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October 27, 2017

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Prüfbericht / Test Report

Nr. / No. 69547-94390-05 (Edition 3)

Applicant: Kaba GmbH
Type of equipment: RFID Reader Module
Type designation: RMs iCLASS SE / Prox
Order No.: 14717
Test standards: FCC Code of Federal Regulations,
CFR 47, Part 15,
Sections 15.205, 15.207, 15.209, 15.215 and 15.225

Industry Canada Radio Standards Specifications
RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 and
RSS-210 Issue 9, Section B.6 (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 :	RMs iCLASS SE / Prox
Parts ² :	
Serial number(s):	0404512501194897
Manufacturer:	Kaba GmbH
Type of equipment:	RFID Reader Module
Version:	As received
FCC ID:	NVI-SE3200
Industry Canada ID:	11038A-SE3200
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:	125 kHz and 13.110 MHz - 14.010 MHz	
Frequency range:	125 kHz and 13.56 MHz	
Operating frequency:	125 kHz and 13.56 MHz	
Type of modulation:	ASK	
Pulse train:	---	
Pulse width:	---	
Number of RF-channels:	2	
Channel spacing:	---	
Designation of emissions ³ :	400HA1D; 50K0A1D	
Type of antenna:	Integrated loop antenna	
Size/length of antenna:	125 kHz:	3.5 cm x 2.5 cm,
	13.56 MHz:	6 cm x 5 cm
Connection of antenna:	<input type="checkbox"/> detachable	<input checked="" type="checkbox"/> not detachable
Type of power supply:	AC supply	
Specifications for power supply:	nominal voltage:	120 V
	nominal frequency:	60 Hz
Type of internal power supply:	DC supply	
Specifications for internal power supply:	nominal voltage:	5.0 V
	minimum voltage:	4.25 V
	maximum voltage:	5.75 V

³ Also known as "Class of Emission".



2 Administrative Data

Application details

Applicant (full address):	Kaba GmbH Albertstraße 3 78056 Villingen-Schwenningen Germany
Contact person:	Mr. Wolfgang Schneider, Hardware Development
Order number:	14717
Receipt of EUT:	2017-01-16; 2017-10-25
Date(s) of test:	2017-01-16 to 2017-01-25; 2017-10-26
Note(s):	Mr. Wolfgang Schneider and Mr. Thomas Jerger attended tests between 2017-01-16 and 2017-01-20.

Report details

Report number:	69547-94390-05
Edition:	3
Issue date:	2017-10-27



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
Laboratory recognition ⁴ :	Registration No. BNetzA-CAB-16/21-15
FCC test site registration number	90926
Industry Canada test site registration:	3050A-2
Contact person:	Mr. Markus Biberger
	Phone: +49 9421 5522-0 Fax: +49 9421 5522-99

⁴ Since 2017-03-16.



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, 15.209, 15.215 and 15.225

of the Federal Communication Commission (FCC) and the

**Radio Standards Specifications
 RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 and
 RSS-210 Issue 9, Section , B.6 (Category I Equipment)**

of Industry Canada (IC).

Die Prüfergebnisse beziehen sich ausschließlich auf das zur Prüfung vorgestellte Prüfmuster. Ohne schriftliche Genehmigung des Prüflabors darf der Prüfbericht auszugsweise nicht vervielfältigt werden. *The test results relate only to the individual item which has been tested. Without the written approval of the test laboratory this report may not be reproduced in extracts.*

Datum / Date	Geprüft von / Tested by	Freigabe durch / Checked by	Prüfergebnis / Test Result <input checked="" type="checkbox"/> Erfüllt / Passed <input type="checkbox"/> Nicht erfüllt / Not passed
2017-10-27	 Martin Steindl Responsible for testing	 Markus Biberger Reviewer	

5 Operation Mode and Configuration of EUT

Operation Mode(s)

Connected to terminal 97 00 with 80 cm reader flatcable (terminal in shielded metal box);
 TP application running, waiting for tag.

Configuration(s) of EUT

The EUT was configured as external of a 97 00 terminal.

The conducted AC emissions were tested two times. First with the antenna attached to the transmitter and second with the antenna-port terminated with 50 Ohms.

List of ports and cables

<i>Port</i>	<i>Description</i>	<i>Classification⁵</i>	<i>Cable type</i>	<i>Cable length</i>
1	AC 120 V power supply of terminal	dc power	Unshielded	1.5 m
2	Reader cable with DC 5 V	signal/control port	Unshielded	80 cm

List of devices connected to EUT

<i>Item</i>	<i>Description</i>	<i>Type Designation</i>	<i>Serial no. or ID</i>	<i>Manufacturer</i>
1	Terminal	97 00-K6	079701100004	Kaba

List of support devices

<i>Item</i>	<i>Description</i>	<i>Type Designation</i>	<i>Serial no. or ID</i>	<i>Manufacturer</i>
1	Transponder card	Legic		
2	Transponder card	Prox		

⁵ 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 9, section A.1.3 ANSI C63.10, section 6.9.1
Guide:	ANSI C63.10 / 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 (6.3)
<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 Conducted AC Powerline Emission

Measurement Procedure:

Rules and specifications:	CFR 47 Part 15, section 15.207 IC RSS-Gen Issue 4, section 8.8
Guide:	ANSI C63.10 / CISPR 22

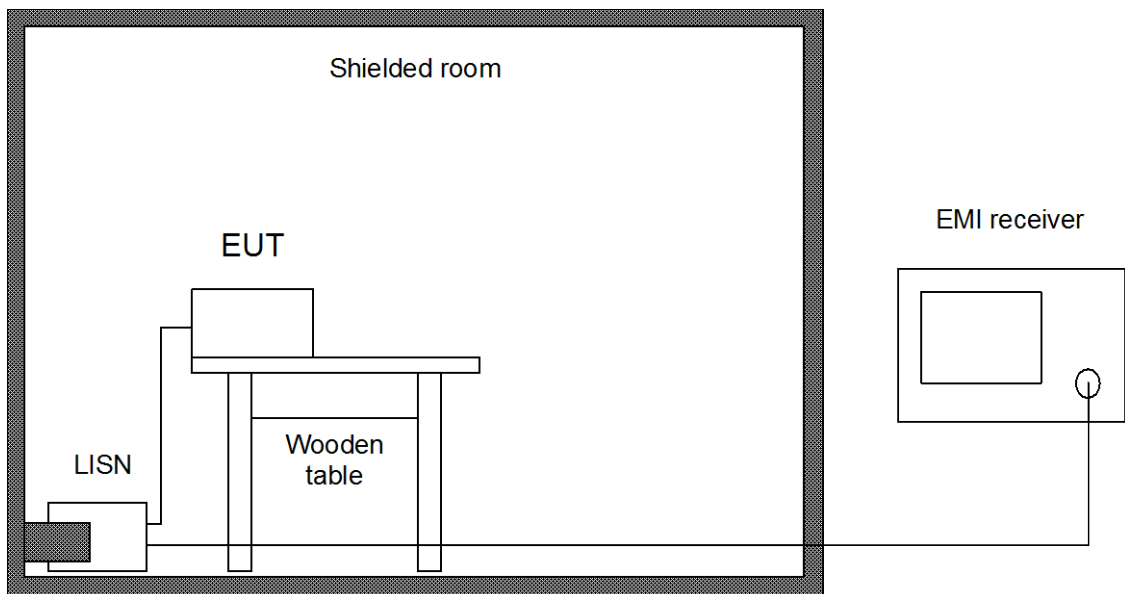
Conducted emission tests in the frequency range 150 kHz to 30 MHz are performed using Line Impedance Stabilization Networks (LISNs). To simplify testing with quasi-peak and average detector the following procedure is used:

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 C63.10, section 6.2.5, 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.



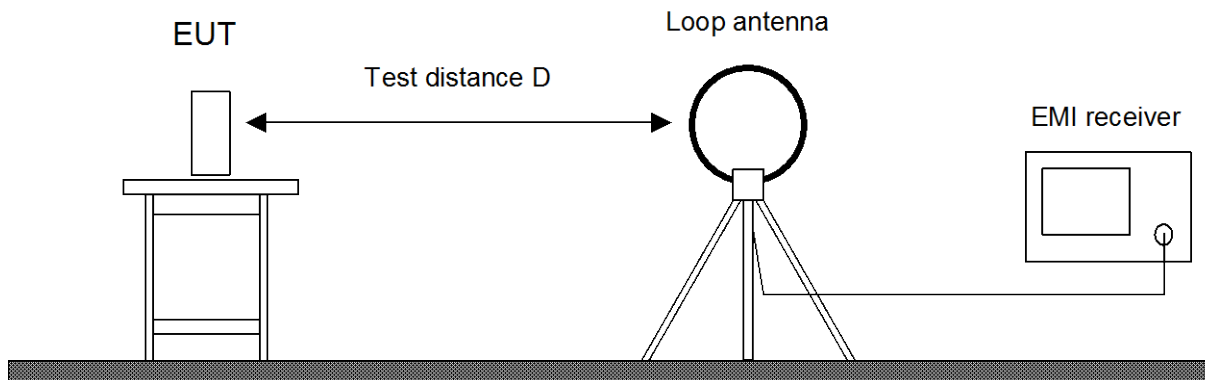


Test instruments used:

Type	Designation	Inv.-no.	Serial No. or ID	Manufacturer
<input type="checkbox"/> Test receiver	ESHS 10	1028	860043/016	Rohde & Schwarz
<input type="checkbox"/> Test receiver	ESCI3	1863		
<input type="checkbox"/> V-network	ESH 3-Z5	1059	894785/005	Rohde & Schwarz
<input checked="" type="checkbox"/> V-network	ESH 3-Z5	1060	862770/021	Rohde & Schwarz
<input 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 checked="" type="checkbox"/> Microwave cable	FB293C1080005050	2157	72110-02	Rosenberger Micro-Coax
<input checked="" type="checkbox"/> Coax cable	RG214 N/N 5m	1188	---	Senton
<input type="checkbox"/> Shielded room	No. 1	1451	---	Albatross
<input type="checkbox"/> Shielded room	No. 4	1454	3FD 100 544	Euroshield
<input checked="" type="checkbox"/> Shielded room	No. 9	21083	---	Albatross
<input checked="" type="checkbox"/> Measurement Software	EMC32_K1 V9.26.01	2230	100281	Rohde & Schwarz

6.3 Radiated Emission Measurement 9 kHz to 30 MHz

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.205, 15.209, 15.215(b) and 15.225(a)-(d) IC RSS-GEN Issue 4, sections 8.9 and 8.10 and IC RSS-210 Issue 9, section B.6
Guide:	ANSI C63.10
<p>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.</p> <p>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.</p> <p>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).</p> <p>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.</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>	



