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June 2, 2015

Prüfbericht / *Test Report* Nr. / *No.* 217697-49624-1e (Edition 6)

Applicant:	Fronius International GmbH
Type of equipment:	RFID module, PCB for building in
Type designation:	NFC1 Module
Order No.:	X/1010/14-2011-710082
Test standards:	FCC Code of Federal Regulations, CFR 47, Part 15, Sections 15.205, 15.207, 15.215 and 15.225

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VAT ID No. DE129484267
Information pursuant to Section 2(1)
DL-InfoV (Germany) at
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TÜV SÜD Product Service GmbH

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Germany

Table of Contents

1 Description of the Equipment Under Test (EUT)

General data of EUT	
Type designation[1]:	NFC1 Module
Parts[2]:	Module, Hostboard, Antenna
Serial number(s):	Test Sample
Manufacturer:	Fronius International GmbH
Type of equipment:	RFID module, PCB for building in
Version:	
FCC ID:	QKWNFC1
Additional parts/accessories:	Hostboard as test board

[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:	13.110 MHz – 14.010 MHz
Frequency range:	13.553 MHz – 13.567 MHz
Operating frequency:	13.56 MHz
Type of modulation:	ASK
Pulse train:	---
Pulse width:	---
Number of RF-channels:	1
Channel spacing:	---
Designation of emissions[3]:	424A1D
Type of antenna:	External plastic foil
Size/length of antenna:	64 mm x 39 mm
Connection of antenna:	☐ detachable ☒ not detachable
Type of power supply:	DC supply
Specifications for power supply:	nominal voltage: 5.0 V minimum voltage: 1.65 V maximum voltage: 5.5 V
Note:	The EUT was operated on a hostboard, used as test board, with a supply voltage range from 7 V to 32 V and a nominal voltage of 9 V.

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

2 Administrative Data

Application details	
Applicant (full address):	Fronius International GmbH Günter-Fronius-Straße 1 A-4600 Wels-Thalheim
Contact person:	Mr. Peter Boxleitner
Order number:	X/1010/14-2011-710082
Receipt of EUT:	2014-11-04, 2015-03-12
Date(s) of test:	2014-11-04 to 2014-11-12, 2015-03-16 to 2015-03-19
Note(s):	Mr. Boxleitner attended tests on 2014-11-04.

Report details	
Report number:	217697-49624-1e
Edition:	6
Issue date:	2015-06-02

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 15.205, 15.207, 15.215 and 15.225** of the Federal Communication Commission (FCC).

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

5 Operation Mode and Configuration of EUT

Operation Mode(s)
The tests were performed with the following modes: [4] • PRBS ISO 14443A @ 424 kBit/s • PRBS ISO 14443A @ 106 kBit/s • APP ISO 15693 • PRBS FELICA @ 424 kBits • PRBS ISO14443B @ 424 kBits/s

Configuration(s) of EUT
The applicant provided a host board as test board for configurating the module. The test board was operated as battery operated stand alone equipment. The test for conducted AC emissions was performed on DC supply and with a terminal resistor on the antenna port.

List of ports and cables

Port	*Description*	*Classification*[5]	*Cable type*	*Cable length*
1	DC supply of test board [6]	dc power	Unshielded	1 m
2	Antenna connector	signal/control port	Shielded	4 cm

List of devices connected to EUT

Item	*Description*	*Type Designation*	*Serial no. or ID*	*Manufacturer*
1	Antenna	MCU1ANT_41,0071,0285_V0.1		Fronius

List of support devices

Item	*Description*	*Type Designation*	*Serial no. or ID*	*Manufacturer*
1	Transponder card	ISO 14443A-3	---	---

[4] For spurious emissions tests in March 2015 the PBRS modes where changed to APP modes since these are the normal operation mode.
[5] Ports shall be classified as ac power, dc power or signal/control port
[6] The DC interface was used for conducted DC emissions, only. All other tests were performed with a 9 V battery supply.

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) ANSI C63.10, section 6.9.1
Guide:	ANSI C63.10
Measurement setup:	☐ Conducted: See below ☒ Radiated: Radiated Emission Measurement 9 kHz to 30 MHz (6.3)

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).

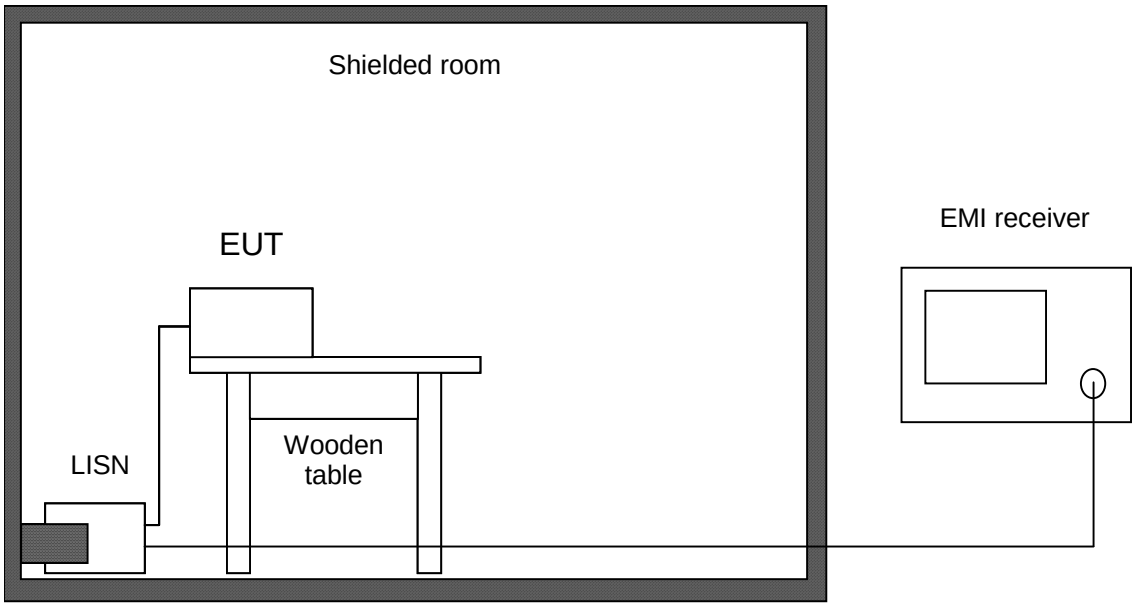
6.2 Conducted AC Powerline Emission

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, section 15.207
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 C63.4, 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
☒	Test receiver	ESCI 3	1863	100008	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
☐	Shielded room	No. 1	1451	---	Albatross
☐	Shielded room	No. 4	1454	3FD 100 544	Euroshield
☒	Shielded room	No. 7	1866	---	Albatross

6.3 Radiated Emission Measurement 9 kHz to 30 MHz

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.205, 15.215(b) and 15.225(a)-(d)
Guide:	ANSI C63.10

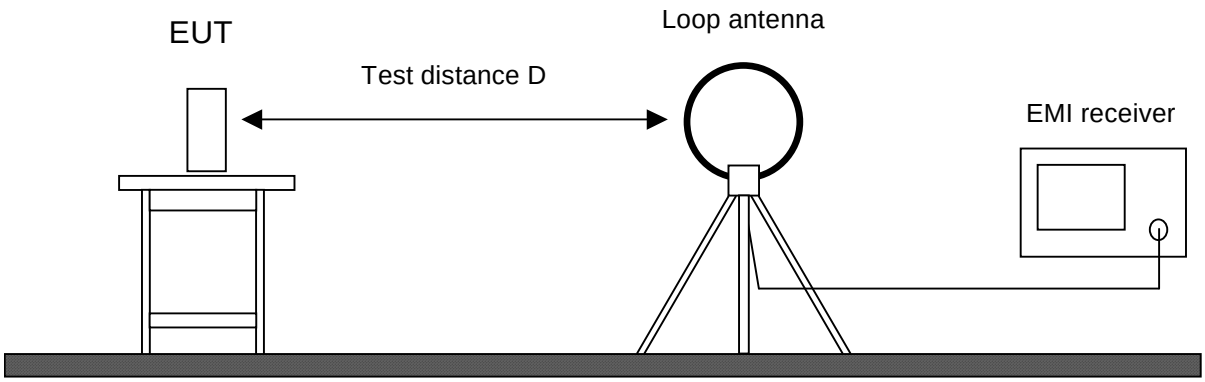
Radiated emission in the frequency range 9 kHz to 30 MHz is measured using an active loop antenna. First the whole spectrum of emission caused by the equipment is recorded at a distance of 3 meters in a fully or semi anechoic room with the detector of the spectrum analyzer or EMI receiver set to peak.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



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Test instruments used:

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☐	Spectrum analyzer		FSP 30	1666	100036	Rohde & Schwarz
☒	EMI test receiver		ESPI 7	2010	101018	Rohde & Schwarz
☐	EMI test receiver		ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☒	EMI test receiver		ESU8	2044	100232	Rohde & Schwarz
☐	Test receiver		ESHS 10	1028	860043/016	Rohde & Schwarz
☐	Preamplifier	Cabin no. 2	CPA9231A	1716	3557	Schaffner
☒	Loop antenna		HFH2-Z2	1016	882964/1	Rohde & Schwarz
☒	Fully anechoic room		No. 2	1452	---	Albatross
☐	Semi anechoic room		No. 3	1453	---	Siemens
☒	Semi anechoic room		No. 8	2057	---	Albatross

6.4 Radiated Emission in Fully or Semi Anechoic Room

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.205(b) and 15.225(d)
Guide:	ANSI C63.10

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.

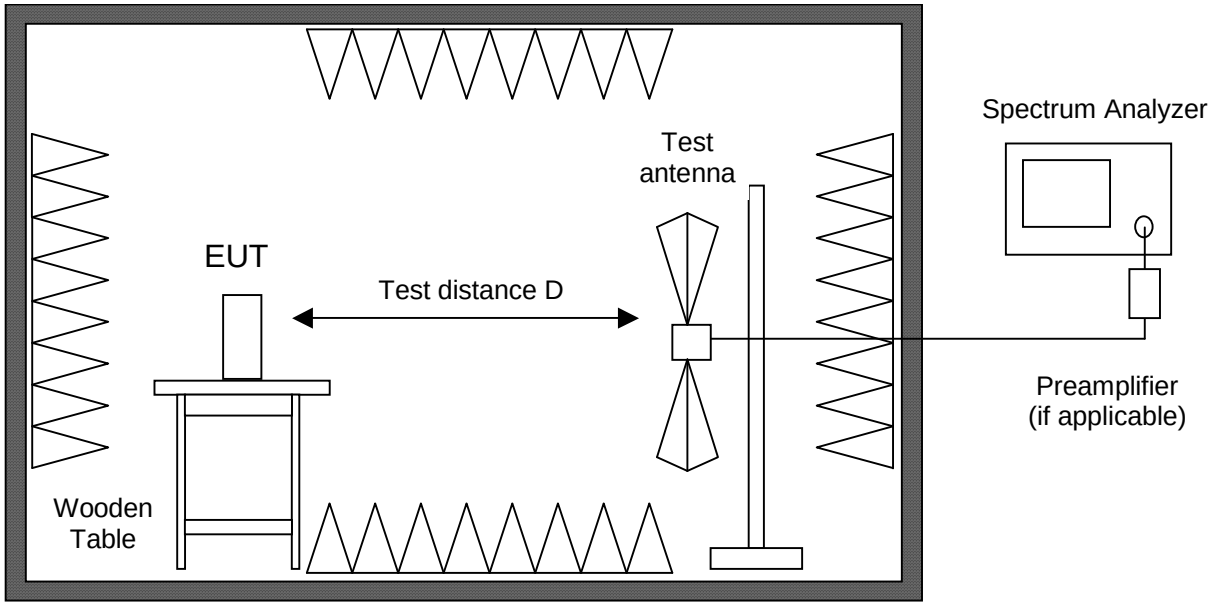
All tests below 8.2 GHz are performed at a test distance D of 3 meters. For higher frequencies the test distance may be reduced (e.g. to 1 meter) due to the sensitivity of the measuring instrument(s) and the test results are calculated according to CFR 47 Part 15 section 15.31(f)(1) using an extrapolation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



Fully or semi anechoic room

Test instruments used:

	Type		*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☒	Spectrum analyzer		FSP30	1666	100036	Rohde & Schwarz
☐	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
☒	Fully anechoic room		No. 2	1452	---	Albatross
☐	Semi anechoic room		No. 3	1453	---	Siemens
☐	Semi anechoic room		No. 8	2057	---	Albatross

6.5 Radiated Emission at Alternative Test Site

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, sections 15.205(b) and 15.225(d)
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 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.

