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March 19, 2013

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## Prüfbericht / Test Report

Nr. / No. 5010161238-13715-1 (Edition 3)

Applicant: mic GmbH

Type of equipment: Microwave Sensor

Type designation: mic Flowmeter

Order No.: Order of October 11, 2012

Test standards: FCC Code of Federal Regulations,  
CFR 47, Part 15,  
Sections 15.205, 15.207, 15.215 and 15.249

Industry Canada Radio Standards Specifications  
RSS-GEN Issue 3, Sections 7.2.2 and 7.2.4 and  
RSS-210 Issue 8, Section A2.9 (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 <sup>1</sup> :	mic Flowmeter
Parts <sup>2</sup> :	
Serial number(s):	12703-001-2293
Manufacturer:	mic GmbH
Type of equipment:	Microwave Sensor
Version:	As received
FCC ID:	
Industry Canada ID:	
Additional parts/accessories:	

### Technical data of EUT

Application frequency range:	24.00 - 24.25 GHz
Frequency range:	24.125 GHz
Operating frequency:	24.125 GHz
Type of modulation:	Continuous wave emission
Pulse train:	---
Pulse width:	---
Number of RF-channels:	1
Channel spacing:	---
Designation of emissions <sup>3</sup> :	NON
Type of antenna:	Integrated
Size/length of antenna:	N/A
Connection of antenna:	<input type="checkbox"/> detachable <input checked="" type="checkbox"/> not detachable
Type of power supply:	DC supply
Specifications for power supply:	nominal voltage: 24 V

<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.

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

## 2 Administrative Data

### Application details

Applicant (full address):	mic GmbH Grimbartweg 123564 LübeckGermany
Contact person:	Mr. Jens Happel
Order number:	Order of October 11, 2012
Receipt of EUT:	October 22, 2012
Date(s) of test:	October 25, 2012 – October 29, 2012
Note(s):	

### Report details

Report number:	5010161238-13715-1
Edition:	3
Issue date:	2013-03-19

### 3 Identification of the Test Laboratory

<b>Details of the Test Laboratory</b>	
Company name:	TÜV SÜD Product Service GmbH
Address:	Aeussere Fruehlingstrasse 45 D-94315 Straubing Germany
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, 15.207, 15.215 and 15.249**  
of the Federal Communication Commission (FCC) and the  
**Radio Standards Specifications**  
**RSS-GEN Issue 3, Sections 7.2.2 and 7.2.4 and**  
**RSS-210 Issue 8, Section A2.9 (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 24.125 GHz

### Configuration(s) of EUT

The EUT was configured as stand alone equipment

### List of ports and cables

Port	Description	Classification <sup>4</sup>	Cable type	Cable length
1	DC supply	dc power	Unshielded	1.5 m
2	20 mA output	signal/control port	Unshielded	1.5 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
---				

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

## 6 Measurement Procedures

### 6.1 Bandwidth Measurements

<b>Measurement Procedure:</b>	
Rules and specifications:	CFR 47 Part 2, section 2.202(a) CFR 47 Part 15, section 15.215(c) IC RSS-Gen Issue 3, sections 4.6.1 and 4.6.2 IC RSS-210 Issue 8, section A1.1.3 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 <input checked="" type="checkbox"/> Radiated: Radiated Emission in Fully or Semi Anechoic Room (6.4)
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.	
If radiated measurements are performed the same test setups and instruments are used as with radiated emission measurements for the appropriate frequency range.	
The analyzer settings are specified by the test description of the appropriate test record(s).	

## 6.2 Conducted AC Powerline Emission

### Measurement Procedure:

Rules and specifications: CFR 47 Part 15, section 15.207  
IC RSS-GEN Issue 3, section 7.2.4

Guide: ANSI C63.4 / CISPR 22

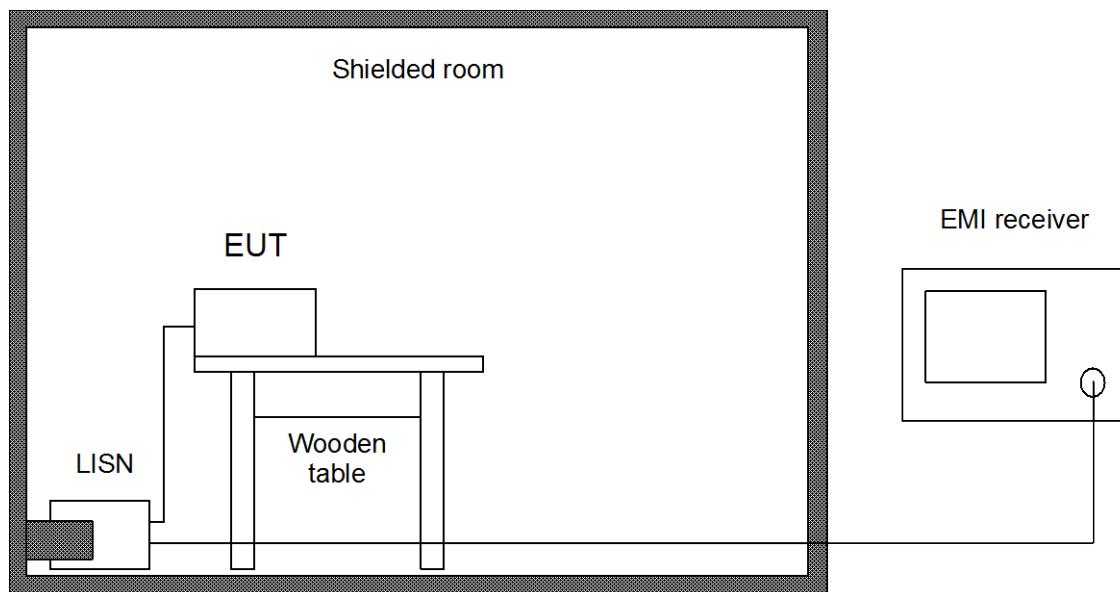
Conducted emission tests in the frequency range 150 kHz to 30 MHz are performed using Line Impedance Stabilization Networks (LISNs). To simplify testing with quasi-peak and average detector the following procedure is used:

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 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

## 6.3 Radiated Emission Measurement 9 kHz to 30 MHz

### Measurement Procedure:

Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.249(d) IC RSS-210 Issue 8, section A2.9(b)
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.

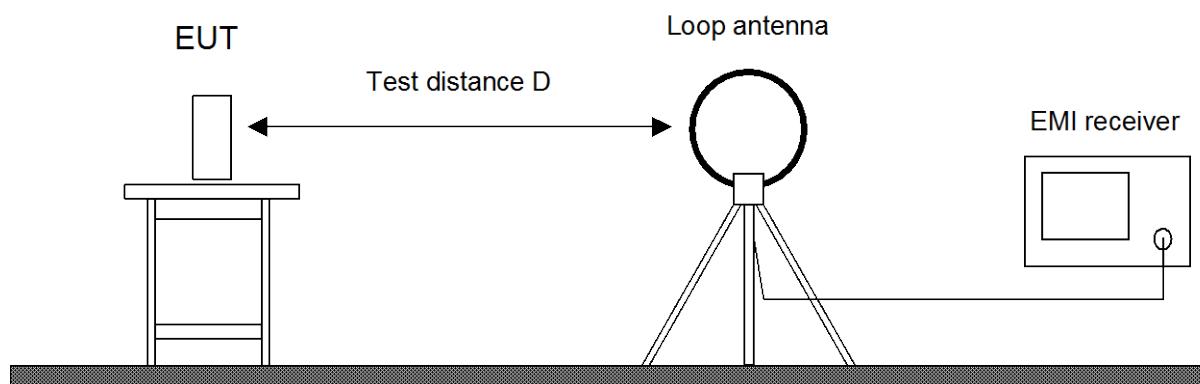
Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

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 checked="" type="checkbox"/> Test receiver	ESHS 10	1028	860043/016	Rohde & Schwarz
<input type="checkbox"/> Preamplifier	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

## 6.4 Radiated Emission in Fully or Semi Anechoic Room

### Measurement Procedure:

Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.249 IC RSS-210 Issue 8, section A2.9
Guide:	ANSI C63.4

Radiated emission in fully or semi anechoic room is measured in the frequency range from 30 MHz to the maximum frequency as specified in CFR 47 Part 15 section 15.33.

Measurements are made in both the horizontal and vertical planes of polarization using a spectrum analyzer with the detector function set to peak and resolution as well as video bandwidth set to 100 kHz (below 1 GHz) or 1 MHz (above 1 GHz).

Testing up to 1 GHz is performed with a linear polarized logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna"). For testing above 1 GHz horn antennas are used.

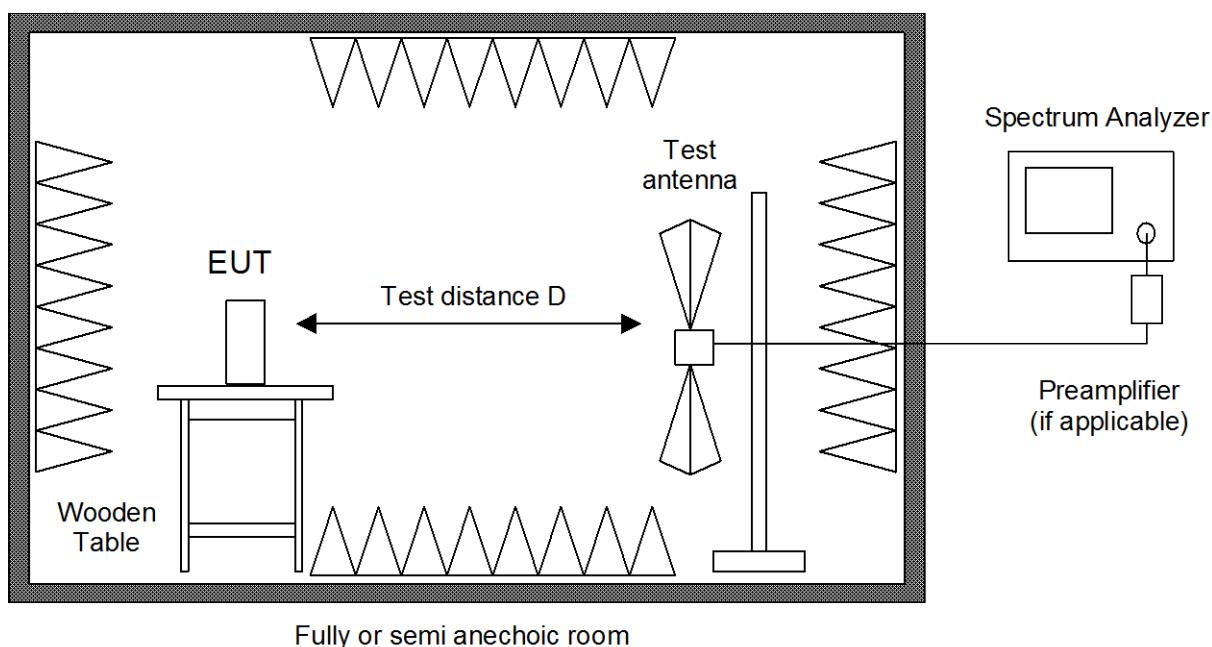
All tests below 8.2 GHz are performed at a test distance D of 3 meters. For higher frequencies the test distance may be reduced (e.g. to 1 meter) due to the sensitivity of the measuring instrument(s) and the test results are calculated according to CFR 47 Part 15 section 15.31(f)(1) using an extrapolation factor of 20 dB/decade. If required, preamplifiers are used for the whole frequency range. Special care is taken to avoid overload, using appropriate attenuators and filters, if necessary.

