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March 13, 2015

Page 1 of 40

Prüfbericht / Test Report

Nr. / No. 69559-57128-01 (Edition 2)

Applicant: Magneti Marelli S.p.A.

Type of equipment: Immobilizer

Type designation: BCML9

Order No.: 15/0108/000

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

Industry Canada Radio Standards Specifications
RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 (Category I Equipment)

Note:

The test data of this report is related only to the individual item which has been tested. This report shall not be reproduced except in full extent without the written approval of the testing laboratory.

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1 Description of the Equipment Under Test (EUT)

| General data of EUT | |
|---------------------------------|------------------------|
| Type designation ¹ : | BCML9 |
| Parts ² : | |
| Serial number(s): | 00002 |
| Manufacturer: | Magneti Marelli S.p.A. |
| Type of equipment: | Immobilizer |
| Version: | 04/11/14 |
| FCC ID: | RX2BCML9 |
| Additional parts/accessories: | |

¹ Type designation of the system if EUT consists of more than one part.

² Type designations of the parts of the system, if applicable.

| Technical data of EUT | |
|---|--|
| Application frequency range: | < 1.705 MHz |
| Frequency range: | 125 kHz |
| Operating frequency: | 125 kHz |
| Type of modulation: | ASK |
| Pulse train: | --- |
| Pulse width: | --- |
| Number of RF-channels: | 1 |
| Channel spacing: | --- |
| Designation of emissions ³ : | 500HA1D |
| Type of antenna: | Loop antenna |
| Size/length of antenna: | Ø 4.5 cm |
| Connection of antenna: | <input type="checkbox"/> detachable <input checked="" type="checkbox"/> not detachable |
| Type of power supply: | Battery supply in vehicular environment |
| Specifications for power supply: | nominal voltage: 12 V |

³ Also known as "Class of Emission".

2 Administrative Data

Application details

| | |
|---------------------------|---|
| Applicant (full address): | Magneti Marelli S.p.A. Viale C. Emanuele II, 150, I-10078 Venaria, Italy |
| Contact person: | Mr. Nicola Scartapacchio, Fakt S.r.l. Via Lithos 53, I-25086 Rezzato, Italy |
| Order number: | 15/0108/000 |
| Receipt of EUT: | 2015-02-04 |
| Date(s) of test: | 2015-03-13 |
| Note(s): | |

Report details

| | |
|----------------|----------------|
| Report number: | 69559-57128-01 |
| Edition: | 2 |
| Issue date: | 2015-03-13 |

3 Identification of the Test Laboratory

Details of the Test Laboratory

| | |
|---|--|
| Company name: | TÜV SÜD Product Service GmbH |
| Address: | Aeussere Fruehlingstrasse 45 D-94315 Straubing Germany |
| Laboratory accreditation: | DAkKS Registration No. D-PL-11321-11-01 |
| FCC test site registration number | 90926 |
| Industry Canada test site registration: | 3050A-2 |
| Contact person: | Mr. Johann Roidt |
| | Phone: +49 9421 5522-0 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, and 15.209

of the Federal Communication Commission (FCC) and the

Radio Standards Specifications

RSS-GEN Issue 4, Sections 8.9 and 8.10 (Category I Equipment)

of Industry Canada (IC).

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)

Transmitting continuously at 125 kHz

Configuration(s) of EUT

The EUT was configured as stand alone device

List of ports and cables

| Port | Description | Classification ⁴ | Cable type | Cable length |
|------|-----------------------------|-----------------------------|------------|--------------|
| 1 | DC supply | dc power | Unshielded | 1 m |
| 2 | Wiring harness with antenna | signal/control port | Unshielded | 1 m |

List of devices connected to EUT

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

List of support devices

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

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

6 Measurement Procedures

6.1 Bandwidth Measurements

| Measurement Procedure: | |
|--|--|
| Rules and specifications: | CFR 47 Part 2, section 2.202(a) CFR 47 Part 15, section 15.215(c) IC RSS-Gen Issue 4, section 6.6 IC RSS-210 Issue 8, section A1.1.3 ANSI C63.4, annex H.6 |
| Guide: | ANSI C63.4 / IC RSS-Gen Issue 4, section 6.6 |
| Measurement setup: | <input type="checkbox"/> Conducted: See below <input checked="" type="checkbox"/> Radiated: Radiated Emission Measurement 9 kHz to 30 MHz (6.2) |
| <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> | |

6.2 Radiated Emission Measurement 9 kHz to 30 MHz

Measurement Procedure:

Rules and specifications: CFR 47 Part 15, sections 15.205 and 15.209
 IC RSS-GEN Issue 4, sections 8.9 and 8.10

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.