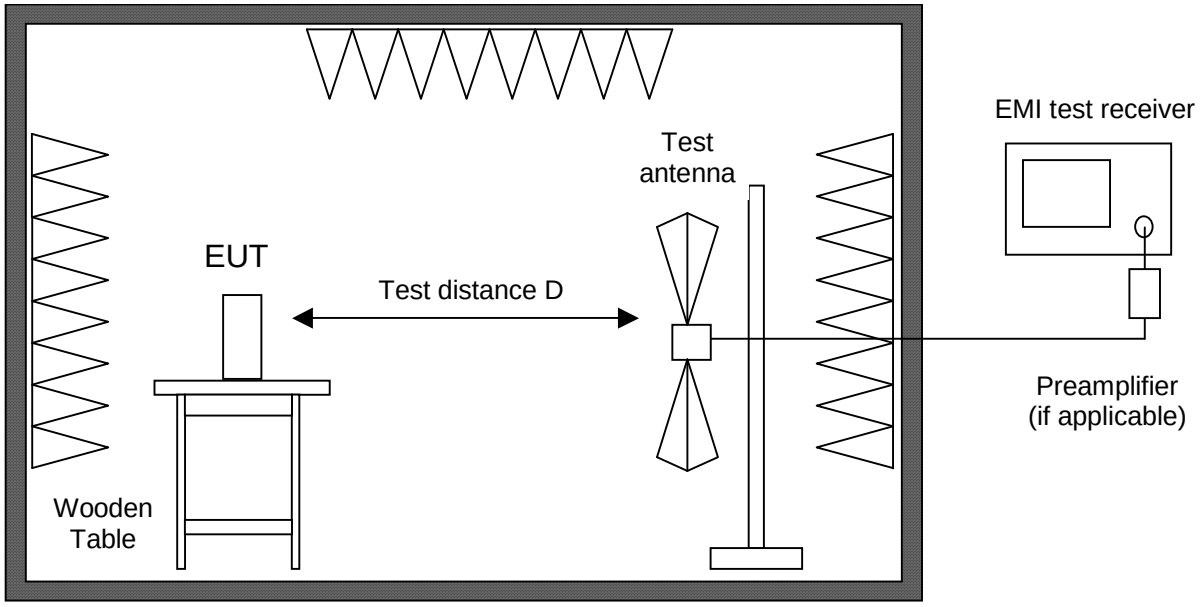
If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete 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
☒	Semi anechoic room		No. 8	2057	---	Albatross

6.6 Carrier Frequency Stability

Measurement Procedure:	
Rules and specifications:	CFR 47 Part 15, section 15.225(e)
Guide:	ANSI C63.10

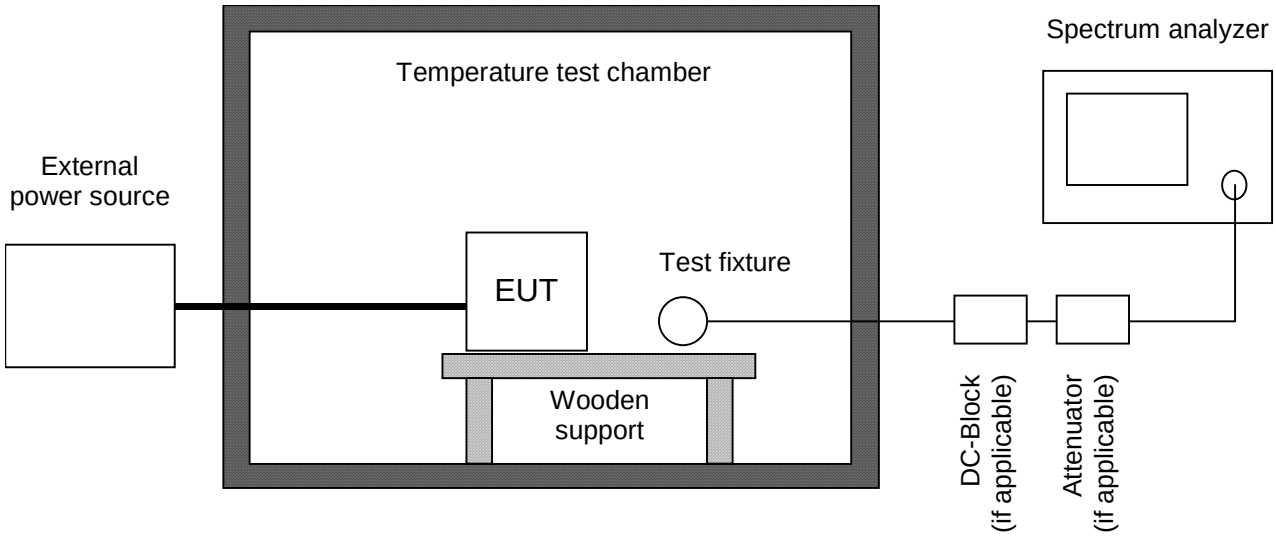
The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 °C.

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

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

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

The EUT is operating providing an unmodulated carrier. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to the shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.
If an unmodulated carrier is not available a significant and stable point on the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1% of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance allowed is larger than the uncertainty of the measured frequency tolerance.

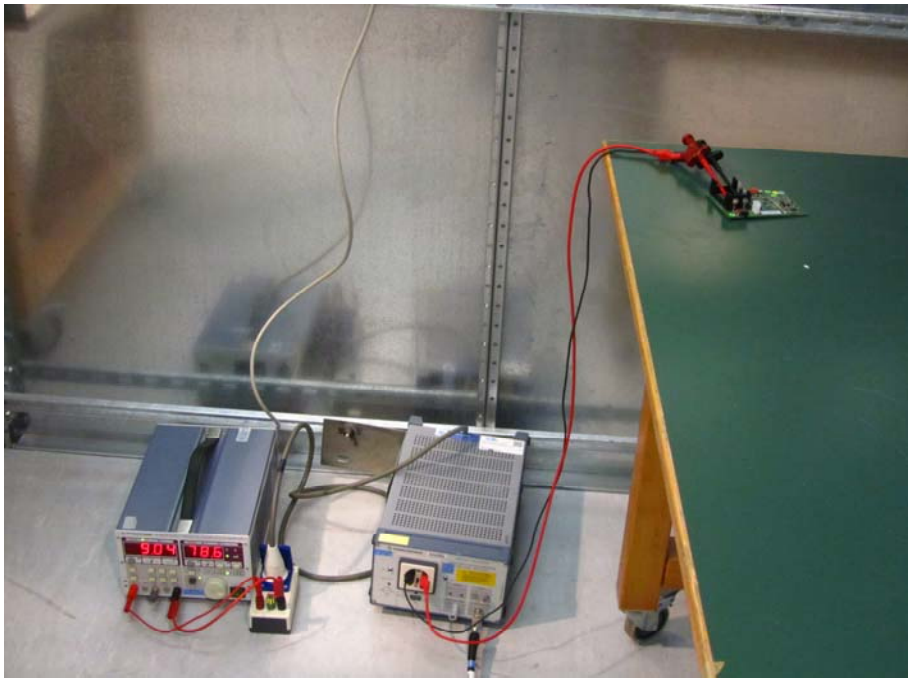


Test instruments used:

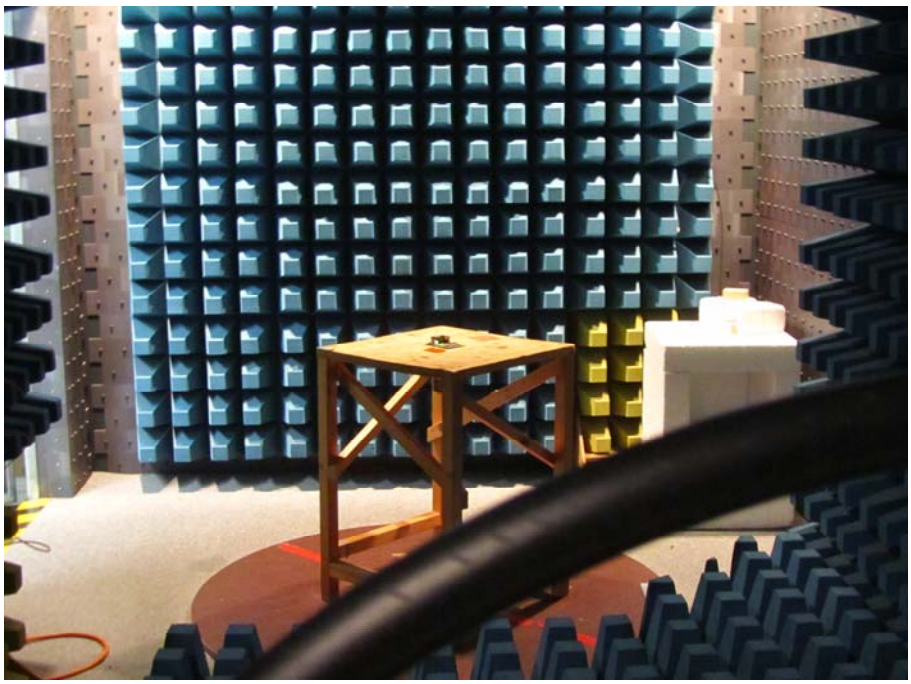
	Type	*Designation*	*Inv.-no.*	*Serial No. or ID*	*Manufacturer*
☐	Spectrum analyzer	FSP30	1666	100036	Rohde & Schwarz
☒	EMI test receiver	ESPI7	1711	836914/0002	Rohde & Schwarz
☐	EMI test receiver	ESMI	1569	839379/013 839587/006	Rohde & Schwarz
☐	DC-block	7006	1636	A2798	Weinschel
☐	Attenuator	4776-10	1638	9412	Narda
☐	Attenuator	4776-20	1639	9503	Narda
☒	Test probe	TP 01	1628	001	TÜV SÜD PS
☐	Multimeter	21 III	1653	76530546	Fluke
☐	Multimeter	21 III	1654	76381229	Fluke
☒	Multimeter	Fluke 77 III	1975	92370108	Fluke
☐	Multimeter	Fluke 77 IV	1976	93090238	Fluke
☐	Multimeter	Fluke 177	2025	96720024	Fluke
☐	Multimeter	Fluke 177	2026	96720025	Fluke
☒	DC power supply	NGSM 32/10	1267	203	Rohde & Schwarz
☐	Isolating transformer	RT 5A	1127	10387	Grundig
☐	Isolating transformer	RT 5A	1128	10416	Grundig
☒	Temperature test chamber	HT 4010	1271	07065550	Heraeus

7 Photographs Taken During Testing

Test setup for conducted DC powerline emission measurement



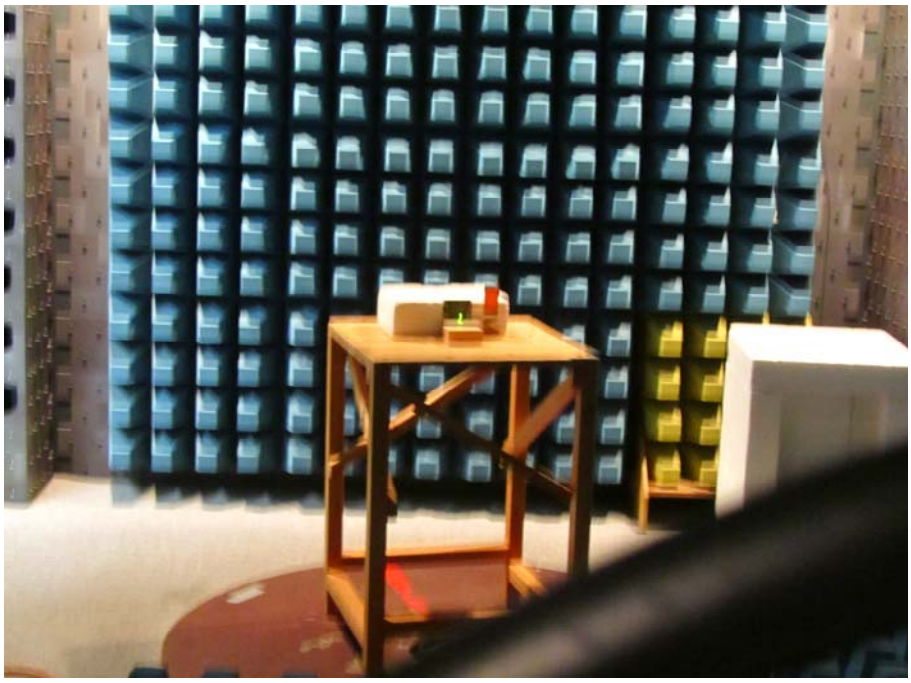
Test setup for radiated emission measurement 9 kHz – 30 MHz



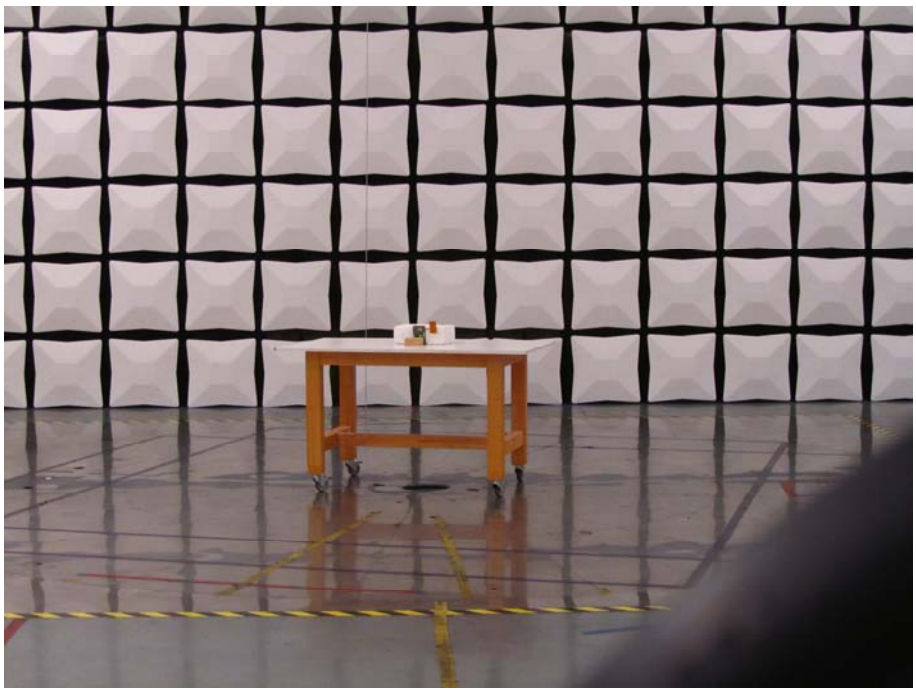
EUT flat on table

Antenna on top

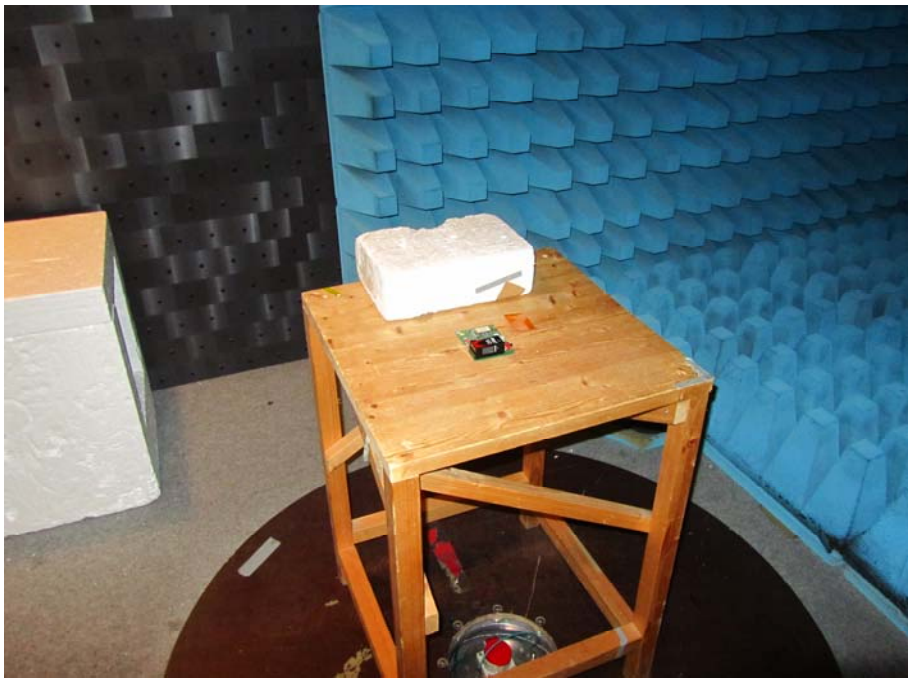
Test setup for radiated emission measurement 9 kHz – 30 MHz - continued -



