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December 3, 2015

Prüfbericht / *Test Report* Nr. / *No.* 67627-52612-8 (Edition 3)

Applicant:	Vectron International GmbH & Co. KG
Type of equipment:	Wireless Sensor Reader - TempTrackr
Type designation:	WSR-T2-A4B7
Order No.:	--
Test standards:	FCC Code of Federal Regulations, CFR 47, Part 15, Sections 15.107, 15.109, 15.207, 15.209 and 15.231

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]:	WSR-T2-A4B7
Parts[2]:	--
Serial number(s):	Prototype
Manufacturer:	Vectron Internationa GmbH & Co. KG
Type of equipment:	Wireless Sensor Reader - TempTrackr
Version:	As received
FCC ID:	X3I-WSRT2
Additional parts/accessories:	--

[1] Type designation of the system if EUT consists of more than one part.
[2] Type designations of the parts of the system, if applicable.

Technical data of EUT	
Application frequency range:	428.0 to 438.9 MHz
Frequency range:	428.0 to 438.9 MHz
Operating frequency:	429.0 MHz; 433.5 MHz; 438.9 MHz
Type of modulation:	FM
Number of RF-channels:	12
Channel spacing:	26.3 kHz
Designation of emissions[3]:	120KF7D
Type of antenna:	ANT-PIF-0001 / ANT-PIF-0002
Size/length of antenna:	20x18x3,5cm / 15x15x3cm
Connection of antenna:	☒ detachable ☐ not detachable
General power supply of system:	AC supply
The EUT was supplied via USB port of the Notebook:	nominal voltage: 120 V AC minimum voltage: 100 V AC maximum voltage: 240 V AC nominal frequency: 50 Hz
Type of power supply:	DC supply
Specifications for power supply connector (1):	nominal voltage: 5 V minimum voltage: 4.5 V maximum voltage: 5 V nominal frequency: DC Hz
Specifications for power supply connector (2):	nominal voltage: 12 V minimum voltage: 9 V maximum voltage: 30 V nominal frequency: DC Hz

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

2 Administrative Data

Application details	
Applicant (full address):	Vectron International GmbH & Co. KG Landstrasse D-74924 Neckarbischofsheim
Contact person:	Mr. Ralf Olbert
Order number:	--
Receipt of EUT:	2014-11-13
Date(s) of test:	2015-02-09 to 2015-02-11 & 2015-12-03
Note(s):	--

Report details	
Report number:	67627-52612-8
Edition:	3
Issue date:	December 03, 2015

3 Identification of the Test Laboratory

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

4 Summary

Summary of test results
The tested sample complies with the requirements set forth in the **Code of Federal Regulations CFR 47, Part 15, Sections FCC Code of Federal Regulations, CFR 47, Part 15, Sections 15.107, 15.109, 15.207, 15.209 and 15.231** of the Federal Communication Commission (FCC).

Personnel involved in this report	
Laboratory Manager:	 Mr. Johann Roidt
Responsible for testing:	 Mr. Markus Biberger
Responsible for test report:	Mr. Markus Biberger

5 Operation Mode and Configuration of EUT

Operation Mode(s)
Conducted power line emission measurement: (operating modes 1, 2) WSR-T2 Software is running with all sensors at one antenna (12 pieces – standard operation) to perform the worst case scenario. The conducted emission have been measured from a test notebook, which is the normal method of operation.
Operating mode 1: 5 V DC supplied from Notebook, RS485 interface, Transmitting at all channels and all antenna ports
Operating mode 2: 9…30 V DC supplied via Notebook PSU, CAN interface, Transmitting at all channels and all antenna ports
Radiated emission measurement: (operating modes 3, 4, 5, 6) The EUT is running in continuous transmitting mode with the operating frequencies of 429.00 MHz (lower frequency) / 433.5 MHz (middle frequency) / 438.9 MHz (upper frequency). The antenna connectors 1, 2, 3 are technical identical. Measurement were carried out on antenna port 1.
Operating mode 3: 5 V DC supplied from Notebook, RS485 interface, Antenna connector 1 with antenna ANT-PIF-0001, lower frequency
Operating mode 4: 5 V DC supplied from Notebook, RS485 interface, Antenna connector 1 with antenna ANT-PIF-0001, middle frequency
Operating mode 5: 5 V DC supplied from Notebook, RS485 interface, Antenna connector 1 with antenna ANT-PIF-0001, upper frequency
Operating mode 6: 9…30 V DC supplied via Notebook PSU, CAN interface, Antenna connector 3 with antenna ANT-PIF-0002, lower frequency
Operating mode 7: 9…30 V DC supplied via Notebook PSU, CAN interface, Antenna connector 3 with antenna ANT-PIF-0002, middle frequency
Operating mode 8: 9…30 V DC supplied via Notebook PSU, CAN interface, Antenna connector 3 with antenna ANT-PIF-0002, higher frequency

Configuration(s) of EUT
The EUT is connected via USB and RS485 to a Notebook with WSR-T2 Software setting “All sensor modules” “TX: +1dBm”. All antenna ports connected to listed antennas. The supply voltage of the EUT is 5V DC and 12V DC.

List of ports and cables				
Port	*Description*	*Classification*[4]	*Cable type*	*Cable length*
1	+5 VDC supply	dc power	Unshielded	3m
2	+9..30V DC supply	dc power	Unshielded	3m
3	RS485	signal/control port	Unshielded	3m
4	CAN	signal/control port	Unshielded	3m
5	Antenna port 1	signal/control port	Shielded	2m
6	Antenna port 2	signal/control port	Shielded	2m
7	Antenna port 3	signal/control port	Shielded	2m

List of devices connected to EUT				
Item	*Description*	*Type Designation*	*Serial no. or ID*	*Manufacturer*
1	Test Notebook	N130	ZJJF93LS903821K	Samsung
2	Power supply unit of Notebook	AA-PA2N40W	--	Samsung
3	Antenna	ANT-PIF-0001	--	Vectron
4	Antenna	ANT-PIF-0002	--	Vectron
5	RS485 to USB converter	USB-RS485-WE	--	Vectron
6	CAN to USB converter	IPEH-002021	--	PEAK

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

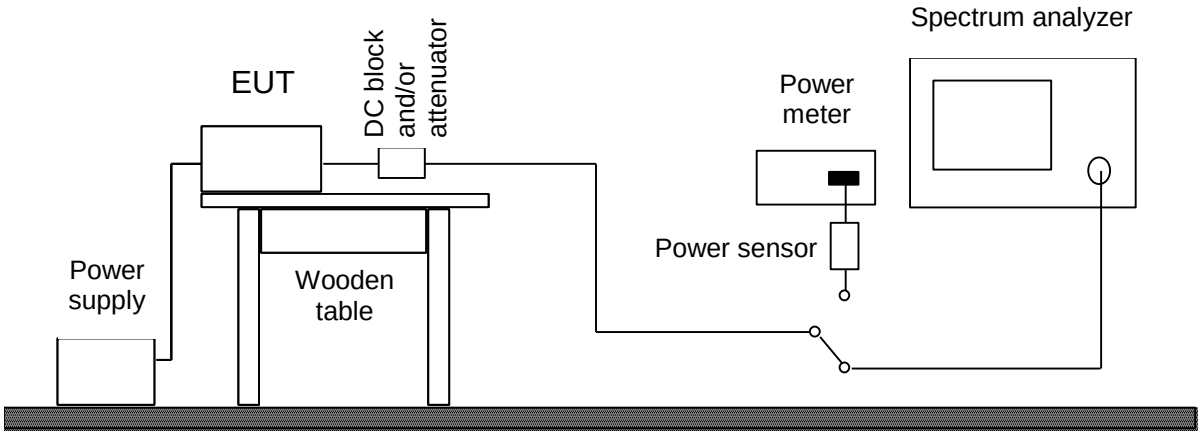
6 Measurement Procedures

6.1 Conducted Output Power

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 2, section 2.1046(a)
Guide:	ANSI C63.10 / CFR 47 Part 2, section 2.1046

Conducted output power is measured at the RF output terminals (e.g. antenna connector if antenna is detachable) when the transmitter is adjusted in accordance with the tune-up procedure, if applicable. The RF output terminals are connected to a spectrum analyzer and/or a power meter with appropriate sensor. 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 a spectrum analyzer is used and no other settings are specified resolution bandwidth shall be selected according to the carrier frequency f_c and set to 10 kHz (150 kHz $\leq f_c <$ 30 MHz), 100 kHz (30 MHz $\leq f_c <$ 1 GHz) or 1 MHz ($f_c \geq$ 1 GHz). The video bandwidth shall be at least three times greater than the resolution bandwidth. The settings used have to be indicated within the appropriate test record(s).



Test instruments used:

	Type	*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Spectrum analyzer	FSP30	1666	100063	Rohde & Schwarz
☒	EMI test receiver	ESPI7	1711	836914/0002	Rohde & Schwarz
☐	EMI test receiver	ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☐	Power meter	NRVS	1264	836856/015	Rohde & Schwarz
☐	Peak power sensor	NRV-Z31	1701	8579604.03	Rohde & Schwarz
☐	Power sensor	NRV-Z52	1499	837901/030	Rohde & Schwarz
☐	Power sensor	NRV-Z4	1034	863828/015	Rohde & Schwarz
☒	Microwave cable	ST-18/SMAm/SMAm/48	1949	696378	Huber+Suhner
☐	DC-block	7006	1636	A2798	Weinschel
☐	Attenuator	4776-10	1638	9412	Narda
☐	Attenuator	4776-20	1639	9503	Narda

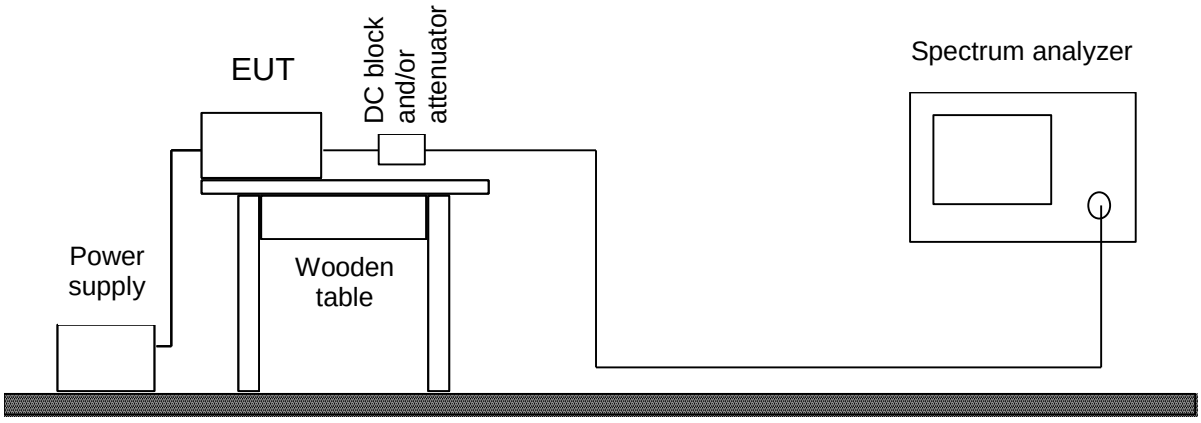
6.2 Bandwidth Measurements

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 2, section 2.202(a) CFR 47 Part 15, section 15.215(c) ANSI C63.10, section 6.9.1
Guide:	ANSI C63.10
Measurement setup:	☒ Conducted: See below ☐ Radiated: Radiated Emission in Fully or Semi Anechoic Room (6.6)

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).



Test instruments used for conducted measurements:

	Type	*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Spectrum analyzer	FSP30	1666	100063	Rohde & Schwarz
☒	EMI test receiver	ESPI7	1711	836914/0002	Rohde & Schwarz
☐	EMI test receiver	ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☐	Power meter	NRVS	1264	836856/015	Rohde & Schwarz
☐	Peak power sensor	NRV-Z31	1701	8579604.03	Rohde & Schwarz
☐	Power sensor	NRV-Z52	1499	837901/030	Rohde & Schwarz
☐	Power sensor	NRV-Z4	1034	863828/015	Rohde & Schwarz
☐	DC-block	7006	1636	A2798	Weinschel
☒	Microwave cable	ST-18/SMAm/SMAm/48	1949	696378	Huber+Suhner
☐	Attenuator	4776-10	1638	9412	Narda
☐	Attenuator	4776-20	1639	9503	Narda

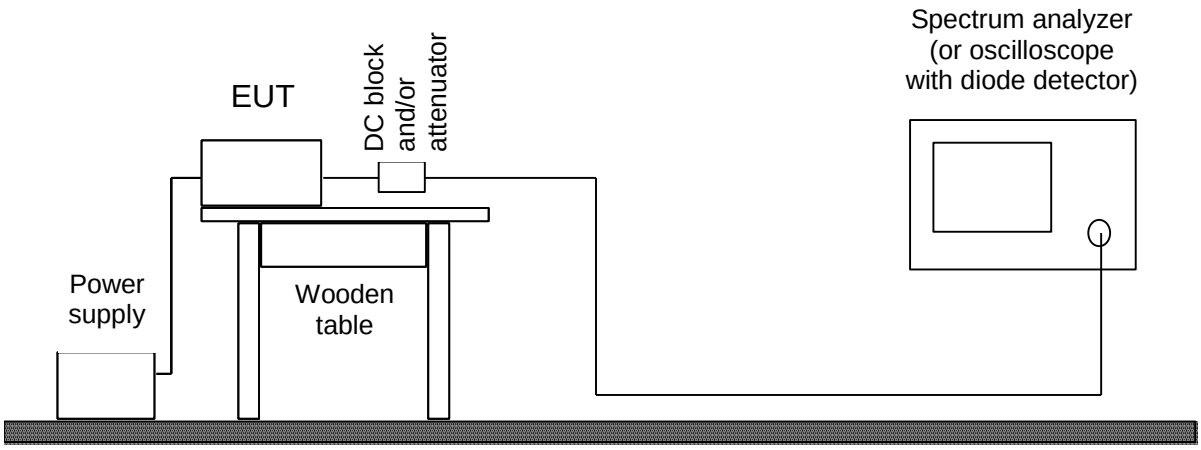
6.3 Pulse Train Measurement

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, section 15.35(c)
Guide:	ANSI C63.10
Measurement setup:	☒ Conducted: See below (direct connection or via test fixture) ☐ Radiated: Radiated Emission in Fully or Semi Anechoic Room (6.6)

If antenna is detachable pulse train measurements shall be performed at the antenna connector (conducted measurement). The RF output terminals are connected to a spectrum analyzer or to a diode detector in combination with an oscilloscope. 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 antenna is not detachable a test fixture may be used instead of direct connection to RF output terminals.

If radiated measurements are performed similar test setups and instruments are used as with radiated emission measurements for the appropriate frequency range. However, the spectrum analyzer may be replaced by a diode detector connected to an oscilloscope.



