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November 23, 2016

Prüfbericht / *Test Report* Nr. / *No.* 80452-81620-5e (Edition 2)

Applicant:	Endress + Hauser GmbH & Co. KG
Type of equipment:	K-Band Tank Level Probing Radar
Type designation:	FMR10 / FMR20
Order No.:	5002110
Test standards:	Industry Canada Radio Standards Specifications RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 (Category I Equipment) RSS-211 Issue 1

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.

Table of Contents

1 Description of the Equipment Under Test (EUT)

General data of EUT	
Type designation[1]:	FMR10 / FMR20
Parts[2]:	
Serial number(s):	L400200117A, L300300117A
Manufacturer:	
Type of equipment:	K-Band Tank Level Probing Radar
Version:	
IC ID:	2519A-2K
Additional parts/accessories:	

Technical data of EUT		
Application frequency range:	24.05 GHz - 29.00 GHz	
Frequency range:	24.05 GHz – 26.50 GHz	
Operating frequency:	24.9 GHz	
Type of modulation:	Unmodulated Pulse Emission	
Pulse train:	1.085 µs	
Pulse width:	2 ns	
Number of RF-channels:	1	
Channel spacing:	---	
Designation of emissions[3]:	1G50P0NAN	
Type of antenna:	Integrated	
Size/length of antenna:	N/A	
Connection of antenna:	☐ detachable	☒ not detachable
Type of power supply:	DC supply	
Specifications for power supply:	nominal voltage:	24.0 V

[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.
[3] Also known as "Class of Emission".

2 Administrative Data

Application details	
Applicant (full address):	Endress + Hauser GmbH & Co. KG Hauptstr. 1 79689 Maulburg Germany
Contact person:	Mr. Ralf Reimelt
Order number:	5002110
Receipt of EUT:	2016-05-11
Date(s) of test:	2016-05-11 to 2016-06-02
Note(s):	Mr. Reimelt, representing the applicant, and Mr. Gätzi attended tests on 2016-05-11 and 2016-05-12.

Report details	
Report number:	80452-81620-5e
Edition:	1
Issue date:	2016-11-23

3 Identification of the Test Laboratory

Details of the Test Laboratory	
Company name:	TÜV SÜD Product Service GmbH
Address:	Aeussere Fruehlingstrasse 45 D-94315 Straubing Germany
Laboratory accreditation:	DAkkS Registration No. D-PL-11321-11-01
FCC test site registration number	90926
Industry Canada test site registration:	3050A-2
Contact person:	Mr. Johann Roidt Phone: +49 9421 5522-0 Fax: +49 9421 5522-99

4 Summary

Summary of test results
The tested sample complies with the requirements set forth in the **Radio Standards Specifications** **RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 (Category I Equipment)** **RSS-211 Issue 1** 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)
Normal operation mode: Measurement with pulsed signal

Configuration(s) of EUT
FCC test setup, DC 24 V power supply, EUT in vertical position on tank.

List of ports and cables				
Port	*Description*	*Classification*[4]	*Cable type*	*Cable length*
1	DC supply with HART communi-cation interface	signal/control port	Shielded	2 m

List of devices connected to EUT				
Item	*Description*	*Type Designation*	*Serial no. or ID*	*Manufacturer*

List of support devices				
Item	*Description*	*Type Designation*	*Serial no. or ID*	*Manufacturer*
	---			

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

6 Measurement Procedures

6.1 Bandwidth Measurements

Measurement Procedure:	
Rules and specifications:	IC RSS-Gen Issue 4, section 6.6 IC RSS-211 Issue 1 ANSI C63.10, section 6.9.1
Guide:	ANSI C63.10
Measurement setup:	☐ Conducted: See below ☒ 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).

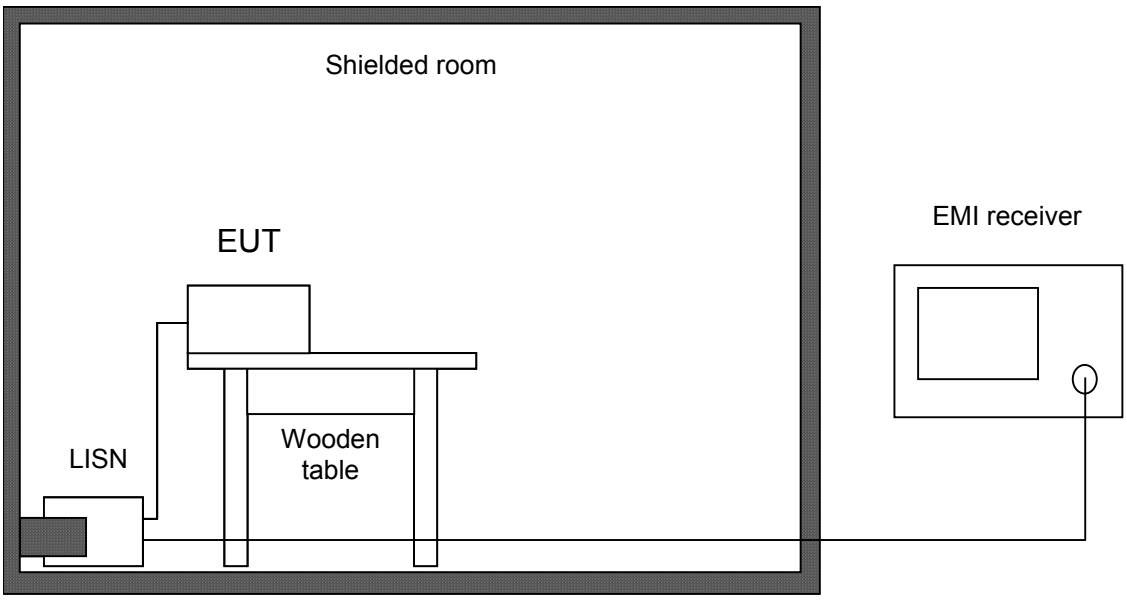
6.2 Conducted AC Powerline Emission

Measurement Procedure:	
Rules and specifications:	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*
☒	Test receiver	ESHS 10	1028	860043/016	Rohde & Schwarz
☒	V-network	ESH 3-Z5	1059	894785/005	Rohde & Schwarz
☐	V-network	ESH 3-Z5	1218	830952/025	Rohde & Schwarz
☐	Artificial mains network	ESH 2-Z5	1536	842966/004	Rohde & Schwarz
☐	Microwave cable	FB293C1080005050	2157	72110-02	Rosenberger Micro-Coax
☐	Coax cable	RG214 N/N 5m	1188	---	Senton
☐	Shielded room	No. 1	1451	---	Albatross
☐	Shielded room	No. 4	1454	3FD 100 544	Euroshield
☒	Shielded room	No. 9		---	Albatross

6.3 Radiated Emission Measurement 9 kHz to 30 MHz

Measurement Procedure:	
Rules and specifications:	IC RSS-GEN Issue 4, sections 8.9 and 8.10 IC RSS-210 Issue 1
Guide:	ANSI C63.4

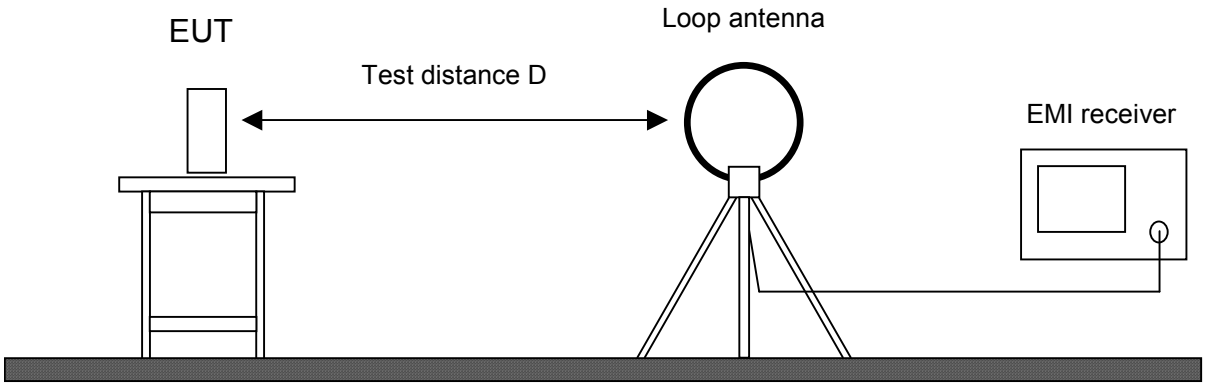
Radiated emission in the frequency range 9 kHz to 30 MHz is measured using an active loop antenna. First the whole spectrum of emission caused by the equipment is recorded at a distance of 3 meters in a fully or semi anechoic room with the detector of the spectrum analyzer or EMI receiver set to peak. 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*
☐	Spectrum analyzer		FSP30	1666	100036	Rohde & Schwarz
☐	EMI test receiver		ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☐	Test receiver		ESHS 10	1028	860043/016	Rohde & Schwarz
☐	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☐	Preamplifier	Cabin no. 2	CPA9231A	1716	3557	Schaffner
☒	Loop antenna		HFH2-Z2	1016	882964/1	Rohde & Schwarz
☐	Microwave cable	Cabin no. 2	UFA210A-FG	1681	23516	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 2	KKSF1040016	2020	289854/4	Huber + Suhner
☐	Microwave cable	Cabin no. 2	FA210AF020000000	2060	64566-2	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	EF393	2053	---	Albatross Projects
☐	Microwave cable	Cabin no. 8	FB293C1050005050	2054	63834-1	Rosenberger Micro-Coax
☒	Microwave cable	Cabin no. 8	FB293C1080005050	2055	63833-1	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.4.12	RFS
☒	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
☐	Microwave cable	Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF04000505G	2056	64567-01	Rosenberger Micro-Coax
☒	Microwave cable	Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
☐	Fully anechoic room		No. 2	1452	---	Albatross
☐	Semi anechoic room		No. 3	1453	---	Siemens
☒	Semi anechoic room		No. 8	2057	---	Albatross