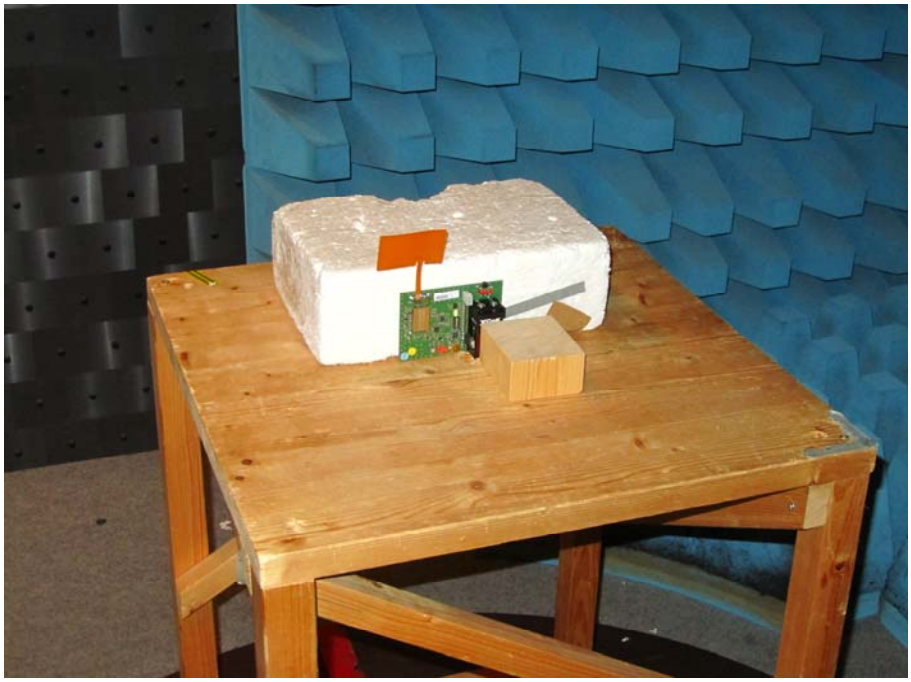
Antenna on side



Test setup for radiated emission measurement (fully anechoic room)



EUT flat on table



Antenna on top

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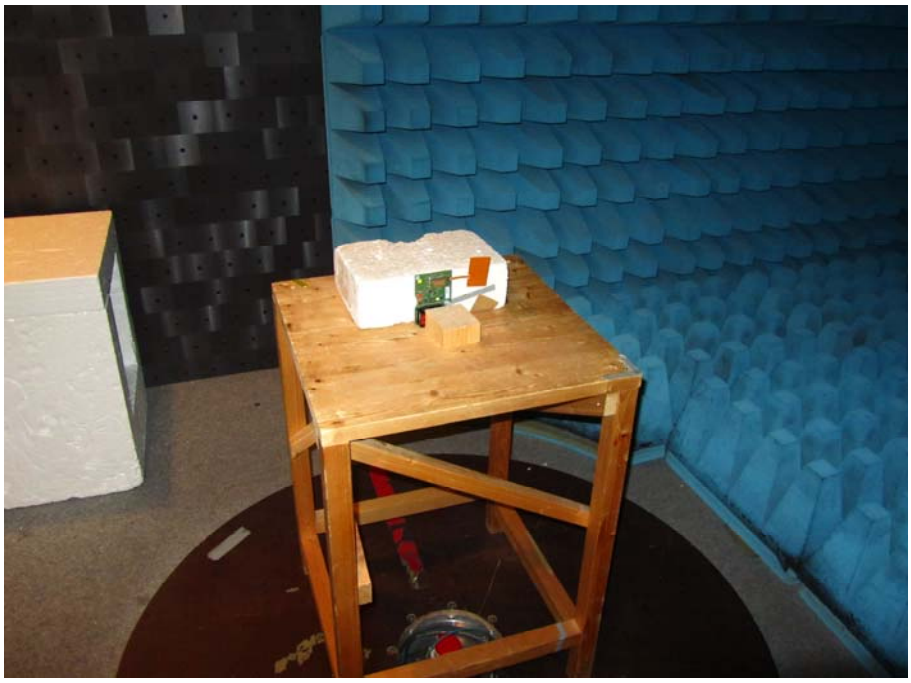
Test setup for radiated emission measurement (fully anechoic room) - continued -



Antenna on side

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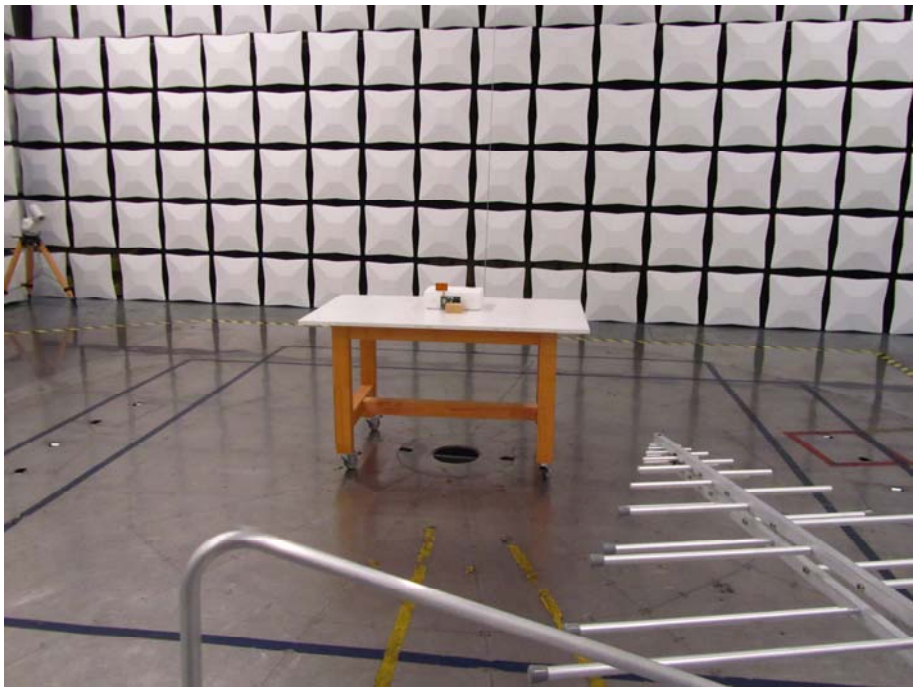
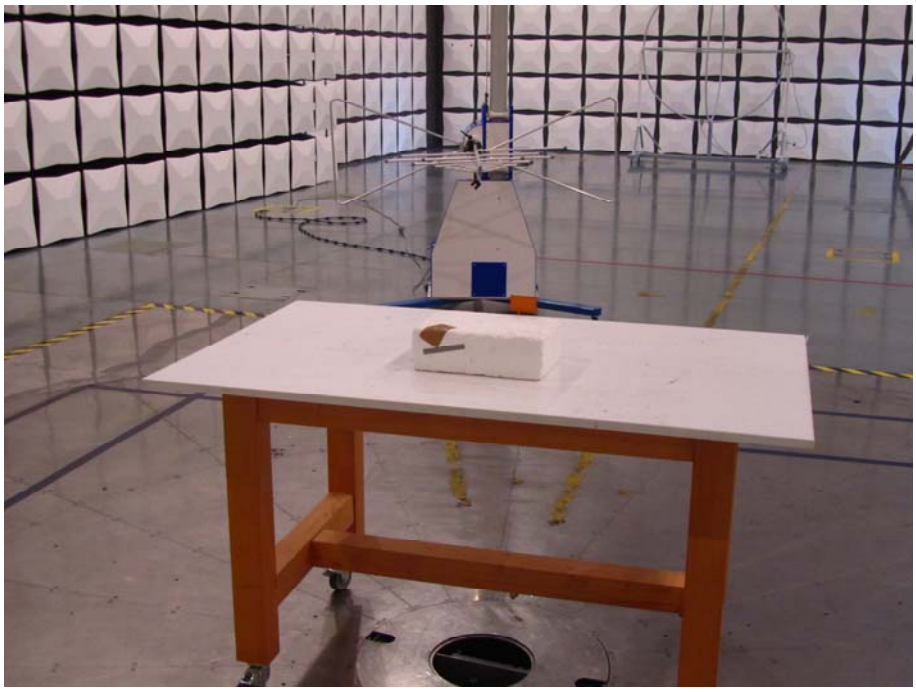
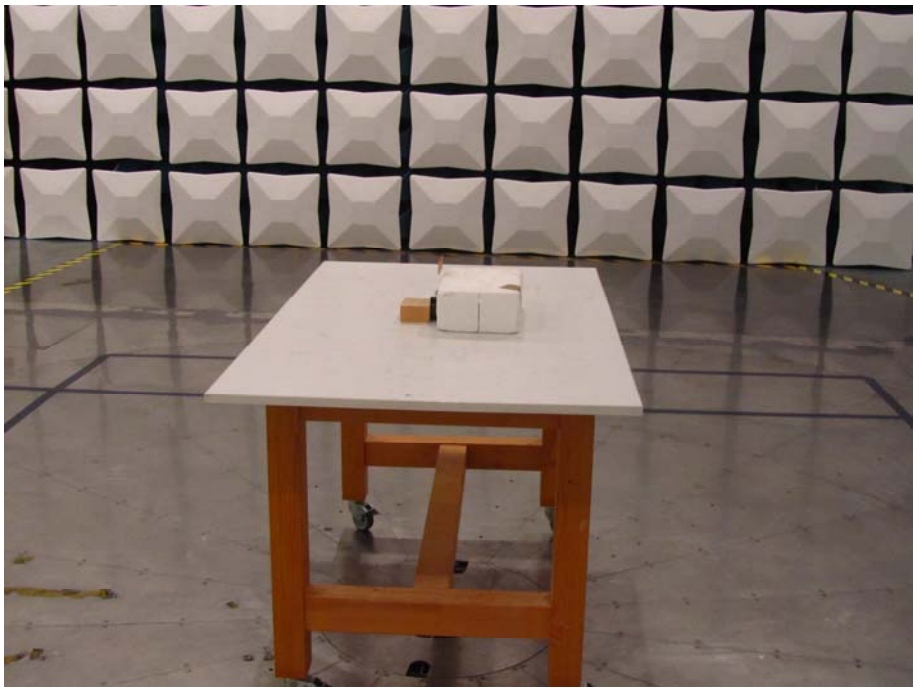
Test setup for radiated emission measurement (alternate test site)



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





8 Test Results

FCC CFR 47 Parts 2 and 15			
Section(s)	*Test*	*Page*	*Result*
2.1046(a)	Conducted output power	---	Not applicable
2.202(a)	Occupied bandwidth	30	Recorded
15.215(c)	Bandwidth of the emission	36	Test passed
2.201, 2.202	Class of emission	42	Calculated
15.35(c)	Pulse train measurement for pulsed operation	---	Not applicable
15.205(a) 15.205(d)(7)	Restricted bands of operation	---[7]	Test passed
15.207	Conducted AC powerline emission 150 kHz to 30 MHz	43	Test passed
15.225(a)-(d)	Spectrum Mask	46	Test passed
15.205(b) 15.215(b) 15.225(a)(d)	Radiated emission 9 kHz to 30 MHz	52	Test passed
15.205(b) 15.225(d)	Radiated emission 30 MHz to 1 GHz	64	Test passed
15.225(e)	Carrier frequency stability	81	Test passed

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

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 C63.4, annex H.6; is measured as the frequency range defined by the points that are 26 dB down relative to the maximum level of the modulated carrier. 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:

Fundamental frequency	Minimum resolution bandwidth
9 kHz to 30 MHz	1 kHz
30 MHz to 1000 MHz	10 kHz
1000 MHz to 40 GHz	100 kHz

The video bandwidth shall be at least three times greater than the resolution bandwidth.

