Product Service

Choose certainty.
Add value.

November 9, 2018

Prüfbericht / *Test Report* Nr. / *No.* TR-80452-29570-04 (Edition 3)

Applicant:	Endress + Hauser SE + Co. KG
Type of equipment:	K-Band Level Probing Radar
Type designation:	FMR10+R7, FMR20+R7, FMR20+R8
Order No.:	50009123
Test standards:	FCC Code of Federal Regulations, CFR 47, Part 15, Sections 15.205, 15.207, 15.209 and 15.256 (partly) Industry Canada Radio Standards Specifications RSS-211 Issue 1, Sections 5.1 and 5.2(partly) RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 (Category I Equipment)

Note:

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

Table of Contents

1 Description of the Equipment Under Test (EUT)

General data of EUT	
Type designation[1]:	FMR10+R7, FMR20+R7, FMR20+R8
Parts[2]:	
Serial number(s):	FMR10+R7: N500190117A FMR20+R8: N500140117A
Manufacturer:	Endress + Hauser SE + Co. KG
Type of equipment:	K-Band Level Probing Radar
Version:	As received
FCC ID:	LCGFMR2XKL
Industry Canada ID:	2519A-2KL
Additional parts/accessories:	

Technical data of EUT	
Application frequency range:	24.05 GHz - 29 GHz
Frequency range:	24.05 GHz – 26 GHz
Operating frequency:	25 MHz
Type of modulation:	Unmodulated Pulse Emission
Pulse train:	N/A
Pulse width:	N/A
Number of RF-channels:	1
Channel spacing:	N/A
Designation of emissions[3]:	800MPXN
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 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 SE + Co. KG Hauptstraße 1 79689 Maulburg Germany
Contact person:	Mr. Ralf Reimelt
Order number:	50009123
	(Agent is Zühlke AG, Wiesenstrasse 10a, CH 8952 Schlieren)
Receipt of EUT:	2018-09-18
Date(s) of test:	2018-09-18 to 2018-09-28
Note(s):	

Report details	
Report number:	TR-80452-29570-04
Edition:	2
Issue date:	2018-11-09

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-11321-11-02
Laboratory recognition:	Registration No. BNetzA-CAB-16/21-15
Industry Canada test site registration:	3050A-2
Contact person:	Mr. Markus Biberger Phone: +49 9421 5522-0 Fax: +49 9421 5522-99

4 Summary

Summary of test results
The tested sample partly complies with the requirements set forth in the **Code of Federal Regulations CFR 47, Part 15, Sections 15.205, 15.207, 15.209 and 15.256** of the Federal Communication Commission (FCC) and the **Radio Standards Specifications** **RSS-210 Issue 1, Sections 5.1 and 5.2** **RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 (Category I Equipment)** of Industry Canada (IC).

Datum / *Date*	Geprüft von / *Tested by*	Freigabe durch / *Checked by*
2018-11-09	Steindl Martin Martin Steindl Responsible for testing	Stump Matthias Stumpe Reviewer

Prüfergebnis / *Test Result*

☒ **Erfüllt / *Passed***

☐ **Nicht erfüllt / *Not passed***

5 Operation Mode and Configuration of EUT

Operation Mode(s)
Transmitting continuously

Configuration(s) of EUT
The EUT was tested as stand alone equipment

List of ports and cables				
Port	*Description*	*Classification*[4]	*Cable type*	*Cable length*
1	DC supply	dc power	Unshielded	2 m

List of devices connected to EUT				
Item	*Description*	*Type Designation*	*Serial no. or ID*	*Manufacturer*
1	AC/DC convertor	LOGO! Power 24 V		Siemens

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

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

6 Measurement Procedures

6.1 Bandwidth Measurements

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 2, section 2.202(a) CFR 47 Part 15, section 15.215(c) IC RSS-Gen Issue 4, section 6.6 IC RSS-210 Issue 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:	☐ 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).

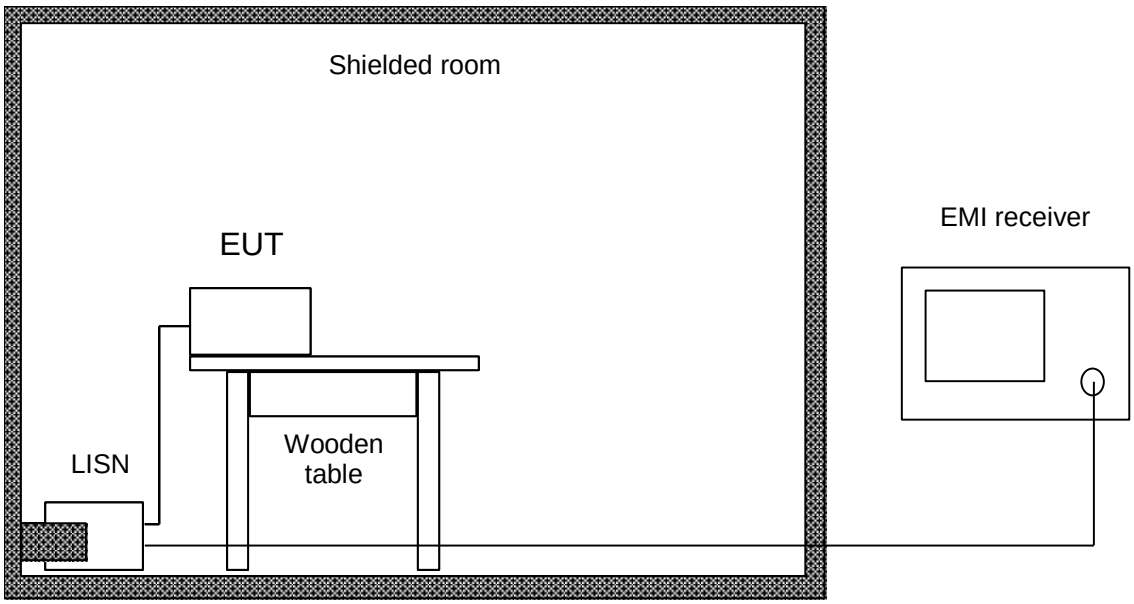
6.2 Conducted AC Powerline Emission

Measurement Procedure:	
Rules and specifications:	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*
☒	Test receiver	ESU8	2044	100232	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	21083	---	Albatross
☒	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 and 15.209 IC RSS-GEN Issue 4, sections 8.9 and 8.10
Guide:	ANSI C63.4

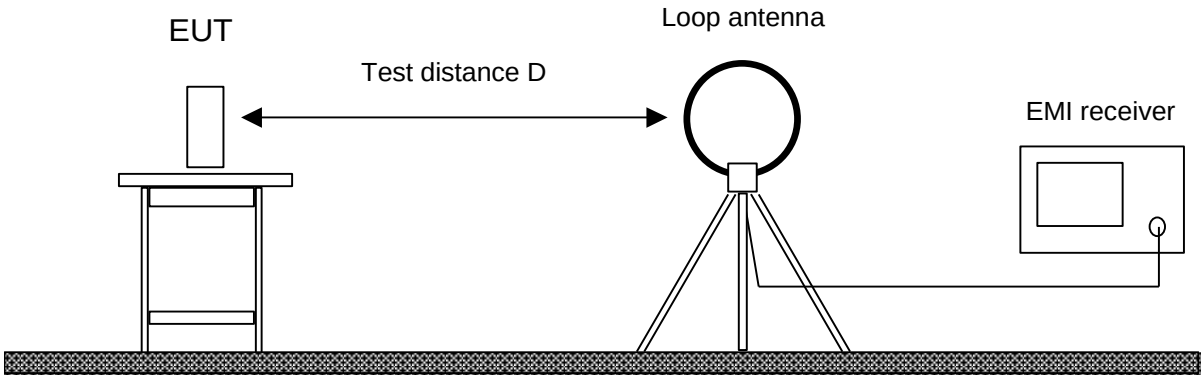
Radiated emission in the frequency range 9 kHz to 30 MHz is measured using an active loop antenna. First the whole spectrum of emission caused by the equipment is recorded at a distance of 3 meters in a fully or semi anechoic room with the detector of the spectrum analyzer or EMI receiver set to peak.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

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

EUT is rotated all around to find the maximum levels of emissions. Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.
If worst case emission of the EUT cannot be recorded with EUT in standard position and loop antenna in vertical polarization the EUT (or the radiating part of the EUT) is rotated by 90 degrees instead of changing the loop antenna to horizontal polarization. This procedure is selected to minimize the influence of the environment (e.g. effects caused by the floor especially with longer distances).

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

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



Test instruments used:

	Type	*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☐	Spectrum analyzer	FSP30	1666	100036	Rohde & Schwarz
☒	EMI test receiver	ESW26	28268	101315	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
☒	Measurement Software	EMC32_K8 V9.25.00	1852	100016	Rohde & Schwarz

6.4 Radiated Emission in Fully or Semi Anechoic Room

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, section 15.209 IC RSS-GEN Issue 4, section 8.9
Guide:	ANSI C63.4

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

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

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

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

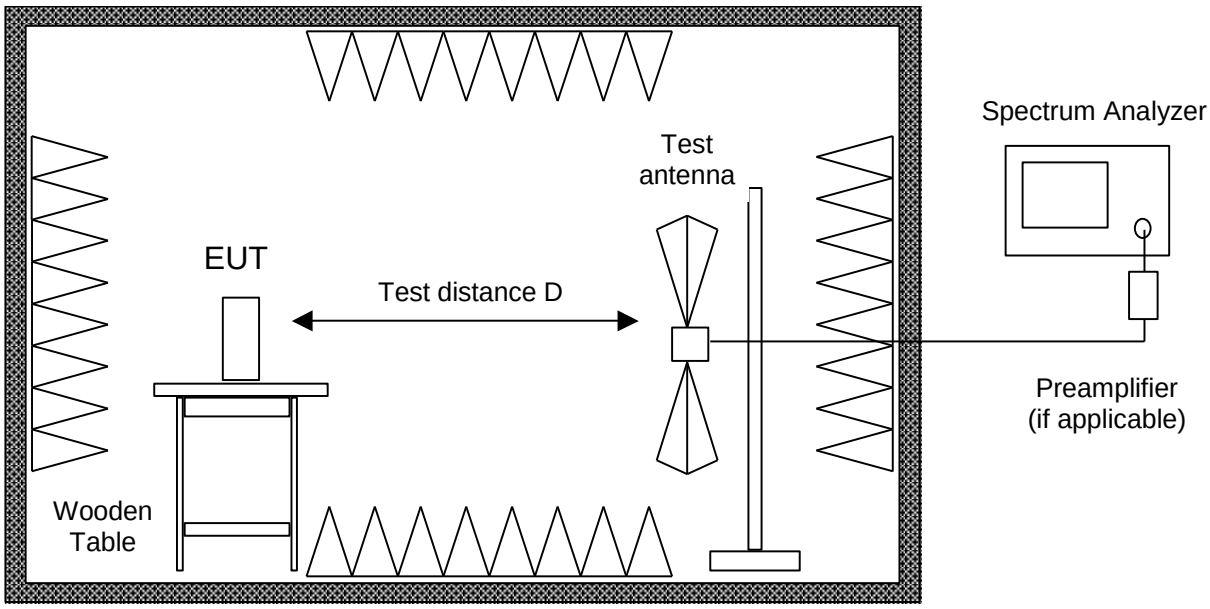
If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete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

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

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

Radiatetd Emissions above 1 GHz were performed with the antenna tilted to the direction of the EUT.

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	2364	101448	Rohde & Schwarz
☐	EMI test receiver	Cabin no. 3	ESPI7	2010	101018	Rohde & Schwarz
☐	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☒	EMI test receiver		ESW26	28268	101315	Rohde & Schwarz
☒	External Waveguide Mixer		FS-Z60	25849	100177	Rohde & Schwarz
☒	External Waveguide Mixer		FS-Z90	25850	101610	Rohde & Schwarz
☒	External Waveguide Mixer		FS-Z110	25851	101464	Rohde & Schwarz
☐	External Waveguide Mixer		FS-Z170	22553	100953	Rohde & Schwarz
☐	External Waveguide Mixer		FS-Z220	25854	100965	Rohde & Schwarz
☐	External Waveguide Mixer		FS-Z325	25855	100922	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

	Type	*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Horn antenna	HF907	2073	100154	Rohde & Schwarz
☐	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	24240-20	19946	157845	FLANN
☐	Horn antenna	25240-20	27898	249763	FLANN
☐	Horn antenna	27240-20	27899	244048	FLANN
☐	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
☐	Measurement Software	EMC32_K2 V9.25.00	2033	100003	Rohde & Schwarz
☒	Measurement Software	EMC32_K8 V9.25.00	1852	100016	Rohde & Schwarz

6.5 Radiated Emission at Alternative Test Site

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, section 15.209 IC RSS-GEN Issue 4, section 8.9
Guide:	ANSI C63.10

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.

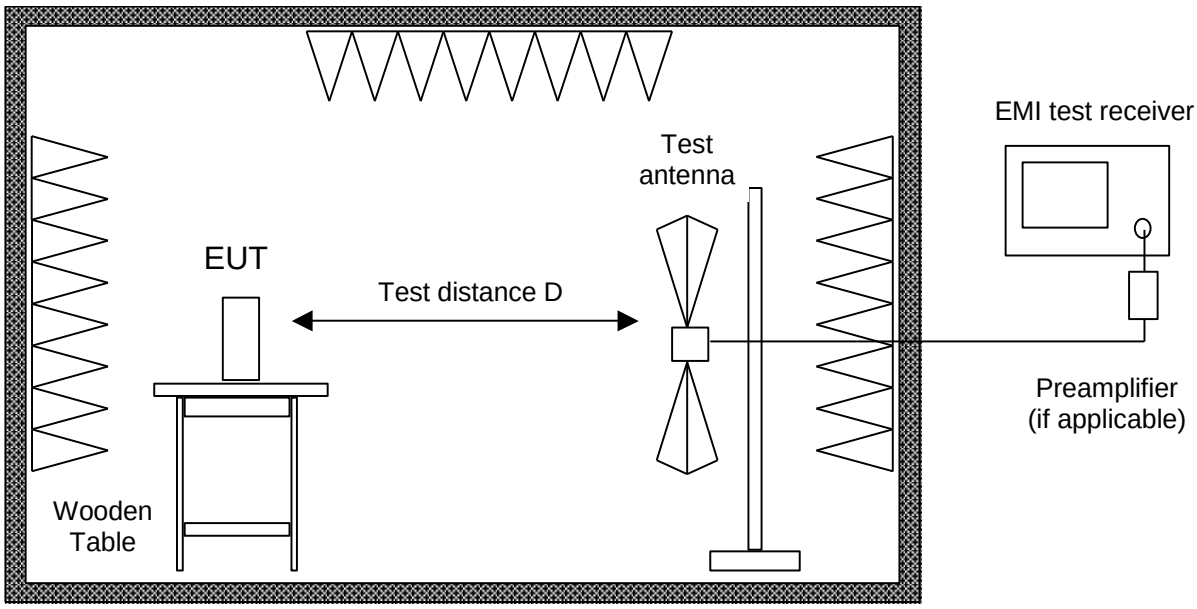
If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete 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
☒	EMI test receiver	ESW26	28268	101315	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
☒	Measurement Software	EMC32_K8 V9.25.00	1852	100016	Rohde & Schwarz

7 Photographs Taken During Testing

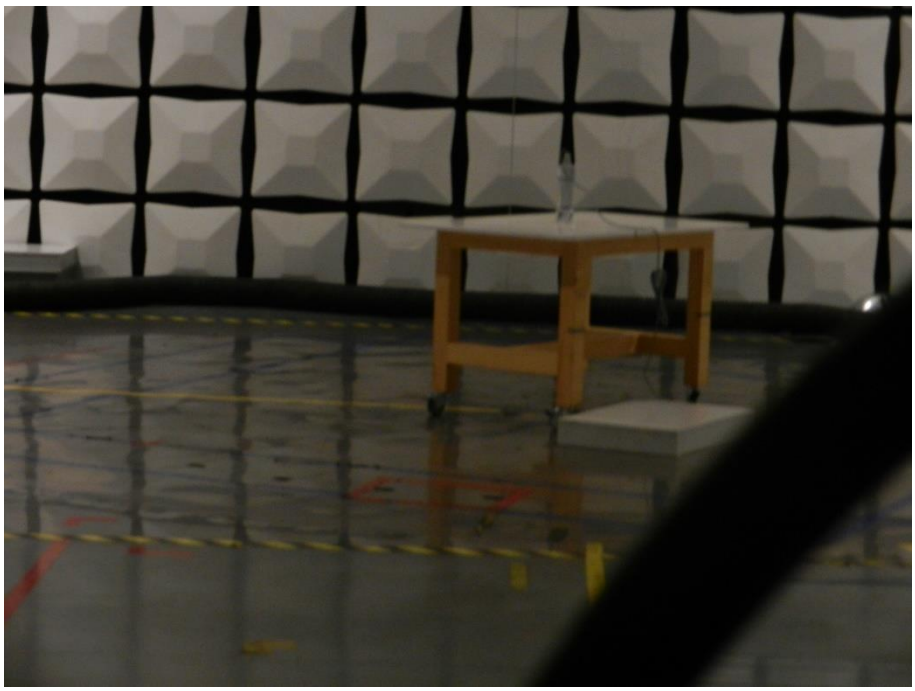
TÜV SÜD Product Service GmbH
Äußere Frühlingstraße 45
94315 Straubing
Germany