6.4 Radiated Emission in Fully or Semi Anechoic Room

Measurement Procedure:	
Rules and specifications:	IC RSS-GEN Issue 4, section 8.9 IC RSS-211 Issue 1
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.

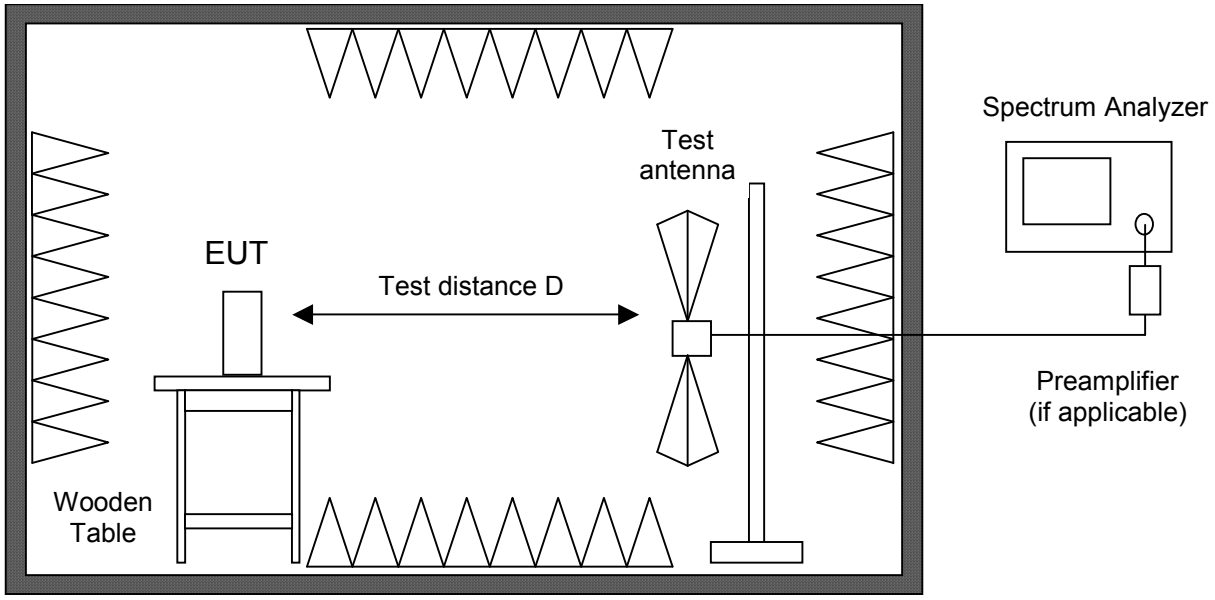
All tests below 8.2 GHz are performed at a test distance D of 3 meters. For higher frequencies the test distance may be reduced (e.g. to 1 meter) due to the sensitivity of the measuring instrument(s) and the test results are calculated according to CFR 47 Part 15 section 15.31(f)(1) using an extrapolation 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 respectively ANSI C63.10 for alternative test sites is used (see 6.5). If prescans are recorded in fully anechoic room they are indicated appropriately.



Fully or semi anechoic room

Test instruments used:

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Spectrum analyzer		FSP30	1666	100036	Rohde & Schwarz
☒	Spectrum analyzer		FSV40			Rohde & Schwarz
☐	EMI test receiver	Cabin no. 3	ESPI7	2010	101018	Rohde & Schwarz
☐	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☐	EMI test receiver		ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☒	Preamplifier	Cabin no. 2	CPA9231A	1716	3557	Schaffner
☐	Preamplifier		R14601	1142	13120026	Advantest
☒	Preamplifier (1 - 8 GHz)		AFS3-00100800-32-LN	1684	847743	Miteq
☐	Preamplifier (0.5 - 8 GHz)		AMF-4D-005080-25-13P	1685	860149	Miteq
☒	Preamplifier (8 - 18 GHz)		ACO/180-3530	1484	32641	CTT

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☐	External Mixer		WM782A	1576	845881/005	Tektronix
☐	Harmonic Mixer Accessories		FS-Z30	1577	624413/003	Rohde & Schwarz
☐	Trilog antenna	Cabin no. 2	VULB 9163	1802	9163-214	Schwarzbeck
☐	Trilog antenna	Cabin no. 3	VULB 9163	1722	9163-188	Schwarzbeck
☐	Trilog antenna	Cabin no. 8	VULB 9163	2058	9163-408	Schwarzbeck
☐	Trilog antenna	Cabin no. 2	VULB 9162	2256	9162-048	Schwarzbeck
☒	Horn antenna		3115	1516	9508-4553	EMCO
☐	Horn antenna		3160-03	1010	9112-1003	EMCO
☐	Horn antenna		3160-04	1011	9112-1001	EMCO
☐	Horn antenna		3160-05	1012	9112-1001	EMCO
☐	Horn antenna		3160-06	1013	9112-1001	EMCO
☒	Horn antenna		3160-07	1014	9112-1008	EMCO
☒	Horn antenna		3160-08	1015	9112-1002	EMCO
☒	Horn antenna		3160-09	1265	9403-1025	EMCO
☒	Horn antenna		3160-10	1575	399185	EMCO
☒	Horn antenna					
☒	Horn antenna					
☒	Horn antenna					
☐	Microwave cable	Cabin no. 2	UFA210A-FG	1681	23516	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 2	KKSF1040016	2020	289854/4	Huber + Suhner
☐	Microwave cable	Cabin no. 2	FA210AF020000000	2060	64566-2	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	EF393	2053	---	Albatross Projects
☐	Microwave cable	Cabin no. 8	FB293C1050005050	2054	63834-1	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FB293C1080005050	2055	63833-1	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.4.12	RFS
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
☐	Microwave cable	Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF04000505G	2056	64567-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
☐	Fully anechoic room		No. 2	1452	---	Albatross
☐	Semi anechoic room		No. 8	2057	---	Albatross

6.5 Radiated Emission at Alternative Test Site

Measurement Procedure:	
Rules and specifications:	IC RSS-GEN Issue 4, section 8.9 IC RSS-211 Issue 1
Guide:	ANSI C63.10

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.