Measurement procedure:	Bandwidth Measurements (6.1)

Comment:	
Date of test:	2014-11-04
Test site:	Fully anechoic room, cabin no. 2

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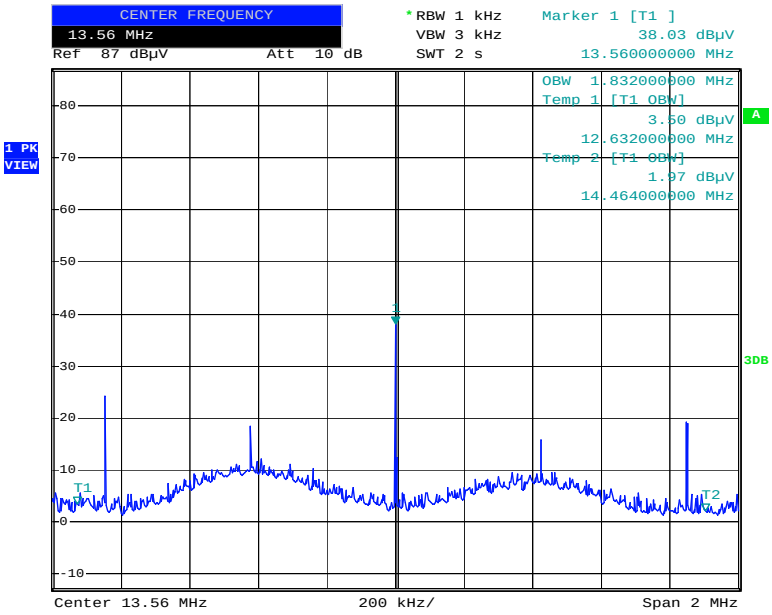
Occupied Bandwidth (99 %):



Operation mode:	PRBS ISO 14443A @ 424 kBit/s
Occupied Bandwidth (99 %):	**1.832 MHz**

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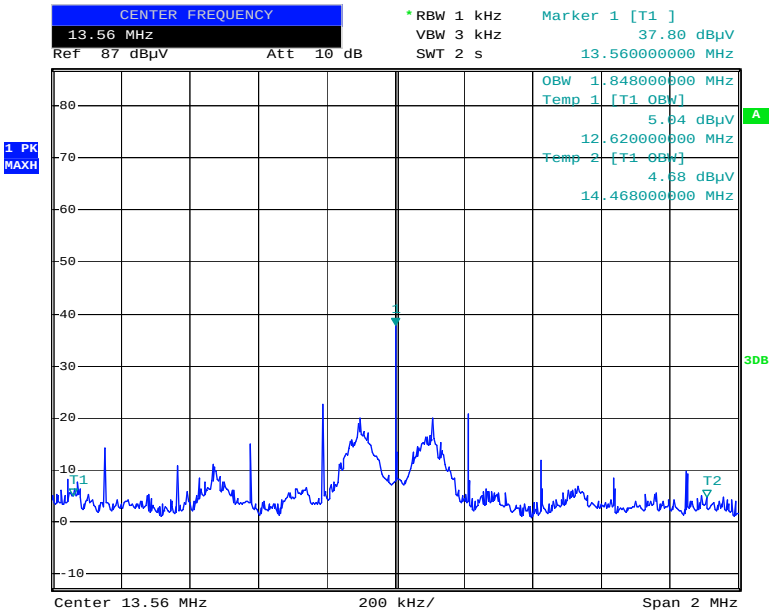
Occupied Bandwidth (99 %):



Operation mode:	PRBS ISO 14443A @ 106 kBit/s
Occupied Bandwidth (99 %):	**1.848 MHz**

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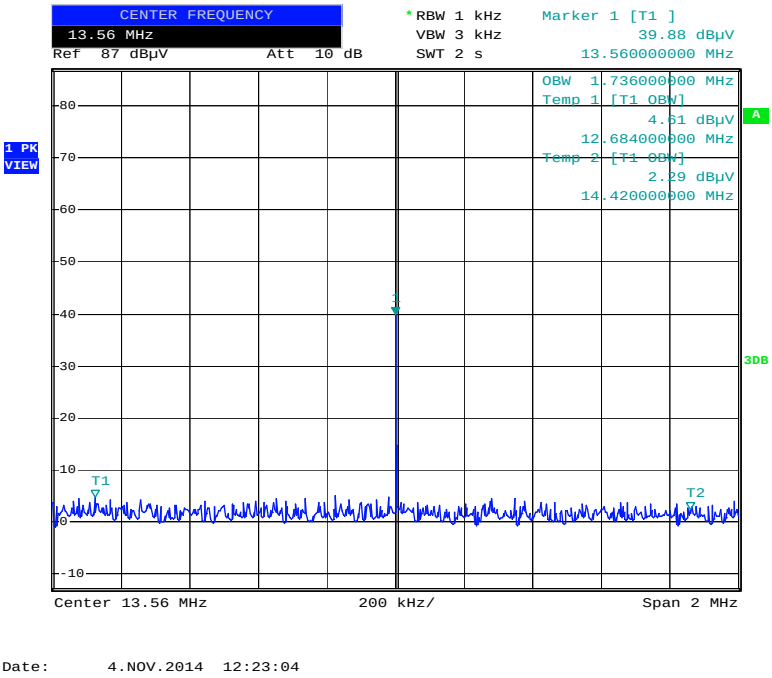
Occupied Bandwidth (99 %):



Operation mode:	APP ISO 15693
Occupied Bandwidth (99 %):	**1.736 MHz**

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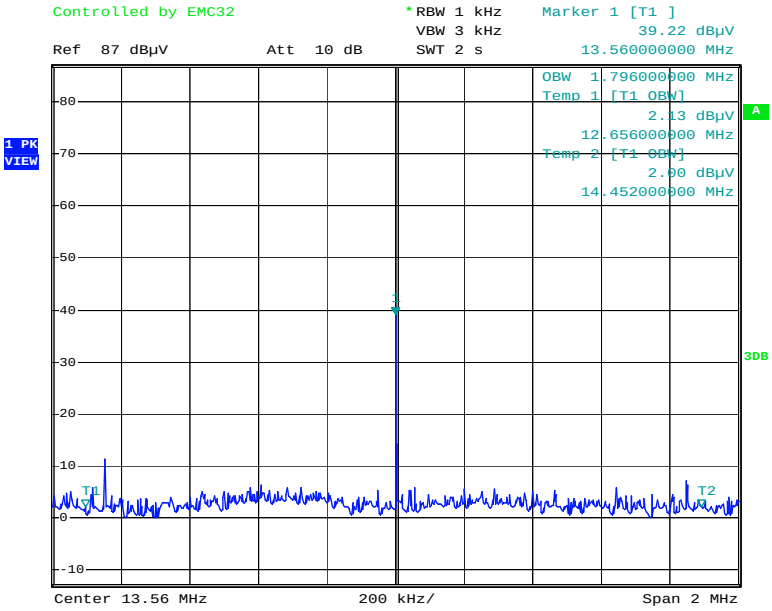
Web: www.tuev-sued.de

Occupied Bandwidth (99 %):



Operation mode:	PRBS FELICA
Occupied Bandwidth (99 %):	**1.796 MHz**

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Germany

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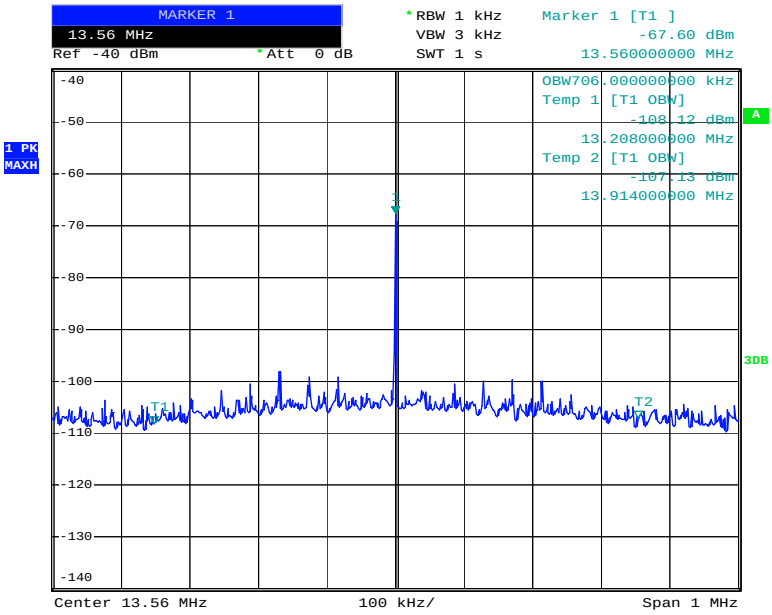
Fax: +49 9421 5522-99
Web: www.tuev-sued.de

Occupied Bandwidth (99 %):



Operation mode:	PRBS ISO14443B @ 424 kBit/s
Occupied Bandwidth (99 %):	**706 kHz**

8.2 Bandwidth of the Emission

Rules and specifications:	CFR 47 Part 15, section 15.215(c)
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 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:

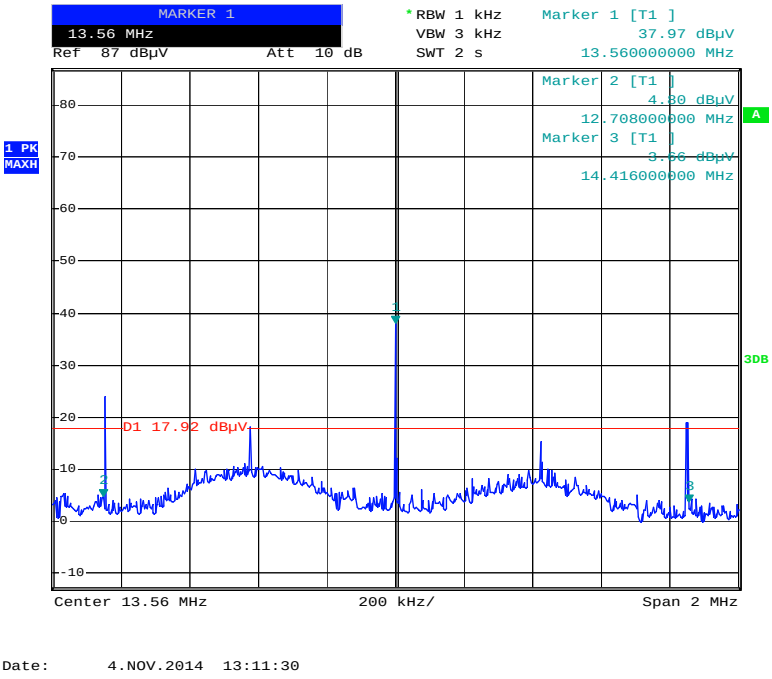
Fundamental frequency	Minimum resolution bandwidth
9 kHz to 30 MHz	1 kHz
30 MHz to 1000 MHz	10 kHz
1000 MHz to 40 GHz	100 kHz

The video bandwidth shall be at least three times greater than the resolution bandwidth.

Measurement procedure:	Bandwidth Measurements (6.1)

Test Result:	Test passed

Comment:	PRBS ISO 14443A @ 424 kBit/s
Date of test:	2014-11-04
Test site:	Fully anechoic room, cabin no. 2

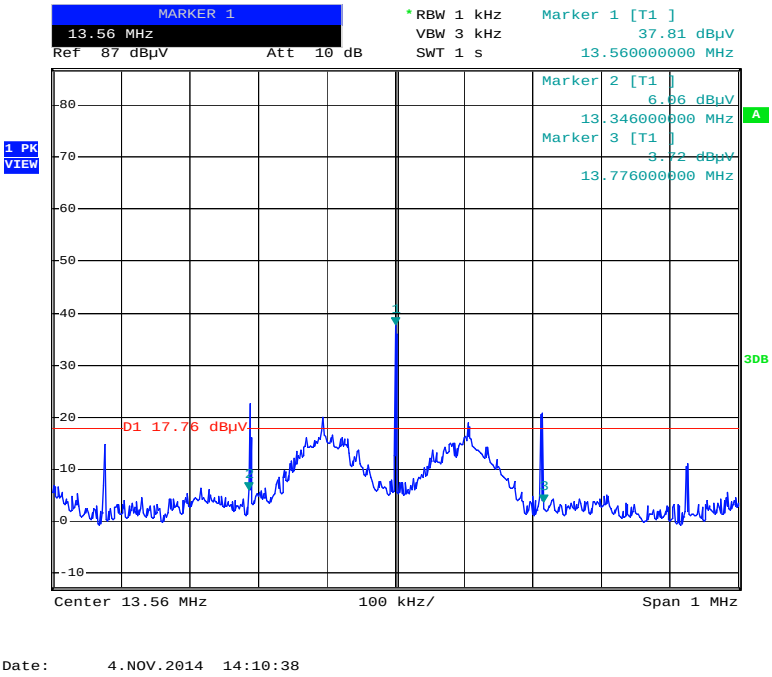


Permitted frequency band:	**13.110 MHz – 14.010** MHz	
20 dB bandwidth:	**1.708 MHz**	
Carrier frequency stability: Maximum frequency tolerances:	☒ **specified** **+0.002 kHz** **-0.072 kHz**	☐ **not specified**
Bandwidth of the emission:	**1.708 MHz**	**within permitted frequency band[8]:** ☒ **yes** ☐ **no**

Test Result:	Test passed

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

Comment:	PRBS ISO 14443A @ 106 kBit/s
Date of test:	2014-11-04
Test site:	Fully anechoic room, cabin no. 2

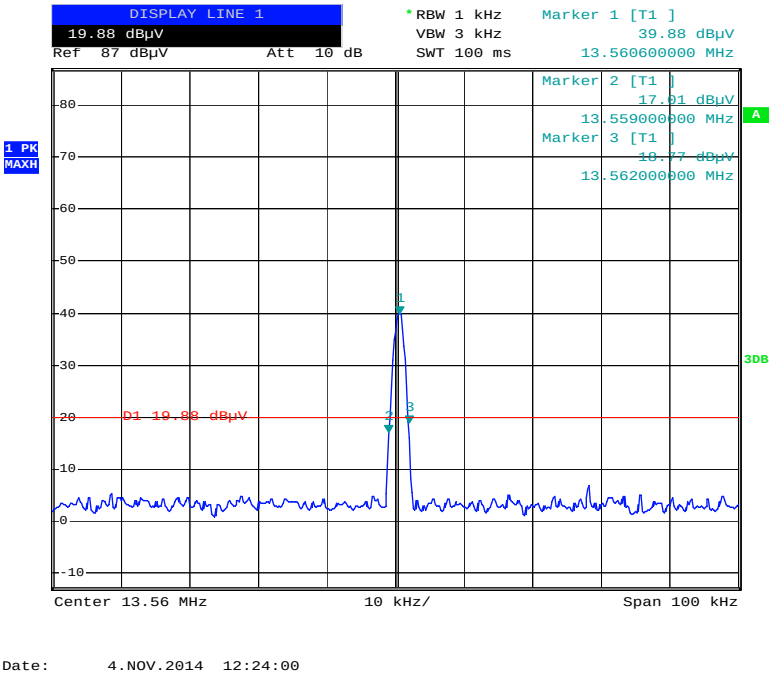


Permitted frequency band:	**13.110 MHz – 14.010** MHz	
20 dB bandwidth:	**430 kHz**	
Carrier frequency stability: Maximum frequency tolerances:	☒ **specified** **+0.002 kHz** **-0.072 kHz**	☐ **not specified**
Bandwidth of the emission:	**430.1 kHz**	**within permitted frequency band[9]:** ☒ **yes** ☐ **no**

Test Result:	Test passed

[9] 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.