Phone: +49 9421 5522-0
Fax: +49 9421 5522-99
Web: www.tuev-sued.de

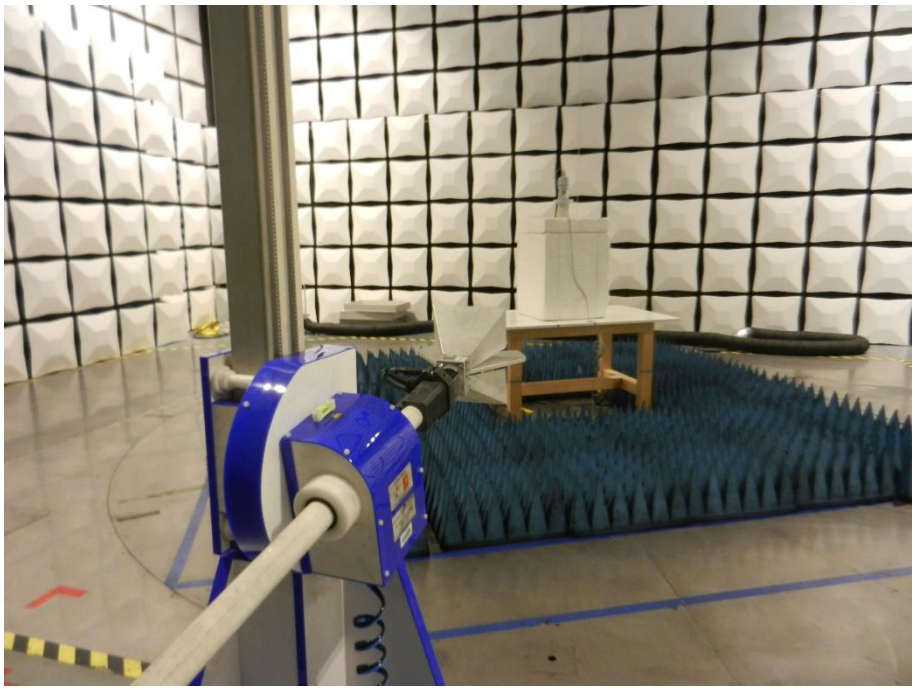
Product Service

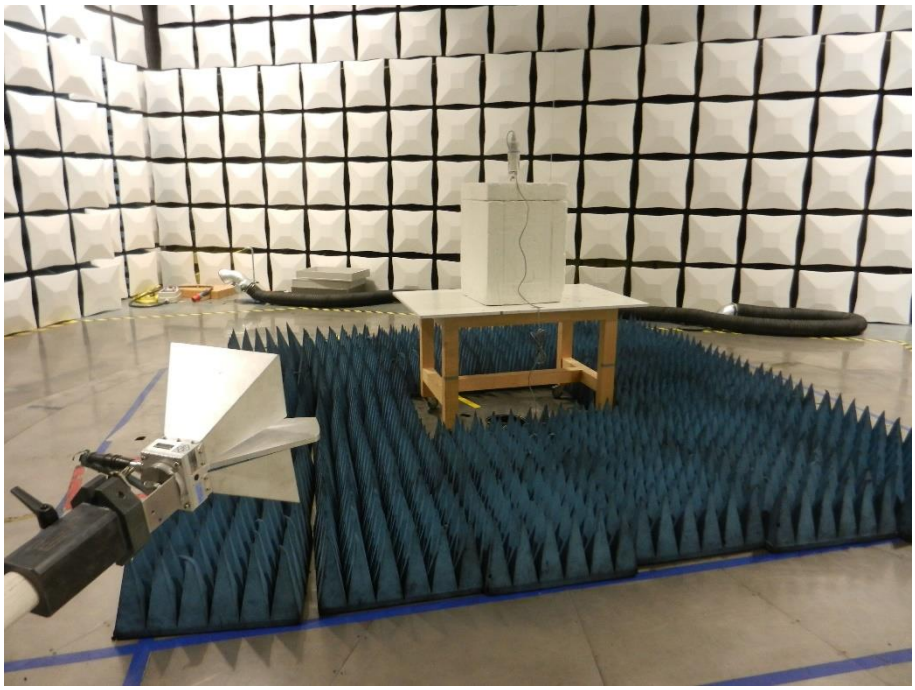
Test setup for conducted AC powerline emission measurement

Test setup for radiated emission measurement 9 kHz – 30 MHz

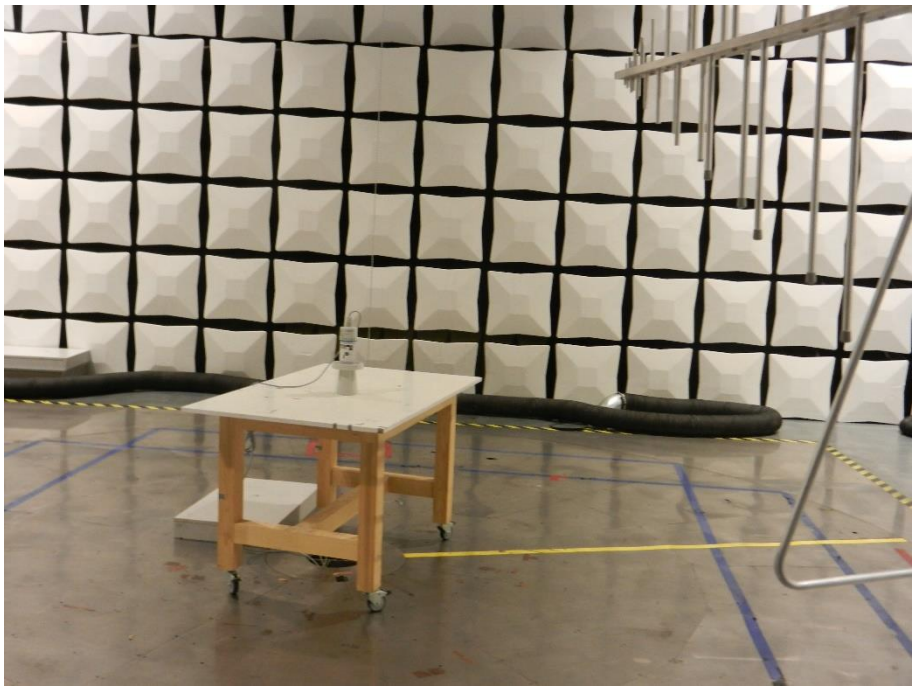


Test setup for radiated emission measurement (fully anechoic room)





Test setup for radiated emission measurement (alternate test site)



8 Test Results

FCC CFR 47 Parts 2 and 15			
Section(s)	*Test*	*Page*	*Result*
2.1046(a)	Conducted output power	---	Not applicable
15.256(g)(2)(ii)	Minimum Occupied bandwidth	25	Test passed
2.201, 2.202	Class of emission	28	Calculated
15.35(c)	Pulse train measurement for pulsed operation	---	Not applicable
15.205(a)	Restricted bands of operation	---	Not applicable
15.207	Conducted AC powerline emission 150 kHz to 30 MHz	46	Test passed
15.205(b) 15.209	Radiated emission 9 kHz to 30 MHz	49	Test passed
15.205(b) 15.209	Radiated emission 30 MHz to 100 GHz	52	Test passed
15.256(g)(3)	Fundamental emissions EIRP	40	Test passed
1.1307(b)(1)	RF Exposure Requirement	68	Test passed

IC RSS-GEN Issue 4			
Section(s)	*Test*	*Page*	*Result*
6.12	Transmitter output power (conducted)	---	Not applicable
9	Designation of emissions	28	Calculated
6.10	Pulsed operation	---	Not applicable
8.8	Transmitter AC power lines conducted emissions 150 kHz to 30 MHz	46	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	49	Test passed
6.4, 6.13, 8.9	Unwanted emissions 30 MHz to 100 GHz	52	Test passed
3.2	Exposure of Humans to RF Fields	69	Exempted from SAR and RF evaluation

IC RSS-211 Issue 1			
Section(s)	*Test*	*Page*	*Result*
5.1 (a)	Minimum Emission Bandwidth	25	Test passed
5.1 (d)	Unwanted emissions 9 kHz to 30 MHz	49	Test passed
5.1 (d)	Unwanted emissions 30 MHz to 100 GHz	52	Test passed
5.2 (a)	Maximum half-power beamwidth	---	Not performed [5]
5.2 (b)	Fundamental Emissions EIRP	43	Test passed
5.2 (c)	Side Lobe Gain	---	Not performed [5]
5.3 (b)	Maximum Average EIRP Outside the Tank Enclosure	---	Not applicable

[5] Not ordered by applicant. Test data will be provided in separate report by applicant.

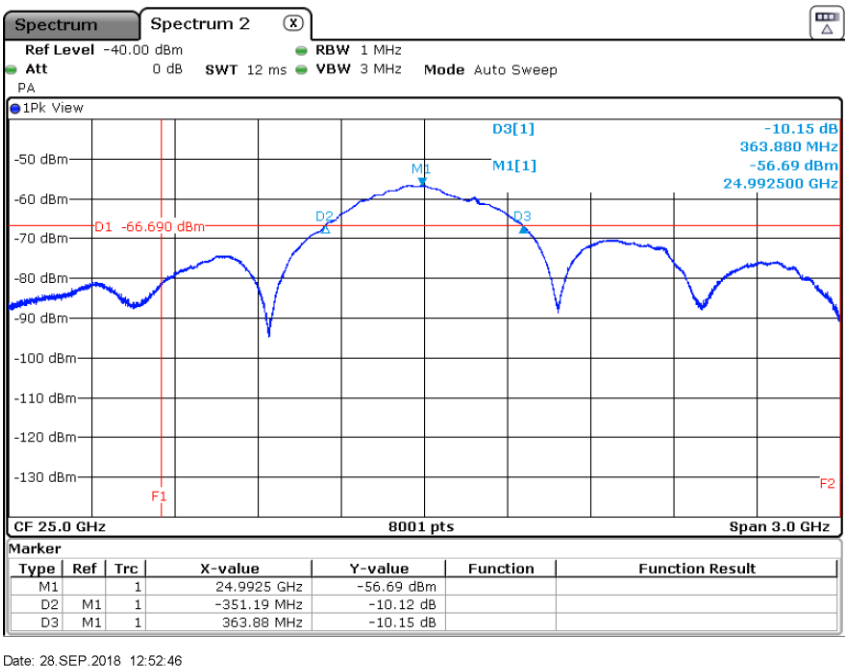
8.1 Occupied Bandwidth

Rules and specifications:	CFR 47 Part 15, sections 15.256(f)(1) IC RSS-211 Issue 1, section 5.1(a)
Guide:	IC RSS-Gen Issue 4, section 6.6
Limit	The minimum fundamental emission bandwidth in the -10 dBc points shall be 50 MHz.
Measurement procedure:	Bandwidth Measurements (6.1)

Comment:	
Date of test:	2018-09-27 and 2018-09-28
Test site:	Fully anechoic room, cabin no. 2

Test Result:	Test passed

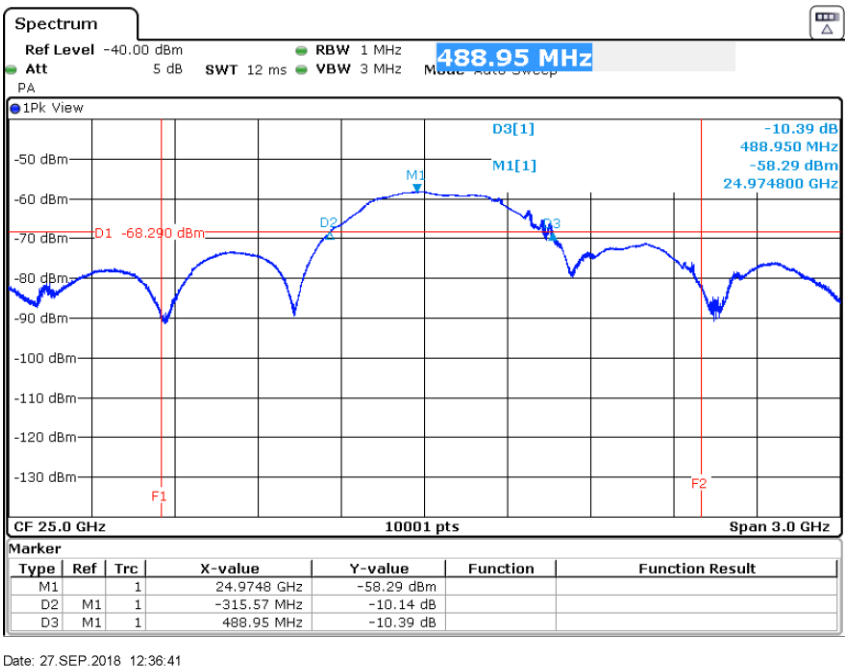
Occupied Bandwidth (-10 dB) EUT FMR10+R7:



Date: 28.SEP.2018 12:52:46

Occupied Bandwidth (-10 dB):	**715.07 MHz**
Limit:	**>50 MHz**

Occupied Bandwidth (-10 dB) EUT FMR20+R8:



Date: 27.SEP.2018 12:36:41

Occupied Bandwidth (-10 dB):	**805.52 MHz**
Limit:	**>50 MHz**

8.2 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:	Unmodulated pulse emission

Designation of Emissions:	**800MPXN**

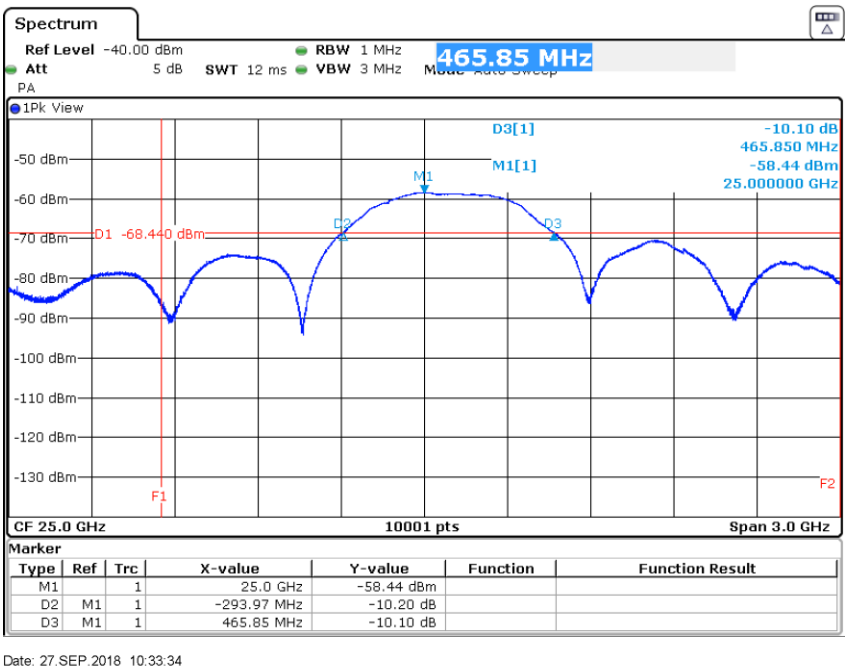
8.3 Band of Operation

Rules and specifications:	CFR 47 Part 2, section 15.256(f)(2)
Guide:	KDB 890966 D01 V01 R01, section H
Description:	LPR devices operating under this section must confine their fundamental emission bandwidth within the 5.925 – 7.250 GHz, 24.05 – 29.0 GHz, and 75 – 85 GHz bands under all conditions of operating. As specified in section 15.215 c), the bandwidth of the fundamental must be contained within the frequency band over the temperature range -20 to +50 degrees Celsius with an imput voltage variation of 85 % to 115 % of rated input voltage. Frequency stability is to be measured according to section 2.1055 at the highest and lowest frequency of operation and with the modulation that produces the widest emission bandwidth.
Measurement procedure:	Bandwidth Measurements (6.1)

Comment:	Test was performed for FMR20+R8, only. See pots for details
Date of test:	2018-09-27
Test site:	Fully anechoic room, cabin no. 2