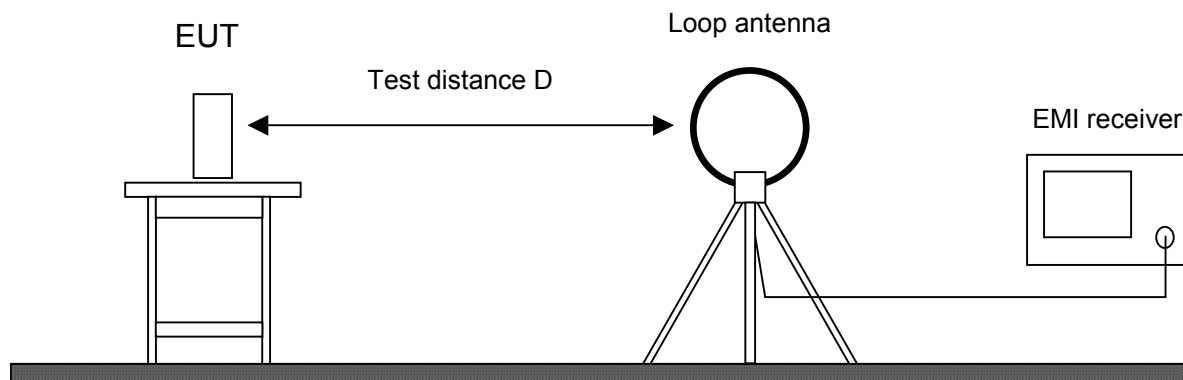
Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

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.

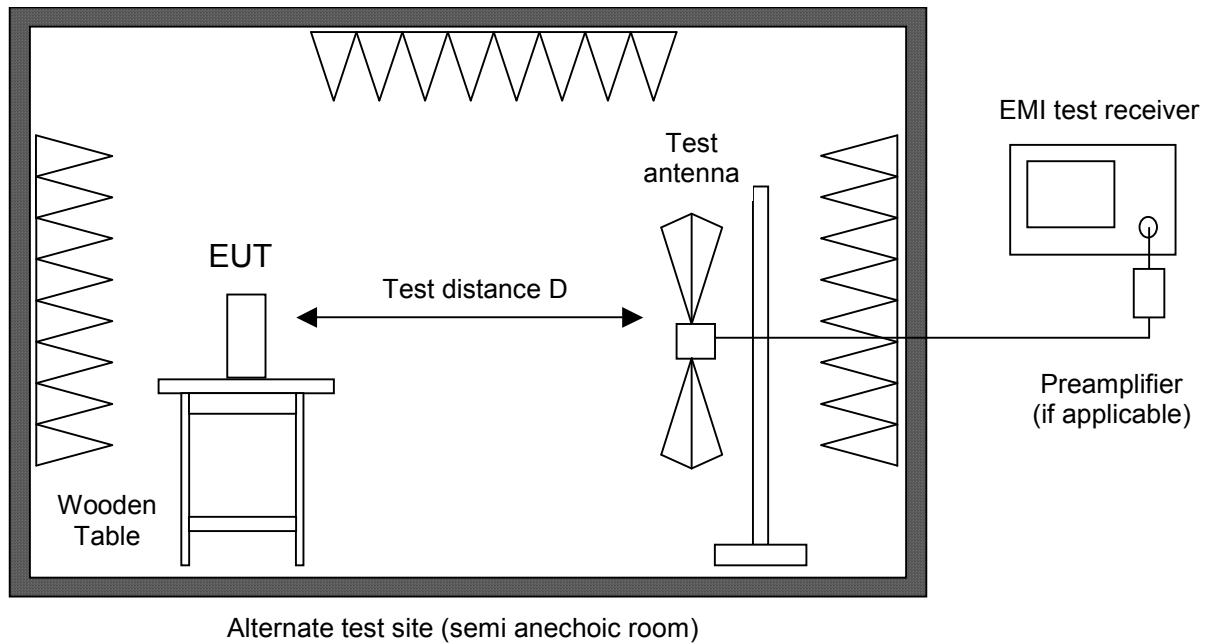


Test instruments used:

| 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 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 | 3557 | Schaffner |
| <input checked="" type="checkbox"/> Loop antenna | HFH2-Z2 | 1016 | 882964/1 | 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 |

6.3 Radiated Emission at Alternative Test Site

| Measurement Procedure: | |
|--|---|
| Rules and specifications: | CFR 47 Part 15, section 15.209 IC RSS-GEN Issue 4, section 8.9 |
| Guide: | ANSI C63.4 |
| <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>With detector of the test receiver set to quasi-peak final measurements are performed immediately after frequency zoom (for drifting disturbances) and maximum adjustment.</p> <p>Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.</p> <p>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.</p> <p>Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.</p> <p>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.</p> | |