Comment:	APP ISO 15693
Date of test:	2014-11-04
Test site:	Fully anechoic room, cabin no. 2

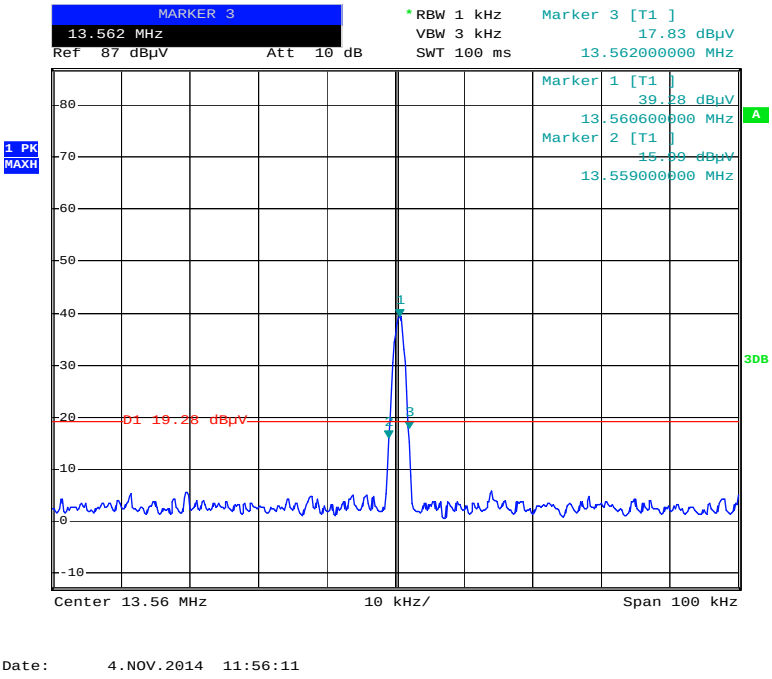


Permitted frequency band:	**13.110 MHz – 14.010** MHz	
20 dB bandwidth:	**3 kHz**	
Carrier frequency stability: Maximum frequency tolerances:	☒ **specified** **+0.002 kHz** **-0.072 kHz**	☐ **not specified**
Bandwidth of the emission:	**3.1 kHz**	**within permitted frequency band[10]:** ☒ **yes** ☐ **no**

Test Result:	Test passed

[10] 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.

Comment:	PRBS BELICA
Date of test:	2014-11-04
Test site:	Fully anechoic room, cabin no. 2

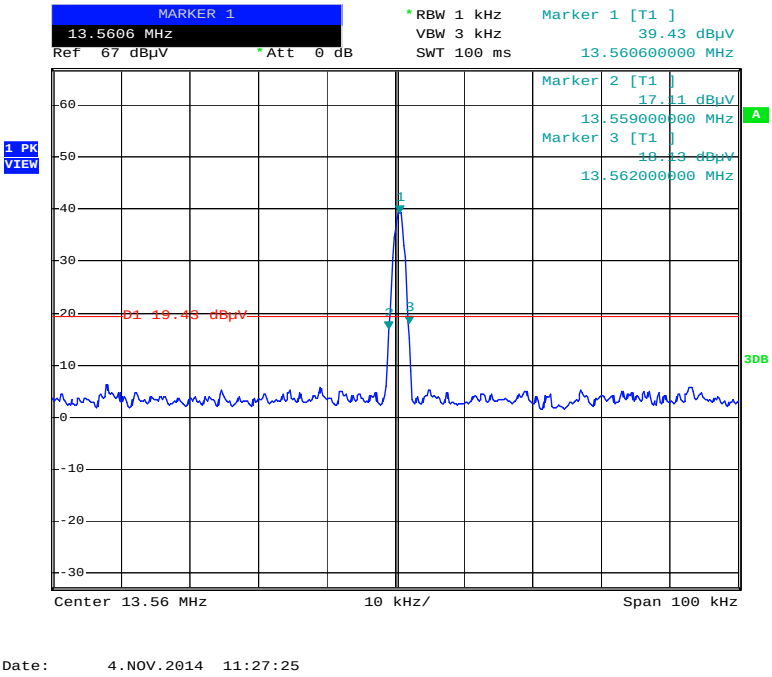


Permitted frequency band:	**13.110 MHz – 14.010** MHz	
20 dB bandwidth:	**3 kHz**	
Carrier frequency stability: Maximum frequency tolerances:	☒ **specified** **+0.002 kHz** **-0.072 kHz**	☐ **not specified**
Bandwidth of the emission:	**3.1 kHz**	**within permitted frequency band[11]:** ☒ **yes** ☐ **no**

Test Result:	Test passed

[11] 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.

Comment:	PRBS ISO 14443B @ 424 kBit/s
Date of test:	2014-11-04
Test site:	Fully anechoic room, cabin no. 2



Permitted frequency band:	**13.110 MHz – 14.010** MHz	
20 dB bandwidth:	**3 kHz**	
Carrier frequency stability: Maximum frequency tolerances:	☒ **specified** **+0.002 kHz** **-0.072 kHz**	☐ **not specified**
Bandwidth of the emission:	**3.1 kHz**	**within permitted frequency band[12]:** ☒ **yes** ☐ **no**

Test Result:	Test passed

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

8.3 Designation of Emissions

Rules and specifications:	CFR 47 Part 2, sections 2.201 and 2.202
Guide:	ANSI C63.10 / TRC-43

Type of modulation:	Amplitude Modulation

B_n = Necessary Bandwidth	B_n = 2BK
B = Modulation rate	B = 212 kHz (maximum)
K = Overall numerical factor	K = 1
Calculation:	$B_n = 2 \cdot (212\ kHz) \cdot 1 = 424\ kHz$

Designation of Emissions:	**424KA1D**

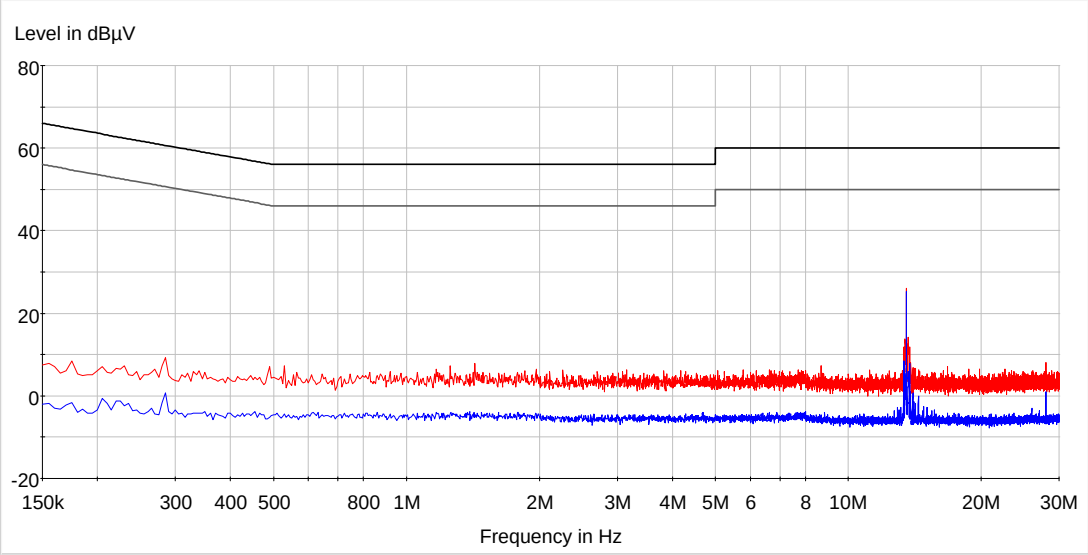
8.4 Conducted Powerline Emission Measurement 150 kHz to 30 MHz

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

Comment:	RF output terminated, Transmitting continuously
Date of test:	2014-11-04
Test site:	Shielded room, cabin no. 7

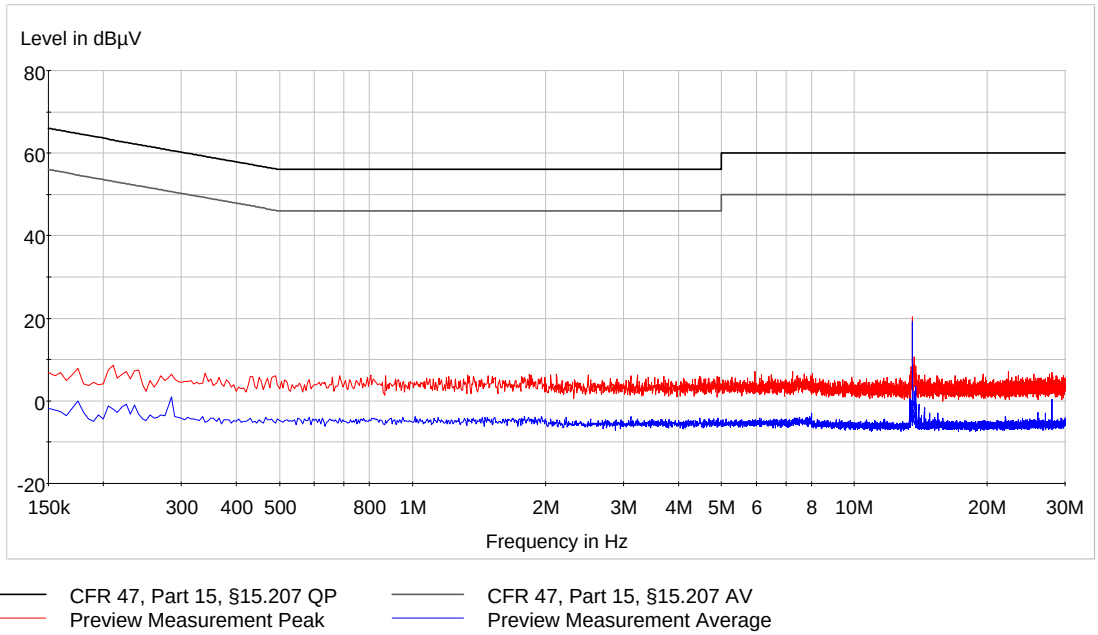
Test Result:	Test passed

Tested on:	Plus



All emissions show more than 20 dB margin to the limit, no emissions noted

Tested on:	Minus



All emissions show more than 20 dB margin to the limit, no emissions noted

Sample calculation of final values:

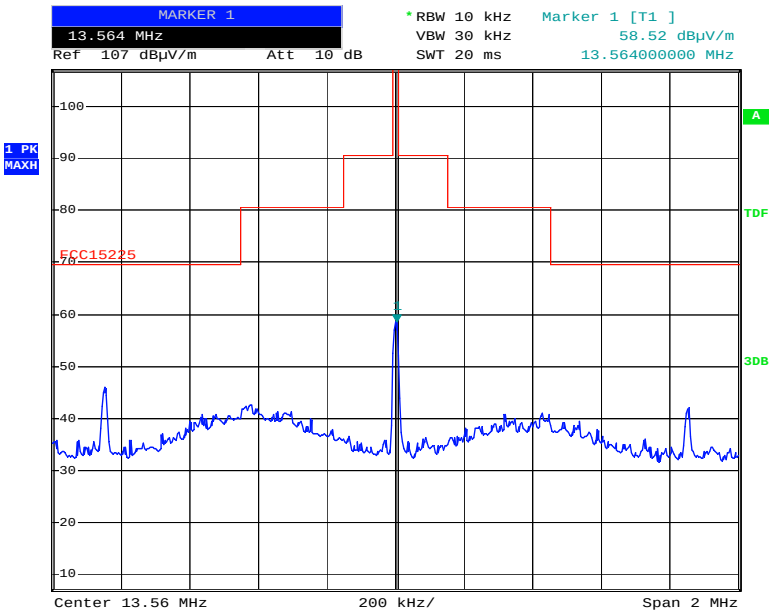
Final Value (dBµV) = Reading Value (dBµV) + Correction Factor (dB)