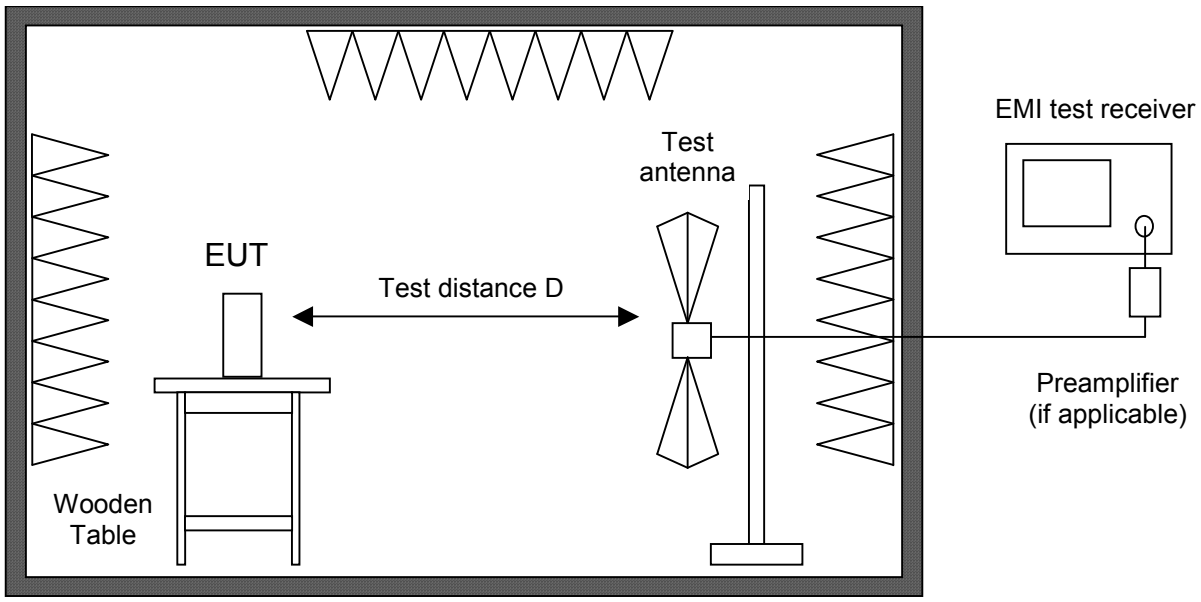
If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete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

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

If no prescan in a fully anechoic room is used first a peak scan is performed in four positions to get the whole spectrum of emission caused by EUT with the measuring antenna raised and lowered from 1 to 4 m to find table position, antenna height and antenna polarization for the maximum emission levels.
Data reduction is applied to these results to select those levels having less margin than 10 dB to or exceeding the limit using subranges and limited number of maximums. Further maximization is following.
With detector of the test receiver set to quasi-peak final measurements are performed immediately after frequency zoom (for drifting disturbances) and maximum adjustment.
Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

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

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



Alternate test site (semi anechoic room)

Test instruments used:

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☒	Trilog antenna	Cabin no. 8	VULB 9163	2058	9163-408	Schwarzbeck
☒	Microwave cable	Cabin no. 8	EF393	2053	---	Albatross Projects
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
☒	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
☐	Microwave cable	Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
☒	Microwave cable	Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
☒	Semi anechoic room		No. 8	2057	---	Albatross

7 Photographs Taken During Testing

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94315 Straubing
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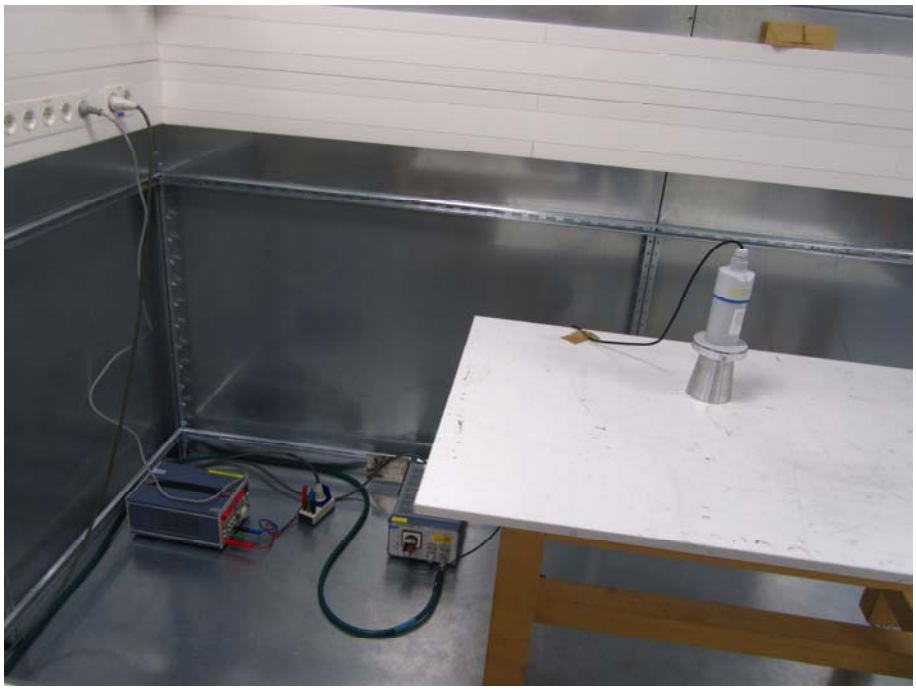
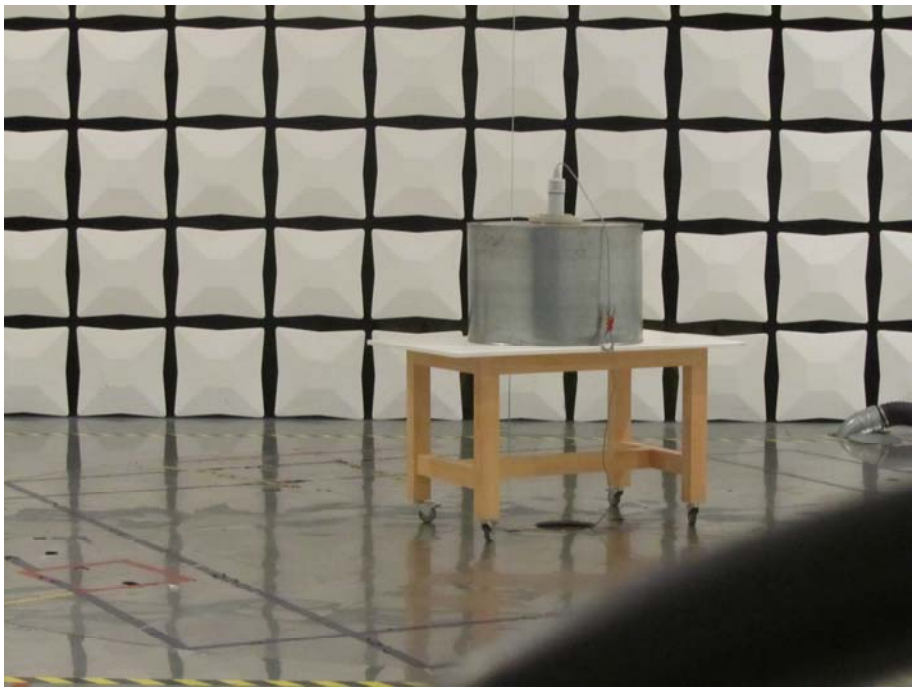
Test setup for conducted DC powerline emission measurement



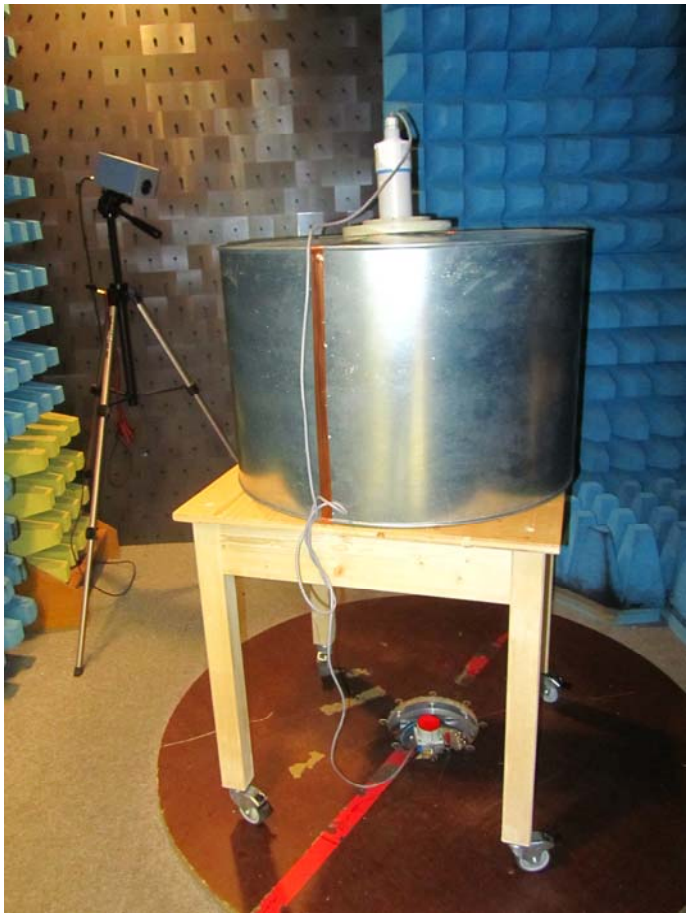
Test setup for radiated emission measurement 9 kHz – 30 MHz



