             | 0,0                          | 33,9                           | 50,0                  | 16,1           |
| 21,677             | Average    | 40,1                             | 0,0                          | 40,1                           | 50,0                  | 9,9            |
| 24,531             | Average    | 42,4                             | 0,0                          | 42,4                           | 50,0                  | 7,6            |

**Sample calculation of final values:**

$$\text{Final Value (dB}\mu\text{V)} = \text{Reading Value (dB}\mu\text{V)} + \text{Correction Factor (dB)}$$

## 8.7 Radiated Emission Measurement 9 kHz to 30 MHz

|                           |   |                             |                                      |                                 |
|---------------------------|---|-----------------------------|--------------------------------------|---------------------------------|
| Rules and specifications: | CFR 47 Part 15, sections 15.205 and 15.209  |                             |                                      |                                 |
| Guide:                    | ANSI C63.4  |                             |                                      |                                 |
| Limit:                    | Frequency of Emission (MHz)   | Field Strength ( $\mu$ V/m) | Field Strength ( $\text{dB}\mu$ V/m) | Measurement Distance d (meters) |
|                           | 0.009 - 0.490   | 2400/F(kHz)                 | 67.6 - 20 · log(F(kHz))              | 300                             |
|                           | 0.490 - 1.705   | 24000/F(kHz)                | 87.6 - 20 · log(F(kHz))              | 30                              |
|                           | 1.705 - 30.000  | 30                          | 29.5                                 | 30                              |
|                           | Additionally, the level of any unwanted emissions shall not exceed the level of the fundamental emission. |                             |                                      |                                 |
| Measurement procedure:    | Radiated Emission Measurement 9 kHz to 30 MHz (6.4)   |                             |                                      |                                 |

|               |                      |
|---------------|----------------------|
| Comment:      |                      |
| Date of test: | 2013-02-06           |
| Test site:    | Open field test site |

|              |             |
|--------------|-------------|
| Test Result: | Test passed |
|--------------|-------------|

| Extrapolation factor: | -40 dB/decade |                 |                |                                   |                          |                           |                             |                                   |                             |             |
|-----------------------|---------------|-----------------|----------------|-----------------------------------|--------------------------|---------------------------|-----------------------------|-----------------------------------|-----------------------------|-------------|
| Frequency (MHz)       | Detector      | Distance d1 (m) | Distance d (m) | Reading Value ( $\text{dB}\mu$ V) | Correction Factor (dB/m) | Extrapolation Factor (dB) | Pulse Train Correction (dB) | Final Value ( $\text{dB}\mu$ V/m) | Limit ( $\text{dB}\mu$ V/m) | Margin (dB) |
| 0,13435               | Peak          | 10              | 300            | 50,7                              | 20,0                     | -59,1                     |                             | 11,6                              | 25,0                        | 13,4        |

### Sample calculation of final values:

$$\text{Extrapolation Factor (dB)} = (\text{Log}(d) - \text{Log}(d_1)) \cdot \text{Extrapolation Factor (dB/decade)}$$

$$\text{Final Value (dB}\mu\text{V/m)} = \text{Reading Value } d_1 \text{ (dB}\mu\text{V)} + \text{Correction Factor (dB/m)} + \text{Extrapolation Factor (dB)} + \text{Pulse Train Correction (dB)}$$

Note: Extrapolation factor (dB) and final value (dB}\mu\text{V/m) are relating to distance d.

## 8.8 Radiated Emission Measurement 30 MHz to 1 GHz

|                           |   |                             |                               |
|---------------------------|---|-----------------------------|-------------------------------|
| Rules and specifications: | CFR 47 Part 15, section 15.209  |                             |                               |
| Guide:                    | ANSI C63.4  |                             |                               |
| Limit:                    | Frequency of Emission (MHz)   | Field Strength ( $\mu$ V/m) | Field Strength (dB $\mu$ V/m) |
|                           | 30 - 88   | 100                         | 40.0                          |
|                           | 88 - 216  | 150                         | 43.5                          |
|                           | 216 - 960   | 200                         | 46.0                          |
|                           | Above 960   | 500                         | 54.0                          |
|                           | Additionally, the level of any unwanted emissions shall not exceed the level of the fundamental emission. |                             |                               |
| Measurement procedures:   | Radiated Emission at Alternative Test Site (6.5)  |                             |                               |