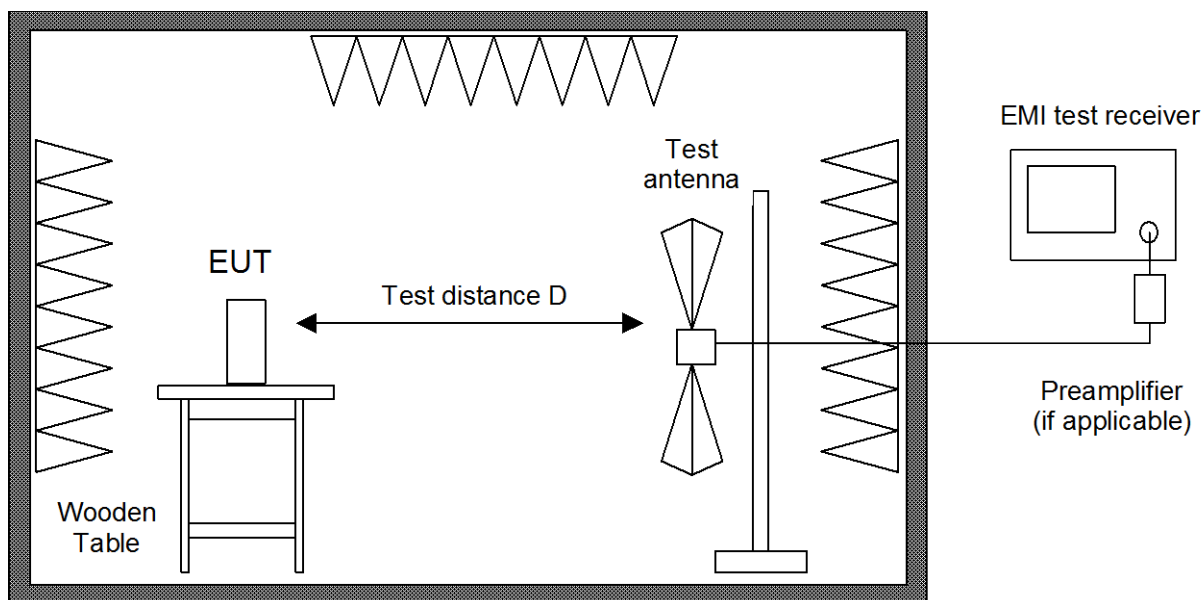


Test instruments used:

Type	Designation	Inv.-no.	Serial No. or ID	Manufacturer
<input type="checkbox"/> Spectrum analyzer	FSP30	1666	100036	Rohde & Schwarz
<input checked="" type="checkbox"/> Spectrum analyzer	FSV	2364	101448	Rohde & Schwarz
<input type="checkbox"/> Test receiver	ESHS 10	1028	860043/016	Rohde & Schwarz
<input type="checkbox"/> EMI test receiver	ESU8	2044	100232	Rohde & Schwarz
<input checked="" type="checkbox"/> EMI test receiver	ESR7	22653	101713	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"/> Microwave cable Cabin no. 2	UFA210A-FG	1681	23516	Rosenberger Micro-Coax
<input type="checkbox"/> Microwave cable Cabin no. 2	KKSF1040016	2020	289854/4	Huber + Suhner
<input type="checkbox"/> Microwave cable Cabin no. 2	FA210AF020000000	2060	64566-2	Rosenberger Micro-Coax
<input type="checkbox"/> Microwave cable Cabin no. 8	EF393	2053	---	Albatross Projects
<input type="checkbox"/> Microwave cable Cabin no. 8	FB293C1050005050	2054	63834-1	Rosenberger Micro-Coax
<input checked="" type="checkbox"/> Microwave cable Cabin no. 8	FB293C1080005050	2055	63833-1	Rosenberger Micro-Coax
<input type="checkbox"/> Microwave cable Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
<input type="checkbox"/> Microwave cable Cabin no. 8	LCF12-50	2057	P1.4.12	RFS
<input checked="" type="checkbox"/> Microwave cable Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
<input type="checkbox"/> Microwave cable Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
<input type="checkbox"/> Microwave cable Cabin no. 8	FA210AF04000505G	2056	64567-01	Rosenberger Micro-Coax
<input checked="" type="checkbox"/> Microwave cable Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
<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
<input checked="" type="checkbox"/> Measurement Software	EMC32_K8 V9.25.00	1852	100016	Rohde & Schwarz

6.4 Radiated Emission at Alternative Test Site

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.205(b), 15.209 and 15.225(d) IC RSS-GEN Issue 4, sections 8.9 and 8.10(b)(c) and IC RSS-210 Issue 9, section B.6
Guide:	ANSI C63.10
<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 respectively ANSI C63.10 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. 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.</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 type="checkbox"/> EMI test receiver	ESU8	2044	100232	Rohde & Schwarz
<input checked="" type="checkbox"/> EMI test receiver	ESR7	22653	101713	Rohde & Schwarz
<input checked="" type="checkbox"/> Trilog antenna Cabin no. 8	VULB 9163	2058	9163-408	Schwarzbeck
<input checked="" type="checkbox"/> Microwave cable Cabin no. 8	EF393	2053	---	Albatross Projects
<input type="checkbox"/> Microwave cable Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
<input checked="" type="checkbox"/> Microwave cable Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
<input type="checkbox"/> Microwave cable Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
<input checked="" type="checkbox"/> Microwave cable Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
<input checked="" type="checkbox"/> Semi anechoic room	No. 8	2057	---	Albatross
<input checked="" type="checkbox"/> Measurement Software	EMC32_K8 V9.25.00	1852	100016	Rohde & Schwarz

6.5 Carrier Frequency Stability

Measurement Procedure:

Rules and specifications:	CFR 47 Part 15, section 15.225(e) IC RSS-Gen Issue 4, section 6.11 and IC RSS-210 Issue 9, section B.6
Guide:	ANSI C63.10

The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 °C.

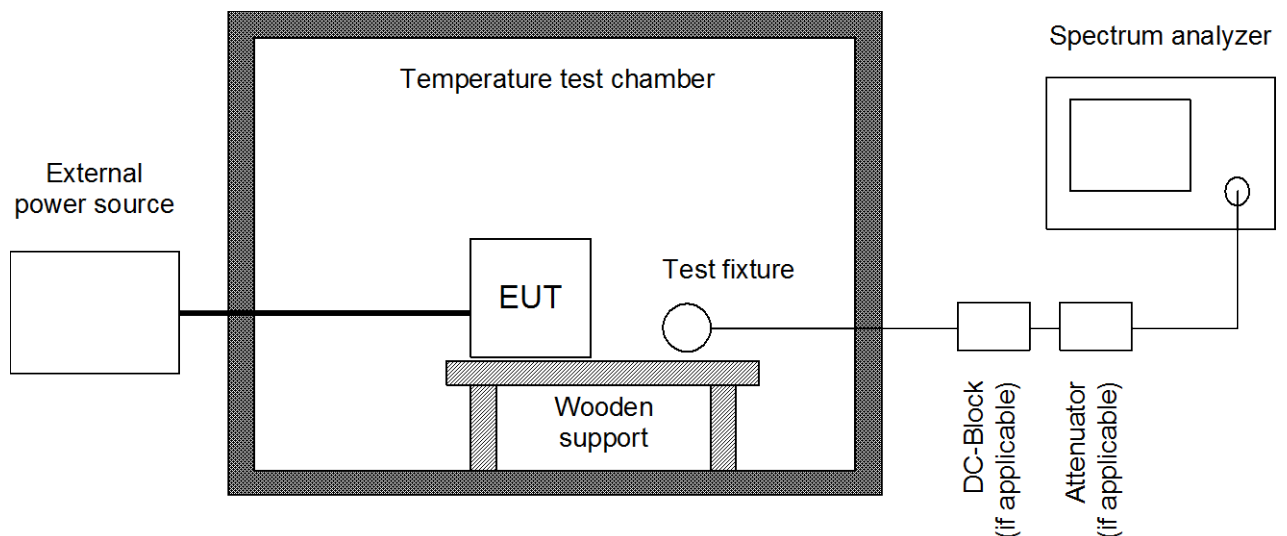
If the EUT provides an antenna connector the spectrum analyzer is connected to this port. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as dc block and appropriate attenuators (50 Ohms). In cases where the EUT does not provide an antenna connector a test fixture is used.

For battery operated equipment, the test is performed using a new battery. Alternatively, an external supply voltage can be used and is at least set to:

- the maximum battery voltage as delivered by a new battery or 115% of the battery nominal voltage
- the battery nominal voltage
- 85% of the battery nominal voltage
- the battery operating end point voltage which shall be specified by the equipment manufacturer

The EUT is operating providing an unmodulated carrier. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to the shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.

If an unmodulated carrier is not available a significant and stable point on the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1% of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance allowed is larger than the uncertainty of the measured frequency tolerance.





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	ESPI7	1711	836914/0002	Rohde & Schwarz
<input type="checkbox"/> EMI test receiver	ESMI	1569	839379/013 839587/006	Rohde & Schwarz
<input type="checkbox"/> Spectrum analyzer	ZVL			Rohde & Schwarz
<input type="checkbox"/> DC-block	7006	1636	A2798	Weinschel
<input type="checkbox"/> Attenuator	4776-10	1638	9412	Narda
<input type="checkbox"/> Attenuator	4776-20	1639	9503	Narda
<input type="checkbox"/> Test probe	TP 01	1628	001	TÜV SÜD PS
<input checked="" type="checkbox"/> Multimeter	21 III	1653	76530546	Fluke
<input type="checkbox"/> Multimeter	21 III	1654	76381229	Fluke
<input type="checkbox"/> Multimeter	Fluke 77 III	1975	92370108	Fluke
<input type="checkbox"/> Multimeter	Fluke 77 IV	1976	93090238	Fluke
<input type="checkbox"/> Multimeter	Fluke 177	2025	96720024	Fluke
<input type="checkbox"/> Multimeter	Fluke 177	2026	96720025	Fluke
<input checked="" type="checkbox"/> DC power supply	NGSM 32/10	1267	203	Rohde & Schwarz
<input type="checkbox"/> Isolating transformer	RT 5A	1127	10387	Grundig
<input type="checkbox"/> Isolating transformer	RT 5A	1128	10416	Grundig
<input checked="" type="checkbox"/> Temperature test chamber	HT 4010	1271	07065550	Heraeus



7 Photographs Taken During Testing

Test setup for conducted AC powerline emission measurement



Test setup for radiated emission measurement 9 kHz – 30 MHz



Test setup for radiated emission measurement (alternate test site)





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	24	Recorded
15.215(c)	Bandwidth of the emission	32	Test passed
2.201, 2.202	Class of emission	35	Calculated
15.35(c)	Pulse train measurement for pulsed operation	---	Not applicable
15.205(a) 15.205(d)(7)	Restricted bands of operation	--- ⁶	Test passed
15.207	Conducted AC powerline emission 150 kHz to 30 MHz	36	Test passed
15.225(a)-(d)	Spectrum Mask	44	Test passed
15.205(b) 15.215(b) 15.225(a)(d)	Radiated emission 9 kHz to 30 MHz	46	Test passed
15.205(b) 15.225(d)	Radiated emission 30 MHz to 1 GHz	48	Test passed
15.225(e)	Carrier frequency stability	50	Test passed

⁶ See "Spectrum Mask" for the 13.36 to 13.41 MHz band. For all other restricted bands see "Radiated Emission".