Test Result:	Test passed

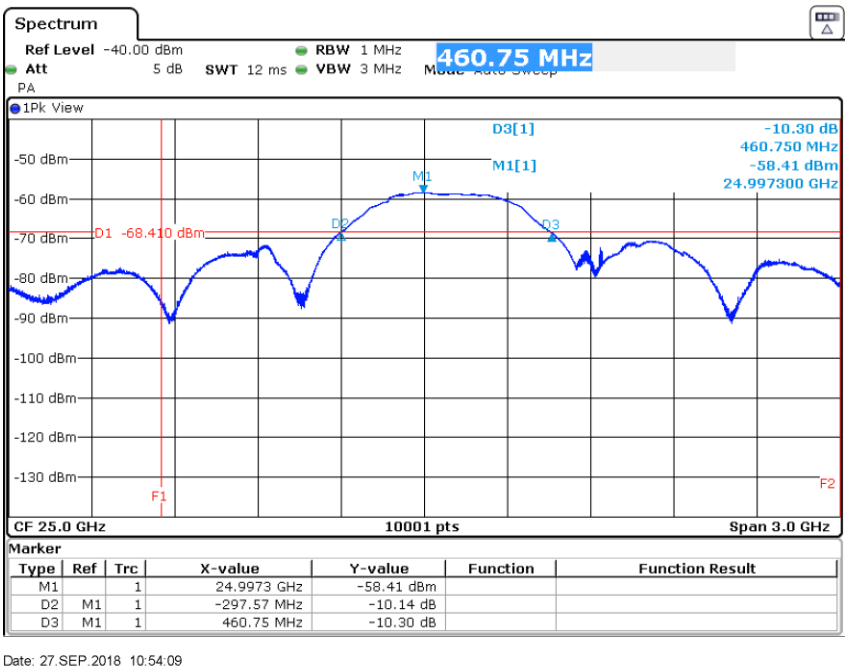
Test plot for -20 °C, 24 V



Date: 27.SEP.2018 10:33:34

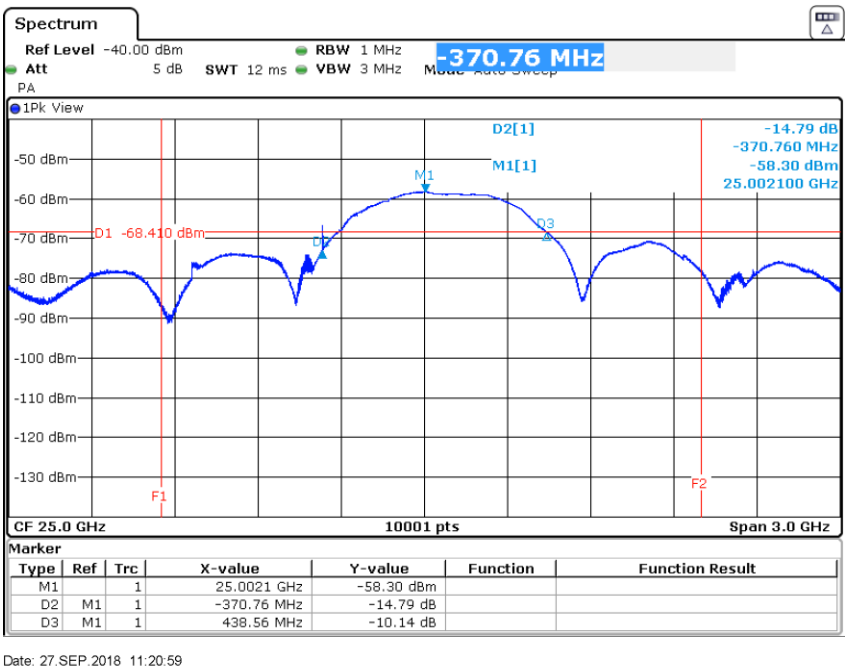
Lower -10 dBc frequency:	**24.70603 GHz**
Upper -10 dBc frequency:	**25.46585 GHz**
Frequency band	**24.05 GHz – 29 GHz**

Test plot for -10 °C, 24 V



Lower -10 dBc frequency:	**24.69973 GHz**
Upper -10 dBc frequency:	**25.45805 GHz**
Frequency band	**24.05 GHz – 29 GHz**

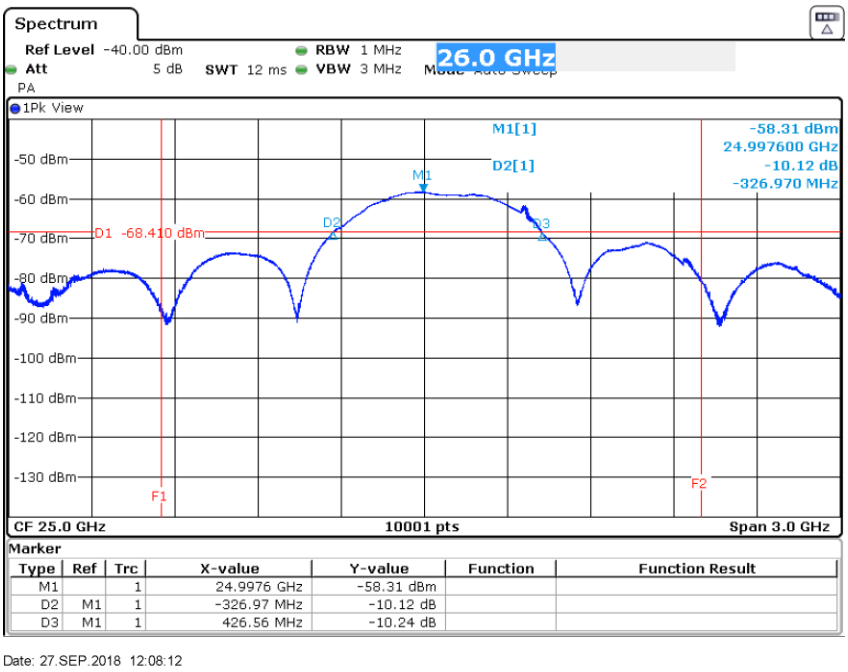
Test plot for 0 °C, 24 V



Date: 27.SEP.2018 11:20:59

Lower -10 dBc frequency:	**24.63134 GHz**
Upper -10 dBc frequency:	**25.44066 GHz**
Frequency band	**24.05 GHz – 29 GHz**

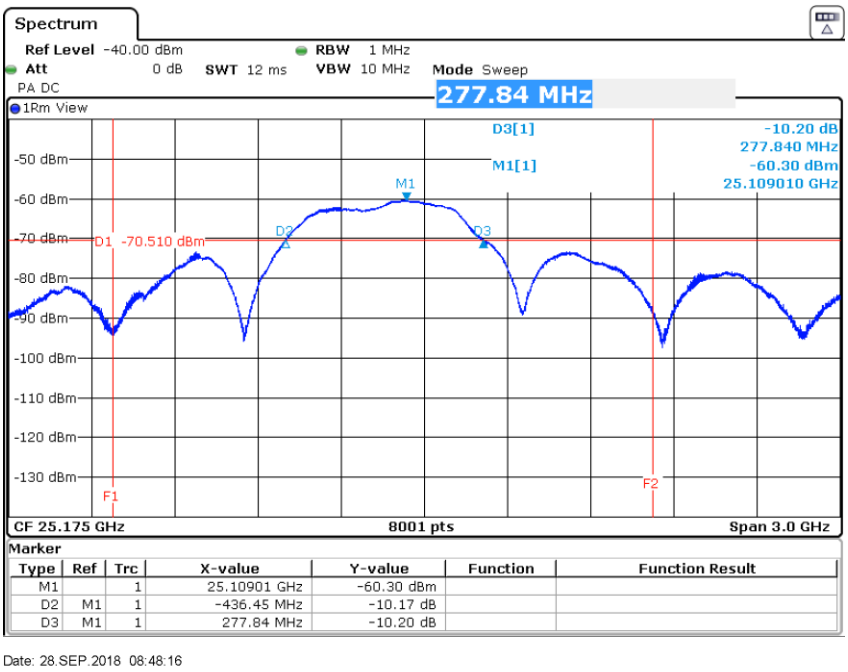
Test plot for +10 °C, 24 V



Date: 27.SEP.2018 12:08:12

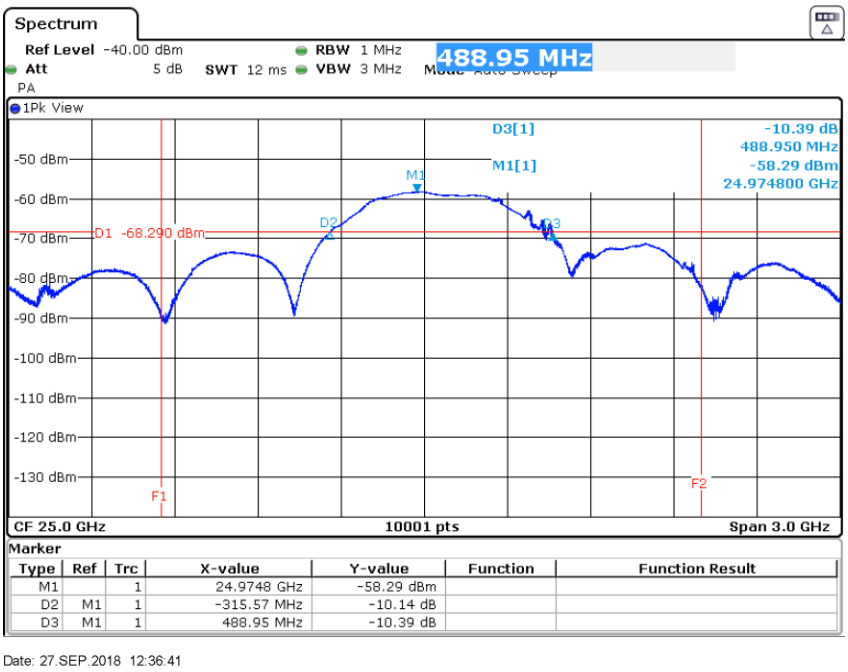
Lower -10 dBc frequency:	**24.67063 GHz**
Upper -10 dBc frequency:	**25.42416 GHz**
Frequency band	**24.05 GHz – 29 GHz**

Test plot for +20 °C, 20.4 V



Lower -10 dBc frequency:	**24.67256 GHz**
Upper -10 dBc frequency:	**25.38685 GHz**
Frequency band	**24.05 GHz – 29 GHz**

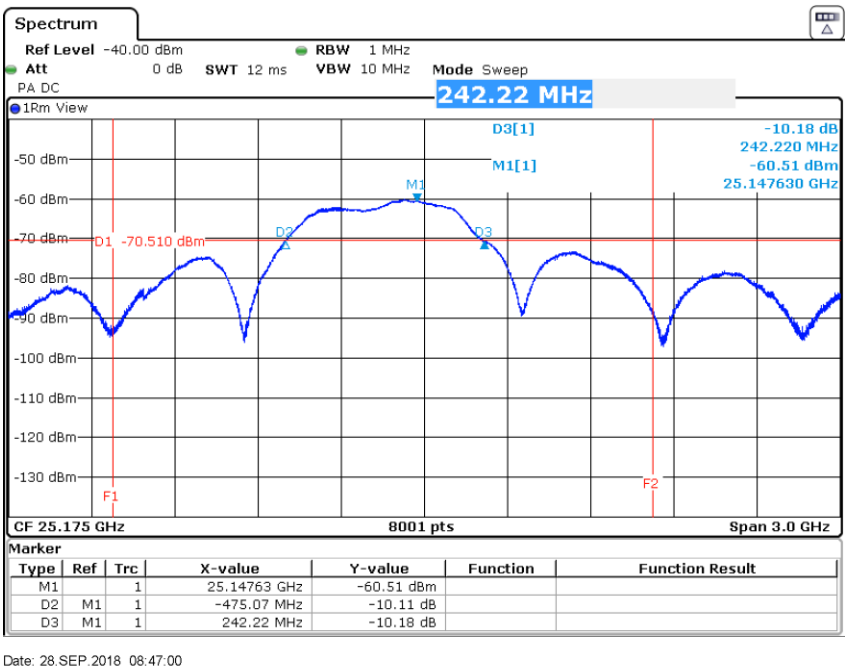
Test plot for +20 °C, 24 V



Date: 27.SEP.2018 12:36:41

Lower -10 dBc frequency:	**24.65923 GHz**
Upper -10 dBc frequency:	**25.46375 GHz**
Frequency band	**24.05 GHz – 29 GHz**

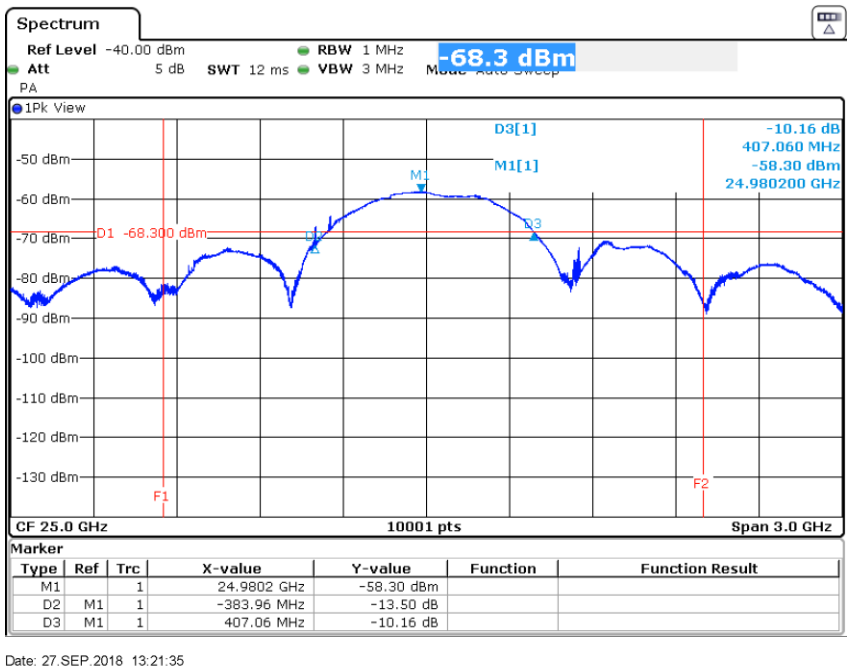
Test plot for +20 °C, 27.6 V



Date: 28.SEP.2018 08:47:00

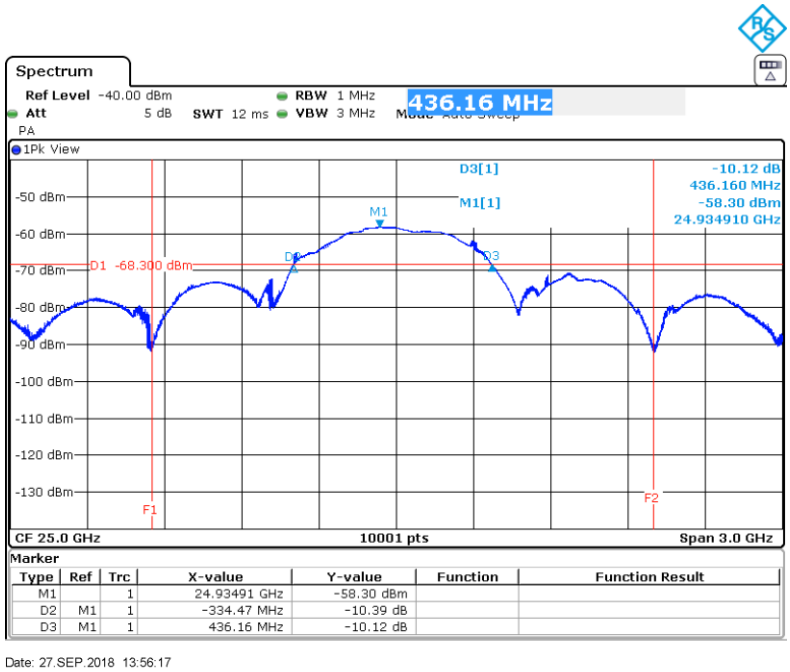
Lower -10 dBc frequency:	**24.67256 GHz**
Upper -10 dBc frequency:	**25.38985 GHz**
Frequency band	**24.05 GHz – 29 GHz**

Test plot for +30 °C, 24 V



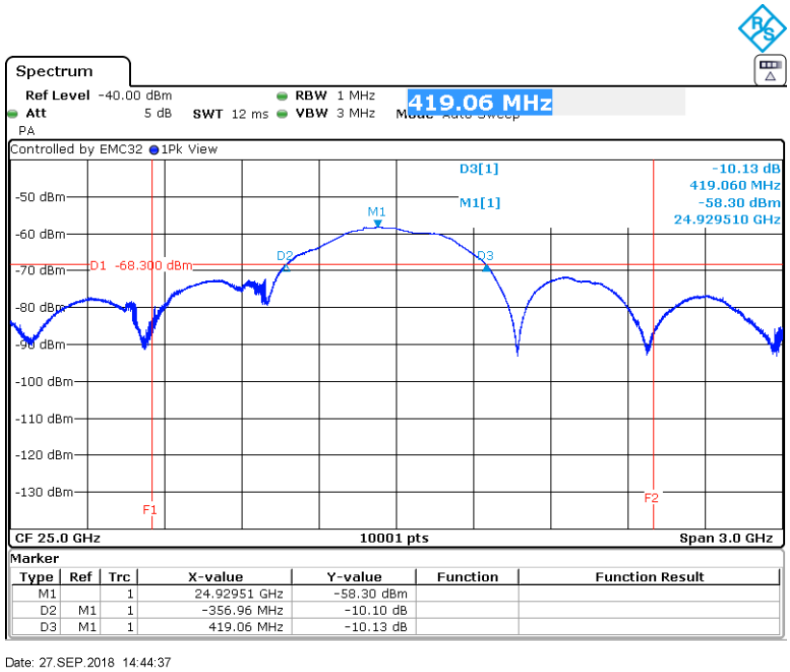
Lower -10 dBc frequency:	**24.59624 GHz**
Upper -10 dBc frequency:	**25.38726 GHz**
Frequency band	**24.05 GHz – 29 GHz**