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

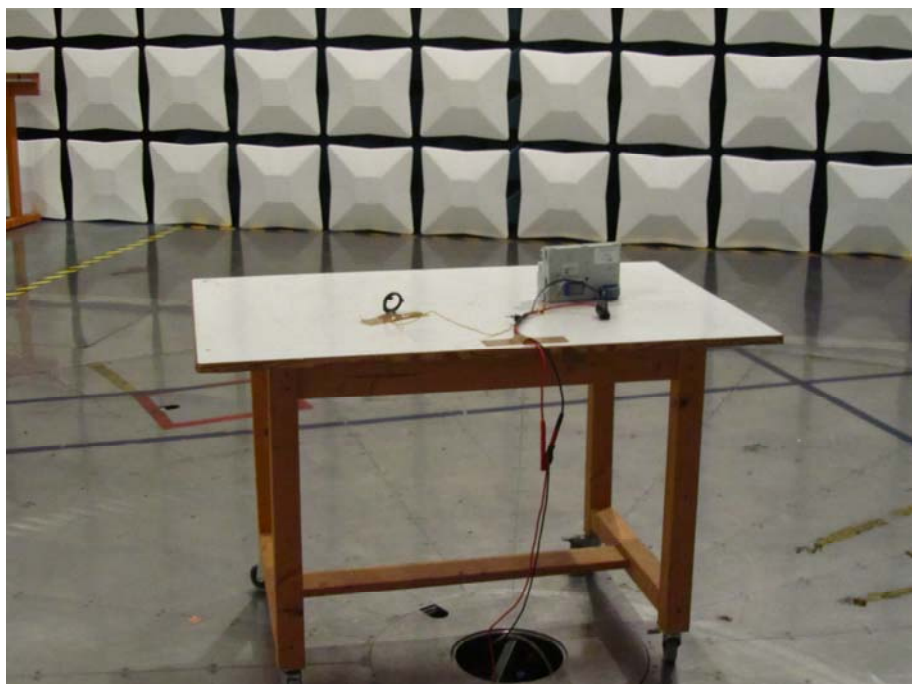
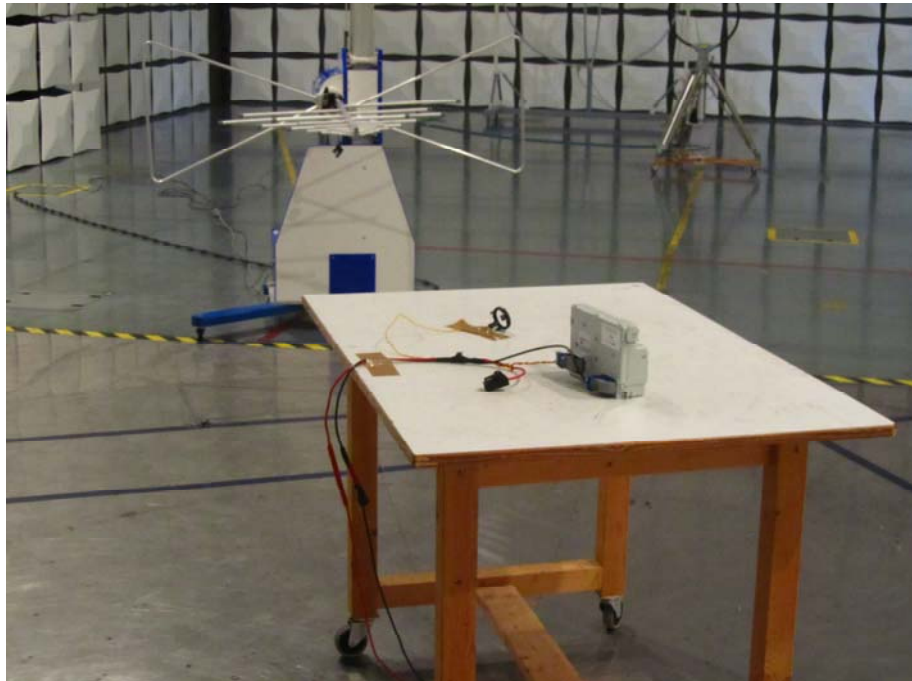
Test setup for radiated emission measurement 9 kHz – 30 MHz



Test setup for radiated emission measurement (alternate test site)



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



8 Test Results

FCC CFR 47 Parts 2 and 15

| Section(s) | Test | Page | Result |
|---------------------|--|------|----------------|
| 2.1046(a) | Conducted output power | --- | Not applicable |
| 2.202(a) | Occupied bandwidth | 19 | Recorded |
| 2.201, 2.202 | Class of emission | 25 | Calculated |
| 15.35(c) | Pulse train measurement for pulsed operation | --- | Not applicable |
| 15.205(a) | Restricted bands of operation | 26 | Test passed |
| 15.207 | Conducted AC powerline emission 150 kHz to 30 MHz | --- | Not applicable |
| 15.205(b) 15.209 | Radiated emission 9 kHz to 30 MHz | 27 | Test passed |
| 15.205(b) 15.209 | Radiated emission 30 MHz to 1 GHz | 29 | Test passed |