Test setup for radiated emission measurement (fully anechoic room)

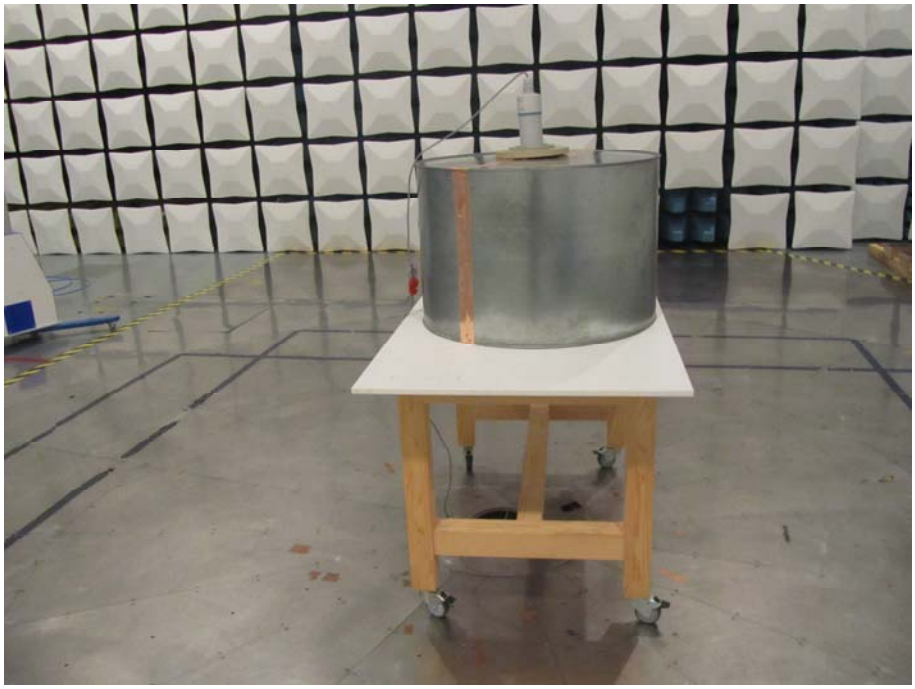
in-beam measurements

Test setup for radiated emission measurement (fully anechoic room) - continued -

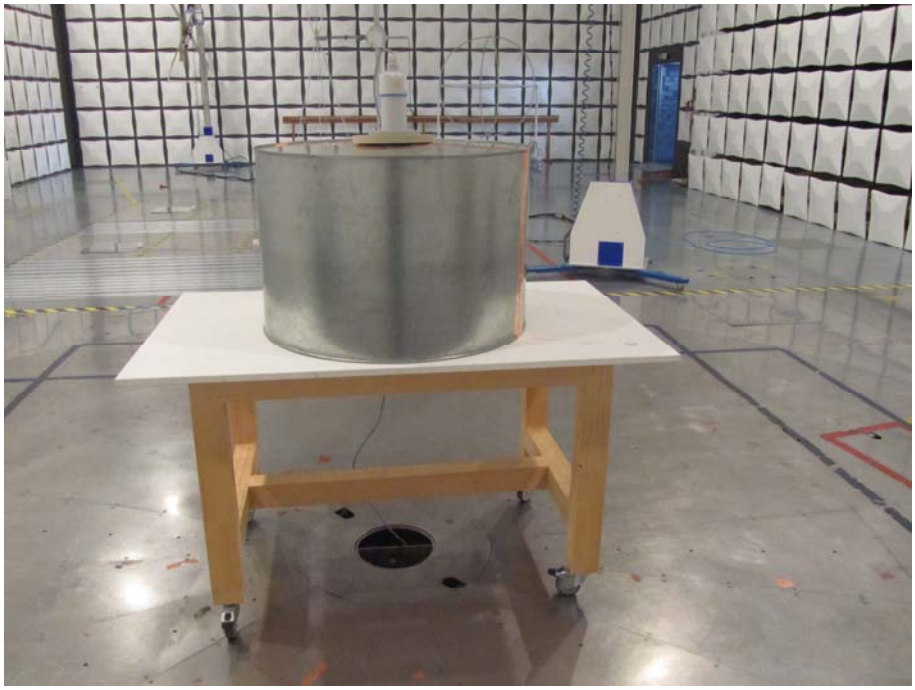


DN80 within tank

Test setup for radiated emission measurement (alternate test site)



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



DN40 with horn

DN40 with horn

8 Test Results

IC RSS-GEN Issue 4			
Section(s)	*Test*	*Page*	*Result*
6.12	Transmitter output power (conducted)	---	Not applicable
6.6	Occupied Bandwidth	27	Recorded
9	Designation of emissions	29	Calculated
6.10	Pulsed operation	---	Not applicable
8.8	Transmitter AC power lines conducted emissions 150 kHz to 30 MHz	32	Test passed
8.10	Restricted bands and unwanted emission frequencies	---	Not applicable
6.4, 6.13, 8.9	Unwanted emissions 9 kHz to 30 MHz	35	Test passed
6.4, 6.13, 8.9	Unwanted emissions 30 MHz to 100 GHz	37	Test passed
3.2	Exposure of Humans to RF Fields	43	Exempted from SAR and RF evaluation

IC RSS-211 Issue 1			
Section(s)	*Test*	*Page*	*Result*
5.1 (a)	Bandwidth of Emission – Fundamential Bandwidth	27	Test passed
5.1 (b)	Designated bands	27	Test passed
5.1 (c)	Restricted bands	---	Test passed [5]
5.1 (d)	Unwanted emissions 9 kHz to 30 MHz	35	Test passed
5.1 (d)	Unwanted emissions 30 MHz to 100 GHz	37	Test passed
5.2 (a)	Half-power beamwidth	---	Not applicable
5.2 (b)	Emission limits	37	Test passed
5.2 (c)	Lobe gain	---	Not applicable
5.3 (b)	Leakage of RF field outside the container	30	Test passed

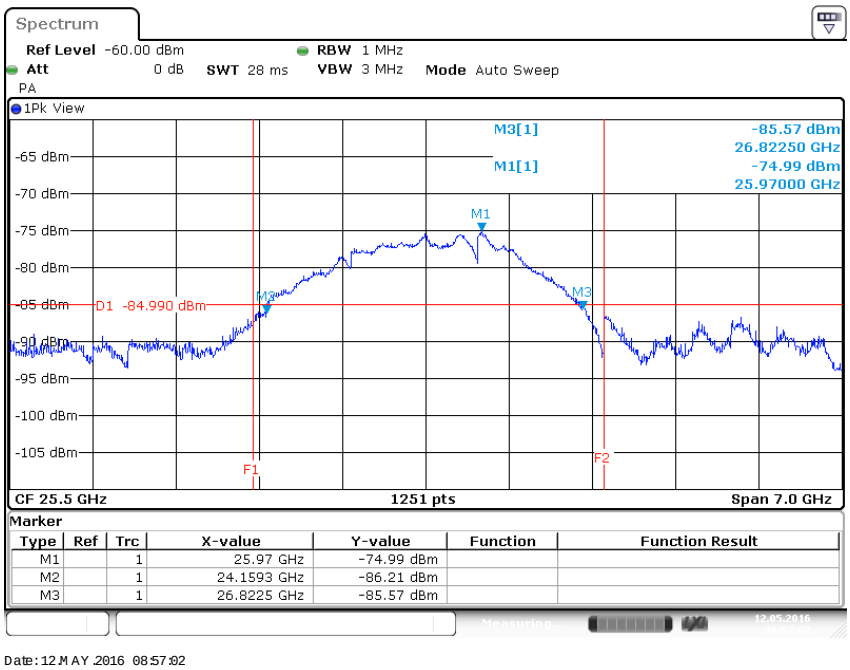
[5] See protocols for Unwanted Emissions for details.