IC RSS-GEN Issue 4			
<i>Section(s)</i>	<i>Test</i>	<i>Page</i>	<i>Result</i>
6.12	Transmitter output power (conducted)	---	Not applicable
6.6	Occupied Bandwidth	24	Recorded
9	Designation of emissions	35	Calculated
6.10	Pulsed operation	---	Not applicable
8.10	Restricted bands and unwanted emission frequencies	--- ⁷	Test passed
6.4, 6.13, 8.9	Unwanted emissions 9 kHz to 30 MHz	46	Test passed
6.4, 6.13, 8.9	Unwanted emissions 30 MHz to 1 GHz	48	Test passed
8.8	Transmitter AC power lines conducted emissions 150 kHz to 30 MHz	36	Test passed
3.2	Exposure of Humans to RF Fields	53	Exempted from SAR and RF evaluation

IC RSS-210 Issue 9			
<i>Section(s)</i>	<i>Test</i>	<i>Page</i>	<i>Result</i>
B.6	Spectrum Mask	44	Test passed
B.6	Unwanted emissions 9 kHz to 30 MHz	46	Test passed
B.6	Unwanted emissions 30 MHz to 1 GHz	48	Test passed
B.6	Carrier frequency stability	50	Test passed

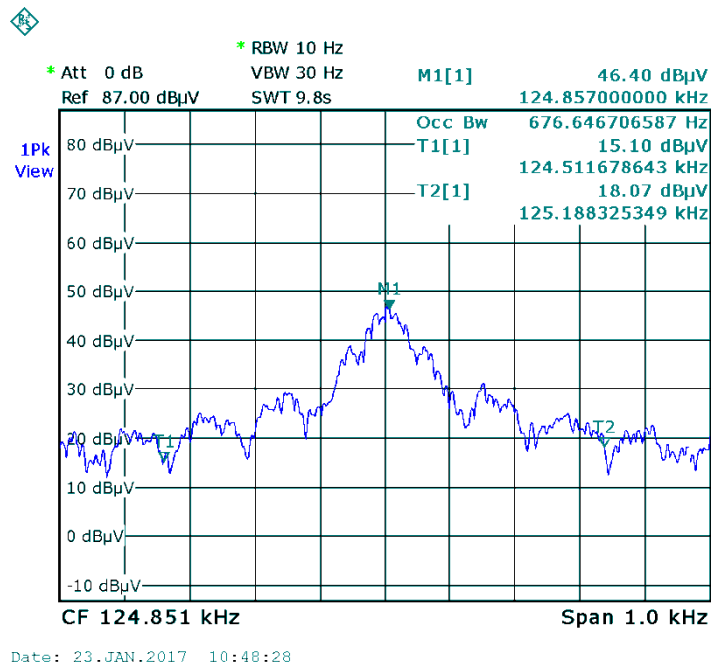
⁷ See "Spectrum Mask" and "Unwanted emissions".

8.1 Occupied Bandwidth

Rules and specifications:	CFR 47 Part 2, section 2.202(a) ANSI C63.10, section 6.9.1
Guide:	ANSI C63.10
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 C63.10, section 6.9.1; 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>The span range of the spectrum analyser display shall be between two times and five times of the occupied bandwidth. The resolution bandwidth of the spectrum analyzer should be approximately 1 % to 5 % of the occupied bandwidth, unless otherwise specified, depending on the applicable requirement. The video bandwidth shall be at least three times greater than the resolution bandwidth. The dynamic range of the spectrum analyzer at the selected resolution bandwidth shall be more than 10 dB below the target “dB down” (attenuation) requirement.</p>
Measurement procedure:	Bandwidth Measurements (6.1)

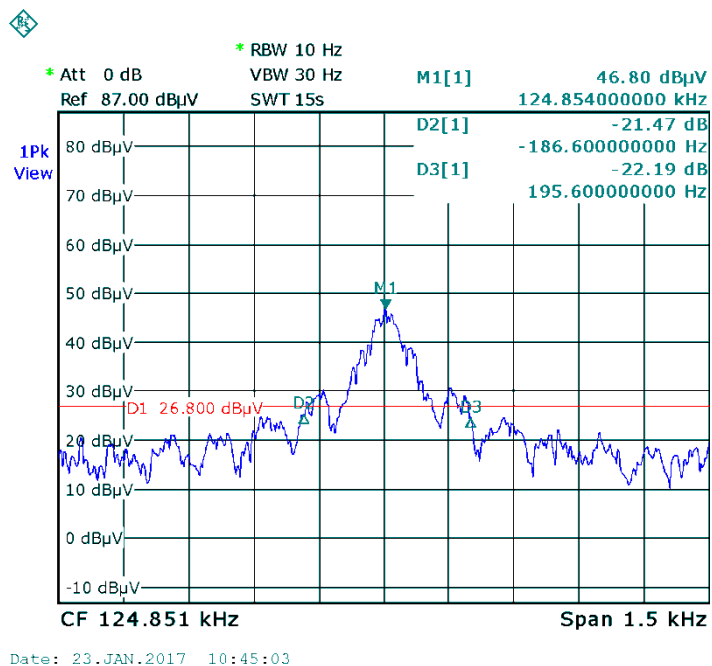
Comment:	
Date of test:	2017-01-23
Test site:	Fully anechoic room, cabin no. 8

Occupied Bandwidth (99 %):



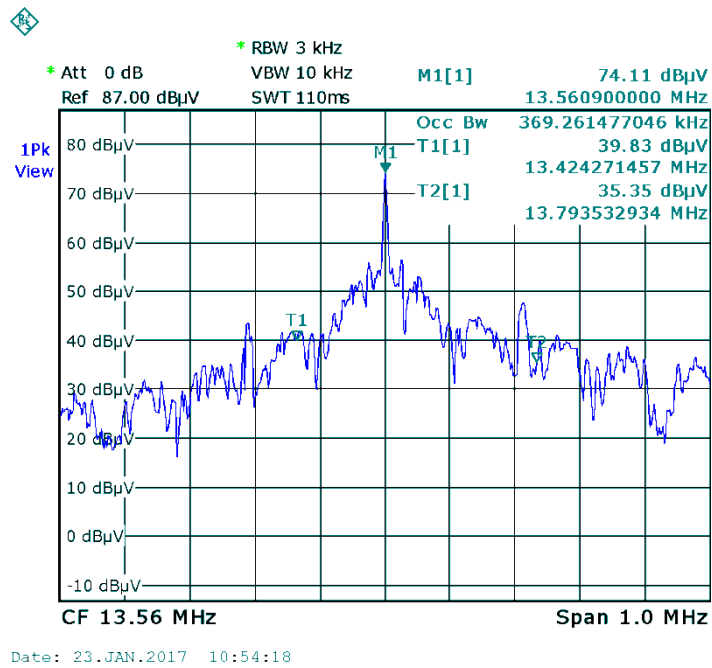
Occupied Bandwidth (99 %): **0.68 kHz**

Occupied Bandwidth (-20 dB):



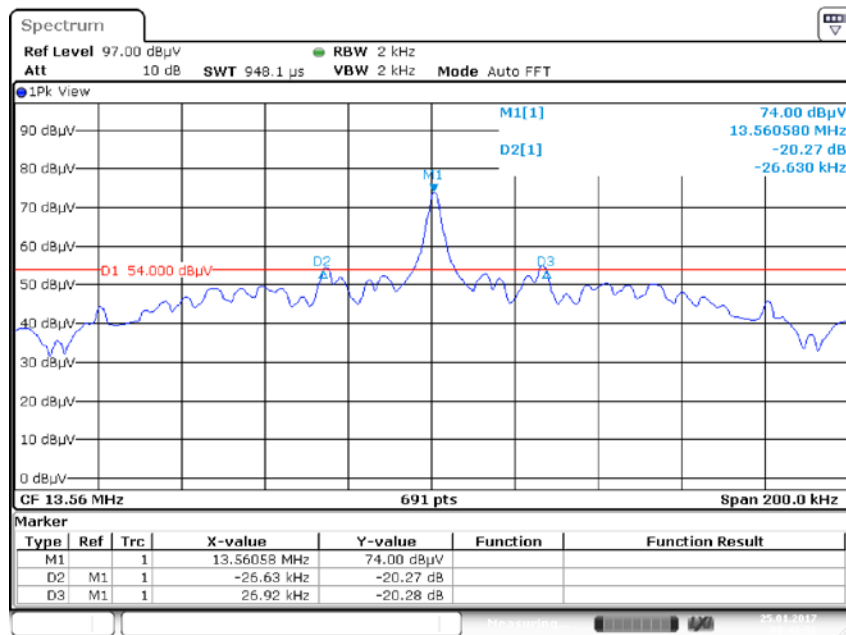
Occupied Bandwidth (-20 dB): **0.38 kHz**

Occupied Bandwidth (99 %):



Occupied Bandwidth (99 %): **369.26 kHz**

Occupied Bandwidth (-20 dB):



Date: 25.JAN.2017 09:48:37

Occupied Bandwidth (-20 dB): **53.55 kHz**

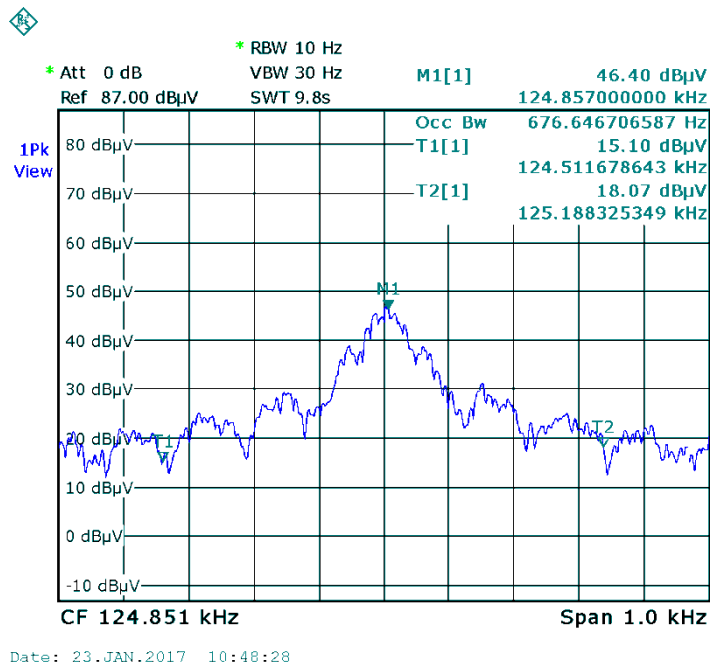


Occupied Bandwidth (continued)

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)