IC RSS-GEN Issue 4

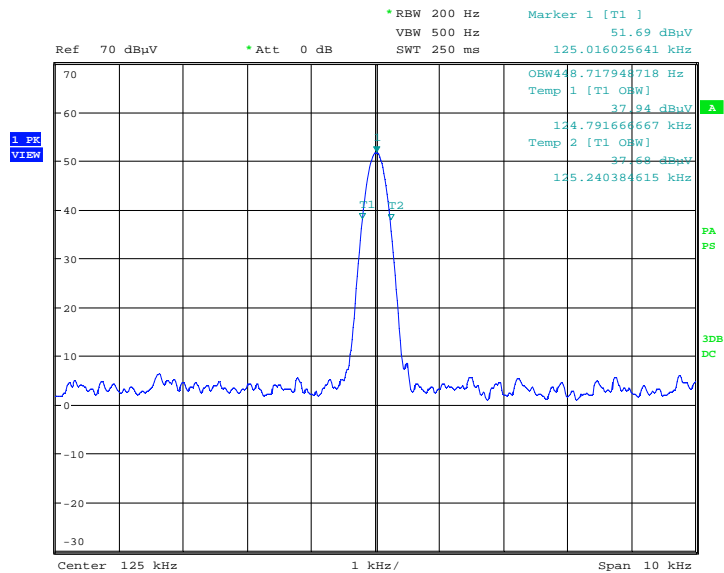
| Section(s) | Test | Page | Result |
|----------------|---|------|---|
| 6.12 | Transmitter output power (conducted) | --- | Not applicable |
| 6.6 | Occupied Bandwidth | 19 | Recorded |
| 9 | Designation of emissions | 25 | Calculated |
| 6.10 | Pulsed operation | --- | Not applicable |
| 8.8 | Transmitter AC power lines conducted emissions 150 kHz to 30 MHz | --- | Not applicable |
| 8.10 | Restricted bands and unwanted emission frequencies | 26 | Test passed |
| 6.4, 6.13, 8.9 | Unwanted emissions 9 kHz to 30 MHz | 27 | Test passed |
| 6.4, 6.13, 8.9 | Unwanted emissions 30 MHz to 1 GHz | 29 | Test passed |
| 3.2 | Exposure of Humans to RF Fields | 31 | Exempted from SAR and RF evaluation |

8.1 Occupied Bandwidth

| | | |
|---------------------------|--|------------------------------|
| Rules and specifications: | CFR 47 Part 2, section 2.202(a) 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> | |
| | 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 |
| | The video bandwidth shall be at least three times greater than the resolution bandwidth. | |
| Measurement procedure: | Bandwidth Measurements (6.1) | |

| | |
|---------------|---------------------------------|
| Comment: | |
| Date of test: | 2015-03-13 |
| Test site: | Semi-anechoic room, cabin no. 8 |

Occupied Bandwidth (99 %):



Date: 13.MAR.2015 09:44:24

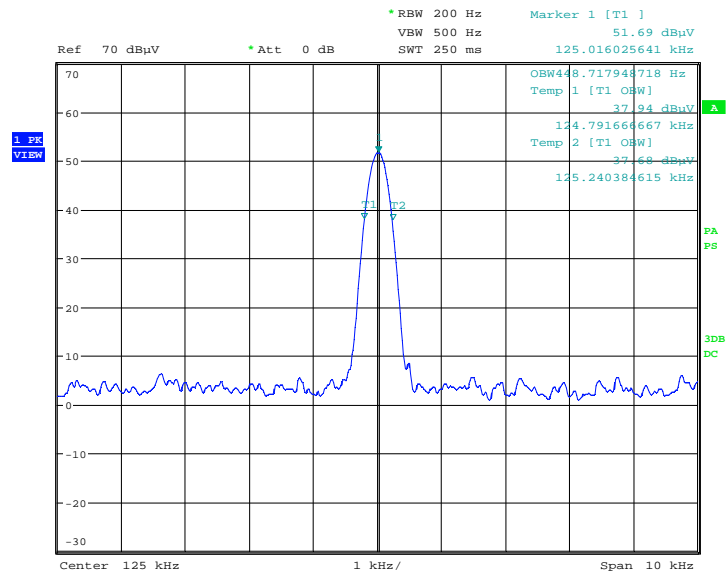
| | |
|----------------------------|--------|
| Occupied Bandwidth (99 %): | 448 Hz |
|----------------------------|--------|

Occupied Bandwidth (continued)

| | |
|---------------------------|---|
| Rules and specifications: | IC RSS-Gen Issue 4, section 6.6 |
| Guide: | IC RSS-Gen Issue 4, section 6.6 |
| Description: | <p>If not specified in the applicable RSS the occupied bandwidth is measured as the 99% emission bandwidth.</p> <p>The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.</p> <p>The trace data points are recovered and are directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is also recorded. The span between the two recorded frequencies is the occupied bandwidth.</p> |
| Measurement procedure: | Bandwidth Measurements (6.1) |

| | |
|---------------|---------------------------------|
| Comment: | |
| Date of test: | 2015-03-13 |
| Test site: | Semi-anechoic room, cabin no. 8 |

Occupied Bandwidth (99 %):

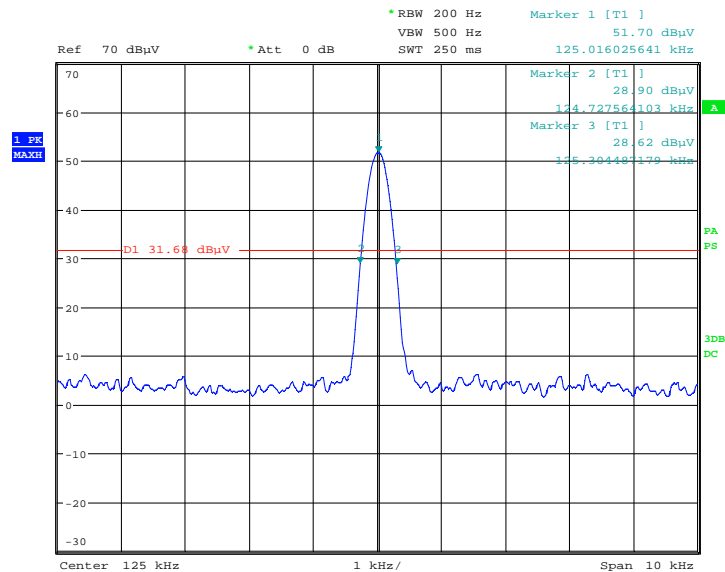


Date: 13.MAR.2015 09:44:24

| | |
|----------------------------|--------|
| Occupied Bandwidth (99 %): | 448 Hz |
|----------------------------|--------|