8.1 Bandwidth of Emission – Fundamental Bandwidth

Rules and specifications:	IC RSS-211 Issue 1, sections 5.1 (a) and 5.1 (b)
Guide:	ANSI C63.10
Description and Limit:	Intentional radiators operating under the alternative provisions to the general emission limit must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained is contained within the frequency banddesignated in the rule section under which the equipment is operated The fundamental bandwidth of an LPR emission is defined as the width of the signal between two points, on below (f_L) and one above (f_H) the center frequency, outside of which all emissions are attenuated by at least 10 dB relative to the maximum transmitter output power when measured in an equivalent resolution bandwidth. The minimum fundamental emission bandwidth shall be 50 MHz for LPR operation under the provisions of this section. LPR devices operating under this section must convine their fundamental emission bandwidth within the 5925 MHz – 7250 MHz, 24.05 GHz – 29.00 GHz, and 75 GHz – 85 GHz bands under all conditions of operation.
	The video bandwidth shall be at least three times greater than the resolution bandwidth.
Measurement procedure:	Bandwidth Measurements (6.1)

Comment:	
Date of test:	2016-05-12
Test site:	Fully anechoic room, cabin no. 2

Test Result:	Test passed



Date: 12.MAY.2016 08:57:02

Minimum frequency f_L:	**24.1593 GHz**	
Maximum frequency f_H:	**26.8225 GHz**	
Bandwidth of the emission:	**2.6632 GHz**	
Minimum bandwidth requirement:	≥ 50 MHz	Test passed
Emission within the designated band:	24.05 GHz – 29.00 GHz	Test passed

8.2 Designation of Emissions

Rules and specifications:	IC RSS-Gen Issue 4, section 9
Guide:	ANSI C63.10 / TRC-43

Type of modulation:	Unmodulated Pulse Emission

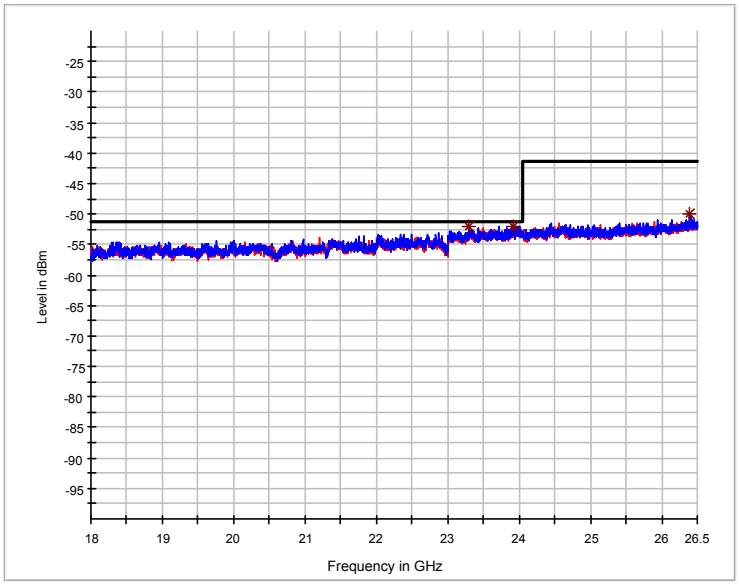
B_n = Necessary Bandwidth	$B_n = 2K/t$
t = Pulse duration at half amplitude	t = 2 ns
K = Overall numerical factor	K = 1.5
Calculation:	$B_n = 2 \cdot 1.5 / 2$ ns = 1.5 GHz

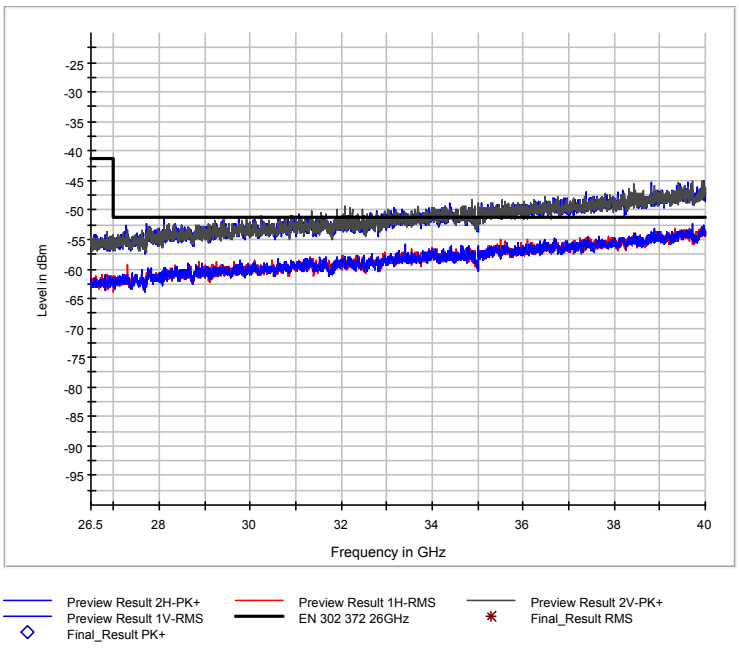
Designation of Emissions:	**1G50P0NAN**

8.3 Leakage of RF field outside the container

Rules and specifications:	IC RSS-211 Issue 1, section 5.3 (b)	
Guide:	ANSI C63.10 / CISPR 22	
Limit:	*Frequency Band* 24.05 GHz – 29.00 GHz	*Maximum average EIRP (in dBm/MHz Outside Tank Enclusure Structure Inside the Operating Frequency Band* -41.3 dBm
Test site:	Fully anechoic room, cabin no. 2	
Measurement procedure:	Radiated Emission in Fully or Semi Anechoic Room (6.4)	

Test Result:	Test passed


-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
Level in dBm
18
19
20
21
22
23
24
25
26
26.5
Frequency in GHz
Preview Result 1H-RMS
EN 302 372 26GHz
Preview Result 1V-RMS
Final_Result RMS


-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
Level in dBm
26.5
28
30
32
34
36
38
40
Frequency in GHz
Preview Result 2H-PK+
Preview Result 1V-RMS
Final_Result PK+
Preview Result 1H-RMS
EN 302 372 26GHz
Preview Result 2V-PK+
Final_Result RMS

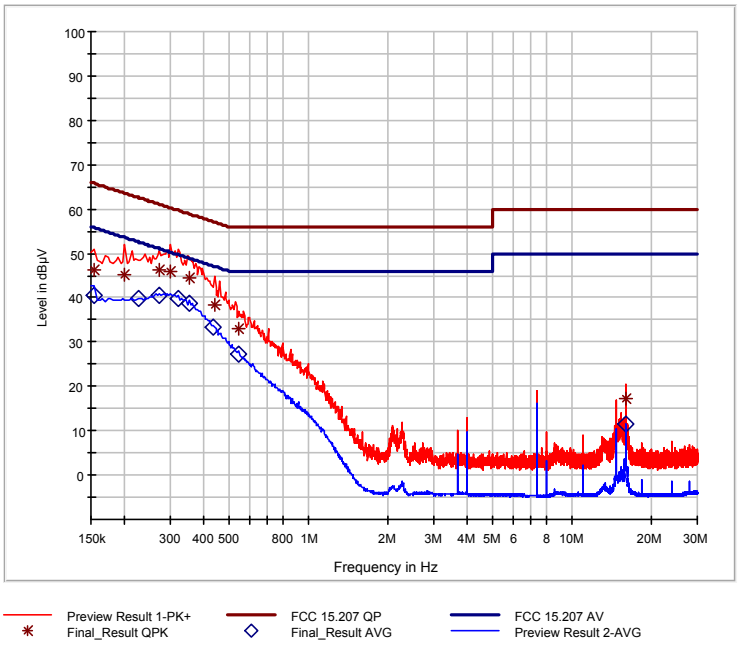
8.4 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

Rules and specifications:	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 0.5 - 5 5 - 30	66 to 56 56 60	56 to 46 46 50
Measurement procedure:	Conducted AC Powerline Emission (6.2)		