Test plot for +40 °C, 24 V



Lower -10 dBc frequency:	**24.60044 GHz**
Upper -10 dBc frequency:	**25.37107 GHz**
Frequency band	**24.05 GHz – 29 GHz**

Test plot for +50 °C, 24 V



Lower -10 dBc frequency:	**24.57255 GHz**
Upper -10 dBc frequency:	**25.34857 GHz**
Frequency band	**24.05 GHz – 29 GHz**

8.4 Fundamental Emissions EIRP

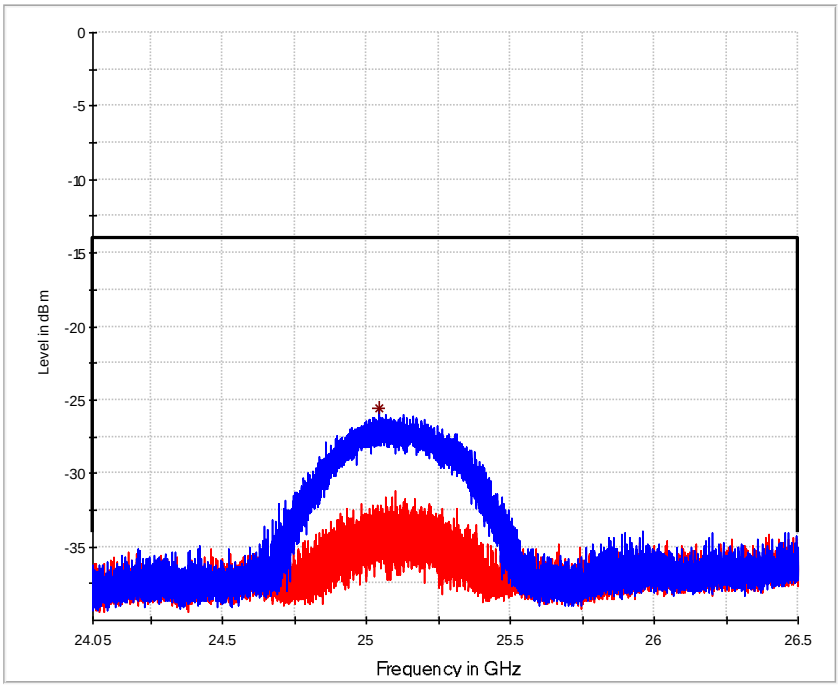
Rules and specifications:	CFR 47 Part 2, section 15.256(g)		
Guide:	KDB 890966 D01 V01 R01, section F		
Limit:	*Frequency band of operation (GHz)*	*Average emission limit (EIRP in dBm measured in 1 MHz)*	*Peak emission limit (EIRP in dBm measured in 50 MHz)*
	5.925 – 7.250	-33	7
	24.05 – 29.00	-14	26
	75 – 85	-3	34
Description:	The EIRP in 1 MHz is computed from the maximum power level measured within any 1 MHz bandwidth using a power averaging detector. The EIRP in 50 MHz is computed from the maximum power level in a 50 MHz bandwidth centered on the frequency at which the maximum average power level is realized and this 50 MHz bandwidth must be contained within the authorized operating bandwidth. The emission limits re based on boresight measurements (i.e. measurements performed within the main beam of the antenna).		
Measurement procedure:	Bandwidth Measurements (6.1)		

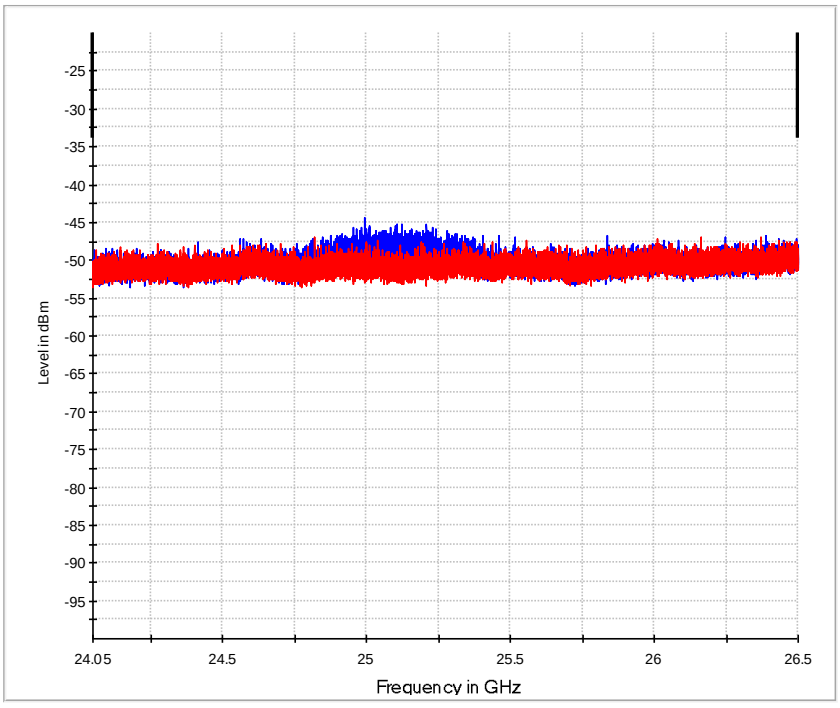
Comment:	See pots for details. The RBW of peak measurement was 10 MHz
Date of test:	2018-09-18
Test site:	Fully anechoic room, cabin no. 2

EUT	*Peak Emission (dBm)*	*Peak Limit(dBm)*	*Average emission (dBm)*	*Average limit (dBm)*
FMR10+R7	-11.6	26.0	-44.4	-14.0
FMR20+R7	-10.1	26.0	-43.9	-14.0

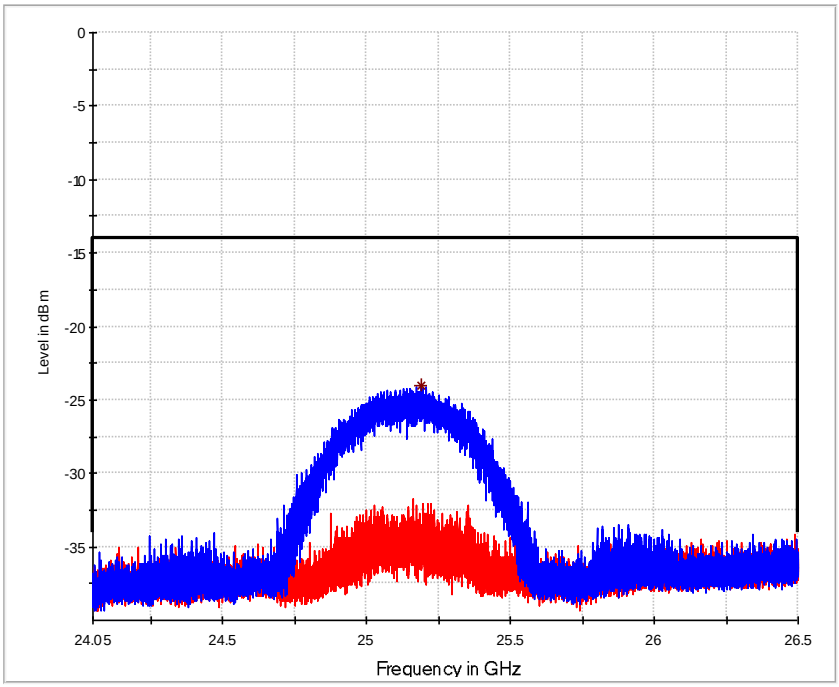
Test Result:	Test passed

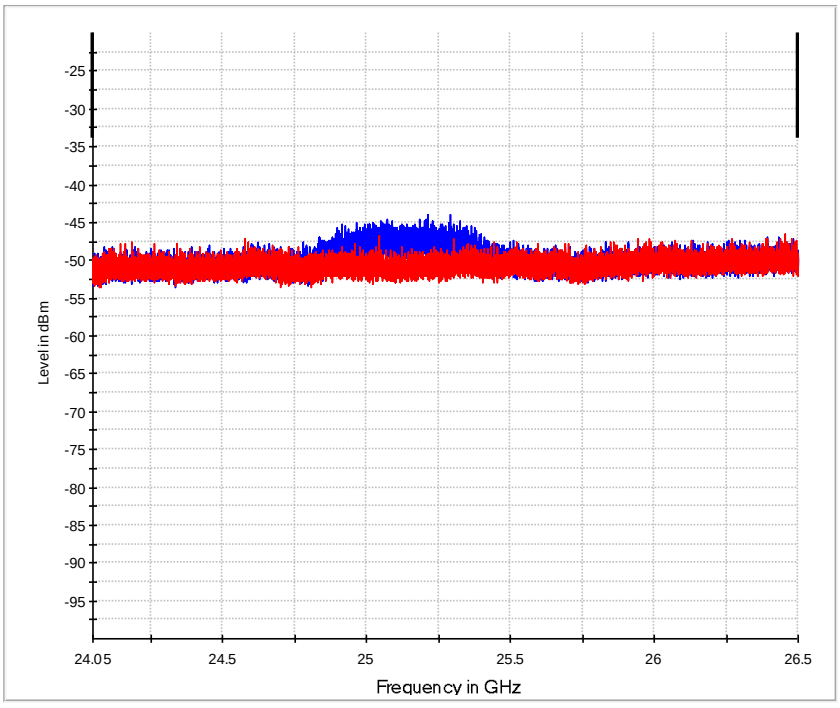
Plot for EUT FMR10+R7





Plot for EUT FMR20+R8





Fundamental Emissions (continued)

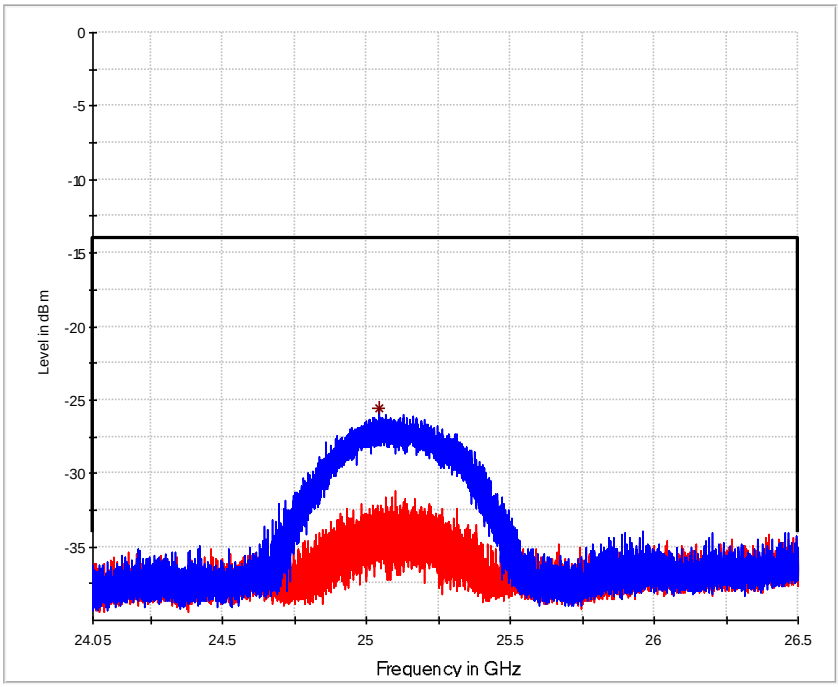
Rules and specifications:	RSS-211, section 5.2 (b)		
Guide:	ETSI EN 302 729		
Limit:	*Frequency band of operation (GHz)*	*Average emission limit (EIRP in dBm measured in 1 MHz)*	*Peak emission limit (EIRP in dBm measured in 50 MHz)*
	5.65 – 8.50	-33	7
	24.05 – 29.00	-14	26
	75 – 85	-3	34
Description:	The EIRP in 1 MHz is computed from the maximum power level measured within any 1 MHz bandwidth using a power averaging detector. The EIRP in 50 MHz is computed from the maximum power level in a 50 MHz bandwidth centered on the frequency at which the maximum average power level is realized and this 50 MHz bandwidth must be contained within the authorized operating bandwidth. The emission limits re based on boresight measurements (i.e. measurements performed within the main beam of the antenna).		
Measurement procedure:	Bandwidth Measurements (6.1)		

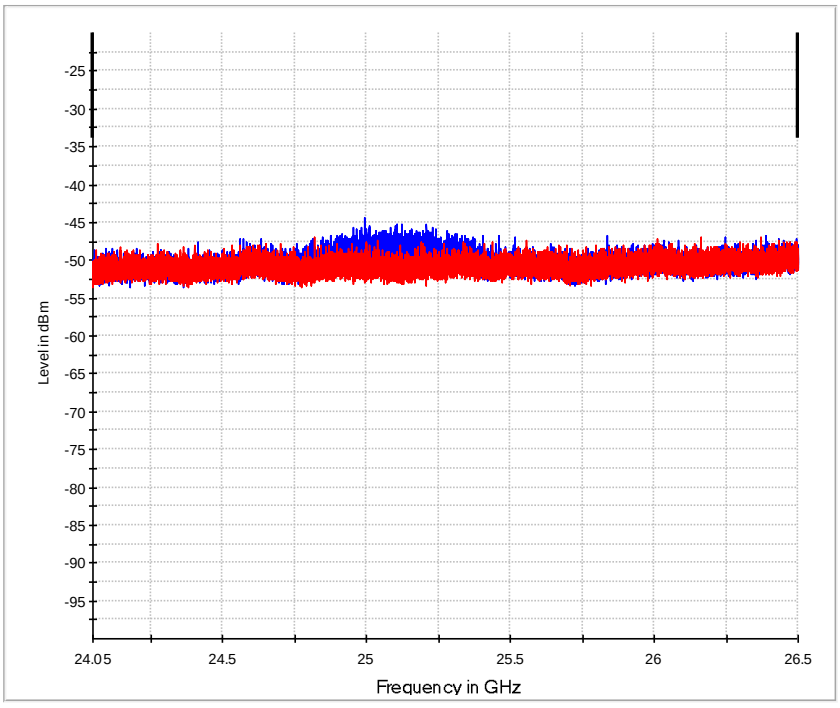
Comment:	See pots for details
Date of test:	2018-09-18
Test site:	Fully anechoic room, cabin no. 2

EUT	*Peak Emission (dBm)*	*Peak Limit(dBm)*	*Average emission (dBm)*	*Average limit (dBm)*
FMR10+R7	-11.6	26.0	-44.4	-14.0
FMR20+R7	-10.1	26.0	-43.9	-14.0