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 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.

During testing the 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.

For final testing below 1 GHz a semi anechoic room complying with the NSA requirements of ANSI C63.4 for alternative test sites is used (see 6.5). If prescans are recorded in fully anechoic room they are indicated appropriately.

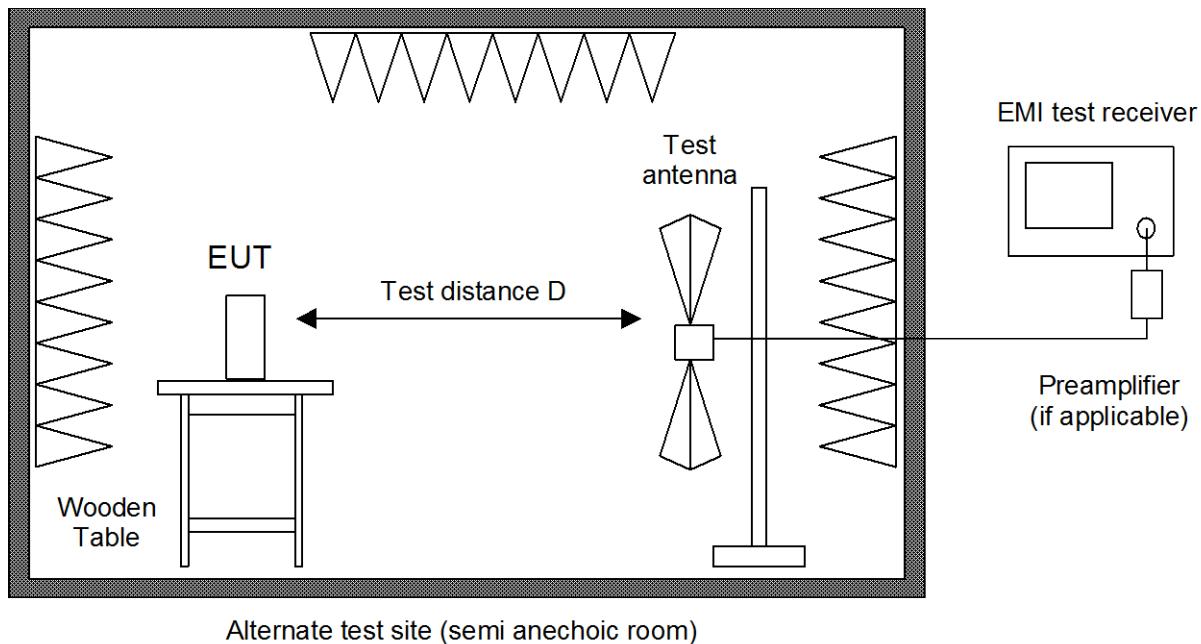


### Test instruments used:

Type	Designation	Inv.-no.	Serial No. or ID	Manufacturer
<input checked="" type="checkbox"/> Spectrum analyzer	FSP30	1666	100036	Rohde & Schwarz
<input type="checkbox"/> EMI test receiver	Cabin no. 3	2010	101018	Rohde & Schwarz
<input type="checkbox"/> EMI test receiver		2044	100232	Rohde & Schwarz
<input checked="" type="checkbox"/> EMI test receiver	ESMI	1569	839379/013 839587/006	Rohde & Schwarz
<input checked="" type="checkbox"/> Preamplifier	Cabin no. 2	1716	3557	Schaffner
<input type="checkbox"/> Preamplifier		1142	13120026	Advantest
<input checked="" type="checkbox"/> Preamplifier (1 - 8 GHz)	AFS3-00100800-32-LN	1684	847743	Miteq
<input type="checkbox"/> Preamplifier (0.5 - 8 GHz)	AMF-4D-005080-25-13P	1685	860149	Miteq
<input checked="" type="checkbox"/> Preamplifier (8 - 18 GHz)	ACO/180-3530	1484	32641	CTT
<input checked="" type="checkbox"/> External Mixer	WM782A	1576	845881/005	Tektronix
<input checked="" type="checkbox"/> Harmonic Mixer Accessories	FS-Z30	1577	624413/003	Rohde & Schwarz
<input type="checkbox"/> Trilog antenna	Cabin no. 2	1802	9163-214	Schwarzbeck
<input type="checkbox"/> Trilog antenna		1722	9163-188	Schwarzbeck
<input type="checkbox"/> Trilog antenna	Cabin no. 8	2058	9163-408	Schwarzbeck
<input checked="" type="checkbox"/> Horn antenna		3115	9508-4553	EMCO
<input type="checkbox"/> Horn antenna	3160-03	1010	9112-1003	EMCO
<input type="checkbox"/> Horn antenna	3160-04	1011	9112-1001	EMCO
<input checked="" type="checkbox"/> Horn antenna	3160-05	1012	9112-1001	EMCO
<input checked="" type="checkbox"/> Horn antenna	3160-06	1013	9112-1001	EMCO
<input checked="" type="checkbox"/> Horn antenna	3160-07	1014	9112-1008	EMCO
<input checked="" type="checkbox"/> Horn antenna	3160-08	1015	9112-1002	EMCO
<input checked="" type="checkbox"/> Horn antenna	3160-09	1265	9403-1025	EMCO
<input type="checkbox"/> Horn antenna	3160-10	1575	399185	EMCO
<input checked="" type="checkbox"/> Fully anechoic room	No. 2	1452	---	Albatross
<input type="checkbox"/> Semi anechoic room	No. 3	1453	---	Siemens
<input type="checkbox"/> Semi anechoic room	No. 8	2057	---	Albatross

## 6.5 Radiated Emission at Alternative Test Site

<b>Measurement Procedure:</b>	
Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.249 IC RSS-210 Issue 8, section A2.9
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>	



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



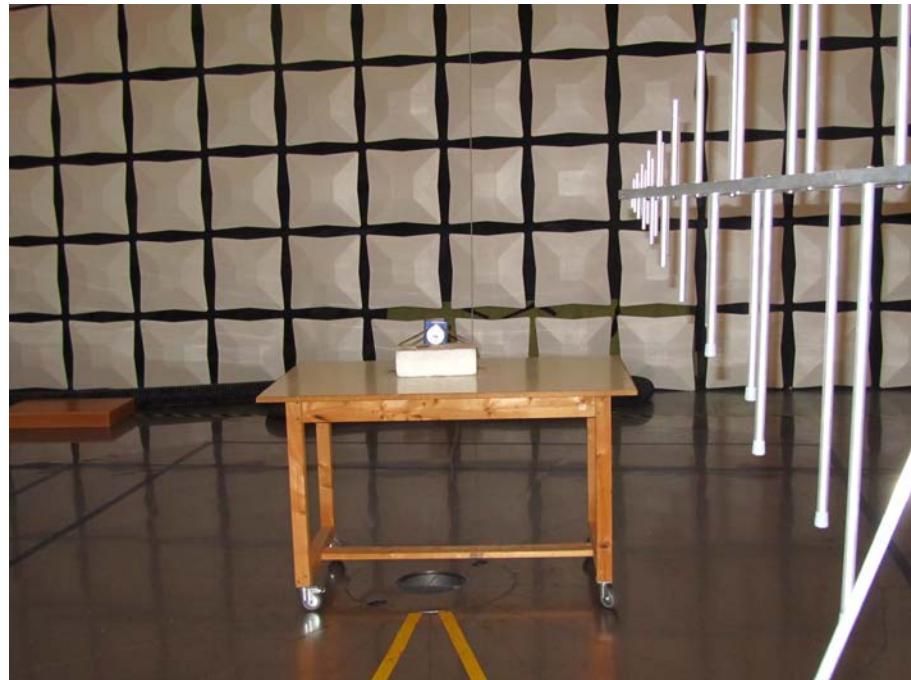
### Test setup for radiated emission measurement 9 kHz – 30 MHz