Test instruments used:

	Type	*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Spectrum analyzer	FSP30	1666	100063	Rohde & Schwarz
☒	EMI test receiver	ESPI7	1711	836914/0002	Rohde & Schwarz
☐	EMI test receiver	ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☐	Power meter	NRVS	1264	836856/015	Rohde & Schwarz
☐	Peak power sensor	NRV-Z31	1701	8579604.03	Rohde & Schwarz
☐	Power sensor	NRV-Z52	1499	837901/030	Rohde & Schwarz
☐	Power sensor	NRV-Z4	1034	863828/015	Rohde & Schwarz
☐	DC-block	7006	1636	A2798	Weinschel
☒	Microwave cable	ST-18/SMAm/SMAm/48	1949	696378	Huber+Suhner
☐	Attenuator	4776-10	1638	9412	Narda
☐	Attenuator	4776-20	1639	9503	Narda

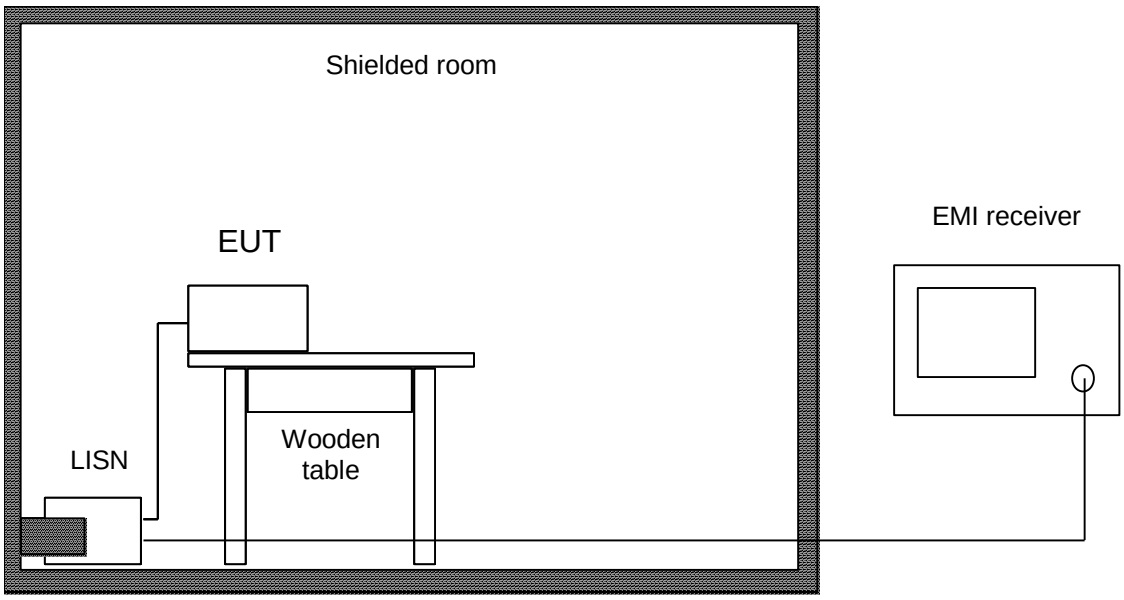
6.4 Conducted AC Powerline Emission

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.107 and 15.207
Guide:	ANSI C63.4 (CISPR 22)

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

First the whole spectrum of emission caused by the equipment under test (EUT) is recorded with detector set to peak using CISPR bandwidth of 10 kHz. After that all emission levels having less margin than 10 dB to or exceeding the average limit are retested with detector set to quasi-peak.
If average limit is kept with quasi-peak levels no additional scan with average detector is necessary. In cases of emission levels between quasi-peak and average limit an additional scan with detector set to average is performed.

According to ANSI C63.4, section 13.1.3.1, testing of intentional radiators with detachable antenna shall be performed using a suitable dummy load connected to the antenna output terminals. Otherwise, the tests shall be made with the antenna connected and, if adjustable, fully extended.
Testing with dummy load may be necessary to distinguish (unintentional) conducted emissions on the supply lines from (intentional) emissions radiated by the antenna and coupling directly to supply lines and/or LISN. Usage of dummy load has to be stated in the appropriate test record(s) and notes should be added to clarify the test setup.



Test instruments used:

	Type	*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Test receiver	ESHS 10	1028	860043/016	Rohde & Schwarz
☒	V-network	ESH 3-Z5	1060	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

6.5 Radiated Emission Measurement 9 kHz to 30 MHz

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, section 15.35(c)
Guide:	ANSI C63.10

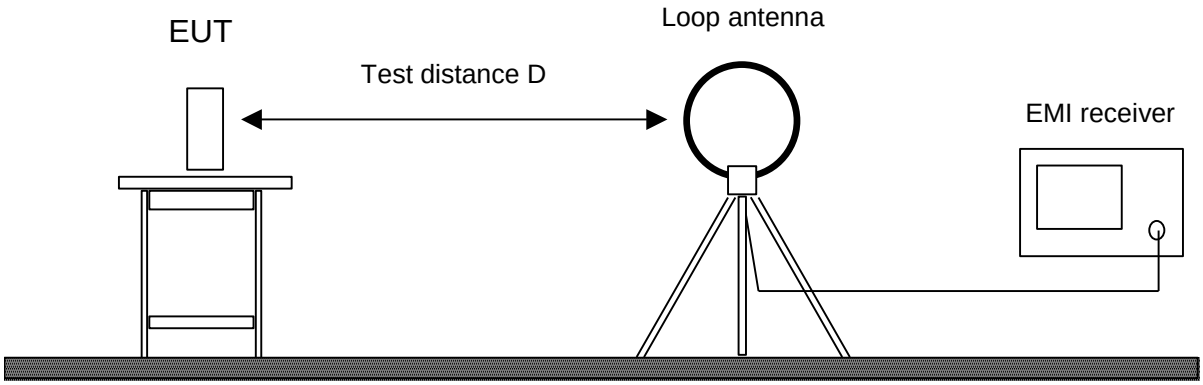
Radiated emission in the frequency range 9 kHz to 30 MHz is measured using an active loop antenna. First the whole spectrum of emission caused by the equipment is recorded at a distance of 3 meters in a fully or semi anechoic room with the detector of the spectrum analyzer or EMI receiver set to peak.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

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

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

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

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



Test instruments used:

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☐	Spectrum analyzer		FSP30	1666	100036	Rohde & Schwarz
☐	EMI test receiver		ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☐	Test receiver		ESHS 10	1028	860043/016	Rohde & Schwarz
☒	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☐	Preamplifier	Cabin no. 2	CPA9231A	1716	3557	Schaffner
☒	Loop antenna		HFH2-Z2	1016	882964/1	Rohde & Schwarz
☐	Microwave cable	Cabin no. 2	UFA210A-FG	1681	23516	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 2	KKSF1040016	2020	289854/4	Huber + Suhner
☐	Microwave cable	Cabin no. 2	FA210AF020000000	2060	64566-2	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	EF393	2053	---	Albatross Projects
☐	Microwave cable	Cabin no. 8	FB293C1050005050	2054	63834-1	Rosenberger Micro-Coax
☒	Microwave cable	Cabin no. 8	FB293C1080005050	2055	63833-1	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
☒	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.4.12	RFS
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
☐	Microwave cable	Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF04000505G	2056	64567-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
☐	Fully anechoic room		No. 2	1452	---	Albatross
☐	Semi anechoic room		No. 3	1453	---	Siemens
☒	Semi anechoic room		No. 8	2057	---	Albatross

6.6 Radiated Emission in Fully or Semi Anechoic Room

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.231
Guide:	ANSI C63.4

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

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

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

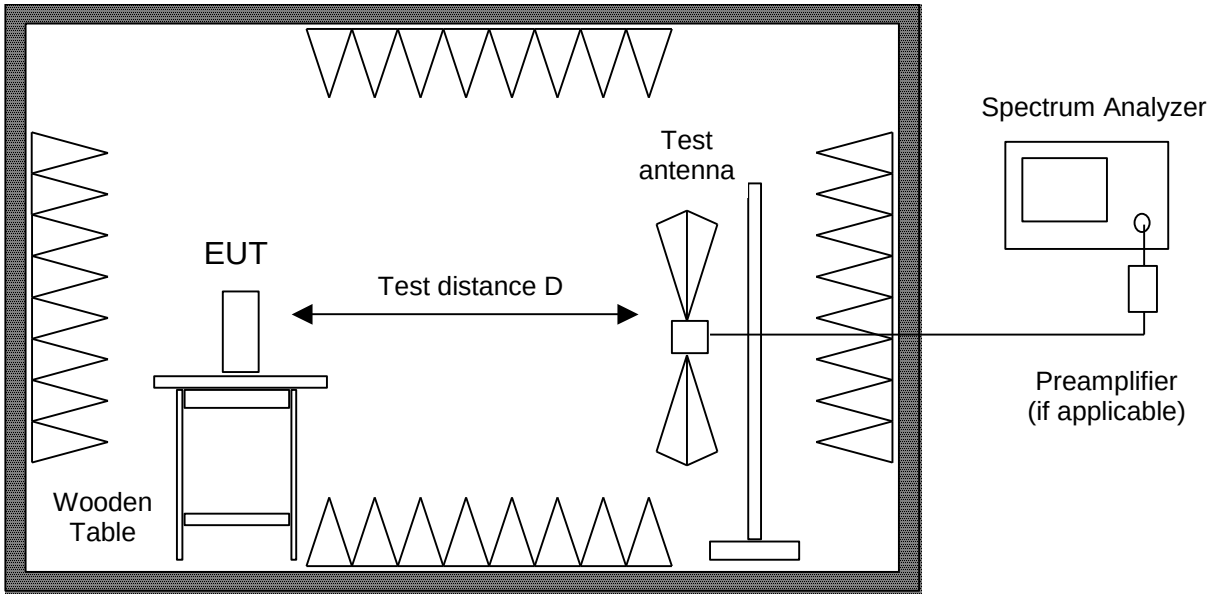
All tests below 8.2 GHz are performed at a test distance D of 3 meters. For higher frequencies the test distance may be reduced (e.g. to 1 meter) due to the sensitivity of the measuring instrument(s) and the test results are calculated according to CFR 47 Part 15 section 15.31(f)(1) using an extrapolation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

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

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

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

For final testing below 1 GHz a semi anechoic room complying with the NSA requirements of ANSI C63.4 for alternative test sites is used (see 6.7). 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
☒	EMI test receiver	Cabin no. 3	ESPI7	2010	101018	Rohde & Schwarz
☐	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☐	EMI test receiver		ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☐	Preamplifier	Cabin no. 2	CPA9231A	1716	3557	Schaffner
☐	Preamplifier		R14601	1142	13120026	Advantest
☒	Preamplifier (1 - 8 GHz)		AFS3-00100800-32-LN	1684	847743	Miteq
☐	Preamplifier (0.5 - 8 GHz)		AMF-4D-005080-25-13P	1685	860149	Miteq

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Preamplifier (8 - 18 GHz)		ACO/180-3530	1484	32641	CTT
☐	External Mixer		WM782A	1576	845881/005	Tektronix
☐	Harmonic Mixer Accessories		FS-Z30	1577	624413/003	Rohde & Schwarz
☐	Trilog antenna	Cabin no. 2	VULB 9163	1802	9163-214	Schwarzbeck
☐	Trilog antenna	Cabin no. 3	VULB 9163	1722	9163-188	Schwarzbeck
☐	Trilog antenna	Cabin no. 8	VULB 9163	2058	9163-408	Schwarzbeck
☐	Trilog antenna	Cabin no. 2	VULB 9162	2256	9162-048	Schwarzbeck
☒	Horn antenna		3115	1516	9508-4553	EMCO
☐	Horn antenna		3160-03	1010	9112-1003	EMCO
☒	Horn antenna		3160-04	1011	9112-1001	EMCO
☒	Horn antenna		3160-05	1012	9112-1001	EMCO
☒	Horn antenna		3160-06	1013	9112-1001	EMCO
☐	Horn antenna		3160-07	1014	9112-1008	EMCO
☐	Horn antenna		3160-08	1015	9112-1002	EMCO
☐	Horn antenna		3160-09	1265	9403-1025	EMCO
☐	Horn antenna		3160-10	1575	399185	EMCO
☒	Microwave cable	Cabin no. 2	UFA210A-FG	1681	23516	Rosenberger Micro-Coax
☒	Microwave cable	Cabin no. 2	KKSF1040016	2020	289854/4	Huber + Suhner
☒	Microwave cable	Cabin no. 2	FA210AF020000000	2060	64566-2	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	EF393	2053	---	Albatross Projects
☐	Microwave cable	Cabin no. 8	FB293C1050005050	2054	63834-1	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FB293C1080005050	2055	63833-1	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.4.12	RFS
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
☐	Microwave cable	Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF04000505G	2056	64567-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
☒	Fully anechoic room		No. 2	1452	---	Albatross
☐	Semi anechoic room		No. 8	2057	---	Albatross

6.7 Radiated Emission at Alternative Test Site

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.231
Guide:	ANSI C63.4

Radiated emission in the frequency range 30 MHz to 1 GHz is measured within a semi-anechoic room with groundplane complying with the NSA requirements of ANSI C63.4 for alternative test sites. A linear polarized logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna") is used. The measurement bandwidth of the test receiver is set to 120 kHz with quasi-peak detector selected.

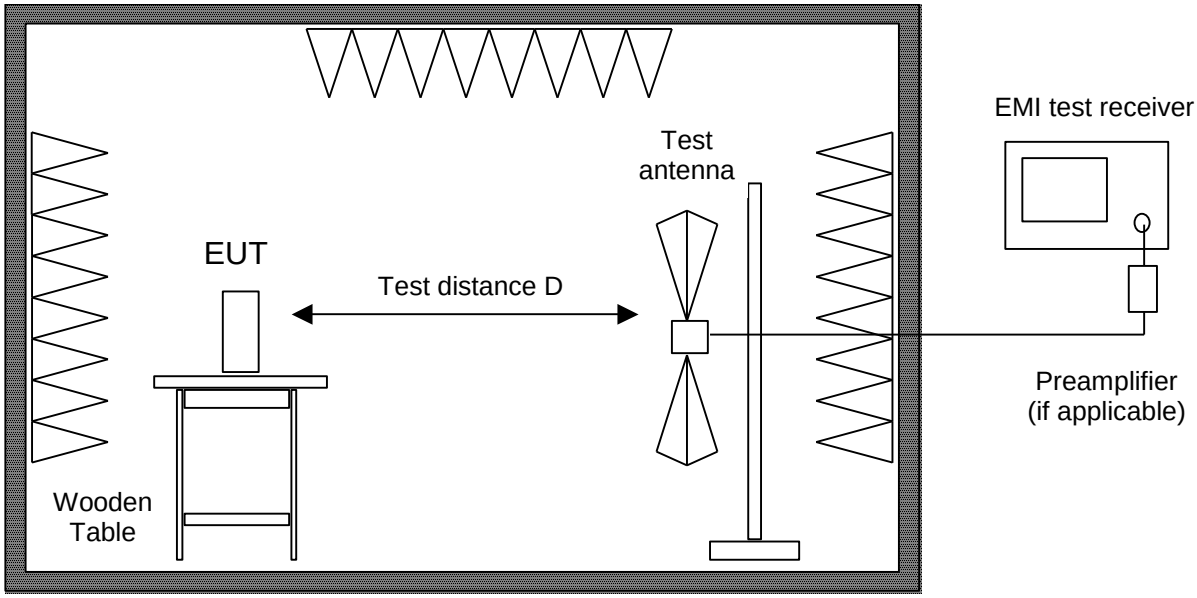
If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete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

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

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

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

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



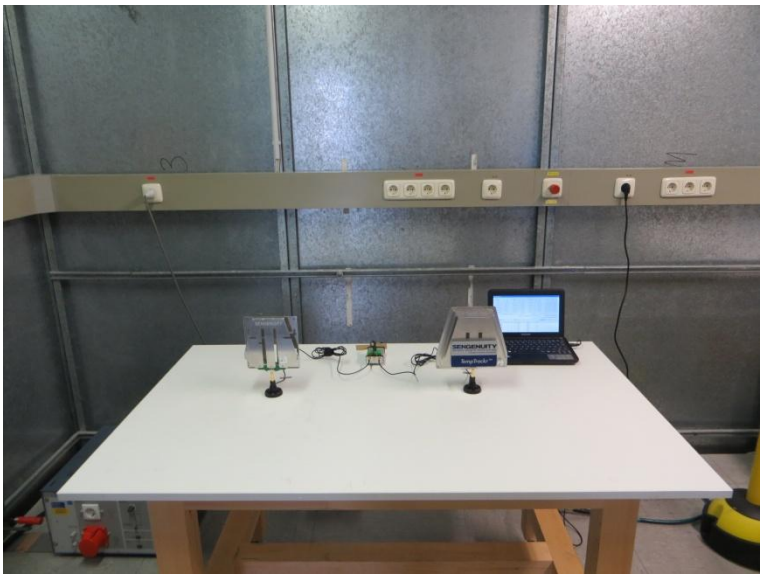
Alternate test site (semi anechoic room)

Test instruments used:

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☒	Trilog antenna	Cabin no. 8	VULB 9163	2058	9163-408	Schwarzbeck
☒	Microwave cable	Cabin no. 8	EF393	2053	---	Albatross Projects
☒	Microwave cable	Cabin no. 8	FA210AF04000505G	2056	64567-01	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.6.19	RFS
☒	Microwave cable	Cabin no. 8	LCF12-50	2057	P1.3.9	RFS
☐	Microwave cable	Cabin no. 8	FA210AF04000505	2068	64610-1	Rosenberger Micro-Coax
☐	Microwave cable	Cabin no. 8	FA210AF040005050G	2127	72061-01	Rosenberger Micro-Coax
☐	Semi anechoic room		No. 8	2057	---	Albatross