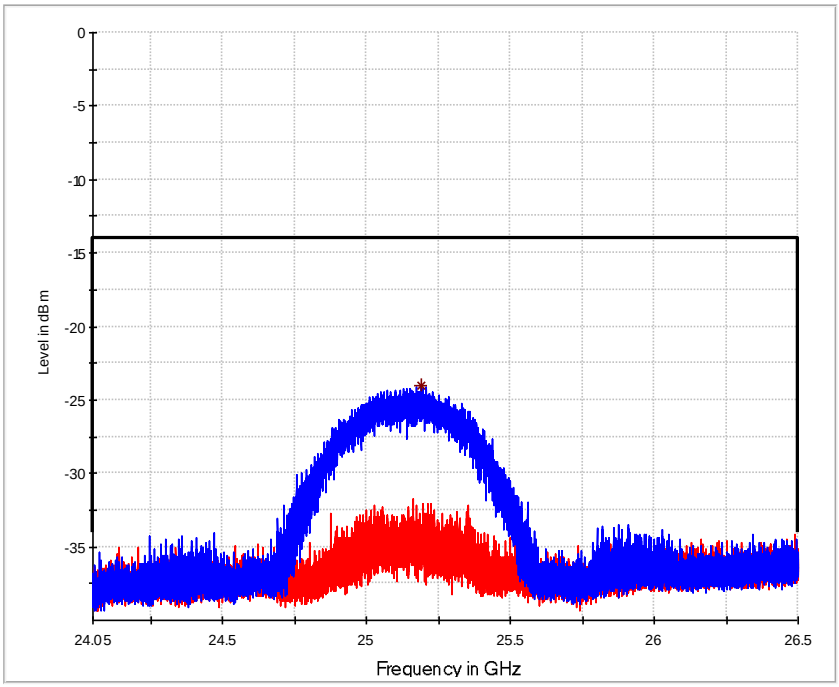
Test Result:	Test passed

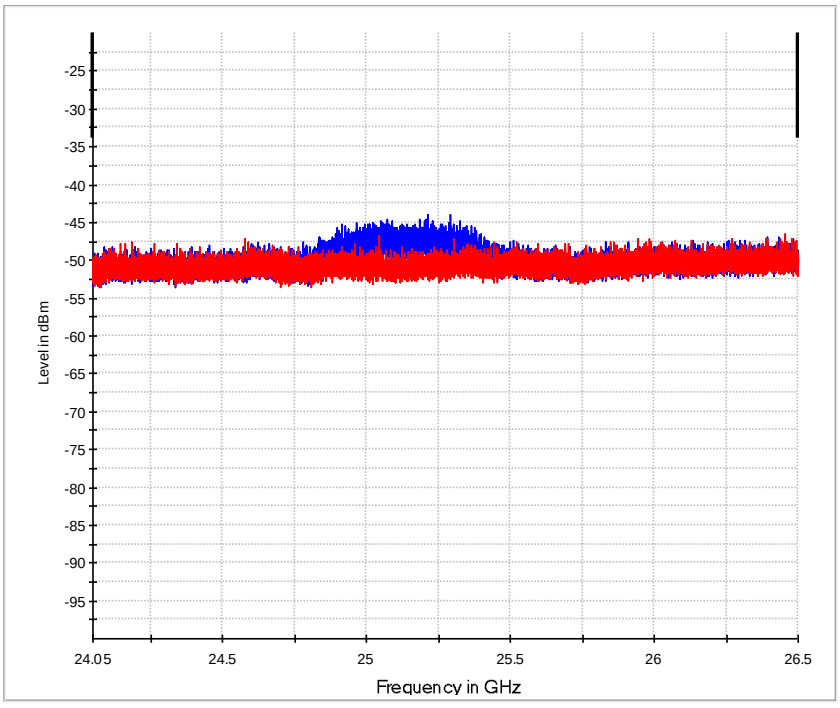
Plot for EUT FMR10+R7





Plot for EUT FMR20+R8





8.5 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

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

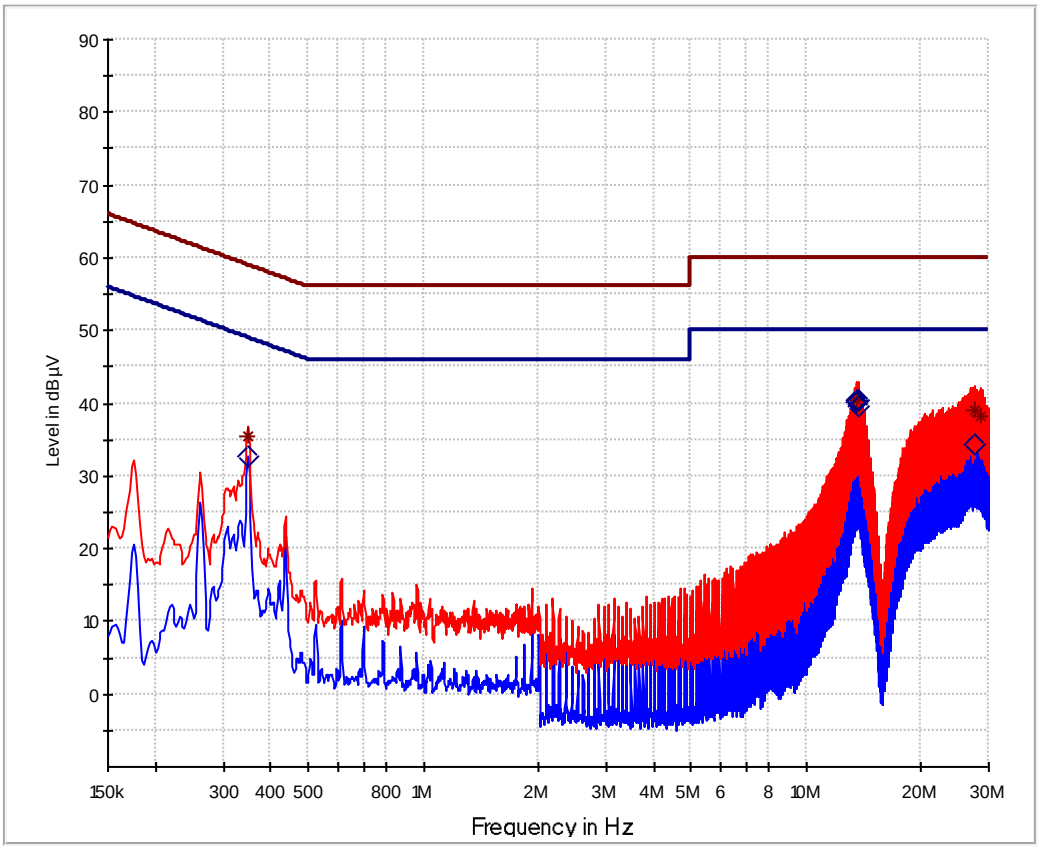
Comment:	The test was performed with the FMR20+R8, only
Date of test:	2018-09-26
Test site:	Shielded room, cabin no. 9

Test Result:	Test passed

Sample calculation of final values:

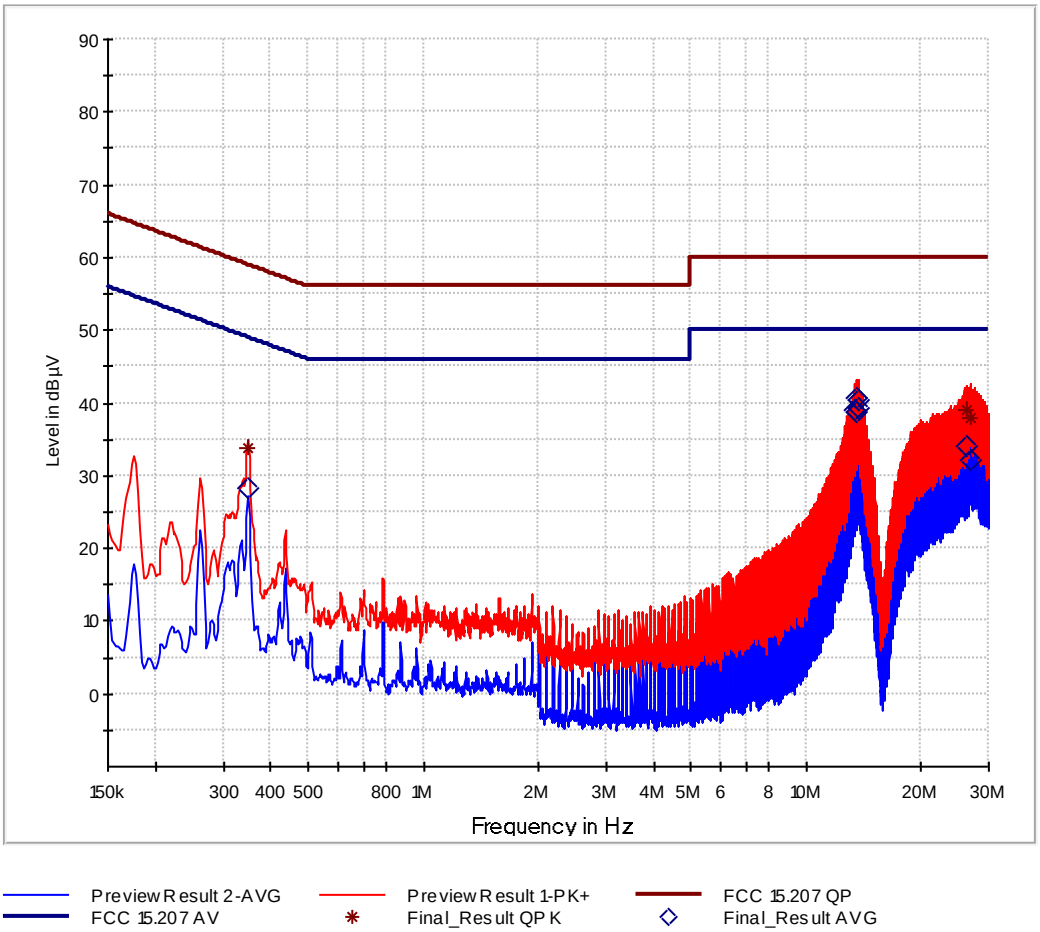
Final Value (dBµV) = Reading Value (dBµV) + Correction Factor (dB)

Tested on:	L1



Frequency MHz	*QuasiPeak dBµV*	*Average dBµV*	*Limit dBµV*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Corr. dB*
0.350250		32.7	49.0	16.2	1000	9	0.0
0.350250	35.6		59.0	23.4	1000	9	0.0
13.528500		40.4	50.0	9.6	1000	9	0.2
13.616250		40.1	50.0	9.9	1000	9	0.2
13.618500	40.3		60.0	19.7	1000	9	0.2
13.704000		39.5	50.0	10.5	1000	9	0.3
13.789500		40.3	50.0	9.7	1000	9	0.3
27.476250	39.0		60.0	21.0	1000	9	0.4
27.649500		34.5	50.0	15.5	1000	9	0.4
28.524750	38.2		60.0	21.8	1000	9	0.4

Tested on:	N



Frequency MHz	*QuasiPeak dBµV*	*Average dBµV*	*Limit dBµV*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Corr. dB*
0.350250		28.4	49.0	20.6	1000	9	0.0
0.350250	33.8		59.0	25.2	1000	9	0.0
13.445250		39.0	50.0	11.0	1000	9	0.2
13.533000		38.8	50.0	11.2	1000	9	0.2
13.618500		40.7	50.0	9.3	1000	9	0.2
13.706250		40.3	50.0	9.7	1000	9	0.3
13.794000		39.3	50.0	10.7	1000	9	0.3
26.171250	39.0		60.0	21.0	1000	9	0.3
26.189250		34.1	50.0	15.9	1000	9	0.3
27.048750	37.8		60.0	22.2	1000	9	0.4
27.064500		32.2	50.0	17.8	1000	9	0.4

8.6 Radiated Emission Measurement 9 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, sections 15.205 and 15.209 IC RSS-GEN Issue 4, sections 8.9 and 8.10			
Guide:	ANSI C63.10			
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:	2018-09-25
Test site:	Open field test site

Test Result:	Test passed

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.

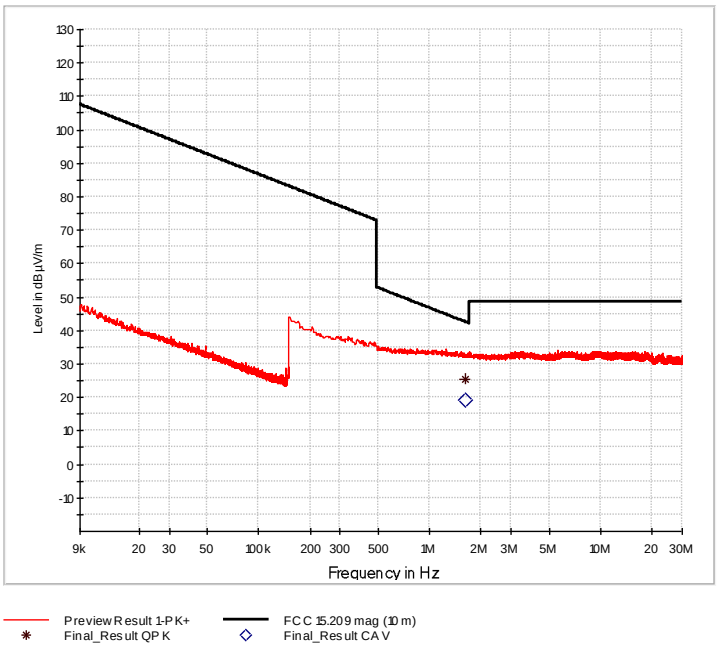
TÜV SÜD Product Service GmbH
Äußere Frühlingstraße 45
94315 Straubing
Germany

Phone: +49 9421 5522-0
Fax: +49 9421 5522-99
Web: www.tuev-sued.de

Plots for EUT FMR10 +R7

Extrapolation factor: -40 dB/decade

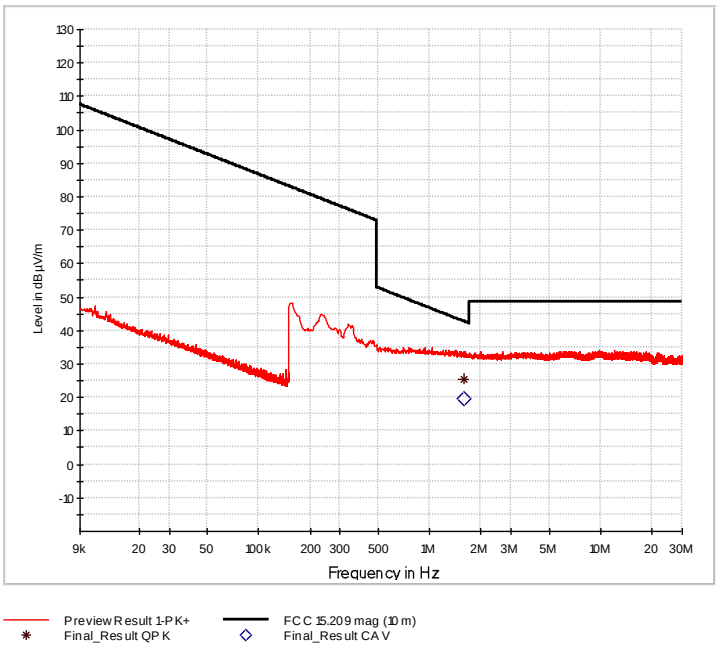
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
1.61925	Quasi-Peak	10	30	5.3	20.0	-19.1		6.2	23.4	**17.2**



Plots for EUT FMR20 +R8

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)
1.59675	Quasi-Peak	10	30	5.4	20.0	-19.1		6.3	23.5	**17.3**



8.7 Radiated Emission Measurement 30 MHz to 100 GHz

Rules and specifications:	CFR 47 Part 15, section 15.209 IC RSS-GEN Issue 4, section 8.9		
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:	2018-03-27 to 2018-04-23
Test site:	Semi-anechoic room, cabin no. 8
Test distance:	Frequencies ≤ 8.2 GHz: 3 m Frequencies > 8.2 GHz, ≤ 18 GHz: 1 m Frequencies > 18 GHz, ≤ 60 GHz: 0.5 m Frequencies > 60 GHz, ≤ 90 GHz: 0.25 m Frequencies > 90 GHz: 0.1 m

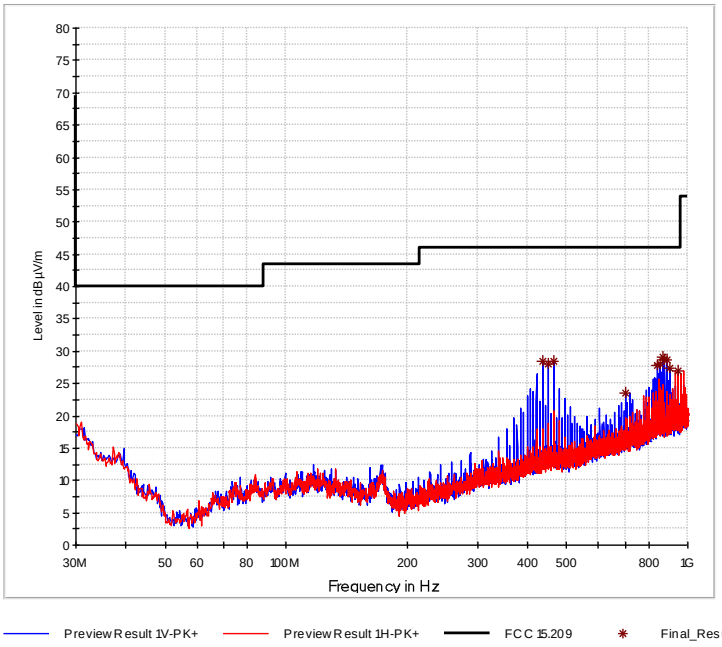
Test Result:	Test passed

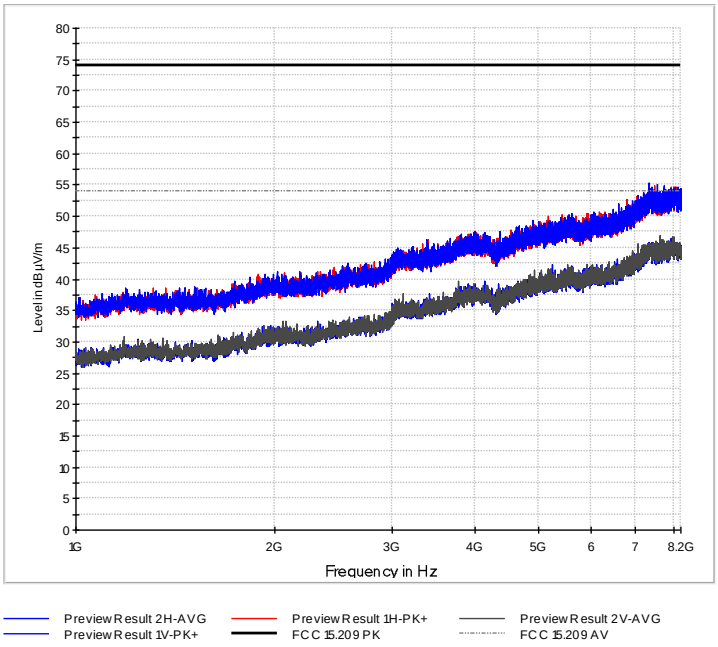
Sample calculation of final values:

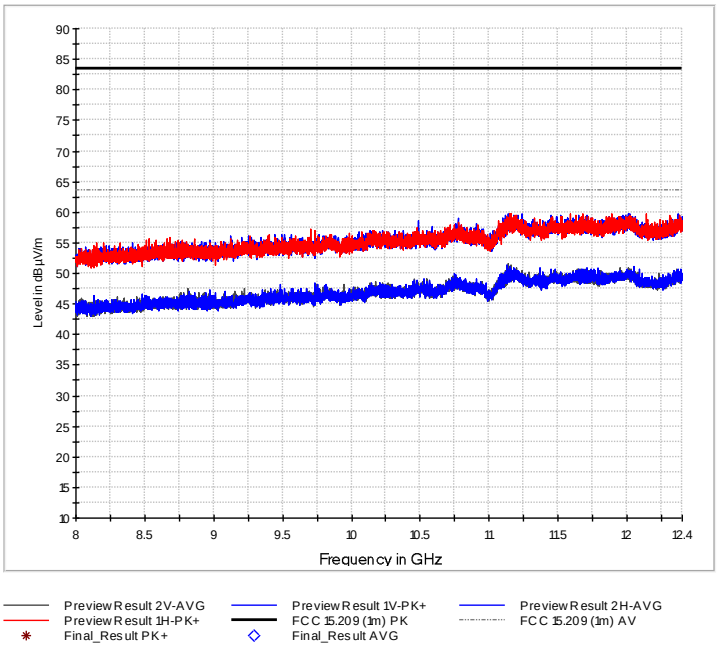
Final Value (dBµV/m) = Reading Value (dBµV) + Correction Factor (dB/m) + Pulse Train Correction (dB)

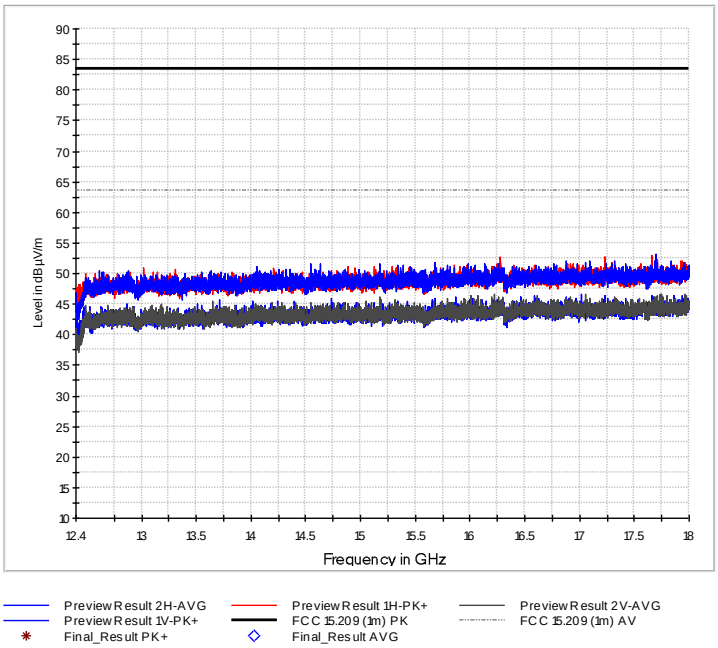
Plots for EUT No. FMR10+R7

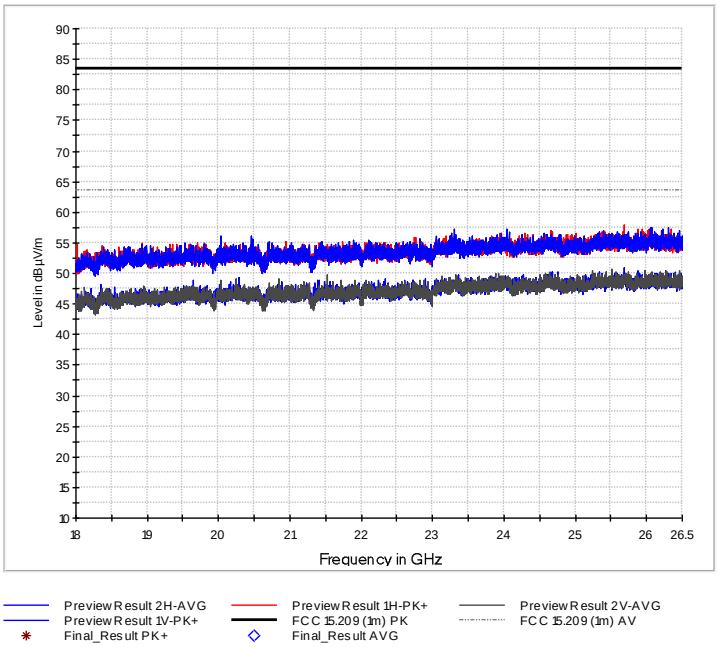
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
435.072	vertical	Peak	44.1	-15.5		28.6	46.0	17.4
449.816	vertical	Peak	43.1	-15.1		28.1	46.0	17.9
464.490	vertical	Quasi-Peak	12.3	18.6		30.9	46.0	15.1
464.560	vertical	Peak	43.4	-14.9		28.5	46.0	17.5
700.464	vertical	Peak	35.1	-11.5		23.6	46.0	22.4
840.532	vertical	Peak	37.9	-10.0		27.9	46.0	18.1
855.276	vertical	Peak	37.8	-9.7		28.1	46.0	17.9
870.020	vertical	Peak	38.7	-9.7		29.0	46.0	17.0
877.392	vertical	Peak	38.2	-9.6		28.6	46.0	17.4
884.764	vertical	Peak	38.2	-9.6		28.7	46.0	17.3
892.140	vertical	Quasi-Peak	5.7	25.3		31.0	46.0	**15.1**
899.508	vertical	Peak	36.8	-9.5		27.3	46.0	18.7
943.934	horizontal	Peak	35.8	-8.8		26.9	46.0	19.1

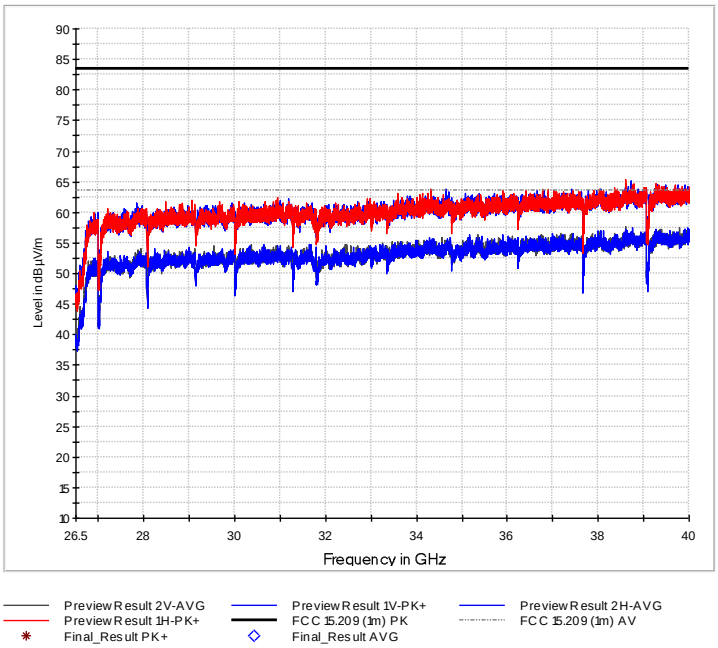

Level in dBµV/m
Frequency in Hz
30M
50
60
80
100M
200
300
400
500
800
1G
Preview Result 1V-PK+
Preview Result 1H-PK+
FCC 15.209
Final_Result PH

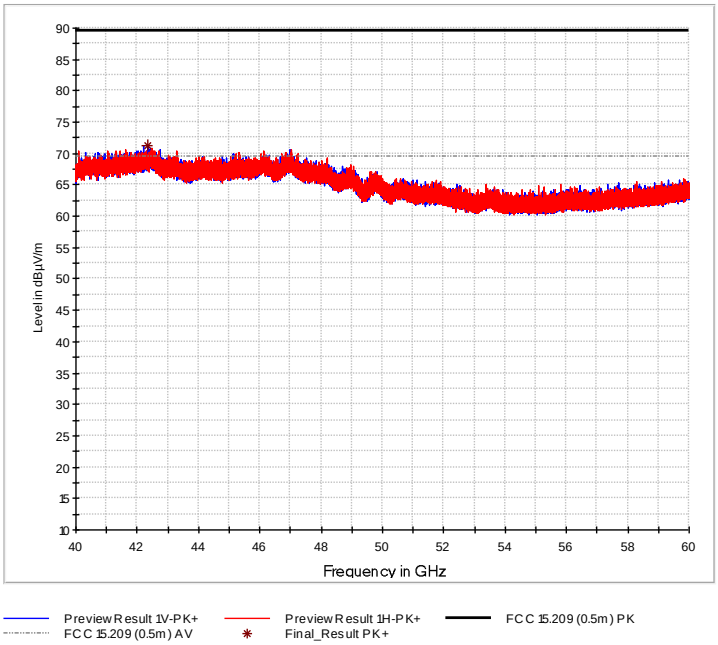

Level in dBµV/m
Frequency in Hz
1G
2G
3G
4G
5G
6
7
8.2G
Preview Result 2H-AVG
Preview Result 1V-PK+
Preview Result 1H-PK+
FCC 15.209 PK
Preview Result 2V-AVG
FCC 15.209 AV

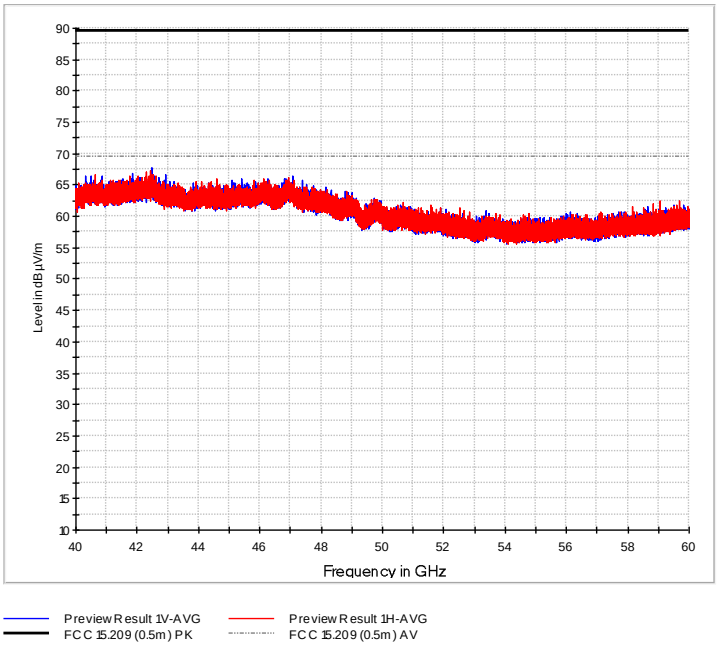

Level in dBµV/m
Frequency in GHz
Preview Result 2V-AVG
Preview Result 1H-PK+
Final_Result PK+
Preview Result 1V-PK+
FCC 15.209 (1m) PK
Final_Result AVG
Preview Result 2H-AVG
FCC 15.209 (1m) AV

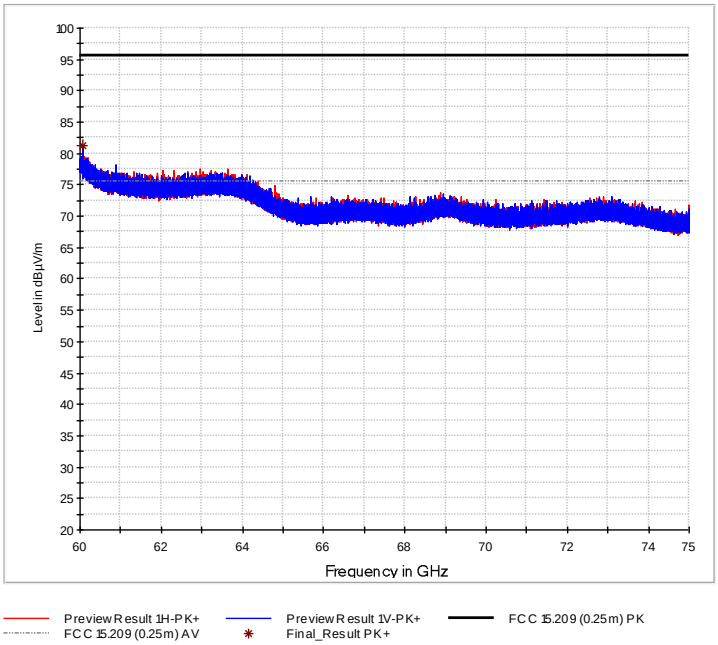

Level in dBµV/m
Frequency in GHz
Preview Result 2H-AVG
Preview Result 1V-PK+
Final_Result PK+
Preview Result 1H-PK+
FCC 15.209 (1m) PK
Final_Result AVG
Preview Result 2V-AVG
FCC 15.209 (1m) AV

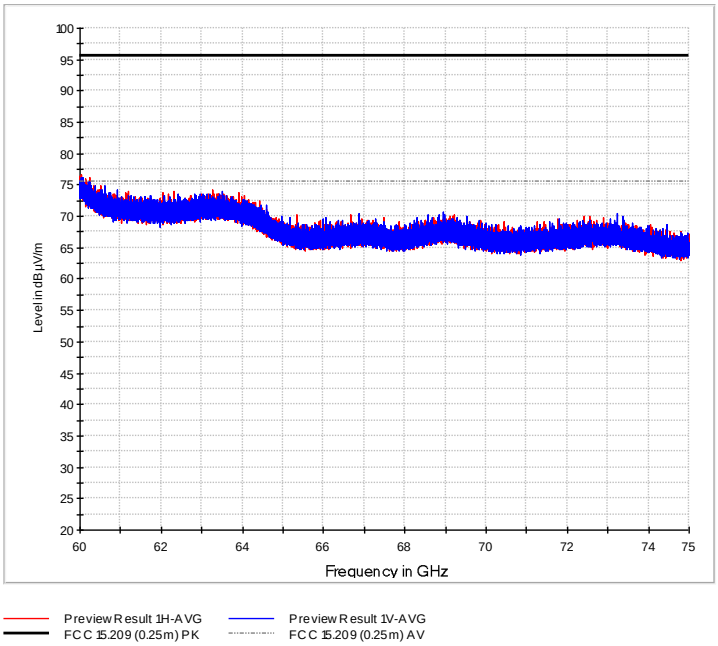

Level in dBµV/m
Frequency in GHz
Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.209 (1m) PK
FCC 15.209 (1m) AV
Final_Result PK+
Final_Result AVG

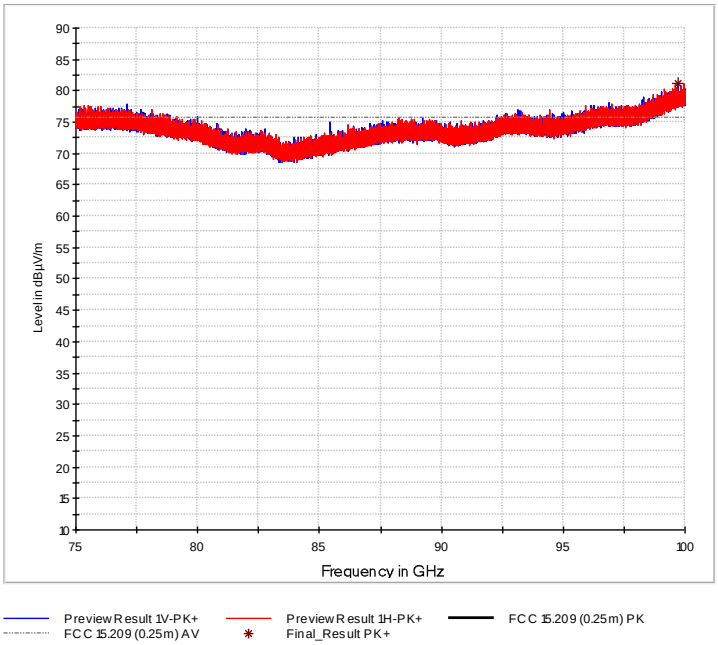

Level in dBµV/m
Frequency in GHz
Preview Result 2V-AVG
Preview Result 1V-PK+
Preview Result 2H-AVG
Preview Result 1H-PK+
FCC 15.209 (1m) PK
FCC 15.209 (1m) AV
Final_Result PK+
Final_Result AVG

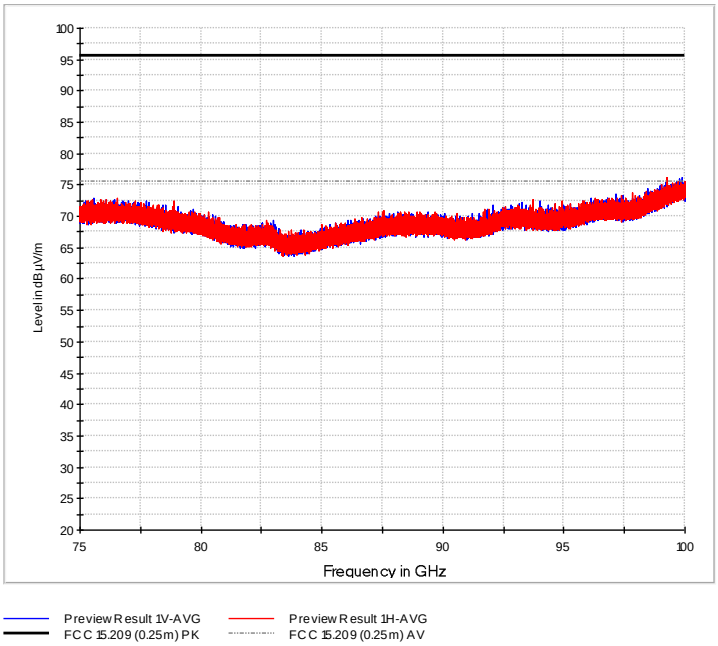

Level in dBµV/m
Frequency in GHz
Preview Result 1V-PK+
FCC 15.209 (0.5m) AV
Preview Result 1H-PK+
Final_Result PK+
FCC 15.209 (0.5m) PK