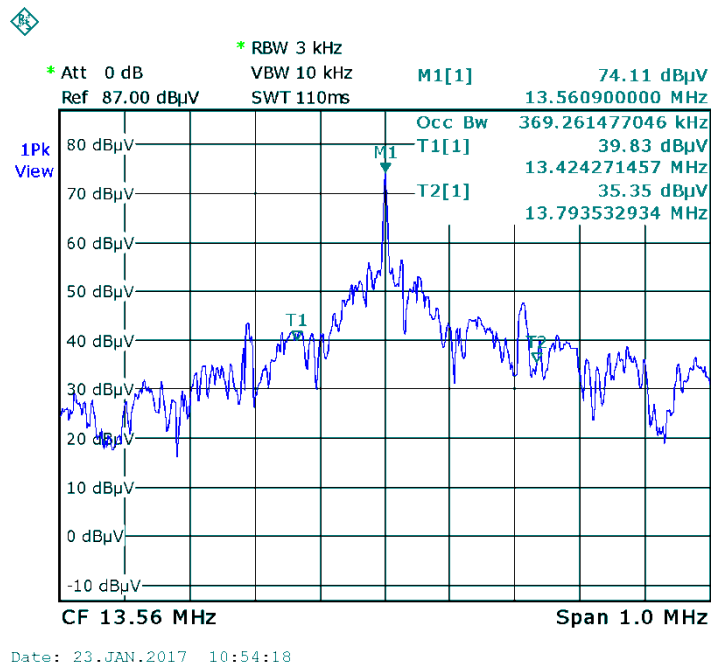
Comment:	
Date of test:	2017-01-23
Test site:	Fully anechoic room, cabin no. 8

Occupied Bandwidth (99 %):



Occupied Bandwidth (99 %): **0.68 kHz**

Occupied Bandwidth (99 %):

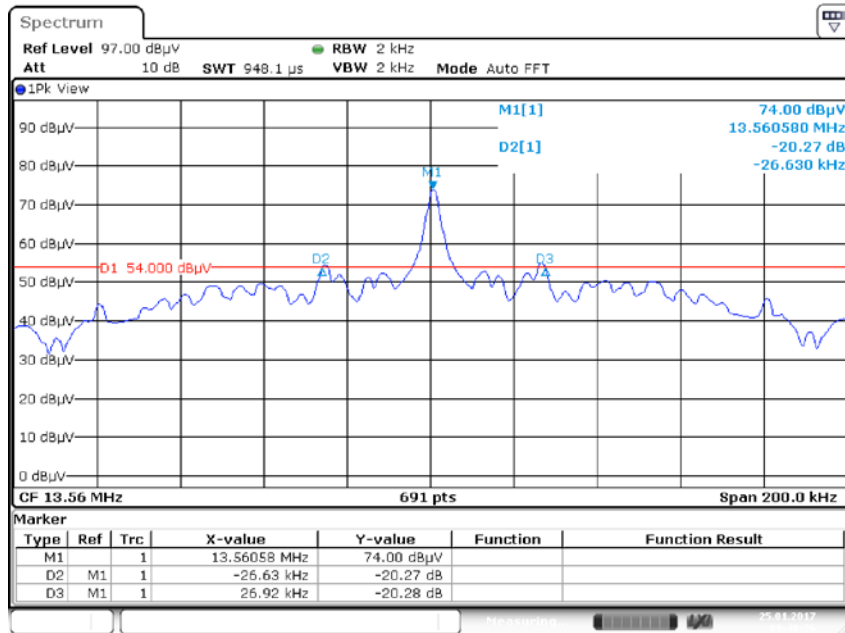


Occupied Bandwidth (99 %): **369.26 kHz**

8.2 Bandwidth of the Emission

Rules and specifications:	CFR 47 Part 15, sections 15.209 and 15.215(c) IC RSS-GEN Issue 4, section 8.9
Guide:	ANSI C63.10
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 span range of the spectrum analyser display shall be between two times and five times of the occupied bandwidth. The resolution bandwidth of the spectrum analyzer should be approximately 1 % to 5 % of the occupied bandwidth, unless otherwise specified, depending on the applicable requirement. The video bandwidth shall be at least three times greater than the resolution bandwidth. The dynamic range of the spectrum analyzer at the selected resolution bandwidth shall be more than 10 dB below the target “dB down” (attenuation) requirement.</p> <p>The video bandwidth shall be at least three times greater than the resolution bandwidth.</p>
Measurement procedure:	Bandwidth Measurements (6.1)

Comment:	
Date of test:	2017-01-23
Test site:	Fully anechoic room, cabin no. 2



Date: 25.JAN.2017 09:48:37

Permitted frequency band:	13.110 MHz – 14.010 MHz	
20 dB bandwidth:	53.55 kHz	
Carrier frequency stability:	<input checked="" type="checkbox"/> specified	<input type="checkbox"/> not specified
Maximum frequency tolerances:	+0.020 kHz -0.102 kHz	
Bandwidth of the emission:	53.67 kHz	within permitted frequency band⁸: <input checked="" type="checkbox"/> yes <input type="checkbox"/> no

Test Result:	Test passed
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⁸ 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 4, section 9
Guide:	ANSI C63.10 / TRC-43

Type of modulation:	Amplitude Modulation
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Frequency	125 kHz	13.56 MHz
B_n = Necessary Bandwidth	$B_n = 2BK$	$B_n = 2BK$
B = Modulation rate	$B = 0.2 \text{ kHz}$	$B = 25 \text{ kHz}$
K = Overall numerical factor	$K = 1$	$K = 1$
Calculation:	$B_n = 2 \cdot (0.2 \text{ kHz}) \cdot 1 = 0.4 \text{ kHz}$	$B_n = 2 \cdot (25 \text{ kHz}) \cdot 1 = 50 \text{ kHz}$

Designation of Emissions:	400HA1D	50K0A1D
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8.4 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, section 15.207 IC RSS-GEN Issue 4, section 8.8		
Guide:	ANSI C63.10 / CISPR 22		
Limit:	Frequency of Emission (MHz)	Conducted Limit (dBµV)	
		Quasi-peak	Average
	0.15 - 0.5	66 to 56	56 to 46
	0.5 - 5	56	46
	5 - 30	60	50
Measurement procedure:	Conducted AC Powerline Emission (6.2)		

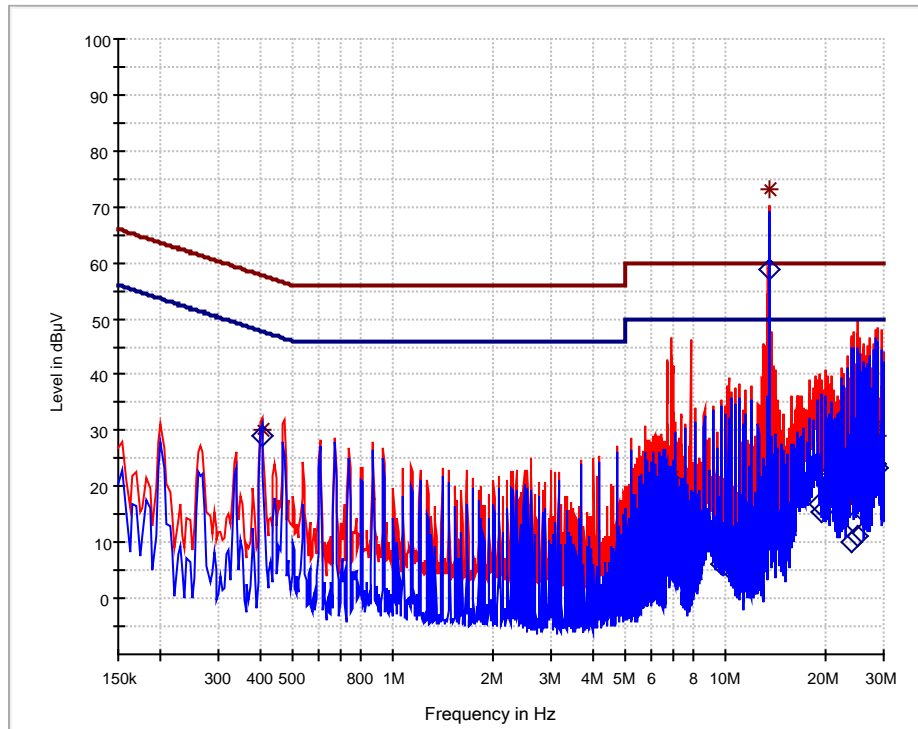
Test Result:	Test passed
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Sample calculation of final values:

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

Comment:	Configured with antenna
Date of test:	2017-01-16
Test site:	Shielded room, cabin no. 9
Test Result:	Test passed - carrier excluded

Tested on:	L1
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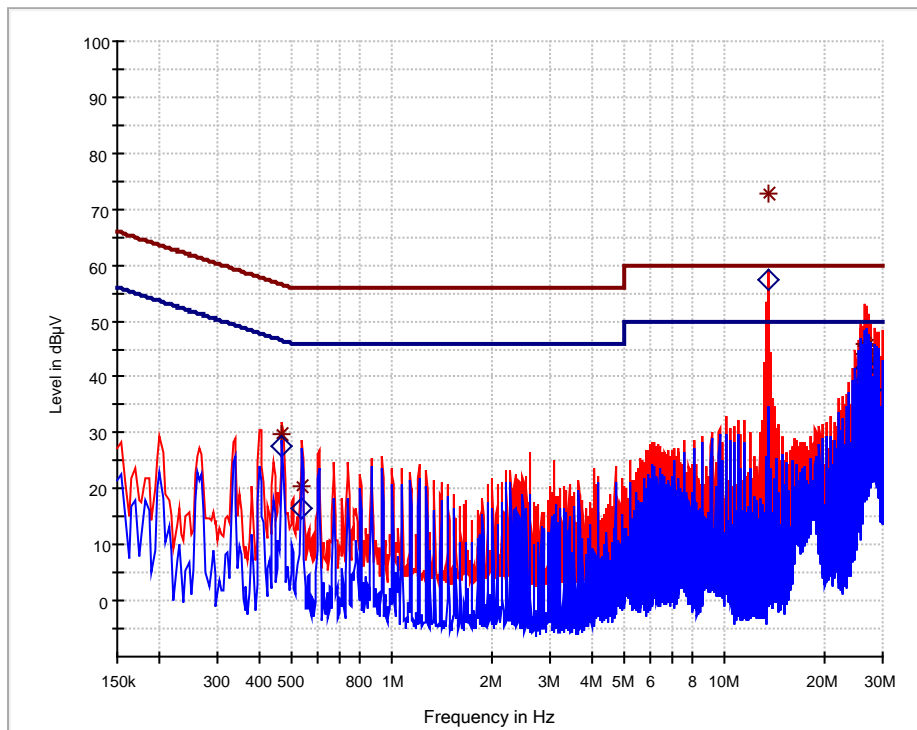
* Preview Result 1-PK+ Final_Result QPK
 ◇ FCC 15.207 QP Final_Result CAV
 — FCC 15.207 AV Preview Result 2-AVG