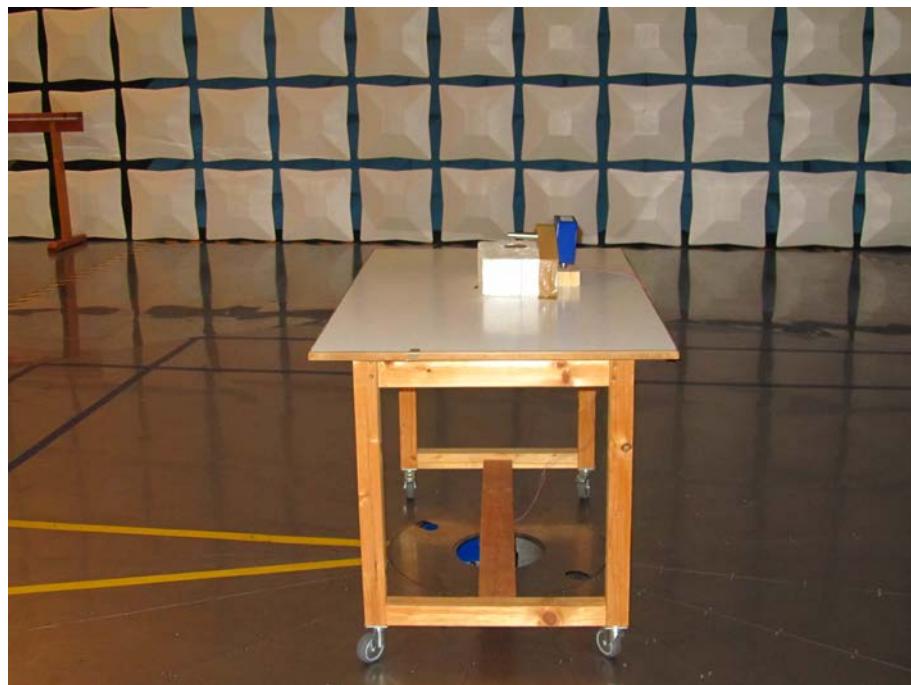
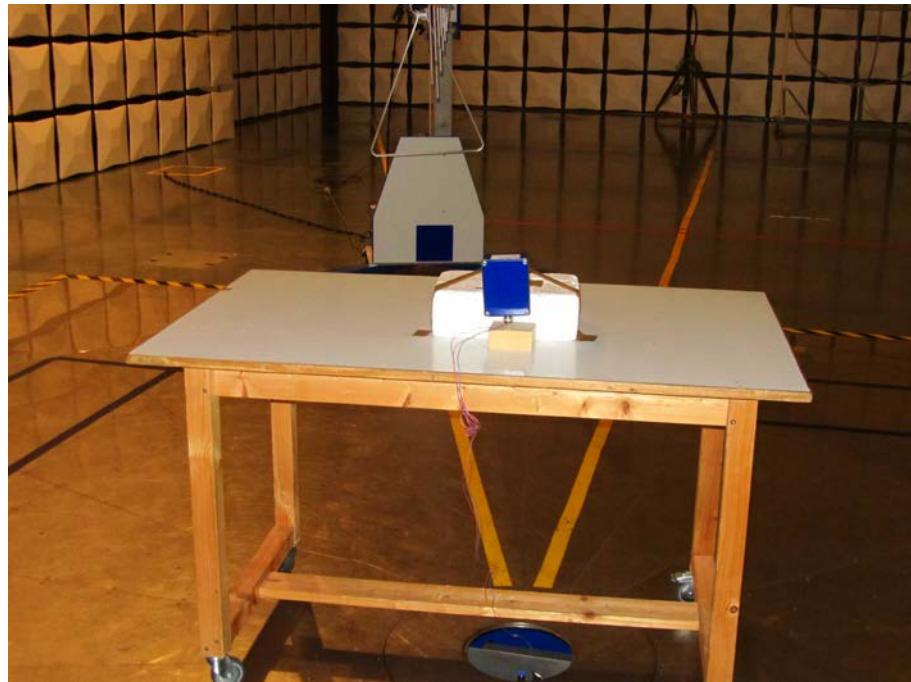
### Test setup for radiated emission measurement (fully anechoic room)



### 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	---	Not applicable
2.202(a)	Occupied bandwidth	25	Recorded
15.215(c)	Bandwidth of the emission	29	Test passed
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 150 kHz to 30 MHz	---	Not applicable
15.207	Conducted DC powerline emission 150 kHz to 30 MHz	33	Test passed
15.205(b) 15.249	Radiated emission 9 kHz to 30 MHz	35	Test passed
15.205(b) 15.215(b) 15.249	Radiated emission 30 MHz to 100 GHz	37	Test passed

**IC RSS-Gen Issue 3**

<i>Section(s)</i>	<i>Test</i>	<i>Page</i>	<i>Result</i>
4.8	Transmitter output power (conducted)	---	Not applicable
4.6.1	Occupied Bandwidth	25	Recorded
8	Designation of emissions	31	Calculated
4.5	Pulsed operation	---	Not applicable
7.2.4	Conducted AC powerline emission 150 kHz to 30 MHz	---	Not applicable
7.2.4	Conducted DC powerline emission 150 kHz to 30 MHz	33	Test passed
2.2(a)	Restricted bands and unwanted emission frequencies	32	Test passed
7.2.2(b)(c), 7.2.5	Unwanted emissions 9 kHz to 30 MHz	35	Test passed
7.2.2(b)(c), 7.2.5	Unwanted emissions 30 MHz to 100 GHz	37	Test passed
5.5	Exposure of Humans to RF Fields	44	Exempted from SAR and RF evaluation

**IC RSS-210 Issue 8**

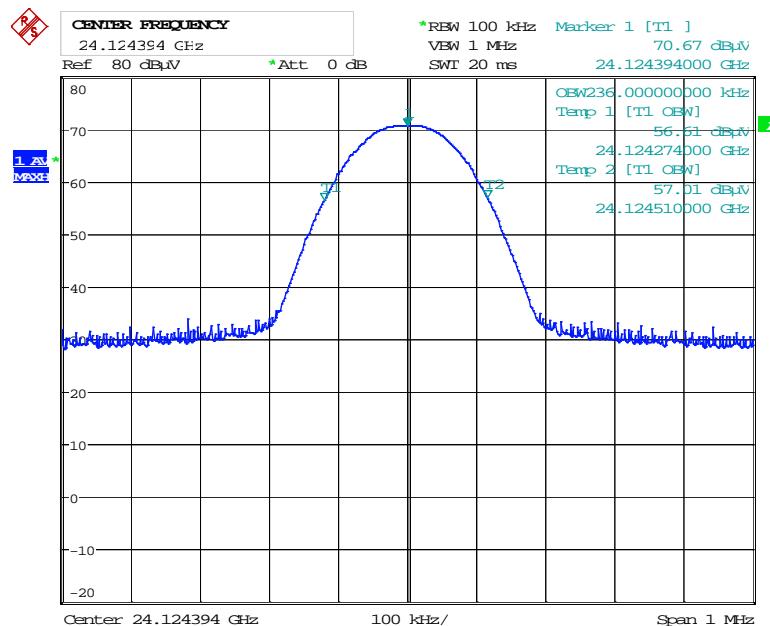
<i>Section(s)</i>	<i>Test</i>	<i>Page</i>	<i>Result</i>
A2.9	Unwanted emissions 9 kHz to 30 MHz	35	Test passed
A2.9	Unwanted emissions 30 MHz to 100 GHz	37	Test passed

## 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> <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 (6.1)								

Comment:	
Date of test:	October 29, 2012
Test site:	Fully anechoic room, cabin no. 2

### Occupied Bandwidth (99 %):



Date: 29.OCT.2012 16:47:44

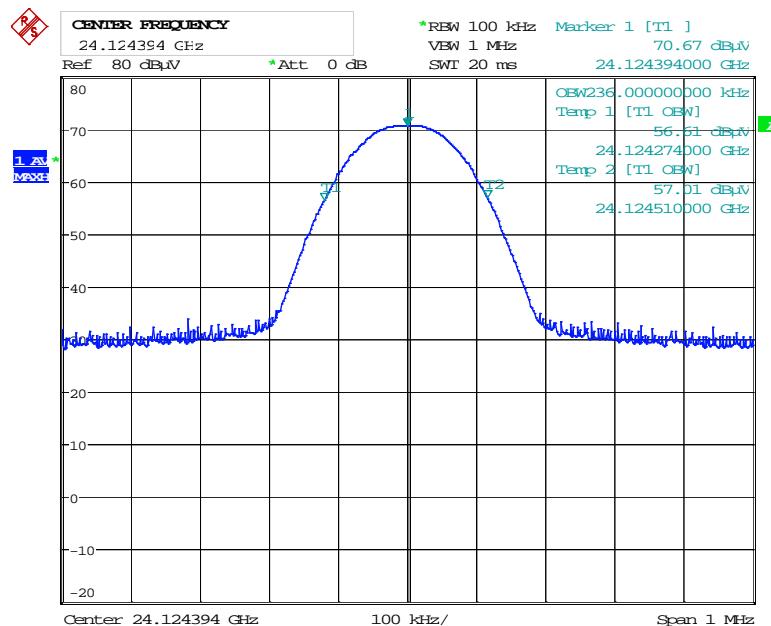
Occupied Bandwidth (99 %): **236 kHz**

## Occupied Bandwidth (continued)

Rules and specifications:	IC RSS-Gen Issue 3, section 4.6.1
Guide:	IC RSS-Gen Issue 3, section 4.6.1
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:	October 29, 2012
Test site:	Fully anechoic room, cabin no. 2

### Occupied Bandwidth (99 %):



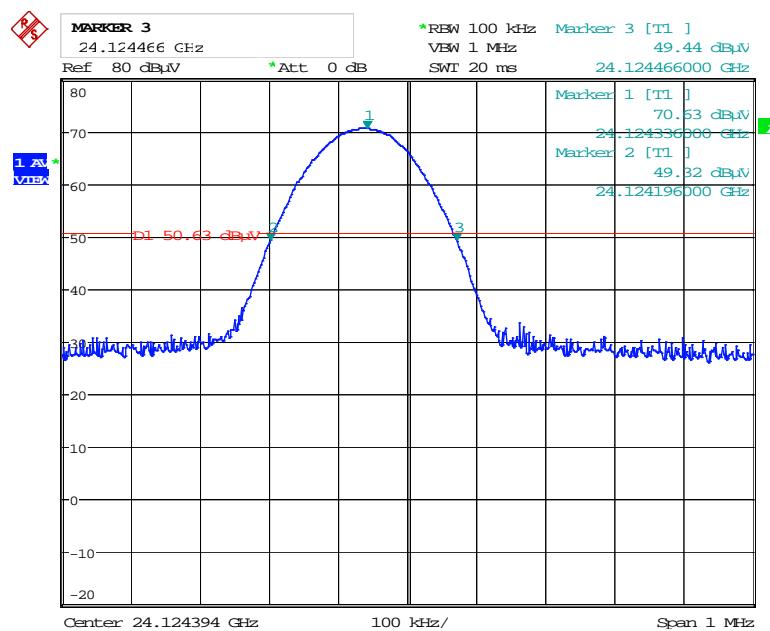
Date: 29.OCT.2012 16:47:44

Occupied Bandwidth (99 %): **236 kHz**

## 8.2 Bandwidth of the Emission

Rules and specifications:	CFR 47 Part 15, section 15.215(c)								
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 (6.1)								