8.2 Bandwidth of the Emission

| | | |
|---------------------------|---|------------------------------|
| Rules and specifications: | CFR 47 Part 15, section 15.209 IC RSS-GEN Issue 4, section 8.9 | |
| 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> | |
| | 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 |
| | The video bandwidth shall be at least three times greater than the resolution bandwidth. | |
| Measurement procedure: | Bandwidth Measurements (6.1) | |
| Comment: | | |
| Date of test: | 2015-03-13 | |
| Test site: | Semi-anechoic room, cabin no. 8 | |



Date: 13.MAR.2015 09:45:48

| | |
|----------------------------|--------|
| Bandwidth of the emission: | 577 Hz |
|----------------------------|--------|

8.3 Designation of Emissions

| | |
|---------------------------|--|
| Rules and specifications: | CFR 47 Part 2, sections 2.201 and 2.202 IC RSS-Gen Issue 4, section 9 |
| Guide: | ANSI C63.4 / TRC-43 |

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

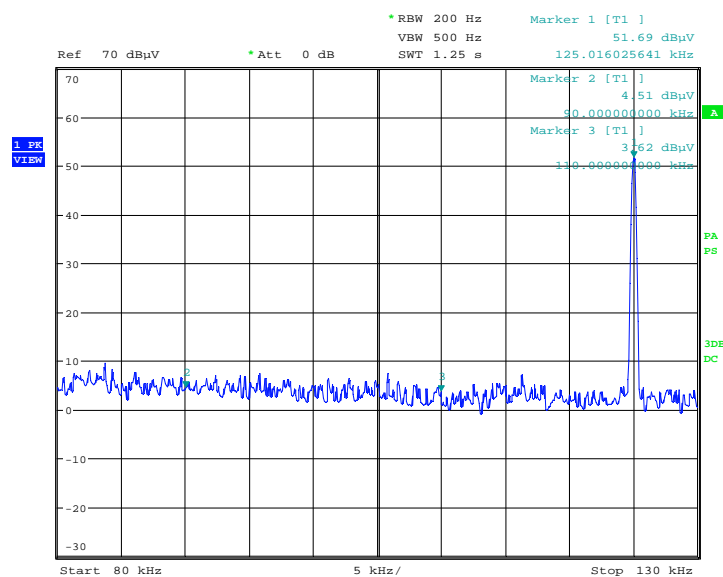
| | |
|--------------------------------|---|
| B_n = Necessary Bandwidth | $B_n = 2BK$ |
| B = Modulation rate | $B = 285 \text{ Hz}$ |
| K = Overall numerical factor | $K = 1$ |
| Calculation: | $B_n = 2 \cdot (285 \text{ Hz}) \cdot 1 = 570 \text{ Hz}$ |

| | |
|---------------------------|----------------|
| Designation of Emissions: | 570HA1D |
|---------------------------|----------------|

8.4 Restricted Bands of Operation

| | |
|---------------------------|--|
| Rules and specifications: | CFR 47 Part 15, section 15.205(a) IC RSS-210 Issue 8, section 7.2.2(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) or IC RSS-210 Issue 7, section 2.2(a). |
| Measurement procedure: | Radiated Emission Measurement 9 kHz to 30 MHz (6.2) |

| | |
|----------------|---------------------------------|
| Comment: | |
| Date of test: | 2015-03-13 |
| Test site: | Semi-anechoic room, cabin no. 8 |
| Test distance: | 3 meters |



Date: 13.MAR.2015 09:47:30

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

8.5 Radiated Emission Measurement 9 kHz to 30 MHz

| | | | | |
|---|---|------------------------------------|---|---------------------------------|
| Rules and specifications: | CFR 47 Part 15, sections 15.205 and 15.209 IC RSS-GEN Issue 4, sections 8.9 and 8.10 | | | |
| Guide: | ANSI C63.4 | | | |
| Limit: | Frequency of Emission (MHz) | Field Strength ($\mu\text{V/m}$) | Field Strength ($\text{dB}\mu\text{V/m}$) | Measurement Distance d (meters) |
| | 0.009 - 0.490 | $2400/F(\text{kHz})$ | $67.6 - 20 \cdot \log(F(\text{kHz}))$ | 300 |
| | 0.490 - 1.705 | $24000/F(\text{kHz})$ | $87.6 - 20 \cdot \log(F(\text{kHz}))$ | 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 (6.2) | | | |

| | |
|---------------|--|
| Comment: | The EUT transmitted with continuous carrier, so the pulse train correction for converting peak to average is 0 dB. |
| Date of test: | 2015-03-13 |
| Test site: | Open field test site |