Comment:	
Date of test:	2016-05-31
Test site:	Shielded room, cabin no. 4

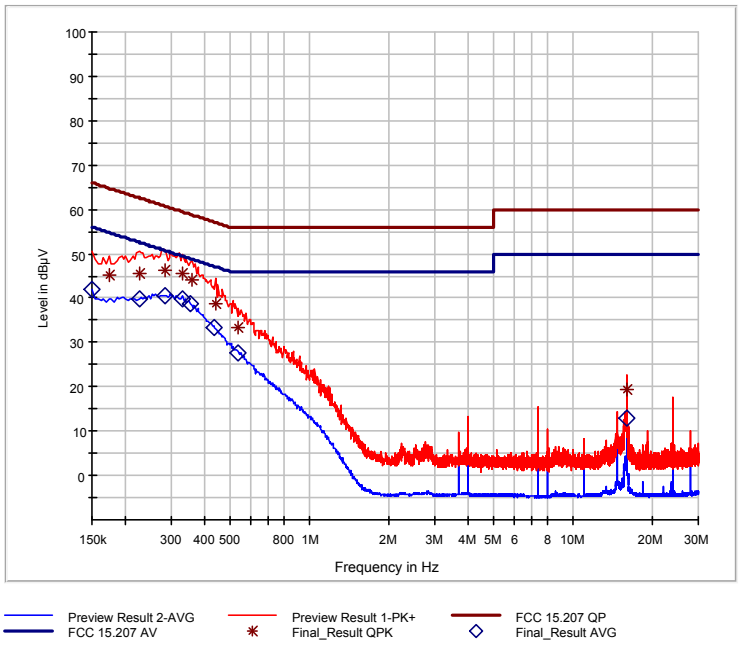
Test Result:	Test passed

Tested on:	Plus



Frequency (MHz)	Detector	Reading Value (dBµV)	Correction Factor (dB)	Final Value (dBµV)	Limit (dBµV)	Margin (dB)
0.154	Average	40.6	0.0	40.6	55.8	15.2
0.154	Quasi-Peak	46.1	0.0	46.1	65.8	19.7
0.202	Quasi-Peak	45.1	0.0	45.1	63.5	18.4
0.226	Average	39.7	0.0	39.7	52.6	12.9
0.274	Average	40.5	0.0	40.5	51.0	10.5
0.274	Quasi-Peak	46.2	0.0	46.2	61.0	14.8
0.302	Quasi-Peak	46.0	0.0	46.0	60.2	14.2
0.322	Average	39.9	0.0	39.9	49.7	**9.8**
0.354	Average	38.6	0.0	38.6	48.9	10.2
0.354	Quasi-Peak	44.4	0.0	44.4	58.9	14.5
0.434	Average	33.4	0.0	33.4	47.2	13.8
0.442	Quasi-Peak	38.6	0.0	38.6	57.0	18.5
0.546	Average	27.3	0.0	27.3	46.0	18.7
0.546	Quasi-Peak	32.9	0.0	32.9	56.0	23.1
15.998	Average	11.0	0.4	11.4	50.0	38.6
16.002	Quasi-Peak	16.8	0.4	17.2	60.0	42.8

Tested on:	Minus



Frequency (MHz)	Detector	Reading Value (dBµV)	Correction Factor (dB)	Final Value (dBµV)	Limit (dBµV)	Margin (dB)
0.150	Average	42.1	0.0	42.1	56.0	13.9
0.174	Quasi-Peak	45.3	0.0	45.3	64.8	19.5
0.226	Average	39.8	0.0	39.8	52.6	12.8
0.226	Quasi-Peak	45.4	0.0	45.4	62.6	17.2
0.282	Average	40.6	0.0	40.6	50.8	10.2
0.282	Quasi-Peak	46.3	0.0	46.3	60.8	14.5
0.330	Average	39.7	0.0	39.7	49.5	**9.8**
0.330	Quasi-Peak	45.4	0.0	45.4	59.5	14.1
0.354	Average	38.6	0.0	38.6	48.9	10.3
0.358	Quasi-Peak	44.1	0.0	44.1	58.8	14.6
0.434	Average	33.3	0.0	33.3	47.2	13.8
0.442	Quasi-Peak	38.8	0.0	38.8	57.0	18.2
0.538	Average	27.7	0.0	27.7	46.0	18.3
0.538	Quasi-Peak	33.3	0.0	33.3	56.0	22.7
15.998	Average	12.6	0.4	13.0	50.0	37.0
15.998	Quasi-Peak	18.9	0.4	19.3	60.0	40.7

Sample calculation of final values:

Final Value (dBµV) = Reading Value (dBµV) + Correction Factor (dB)

8.5 Radiated Emission Measurement 9 kHz to 30 MHz

Rules and specifications:	IC RSS-GEN Issue 4, sections 8.9 and 8.10 IC RSS-211 Issue 1, section 5.1 (d)			
Guide:	ANSI C63.10			
Limit:	Frequency of Emission (MHz)	Field Strength (µV/m)	Field Strength (dBµV/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:	
Date of test:	2016-11-22
Test site:	Open field test site

Test Result:	Test passed

Extrapolation factor: -40 dB/decade

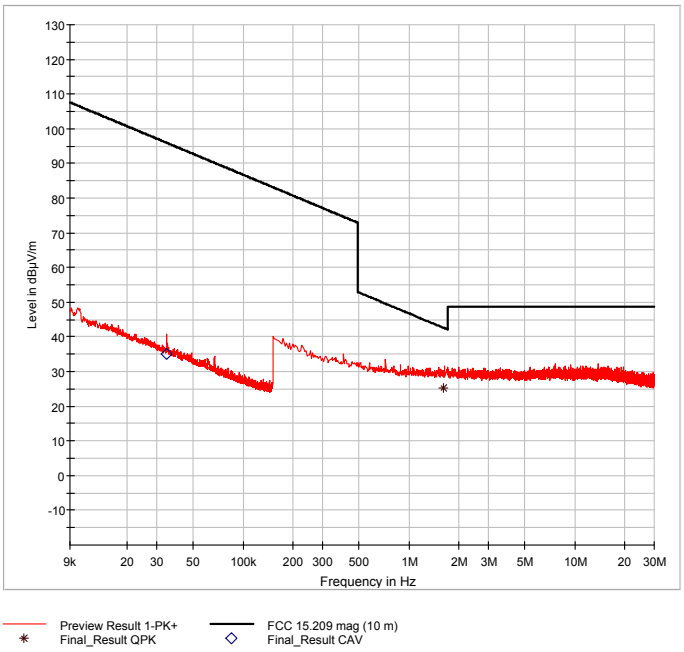
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
0.03455	Average	10	300	15.2	20.0	-59.1		-23.9	36.8	60.7
1.60800	Quasi-Peak	10	30	5.2	20.0	-19.1		6.1	23.5	**17.4**

Sample calculation of final values:

Extrapolation Factor (dB) = (Log(d) - Log(d_1)) · Extrapolation Factor (dB/decade)

Final Value (dBµV/m) = Reading Value d_1 (dBµV) + Correction Factor (dB/m) + Extrapolation Factor (dB) + Pulse Train Correction (dB)

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



8.6 Radiated Emission Measurement 30 MHz to 100 GHz

Rules and specifications:	IC RSS-GEN Issue 4, section 8.9 IC RSS-211 Issue 1, section 5.1 (d)		
Guide:	ANSI C63.10		
Limit:	Frequency of Emission (MHz)	Field Strength (µV/m)	Field Strength (dBµV/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:	
Date of test:	2016-05-29 to 2016-06-02; 2016-11-22
Test site:	Frequencies ≤ 1 GHz: Semi-anechoic room, cabin no. 8 Frequencies > 1 GHz: Fully anechoic room, cabin no. 2
Test distance:	Frequencies ≤ 8.2 GHz: 3 meters Frequencies > 8.2 GHz to ≤ 26 GHz: 1 meter Frequencies > 26 GHz to ≤ 40 GHz: 0.25 meters Frequencies > 40 GHz: 0.1 meters