Comment:	
Date of test:	October 29, 2012
Test site:	Fully anechoic room, cabin no. 2



Date: 29.OCT.2012 16:49:47

Permitted frequency band:	<b>24.00 - 24.25 GHz</b>	
20 dB bandwidth:	<b>270 kHz</b>	
Carrier frequency stability:	<input type="checkbox"/> specified	<input checked="" type="checkbox"/> not specified
Maximum frequency tolerances:	---	
Bandwidth of the emission:	<b>270 kHz</b>	<b>within permitted frequency band<sup>5</sup>:</b> <input checked="" type="checkbox"/> yes <input type="checkbox"/> no

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

<sup>5</sup> If a frequency stability is not specified, it is recommended that the fundamental emission is kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

### 8.3 Designation of Emissions

Rules and specifications:	CFR 47 Part 2, sections 2.201 and 2.202 IC RSS-Gen Issue 3, sections 8
Guide:	ANSI C63.4 / TRC-43

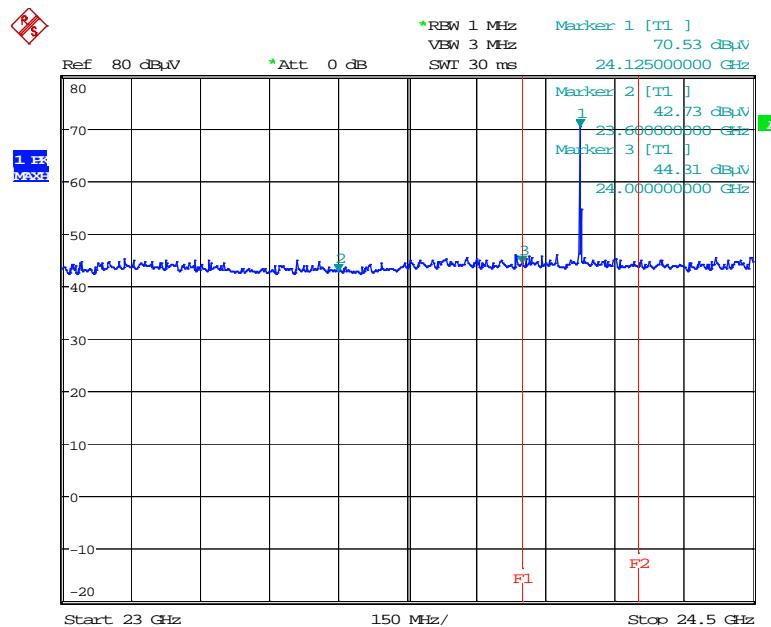
Type of modulation:	Continuous Wave Emission
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Designation of Emissions:	<b>NON</b>
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## 8.4 Restricted Bands of Operation

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 in Fully or Semi Anechoic Room (6.4)

Comment:	
Date of test:	October 29, 2012
Test site:	Fully anechoic room, cabin no. 2
Test distance:	3 meters



Date: 29.OCT.2012 16:53:56

Test Result:	Test passed
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## 8.5 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, section 15.207 IC RSS-GEN Issue 3, section 7.2.4		
Guide:	ANSI C63.4 / CISPR 22		
Limit:	Frequency of Emission (MHz)		Conducted Limit (dB $\mu$ V)
		Quasi-peak	Average
	0.15 - 0.5	66 to 56	56 to 46
	0.5 - 5	56	46
Measurement procedure:	5 - 30	60	50
	Conducted AC Powerline Emission (6.2)		

Comment:	$U_{AC} = 115$ V Conducted emissions have been tested at the DC terminals of the test sample since a dedicated AC-DC adapter has not been assigned. This represents worst-case emissions.
Date of test:	October 29, 2012
Test site:	Shielded room, cabin no. 1

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

Tested on:	PLUS
------------	------

All emissions show more than 20 dB margin to the limit, no values noted

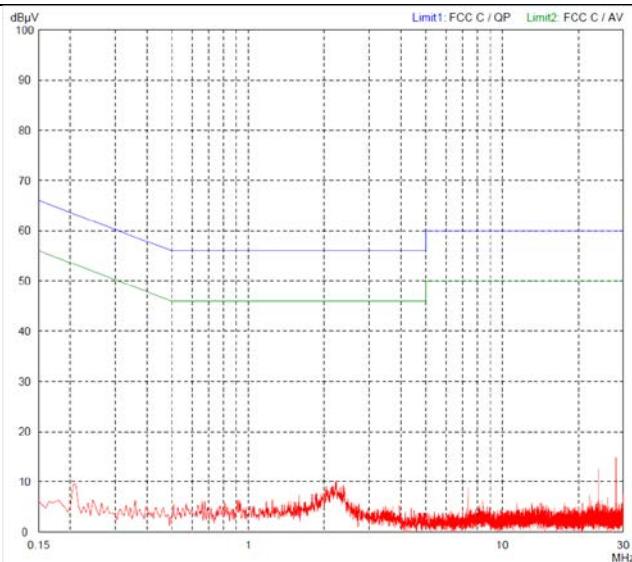
Tested on:	MINUS
------------	-------

All emissions show more than 20 dB margin to the limit, no values noted

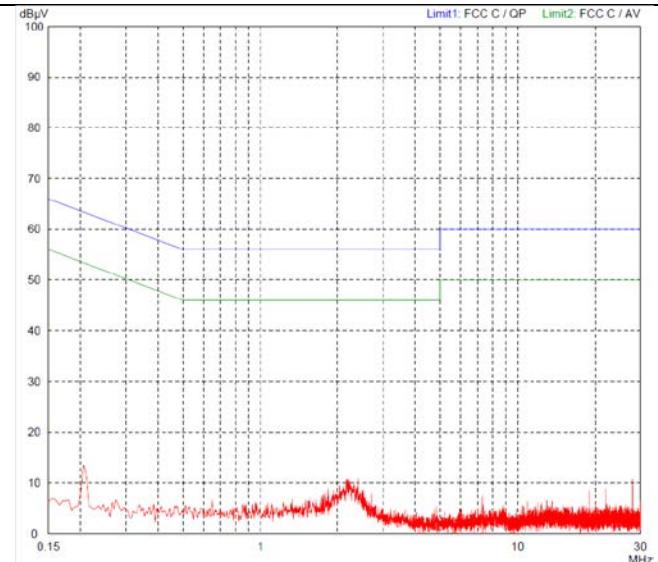
### Sample calculation of final values:

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

Linecord DC 24 V  
MINUS



Linecord DC 24 V  
PLUS



## 8.6 Radiated Emission Measurement 9 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.249(d) IC RSS-210 Issue 8, section A2.9(b)			
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 (6.3)			

Comment:	Vertical polarization of test antenna
Date of test:	October 26, 2012
Test site:	Open field test site

Test Result:	Test passed
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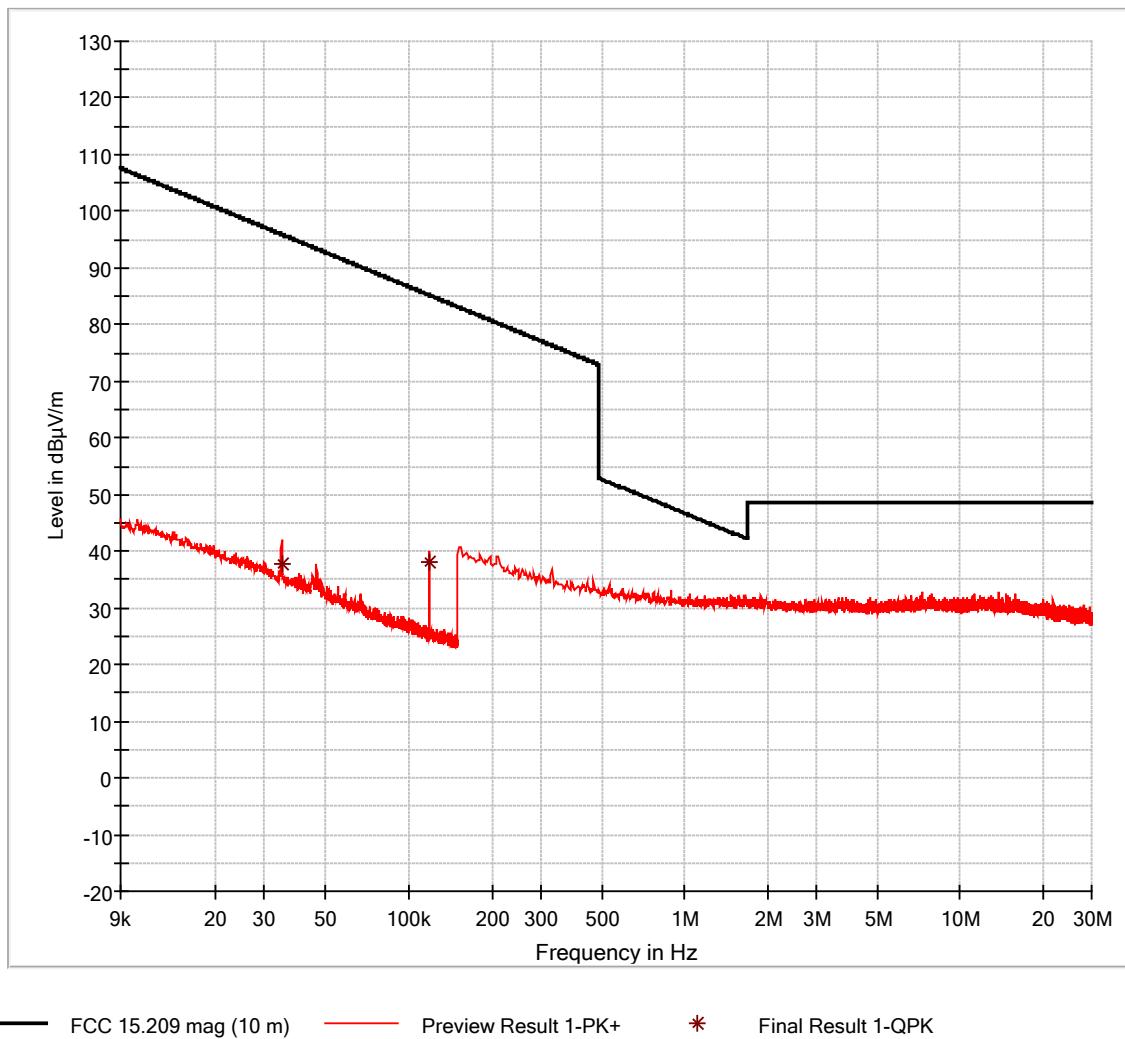
Extrapolation factor:	-40 dB/decade									
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value ( $\text{dB}\mu$ V)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value ( $\text{dB}\mu$ V/m)	Limit ( $\text{dB}\mu$ V/m)	Margin (dB)
0,03455	Quasi-Peak	10	300	17,7	20,0	-59,1		-21,4	36,8	58,2
0,11860	Quasi-Peak	10	300	18,1	20,0	-59,1		-21,0	26,1	47,1