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

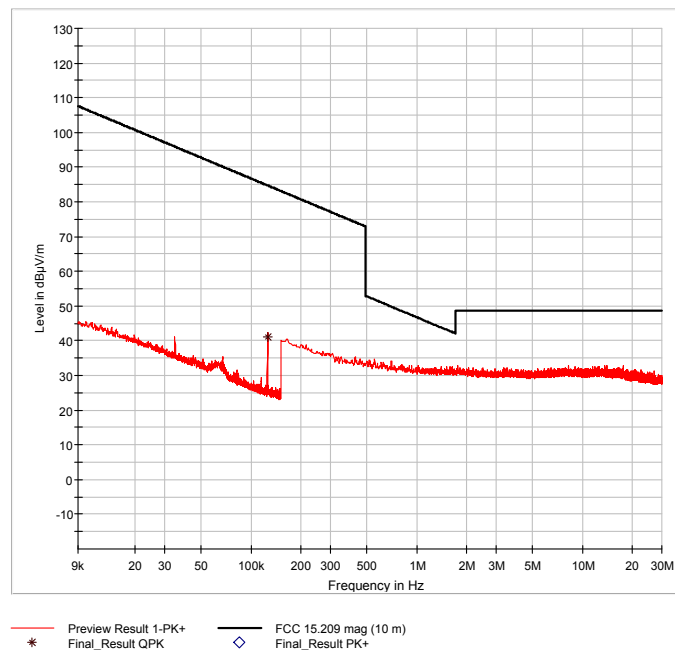
| Extrapolation factor: -40 dB/decade | | | | | | | | | | |
|---|----------|-----------|----------|-----------------|------------------|----------------|--------------------|-------------------|----------|--------|
| Frequency (MHz) | Detector | Distance | | Reading | Correction | Extrapolation | Pulse Train | Final | Limit | Margin |
| | | d1 (m) | d (m) | Value (dBμV) | Factor (dB/m) | Factor (dB) | Correction (dB) | Value (dBμV/m) | (dBμV/m) | (dB) |
| 0.12500 | Peak | 10 | 300 | 22.4 | 20.0 | -59.1 | 0.0 | -16.7 | 25.7 | 42.3 |

Sample calculation of final values:

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

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

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



8.6 Radiated Emission Measurement 30 MHz to 1 GHz

| | | | |
|---|---|------------------------------------|---|
| Rules and specifications: | CFR 47 Part 15, section 15.209 IC RSS-GEN Issue 4, section 8.9 | | |
| Guide: | ANSI C63.4 | | |
| Limit: | Frequency of Emission (MHz) | Field Strength ($\mu\text{V/m}$) | Field Strength ($\text{dB}\mu\text{V/m}$) |
| | 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 (6.3) | | |

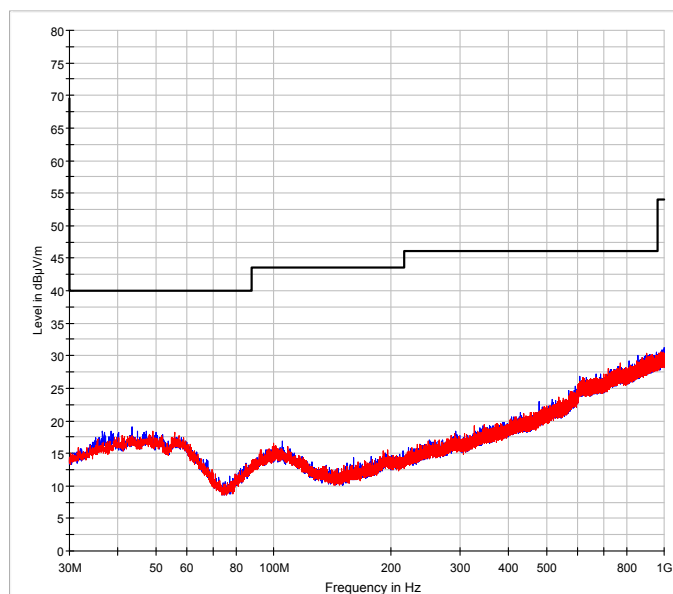
| | | | |
|----------------|---|--|--|
| Comment: | | | |
| Date of test: | 2015-03-13 | | |
| Test site: | Frequencies ≤ 1 GHz: Semi-anechoic room, cabin no. 8 | | |
| Test distance: | Frequencies ≤ 8.2 GHz: 3 meters | | |

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

No emissions above noise level detected.

Sample calculation of final values:

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



Preview Result 1V-PK+ CFR 47 Part 15 §15.209
 Final_Result QPK Preview Result 1H-PK+

8.7 Exposure of Humans to RF Fields

| | |
|---------------------------|---------------------------------|
| Rules and specifications: | IC RSS-Gen Issue 4, section 3.2 |
| Guide: | IC RSS-102 Issue 4, section 2.5 |

