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July 9, 2018

Page 1 of 117

Prüfbericht / Test Report

Nr. / No. TR-50511-28778-03 (Edition 2)

Applicant: Endress + Hauser GmbH + Co. KG
Type of equipment: Tank Level Probing Radar
Type designation: Micropilot FMR60L, FMR62L, FMR62T and FMR67L
Order No.: 125/1017392725
Test standards: FCC Code of Federal Regulations,
CFR 47, Part 15,
Sections 15.205, 15.207 and 15.209

Industry Canada Radio Standards Specifications
RSS-211 Issue 1, Sections 5.1 and 5.3
RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 (Category I Equipment)

Note:

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

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1 Description of the Equipment Under Test (EUT)

General data of EUT	
Type designation ¹ :	Micropilot FMR60L, FMR62L, FMR62T and FMR67L
Parts ² :	
Serial number(s):	See list of EUTs
Manufacturer:	Endress + Hauser GmbH + Co. KG
Type of equipment:	Tank Level Probing Radar
Version:	As received
FCC ID ³ :	LCGFMR6XEL LCGFMR6XET
Industry Canada ID ³ :	2519A-6EL 2519A-6E
Additional parts/accessories:	

Technical data of EUT	
Application frequency range:	75 GHz - 85 GHz
Frequency range:	79 GHz – 83 GHz
Operating frequency:	80 GHz
Type of modulation:	FMCW
Pulse train:	N/A
Pulse width:	N/A
Number of RF-channels:	1
Channel spacing:	N/A
Designation of emissions ⁴ :	4G5XXN
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 See "List of EUTs" for details

⁴ Also known as "Class of Emission".

List of EUTs

No.	Model	Type designation (Model and Antenna)	Housing	FCC-ID	IC
1	FMR60L	FMR60 Drip-off PTFE 2"	Plastic	LCGFMR6EL	2519A-6EL
2	FMR62T	FMR62 Integrated PEEK ¾"	Plastic	LCGFMR6ET	2519A-6ET
3	FMR62T	FMR62 PTFE claddeD DN50	Plastic	LCGFMR6ET	2519A-6ET
4	FMR62L	FMR62 Integrated PEEK 1.5"	Aluminium	LCGFMR6EL	2519A-6EL
5	FMR62T	FMR62 PTFE claddeD DN80	Plastic	LCGFMR6ET	2519A-6ET
6	FMR67L	FMR67 flush mount 3"	Aluminium	LCGFMR6EL	2519A-6EL

2 sAdministrative Data

Application details

Applicant (full address):	Endress + Hauser GmbH + Co. KG Hauptstraße 1 79689 Maulburg Germany
Contact person:	Mr. Ralf Reimelt
Order number:	125/1017392725
Receipt of EUT:	2018-03-22
Date(s) of test:	2018-03-27 to 2018-04-23s
Note(s):	

Report details

Report number:	TR-50511-28778-03
Edition:	2
Issue date:	2018-07-09

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:	DAkS 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 complies with the requirements set forth in the

Code of Federal Regulations CFR 47, Part 15, Sections 15.205, 15.207 and 15.209

of the Federal Communication Commission (FCC) and the

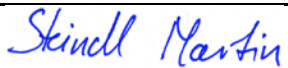
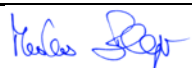
Radio Standards Specifications

RSS-211 Issue 1, Sections 5.1 and 5.3

RSS-GEN Issue 4, Sections 8.8, 8.9 and 8.10 (Category I Equipment)

of Industry Canada (IC).

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

Datum / Date	Geprüft von / Tested by	Freigabe durch / Checked by	Prüfergebnis / Test Result
2018-07-09	 Martin Steindl Responsible for testing	 Markus Biberger Reviewer	☒ 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 mounted in a metal tank

List of ports and cables

Port	Description	Classification ⁵	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
1	Metal Dummy Tank Ø 750 x 500w	---	---	H. Bachl

⁵ Ports shall be classified as ac power, dc power or signal/control port

6 Measurement Procedures

6.1 Bandwidth Measurements

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 2, section 2.202(a) CFR 47 Part 15, section 15.215(c) IC RSS-Gen Issue 4, section 6.6 IC RSS-211 Issue 1, section 5.3 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

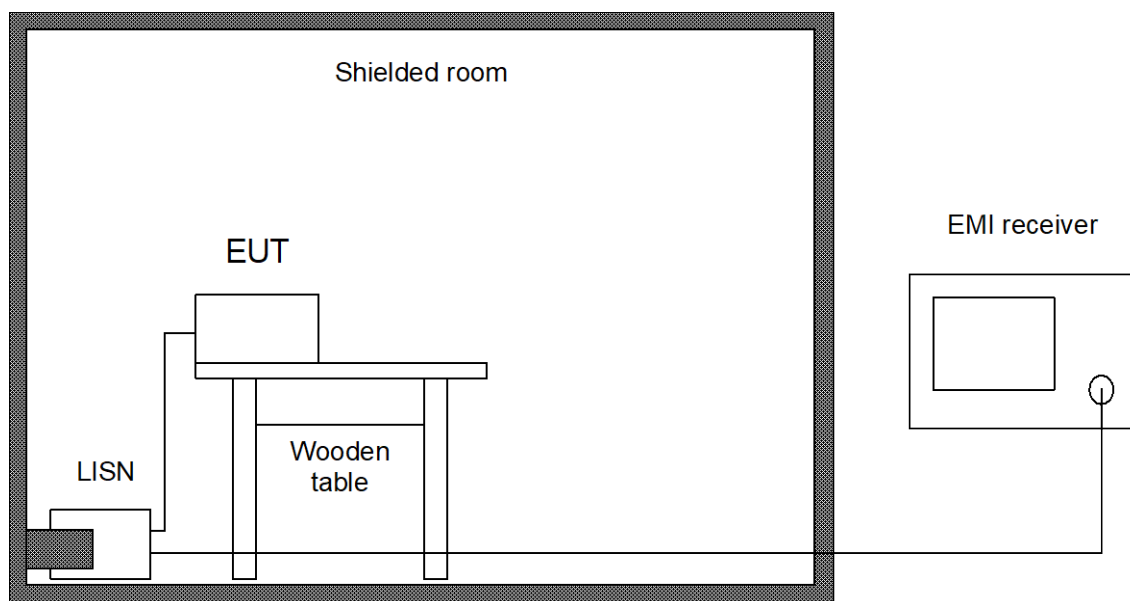
Conducted emission tests in the frequency range 150 kHz to 30 MHz are performed using Line Impedance Stabilization Networks (LISNs). To simplify testing with quasi-peak and average detector the following procedure is used:

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
 IC RSS-211 Issue 1, section 5.3

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.

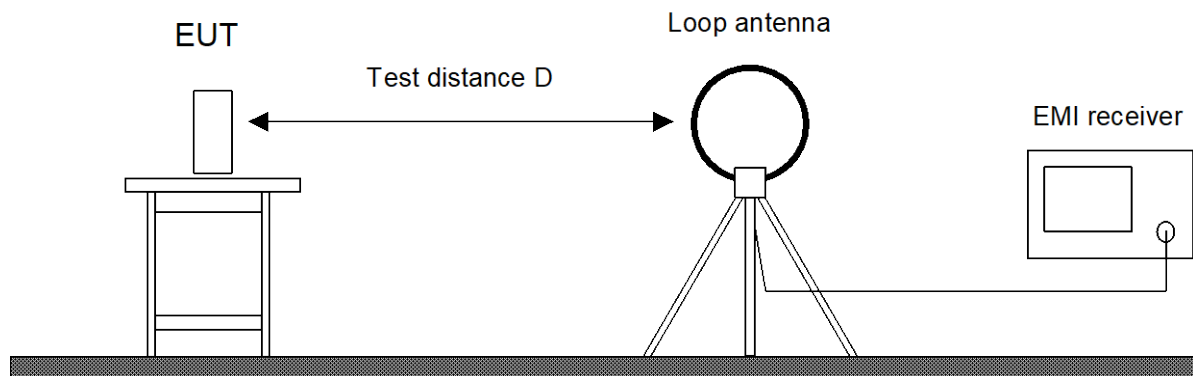
Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

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.