|                |  |
|----------------|--|
| Comment:       |  |
| Date of test:  | 2013-02-07   |
| Test site:     | Frequencies $\leq$ 1 GHz: Semi-anechoic room, cabin no. 8<br>Frequencies $>$ 1 GHz: Fully anechoic room, cabin no. 2 |
| Test distance: | 3 meters   |

|              |             |
|--------------|-------------|
| Test Result: | Test passed |
|--------------|-------------|

| Frequency (MHz) | Antenna Polarization | Detector   | Receiver Reading (dB $\mu$ V) | Correction Factor (dB/m) | Pulse Train Correction (dB) | Final Value (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|-----------------|----------------------|------------|-------------------------------|--------------------------|-----------------------------|----------------------------|----------------------|-------------|
| 37,700          | vertical             | Quasi-Peak | 18,7                          | 15,0                     |                             | 33,7                       | 40,0                 | 6,3         |
| 42,900          | vertical             | Quasi-Peak | 16,9                          | 15,8                     |                             | 32,7                       | 40,0                 | 7,3         |
| 43,180          | vertical             | Quasi-Peak | 13,7                          | 15,8                     |                             | 29,5                       | 40,0                 | 10,5        |
| 64,920          | vertical             | Quasi-Peak | 19,4                          | 12,2                     |                             | 31,6                       | 40,0                 | 8,4         |
| 293,860         | horizontal           | Quasi-Peak | 15,7                          | 14,7                     |                             | 30,4                       | 46,0                 | 15,6        |
| 303,010         | horizontal           | Quasi-Peak | 20,8                          | 14,8                     |                             | 35,6                       | 46,0                 | 10,4        |
| 316,910         | horizontal           | Quasi-Peak | 20,4                          | 15,2                     |                             | 35,6                       | 46,0                 | 10,4        |
| 334,070         | horizontal           | Quasi-Peak | 21,6                          | 15,8                     |                             | 37,4                       | 46,0                 | 8,6         |
| 355,620         | horizontal           | Quasi-Peak | 23,3                          | 16,5                     |                             | 39,8                       | 46,0                 | 6,2         |
| 380,570         | horizontal           | Quasi-Peak | 25,9                          | 16,6                     |                             | 42,5                       | 46,0                 | 3,5         |

### Sample calculation of final values:

$$\text{Final Value (dB}\mu\text{V/m)} = \text{Reading Value (dB}\mu\text{V)} + \text{Correction Factor (dB/m)} + \text{Pulse Train Correction (dB)}$$

## 9 Referenced Regulations

All tests were performed with reference to the following regulations and standards:

|                                     |                |   |  |
|-------------------------------------|----------------|---|--|
| <input checked="" type="checkbox"/> | CFR 47 Part 2  | Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)   | October 1, 2012                                      |
| <input checked="" type="checkbox"/> | CFR 47 Part 15 | Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)   | October 1, 2012                                      |
| <input checked="" type="checkbox"/> | ANSI C63.4     | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz                                     | December 11, 2003<br>(published on January 30, 2004) |
| <input type="checkbox"/>            | ANSI C63.4     | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz                                     | June 7, 2009<br>(published on September 15, 2009)    |
| <input type="checkbox"/>            | RSS-Gen        | Radio Standards Specification RSS-Gen Issue 3 containing General Requirements and Information for the Certification of Radiocommunication Equipment, published by Industry Canada                       | December 2010  |
| <input type="checkbox"/>            | RSS-210        | Radio Standards Specification RSS-210 Issue 8 for Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, published by Industry Canada                         | December 2010  |
| <input type="checkbox"/>            | RSS-310        | Radio Standards Specification RSS-310 Issue 3 for Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category II Equipment, published by Industry Canada                        | December 2010  |
| <input checked="" type="checkbox"/> | RSS-102        | Radio Standards Specification RSS-102 Issue 4: Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), published by Industry Canada                             | March 2010,<br>footnote 13 updated December 2010     |
| <input type="checkbox"/>            | ICES-003       | Interference-Causing Equipment Standard ICES-003 Issue 4 for Digital Apparatus, published by Industry Canada  | February 7, 2004                                     |
| <input checked="" type="checkbox"/> | CISPR 22       | Third Edition of the International Special Committee on Radio Interference (CISPR), Pub. 22, "Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement" | 1997   |