Level in dBµV/m
Frequency in GHz
Preview Result 1V-AVG
FCC 15.209 (0.5m) PK
Preview Result 1H-AVG
FCC 15.209 (0.5m) AV


Level in dBµV/m
Frequency in GHz
Preview Result 1H-PK+
FCC 15.209 (0.25m) AV
Preview Result 1V-PK+
Final_Result PK+
FCC 15.209 (0.25m) PK

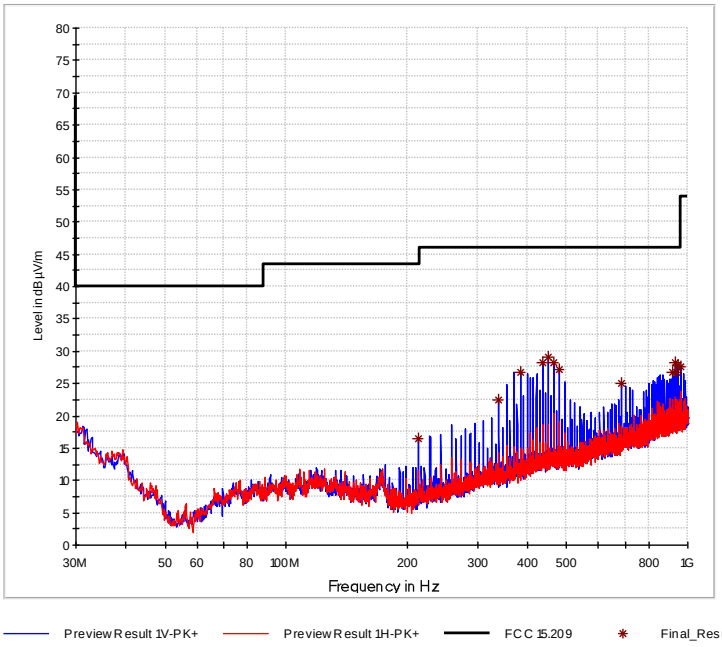

Level in dBµV/m
Frequency in GHz
Preview Result 1H-AVG
FCC 15.209 (0.25m) PK
Preview Result 1V-AVG
FCC 15.209 (0.25m) AV


Level in dBµV/m
Frequency in GHz
Preview Result 1V-PK+
FCC 15.209 (0.25m) AV
Preview Result 1H-PK+
Final_Result PK+
FCC 15.209 (0.25m) PK

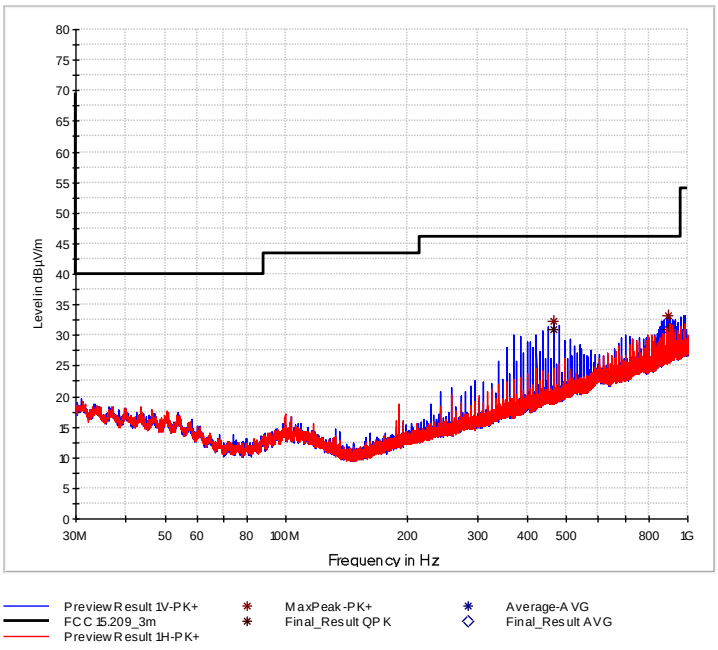

Level in dBµV/m
Frequency in GHz
Preview Result 1V-AVG
FCC 15.209 (0.25m) PK
Preview Result 1H-AVG
FCC 15.209 (0.25m) AV

Plots for EUT No. FMR20+R8

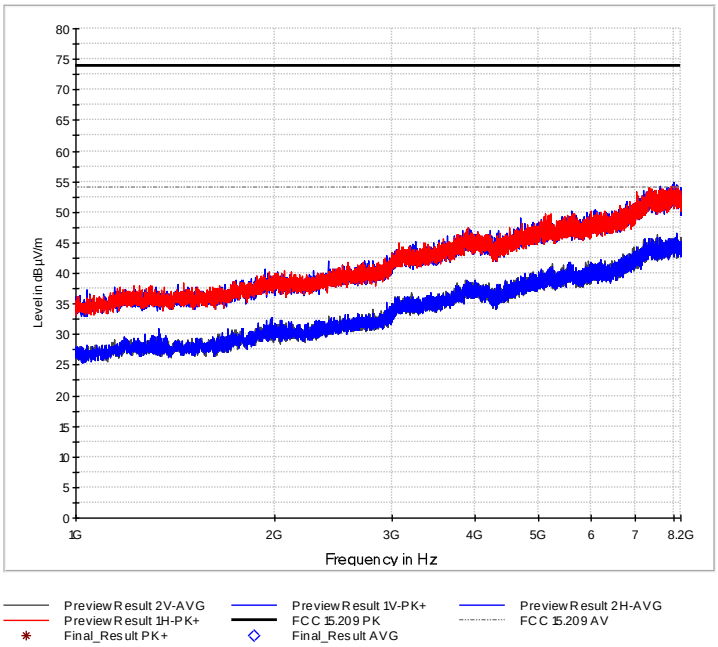
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
213.912	vertical	Peak	36.9	-20.4		16.5	43.5	27.0
339.236	vertical	Peak	39.9	-17.4		22.5	46.0	23.5
383.468	vertical	Peak	43.4	-16.7		26.8	46.0	19.2
435.072	vertical	Peak	43.9	-15.5		28.3	46.0	17.7
449.622	vertical	Peak	44.2	-15.1		29.1	46.0	16.9
464.490	vertical	Quasi-Peak	12.3	18.6		30.9	46.0	15.1
464.560	vertical	Peak	43.2	-14.9		28.3	46.0	17.7
479.304	vertical	Peak	42.2	-15.0		27.2	46.0	18.8
685.720	vertical	Peak	36.9	-12.0		24.9	46.0	21.1
892.140	vertical	Quasi-Peak	5.7	25.3		31.0	46.0	**15.1**
914.446	vertical	Peak	35.9	-9.2		26.7	46.0	19.3
928.996	vertical	Peak	37.2	-9.1		28.2	46.0	17.8
936.368	vertical	Peak	35.7	-9.0		26.7	46.0	19.3
943.934	vertical	Peak	36.7	-8.8		27.8	46.0	18.2
958.678	vertical	Peak	36.3	-8.7		27.6	46.0	18.4



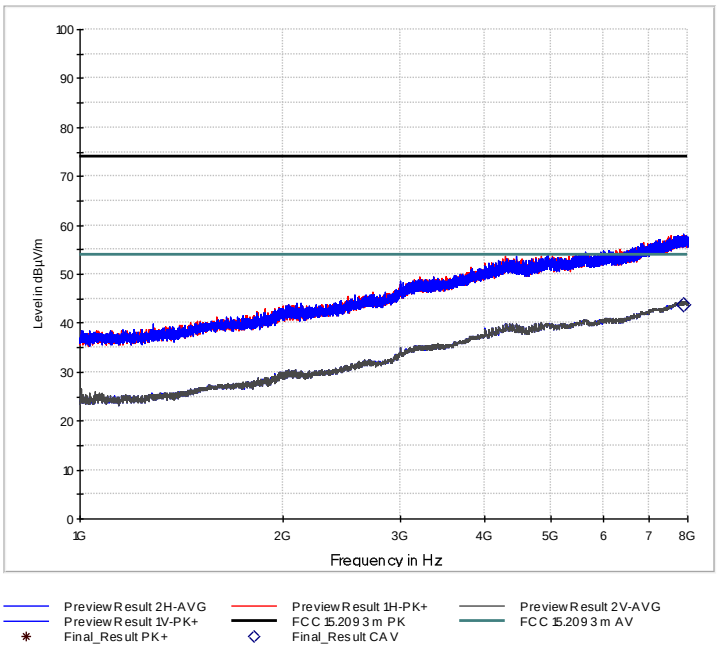
Prescan 30 MHz – 1 GHz



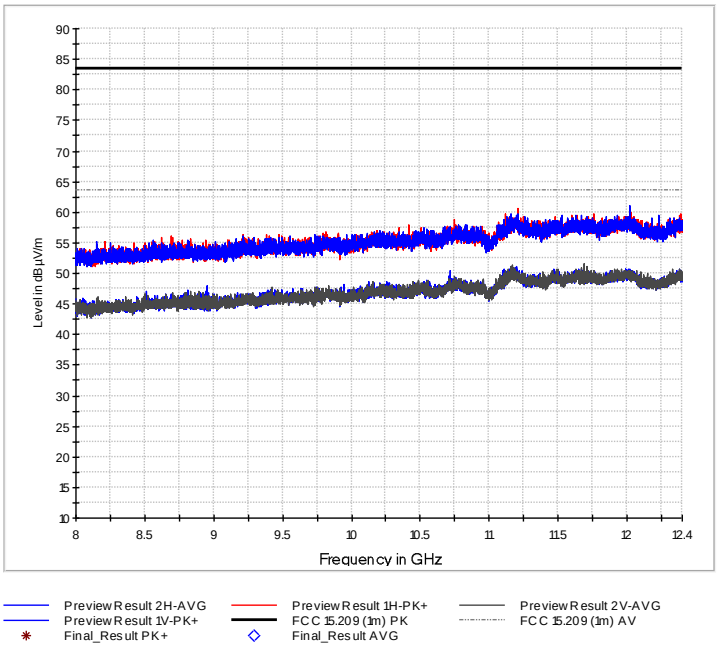
Final test 30 MHz – 1 GHz

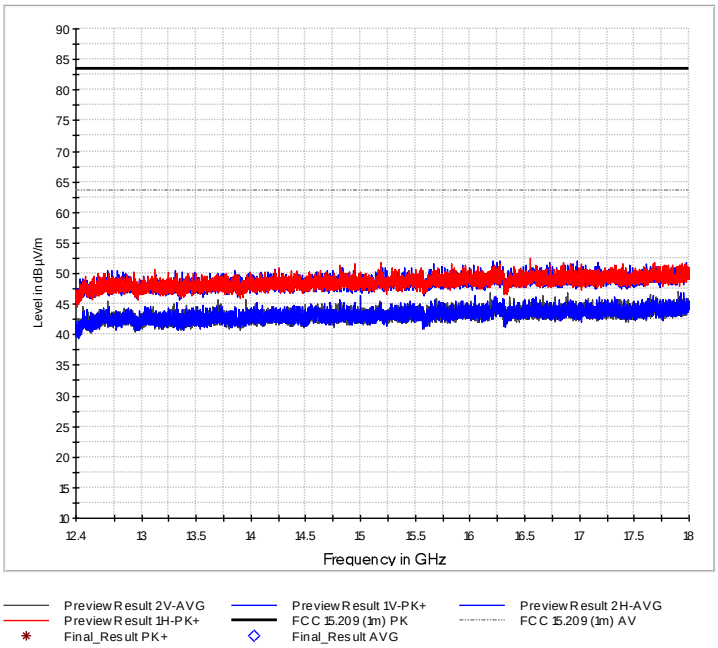


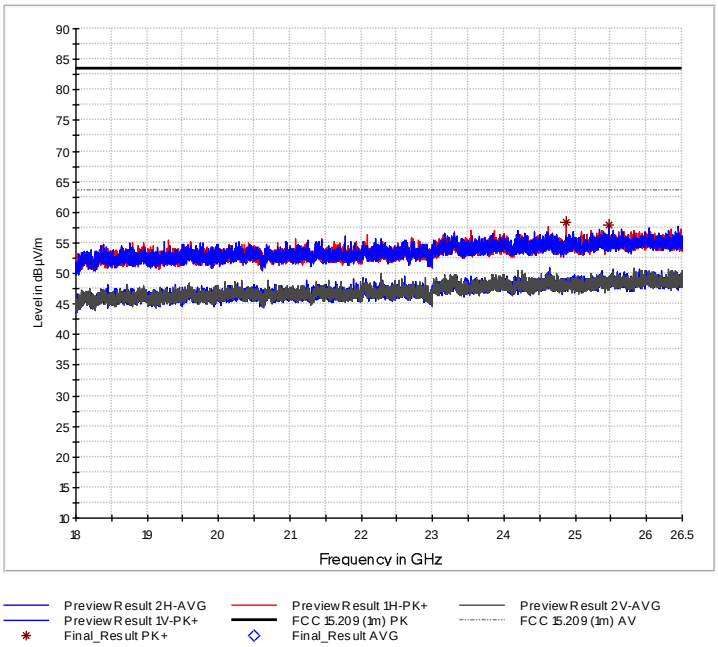
Prescan 1 GHz – 8 GHz

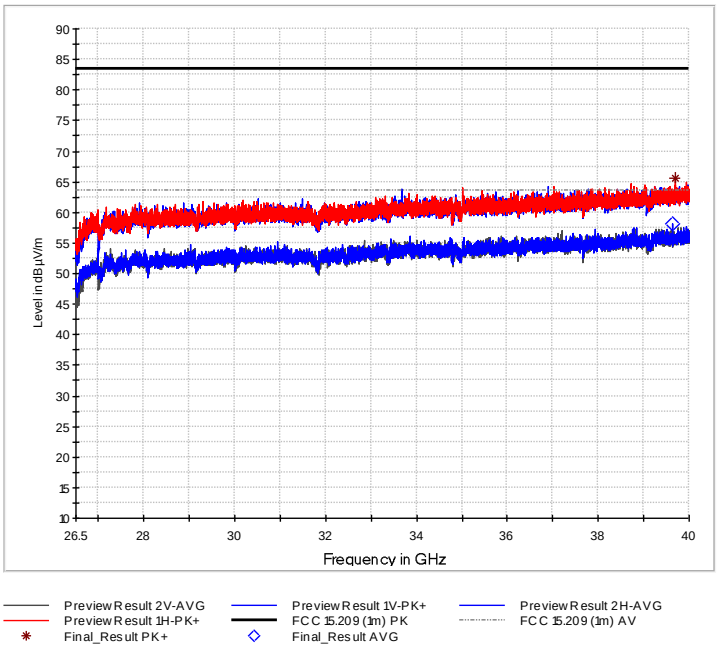


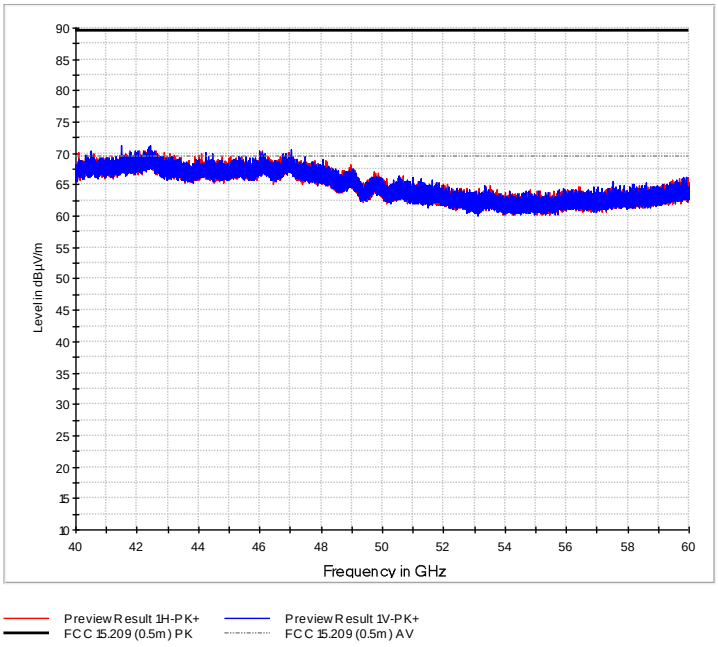
Final test 1 GHz – 8 GHz

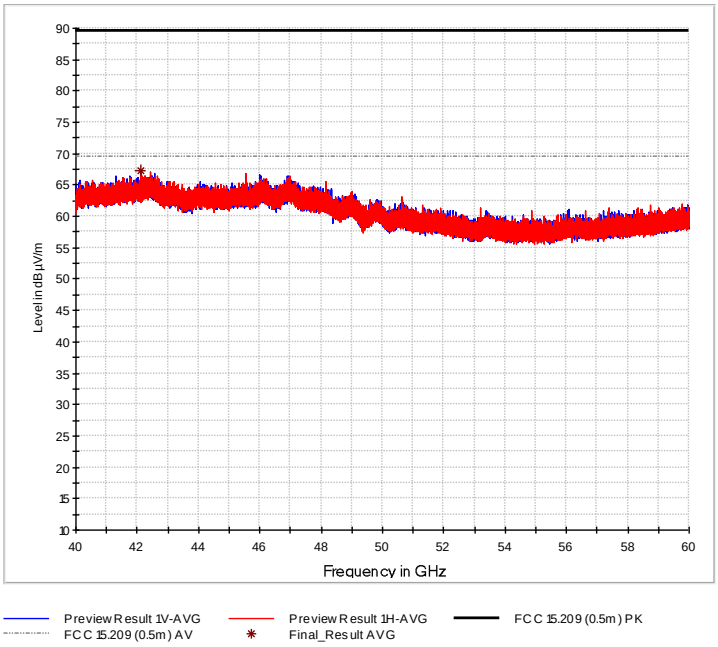

Level in dBµV/m
Frequency in GHz
Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.209 (1m) PK
FCC 15.209 (1m) AV
Final_Result PK+
Final_Result AVG