### 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.



## 8.7 Radiated Emission Measurement 30 MHz to 100 GHz

Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.249 IC RSS-210 Issue 8, section A2.9		
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 in Fully or Semi Anechoic Room (6.4) Radiated Emission at Alternative Test Site (6.5)		

Comment:	Markers on the spectrum plots overleaf may show deviations in terms of frequency compared to the values in the table below. This is caused by the big span of the spectrum analyzer and is typical behavior.
Date of test:	October 25, 2012; October 26, 2012; October 29, 2012
Test site:	Frequencies $\leq$ 1 GHz: Semi-anechoic room, cabin no. 8 Frequencies $>$ 1 GHz: Fully anechoic room, cabin no. 2
Test distance:	Frequencies $\leq$ 8.2 GHz: 3 meters Frequencies $>$ 8.2 GHz and $\leq$ 18 GHz: 1 meters Frequencies $>$ 18 GHz and $\leq$ 40 GHz: 0.5 meters, except Frequencies $>$ 24 GHz and $\leq$ 24.25 GHz: 3 meters Frequencies $>$ 40 GHz and $\leq$ 60 GHz: 0.3 meters Frequencies $>$ 50 GHz and $\leq$ 75 GHz: 0.25 meters Frequencies $>$ 75 GHz and $\leq$ 100 GHz: 0.2 meters

Test Result:	Test passed
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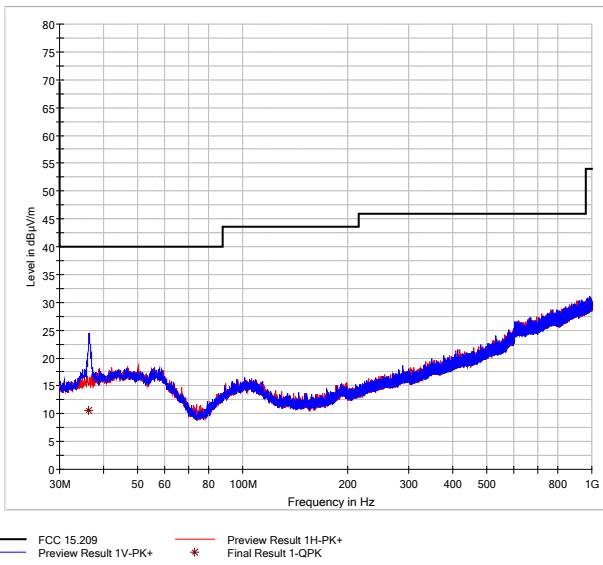
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dB $\mu$ V)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
36,370	vertical	Quasi-Peak	-4,4	14,9		10,6	40,0	29,4
24126,000	vertical	Peak	63,1	42,7		105,8	108,0	2,2

### Sample calculation of final values:

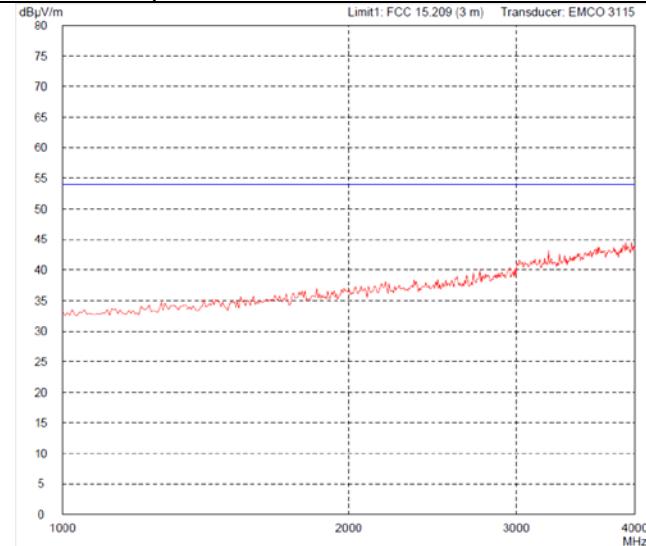
$$\text{Final Value (dB $\mu$ V/m)} = \text{Reading Value (dB $\mu$ V)} + \text{Correction Factor (dB/m)} + \text{Pulse Train Correction (dB)}$$

## Spectrum Plots – Radiated Emissions 30 MHz – 100 GHz

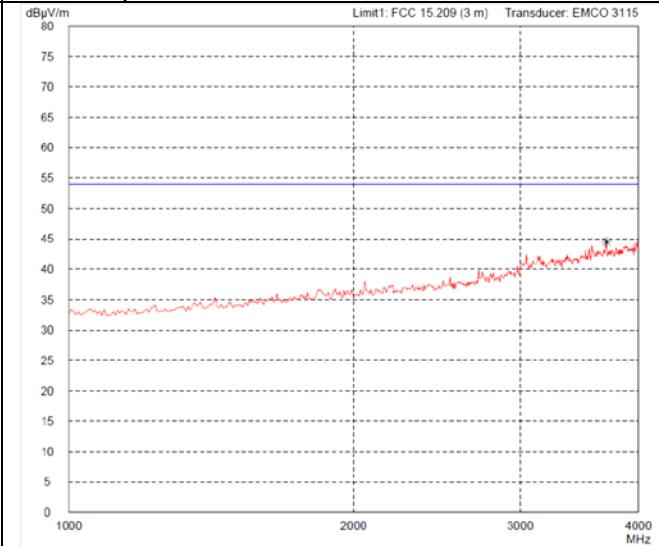
Horizontal (red trace)  
Vertical (blue trace) polarization