|                                     |                                 |  |               |
|-------------------------------------|---------------------------------|--|---------------|
| <input type="checkbox"/>            | CAN/CSA-<br>CEI/IEC<br>CISPR 22 | Limits and Methods of Measurement of Radio<br>Disturbance Characteristics of Information<br>Technology Equipment   | 2002          |
|                                     |                                 | CAN/CSA CISPR 22-10<br>Information technology equipment -<br>Radio disturbance characteristics -<br>Limits and methods of measurement<br>(Adopted IEC CISPR 22:2008, sixth edition, 2008-09) |               |
| <input type="checkbox"/>            | CAN/CSA<br>CISPR 22-10          | Information technology equipment -<br>Radio disturbance characteristics -<br>Limits and methods of measurement<br>(Adopted IEC CISPR 22:2008, sixth edition, 2008-09)                        | 2010          |
| <input checked="" type="checkbox"/> | TRC-43                          | Notes Regarding Designation of Emissions (Including<br>Necessary Bandwidth and Classification), Class of<br>Station and Nature of Service, published by Industry<br>Canada                   | October, 2008 |

## 10 Test Equipment List with Calibration Data

| Type                     | Inv.-No. | Type Designation | Serial Number | Manufacturer    | Calibration Organization | Last Calibration | Next Calibration |
|--------------------------|----------|------------------|---------------|-----------------|--------------------------|------------------|------------------|
| EMI test receiver        | 1028     | ESHS10           | 860043/016    | Rohde & Schwarz | Rohde & Schwarz          | 04/2012          | 10/2013          |
| EMI test receiver        | 1569     | ESMI             | 839699/006    | Rohde & Schwarz | Rohde & Schwarz          | 11/2012          | 11/2014          |
| EMI test receiver        | 1711     | ESPI7            | 836914/0002   | Rohde & Schwarz | Rohde & Schwarz          | 11/2012          | 05/2014          |
| EMI test receiver        | 2044     | ESU8             | 100232        | Rohde & Schwarz | Rohde & Schwarz          | 07/2012          | 01/2014          |
| V-network                | 1059     | ESH3-Z5          | 894785/005    | Rohde & Schwarz | Rohde & Schwarz          | 08/2011          | 08/2013          |
| V-network                | 1218     | ESH3-Z5          | 830952/025    | Rohde & Schwarz | Rohde & Schwarz          | 08/2011          | 08/2013          |
| Loop antenna             | 1016     | HFH2-Z2          | 882964/0001   | Rohde & Schwarz | Rohde & Schwarz          | 11/2012          | 05/2014          |
| TRILOG Broadband Antenna | 2058     | VULB 9163        | 9163-408      | Schwarzbeck     | Rohde & Schwarz          | 11/2012          | 05/2014          |

Note 1: No calibration required.

Note 2: Not calibrated separately but with the whole test system when recording calibration data.

Note 3: No calibration required. Devices are checked before use.