Frequency MHz	QuasiPeak dBµV	CAverage dBµV	Limit dBµV	Margin dB	Meas. Time ms	Bandwidth kHz	Corr. dB
0.406		29.1	47.7	18.6	1000	9	0.0
0.406	30.0		57.7	27.8	1000	9	0.0
6.714		6.00	50.0	44.0	1000	9	0.2
6.714	22.2		60.0	37.8	1000	9	0.2
6.898		5.34	50.0	44.7	1000	9	0.2
6.898	21.6		60.0	38.4	1000	9	0.2
9.718		5.99	50.0	44.0	1000	9	0.0
9.718	11.3		60.0	48.8	1000	9	0.0
10.506		4.88	50.0	45.1	1000	9	0.0
10.506	10.3		60.0	49.8	1000	9	0.0
13.560		58.9			1000	9	0.2
13.560	73.3				1000	9	0.2
19.282		16.8	50.0	33.2	1000	9	0.3
19.282	22.3		60.0	37.7	1000	9	0.3
19.430		15.5	50.0	34.5	1000	9	0.3
19.430	21.1		60.0	38.9	1000	9	0.3



<i>Frequency MHz</i>	<i>QuasiPeak dBµV</i>	<i>CAverage dBµV</i>	<i>Limit dBµV</i>	<i>Margin dB</i>	<i>Meas. Time ms</i>	<i>Bandwidth kHz</i>	<i>Corr. dB</i>
23.890		10.0	50.0	40.0	1000	9	0.3
23.890	18.5		60.0	41.5	1000	9	0.3
24.414		13.8	50.0	36.3	1000	9	0.3
24.414	20.1		60.0	39.9	1000	9	0.3
24.938		11.1	50.0	38.9	1000	9	0.3
24.938	18.3		60.0	41.7	1000	9	0.3
28.350		24.2	50.0	25.8	1000	9	0.4
28.350	30.7		60.0	29.3	1000	9	0.4
28.874		23.3	50.0	26.7	1000	9	0.4
28.874	29.1		60.0	30.9	1000	9	0.4

Tested on: N

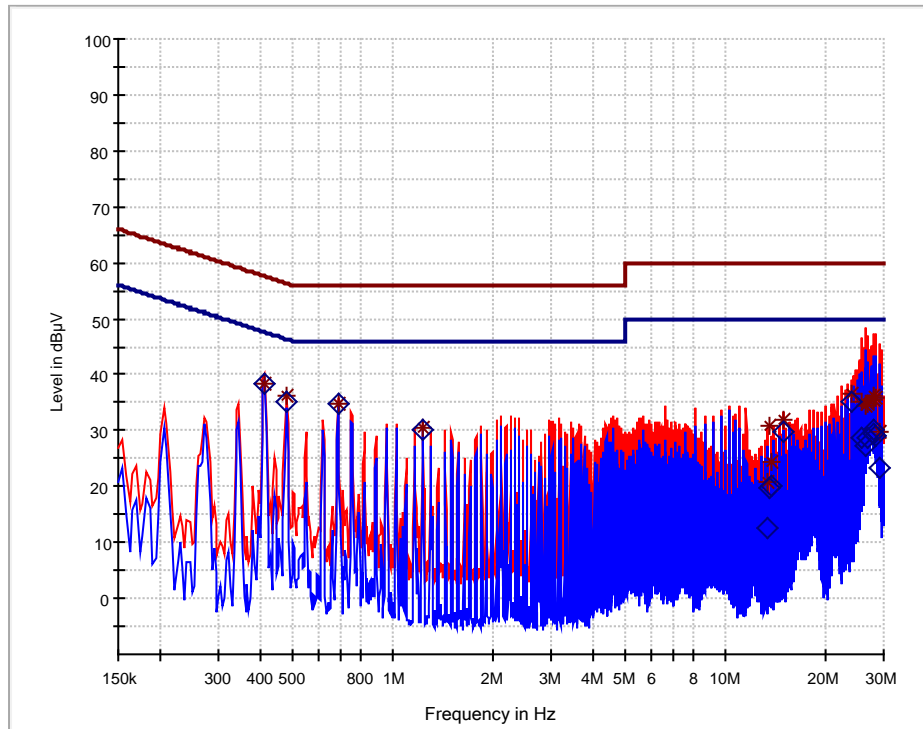


* Preview Result 1-PK+ Final_Result QPK
 ◇ FCC 15.207 QP Final_Result CAV
 — FCC 15.207 AV Preview Result 2-AVG

Frequency MHz	QuasiPeak dBµV	CAverage dBµV	Limit dBµV	Margin dB	Meas. Time ms	Bandwidth kHz	Corr. dB
0.470		27.7	46.5	18.9	1000	9	0.0
0.470	29.9		56.5	26.6	1000	9	0.0
0.538		16.6	46.0	29.4	1000	9	0.0
0.538	20.5		56.0	35.5	1000	9	0.0
13.560		57.5			1000	9	0.2
13.560	72.6				1000	9	0.2
23.826		19.9	50.0	30.1	1000	9	0.2
23.826	25.5		60.0	34.5	1000	9	0.2
25.922		23.6	50.0	26.4	1000	9	0.3
25.922	34.3		60.0	25.7	1000	9	0.3
26.442		39.0	50.0	11.0	1000	9	0.3
26.442	45.7		60.0	14.3	1000	9	0.3
26.446		36.8	50.0	13.2	1000	9	0.3
26.446	44.0		60.0	16.0	1000	9	0.3
26.706		41.7	50.0	8.3	1000	9	0.4
26.706	45.7		60.0	14.3	1000	9	0.4
27.230		40.2	50.0	9.8	1000	9	0.4
27.230	44.3		60.0	15.7	1000	9	0.4
27.754		37.6	50.0	12.4	1000	9	0.4
27.754	43.0		60.0	17.0	1000	9	0.4

Comment:	Configured with antenna
Date of test:	2017-01-16
Test site:	Shielded room, cabin no. 9
Test Result:	Test passed - carrier excluded

Tested on:	L1
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— Preview Result 1-PK+ — Preview Result 2-AVG — FCC 15.207 QP
— FCC 15.207 AV * Final_Result QPK ◇ Final_Result CAV

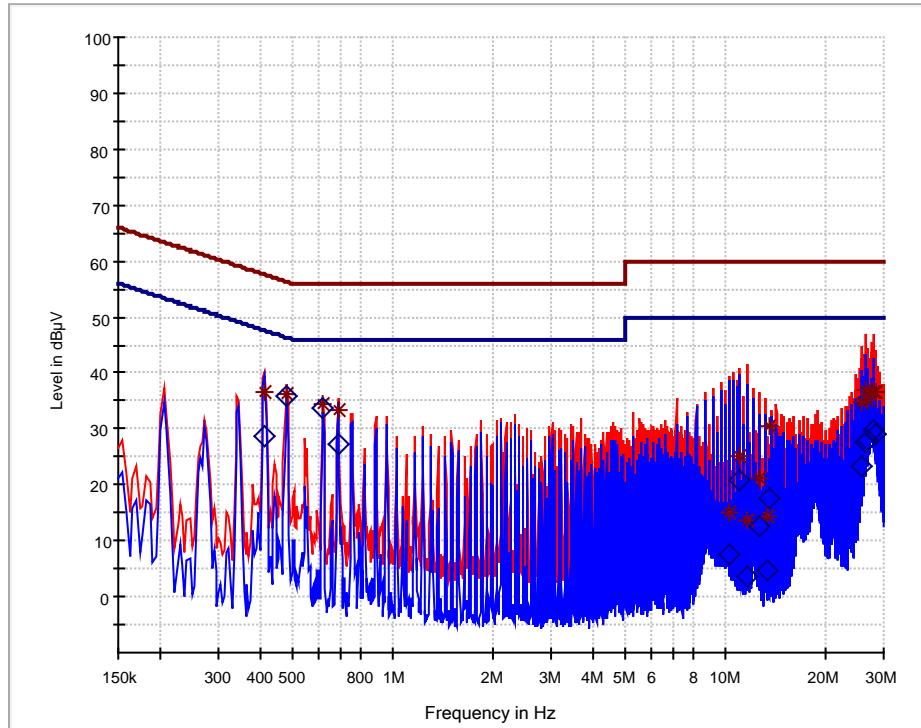
Frequency MHz	QuasiPeak dBµV	CAverage dBµV	Limit dBµV	Margin dB	Meas. Time ms	Bandwidth kHz	Corr. dB
0.414		38.2	47.6	9.3	1000	9	0.0
0.414	38.4		57.6	19.2	1000	9	0.0
0.482		35.2	46.3	11.1	1000	9	0.0
0.482	36.3		56.3	20.1	1000	9	0.0
0.686		34.9	46.0	11.1	1000	9	0.0
0.686	34.8		56.0	21.2	1000	9	0.0
1.234		30.0	46.0	16.0	1000	9	0.0
1.234	30.6		56.0	25.5	1000	9	0.0
13.446		12.5	50.0	37.5	1000	9	0.2
13.446	20.7		60.0	39.3	1000	9	0.2
13.560		19.87	50.0	30.1	1000	9	0.2
13.560	31.0		60.0	29.0	1000	9	0.2
13.710		20.0	50.0	30.0	1000	9	0.3
13.710	24.3		60.0	35.7	1000	9	0.3
15.026		29.9	50.0	20.1	1000	9	0.3
15.026	32.0		60.0	28.1	1000	9	0.3



<i>Frequency MHz</i>	<i>QuasiPeak dBµV</i>	<i>CAverage dBµV</i>	<i>Limit dBµV</i>	<i>Margin dB</i>	<i>Meas. Time ms</i>	<i>Bandwidth kHz</i>	<i>Corr. dB</i>
23.986		35.1	50.0	14.9	1000	9	0.3
23.986	36.4		60.0	23.6	1000	9	0.3
25.834		28.6	50.0	21.4	1000	9	0.3
25.834	35.1		60.0	24.9	1000	9	0.3
26.362		27.1	50.0	22.9	1000	9	0.3
26.362	34.3		60.0	25.7	1000	9	0.3
26.886		28.6	50.0	21.4	1000	9	0.4
26.886	34.7		60.0	25.3	1000	9	0.4
27.938		30.0	50.0	20.0	1000	9	0.4
27.938	36.3		60.0	23.7	1000	9	0.4
27.942		29.5	50.0	20.5	1000	9	0.4
27.942	35.4		60.0	24.7	1000	9	0.4
28.466		29.1	50.0	20.9	1000	9	0.4
28.466	36.0		60.0	24.0	1000	9	0.4
28.994		23.3	50.0	26.7	1000	9	0.4
28.994	29.9		60.0	30.12	1000	9	0.4

Tested on:

N



— Preview Result 1-PK+ — Preview Result 2-AVG — FCC 15.207 QP
— FCC 15.207 AV * Final_Result QPK ◊ Final_Result CAV