8.5 Spectrum Mask

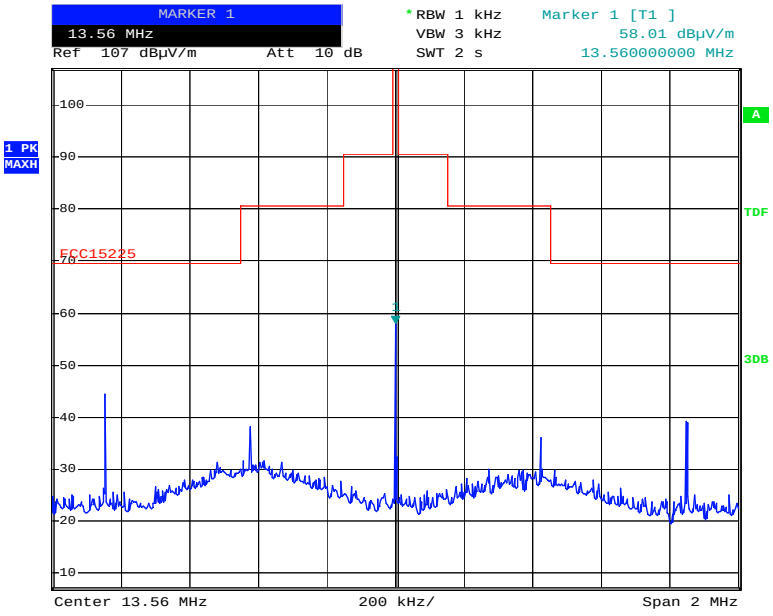
Rules and specifications:	CFR 47 Part 15, section 15.225(a)-(d)			
Guide:	ANSI C63.10			
Description:	Compliance with the spectrum mask is tested using a spectrum analyzer with resolution bandwidth set to a 1 kHz for the band 13.553 to 13.567 MHz and to 10 kHz outside this band. The video bandwidth shall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

Comment:	
Date of test:	2014-11-04
Test site:	Fully anechoic room, cabin no. 2
Test distance:	3 meters
Extrapolation Factor:	40 dB/decade

Mode	PRBS ISO 14443A @ 424 kBit/s
Test Result:	Test passed

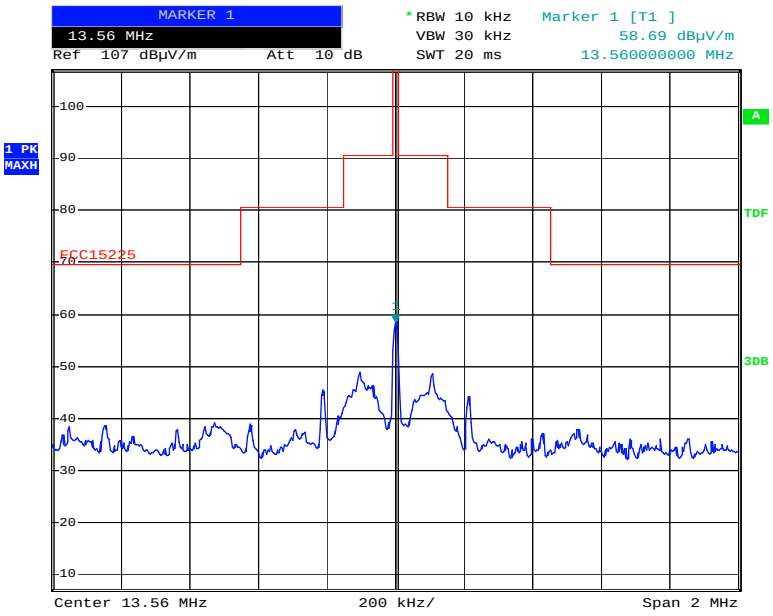


Date: 4.NOV.2014 13:12:48

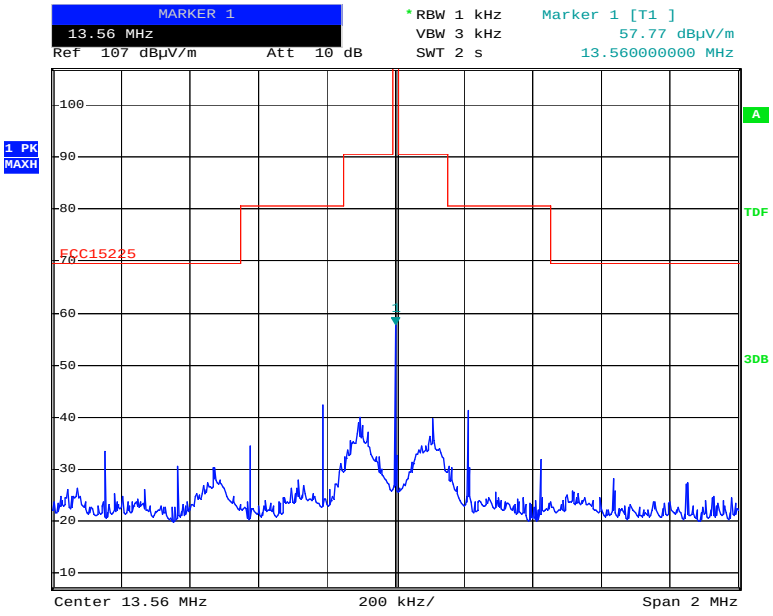


Date: 4.NOV.2014 13:12:26

Mode	PRBS ISO 14443A @ 106 kBit/s
Test Result:	Test passed

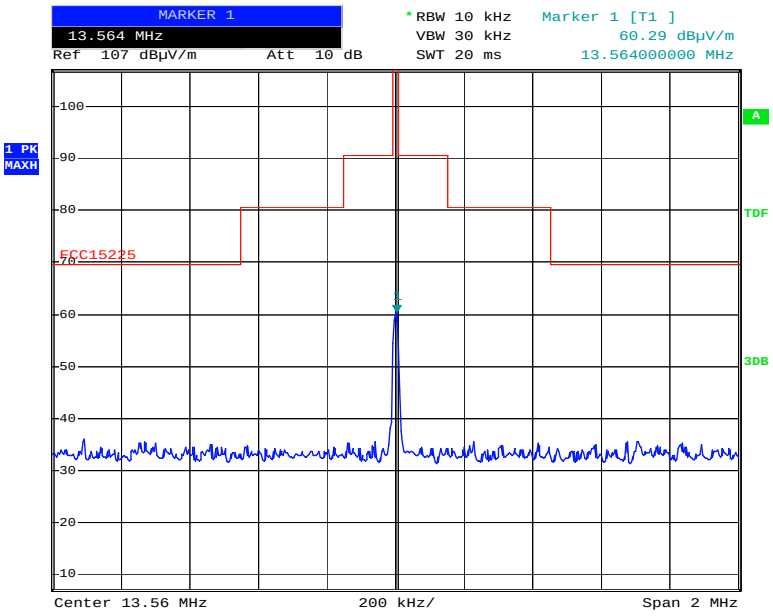


Date: 4.NOV.2014 14:11:55

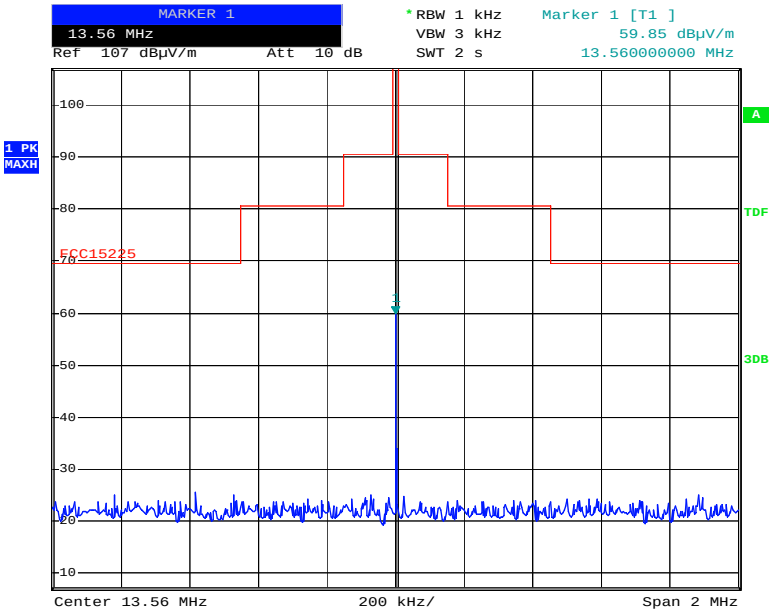


Date: 4.NOV.2014 14:11:29

Mode	APP ISO 15693
Test Result:	Test passed

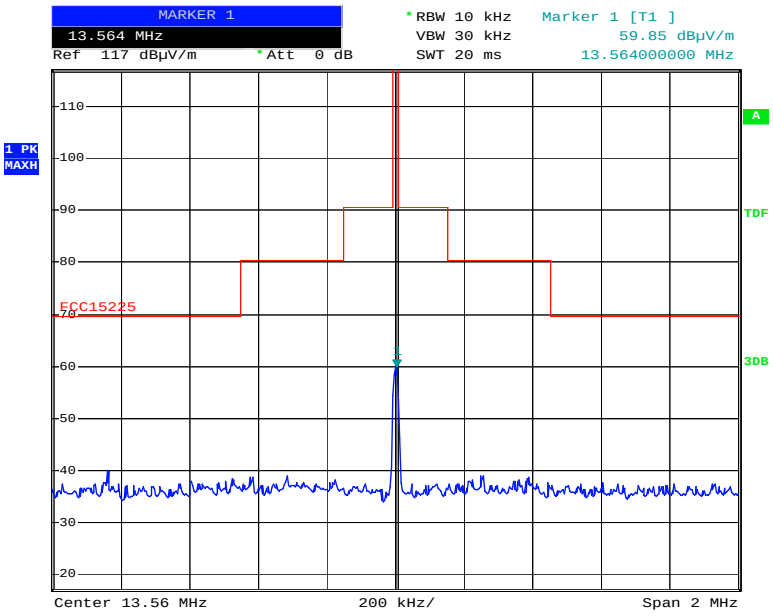


Date: 4.NOV.2014 12:25:06

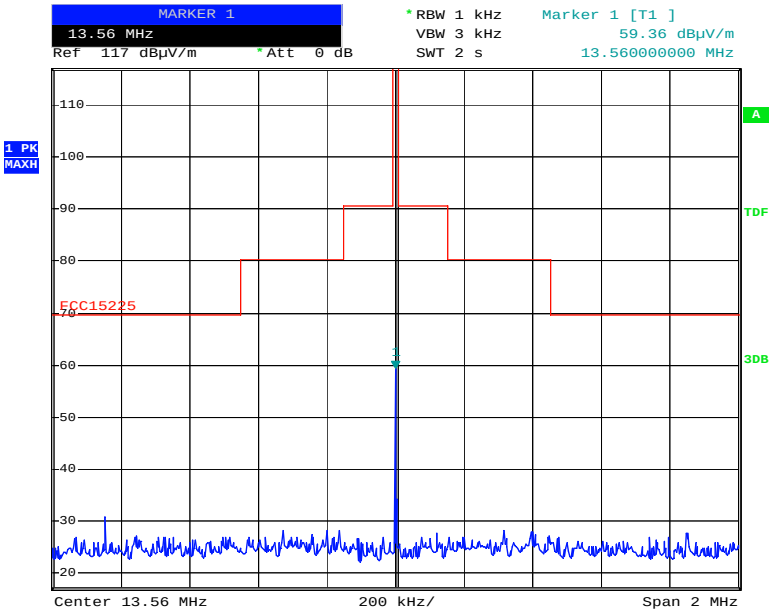


Date: 4.NOV.2014 12:24:48

Mode	PRBS FELICA @ 424 kBit/s
Test Result:	Test passed

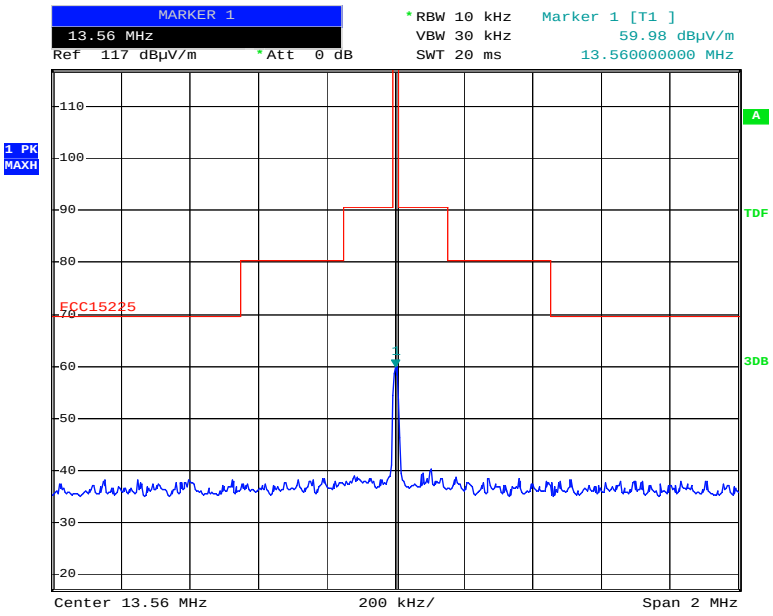


Date: 4.NOV.2014 11:58:12

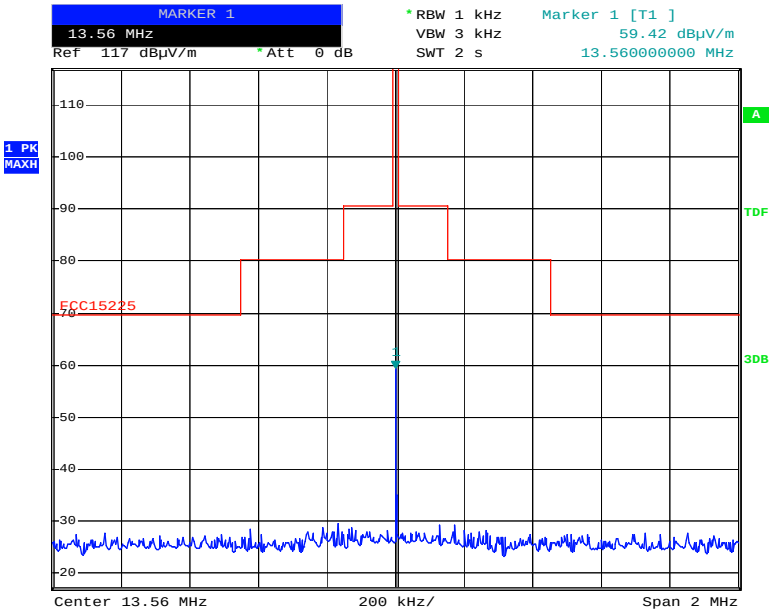


Date: 4.NOV.2014 11:57:47

Mode	PRBS ISO 14443B @ 424 kBit/s
Test Result:	Test passed



Date: 4.NOV.2014 11:29:39



Date: 4.NOV.2014 11:31:17

8.6 Radiated Emission Measurement 9 kHz to 30 MHz

Rules and specifications:	CFR 47 Part 15, sections 15.205 and 15.225(a)-(d)			
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 - 13.110	30	29.5	30
	13.110 - 13.410	106	40.5	30
	13.410 - 13.553	334	50.5	30
	13.553 - 13.567	15848	84.0	30
	13.567 - 13.710	334	50.5	30
	13.710 - 14.010	106	40.5	30
	14.010 - 30.000	30	29.5	30
	Additionally, the level of any unwanted emissions shall not exceed the level of the fundamental emission.			
Measurement procedure:	Radiated Emission Measurement 9 kHz to 30 MHz (6.3)			