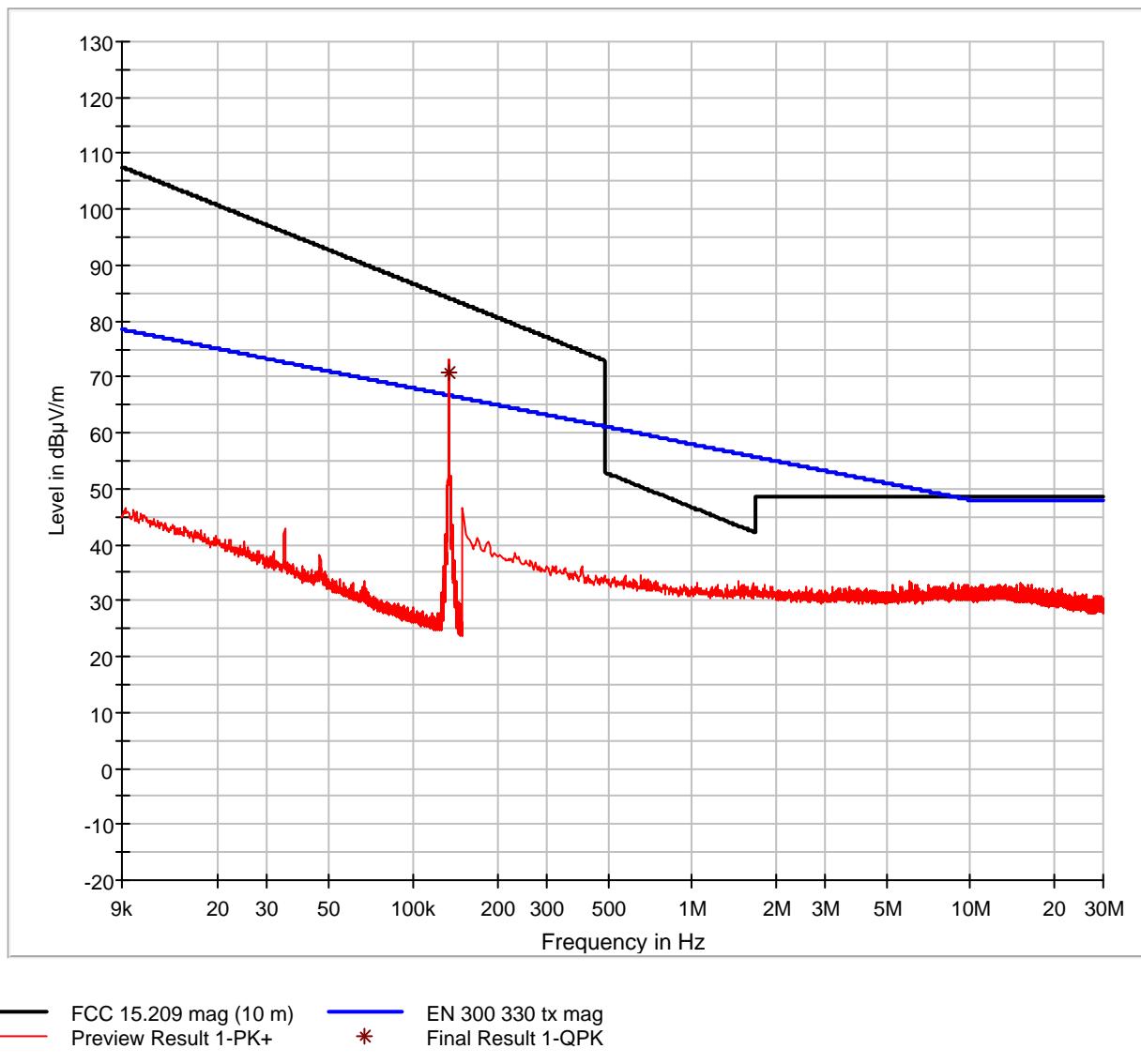
Note 4: No calibration required. Devices are checked by calibrated equipment during test.