7 Photographs Taken During Testing

Test setup for conducted AC powerline emission measurement



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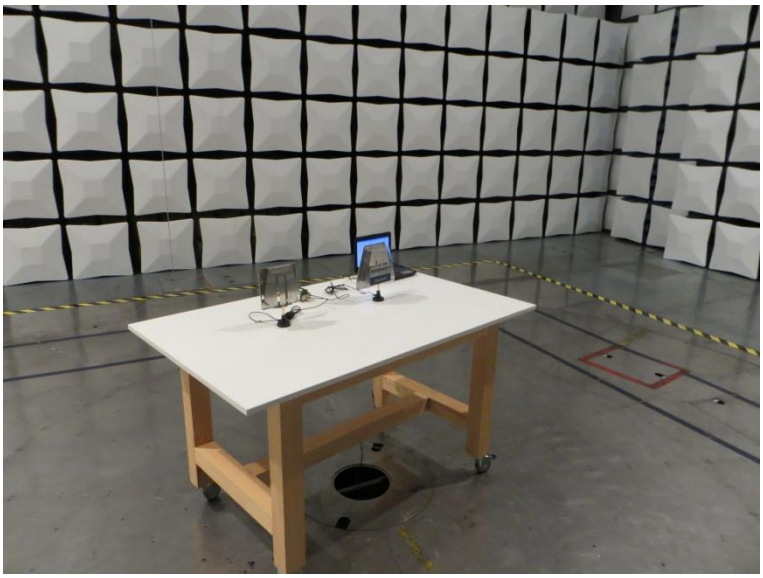
Test setup for conducted AC powerline emission measurement - continued -

Test setup for radiated emission measurement 9 kHz – 30 MHz



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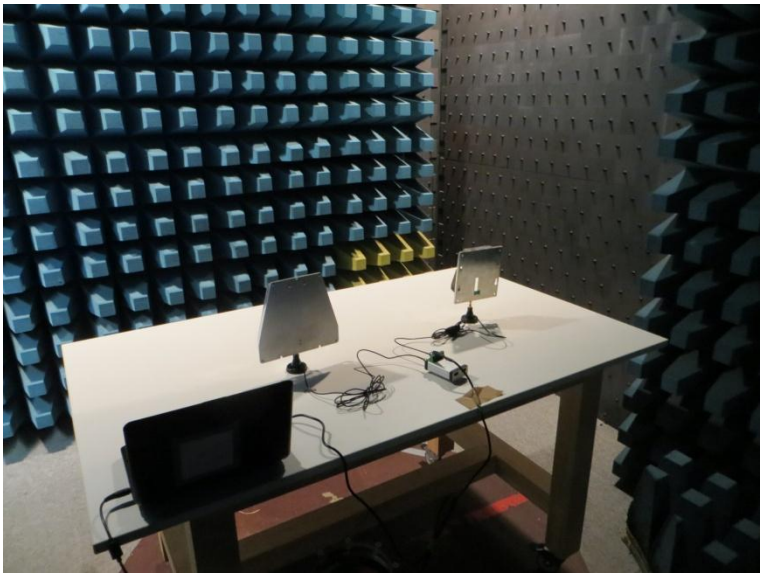
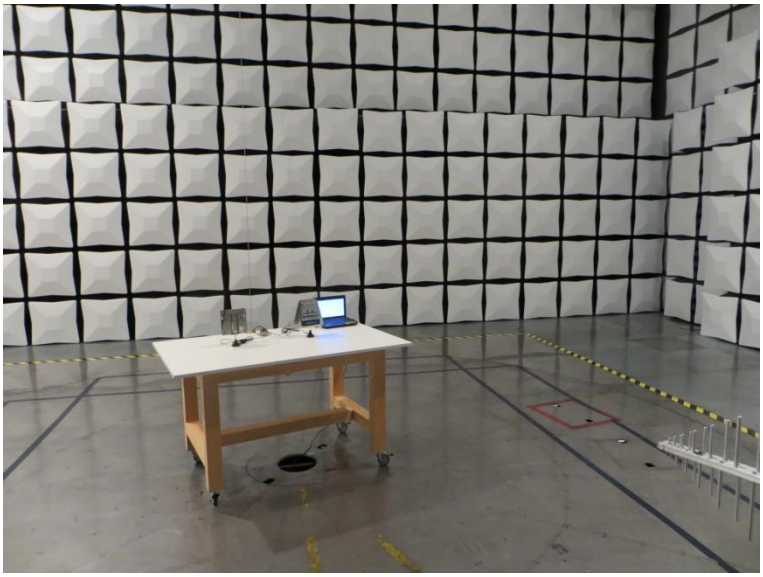
Product Service

Test setup for radiated emission measurement (fully anechoic room)



Test setup for radiated emission measurement (alternate test site)



8 Test Results for Transmitter

FCC CFR 47 Parts 2 and 15			
Section(s)	*Test*	*Page*	*Result*
2.1046(a)	Conducted output power	32	Recorded
2.202(a)	Occupied bandwidth	35	Recorded
15.215(c) 15.231(c)	Bandwidth of the emission	39	Test passed
2.201, 2.202	Class of emission	43	Calculated
15.35(c)	Pulse train measurement for pulsed operation	44	Recorded
15.205(a)	Restricted bands of operation	48	Test passed
15.207	Conducted AC powerline emission 150 kHz to 30 MHz	49	Test passed
15.205(b) 15.231(b) 15.231(e)	Radiated emission 9 kHz to 30 MHz	51	Test passed
15.205(b) 15.215(b) 15.231(b) 15.231(e)	Radiated emission 30 MHz to 4.5 GHz	53	Test passed
15.231(d)	Carrier frequency stability	---	Not applicable

8.1 Conducted Output Power

Rules and specifications:	CFR 47 Part 2, section 2.1046(a)
Guide:	ANSI C64.10 / CFR 47 Part 2, section 2.1046
Description:	Conducted output power shall be measured at the RF output terminals (e.g. antenna connector if antenna is detachable) when the transmitter is adjusted in accordance with the tune-up procedure, if applicable. The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.
Measurement procedure:	Conducted Output Power (6.1)

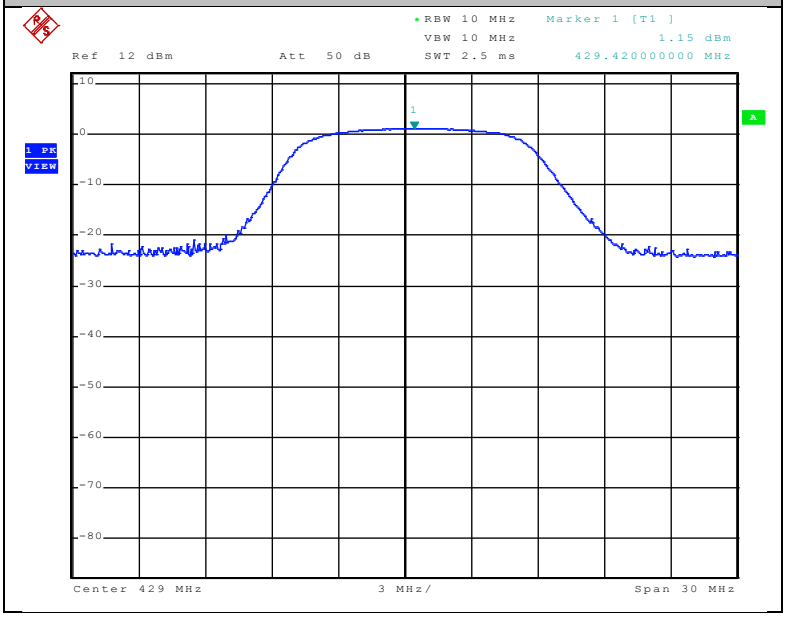
Comment:	Operating modes 3, 4, 5
Date of test:	February 9, 2015
Test site:	Unshielded room

Test Result:	Test passed

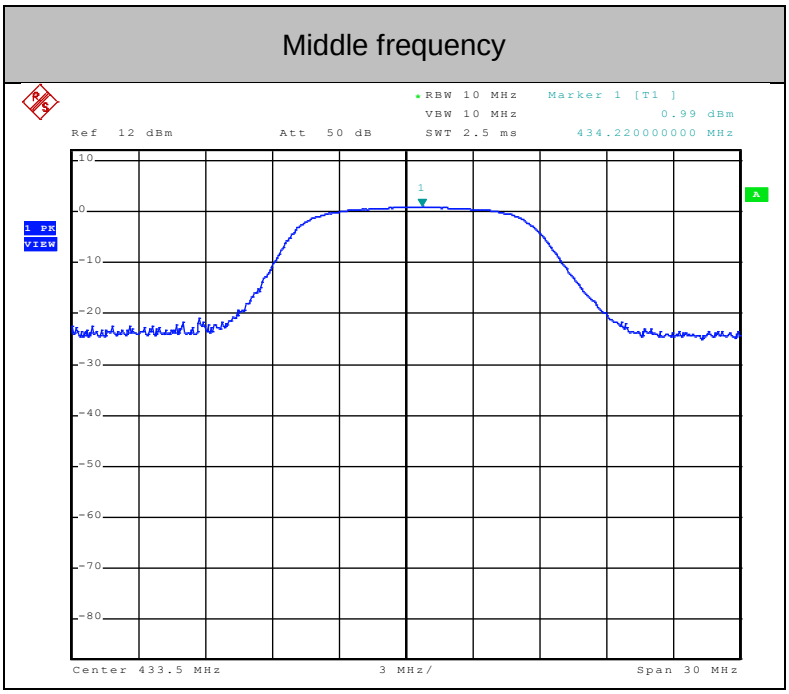
Antenna gain: 3,1 dBi

Mode	Frequency (MHz)	Power Type	Reading (dBm)	Correction (dB)	Output Power (dBm)	Limit (dBm)	Margin (dB)
3	429,0	Peak	-1,0	2,1	1,1		
4	434,9	Peak	-1,1	2,1	1,0		
5	439,4	Peak	-1,6	2,1	0,5		

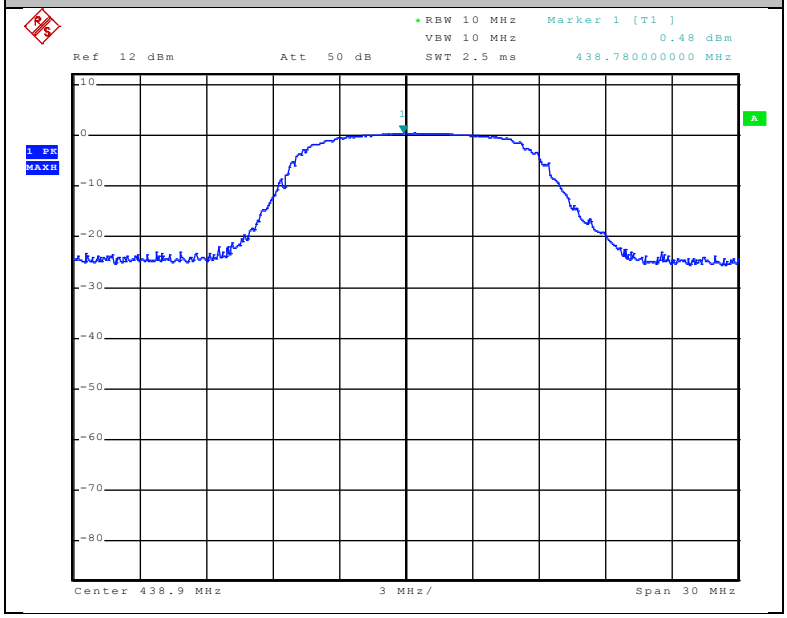
Lower frequency



Middle frequency



Upper frequency



Note 1: If applicable, PEP (peak envelope power) and RMS values are measured using a power meter with appropriate sensor.

Note 2: If applicable, peak or average values are measured using a spectrum analyzer with resolution and video bandwidth set to: RBW = 10MHz, VBW = 10MHz.

Note 3: If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power limit is reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

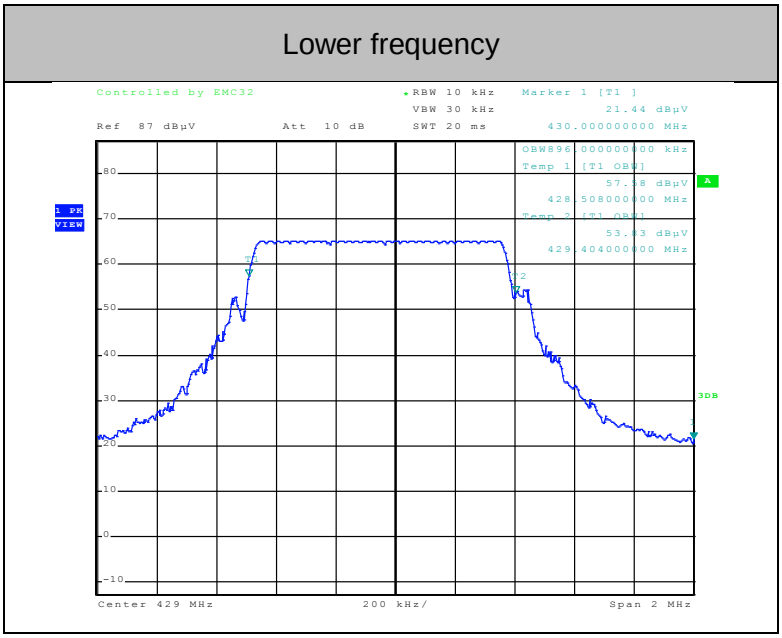
8.2 Occupied Bandwidth

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 analysator 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 analyzator at the selected resolution bandwidth shall be more than 10 dB below the target “dB down” (attenuation) requirement.
Measurement procedure:	Bandwidth Measurements (6.2)

Comment:	--
Date of test:	December 2, 2015
Test site:	Fully anechoic room, cabin no. 2

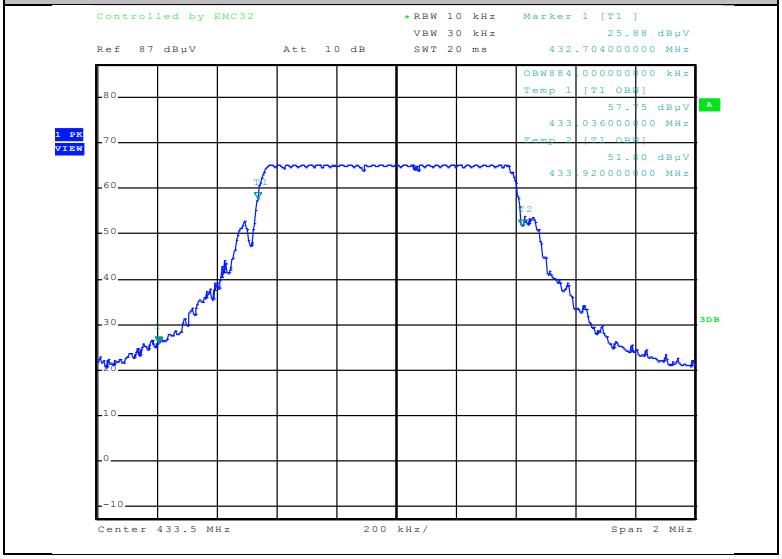
Occupied Bandwidth (99 %):