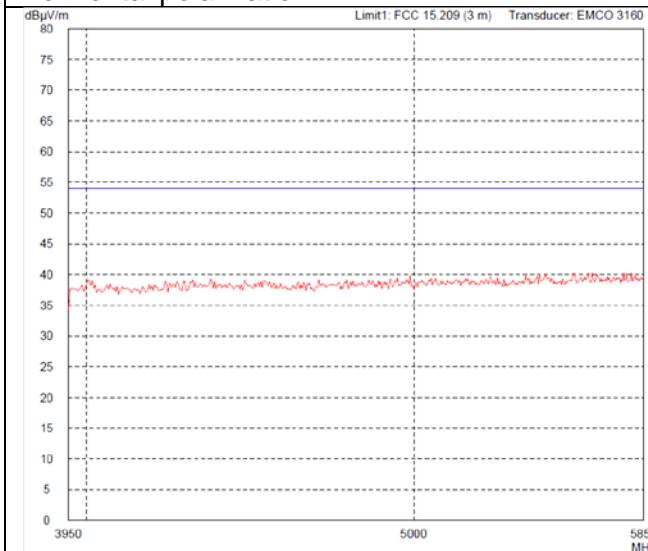
Horizontal polarization



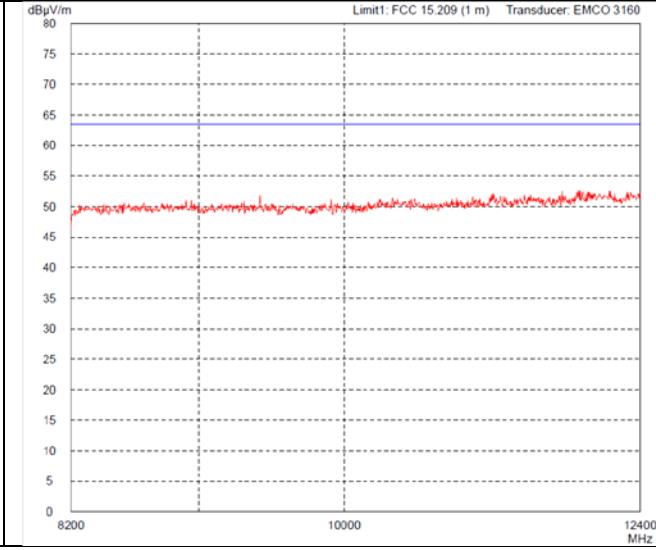
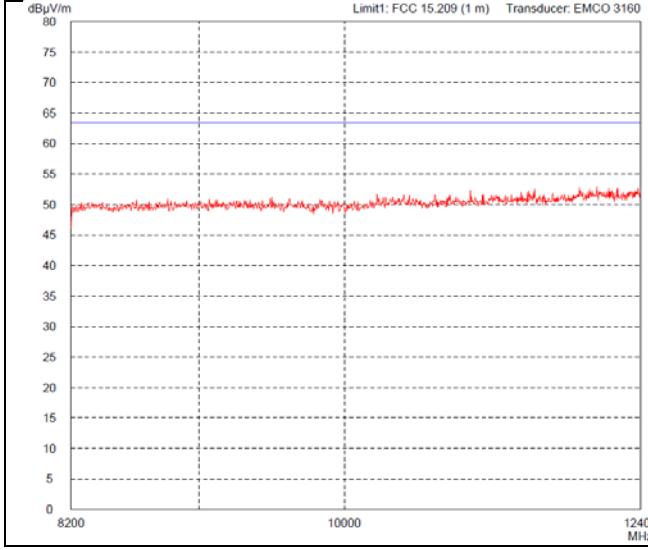
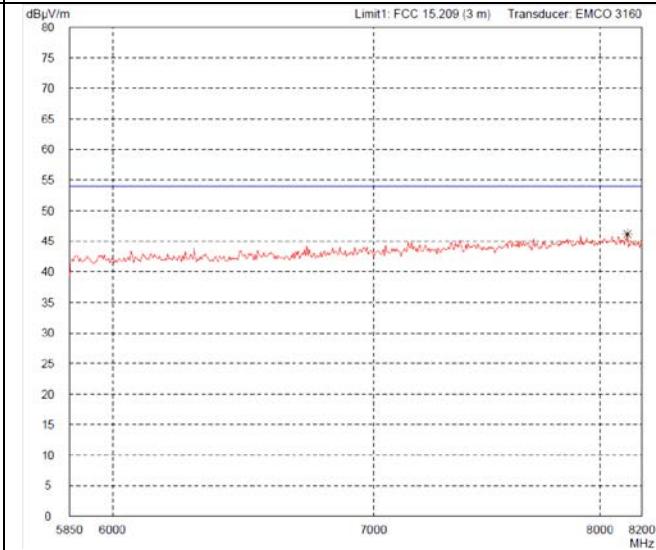
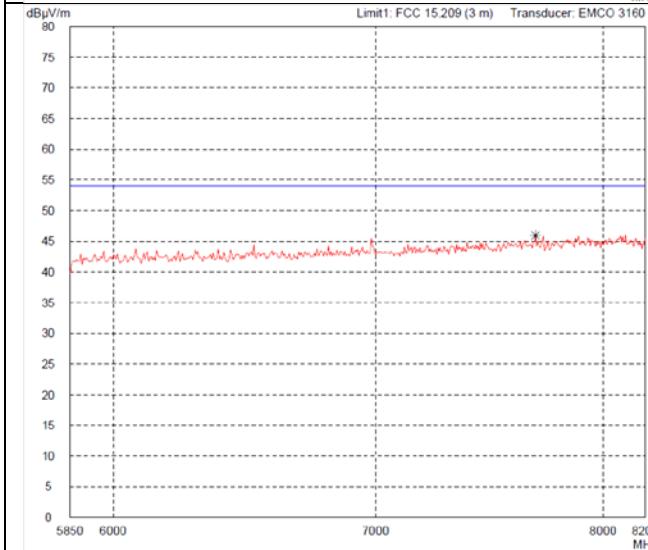
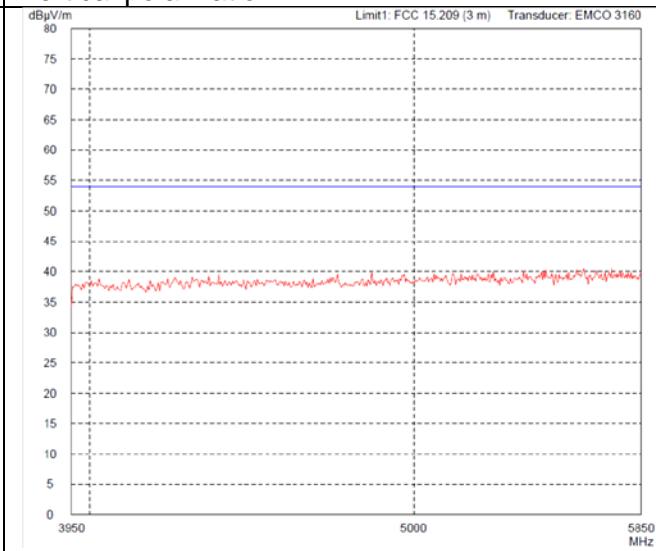
Vertical polarization