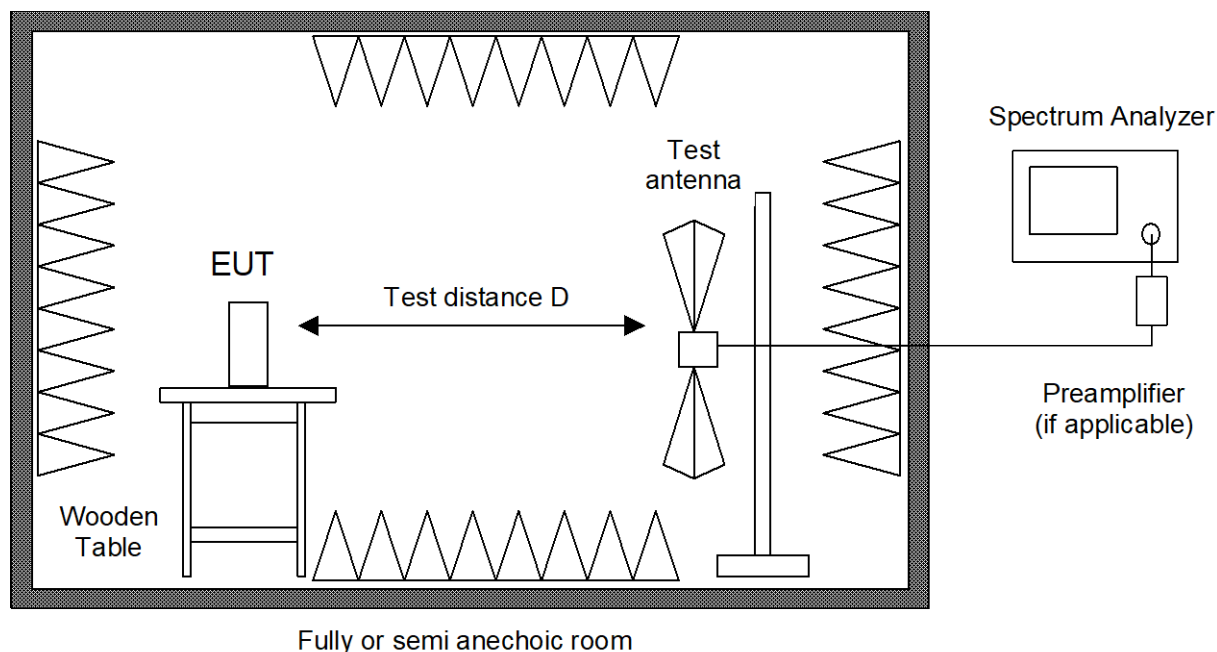


Test instruments used:

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 IC RSS-211 Issue 1, section 5.3
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. Radiated 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.	



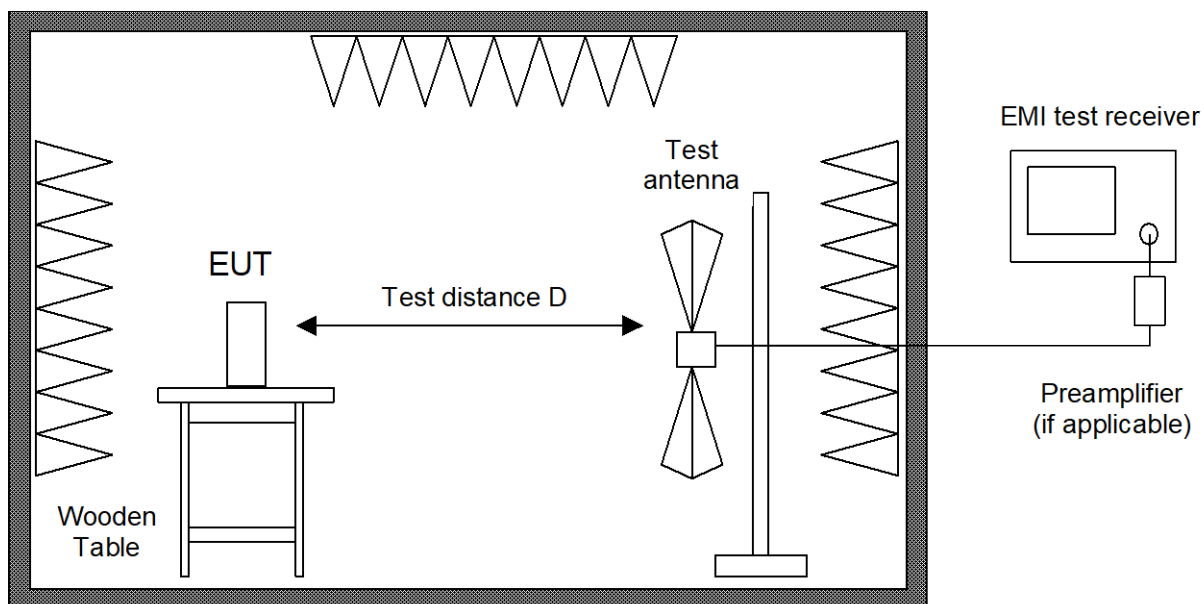
Test instruments used:

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 IC RSS-211 Issue 1, section 5.3
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 discharged quickly) final measurements with quasi-peak detector are performed manually at frequencies indicated by prescan with EUT rotating all around and receiving antenna raising and lowering within 1 meter to 4 meters to find the maximum levels of emission. 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.	



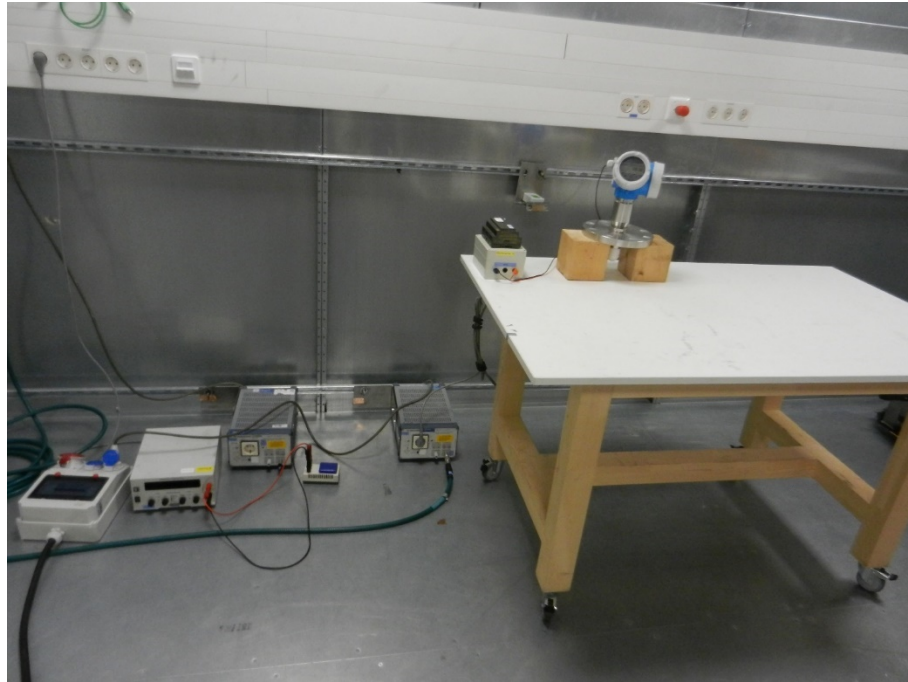
Alternate test site (semi anechoic room)

Test instruments used:

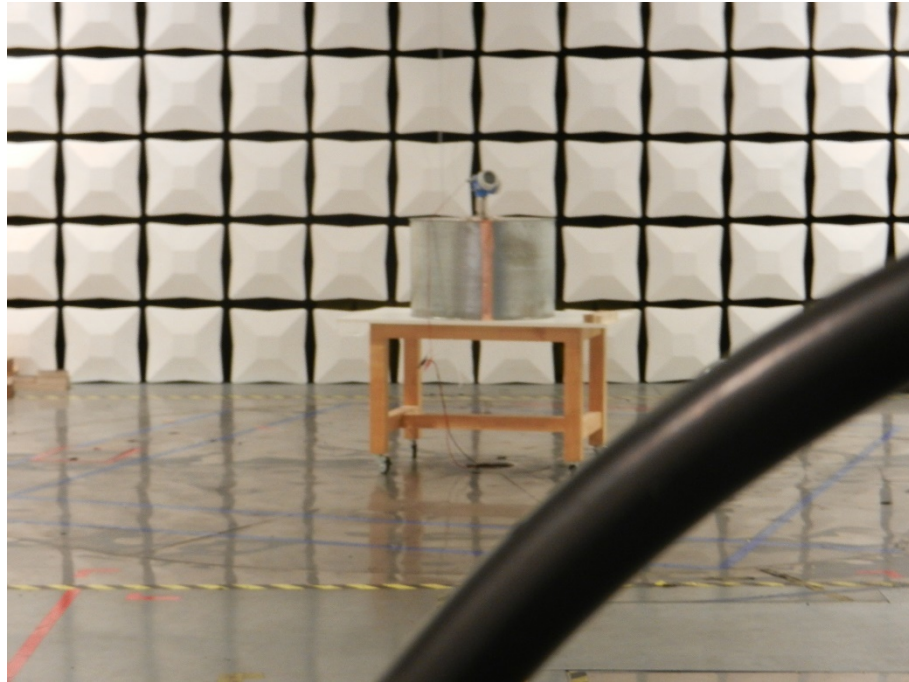
Type	Designation	Inv.-no.	Serial No. or ID	Manufacturer
☐ EMI test receiver	ESU8	2044	100232	Rohde & Schwarz
☒ EMI test receiver	ESW26	28268	101315	Rohde & Schwarz
☒ Trilog antenna Cabin no. 8	VULB 9163	2058	9163-408	Schwarzbeck
☒ Microwave cable Cabin no. 8	EF393	2053	---	Albatross Projects
☐ Microwave 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

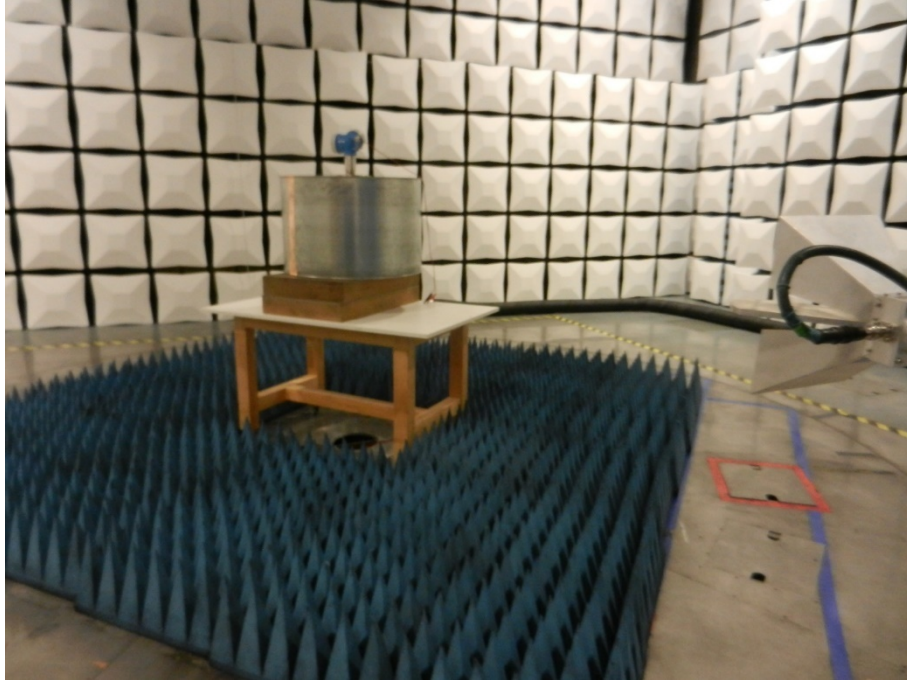
Test setup for conducted AC powerline emission measurement



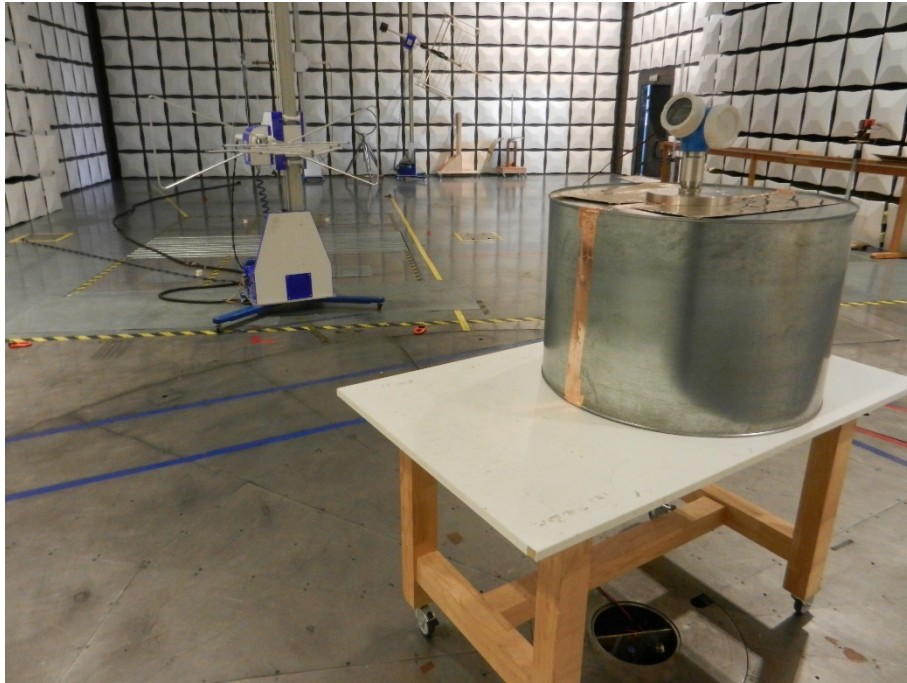
Test setup for radiated emission measurement 9 kHz – 30 MHz



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 1, 2 and 15			
Section(s)	Test	Page	Result
1.1307(b)(1)	RF Exposure Requirement	104	Test passed
2.1046(a)	Conducted output power	---	Not applicable
2.202(a)	Occupied bandwidth	---	Not applicable
2.201, 2.202	Class of emission	47	Calculated
15.205(a)	Restricted bands of operation	--- ⁶	Test passed
15.207	Conducted AC powerline emission 150 kHz to 30 MHz	48	Test passed
15.205(b) 15.209	Radiated emission 9 kHz to 30 MHz	51	Test passed
15.205(b) 15.209	Radiated emission 30 MHz to 200 GHz	53	Test passed

⁶ See "Radiated emissions".

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Section(s)	Test	Page	Result
6.12	Transmitter output power (conducted)	---	Not applicable
6.6	Occupied Bandwidth	26	Recorded
9	Designation of emissions	47	Calculated
6.10	Pulsed operation	---	Not applicable
8.8	Transmitter AC power lines conducted emissions 150 kHz to 30 MHz	48	Test passed
8.10	Restricted bands and unwanted emission frequencies	--- ⁷	Test passed
6.4, 6.13, 8.9	Unwanted emissions 9 kHz to 30 MHz	51	Test passed
6.4, 6.13, 8.9	Unwanted emissions 30 MHz to 200 GHz	53	Test passed
3.2	Exposure of Humans to RF Fields	105	Exempted from SAR and RF evaluation

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Section(s)	Test	Page	Result
5.1 (a)	Minimum Emission Bandwidth	26	Test passed
5.1 (d)	Unwanted emissions 9 kHz to 30 MHz	51	Test passed
5.1 (d)	Unwanted emissions 30 MHz to 200 GHz	53	Test passed
5.2 (a)	Maximum half-power beamwidth	---	Not applicable
5.2 (b)	Average Emission	---	Not applicable
5.2 (b)	Side Lobe Gain	---	Not applicable
5.3 (b)	Maximum Average EIRP Outside the Tank Enclosure	97	Test passed