Lower frequency



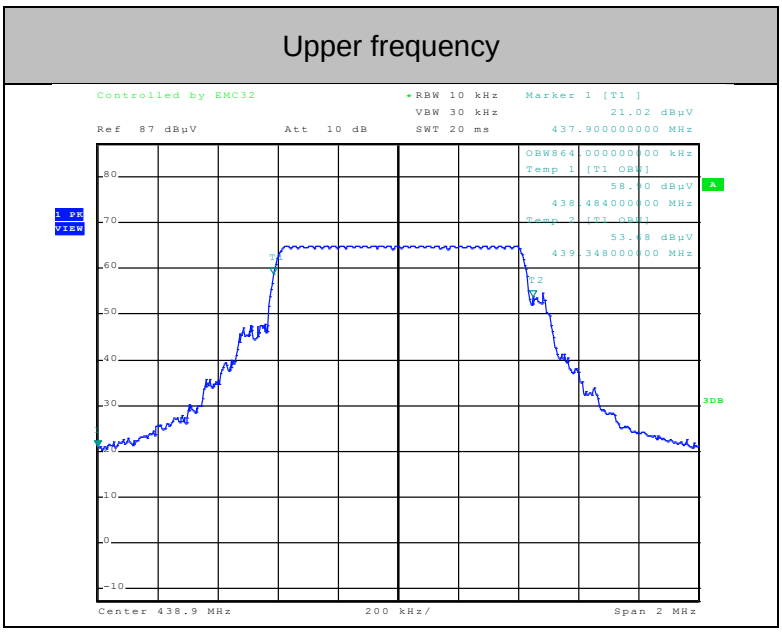
Occupied Bandwidth (99 %):	**896 kHz**

Middle frequency



Occupied Bandwidth (99 %):	**884 kHz**

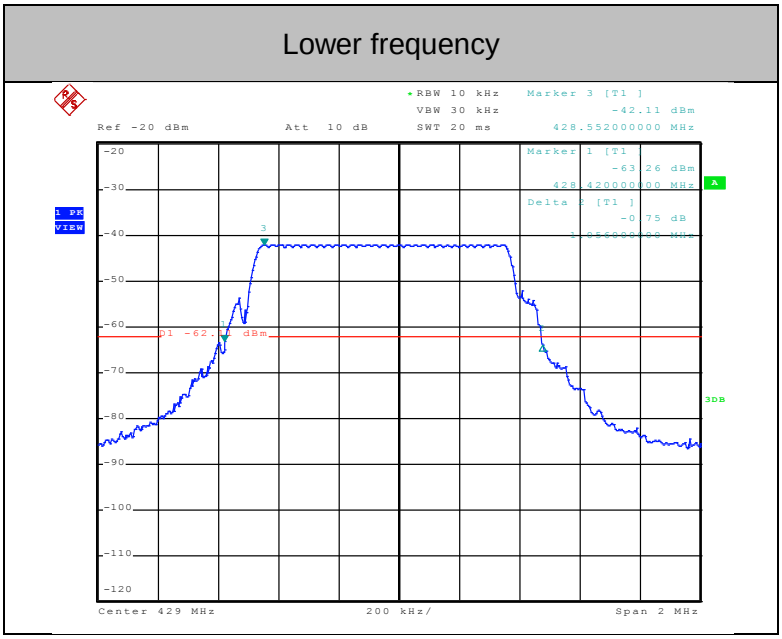
Upper frequency



Occupied Bandwidth (99 %):	**864 kHz**

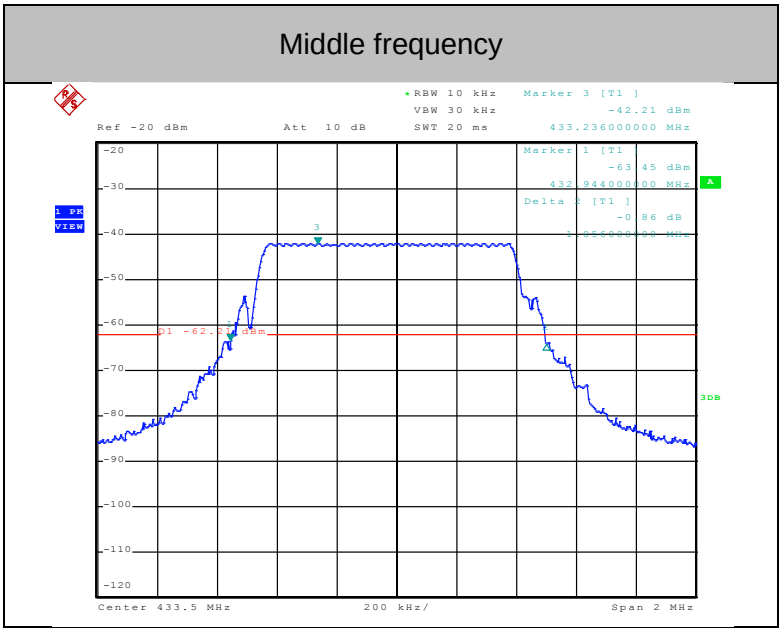
Occupied Bandwidth (-20 dB):

Lower frequency



Occupied Bandwidth (-20 dB):	**1056 kHz**

Middle frequency



Occupied Bandwidth (-20 dB):	**1056 kHz**

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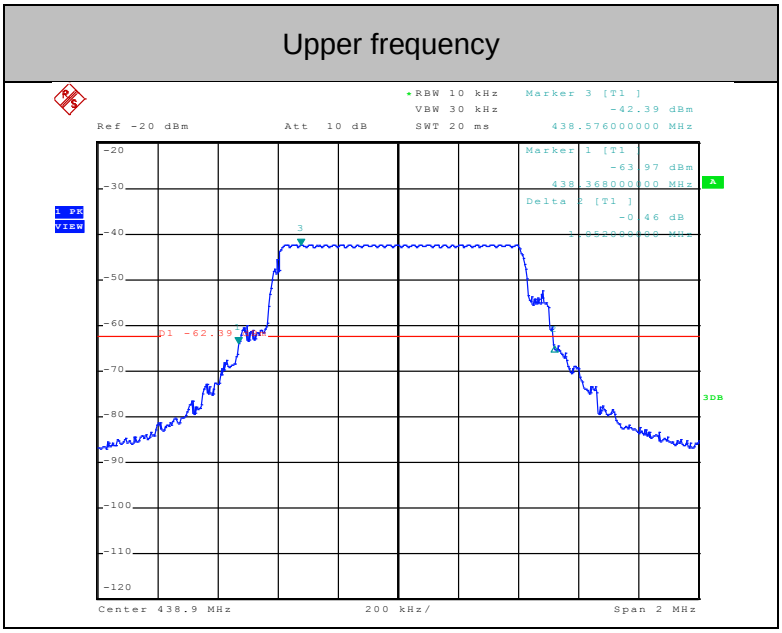
Upper frequency



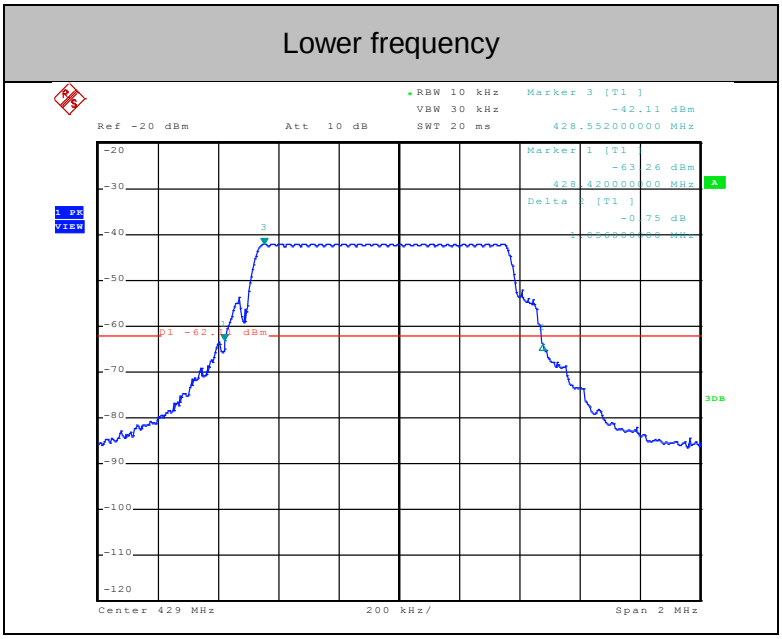
Occupied Bandwidth (-20 dB):	**1052 kHz**

8.3 Bandwidth of the Emission

<table>
<tr><td>Rules and specifications:</td><td colspan="2">CFR 47 Part 15, section 15.215(c)</td></tr>
<tr><td>Guide:</td><td colspan="2">ANSI C63.4</td></tr>
<tr><td>Description:</td><td colspan="2">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 resolution bandwidth of the spectrum analyzer shall be set to a value greater than 5.0% of the allowed bandwidth. If no bandwidth specifications are given, the following guidelines are used:</td></tr>
<tr><td></td><td>Fundamental frequency</td><td>Minimum resolution bandwidth</td></tr>
<tr><td></td><td>9 kHz to 30 MHz</td><td>1 kHz</td></tr>
<tr><td></td><td>30 MHz to 1000 MHz</td><td>10 kHz</td></tr>
<tr><td></td><td>1000 MHz to 40 GHz</td><td>100 kHz</td></tr>
<tr><td></td><td colspan="2">The video bandwidth shall be at least three times greater than the resolution bandwidth.</td></tr>
<tr><td>Measurement procedure:</td><td colspan="2">Bandwidth Measurements (6.2)</td></tr>
</table>

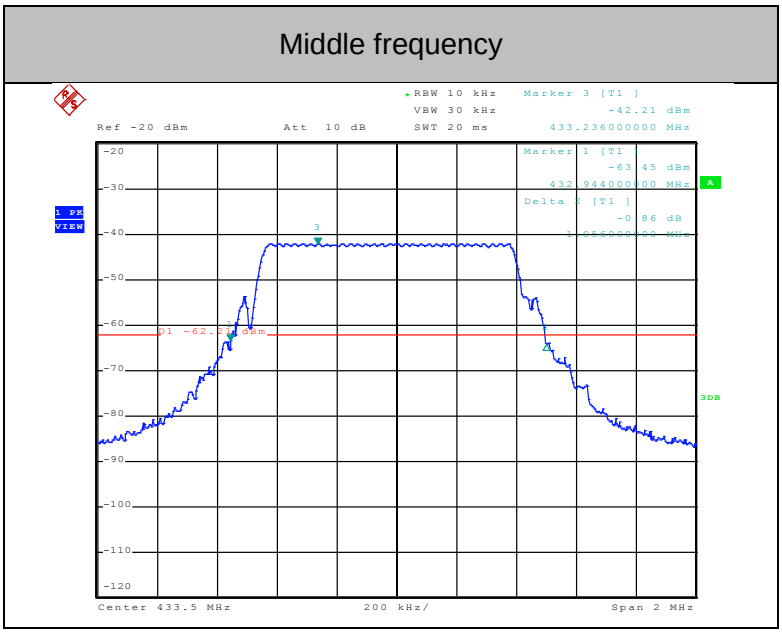
Comment:	--
Date of test:	December 2, 2015
Test site:	Fully anechoic room, cabin no. 2

Lower frequency

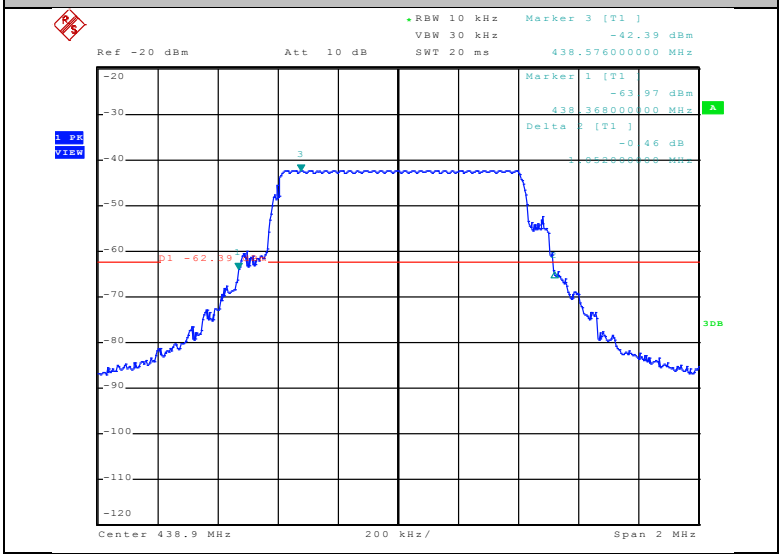


20dB bandwidth:	**1056 kHz**

Middle frequency



20dB bandwidth:	**1056 kHz**

Upper frequency


20dB bandwidth:	**1052 kHz**

Permitted frequency band:	**428.0 to 438.9 MHz**	
20 dB bandwidth:	**1084 kHz**	
Carrier frequency stability: Maximum frequency tolerances:	☐ **specified** **+..... kHz** **- ..... kHz**	☒ **not specified**
Bandwidth of the emission:	**1084 kHz**	**within permitted frequency band[5]:** ☒ **yes** ☐ **no**

Test Result:	Test passed

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

8.4 Bandwidth of Momentary Signals

Rules and specifications:	CFR 47 Part 15, section 15.231(c)
Guide:	ANSI C63.4
Limit:	For the purpose of Section A1.1, the 99% bandwidth shall be no wider than 0.25% of the centre frequency for devices operating between 70 and 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the centre frequency.

Frequency [MHz]	99% BW [MHz]	Limit [MHz]	Result
429.00	0.896	1.0725	**Pass**
433.50	0.884	1.08375	**Pass**
438.90	0.864	1.09725	**Pass**

Rules and specifications:	CFR 47 Part 15, section 15.231(c)
Guide:	ANSI C63.4
Limit:	The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz… Bandwidth is determined at the points 20 dB down from the modulated carrier.

Frequency [MHz]	20 dB BW [MHz]	Limit [MHz]	Result
429.00	1.056	1.0725	**Pass**
433.50	1.056	1.08375	**Pass**
438.90	1.052	1.09725	**Pass**

Test Result:	Test passed

8.5 Designation of Emissions

Rules and specifications:	CFR 47 Part 2, sections 2.201 and 2.202
Guide:	ANSI C63.4 / TRC-43

Frequency Modulation:

Type of modulation:	Frequency Modulation

B_n = Necessary Bandwidth	B_n = 2M + 2DK
M = Modulation frequency	M = 50 kHz
D = Peak deviation	D = 10 kHz
K = Overall numerical factor	K = 1
Calculation:	$B_n = 2 \cdot (50\ kHz) + 2 \cdot (10\ kHz) \cdot 1 = 120\ kHz$

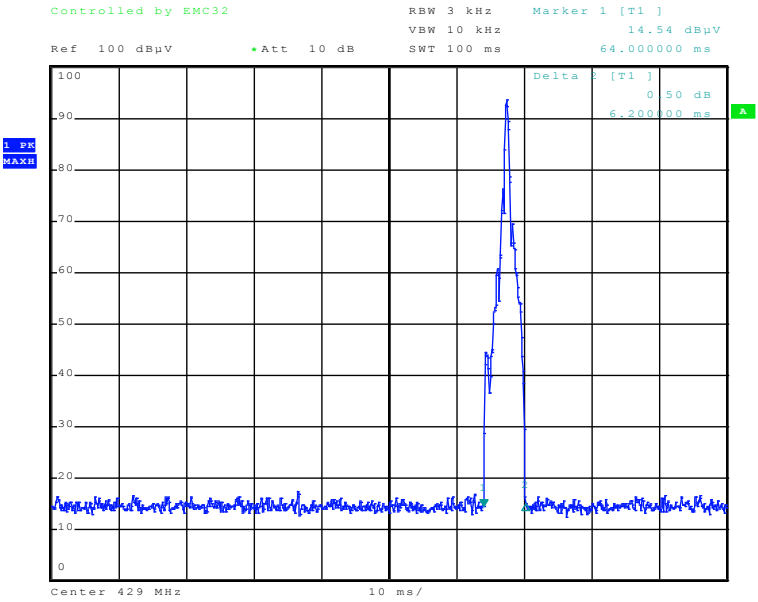
Designation of Emissions:	**120KF7D**

8.6 Pulse Train Measurement – Transmission duration – Silent Period

Rules and specifications:	CFR 47 Part 15, section 15.35(c) CFR 47 Part 15, section 15.231 (e)
Guide:	ANSI C63.4
Measurement procedure:	Pulse Train Measurement (6.10)

Comment:	--
Date of test:	2015-02-06
Test site:	Fully anechoic room, cabin no. 2

Total Pulse Train:



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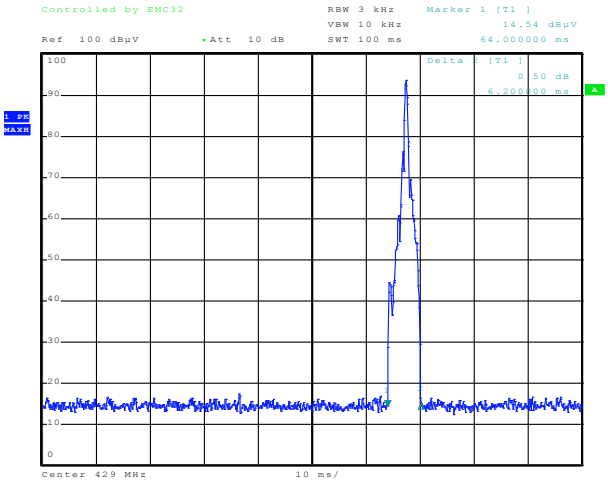
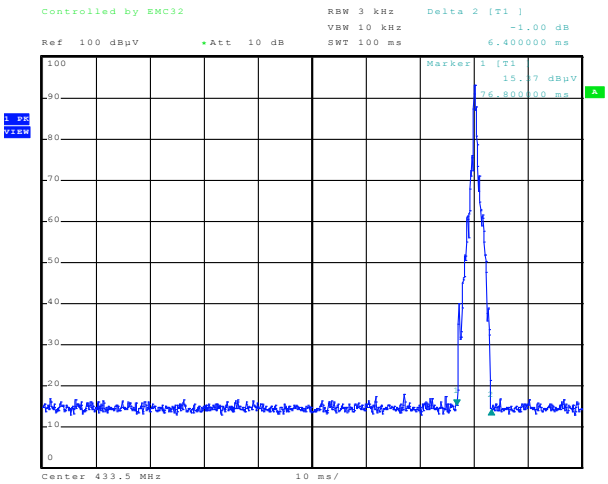
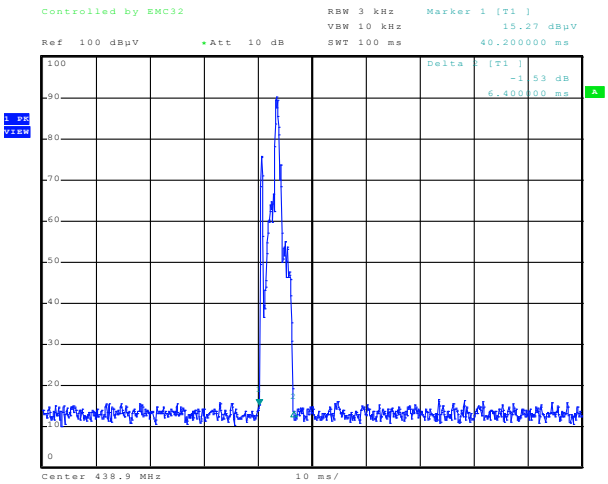
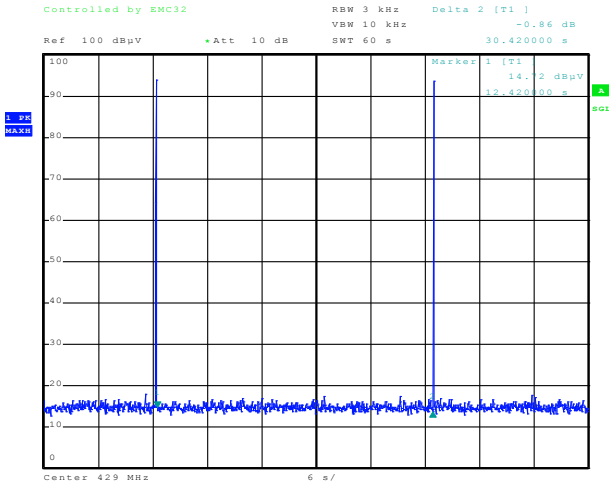
Worst case 0.1 second interval / Transmission duration:

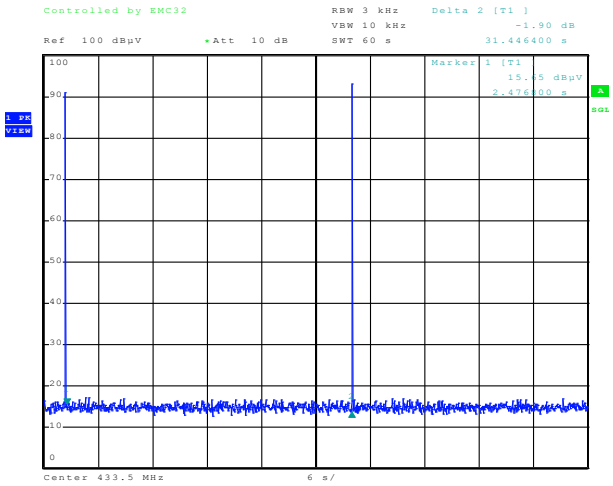


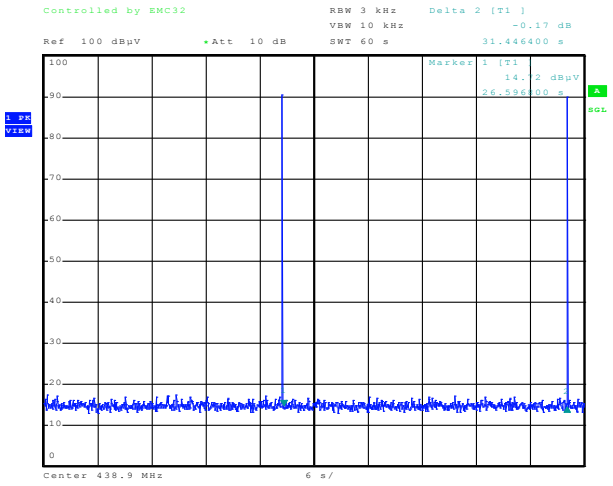




Silent period:







Transmission duration, Pulse train correction, silent period:

TX-On-Time (worst case):	T_{on}	=	6.4 ms	(Limit: <100ms)
TX-Off-Time (worst case):	T_{off}	=	31446.4 ms	(Limit: > 10 s)
Period Time:	T_{period}	=	31452.8 ms	
Pulse Train Correction:	C_{pt}	=	20 Log (T_{on} / T_{period}) dB	
		=	**-73.8 dB***	

* A maximum allowable correction factor of 20dB was used!

8.7 Restricted Bands of Operation

Rules and specifications:	CFR 47 Part 15, section 15.205(a)
Guide:	ANSI C63.10
Limit:	Only spurious emissions are permitted in any of the frequency bands listed in CFR 47 Part 15, section 15.205(a).
Measurement procedure:	Radiated Emission in Fully or Semi Anechoic Room (6.6)

Comment:	The fundamental is not in a restricted band and the spurious and harmonic emissions in the restricted band comply with the general emission limits of 15.209
Date of test:	February 10, 2015
Test site:	Fully anechoic room, cabin no. 2
Test distance:	3 meters

Test Result:	Test passed

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8.8 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

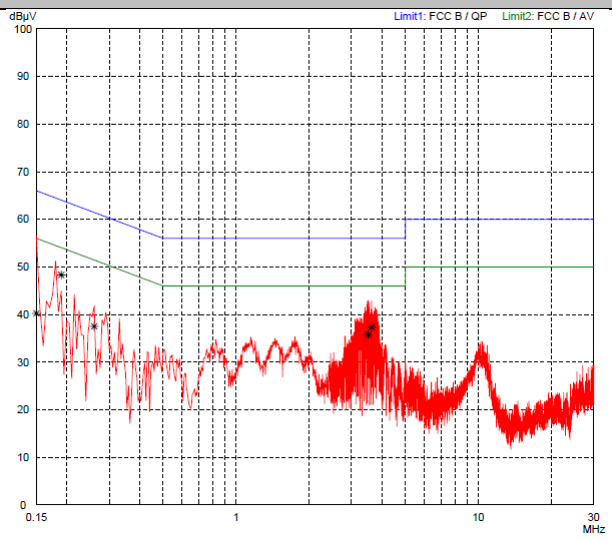
Rules and specifications:	CFR 47 Part 15, section 15.207		
Guide:	ANSI C63.10 / CISPR 22		
Limit:	Frequency of Emission (MHz)	Conducted Limit (dBµV)	
		Quasi-peak	Average
	0.15 - 0.5	66 to 56	56 to 46
	0.5 - 5	56	46
	5 - 30	60	50
Measurement procedure:	Conducted AC Powerline Emission (6.4)		

Comment:	Operating mode 1 & 2
Date of test:	February 10, 2015
Test site:	Shielded room, cabin no. 1

Test Result:	Test passed

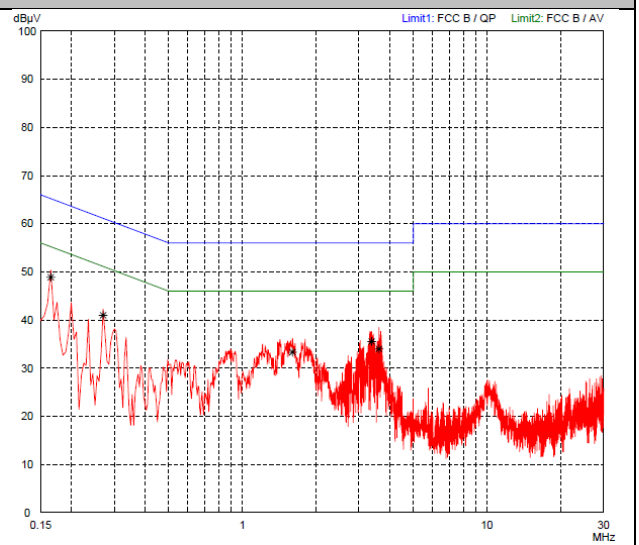
Operating mode 1

L1 (QP)



Frequency MHz	Reading dBµV	Correction factor dB	Value dBµV	Limit dBµV	Margin dB
0.15	40.2		40.2	66.0	25.8
0.19	48.3		48.3	64.0	15.7
0.26	37.5		37.5	61.4	23.9
3.51	35.8		35.8	56.0	20.2
3.63	37.4		37.4	56.0	18.6

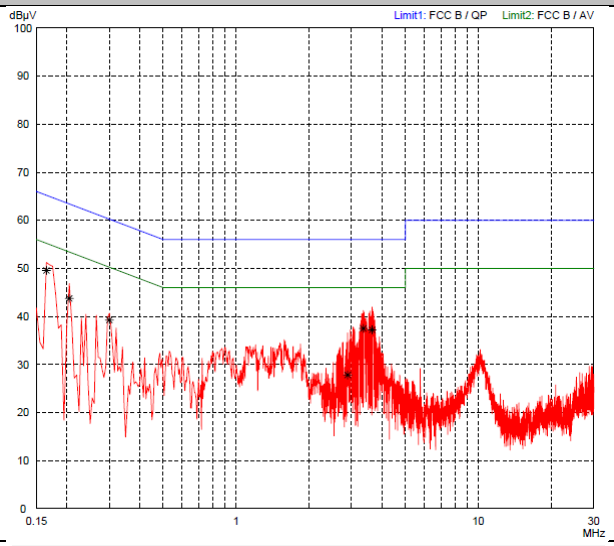
N (QP)



Frequency MHz	Reading dBµV	Correction factor dB	Value dBµV	Limit dBµV	Margin dB
0.165	48.9		48.9	65.2	16.3
0.270	41.0		41.0	61.1	20.1
1.605	33.3		33.3	56.0	22.7
3.380	35.5		35.5	56.0	20.5
3.620	34.0		34.0	56.0	22.0

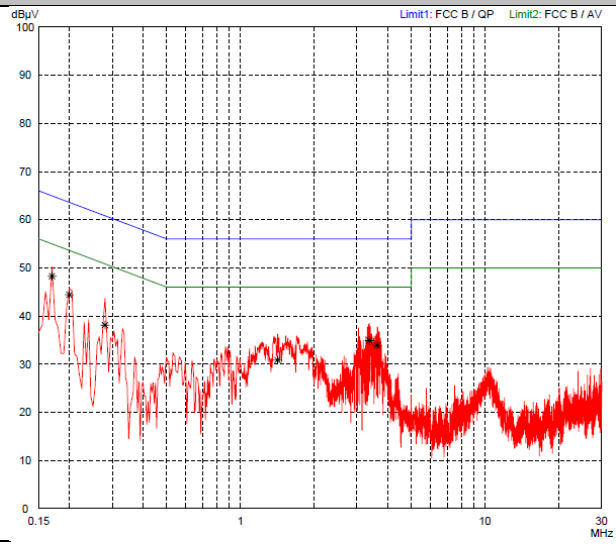
Operating mode 2

L1 (QP)



Frequency MHz	Reading dBµV	Correction factor dB	Value dBµV	Limit dBµV	Margin dB
0.165	49.6		49.6	65.2	15.6
0.205	43.7		43.7	63.4	19.7
0.300	39.2		39.2	60.2	21.0
2.890	27.8		27.8	56.0	28.2
3.355	37.5		37.5	56.0	18.5
3.645	37.2		37.2	56.0	18.8

N (QP)



Frequency MHz	Reading dBµV	Correction factor dB	Value dBµV	Limit dBµV	Margin dB
0.170	48.3		48.3	65.0	16.7
0.200	44.4		44.4	63.6	19.2
0.280	38.1		38.1	60.8	22.7
1.420	30.8		30.8	56.0	25.2
3.370	34.9		34.9	56.0	21.1
3.625	33.9		33.9	56.0	22.1

Sample calculation of final values:

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

8.9 Radiated Emission Measurement 9 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, sections 15.215(b) and 15.231(b)(3)			
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 (6.5)			

Comment:	Operating mode 3 / 4 / 5 / 6 / 7 / 8
Date of test:	February 10, 2015
Test site:	Alternative test site

Test Result:	Test passed

Note: No results!

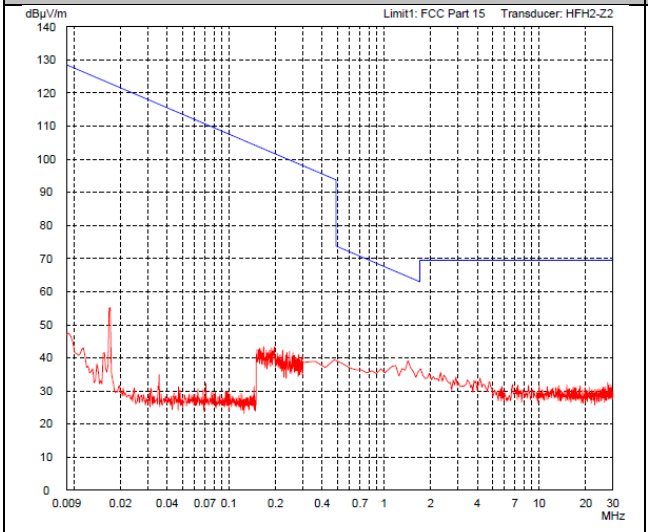
Sample calculation of final values:

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)

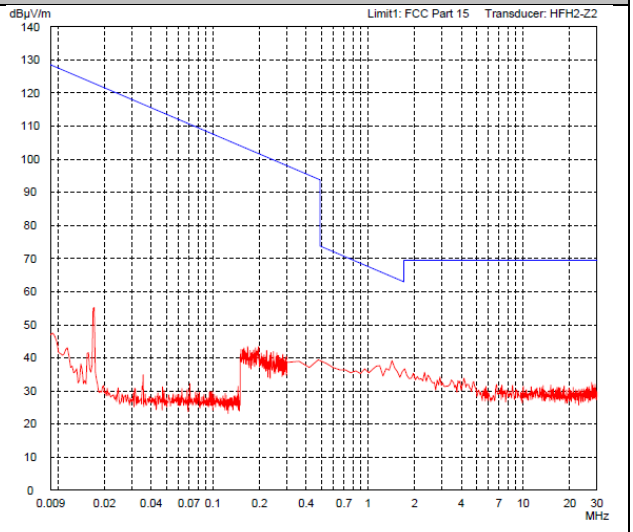
Note: Extrapolation factor (dB) and final value (dBµV/m) are relating to distance d.