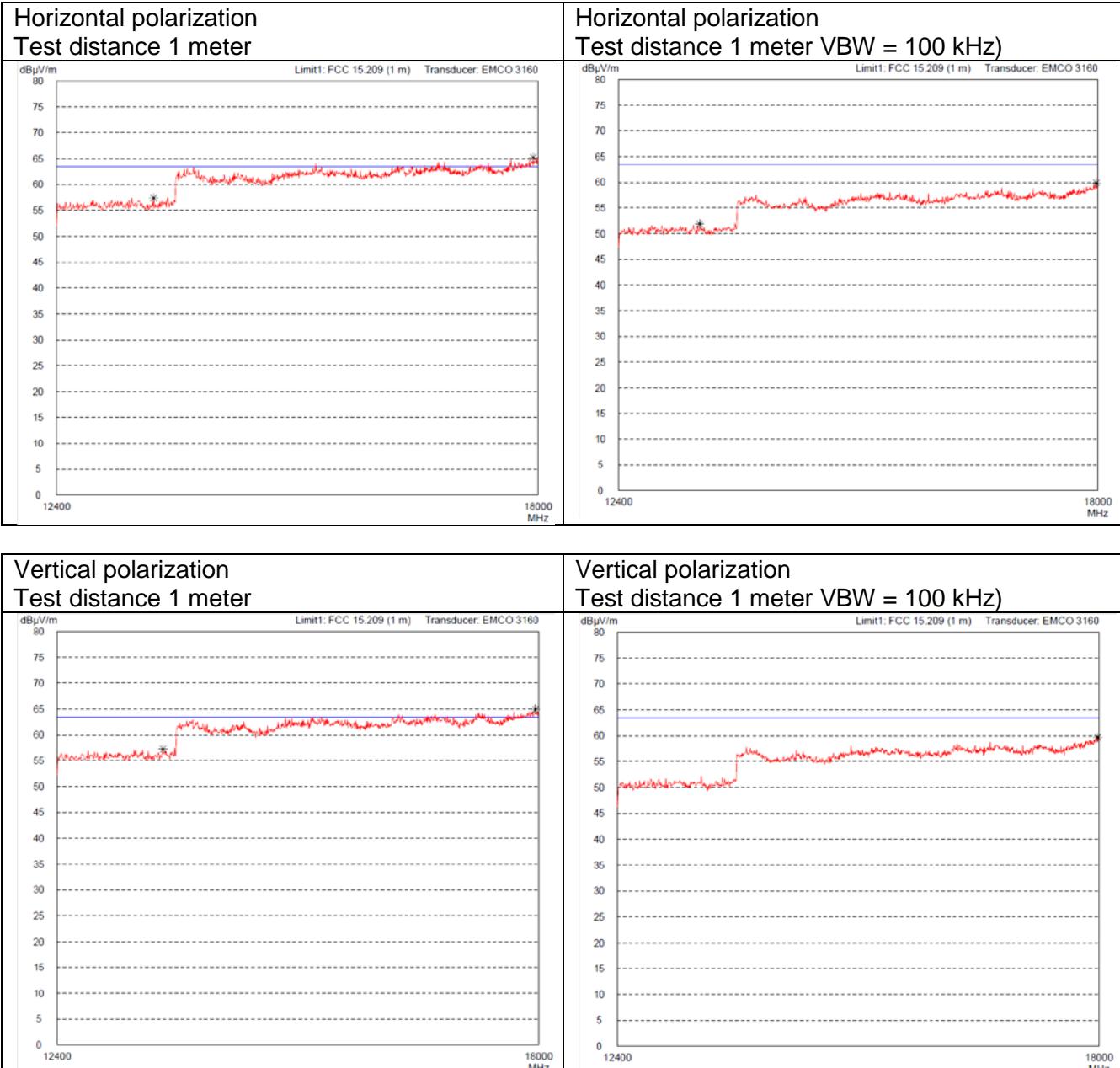


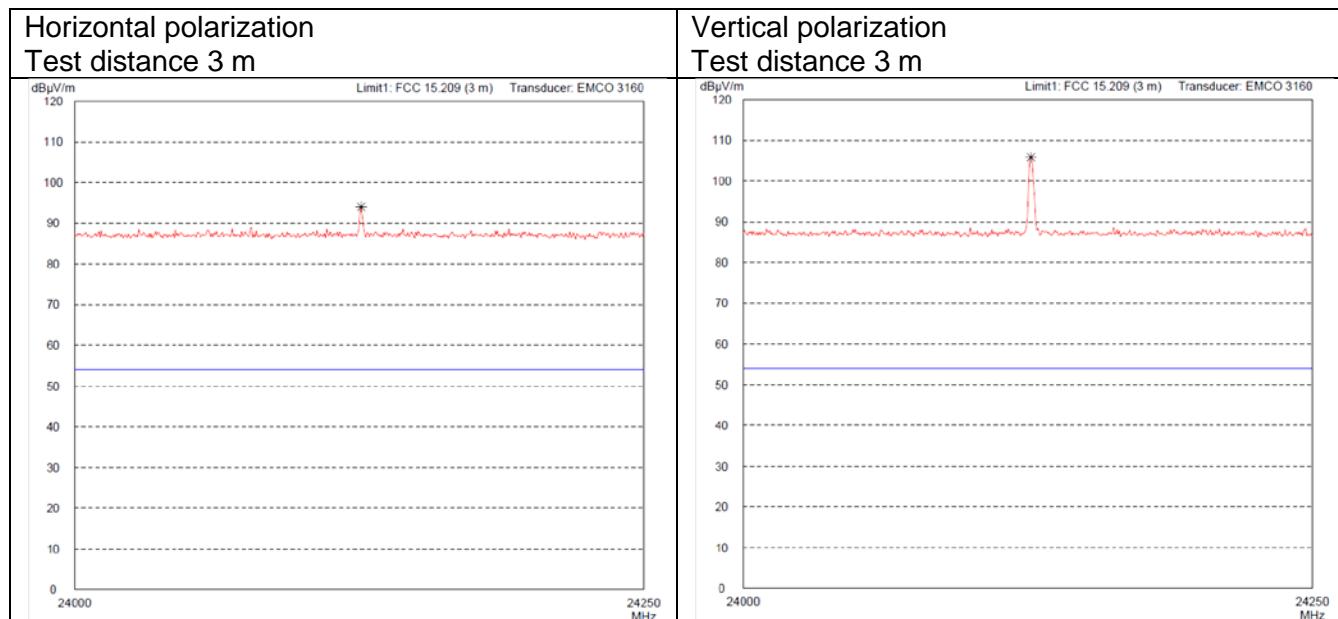
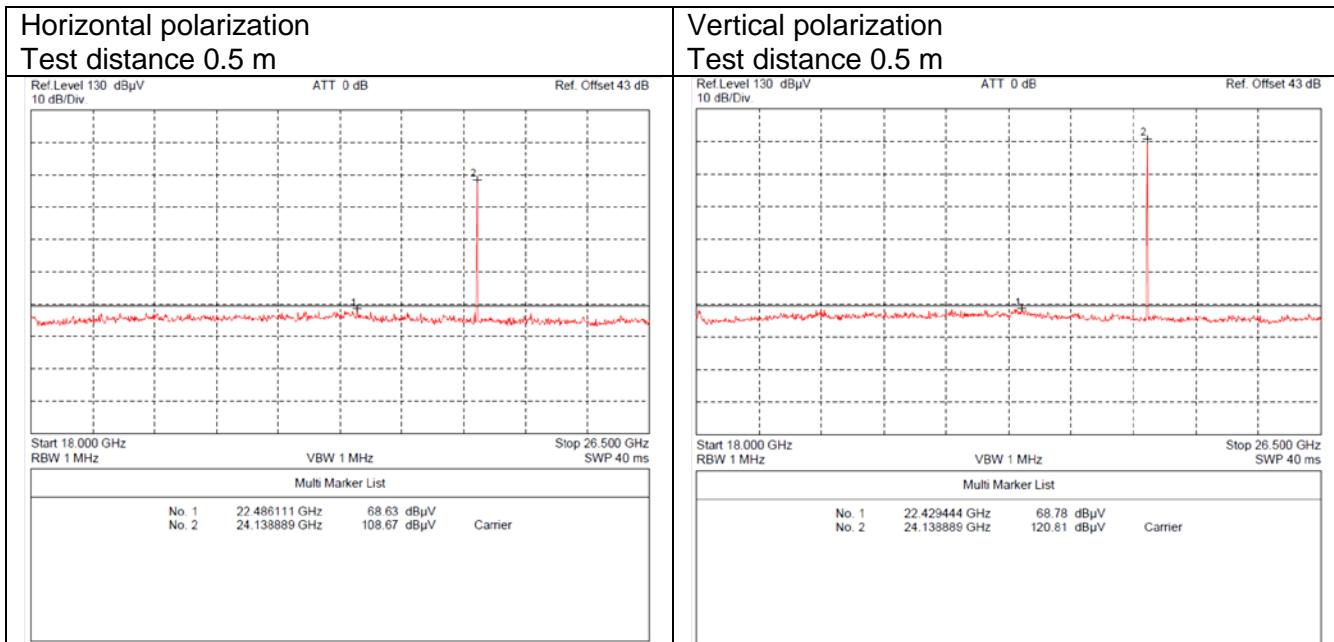
**Horizontal polarization**

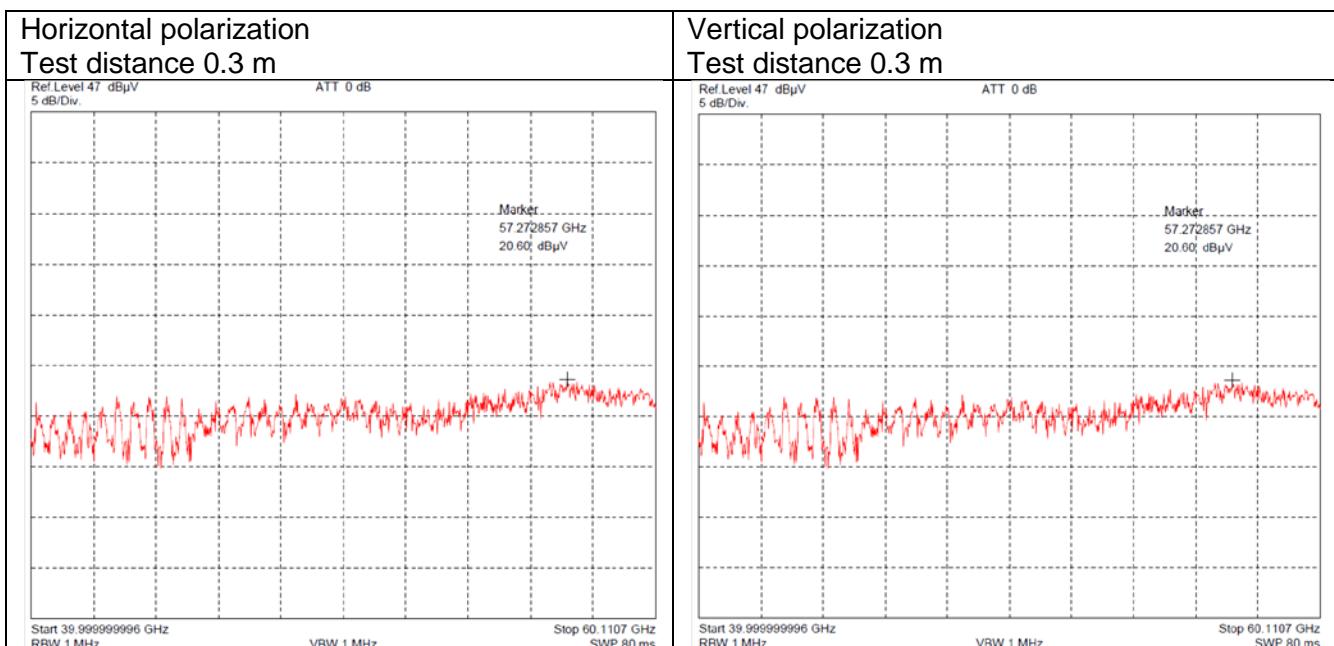
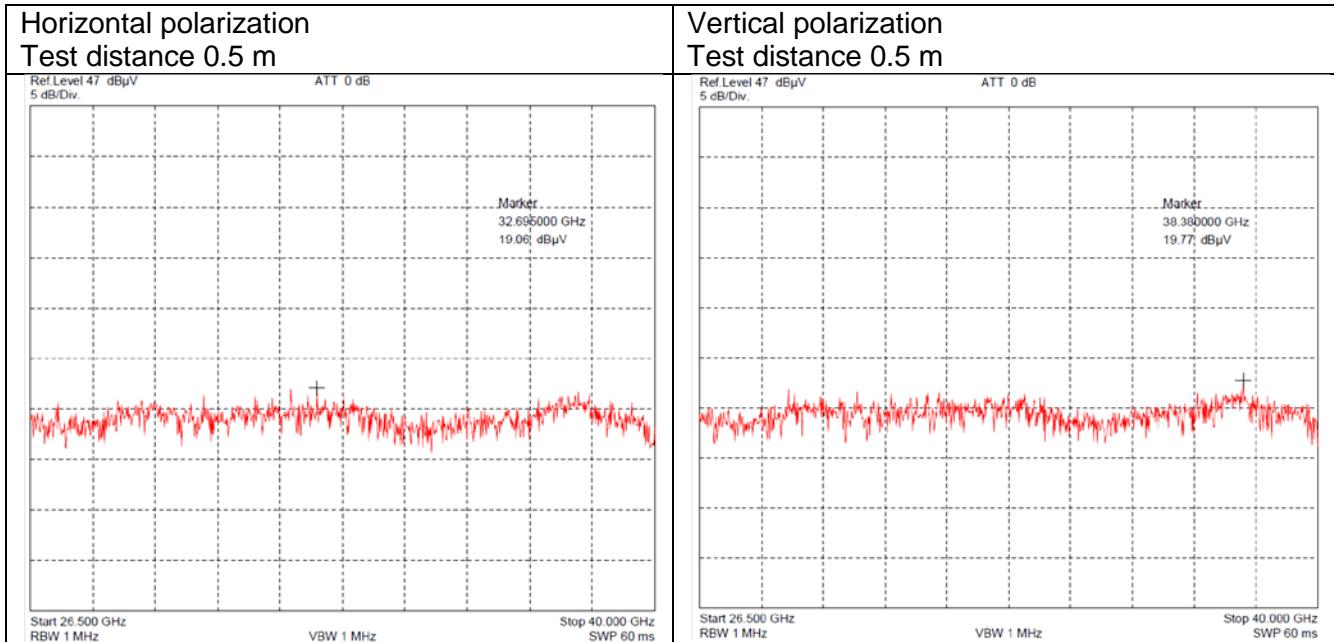