Comment:	
Test distance	Prescans: 3 m Final measurement: 10 m
Test site:	Prescans: Fully anechoic room, cabin no. 2 Final measurement: Semi-anechoic room, cabin no. 8

Test Result:	Test passed

Comment:	Final test for mode “APP FELICA @ 424 kBit/s” for third position
Date of test:	2015-03-19
Test Result:	Test passed

Extrapolation factor: -40 dB/decade

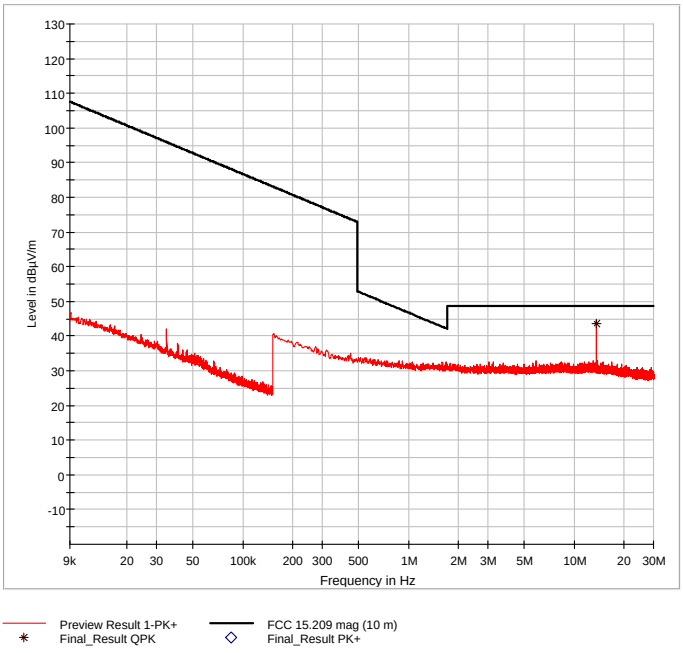
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
13.56000	Quasi-Peak	10	30	23.7	20.0	-19.1		24.6	84.0	**59.4**

Sample calculation of final values:

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

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

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



Comment:	Prescan for mode “APP ISO14443A @ 424 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis. Known external interference at 17.1 kHz on test side “cabin No. 2” no evaluated.
Date of test:	2015-03-16
Test Result:	Prescan

Extrapolation factor: -40 dB/decade

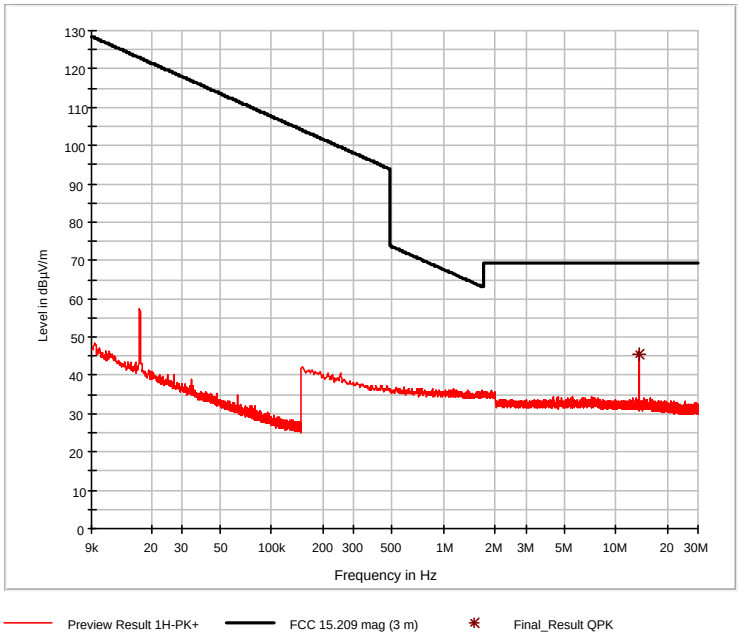
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
13.56000	Quasi-Peak	3	30	29.3	20.0	-40.0		9.3	84.0	**74.7**

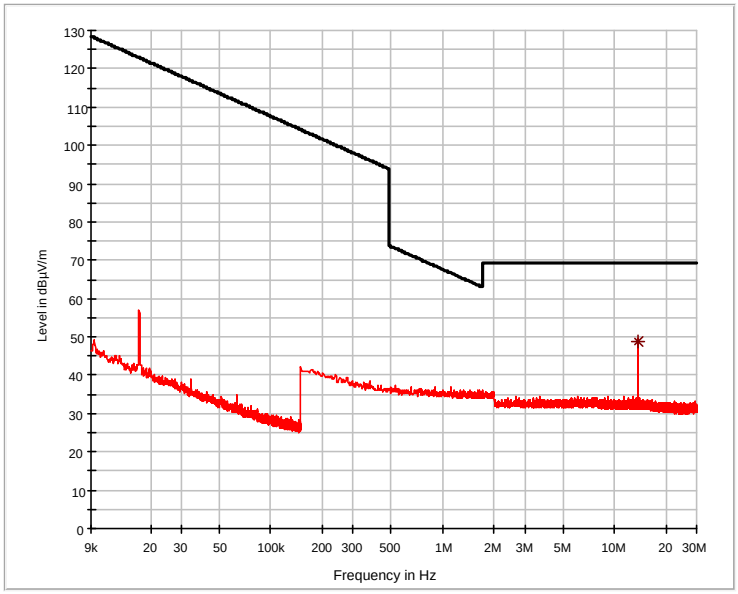
Sample calculation of final values:

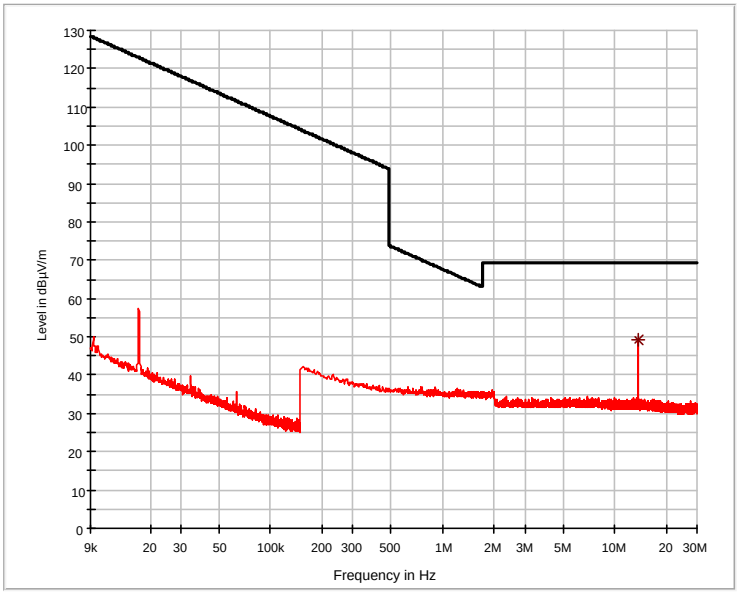
Extrapolation Factor (dB) = (Log(d) - Log(d_1)) · Extrapolation Factor (dB/decade)

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.




130
120
110
100
90
80
70
60
50
40
30
20
10
0
Level in dBµV/m
9k
20
30
50
100k
200
300
500
1M
2M
3M
5M
10M
20
30M
Frequency in Hz
Preview Result 1H-PK+
FCC 15.209 mag (3 m)
Final_Result QPK


130
120
110
100
90
80
70
60
50
40
30
20
10
0
Level in dBµV/m
9k
20
30
50
100k
200
300
500
1M
2M
3M
5M
10M
20
30M
Frequency in Hz
Preview Result 1H-PK+
FCC 15.209 mag (3 m)
Final_Result QPK

Comment:	Prescan for mode “APP ISO14443A @ 106 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis. Known external interference at 17.1 kHz on test side “cabin No. 2” no evaluated. See prescan of final measurement for details.
Date of test:	2015-03-16
Test Result:	Prescan

Extrapolation factor: -40 dB/decade

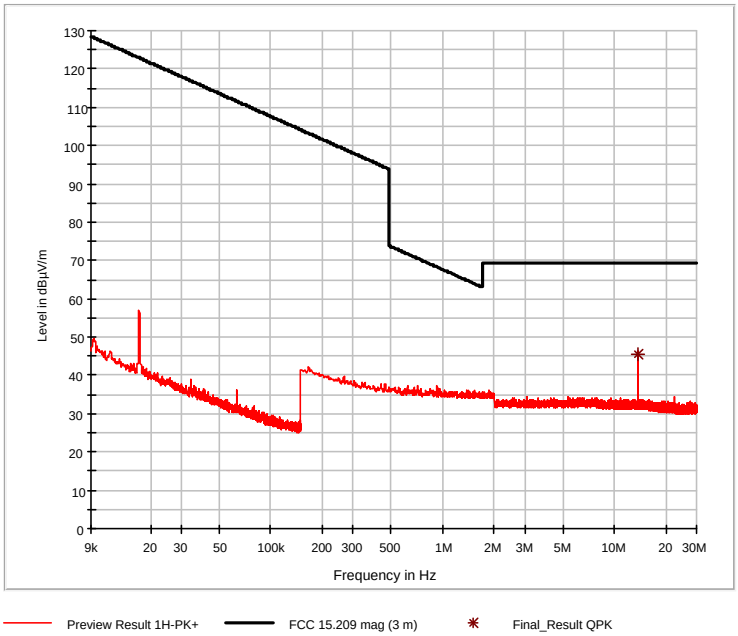
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
13.56000	Quasi-Peak	3	30	29.4	20.0	-40.0		9.4	84.0	**74.6**

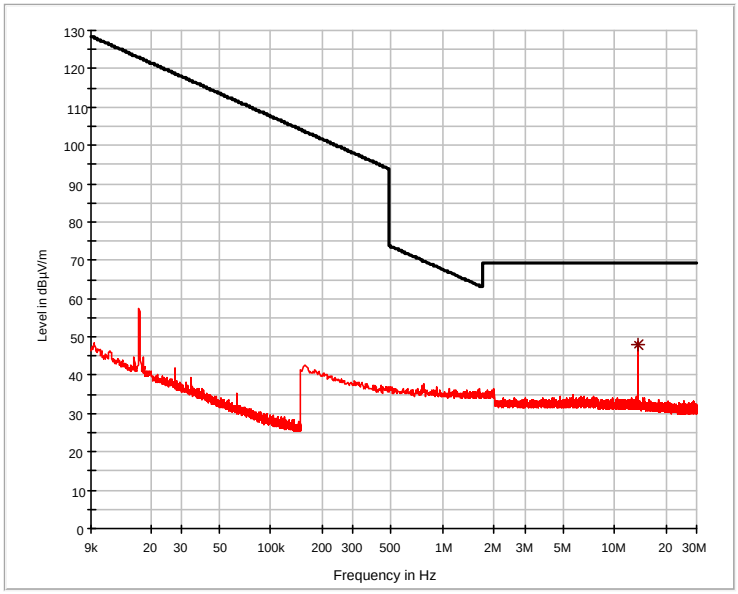
Sample calculation of final values:

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

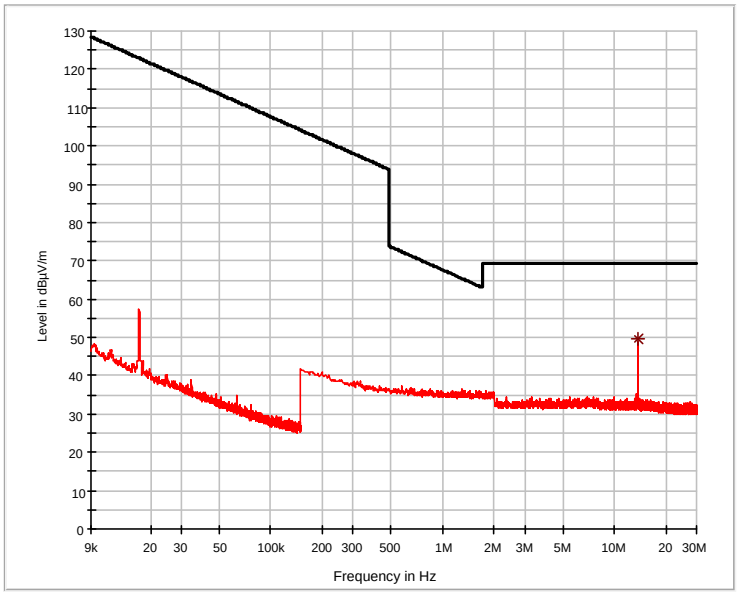
Final Value (dBµV/m) = Reading Value d_1 (dBµV) + Correction Factor (dB/m) + Extrapolation Factor (dB) + Pulse Train Correction (dB)