Operating mode 3



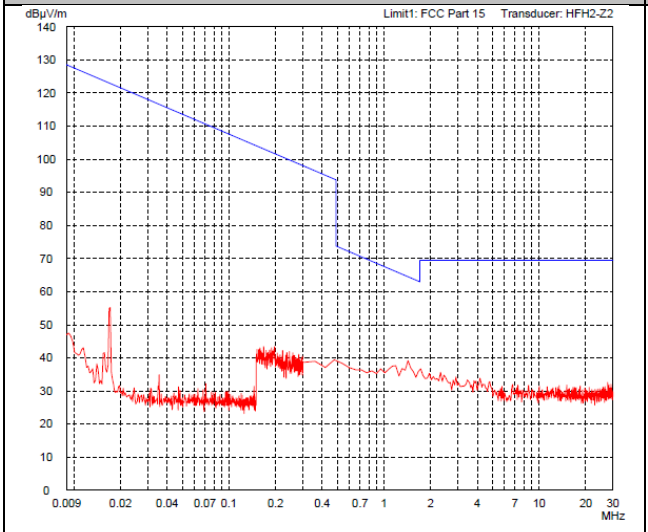
Frequency [MHz]	Reading [dBµV]	Correction factor [dB]	Value [dBµV/m]	Limit [dBµV/m]	Limit exceeded
no results					

Operating mode 4



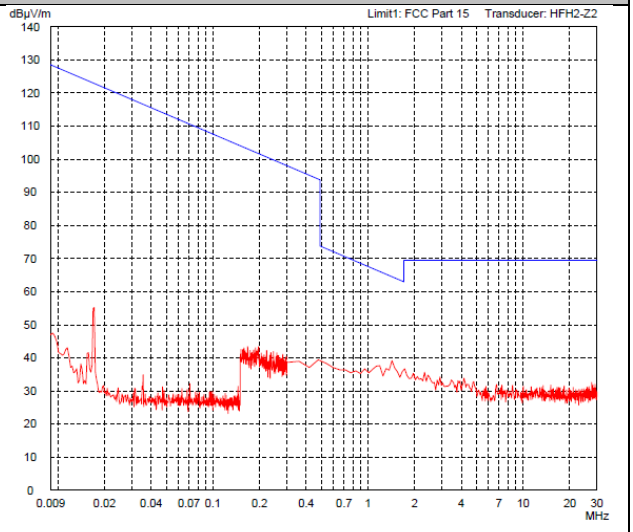
Frequency [MHz]	Reading [dBµV]	Correction factor [dB]	Value [dBµV/m]	Limit [dBµV/m]	Limit exceeded
no results					

Operating mode 5

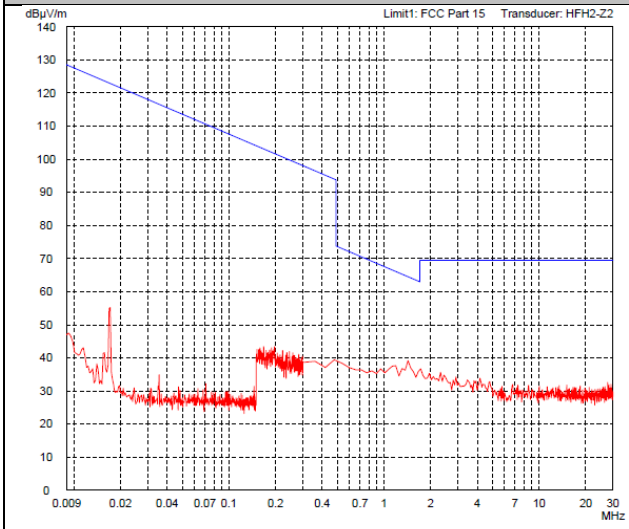
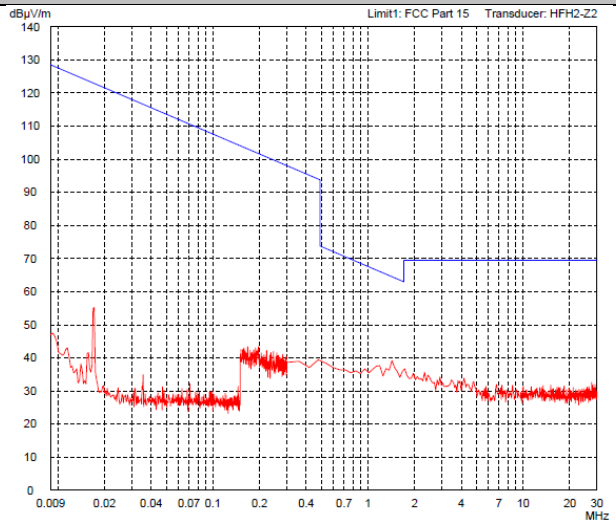


Frequency [MHz]	Reading [dBµV]	Correction factor [dB]	Value [dBµV/m]	Limit [dBµV/m]	Limit exceeded
no results					

Operating mode 6



Frequency [MHz]	Reading [dBµV]	Correction factor [dB]	Value [dBµV/m]	Limit [dBµV/m]	Limit exceeded
no results					

Operating mode 7	Operating mode 8
	

Frequency [MHz]	Reading [dBµV]	Correction factor [dB]	Value [dBµV/m]	Limit [dBµV/m]	Limit exceeded
no results					

Frequency [MHz]	Reading [dBµV]	Correction factor [dB]	Value [dBµV/m]	Limit [dBµV/m]	Limit exceeded
no results					

Sample calculation of final values:

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

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

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

8.10 Radiated Emission Measurement 30 MHz to 4.5 GHz

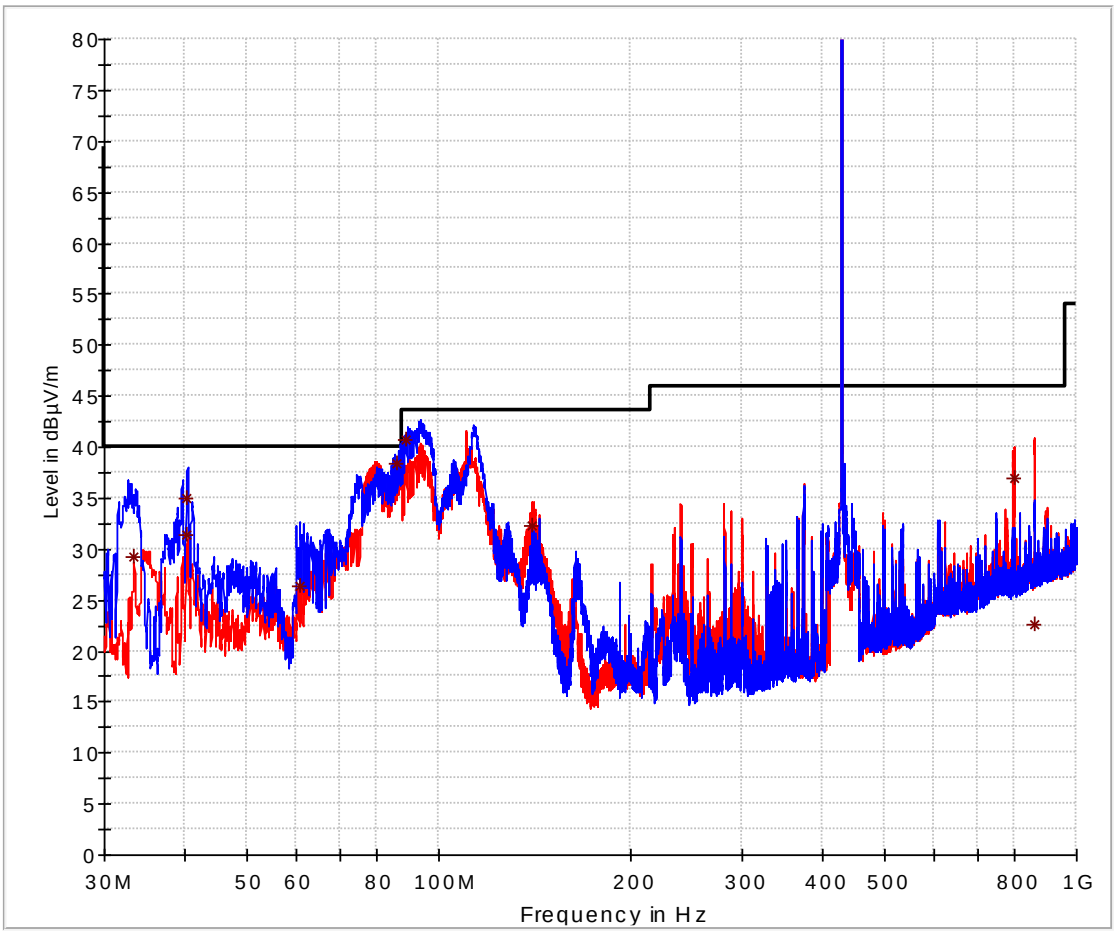
Rules and specifications:	CFR 47 Part 15, sections 15.205, 15.215(b) and 15.231(e)				
Guide:	ANSI C63.10				
Limit:	In addition to the provisions of section 15.205, the field strength shall not exceed the levels as listed in the table below or the general limits shown in section 15.209, whichever limit permits a higher field strength. In no case shall the level of the unwanted emissions exceed the field strength of the fundamental emission.				
	Frequency of Emission (MHz)	Field Strength of Fundamental (µV/m)	(dBµV/m)	Field Strength of Spurious Emissions (µV/m)	(dBµV/m)
	40.66 - 40.70	1,000	60.0	100	40.0

	70 - 130	500	54.0	50	34.0
	130 - 174	500 to 1,500 *	54.0 to 63.5	50 to 150 *	34.0 to 43.5
	174 - 260	1,500	63.5	150	43.5
	260 - 470	1,500 to 5,000 *	63.5 to 74.0	150 to 500 *	43.5 to 54.0
	Above 470	5,000	74.0	500	54.0
	* linear interpolations				
Measurement procedures:	Radiated Emission in Fully or Semi Anechoic Room (6.6) Radiated Emission at Alternative Test Site (6.7)				

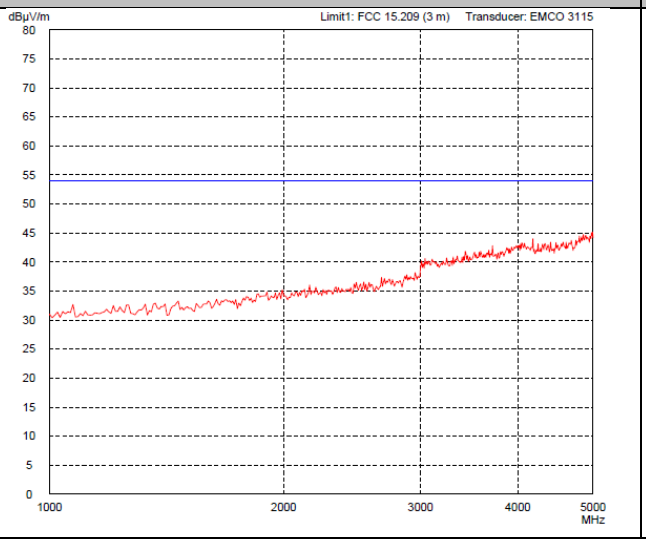
Comment:	Operating mode 3 / 4 / 5 / 6 / 7 / 8
Date of test:	February 9, 10, 2015
Test site:	Frequencies ≤ 1 GHz: Semi-anechoic room, cabin no. 8 Frequencies > 1 GHz: Fully anechoic room, cabin no. 2
Test distance:	3 meters

Test Result:	Test passed

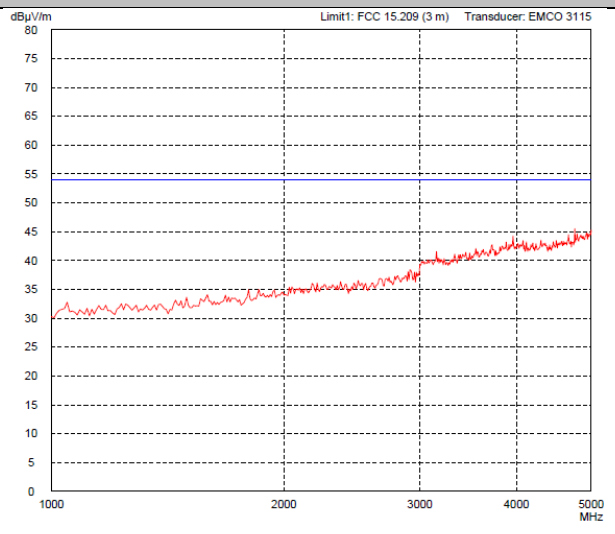
Operating mode 3



Horizontal Polarization



Vertical Polarization



Final measurement values:

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)
33,420	vertical	Quasi-Peak	15,3	13,9	0,0	29,2	40,0	10,8
40,240	vertical	Quasi-Peak	15,7	15,6	0,0	31,3	40,0	8,7
40,350	vertical	Quasi-Peak	19,4	15,6	0,0	35,0	40,0	5,0
60,560	vertical	Quasi-Peak	12,1	14,3	0,0	26,4	40,0	13,6
85,850	vertical	Quasi-Peak	27,0	11,5	0,0	38,5	40,0	**1,5**
88,740	vertical	Quasi-Peak	28,5	12,2	0,0	40,7	43,5	2,8
140,330	horizontal	Quasi-Peak	22,2	10,1	0,0	32,3	43,5	11,2
799,560	horizontal	Quasi-Peak	13,6	23,3	0,0	36,9	46,0	9,1
857,370	horizontal	Quasi-Peak	-1,7	24,3	0,0	22,6	46,0	23,4

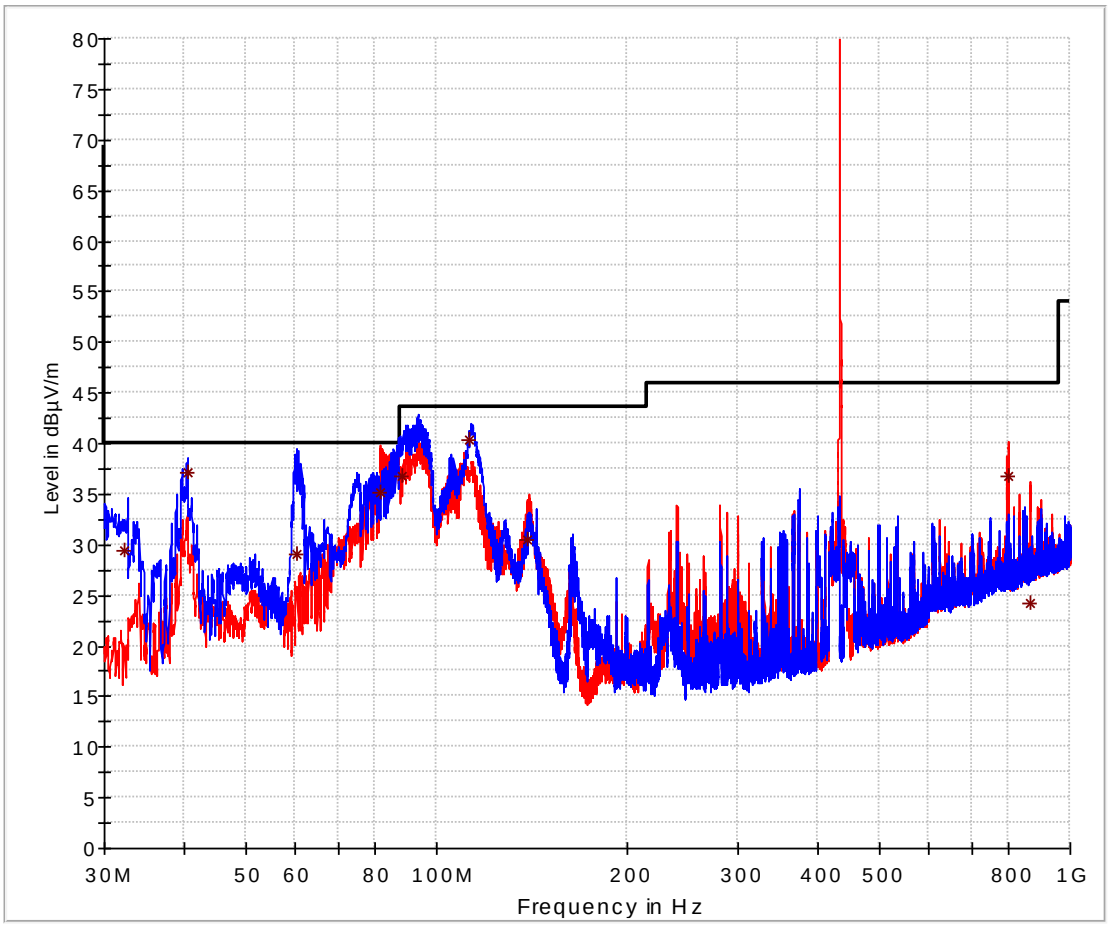
Fundamental field strength:

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)
429,000	vertical	Quasi-Peak	72,6	17,8	-20,0	70,4	73,0	**2,6**

Sample calculation of final values:

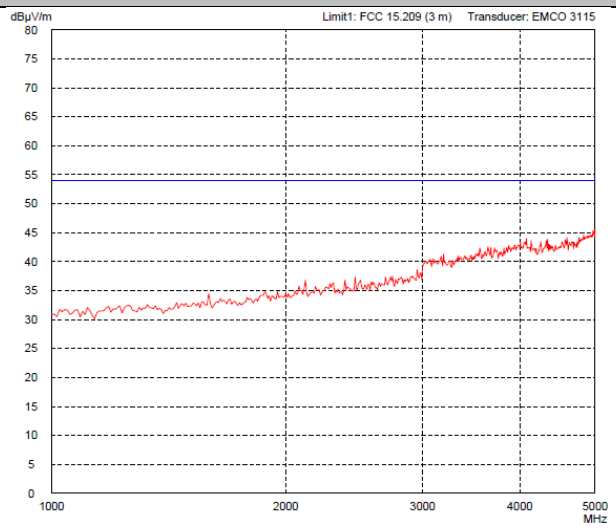
Final Value (dBµV/m) = Reading Value (dBµV) + Correction Factor (dB/m) + Pulse Train Correction (dB)

Operating mode 4

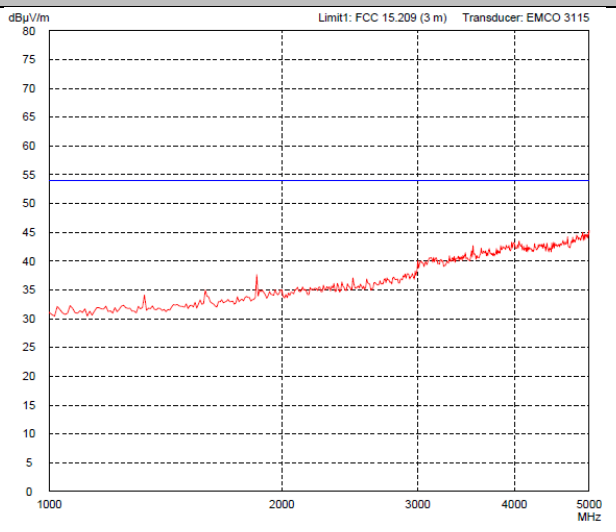


FCC 15.209
Preview Result 1V-PK+
Preview Result 1H-PK+
Final Result 1-QPK

Horizontal Polarization



Vertical Polarization



Final measurement values:

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)
32,320	vertical	Quasi-Peak	15,8	13,6	0,0	29,4	40,0	10,6
40,570	vertical	Quasi-Peak	21,6	15,6	0,0	37,2	40,0	**2,8**
60,460	vertical	Quasi-Peak	14,7	14,4	0,0	29,1	40,0	10,9
81,480	horizontal	Quasi-Peak	25,0	10,2	0,0	35,2	40,0	4,8
88,680	vertical	Quasi-Peak	24,7	12,2	0,0	36,9	43,5	6,6
112,950	vertical	Quasi-Peak	27,3	13,1	0,0	40,4	43,5	3,1
139,520	horizontal	Quasi-Peak	20,4	10,2	0,0	30,6	43,5	12,9
799,600	horizontal	Quasi-Peak	13,5	23,3	0,0	36,8	46,0	9,2
867,740	horizontal	Quasi-Peak	-0,2	24,4	0,0	24,2	46,0	21,8

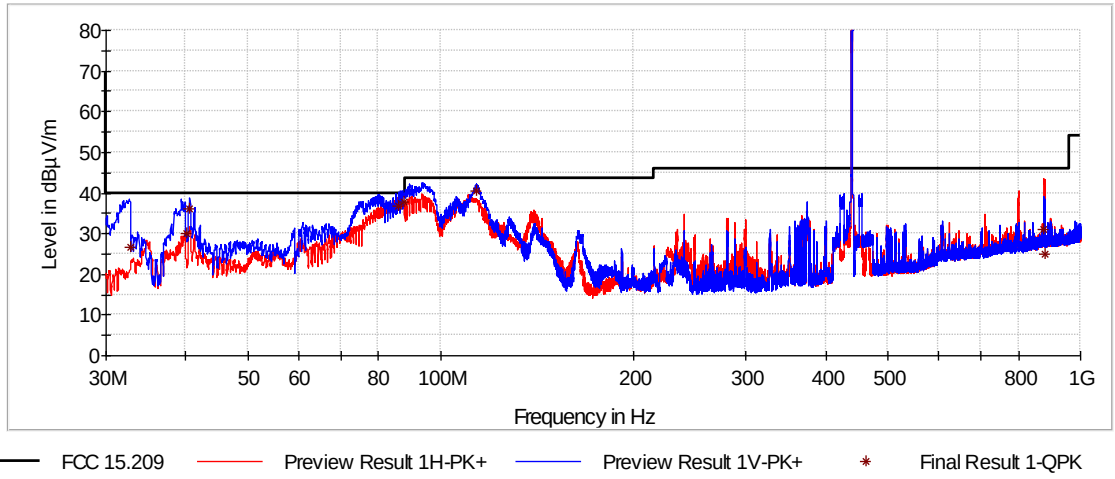
Fundamental field strength:

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)
433,500	vertical	Quasi-Peak	73,1	17,8	-20,0	70,9	72,9	**1,9**

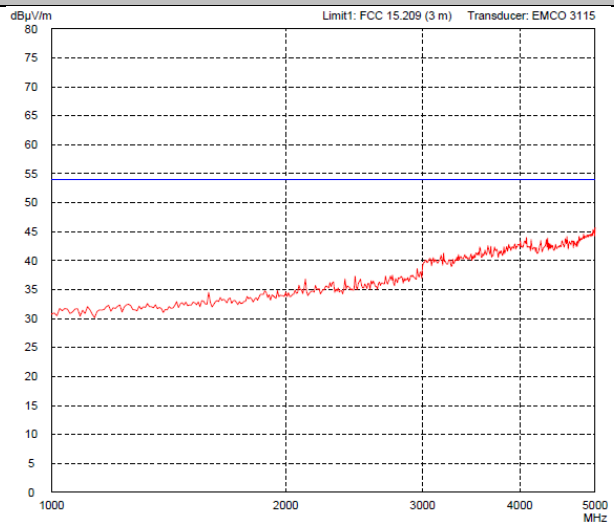
Sample calculation of final values:

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

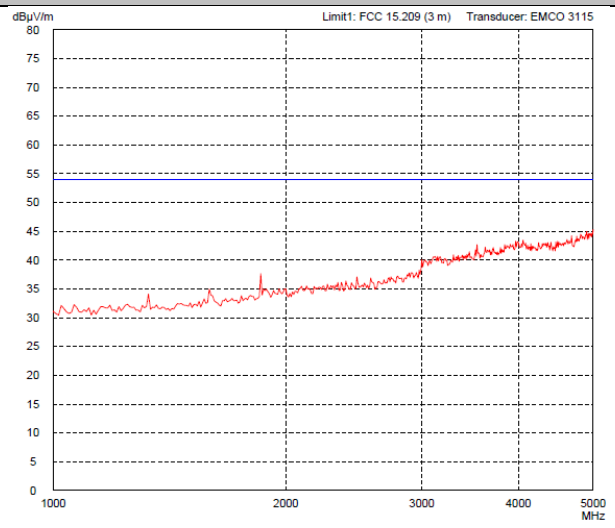
Operating mode 5



Horizontal Polarization



Vertical Polarization



Final measurement values:

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)
32,560	vertical	Quasi-Peak	11,4	13,6	0,0	25,0	40,0	15,0
40,760	vertical	Quasi-Peak	21,6	15,6	0,0	37,2	40,0	**2,8**
40,980	vertical	Quasi-Peak	14,4	15,7	0,0	30,1	40,0	9,9
88,680	horizontal	Quasi-Peak	26,8	10,2	0,0	37,0	40,0	3,0
89,560	vertical	Quasi-Peak	27,7	10,2	0,0	37,9	43,5	5,6
112,900	vertical	Quasi-Peak	27,6	13,1	0,0	40,7	43,5	**2,8**
876,900	horizontal	Quasi-Peak	6,8	24,7	0,0	31,5	46,0	14,5
877,300	horizontal	Quasi-Peak	0,8	24,8	0,0	25,6	46,0	20,4

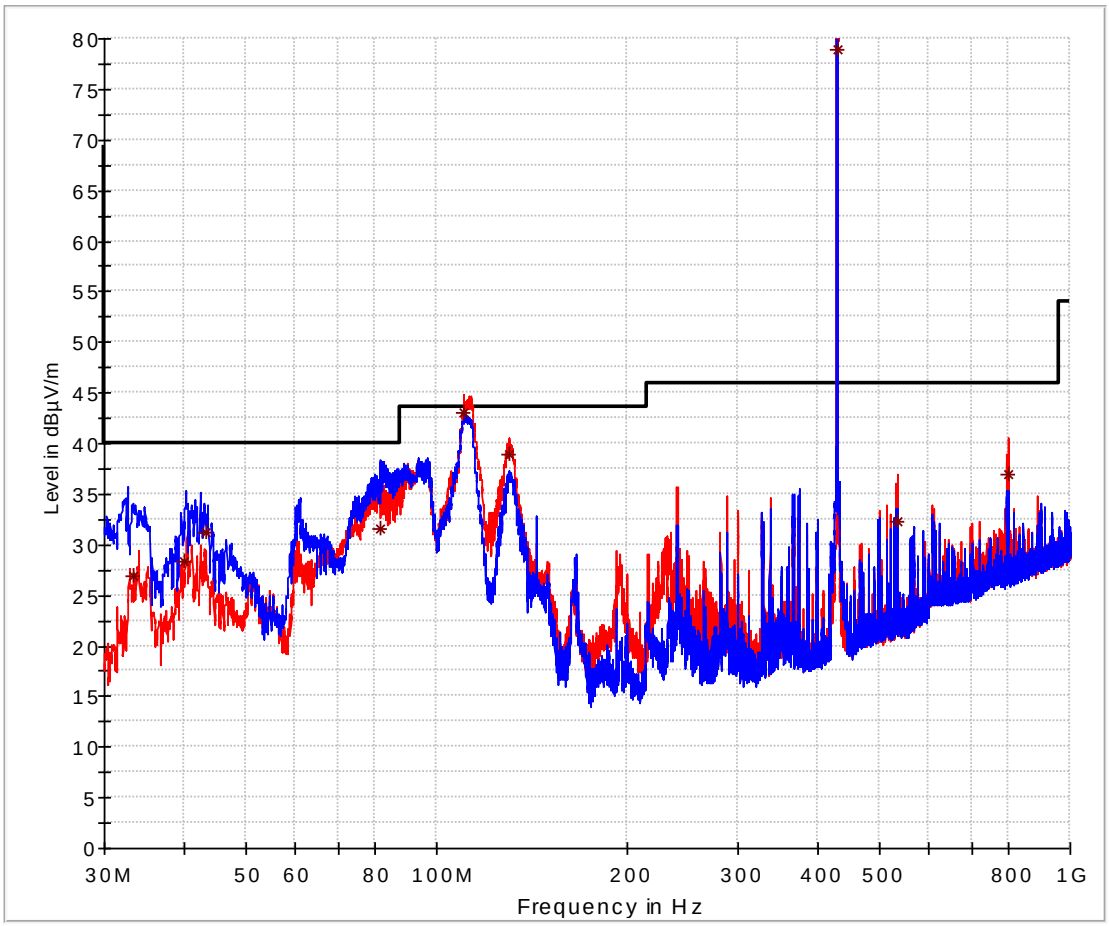
Fundamental field strength:

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)
438,900	vertical	Quasi-Peak	73,0	17,9	-20,0	70,9	73,0	**2,1**

Sample calculation of final values:

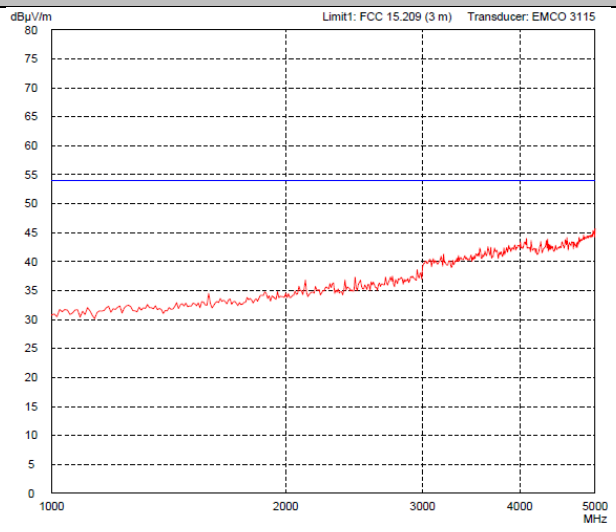
Final Value (dBµV/m) = Reading Value (dBµV) + Correction Factor (dB/m) + Pulse Train Correction (dB)

Operating mode 6

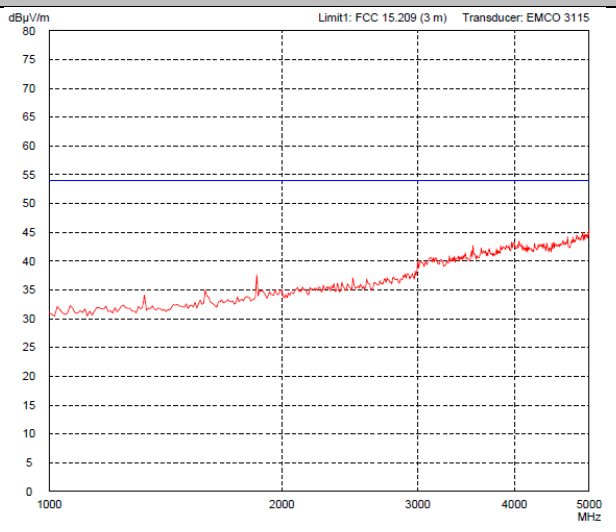


FCC 15.209
Preview Result 1V-PK+
Preview Result 1H-PK+
Final Result 1-QPK

Horizontal Polarization



Vertical Polarization



Final measurement values:

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)
33,280	vertical	Quasi-Peak	13,1	13,9	0,0	27,0	40,0	13,0
40,060	vertical	Quasi-Peak	12,8	15,6	0,0	28,4	40,0	11,6
43,430	vertical	Quasi-Peak	15,2	16,0	0,0	31,2	40,0	8,8
81,530	vertical	Quasi-Peak	21,4	10,2	0,0	31,6	40,0	8,4
110,970	horizontal	Quasi-Peak	29,7	13,4	0,0	43,1	43,5	0,4
130,320	horizontal	Quasi-Peak	28,3	10,7	0,0	39,0	43,5	4,5
533,050	vertical	Quasi-Peak	12,7	19,5	0,0	32,2	46,0	13,8
799,560	horizontal	Quasi-Peak	13,6	23,3	0,0	36,9	46,0	9,1

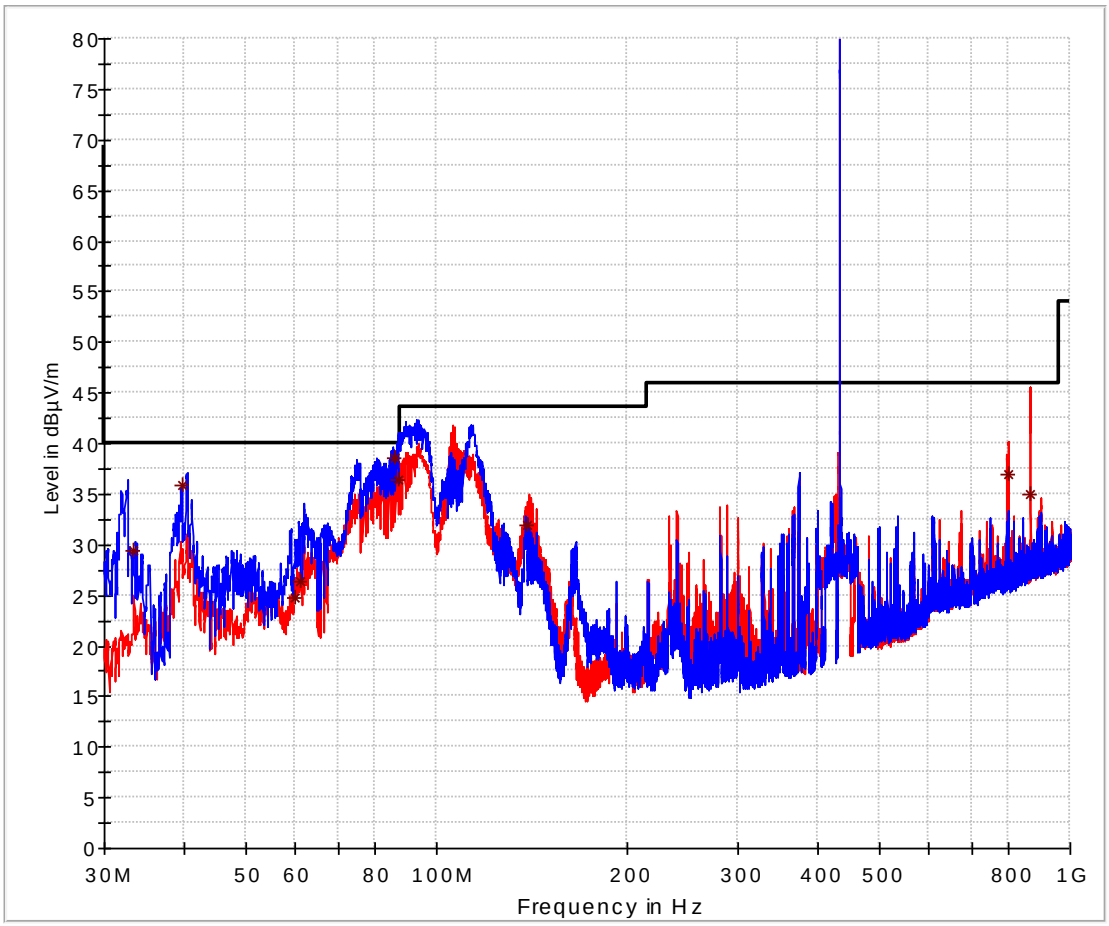
Fundamental field strength:

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)
429,000	vertical	Quasi-Peak	73,6	17,8	-20,0	70,1	73,0	**2,9**

Sample calculation of final values:

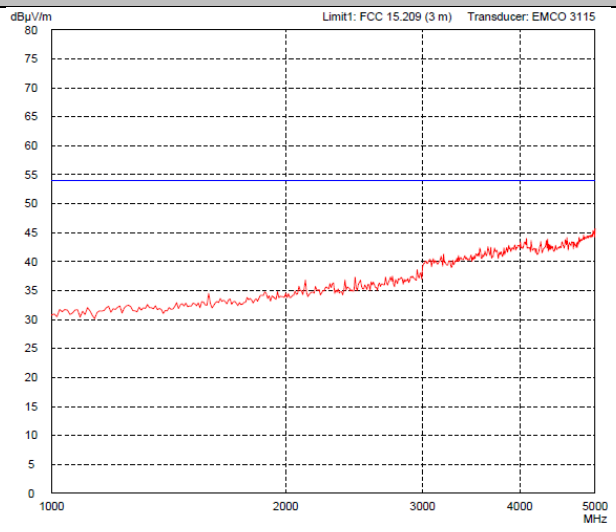
Final Value (dBµV/m) = Reading Value (dBµV) + Correction Factor (dB/m) + Pulse Train Correction (dB)

Operating mode 7

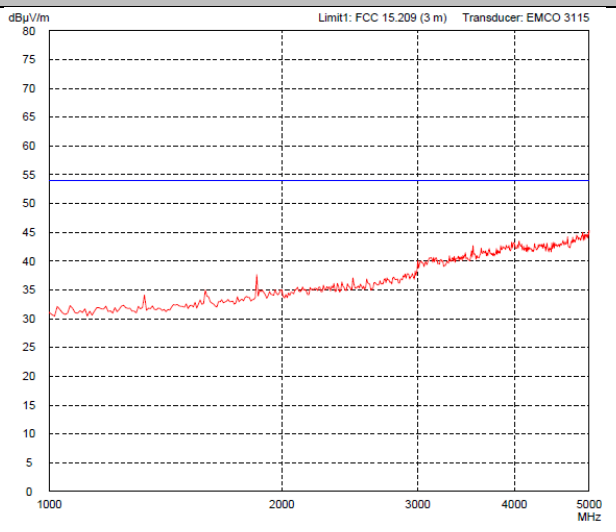


FCC 15.209
Preview Result 1V-PK+
Preview Result 1H-PK+
Final Result 1-QPK

Horizontal Polarization



Vertical Polarization



Final measurement values:

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)
33,400	vertical	Quasi-Peak	15,5	13,9	0,0	29,4	40,0	10,6
39,830	vertical	Quasi-Peak	20,4	15,5	0,0	35,9	40,0	4,1
59,790	vertical	Quasi-Peak	10,1	14,7	0,0	24,8	40,0	15,2
61,270	vertical	Quasi-Peak	12,4	14,0	0,0	26,4	40,0	13,6
86,030	vertical	Quasi-Peak	27,0	11,5	0,0	38,5	40,0	**1,5**
87,190	vertical	Quasi-Peak	24,5	11,9	0,0	36,4	40,0	3,6
139,490	horizontal	Quasi-Peak	21,7	10,2	0,0	31,9	43,5	11,6
799,550	horizontal	Quasi-Peak	13,7	23,3	0,0	37,0	46,0	9,0

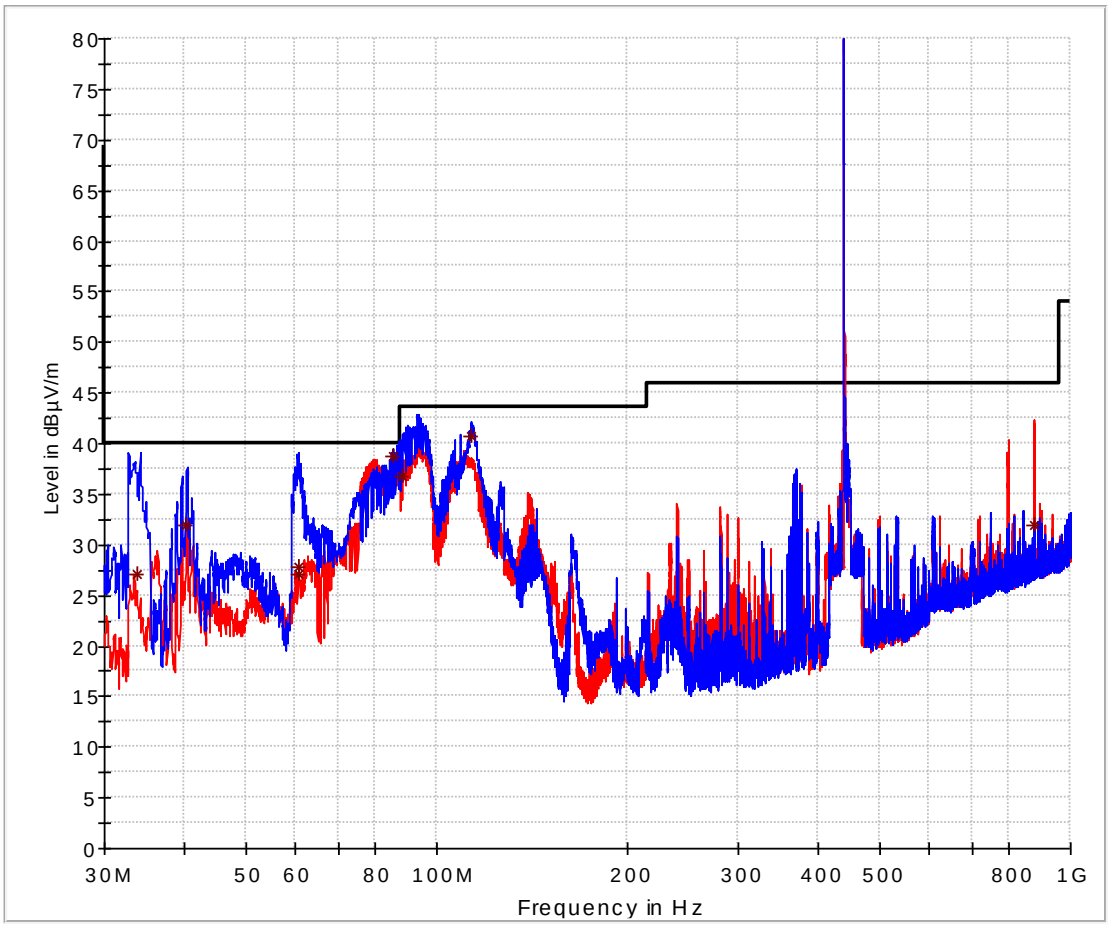
Fundamental field strength:

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)
433,500	vertical	Quasi-Peak	73,6	17,8	-20,0	71,4	72,9	**1,5**

Sample calculation of final values:

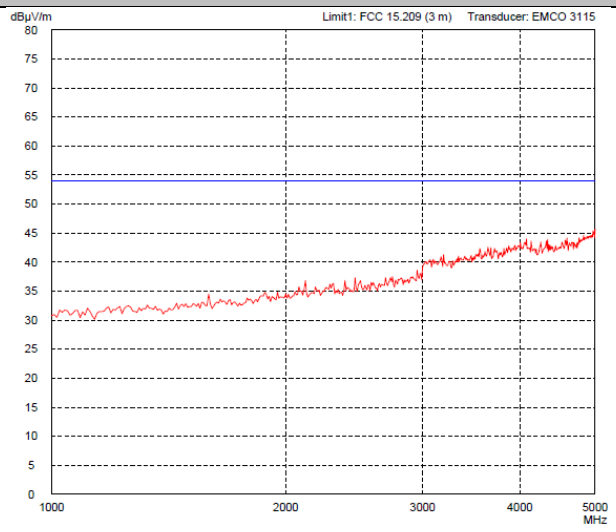
Final Value (dBµV/m) = Reading Value (dBµV) + Correction Factor (dB/m) + Pulse Train Correction (dB)

Operating mode 8

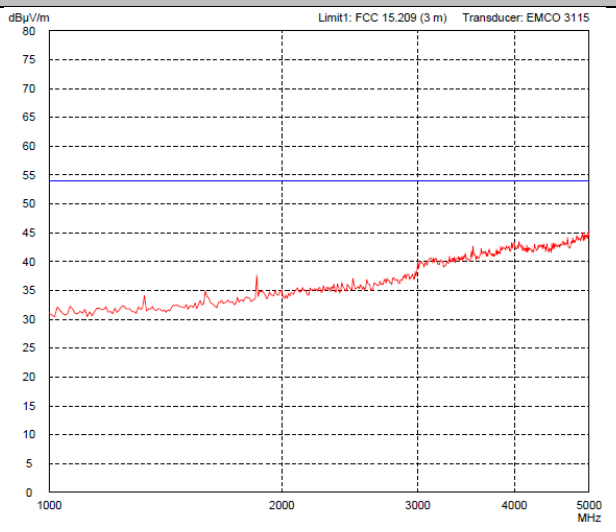


FCC 15.209
Preview Result 1V-PK+
Preview Result 1H-PK+
Final Result 1-QPK

Horizontal Polarization



Vertical Polarization



Final measurement values:

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)
33,820	vertical	Quasi-Peak	13,0	14,1	0,0	27,1	40,0	12,9
40,230	vertical	Quasi-Peak	16,4	15,6	0,0	32,0	40,0	8,0
60,670	vertical	Quasi-Peak	12,8	14,3	0,0	27,1	40,0	12,9
60,690	vertical	Quasi-Peak	14,5	14,3	0,0	27,8	40,0	12,2
85,830	vertical	Quasi-Peak	27,2	11,5	0,0	38,7	40,0	**1,3**
88,640	vertical	Quasi-Peak	24,5	12,2	0,0	36,7	40,0	3,3
113,690	vertical	Quasi-Peak	27,8	13,0	0,0	40,8	43,5	2,7
877,190	horizontal	Quasi-Peak	7,4	24,5	0,0	31,9	46,0	14,1

Fundamental field strength:

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)
438,900	vertical	Quasi-Peak	71,8	17,9	-20,0	69,7	73,0	**3,3**

Sample calculation of final values:

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

9 Test Results for Receiver

Note:
The EUT does not have a dedicated receive mode, the EUT transmits and receives together. The Spurious emission data is for both transmit and receive mode.

10 RF exposure requirement

Rules and specifications:	CFR 47 Part 1, section 1.1307(b)(1) CFR 47 Part 2, section 2.1091				
Guide:	OET Bulletin 65, Edition 97-01				
Limits:	Limits for general population / uncontrolled exposure				
	Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm²)	Averaging Time (minutes)
	0.3 - 1.34	614	1.63	(100)*	30
	1.34 - 30	824 / f	2.19 / f	(180 / f²)*	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				

RF exposure			Declared by applicant	Measured
Prediction [6]:	S	= P G / 4 π R²		
Where:	S	= Power density		
	P	= Power input of antenna		
	G	= Power gain of the antenna relativ to an isotropic radiator		
	R	= Distance to the center of radiation of the antenna		
Maximum output power:	P	= 1.1 dBm =1.3 mW	☒	☒
Antenna gain:	G	= 3.5		
Prediction distance:	R	= 20 cm		
Power density at 20 cm:	**S**	**= 0.91 µW/cm²**		

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

11 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, 2014
☒	CFR 47 Part 15	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)	October 1, 2014
☐	ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz	December 11, 2003 (published on January 30, 2004)
☒	ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz	June 7, 2009 (published on September 15, 2009)
☐	RSS-Gen	Radio Standards Specification RSS-Gen Issue 4 containing General Requirements and Information for the Certification of Radiocommunication Equimpment, published by Industry Canada	December 2014
☐	RSS-210	Radio Standards Specification RSS-210 Issue 8 for Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, published by Industry Canada	December 2010
☐	RSS-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 4: Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), published by Industry Canada	March 2010, footnote 13 updated December 2010
☐	ICES-003	Interference-Causing Equipment Standard ICES-003 Issue 5 (Information Technology Equipment (ITE) - Limits and methods of measurement), published by Industry Canada	August 2012
☒	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

12 Test Equipment List with Calibration Data

Type	*Inv.-No.*	*Type Designation*	*Serial Number*	*Manufacturer*	*Calibration Organization*	*Last Calibration*	*Next Calibration*
EMI test receiver	1028	ESHS10	860043/016	Rohde & Schwarz	Rohde & Schwarz	09/2014	09/2015
EMI test receiver	2010	ESPI7	101018	Rohde & Schwarz	Rohde & Schwarz	06/2014	12/2015
EMI test receiver	2044	ESU8	100232	Rohde & Schwarz	Rohde & Schwarz	10/2014	10/2015
Spectrum analyser	1666	FSP30	100063	Rohde & Schwarz	Rohde & Schwarz	05/2014	05/2015
Preamplifier	1651	CPA9231A	3393	Schaffner Electrotest	TÜV SÜD PS-EMC-STR	09/2014	03/2016
Preamplifier	1684	AFS3-00100800-32-LN	847743	MITEQ	TÜV SÜD PS-EMC-STR	10/2013	04/2015
Preamplifier	1685	AMF-4D-005080-25-13P	860149	MITEQ	TÜV SÜD PS-EMC-STR	08/2013	11/2015
Preamplifier	1716	CPA9231A	3557	Schaffner EMC Systems	TÜV SÜD PS-EMC-STR	01/2014	06/2015
V-network	1059	ESH3-Z5	894785/005	Rohde & Schwarz	Rohde & Schwarz	08/2013	08/2015
Double ridged waveguide horn antenna	1516	3115	9508-4553	EMCO Elektronik	Seibersdorf Laboratories	01/2015	01/2017
Loop antenna	1016	HFH2-Z2	882964/0001	Rohde & Schwarz	Rohde & Schwarz	05/2014	05/2015
TRILOG Broadband Antenna	1802	VULB 9163	9163-214	Schwarzbeck	Rohde & Schwarz	11/2014	11/2016
TRILOG Broadband Antenna	2256	VULB 9162	9162-048	Schwarzbeck	Schwarzbeck	09/2013	03/2015

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.

13 Revision History

Revision History			
Edition	*Date*	*Issued by*	*Modifications*
1	2015-02-11	M. Biberger	First Edition
2	2015-09-15	M. Biberger	Second Edition: Silent period added (8.6), Pulse train calculation corrected (8.6), Page 4: Operating frequencies corrected, 8.9 Fundamental field strength: Detector corrected from Pk to QP
3	2015-12-02	M. Biberger	Third Edition: Page 9: List of devices connected to EUT: PSU of Notebook added, 99% & 20dB Bandwidth measured

Annex A Charts taken during testing