Frequency MHz	QuasiPeak dBµV	CAverage dBµV	Limit dBµV	Margin dB	Meas. Time ms	Bandwidth kHz	Corr. dB
0.414		28.6	47.57	18.98	1000	9	0.0
0.414	36.6		57.57	21.01	1000	9	0.0
0.482		35.8	46.31	10.55	1000	9	0.0
0.482	36.4		56.31	19.91	1000	9	0.0
0.618		33.7	46.00	12.28	1000	9	0.0
0.618	34.3		56.00	21.66	1000	9	0.0
0.686		27.2	46.00	18.77	1000	9	0.0
0.686	33.2		56.00	22.78	1000	9	0.0
10.318		7.7	50.00	42.35	1000	9	0.0
10.318	15.1		60.00	44.95	1000	9	0.0
11.110		20.9	50.00	29.12	1000	9	0.1
11.110	25.0		60.00	35.04	1000	9	0.1
11.638		3.6	50.00	46.44	1000	9	0.1
11.638	13.7		60.00	46.32	1000	9	0.1
12.698		12.5	50.00	37.50	1000	9	0.2
12.698	21.2		60.00	38.85	1000	9	0.2
13.490		4.6	50.00	45.44	1000	9	0.2
13.490	14.4		60.00	45.63	1000	9	0.2
13.560		17.6	50.00	32.45	1000	9	0.2
13.560	30.3		60.00	29.66	1000	9	0.2
25.906		23.5	50.00	26.53	1000	9	0.3
25.906	34.9		60.00	25.15	1000	9	0.3
26.434		27.6	50.00	22.36	1000	9	0.3



<i>Frequency MHz</i>	<i>QuasiPeak dBμV</i>	<i>CAverage dBμV</i>	<i>Limit dBμV</i>	<i>Margin dB</i>	<i>Meas. Time ms</i>	<i>Bandwidth kHz</i>	<i>Corr. dB</i>
26.434	36.9		60.00	23.15	1000	9	0.3
26.962		28.0	50.00	21.97	1000	9	0.4
26.962	35.0		60.00	24.96	1000	9	0.4
28.018		29.7	50.00	20.33	1000	9	0.4
28.018	36.4		60.00	23.58	1000	9	0.4
28.282		29.1	50.00	20.87	1000	9	0.4
28.282	36.5		60.00	23.51	1000	9	0.4

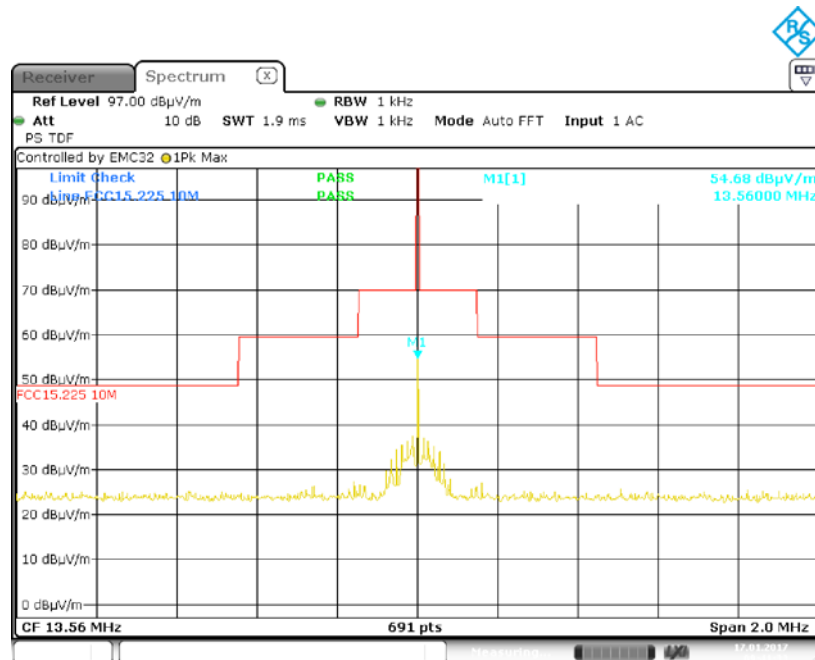
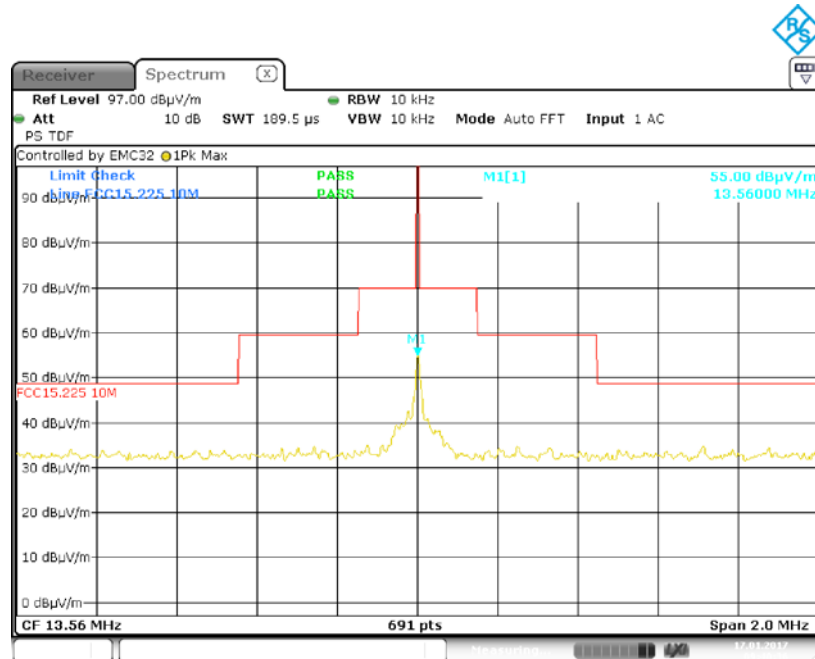


8.5 Spectrum Mask

Rules and specifications:	CFR 47 Part 15, section 15.225(a)-(d) IC RSS-210 Issue 9, section B.6			
Guide:	ANSI C63.10			
Description:	Compliance with the spectrum mask is tested using a spectrum analyzer with resolution bandwidth set to a 1 kHz for the band 13.553 to 13.567 MHz and to 10 kHz outside this band. The video bandwidth shall be at least three times greater than the resolution bandwidth. General fieldstrength limit according to RSS-GEN is applicable outside the band 13.110 MHz – 14.010 MHz. See Radiated Emission Measurement 9 kHz to 30 MHz (8.6) for details.			
Limit:	Frequency of Emission (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)	Measurement Distance d (meters)
	1.705 - 13.110	30	29.5	30
	13.110 - 13.410	106	40.5	30
	13.410 - 13.553	334	50.5	30
	13.553 - 13.567	15848	84.0	30
	13.567 - 13.710	334	50.5	30
	13.710 - 14.010	106	40.5	30
	14.010 - 30.000	30	29.5	30
Measurement procedure:	Radiated Emission Measurement 9 kHz to 30 MHz (6.3)			

Comment:	
Date of test:	2017-01-17
Test site:	Semi anechoic room, cabin no. 8
Test distance:	10 meters
Extrapolation Factor:	40 dB/decade

Test Result:	Test passed
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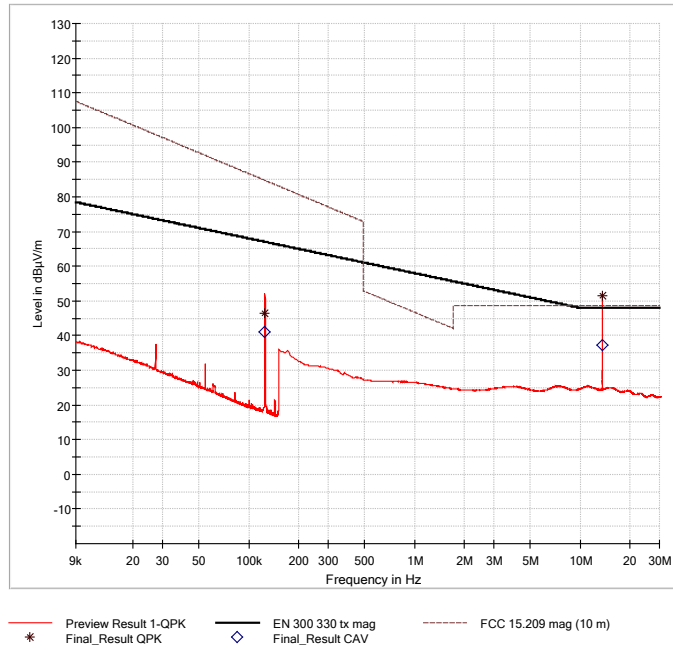


8.6 Radiated Emission Measurement 9 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, sections 15.205 and 15.225(a)-(d) IC RSS-GEN Issue 4, sections 8.9 and 8.10(b)(c) and IC RSS-210 Issue 9, section B.6			
Guide:	ANSI C63.10			
Limit:	Frequency of Emission (MHz)	Field Strength ($\mu\text{V}/\text{m}$)	Field Strength ($\text{dB}\mu\text{V}/\text{m}$)	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 - 13.110	30	29.5	30
	13.110 - 13.410	106	40.5	30
	13.410 - 13.553	334	50.5	30
	13.553 - 13.567	15848	84.0	30
	13.567 - 13.710	334	50.5	30
	13.710 - 14.010	106	40.5	30
	14.010 - 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:	
Date of test:	2017-01-18
Test site:	Semi anechoic room, cabin no. 8

Test Result:	Test passed
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Extrapolation factor: -40 dB/decade

Frequency (MHz)	Detector	Distance		Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
		d1 (m)	d (m)							
0,12485	Peak	10	300	26,5	20,0	-59,1		-12,6	25,7	38,3
13,56000	Quasi-Peak	10	30	31,4	20,0	-19,1		32,3	84,0	51,7

Sample calculation of final values:

$$\begin{aligned} \text{Extrapolation Factor (dB)} &= (\text{Log}(d) - \text{Log}(d_1)) \cdot \text{Extrapolation Factor (dB/decade)} \\ \text{Final Value (dB}\mu\text{V/m)} &= \text{Reading Value } d_1 \text{ (dB}\mu\text{V)} + \text{Correction Factor (dB/m)} \\ &\quad + \text{Extrapolation Factor (dB)} + \text{Pulse Train Correction (dB)} \end{aligned}$$

Note: Extrapolation factor (dB) and final value (dBµV/m) are relating to distance d.