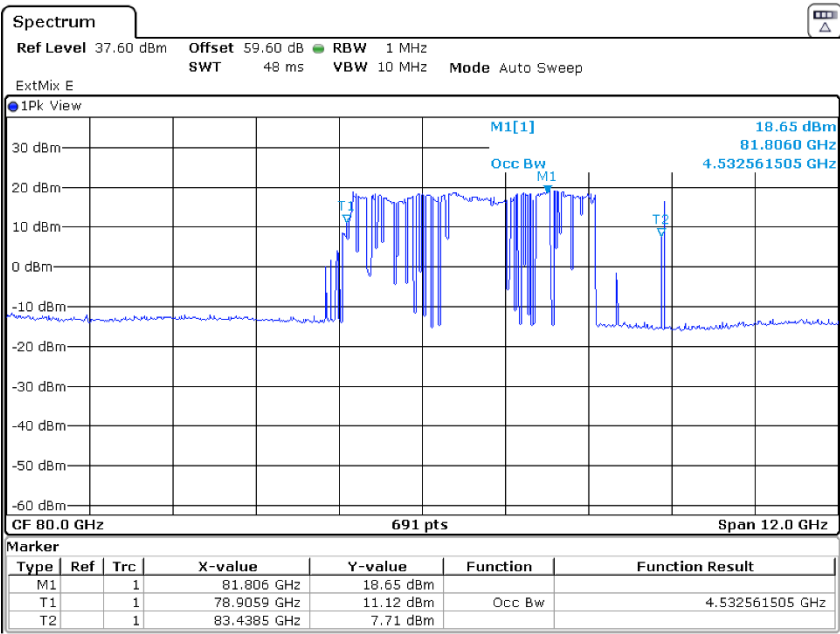
⁷ See "Unwanted emissions".

8.1 Occupied Bandwidth

Rules and specifications:	CFR 47 Part 2, section 2.202(a) ANSI C63.10, section 6.9.1
Guide:	ANSI C63.10
Description:	The occupied bandwidth according to CFR 47 Part 2, section 2.202(a), is measured as the 99% emission bandwidth, i.e. below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5% of the total mean power radiated by a given emission. The occupied bandwidth according to ANSI C63.10, section 6.9.1; is measured as the frequency range defined by the points that are 20 dB down relative to the maximum level of the modulated carrier. The span range of the spectrum analyser display shall be between two times and five times of the occupied bandwidth. The resolution bandwidth of the spectrum analyzer should be approximately 1 % to 5 % of the occupied bandwidth, unless otherwise specified, depending on the applicable requirement. The video bandwidth shall be at least three times greater than the resolution bandwidth. The dynamic range of the spectrum analyzer at the selected resolution bandwidth shall be more than 10 dB below the target "dB down" (attenuation) requirement.
Measurement procedure:	Bandwidth Measurements (6.1)

Comment:	
Date of test:	2018-04-06
Test site:	Fully anechoic room, cabin no. 2

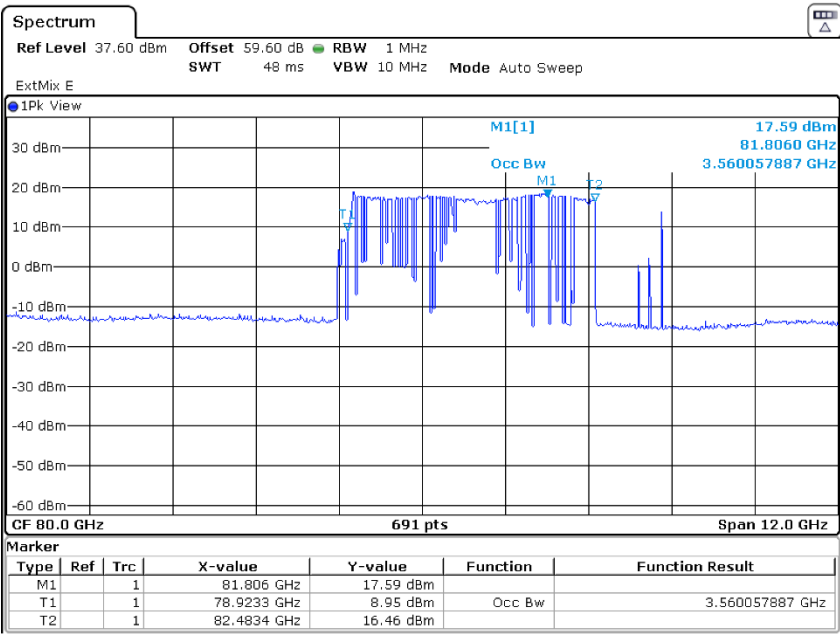
Occupied Bandwidth (99 %) EUT 1:



Date: 6 APR 2018 11:02:57

Occupied Bandwidth (99 %):	4.533 GHz
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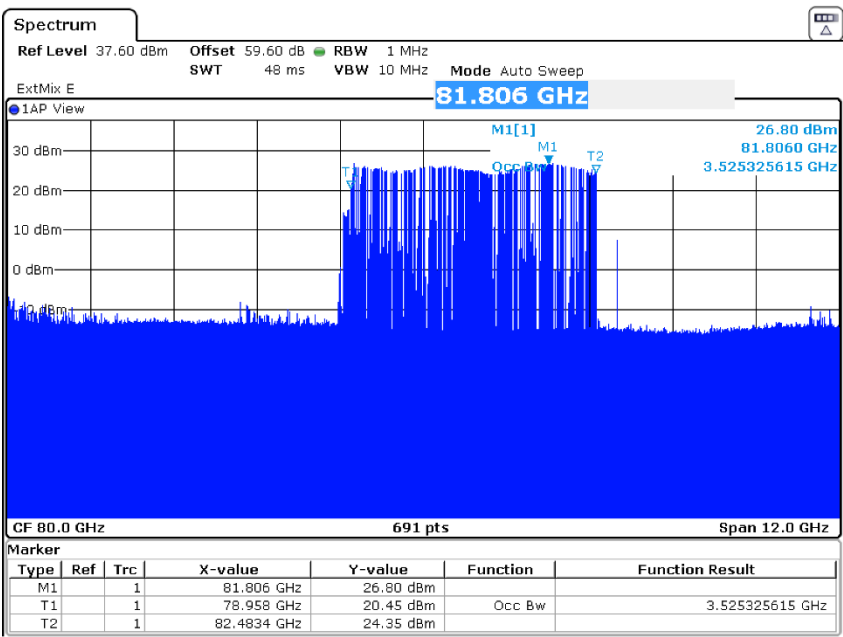
Occupied Bandwidth (99 %) EUT 2:



Date: 6 APR 2018 12:12:17

Occupied Bandwidth (99 %):	3.560 GHz
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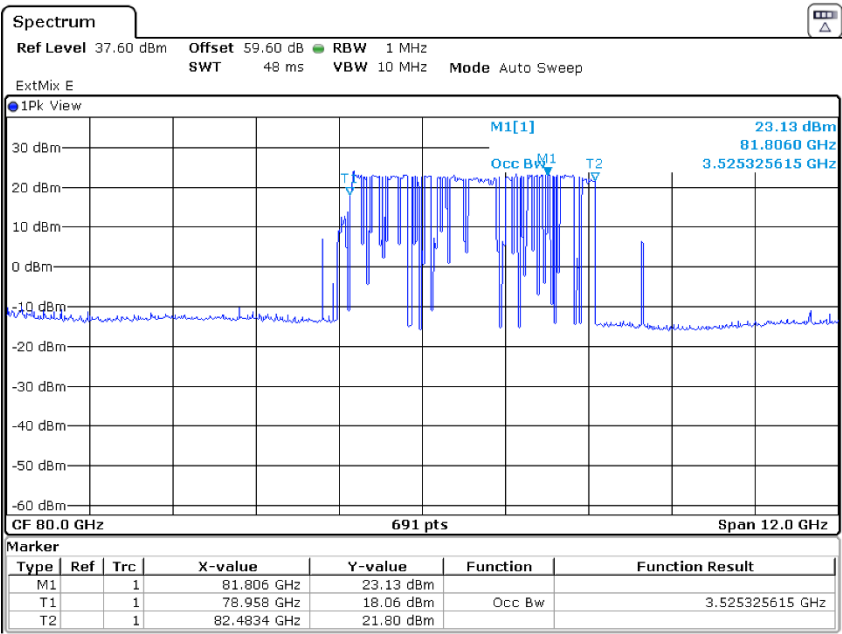
Occupied Bandwidth 99 %) EUT 3:



Date: 6 APR 2018 10:17:59

Occupied Bandwidth (99 %):	3.535 GHz
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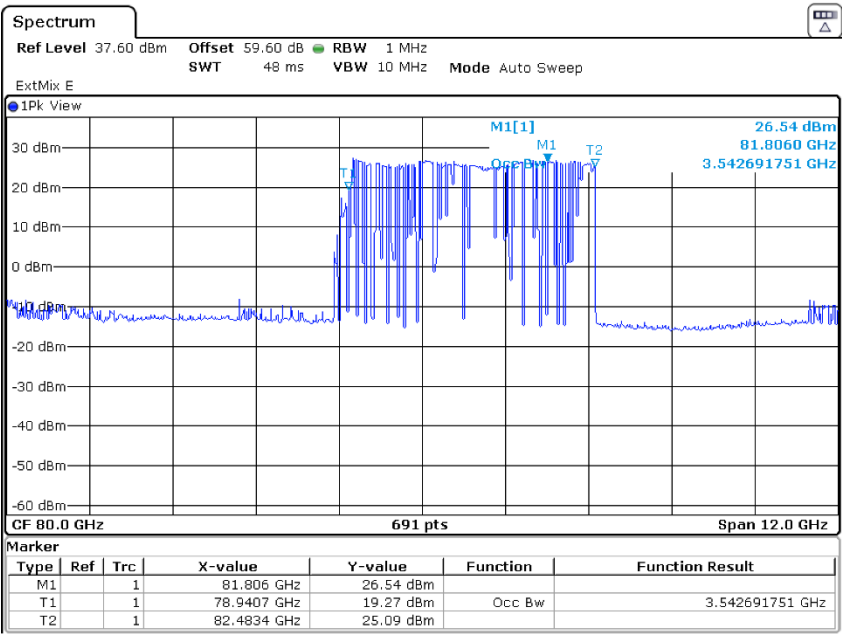
Occupied Bandwidth (99 %) EUT 4:



Date: 6 APR 2018 13:06:02

Occupied Bandwidth (99 %):	3.525 GHz
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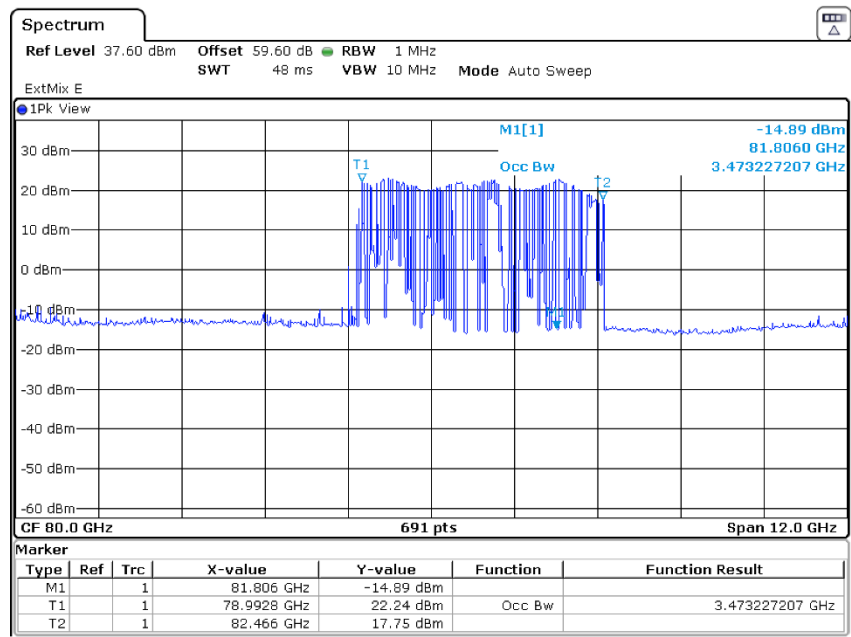
Occupied Bandwidth (99 %) EUT 5:



Date: 6 APR 2018 14:58:20

Occupied Bandwidth (99 %):	3.543 GHz
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Occupied Bandwidth (99 %) EUT 6:



Date: 6 APR 2018 15:27:07

Occupied Bandwidth (99 %):	3.473 GHz
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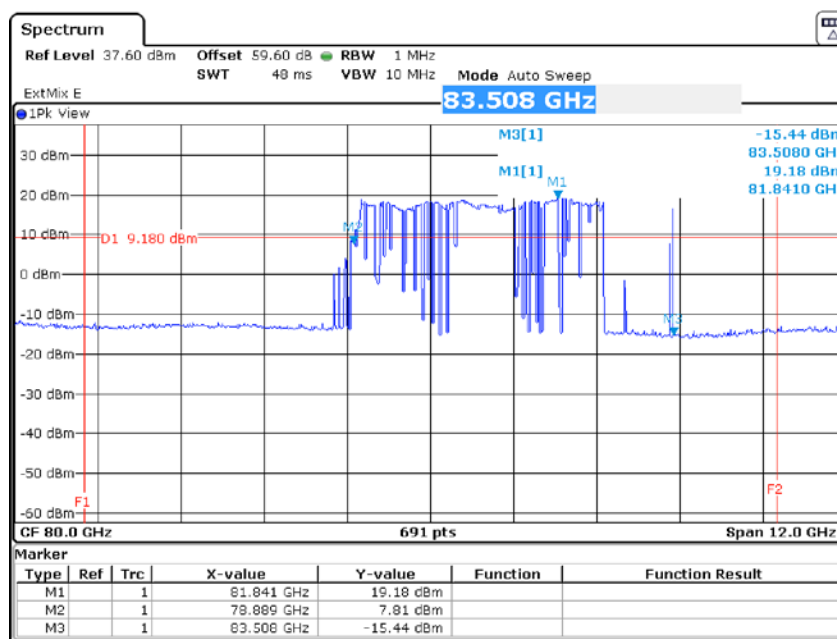
Occupied Bandwidth (continued)

Rules and specifications:	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:	2018-04-06
Test site:	Fully anechoic room, cabin no. 2

Test Result:	Test passed
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Occupied Bandwidth (-10 dB) EUT 1:

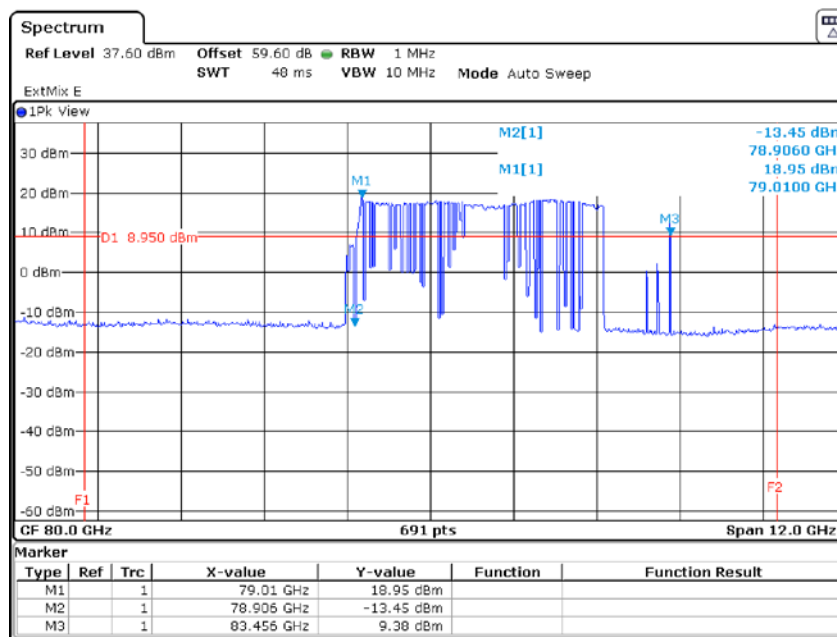


Date: 8.APR.2018 11:00:49

Occupied Bandwidth (-10 dB): **4.619 GHz**

Limit: **50 MHz**

Occupied Bandwidth (-10 dB) EUT 2:

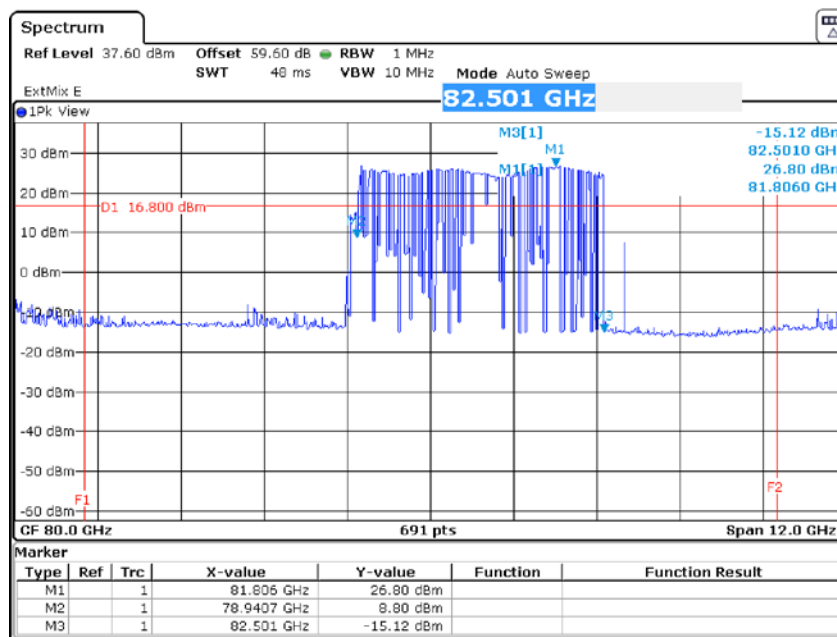


Date: 8.APR.2018 12:07:42

Occupied Bandwidth (-10 dB): **4.559 GHz**

Limit: **50 MHz**

Occupied Bandwidth (-10 dB) EUT 3:

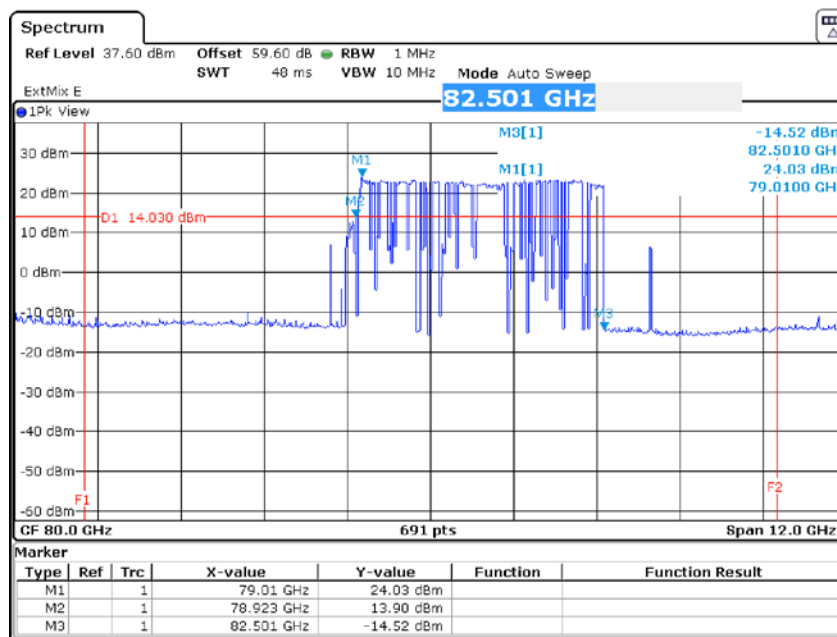


Date: 8.APR.2018 10:15:59

Occupied Bandwidth (-10 dB): **3.560 GHz**

Limit: **50 MHz**

Occupied Bandwidth (-10 dB) EUT 4:

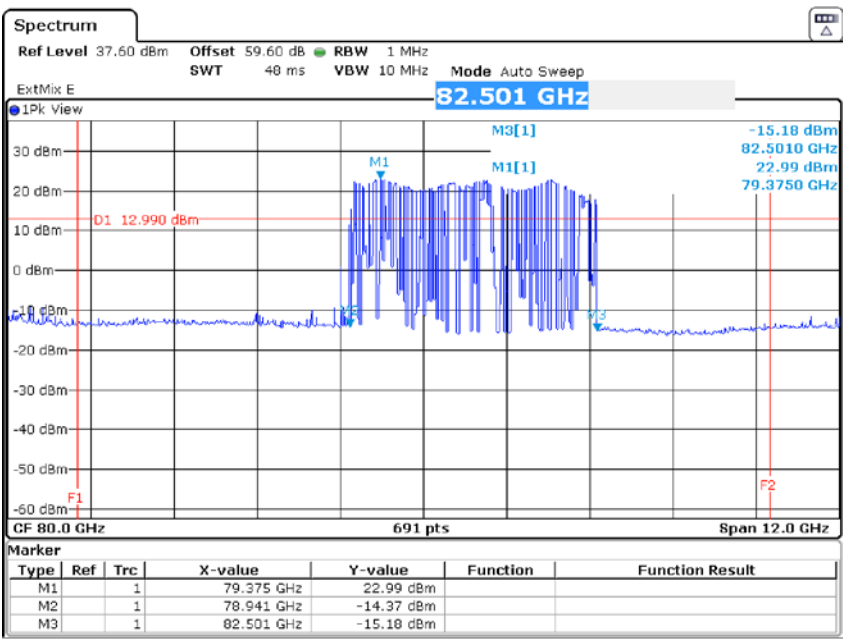


Date: 8.APR.2018 13:04:31

Occupied Bandwidth (-10 dB): **3.578 GHz**

Limit: **50 MHz**

Occupied Bandwidth (-10 dB) EUT 6:



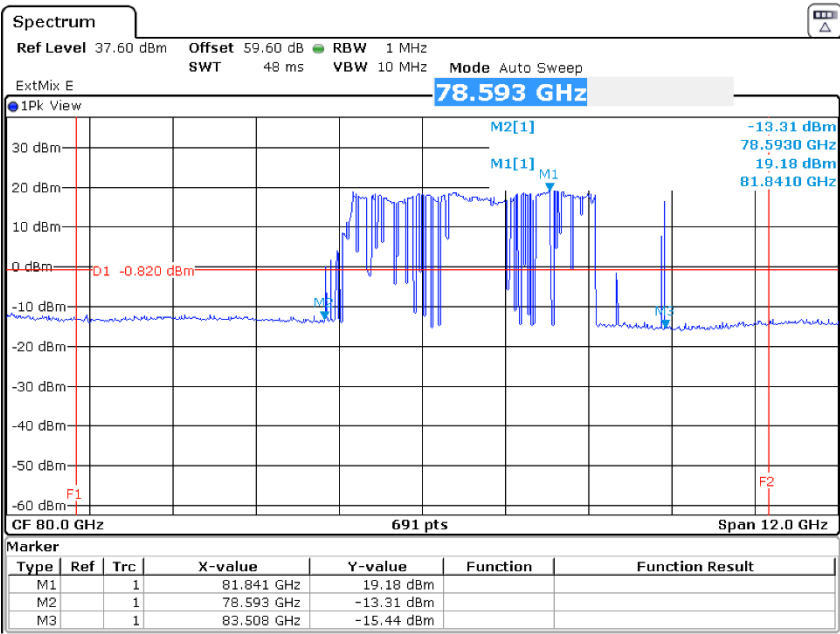
Date: 8.APR.2018 15:24:48

Occupied Bandwidth (-10 dB):	3.560 GHz
Limit:	50 MHz

8.2 Bandwidth of the Emission

Rules and specifications:	CFR 47 Part 15, section 15.209 IC RSS-GEN Issue 4, section 8.9
Guide:	ANSI C63.10
Description:	The 20 dB bandwidth of the emission is measured as the frequency range defined by the points that are 20 dB down relative to the maximum level of the modulated carrier. For intentional radiators operating under the alternative provisions to the general emission limits the requirement to contain the 20 dB bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation. The span range of the spectrum analyser display shall be between two times and five times of the occupied bandwidth. The resolution bandwidth of the spectrum analyzer should be approximately 1 % to 5 % of the occupied bandwidth, unless otherwise specified, depending on the applicable requirement. The video bandwidth shall be at least three times greater than the resolution bandwidth. The dynamic range of the spectrum analyzer at the selected resolution bandwidth shall be more than 10 dB below the target "dB down" (attenuation) requirement. The video bandwidth shall be at least three times greater than the resolution bandwidth.
Measurement procedure:	Bandwidth Measurements (6.1)
Comment:	
Date of test:	2018-06-04
Test site:	Fully anechoic room, cabin no. 2