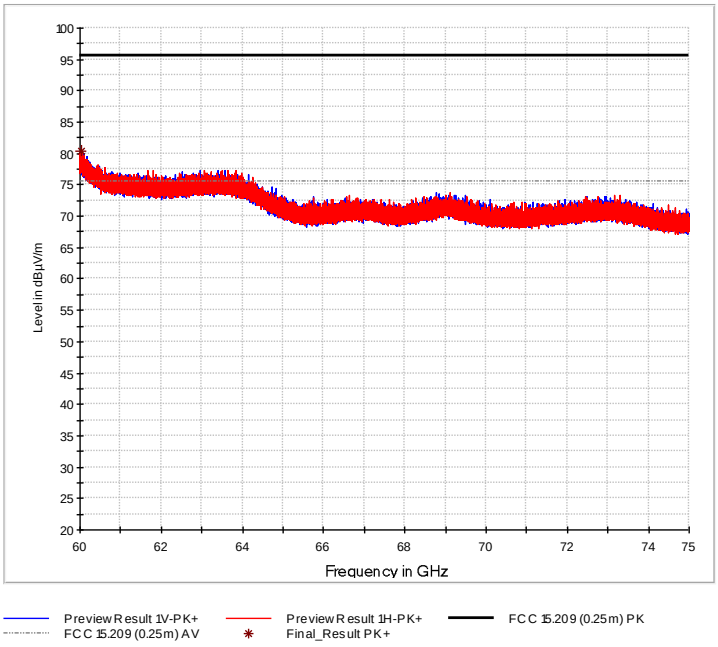

Level in dBµV/m
Frequency in GHz
Preview Result 2V-AVG
Preview Result 1V-PK+
Preview Result 2H-AVG
Preview Result 1H-PK+
FCC 15.209 (1m) PK
FCC 15.209 (1m) AV
Final_Result PK+
Final_Result AVG

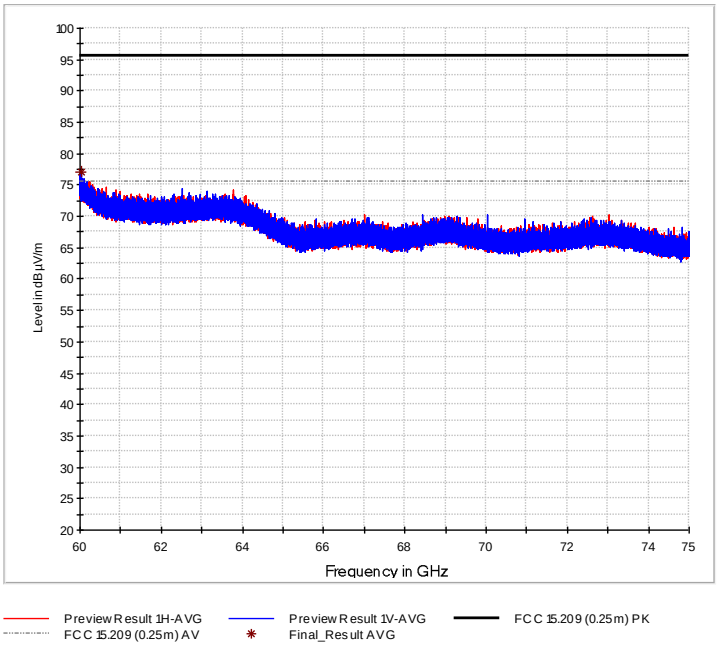

Level in dBµV/m
Frequency in GHz
Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.209 (1m) PK
FCC 15.209 (1m) AV
Final_Result PK+
Final_Result AVG

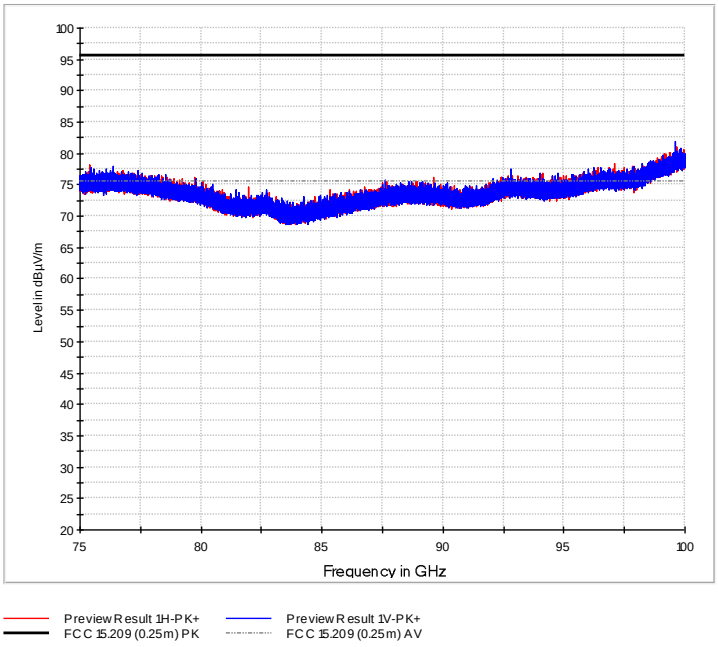

Level in dBµV/m
Frequency in GHz
Preview Result 2V-AVG
Preview Result 1V-PK+
Preview Result 2H-AVG
Preview Result 1H-PK+
FCC 15.209 (1m) PK
FCC 15.209 (1m) AV
Final_Result PK+
Final_Result AVG

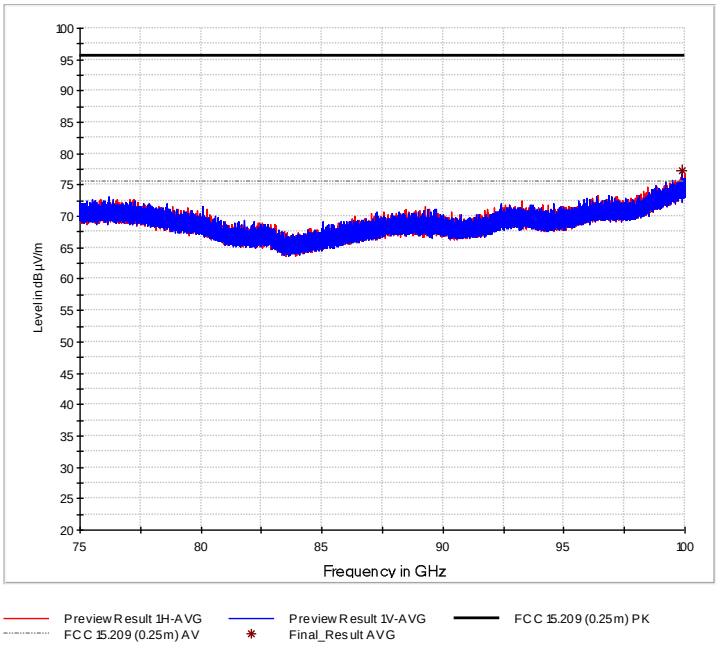

Level in dBµV/m
Frequency in GHz
Preview Result 1H-PK+
FCC 15.209 (0.5m) PK
Preview Result 1V-PK+
FCC 15.209 (0.5m) AV


Level in dBµV/m
Frequency in GHz
Preview Result 1V-AVG
FCC 15.209 (0.5m) AV
Preview Result 1H-AVG
Final_Result AVG
FCC 15.209 (0.5m) PK


Level in dBµV/m
Frequency in GHz
Preview Result 1V-PK+
Preview Result 1H-PK+
FCC 15.209 (0.25m) PK
FCC 15.209 (0.25m) AV
Final_Result PK+


Level in dBµV/m
Frequency in GHz
Preview Result 1H-AVG
Preview Result 1V-AVG
FCC 15.209 (0.25m) PK
FCC 15.209 (0.25m) AV
Final_Result AVG


Level in dBµV/m
Frequency in GHz
Preview Result 1H-PK+
FCC 15.209 (0.25m) PK
Preview Result 1V-PK+
FCC 15.209 (0.25m) AV


Level in dBµV/m
Frequency in GHz
Preview Result 1H-AVG
FCC 15.209 (0.25m) AV
Preview Result 1V-AVG
Final_Result AVG
FCC 15.209 (0.25m) PK

8.8 RF Exposure Requirement

Rules and specifications:	CFR 47 Part 1, section 1.1307(b)(1)
Guide:	OET Bulletin 65, Edition 97-01
Limits	Limits for general population / uncontrolled exposure:

Frequency Range (MHz)	*Electric Field Strength (V/m)*	*Magnetic Field Strength (A/m)*	*Power Density (mW/cm²)*	*Averaging Time (min)*
0.3 – 1.34	614	1.63	100 *	30
1.34 – 30	824/f	2.19 / f	180 / f *	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	---	---	f / 1500	30
1500 - 100000	---	---	1.0	30

f = Frequency in MHz

* Plane wave equivalent power density

EUT	*$EIRP_{RMS}$ (dBm)*	*$EIRP_{RMS}$ (µW)*
FMR10 + R7	-44.4	0.036
FMR20 + R7	-43.9	0.041

Prediction:[6]	$S = PG / (4 \pi R^2)$
Where:	S: Power density P: Power input into antenna G: Power gain of the antenna relative to an isotropic radiator R: Distance to the center of radiation of the antenna
Maximum output power: Antenna gain: Prediction distance	P =0.041 µW G: Not applicable R = 5 mm
Power density at 20 cm:	$S = 0.00001$ mW/cm²
Limit	$S_{lim} = 1.0$ mW/cm²

Test Result:	Test passed

[6] MPE Prediction of MPE according to equation from page 19 of OET Bulletin 65, Ed. 97-01

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				
☐ 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[7] 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[7]:				
EUT / *$EIRP_{RMS}$ (dBm)* / *$EIRP_{RMS}$ (µW)*				
FMR10 + R7 / -44.4 / 0.036			☒	
FMR20 + R7 / -43.9 / 0.041			☒	
Selection of output power				
The output power TP is the higher of the conducted or effective isotropic radiated power (e.i.r.p.): TP = **0.041 µW**				

Exposure of Humans to RF Fields (continued)	Applicable	Declared by applicant	Measured	Exemption

[7] 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.

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.

Frequency (MHz)	Exemption limits (mW)[8] 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 [9]	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

Carrier frequency:	f	=	**24.05 GHz – 29 GHz**
Distance:	d	=	**5 mm**
Transmitter output power:	TP	=	**0.000041 mW**
Limit:	TP_{limit}	=	**1 mW** ☒

☐ SAR evaluation is documented in test report no. .....

[8] The excemption 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.

[9] 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[10] 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 · $10^{-2}f^{0.6834}$ 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 = Transmitter output power: TP = Limit: TP_{limit} =				☐
☐ RF exposure evaluation is documented in test report no.				

Test Result:	Test passed

[10] 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.

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, 2017
☒	CFR 47 Part 15	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)	October 1, 2017
☐	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 9 for Licence-Exempt Radio Apparatus: Category I Equipment, published by Industry Canada	August 2016
☐	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	2044	ESU8	100232	Rohde & Schwarz	Rohde & Schwarz	12-2017	12-2018
EMI test receiver	28268	ESW26	101315	Rohde & Schwarz	Rohde & Schwarz	05-2018	05-2019
Spectrum analyser	1666	FSP30	100063	Rohde & Schwarz	Rohde & Schwarz	08-2017	08-2019
Spectrum analyser	2364	FSV40	101448	Rohde & Schwarz	Rohde & Schwarz	01-2018	01-2019
V-network	1059	ESH3-Z5	894785/005	Rohde & Schwarz	Rohde & Schwarz	10-2016	10-2019
Double ridged horn antenna	2073	HF907	100154	Rohde & Schwarz	Rohde & Schwarz	06-2017	06-2019
Horn antenna	1014	3160-07	9112-1008	EMCO Elektronik	See note 3		
Horn antenna	1015	3160-08	9112-1002	EMCO Elektronik	See note 3		
Horn antenna	1265	3160-09	9403-1025 (931941-010)	EMCO Elektronik	See note 3		
Horn antenna	1575	3160-10	399185	EMCO Elektronik	See note 3		
Horn antenna	2086	24240-20	157845	Flann	See note 3		
Horn antenna	27898	25240-20	249763	Flann	See note 3		
Horn antenna	27899	27240-20	244048	Flann	See note 3		
Loop antenna	1016	HFH2-Z2	882964/0001	Rohde & Schwarz	Rohde & Schwarz	07-2016	07-2019
TRILOG Broadband Antenna	2058	VULB 9163	9163-408	Schwarzbeck	Rohde & Schwarz	07-2016	07-2019
Waveguide mixer	25849	FS-Z60	100177	Rohde & Schwarz	Rohde & Schwarz	04-2017	04-2020
Waveguide mixer	25850	FS-Z90	101610	Rohde & Schwarz	Rohde & Schwarz	12-2016	12-2019
Waveguide mixer	25851	FS-Z110	101464	Rohde & Schwarz	Rohde & Schwarz	11-2016	11-2019

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.

12 Measurement Uncertainty

Radio Testing			
Test	k_p	*Expanded Uncer-tainty*	*Note*
Occupied Bandwidth	2.0	±1.14 %	2
RF-Frequency error	1.96	$\pm 1 \cdot 10^{-7}$	7
RF-Power, conducted carrier	2	±0.079 dB	2
RF-Power uncertainty for given BER	1.96	+0.94 dB / -1.05	7
RF power, conducted, spurious emissions	1.96	+1.4 dB / -1.6 dB	7
RF power, radiated			
25 MHz – 4 GHz	1.96	+3.6 dB / -5.2 dB	8
1 GHz – 18 GHz	1.96	+3.8 dB / -5.6 dB	8
18 GHz – 26.5 GHz	1.96	+3.4 dB / -4.5 dB	8
40 GHz – 170 GHz	1.96	+4.2 dB / -7.1 dB	8
Spectral Power Density, conducted	2.0	±0.53 dB	2
Maximum frequency deviation			
300 Hz – 6 kHz	2	±2,89 %	2
6 kHz – 25 kHz	2	±0.2 dB	2
Maximum frequency deviation for FM	2	±2,89 %	2
Adjacent channel power 25 MHz – 1 GHz	2	±2.31 %	2
Temperature	2	±0.39 K	4
(Relative) Humidity	2	±2.28 %	2
DC- and low frequency AC voltage			
DC voltage	2	±0.01 %	2
AC voltage up to 1 kHz	2	±1.2 %	2
Time	2	±0.6 %	2

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

Radio Interference Emission Testing (continued)			
Test	*k_p*	*Expanded Uncer-tainty*	*Note*
Radio Interference Power			
30 MHz to 300 MHz	2	± 3.5 dB	1
Harmonic Current Emissions			4
Voltage Changes, Voltage Fluctuations and Flicker			4

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

Note 1:
The expanded uncertainty reported according to CISPR 16-4-2:2003-11 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%

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

Note 3:
The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of kp = 2.05, providing a level of confidence of p = 95.45%

Note 4:
It has been demonstrated that the used test equipment meets the specified requirements in the standard with at least a 95%confidence.

Note 5:
The expanded wuncertainty reported according to IEC 61000-4-3 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%

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

Note 7:
The expanded uncertainty reported according ETSI TR 100 028 V1.4.1 (all parts) to is based on a standard uncertainty multiplied by a coverage factor of k_p = 1.96, providing a level of confidence of p = 95.45%

Note 8:
The expanded uncertainty reported according to ETSI TR 102 273 V1.2.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of kp = 1.96, providing a level of confidence of p = 95.45%

13 Revision History

Revision History			
Edition	*Date*	*Issued by*	*Modifications*
1	2018-10-08	M. Steindl	First Edition
2	2018-11-07	M. Steindl	Changed applicant to Endress + Hauser SE + Co. KG
3	2018-11-09	M. Steindl	Changed manufacturer to Endress + Hauser SE + Co. KG