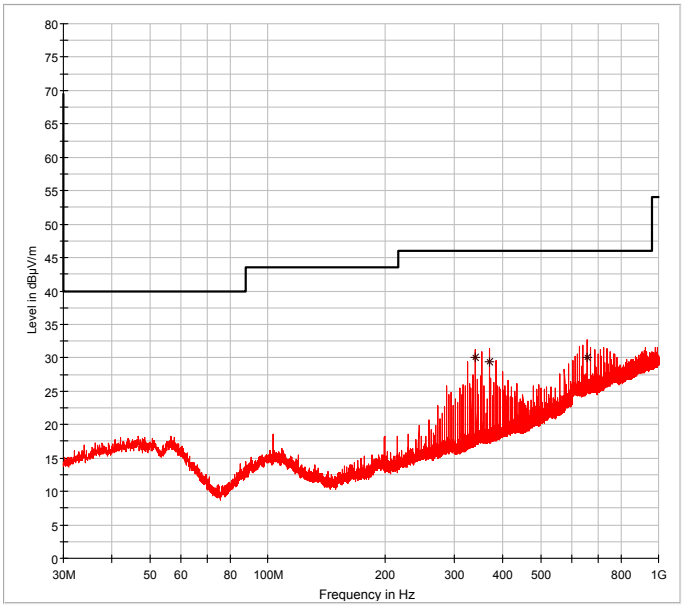
Test Result:	Test passed

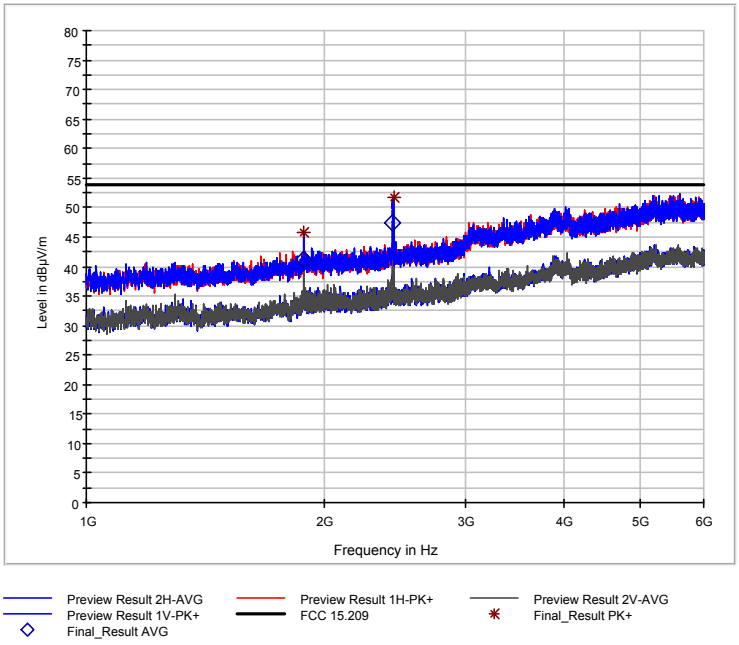
Comment:	
Test Result:	Test passed

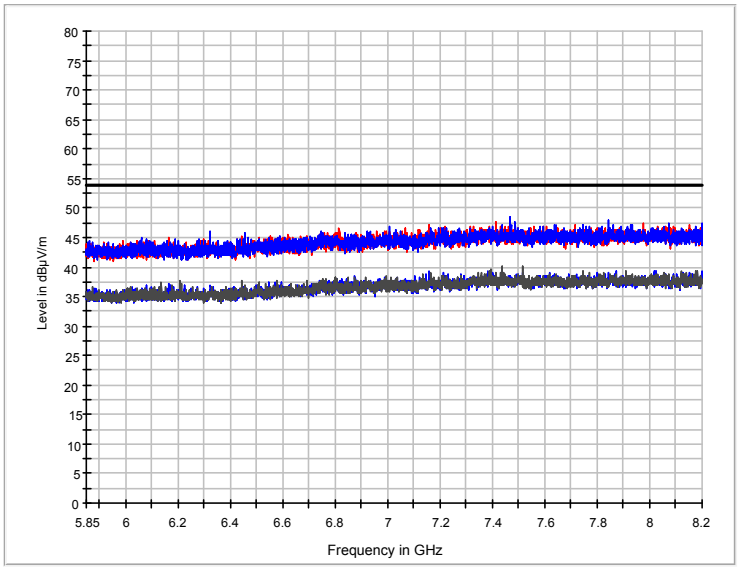
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
399.160	vertical	Quasi-Peak	13.9	16.1		30.0	46.0	16.0
368.650	vertical	Quasi-Peak	12.8	16.6		29.4	46.0	16.6
656.200	vertical	Quasi-Peak	8.3	21.8		30.1	46.0	15.9
1882.000	vertical	Peak	46.9	-1.1		45.8	74.0	28.2
1882.000	vertical	Average	42.2	-1.1		41.1	54.0	12.9
2438.000	vertical	Peak	51.1	0.6		51.7	74.0	22.3
2438.000	vertical	Average	46.7	0.6		47.3	54.0	**6.7**

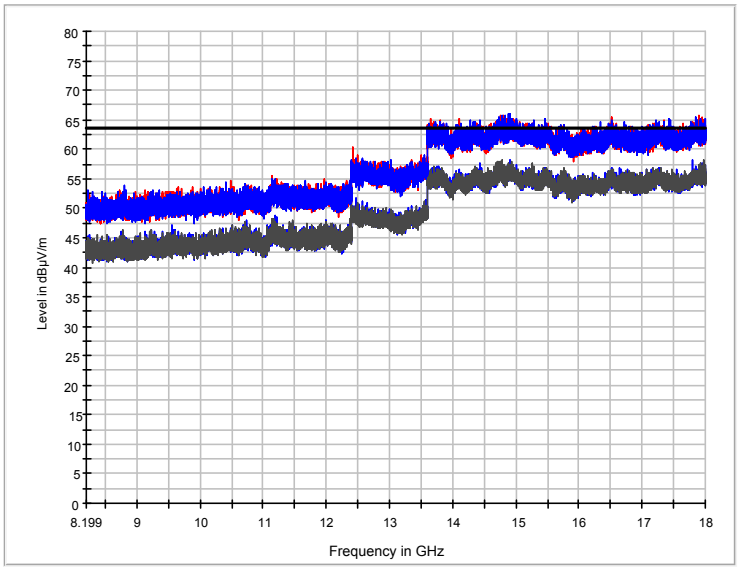
Sample calculation of final values:

Final Value (dBµV/m) = Reading Value (dBµV) + Correction Factor (dB/m) + Pulse Train Correction (dB)

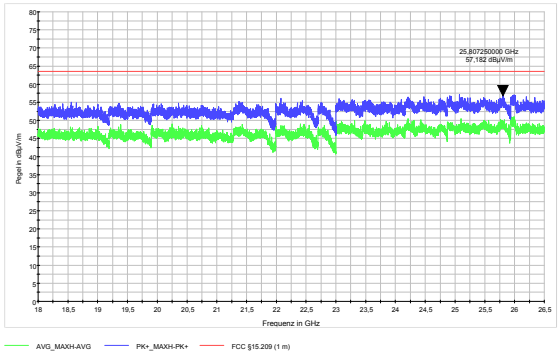

Level in dBµV/m
Frequency in Hz
30M
50
60
80
100M
200
300
400
500
800
1G
ExistingD1-PK+
FCC 15.209_3m
Final_Result QPK
Final_Result AVG

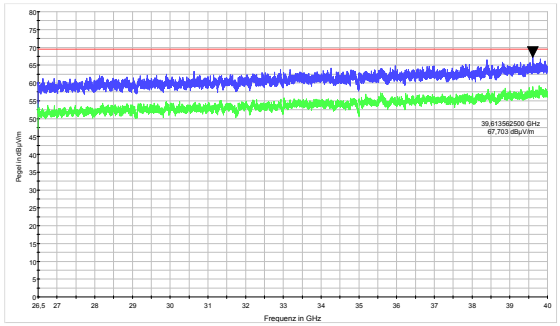

Level in dBµV/m
Frequency in Hz
1G
2G
3G
4G
5G
6G
Preview Result 2H-AVG
Preview Result 1V-PK+
Final_Result AVG
Preview Result 1H-PK+
FCC 15.209
Preview Result 2V-AVG
Final_Result PK+


Level in dBµV/m
Frequency in GHz
Preview Result 2H-AVG
Preview Result 1V-PK+
Final_Result AVG
Preview Result 1H-PK+
FCC 15.209
Preview Result 2V-AVG
Final_Result PK+

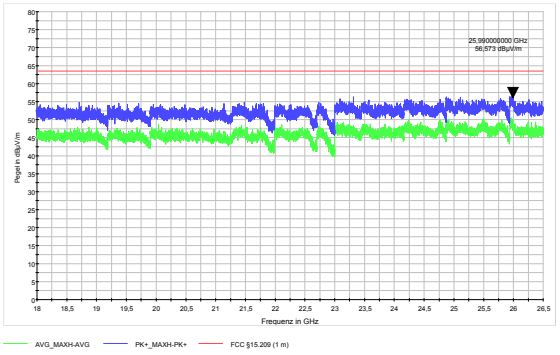

Level in dBµV/m
Frequency in GHz
Preview Result 2H-AVG
Preview Result 1V-PK+
Final_Result AVG
Preview Result 1H-PK+
FCC 15.209 (1m)
Preview Result 2V-AVG
Final_Result PK+