8.7 Radiated Emission Measurement 30 MHz to 1 GHz

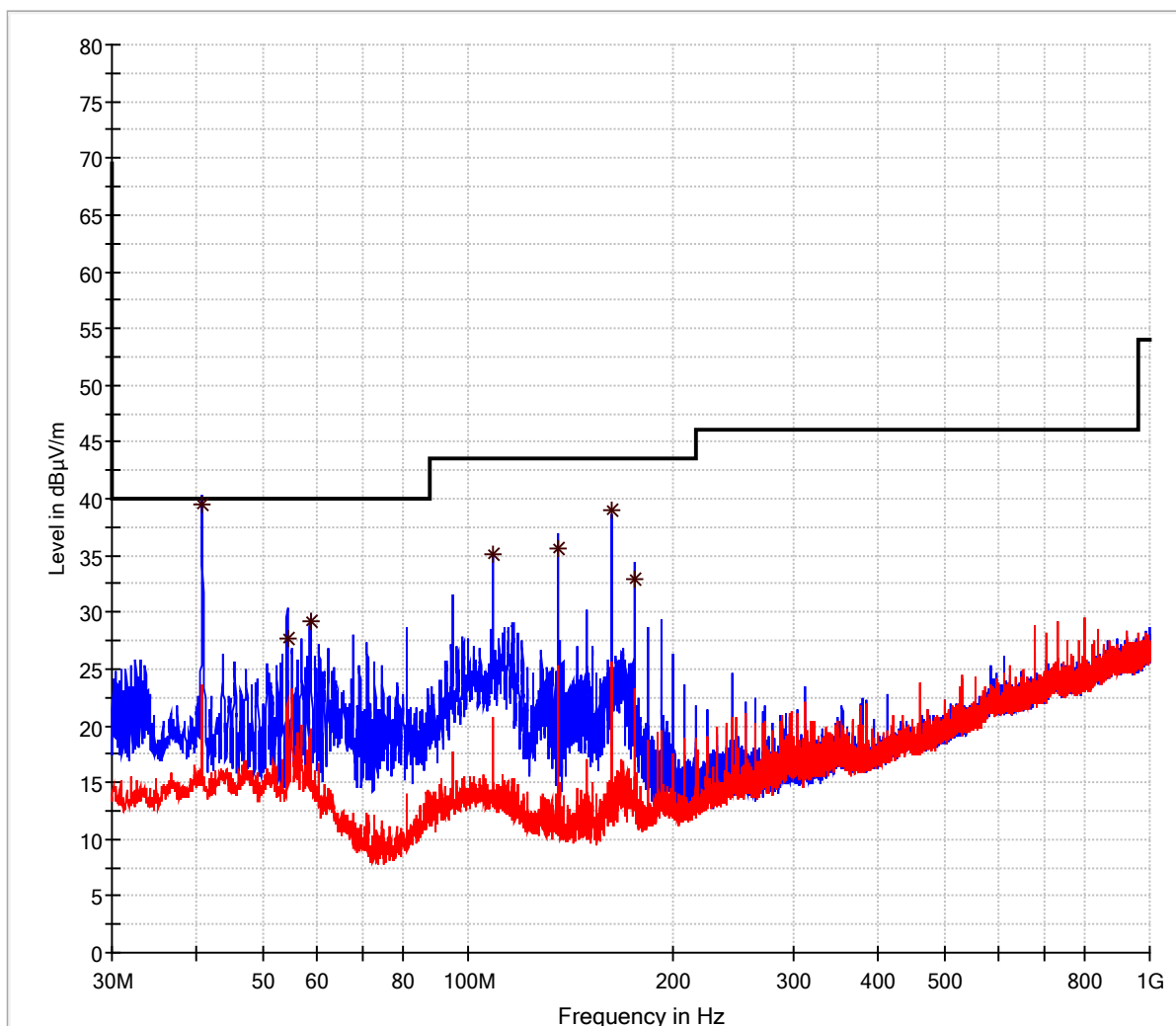
Rules and specifications:	CFR 47 Part 15, sections 15.205(b) and 15.225(d) IC RSS-GEN Issue 4, sections 8.9 and 8.10(b)(c) and IC RSS-210 Issue 9, section B.6		
Guide:	ANSI C63.10		
Limit:	Frequency of Emission (MHz)	Field Strength ($\mu\text{V}/\text{m}$)	Field Strength ($\text{dB}\mu\text{V}/\text{m}$)
	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 (6.4)		

Comment:			
Date of test:	2017-01-17		
Test site:	Frequencies > 1 GHz: Fully anechoic room, cabin no. 2		
Test distance:	Frequencies \leq 8.2 GHz:	3 meters	
	Frequencies > 8.2 GHz:	1 meter	

Test Result:	Test passed
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Sample calculation of final values:

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



— Preview Result 1V-PK+ — Preview Result 1H-PK+ — FCC 15.209_3m
* Final_Result QPK ◇ Final_Result AVG

Frequency MHz	QuasiPeak dBµV/m	Limit dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
40,680	39,4	40,0	0,6	1000	120	100	V	-72	15,5
54,240	27,7	40,0	12,4	1000	120	103	V	-67	14,9
58,630	29,2	40,0	10,8	1000	120	150	V	-165	15,3
108,480	35,1	43,5	8,4	1000	120	100	V	-48	13,7
135,600	35,6	43,5	7,9	1000	120	106	V	-31	10,8
162,720	39,0	43,5	4,6	1000	120	106	V	-50	10,4
175,800	33,0	43,5	10,5	1000	120	103	V	-48	10,8



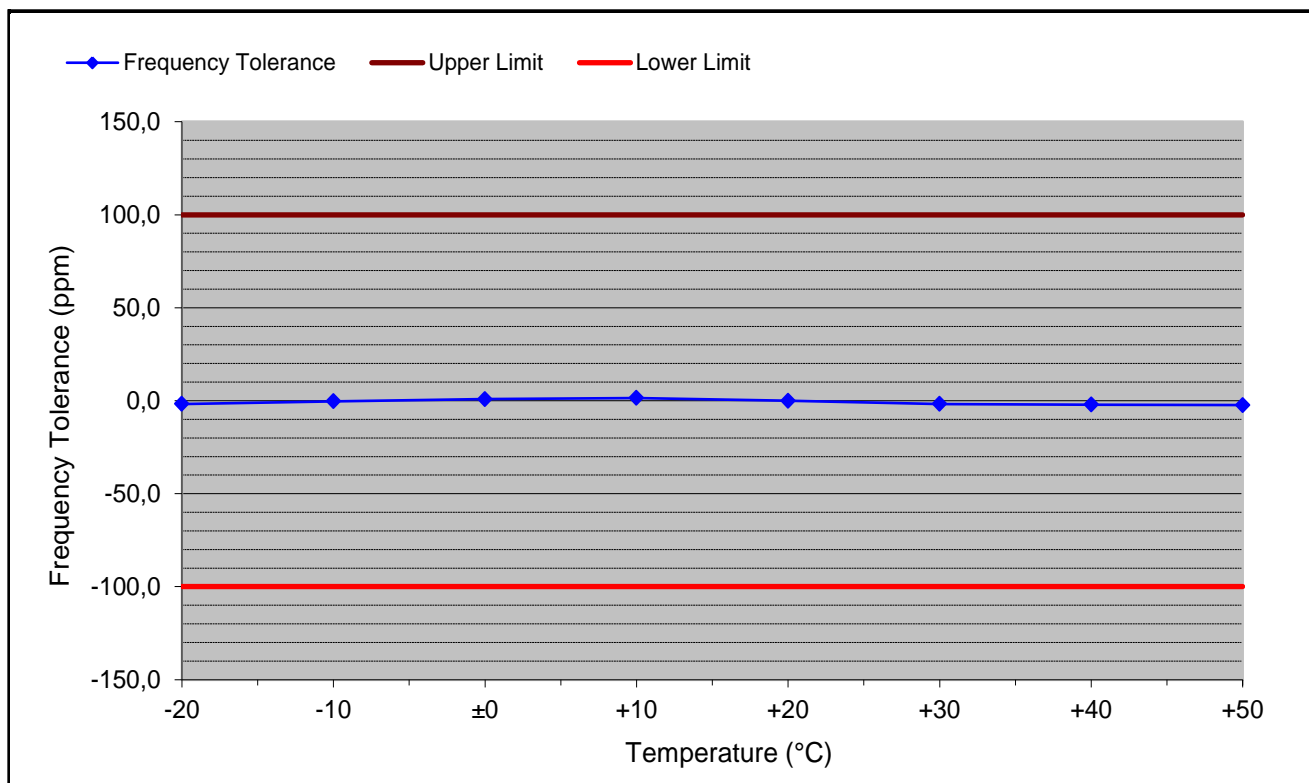
8.8 Carrier Frequency Stability

Rules and specifications:	CFR 47 Part 15, section 15.225(e) IC RSS-Gen Issue 4, section 8.11 and IC RSS-210 Issue 9, section B.6
Guide:	ANSI C63.10
Limit:	The frequency tolerance of the carrier signal shall be maintained within ± 0.01 % (± 100 ppm) of the carrier frequency under nominal conditions.
Temperature range:	-20°C to +50°C (at normal supply voltage)
Voltage range:	85% to 115% of the rated supply voltage (at a temperature of +20°C)
Measurement procedure:	Carrier Frequency Stability (6.5)

Comment:	
Date of test:	2017-01-26



8.8.1 Carrier Frequency Stability vs. Temperature

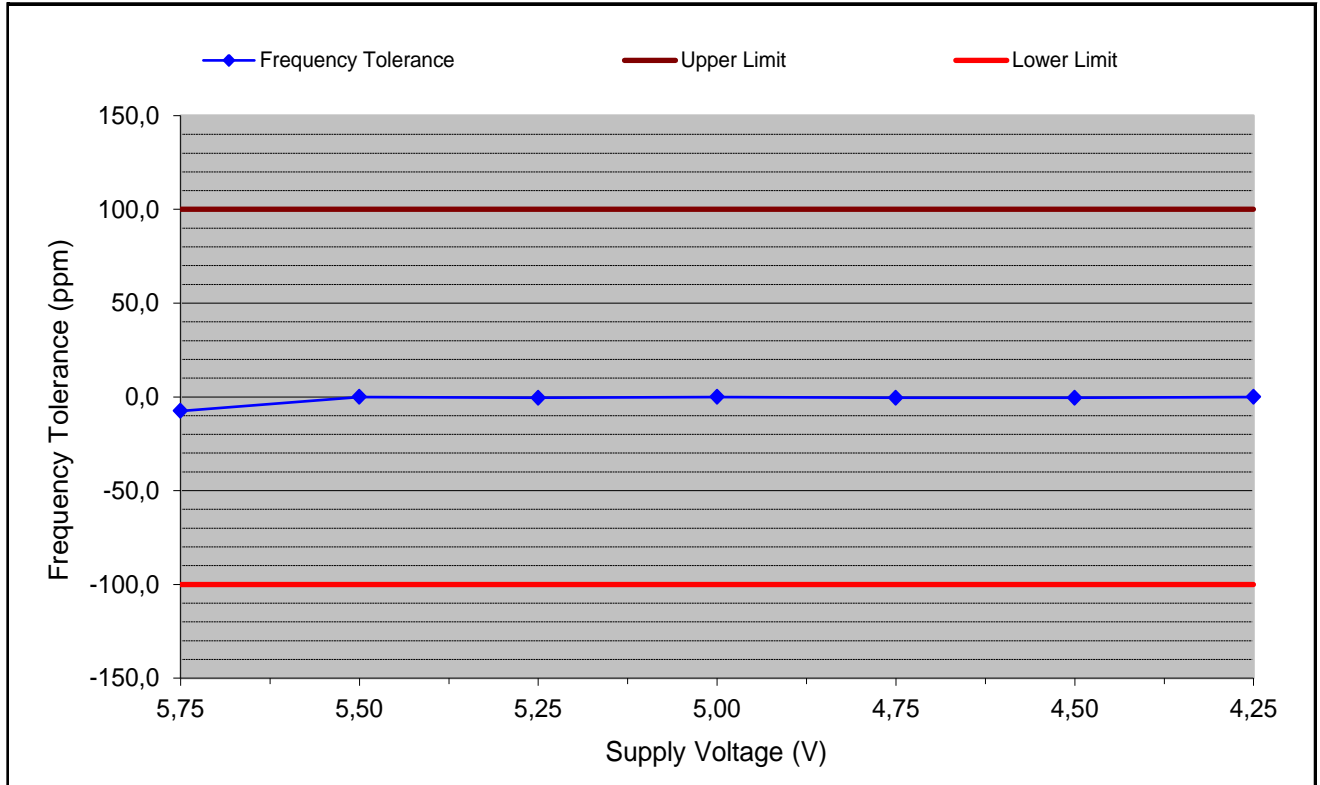


Supply voltage: 12 V Nominal frequency: 13,560627 MHz

Temperature (°C)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
-20	13,560603	-24	-1,8	+100,0	-100,0	98,2
-10	13,560623	-4	-0,3	+100,0	-100,0	99,7
±0	13,560639	12	0,9	+100,0	-100,0	99,1
+10	13,560647	20	1,5	+100,0	-100,0	98,5
+20	13,560627	0	0,0	+100,0	-100,0	100,0
+30	13,560603	-24	-1,8	+100,0	-100,0	98,2
+40	13,560599	-28	-2,1	+100,0	-100,0	97,9
+50	13,560595	-32	-2,4	+100,0	-100,0	97,6