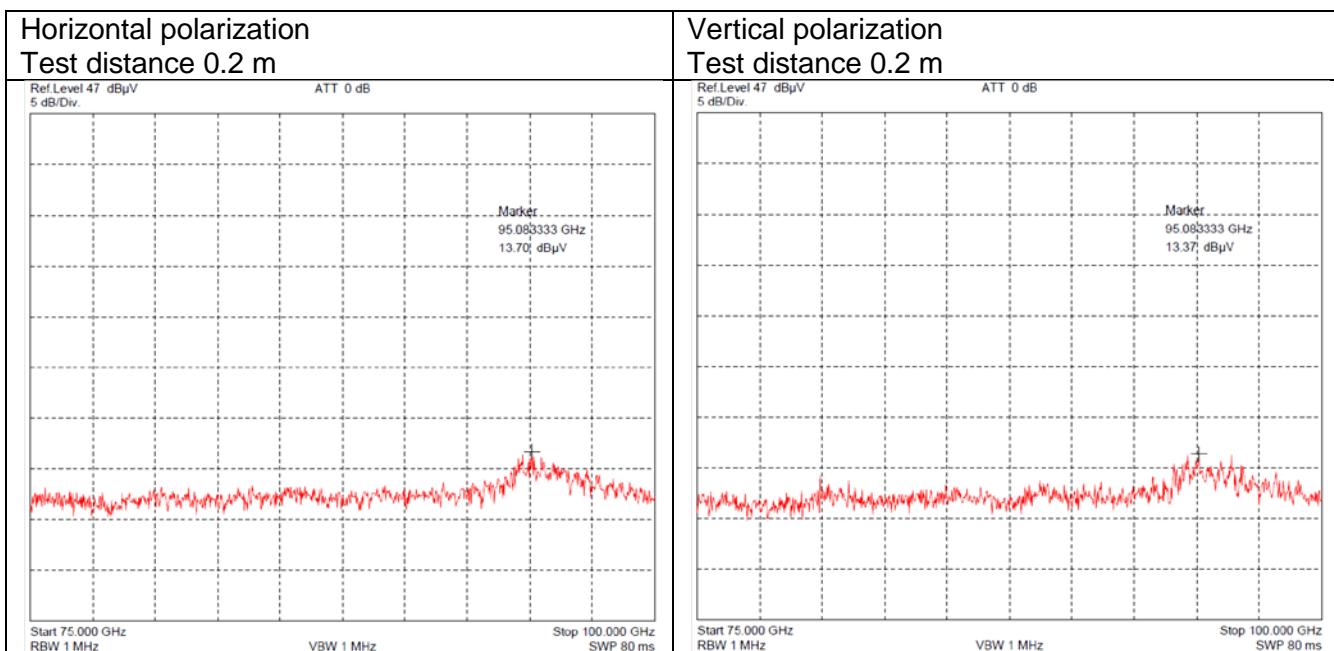
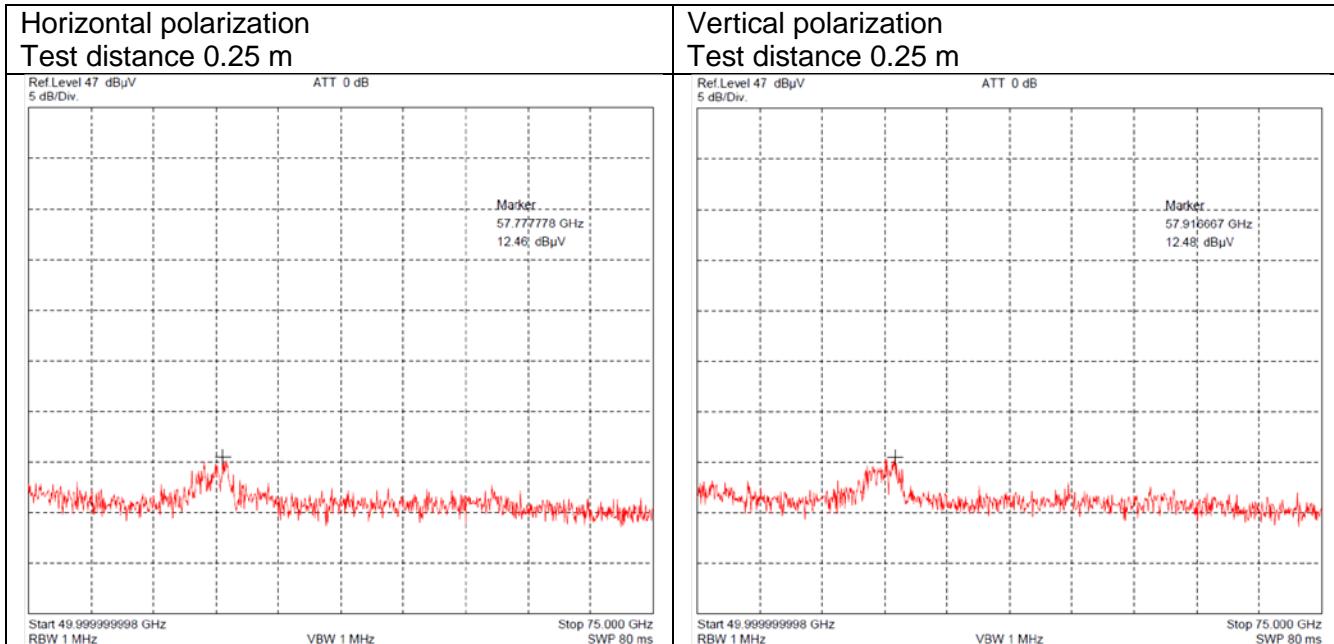
**Vertical polarization**











## 8.8 Exposure of Humans to RF Fields

Rules and specifications:	IC RSS-Gen Issue 3, section 5.6
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					
The conducted output power (CP in watts) is measured at the antenna connector:	$CP = \dots \text{ W}$			<input type="checkbox"/>	
The effective isotropic radiated power (EIRP in watts) is calculated using			<input type="checkbox"/>		
<input type="checkbox"/> the numerical antenna gain: $G = \dots$	$EIRP = G \cdot CP \Rightarrow EIRP = \dots \text{ W}$		<input type="checkbox"/>		
<input type="checkbox"/> the field strength <sup>6</sup> in V/m: $FS = \dots \text{ V/m}$			<input type="checkbox"/>		
	$EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP = \dots \text{ W}$				
with:					
Distance between the antennas in m: $D = \dots \text{ m}$			<input type="checkbox"/>		
<input checked="" type="checkbox"/> not detachable					
A field strength measurement is used to determine the effective isotropic radiated power (EIRP in watts) given by <sup>6</sup> :	$EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP = 11.4 \text{ mW}$				
with:					
Field strength in V/m: $FS = 194.98 \mu\text{V/m}$				<input type="checkbox"/>	
Distance between the two antennas in m: $D = 3 \text{ m}$				<input checked="" type="checkbox"/>	
Selection of output power					
The output power TP is the higher of the conducted or effective isotropic radiated power (e.i.r.p.):	$TP = 11.4 \text{ mW}$				

<sup>6</sup> 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.

Exposure of Humans to RF Fields (continued)	Applicable	Declared by applicant	Measured	Exemption
Separation distance between the user and the transmitting device is	<input type="checkbox"/> less than or equal to 20 cm	<input checked="" type="checkbox"/> greater than 20 cm	<input checked="" type="checkbox"/>	
Transmitting device is	<input type="checkbox"/> in the vicinity of the human head	<input type="checkbox"/> body-worn	<input checked="" type="checkbox"/>	
SAR evaluation				
<p>SAR evaluation is required if the separation distance between the user and the device is less than or equal to 20 cm.</p> <p><input type="checkbox"/> The device operates from 3 kHz up to 1 GHz inclusively and with output power (i.e. the higher of the conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 200 mW for general public use and 1000 mW for controlled use.</p> <p><input type="checkbox"/> The device operates above 1 GHz and up to 2.2 GHz inclusively and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 100 W for general public use and 500 W for controlled use.</p> <p><input type="checkbox"/> The device operates above 2.2 GHz and up to 3 GHz inclusively and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use and 100 mW for controlled use.</p> <p><input type="checkbox"/> The device operates above 3 GHz and up to 6 GHz inclusively and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 10 mW for general public use and 50 mW for controlled use.</p> <p><input type="checkbox"/> SAR evaluation is documented in test report no. ....</p>				<input type="checkbox"/>
RF exposure evaluation				
<p>RF exposure evaluation is required if the separation distance between the user and the device is greater than 20 cm.</p> <p><input type="checkbox"/> The device operates below 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 2.5 W.</p> <p><input checked="" type="checkbox"/> The device operates at or above 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 5 W.</p> <p><input type="checkbox"/> RF exposure evaluation is documented in test report no. ....</p>				<input type="checkbox"/>

## 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 (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 3 containing General Requirements and Information for the Certification of Radiocommunication Equipment, published by Industry Canada	December 2010
<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 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- CEI/IEC CISPR 22	Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment	2002
		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)	
<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	Notes Regarding Designation of Emissions (Including Necessary Bandwidth and Classification), Class of Station and Nature of Service, published by Industry 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	839379/013	Rohde & Schwarz	TÜV SÜD PS-EMC-STR Rohde & Schwarz	10/2012 11/2012 7	10/2013 11/2014
EMI test receiver	2044	ESU8	100232	Rohde & Schwarz	Rohde & Schwarz	07/2012	01/2014
Spectrum analyser	1666	FSP30	100063	Rohde & Schwarz	Rohde & Schwarz	05/2011	11/2012
Preamplifier	1484	ACO/180-3530	32641	CTT	TÜV SÜD PS-EMC-STR	06/2011	12/2012
Preamplifier	1684	AFS3-00100800-32-LN	847743	MITEQ	TÜV SÜD PS-EMC-STR	10/2011	04/2013
Preamplifier	1716	CPA9231A	3557	Schaffner EMC Systems	TÜV SÜD PS-EMC-STR	07/2012	01/2014
V-network	1218	ESH3-Z5	830952/025	Rohde & Schwarz	Rohde & Schwarz	08/2011	08/2013
Double ridged waveguide horn antenna	1516	3115	9508-4553	EMCO Elektronik	Seibersdorf Laboratories	10/2010	10/2012
Horn antenna	1012	3160-05	9112-1001	EMCO Elektronik		see note 1	
Horn antenna	1013	3160-06	9112-1001	EMCO Elektronik		see note 1	
Horn antenna	1014	3160-07	9112-1008	EMCO Elektronik		see note 1	
Horn antenna	1015	3160-08	9112-1002	EMCO Elektronik		see note 1	
Horn antenna	1265	3160-09	9403-1025 (931941-010)	EMCO Elektronik		see note 1	
Horn antenna	1575	3160-10	399185	EMCO Elektronik		see note 1	
Horn antenna	2086	24240-20	157845	Flann		see note 1	
Horn antenna	2180	25240-25	205900	Flann		see note 1	
Horn antenna	2182	27240-25	204260	Flann		see note 1	
Loop antenna	1016	HFH2-Z2	882964/0001	Rohde & Schwarz	Rohde & Schwarz	05/2011	11/2012
TRILOG Broadband Antenna	2058	VULB 9163	9163-408	Schwarzbeck	Rohde & Schwarz	05/2011	11/2012

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.

<sup>7</sup> Incoming results within specifications

## 11 Revision History

<b>Revision History</b>			
<i>Edition</i>	<i>Date</i>	<i>Issued by</i>	<i>Modifications</i>
1	2012-11-06	Martin Steindl (gz)	First Edition
2	2013-03-19	J. Roidt	Update of FCC-Regulations, notes for clarification added
3	2013-03-25	J. Roidt	“Test Equipment List with Calibration Data” revised