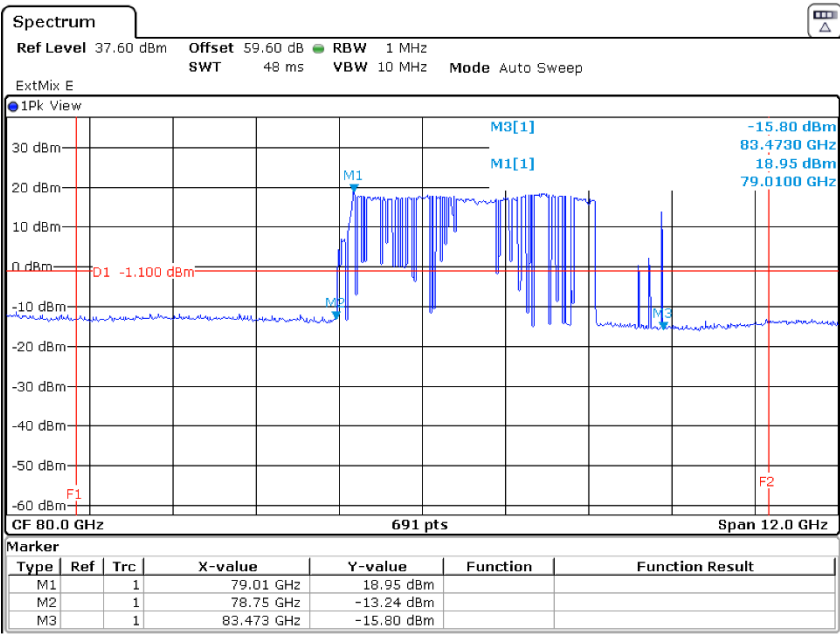
Occupied Bandwidth (-20 dB) EUT 1:



Date: 6 APR 2018 11:01:56

Occupied Bandwidth (-20 dB):	4.915 GHz
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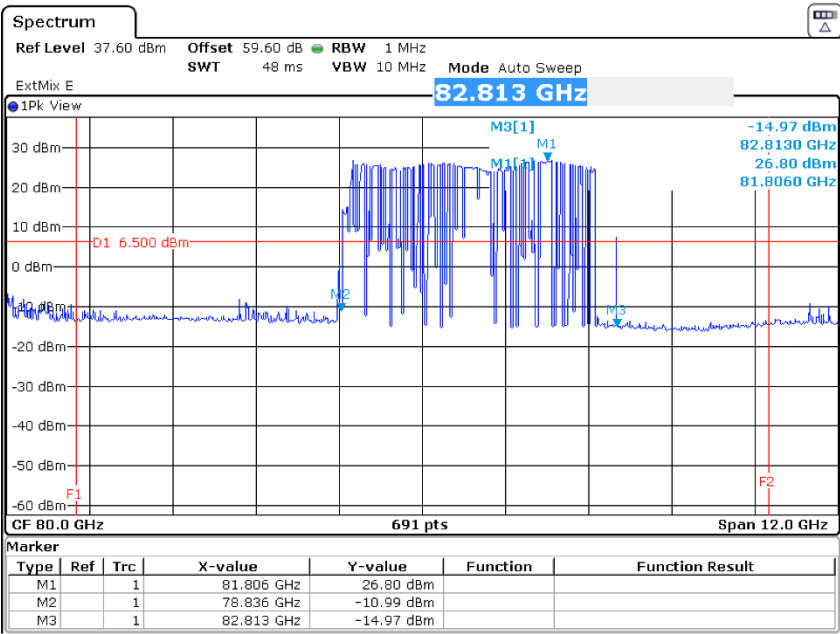
Occupied Bandwidth (-20 dB) EUT 2:



Date: 6 APR 2018 12:10:09

Occupied Bandwidth (-20 dB):	4.723 GHz
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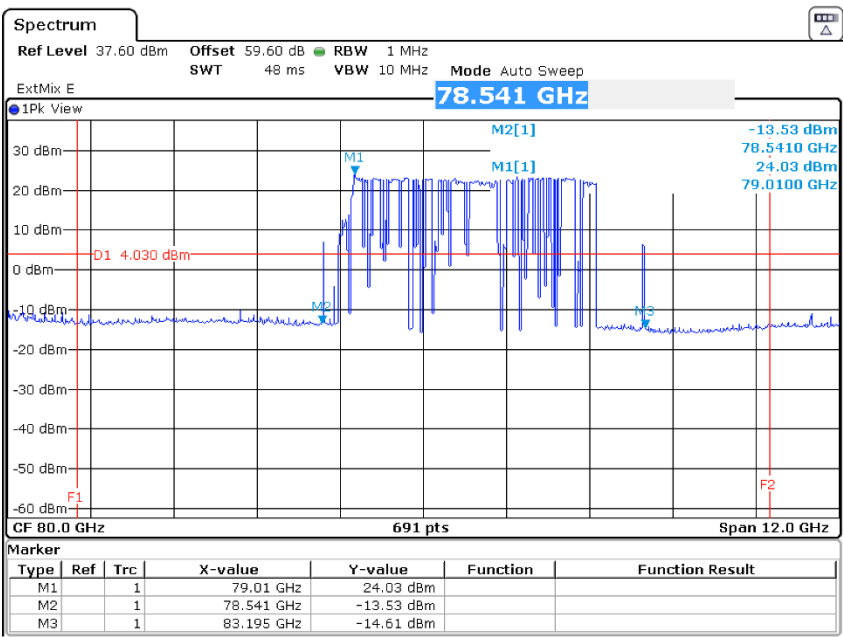
Occupied Bandwidth (-20 dB) EUT 3:



Date: 6 APR 2018 10:16:55

Occupied Bandwidth (-20 dB): **3.977 GHz**

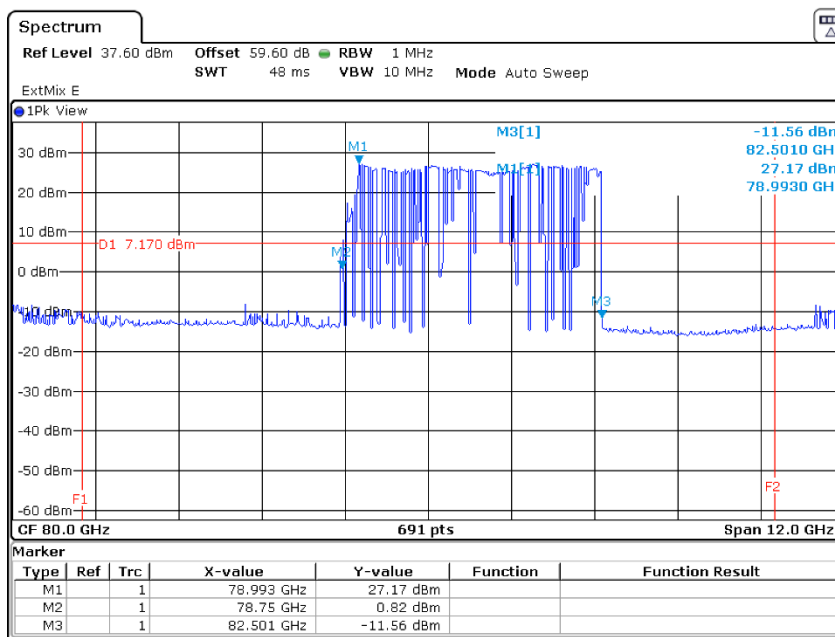
Occupied Bandwidth (-20 dB) EUT 4:



Date: 6 APR 2018 13:05:23

Occupied Bandwidth (-20 dB): 4.654 GHz

Occupied Bandwidth (-20 dB) EUT 5:



Date: 6.APR.2018 14:57:29

Occupied Bandwidth (-20 dB): **3.751 GHz**

8.3 Designation of Emissions

Rules and specifications:	CFR 47 Part 2, sections 2.201 and 2.202 IC RSS-Gen Issue 4, section 9
Guide:	ANSI C63.10 / TRC-43

Type of modulation:	Frequency Modulation Continuous Wave (FMCW)
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Designation of Emissions:	4G5XXN
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8.4 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

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

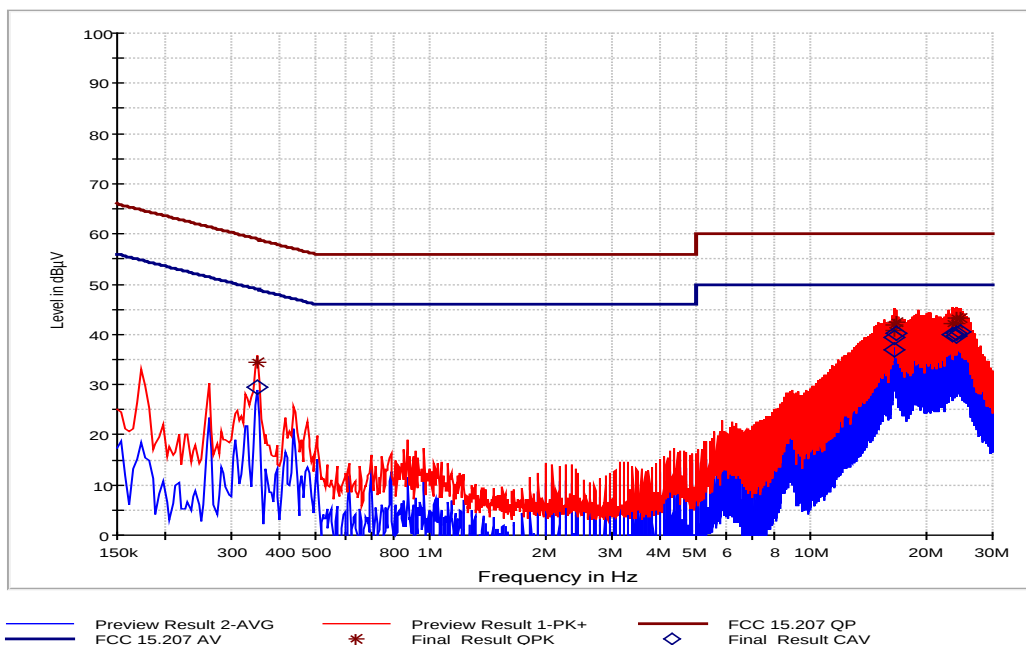
Comment:	
Date of test:	2018-04-24
Test site:	Shielded room, cabin no. 9

Test Result:	Test passed
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Sample calculation of final values:

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

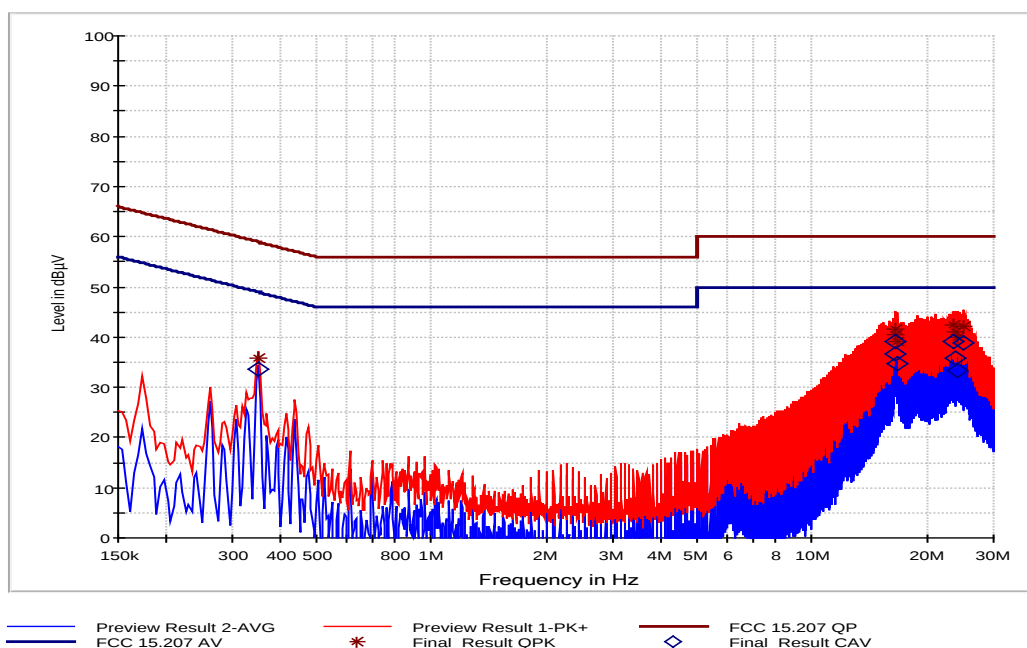
Tested on: L1



Frequency MHz	QuasiPeak dBµV	CAverage dBµV	Limit dBµV	Margin dB	Meas. Time ms	Bandwidth kHz	Corr. dB
0.350		29.4	49.0	19.6	1000	9	0.0
0.350	34.3		59.0	24.7	1000	9	0.0
16.478		39.3	50.0	10.7	1000	9	0.4
16.478	42.0		60.0	18.0	1000	9	0.4
16.654		36.8	50.0	13.2	1000	9	0.4
16.654	40.7		60.0	19.3	1000	9	0.4
16.738		40.2	50.0	9.8	1000	9	0.4
16.738	42.4		60.0	17.6	1000	9	0.4
23.450		39.9	50.0	10.1	1000	9	0.2
23.450	42.1		60.0	17.9	1000	9	0.2
23.974		39.7	50.0	10.3	1000	9	0.3
23.974	42.3		60.0	17.7	1000	9	0.3
24.214		40.2	50.0	9.8	1000	9	0.3
24.214	43.2		60.0	16.8	1000	9	0.3
24.562		40.6	50.0	9.4	1000	9	0.3
24.562	43.3		60.0	16.7	1000	9	0.3

Tested on:

N



Frequency MHz	QuasiPeak dBµV	CAverage dBµV	Limit dBµV	Margin dB	Meas. Time ms	Bandwidth kHz	Corr. dB
0.350		33.7	49.0	15.3	1000	9	0.0
0.350	35.7		59.0	23.3	1000	9	0.0
16.474		39.2	50.0	10.8	1000	9	0.4
16.474	41.7		60.0	18.3	1000	9	0.4
16.650		36.7	50.0	13.3	1000	9	0.4
16.650	40.5		60.0	19.5	1000	9	0.4
16.738		34.7	50.0	15.3	1000	9	0.4
16.738	39.3		60.0	20.7	1000	9	0.4
23.506		39.2	50.0	10.8	1000	9	0.2
23.506	42.4		60.0	17.6	1000	9	0.2
23.950		35.8	50.0	14.2	1000	9	0.3
23.950	41.1		60.0	18.9	1000	9	0.3
24.126		33.4	50.0	16.6	1000	9	0.3
24.126	39.9		60.0	20.1	1000	9	0.3
24.906		38.9	50.0	11.1	1000	9	0.3
24.906	42.2		60.	17.8	1000	9	0.3

8.5 Radiated Emission Measurement 9 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, sections 15.205 and 15.209 IC RSS-GEN Issue 4, sections 8.9 and 8.10			
Guide:	ANSI C63.10			
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:	2018-04-09
Test site:	Open field test site

Test Result:	Test passed
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Extrapolation factor: -40 dB/decade										
Frequency (MHz)	Detector	Distance		Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
		d1 (m)	d (m)							
0.44250	Average	10	300	5.6	20.0	-59.1		-33.5	14.7	48.1
0.45150	Average	10	300	5.8	20.0	-59.1		-33.3	14.5	47.8

Sample calculation of final values:

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

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

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