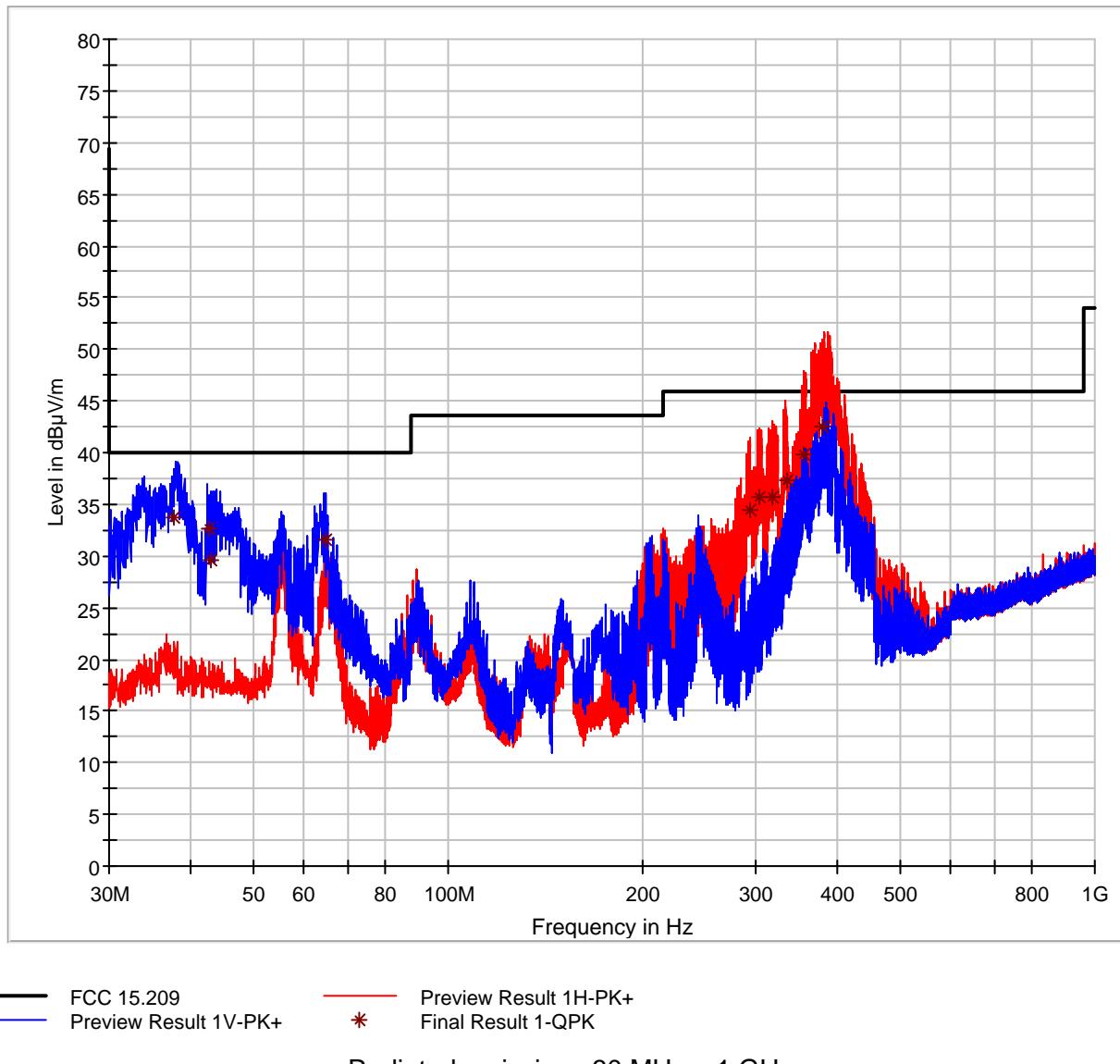
## 11 Revision History

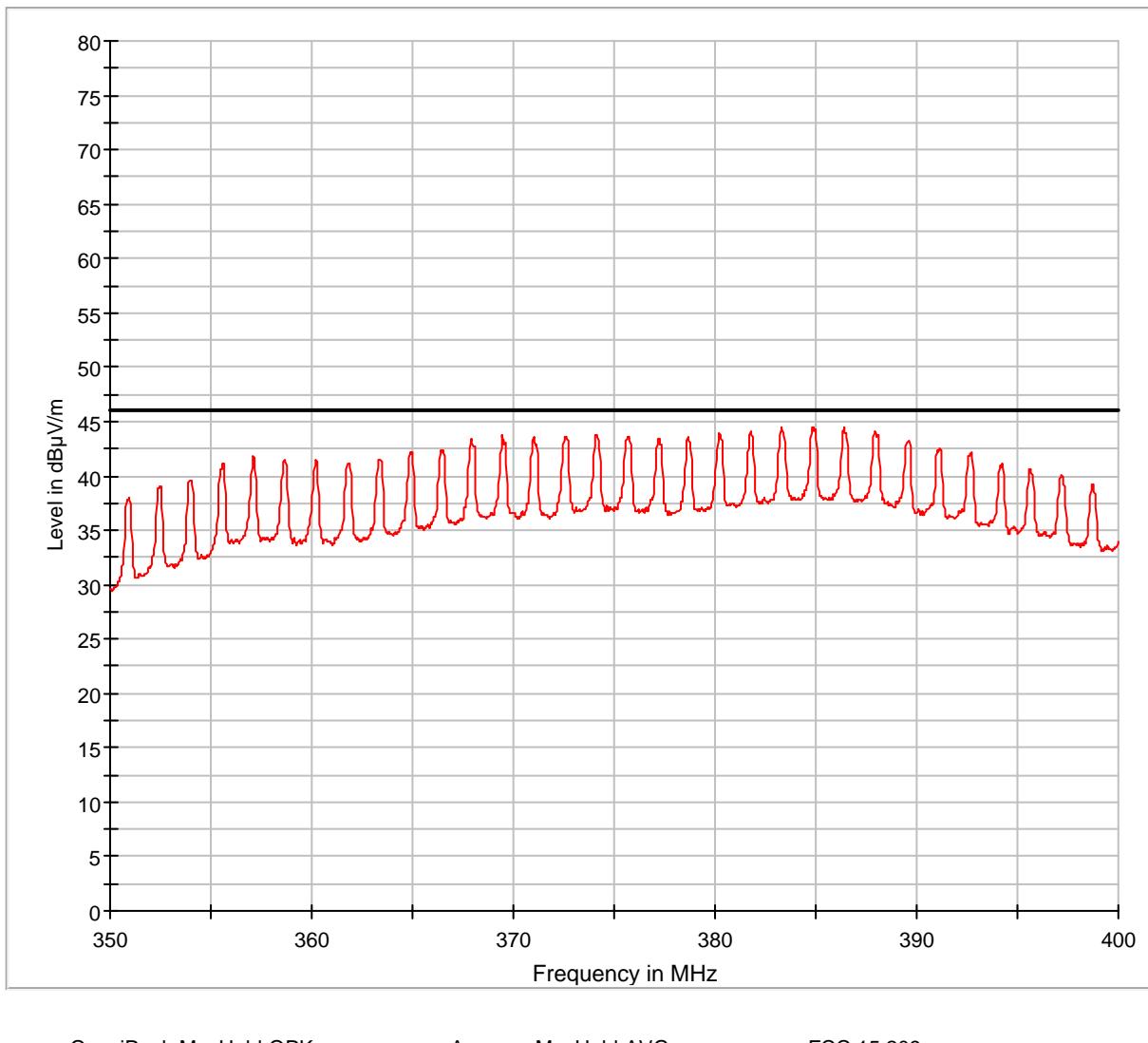
| Revision History |             |                        |  |
|------------------|-------------|------------------------|--|
| <i>Edition</i>   | <i>Date</i> | <i>Issued by</i>       | <i>Modifications</i>                       |
| 1                | 2013-02-28  | Martin Steindl<br>(gz) | First Edition                              |
| 2                | 2013-05-06  | J. Roidt (aw)          | Page 4; Operating frequency: 134,2 kHz     |
| 3                | 2013-07-08  | J. Roidt (aw)          | Page 3 and page 8; Antenna <b>ANT-7K15</b> |

## Annex A Charts taken during testing

### A.1 Plots taken during testing







Radiated emission 350 MHz – 400 MHz in maximum position, horizontal polarisation with quasi-peak detector