| Exposure of Humans to RF Fields | Applicable | Declared by applicant | Measured | Exemption |
|--|------------|--------------------------|-------------------------------------|-------------------------------------|
| The antenna is | | | | |
| <input type="checkbox"/> detachable | | | | |
| <p>The conducted output power (CP in watts) is measured at the antenna connector:</p> <p style="text-align: center;">$CP = \dots\dots\dots \text{ W}$</p> <p>The effective isotropic radiated power (EIRP in watts) is calculated using</p> <p><input type="checkbox"/> the numerical antenna gain: $G = \dots\dots\dots$</p> <p style="text-align: center;">$EIRP = G \cdot CP \Rightarrow EIRP = \dots\dots\dots \text{ W}$</p> <p><input type="checkbox"/> the field strength⁵ in V/m: $FS = \dots\dots\dots \text{ V/m}$</p> <p style="text-align: center;">$EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP = \dots\dots\dots \text{ W}$</p> <p>with:</p> <p>Distance between the antennas in m: $D = \dots\dots\dots \text{ m}$</p> | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> not detachable | | | | |
| <p>A field strength measurement is used to determine the effective isotropic radiated power (EIRP in watts) given by⁵:</p> <p style="text-align: center;">$EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP = 4.4 \mu\text{W}$</p> <p>with:</p> <p>Field strength in V/m: $FS = 3.8 \text{ mV/m}$</p> <p>Distance between the two antennas in m: $D = 3 \text{ m}$</p> | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Selection of output power | | | | |
| <p>The output power TP is the higher of the conducted or effective isotropic radiated power (e.i.r.p.):</p> <p style="text-align: center;">$TP = 4.4 \mu\text{W}$</p> | | | | |

⁵ The conversion formula is valid only for properly matched antennas. In other cases the transmitter output power may have to be measured by a terminated measurement when applying the exemption clauses. If an open area test site is used for field strength measurement, the effect due to the metal ground reflecting plane should be subtracted from the maximum field strength value in order to reference it to free space, before calculating TP.

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, 2014 |
| <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, 2014 |
| <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 (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 (published on September 15, 2009) |
| <input checked="" type="checkbox"/> | RSS-Gen | Radio Standards Specification RSS-Gen Issue 4 containing General Requirements for Compliance of Radio Apparatus, published by Industry Canada | November 2014 |
| <input checked="" 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, footnote 13 updated December 2010 |
| <input type="checkbox"/> | ICES-003 | Interference-Causing Equipment Standard ICES-003 Issue 5 (Information Technology Equipment (ITE) - Limits and methods of measurement), published by Industry Canada | August 2012 |
| <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 CISPR 22-10 | Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (Adopted IEC CISPR 22:2008, sixth edition, 2008-09) | 2010 |
| <input checked="" type="checkbox"/> | TRC-43 | Designation of Emissions, Class of Station and Nature of Service, published by Industry Canada | November 2012 |

10 Test Equipment List with Calibration Data

| Type | Inv.-No. | Type Designation | Serial Number | Manufacturer | Calibration Organization | Last Calibration | Next Calibration |
|--------------------------|----------|------------------|---------------|-----------------|--------------------------|------------------|------------------|
| EMI test receiver | 2044 | ESU8 | 100232 | Rohde & Schwarz | Rohde & Schwarz | 10/2014 | 10/2015 |
| Loop antenna | 1016 | HFH2-Z2 | 882964/0001 | Rohde & Schwarz | Rohde & Schwarz | 05/2014 | 05/2016 |
| TRILOG Broadband Antenna | 2058 | VULB 9163 | 9163-408 | Schwarzbeck | Rohde & Schwarz | 06/2014 | 06/2016 |

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 Measurement uncertainty

| Radio Testing | | | |
|---|-------|-----------------------|------|
| Test | k_p | Expanded Uncertainty | Note |
| RF-Frequency error | 1.96 | $\pm 1 \cdot 10^{-7}$ | 7 |
| RF-Power, conducted carrier | 1.96 | +0.077 dB / -0.078 dB | 7 |
| RF-Power uncertainty for given BER | 1.96 | +0.94 dB / -1.05 | 7 |
| RF power, conducted, spurious emissions | 1.96 | +1.4 dB / -1.6 dB | 7 |
| RF power, radiated | | | |
| 25 MHz – 4 GHz | 1.96 | +3.6 dB / -5.2 dB | 8 |
| 1 GHz – 18 GHz | 1.96 | +3.8 dB / -5.6 dB | 8 |
| 18 GHz – 26.5 GHz | 1.96 | +3.5 dB / -4.5 dB | 8 |
| 26.5 GHz – 66 GHz | 1.96 | +4.0 dB / -6.5 dB | 8 |
| Spectral Power Density, conducted | 1.96 | +1.4 dB / -1.6 dB | 5 |
| Maximum frequency deviation | | | |
| 300 Hz – 6 kHz | 2 | $\pm 2.89 \%$ | 2 |
| 6 kHz – 25 kHz | 2 | $\pm 0.2 \text{ dB}$ | 2 |
| Maximum frequency deviation for FM | 2 | $\pm 2.89 \%$ | 2 |
| Adjacent channel power 25 MHz – 1 GHz | 2 | $\pm 2.31 \%$ | 2 |
| Temperature | 2 | $\pm 0.39 \text{ K}$ | 4 |
| (Relative) Humidity | 2 | $\pm 2.28 \%$ | 2 |
| DC- and low frequency AC voltage | | | |
| DC voltage | 2 | $\pm 0.01 \%$ | 2 |
| AC voltage up to 1 kHz | 2 | $\pm 1.2 \%$ | 2 |
| Time | 2 | $\pm 0.6 \%$ | 2 |