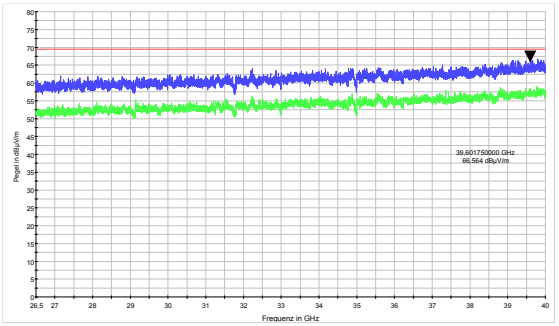
Horizontal polarization



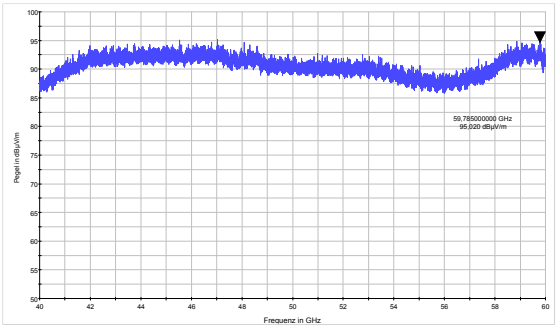


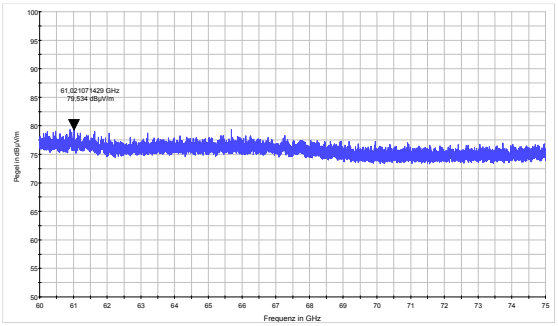
Vertical polarisation

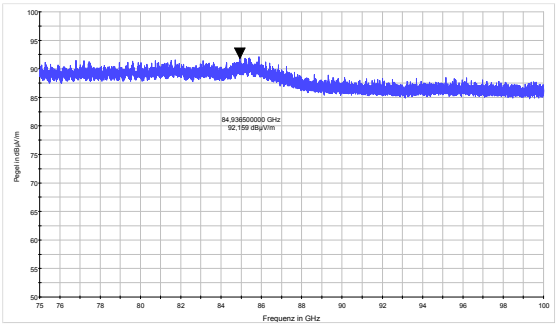




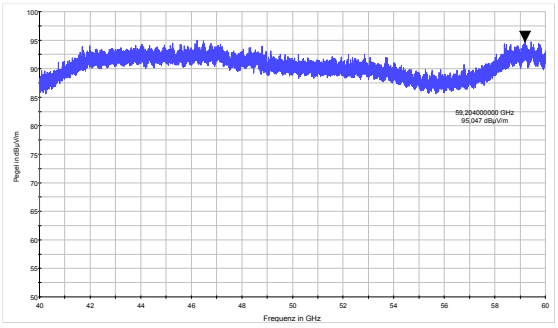
Horizontal polarization

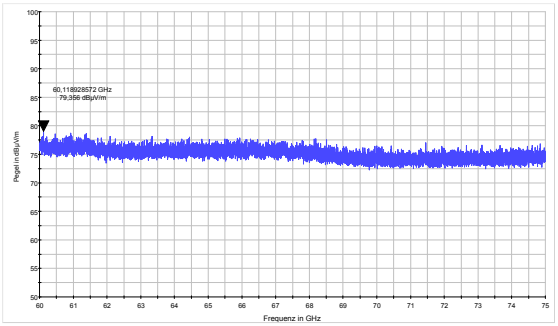


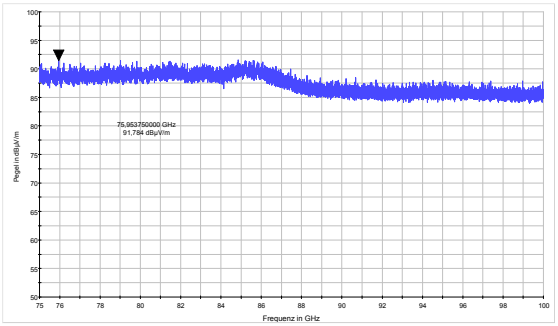




Vertical polarisation







8.7 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				
☐ detachable				
The conducted output power (CP in watts) is measured at the antenna connector: CP = **..... W**			☐	
The effective isotropic radiated power (EIRP in watts) is calculated using				
☐ the numerical antenna gain: G = **.....**		☐		
$EIRP = G \cdot CP \Rightarrow EIRP$ = **..... W**				
☐ the field strength[6] in V/m: FS = **..... V/m**			☐	
$EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP$ = **..... W**				
with:				
Distance between the antennas in m: D = **..... m**			☐	
☐ not detachable				
A field strength measurement is used to determine the effective isotropic radiated power (EIRP in watts) given by[6]:				
$EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP$ = **..... W**				
with:				
Field strength in V/m: FS = **..... V/m**			☐	
Distance between the two antennas in m: D = **..... m**			☐	
Selection of output power				
The output power TP is the higher of the conducted or effective isotropic radiated power (e.i.r.p.): TP = **..... W**				

[6] 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					
☐ less than or equal to 20 cm	☐ greater than 20 cm		☐		
Transmitting device is					
☐ in the vicinity of the human head	☐ 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.				
Carrier frequency: f = ... **MHz** Distance: d = ... **mm** Transmitter output power: TP = ... **mW** Limit: TP_{limit} = ... **mW**				☐
☐ SAR evaluation is documented in test report no.				

Frequency (MHz)	Exemption limits (mW)[7] 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 [8]	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

[7] The exemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separaton 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 alinear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from athird order polynomial fit.

[8] 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.

Exposure of Humans to RF Fields (continued)	Applicable	Declared by applicant	Measured	Exemption
RF exposure evaluation				
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: ☐ below 20 MHz[9] 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). ☐ between 3 kHz and 10 MHz exposure limits apply as following: ☐ In a uncontrolled environment the basic restriction for the instantaneous internal electric field strength is equal to or less than 2.7 · 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}. ☐ In a controlled environment the basic restriction for the instantaneous internal electric field strength is equal to or less than 1.35 · 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}. ☐ 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. ☐ 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). ☐ 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. ☒ 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). 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.				
Carrier frequency: f = **24.93 GHz** Transmitter output power: TP = **1 mW e.i.r.p.** [10] Limit: TP_{limit} = **5000 mW**				☒
☐ RF exposure evaluation is documented in test report no.				

[9] Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine RF Exposure evaluation, shall demostrate compilance tot he instanteneous limits in IC RSS-102, issue 5, section 4.
[10] See test report 80452-81620-3e for details on in-beam radiated emissions.

9 Referenced Regulations

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

☐	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, 2016
☐	CFR 47 Part 15	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)	October 1, 2016
☐	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)
☒	ANSI C63.10	American national Standard of Procedures for Compilance Testing of Unlicensed Wireless Devices	June 27, 2013 (published on September 13, 2013)
☒	RSS-Gen	Radio Standards Specification RSS-Gen Issue 4 containing General Requirements for Compilance of Radio Apparatus, published by Industry Canada	November 2014
☐	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
☒	RSS-211	Radio Standards Specification RSS-211 Issue 1 for Level Probing Radar Equipment	March 2015
☐	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
☒	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
☐	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
☒	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

☐	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	1028	ESHS10	860043/016	Rohde & Schwarz	Rohde & Schwarz	10/2015	10/2016
EMI test receiver	2044	ESU8	100232	Rohde & Schwarz	Rohde & Schwarz	11/2016	11/2017
Spectrum analyser	1666	FSP30	100063	Rohde & Schwarz	Rohde & Schwarz	06/2015	06/2016
Spectrum analyser	2364	FSV40	101448	Rohde & Schwarz	Rohde & Schwarz	08/2015	08/2016
Preamplifier	1484	ACO/180-3530	32641	CTT	TÜV SÜD PS-EMC-STR	07/2015	07/2017
Preamplifier	1684	AFS3-00100800-32-LN	847743	MITEQ	TÜV SÜD PS-EMC-STR	11/2015	11/2017
Preamplifier	1716	CPA9231A	3557	Schaffner EMC Systems	TÜV SÜD PS-EMC-STR	11/2015	11/2017
V-network	1059	ESH3-Z5	894785/005	Rohde & Schwarz	Rohde & Schwarz	08/2013	08/2016
Double ridged waveguide horn antenna	1516	3115	9508-4553	EMCO Elektronik	Seibersdorf Laboratories	01/2015	01/2017
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	05/2014	05/2016
TRILOG Broadband Antenna	2058	VULB 9163	9163-408	Schwarzbeck	Rohde & Schwarz	06/2014	06/2016
Waveguide mixer	2085	WM780U	B030121	Tektronix	Rohde & Schwarz	01/2013	01/2017
Waveguide mixer	2140	WM782V	B030132	Tektronix	Rohde & Schwarz	01/2013	01/2017
Waveguide mixer	2181	WM782W	B010193	Tektronix	Rohde & Schwarz	01/2013	01/2017

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			
Edition	*Date*	*Issued by*	*Modifications*
1	2016-11-23	M. Steindl (as)	First edition