Test Result: Test passed

8.8.2 Carrier Frequency Stability vs. Supply Voltage



Temperature: +20 °C Battery End Point: Not applicable
 Nominal frequency: 13,560623 MHz

Supply Voltage (V)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
5,75	13,560521	-102	-7,5	+100,0	-100,0	92,5
5,50	13,560623	0	0,0	+100,0	-100,0	100,0
5,25	13,560617	-6	-0,4	+100,0	-100,0	99,6
5,00	13,560623	0	0,0	+100,0	-100,0	100,0
4,75	13,560617	-6	-0,4	+100,0	-100,0	99,6
4,50	13,560617	-6	-0,4	+100,0	-100,0	99,6
4,25	13,560623	0	0,0	+100,0	-100,0	100,0

Test Result: Test passed



8.9 Exposure of Humans to RF Fields

Rules and specifications:	IC RSS-Gen Issue 4, section 3.2
Guide:	IC RSS-102 Issue 5, 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: $CP = \dots\dots\dots W$</p> <p>The effective isotropic radiated power (EIRP in watts) is calculated using</p> <p><input type="checkbox"/> the numerical antenna gain: $G = \dots\dots\dots$ $EIRP = G \cdot CP \Rightarrow EIRP = \dots\dots\dots W$</p> <p><input type="checkbox"/> the field strength⁹ in V/m: $FS = \dots\dots\dots V/m$ $EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP = \dots\dots\dots W$</p> <p>with: Distance between the antennas in m: $D = \dots\dots\dots m$</p>			<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 by⁹:</p> <p style="text-align: center;">125 kHz 13.56 MHz</p> $EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP = \mathbf{0.070 \mu W} = \mathbf{0.124 \mu W}$ <p>with:</p> <p>Field strength in V/m: $FS = \mathbf{211.34 \mu V/m} = \mathbf{371.54 \mu V/m}$</p> <p>Distance between the two antennas in m: $D = \mathbf{10 m} = \mathbf{10 m}$</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;">$TP = \mathbf{0.070 \mu W}$ and $\mathbf{0.124 \mu W}$</p>				

⁹ 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 checked="" type="checkbox"/> less than or equal to 20 cm			<input type="checkbox"/>	
	<input type="checkbox"/> greater than 20 cm			
Transmitting device is				
<input type="checkbox"/> in the vicinity of the human head			<input type="checkbox"/>	
	<input type="checkbox"/> body-worn			

SAR evaluation

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in the table.

For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in the table, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.

Frequency (MHz)	Exemption limits (mW) ¹⁰ at separation distance of									
	≤5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	≥50 mm
≤300 ¹¹	71	101	132	162	193	223	254	284	315	345
450	52	70	88	106	123	141	159	177	195	213
835	17	30	42	55	67	80	92	105	117	130
1900	7	10	18	34	60	99	153	225	316	431
2450	4	7	15	30	52	83	123	173	235	309
3500	2	6	16	32	55	86	124	170	225	290
5800	1	6	15	27	41	56	71	85	97	106

¹⁰ The exemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

¹¹ Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in IC RSS-102, issue 5, section 4.



Carrier frequency:	f	=	125 kHz				
Distance:	d	=	5 mm				
Transmitter output power:	TP	=	0.070 μW				
Limit:	TP_{limit}	=	71000 μW				☒
Carrier frequency:	f	=	13.56 MHz				
Distance:	d	=	5 mm				
Transmitter output power:	TP	=	0.124 μW				
Limit:	TP_{limit}	=	71000 μW				☒
<input type="checkbox"/> SAR evaluation is documented in test report no.							



<i>Date of test:</i>	2017-10-26
<i>Operator:</i>	M. Steindl
<i>Test site:</i>	Shielded room, cabin no. 1

Prüfergebnis / Test Result	
<input checked="" type="checkbox"/>	Erfüllt / Passed
<input type="checkbox"/>	Nicht erfüllt / Not passed

<i>Specifications:</i>	RSS-102, Issue 5, Section 4, Table 4, Uncontrolled Environment SPR-002, Issue 1
<i>Operation mode:</i>	Transmitting continuously
<i>Comment:</i>	The nerve stimulation exposure limit is defined for the frequency range 3 kHz to 10 MHz, only. Thus, the carrier at 125 kHz was evaluated, only.

<i>Test procedure:</i>	IEC 62236-1, Section 4.2 "Measurement to show accordance to the reference levels"			
<i>Test distance:</i>	Direct contact to EUT			
<i>Limit:</i>	<i>Frequency Range (MHz)</i>	<i>Electric Field (V/m_{rms})</i>	<i>Magnetic Field (A/m_{rms})</i>	<i>Reference Periode (min)</i>
	0.003 – 10	83	90	Instantaneous
	0.1 – 10	---	0.73 / f	6
	1.1 - 10	87/f ^{0.5}	---	6
	f in MHz			
<i>Test positions:</i>	All surfaces: The antenna was moved all over the equipment under test using a test distance as stated above.			

<i>Measured maximum value (V/m)</i>	<i>Maximum Limit at 125 kHz (V/m)</i>	<i>Margin to reference value (V/m)</i>
42.18	83.00	40.82

<i>Measured maximum value (A/m)</i>	<i>Maximum Limit at 125 kHz (A/m)</i>	<i>Margin to reference value (A/m)</i>
0.7336	90.00	89.27

<i>Measured average value (A/m)</i>	<i>Average Limit at 125 kHz (A/m)</i>	<i>Margin to reference value (A/m)</i>
0.4382	5.84	5.40



Exposure of Humans to RF Fields (continued)	Applicable	Declared by applicant	Measured	Exemption
RF exposure evaluation				
<p>RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:</p> <p><input type="checkbox"/> below 20 MHz¹² and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance).</p> <p><input type="checkbox"/> between 3 kHz and 10 MHz exposure limits apply as following:</p> <p><input type="checkbox"/> In a controlled environment the basic restriction for the instantaneous internal electric field strength is equal to or less than $2.7 \cdot 10^{-4} f V/m_{rms}$ at any part of the body where f is in Hz. The instantaneous RF field strength is equal or less than $83 V/m_{rms}$ and equal or less than $90 A/m_{rms}$.</p> <p><input type="checkbox"/> In a uncontrolled environment the basic restriction for the instantaneous internal electric field strength is equal to or less than $1.35 \cdot 10^{-4} f V/m_{rms}$ at any part of the body where f is in Hz. The instantaneous RF field strength is equal or less than $170 V/m_{rms}$ and equal or less than $180 A/m_{rms}$.</p> <p><input type="checkbox"/> at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4,49/f^{0.5} W$ (adjusted for tune-up tolerance, where f is in MHz).</p> <p><input type="checkbox"/> at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance).</p> <p><input type="checkbox"/> at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \cdot 10^{-2} f^{0.6834} W$ (adjusted for tune-up tolerance), where f is in MHz.</p> <p><input type="checkbox"/> at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).</p> <p>In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.</p>				
<p>Carrier frequency: $f = \dots$...</p> <p>Transmitter output power: $TP = \dots$...</p> <p>Limit: $TP_{limit} = \dots$...</p>				<input type="checkbox"/>
<p><input type="checkbox"/> RF exposure evaluation is documented in test report no.</p>				

¹² Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine RF Exposure evaluation, shall demonstrate compliance to the instantaneous limits in IC RSS-102, issue 5, section 4.

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 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 13, 2014 (published on June 20, 2014)
<input checked="" type="checkbox"/>	ANSI C63.10	American national Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices	June 27, 2013 (published on September 13, 2013)
<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 9 for Licence-Exempt Radio Apparatus: Category I Equipment, published by Industry Canada	August 2016
<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 5: Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), published by Industry Canada	March 2015
<input type="checkbox"/>	ICES-003	Interference-Causing Equipment Standard ICES-003 Issue 6: Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement, published by Industry Canada	January 2016
<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



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	1863	ESCI3	100008	Rohde & Schwarz	Rohde & Schwarz	10/2016	10/2017
EMI test receiver	2044	ESU8	100232	Rohde & Schwarz	Rohde & Schwarz	11/2016	11/2017
EMI test receiver	22653	ESR7	101713	Rohde & Schwarz	Rohde & Schwarz	11/2016	11/2017
Spectrum analyser	2034	ZVL6	100377	Rohde & Schwarz	Rohde & Schwarz	10/2016	10/2019
V-network	1059	ESH3-Z5	894785/005	Rohde & Schwarz	Rohde & Schwarz	10/2016	10/2019
Loop antenna	1016	HFH2-Z2	882964/0001	Rohde & Schwarz	Rohde & Schwarz	07/2016	07/2018
TRILOG Broadband Antenna	2058	VULB 9163	9163-408	Schwarzbeck	Rohde & Schwarz	07/2016	07/2018
Multimeter	1653	21 III	76530546	Fluke	ZMK	03/2015	03/2017
Temperature test chamber	1271	HT 4010	07065550	Heraeus	TÜV SÜD PS-EMC-STR	06/2015	12/2017
DC power supply	1267	NGSM 32/10	203	Rohde & Schwarz		see note 4	
Electromagnetic radiation meter	1723	EMR-200	AT-0023	Narda	Seibersdorf Labor	2016/10	2019/10
Electric field probe	1724	Type 8.3	AU-0008	Narda	Seibersdorf Labor	2016/10	2019/10
Magnetic field probe	1725	Type 12.1 (Model 2244/90.28)	W-0018	Narda	Seibersdorf Labor	2016/10	2019/10

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	2017-02-27	M. Steindl (lc)	First Edition
2	2017-05-17	M. Steindl (lc)	Added laboratory recognition number.
3	2017-10-27	M. Steindl (lc)	Changed RF-Exposure exemption from 20 cm to 5 mm and added special evaluation for frequency 3 kHz – 10 MHz.