| Radio Interference Emission Testing | | | |
|--|-------|----------------------|------|
| Test | k_p | Expanded Uncertainty | Note |
| Conducted Voltage Emission | | | |
| 9 kHz to 150 kHz (50Ω/50μH AMN) | 2 | ± 3.8 dB | 1 |
| 150 kHz to 30 MHz (50Ω/50μH AMN) | 2 | ± 3.4 dB | 1 |
| 100 kHz to 200 MHz (50Ω/5μH AMN) | 2 | ± 3.6 dB | 1 |
| Discontinuous Conducted Emission | | | |
| 9 kHz to 150 kHz (50Ω/50μH AMN) | 2 | ± 3.8 dB | 1 |
| 150 kHz to 30 MHz (50Ω/50μH AMN) | 2 | ± 3.4 dB | 1 |
| Conducted Current Emission | | | |
| 9 kHz to 200 MHz | 2 | ± 3.5 dB | 1 |
| Magnetic Fieldstrength | | | |
| 9 kHz to 30 MHz (with loop antenna) | 2 | ± 3.9 dB | 1 |
| 9 kHz to 30 MHz (large-loop antenna 2 m) | 2 | ± 3.5 dB | 1 |
| Radiated Emission | | | |
| Test distance 1 m (ALSE) | | | |
| 9 kHz to 150 kHz | 2 | ± 4.6 dB | 1 |
| 150 kHz to 30 MHz | 2 | ± 4.1 dB | 1 |
| 30 MHz to 200 MHz | 2 | ± 5.2 dB | 1 |
| 200 MHz to 2 GHz | 2 | ± 4.4 dB | 1 |
| 2 GHz to 3 GHz | 2 | ± 4.6 dB | 1 |
| Test distance 3 m | | | |
| 30 MHz to 300 MHz | 2 | ± 4.9 dB | 1 |
| 300 MHz to 1 GHz | 2 | ± 5.0 dB | 1 |
| 1 GHz to 6 GHz | 2 | ± 4.6 dB | 1 |
| Test distance 10 m | | | |
| 30 MHz to 300 MHz | 2 | ± 4.9 dB | 1 |
| 300 MHz to 1 GHz | 2 | ± 4.9 dB | 1 |

Radio Interference Emission Testing (continued)

| Test | k_p | Expanded Uncertainty | Note |
|---|-------|----------------------|------|
| Radio Interference Power | | | |
| 30 MHz to 300 MHz | 2 | ± 3.5 dB | 1 |
| Harmonic Current Emissions | | | 4 |
| Voltage Changes, Voltage Fluctuations and Flicker | | | 4 |

Immunity Testing

| Test | k_p | Expanded Uncertainty | Note |
|--|-------|----------------------|------|
| Electrostatic Discharges | | | 4 |
| Radiated RF-Field | | | |
| Pre-calibrated field level | 2 | +32.2 / -24.3 % | 5 |
| Dynamic feedback field level | 2.05 | +21.2 / -17.5 % | 3 |
| Electrical Fast Transients (EFT) / Bursts | | | 4 |
| Surges | | | 4 |
| Conducted Disturbances, induced by RF-Fields | | | |
| via CDN | 2 | +15.1 / -13.1 % | 6 |
| via EM clamp | 2 | +42.6 / -29.9 % | 6 |
| via current clamp | 2 | +43.9 / -30.5 % | 6 |
| Power Frequency Magnetic Field | 2 | +20.7 / -17.1 % | 2 |
| Pulse Magnetic Field | | | 4 |
| Voltage Dips, Short Interruptions and Voltage Variations | | | 4 |
| Oscillatory Waves | | | 4 |
| Conducted Low Frequency Disturbances | | | |
| Voltage setting | 2 | ± 0.9 % | 2 |
| Frequency setting | 2 | ± 0.1 % | 2 |
| Electrical Transient Transmission in Road Vehicles | | | 4 |

Note 1:

The expanded uncertainty reported according to CISPR 16-4-2:2003-11 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$, providing a level of confidence of $p = 95.45\%$

Note 2:

The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$, providing a level of confidence of $p = 95.45\%$

Note 3:

The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2.05$, providing a level of confidence of $p = 95.45\%$

Note 4:

It has been demonstrated that the used test equipment meets the specified requirements in the standard with at least a 95% confidence.

Note 5:

The expanded uncertainty reported according to IEC 61000-4-3 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$, providing a level of confidence of $p = 95.45\%$

Note 6:

The expanded uncertainty reported according to IEC 61000-4-6 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$, providing a level of confidence of $p = 95.45\%$

Note 7:

The expanded uncertainty reported according to ETSI TR 100 028 V1.4.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of $k_p = 1.96$, providing a level of confidence of $p = 95.45\%$

Note 8:

The expanded uncertainty reported according to ETSI TR 102 273 V1.2.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of $k_p = 1.96$, providing a level of confidence of $p = 95.45\%$

12 Revision History

| Revision History | | | |
|------------------|-------------|------------------|--|
| <i>Edition</i> | <i>Date</i> | <i>Issued by</i> | <i>Modifications</i> |
| 1 | 2015-03-13 | M. Steindl (as) | First Edition |
| 2 | 2015-07-24 | M. Steindl(as) | Added FCC-ID Altered test result for 125 kHz to Peak/Average Added Measurment uncertainty. |