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





Preview Result 1H-PK+ FCC 15.209 mag (3 m) Final_Result QPK



Preview Result 1H-PK+ FCC 15.209 mag (3 m) Final_Result QPK

Comment:	Prescan for mode “APP ISO15693” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis. Known external interference at 17.1 kHz on test side “cabin No. 2” no evaluated. See prescan of final measurement for details.
Date of test:	2015-03-16
Test Result:	Prescan

Extrapolation factor: -40 dB/decade

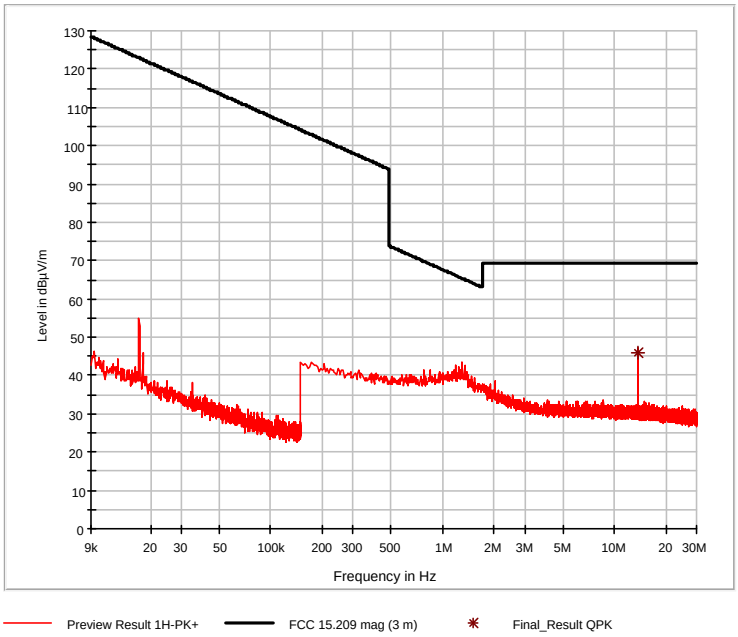
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
0.02748	Quasi-Peak	3	300	8.2	20.0	-80.0		-51.8	38.8	90.7
13.56000	Quasi-Peak	3	30	29.5	20.0	-40.0		9.5	84.0	**74.5**

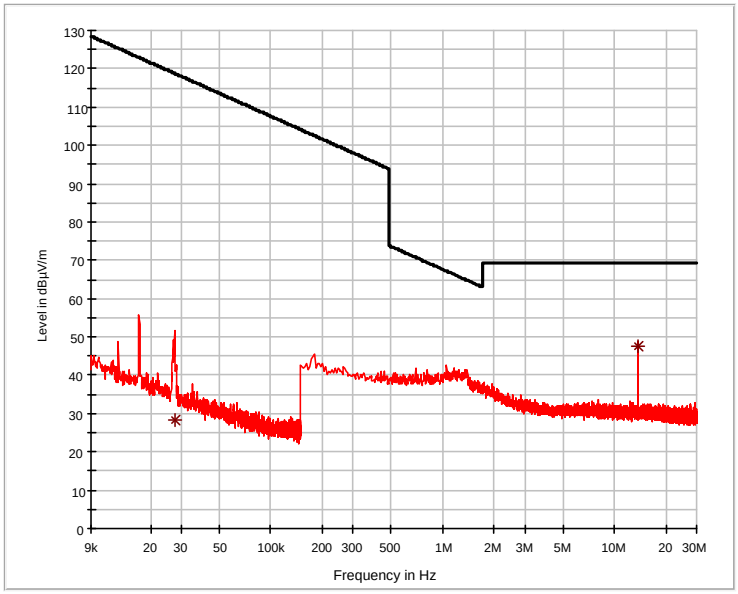
Sample calculation of final values:

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

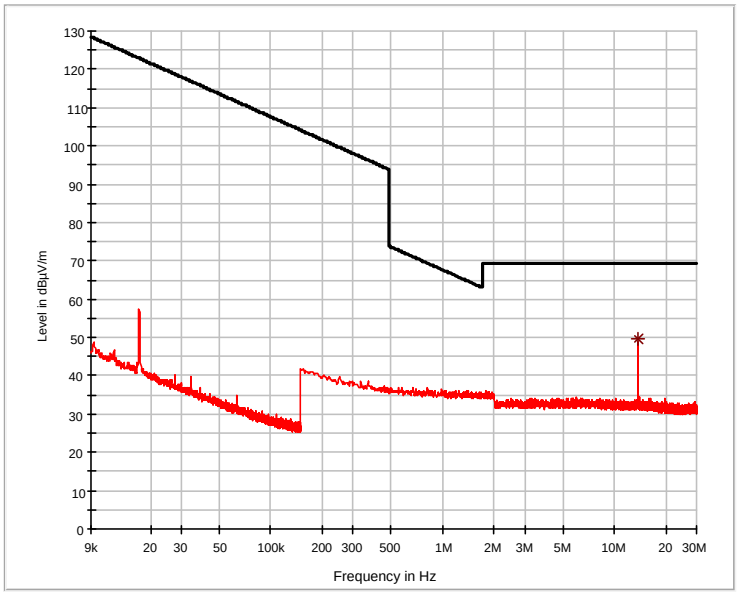
Final Value (dBµV/m) = Reading Value d_1 (dBµV) + Correction Factor (dB/m) + Extrapolation Factor (dB) + Pulse Train Correction (dB)

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





Preview Result 1H-PK+ FCC 15.209 mag (3 m) Final_Result QPK



Preview Result 1H-PK+ FCC 15.209 mag (3 m) Final_Result QPK

Comment:	Prescan for mode “APP FELICA @ 424 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis. Known external interference at 17.1 kHz on test side “cabin No. 2” no evaluated. See prescan of final measurement for details.
Date of test:	2015-03-16
Test Result:	Prescan

Extrapolation factor: -40 dB/decade

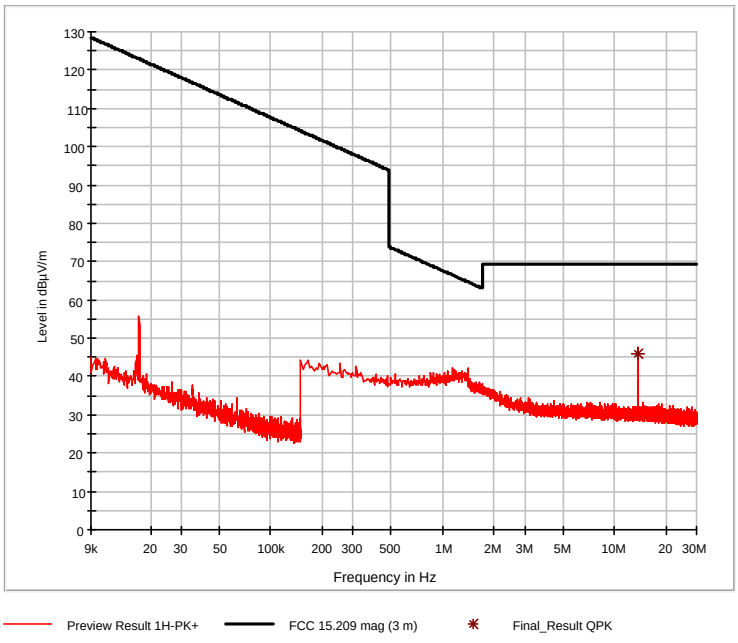
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
13.56000	Quasi-Peak	3	30	29.7	20.0	-40.0		9.7	84.0	**74.3**

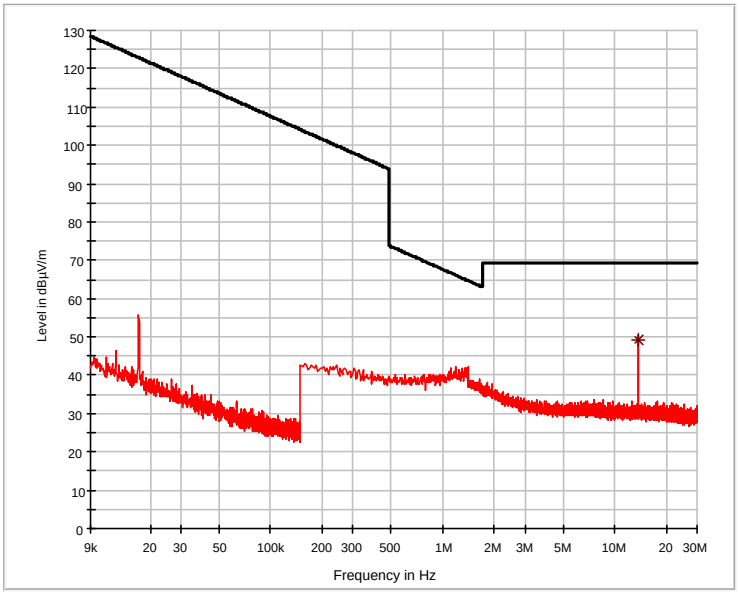
Sample calculation of final values:

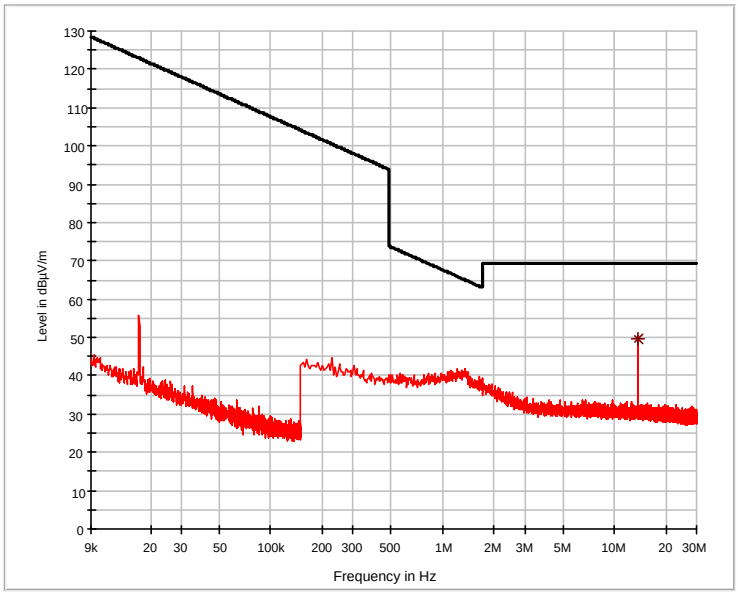
Extrapolation Factor (dB) = (Log(d) - Log(d_1)) · Extrapolation Factor (dB/decade)

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.




130
120
110
100
90
80
70
60
50
40
30
20
10
0
Level in dBµV/m
9k
20
30
50
100k
200
300
500
1M
2M
3M
5M
10M
20
30M
Frequency in Hz
Preview Result 1H-PK+
FCC 15.209 mag (3 m)
Final_Result QPK


130
120
110
100
90
80
70
60
50
40
30
20
10
0
Level in dBµV/m
9k
20
30
50
100k
200
300
500
1M
2M
3M
5M
10M
20
30M
Frequency in Hz
Preview Result 1H-PK+
FCC 15.209 mag (3 m)
Final_Result QPK

Comment:	Prescan for mode “APP ISO14443B @ 424 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis. Known external interference at 17.1 kHz on test side “cabin No. 2” no evaluated. See prescan of final measurement for details.
Date of test:	2015-03-16
Test Result:	Prescan

Extrapolation factor: -40 dB/decade

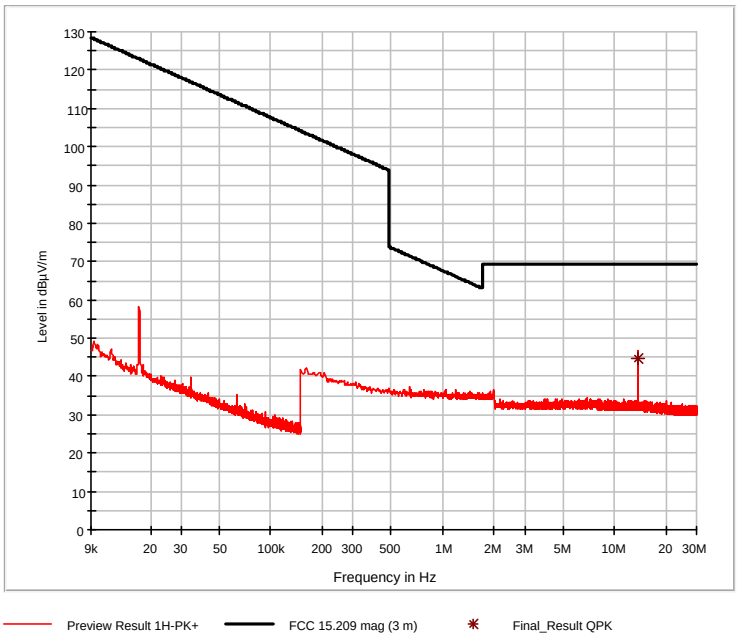
Frequency (MHz)	Detector	Distance d1 (m)	Distance d (m)	Reading Value (dBµV)	Correction Factor (dB/m)	Extrapolation Factor (dB)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
13.56000	Quasi-Peak	3	30	29.1	20.0	-40.0		9.1	84.0	**74.9**

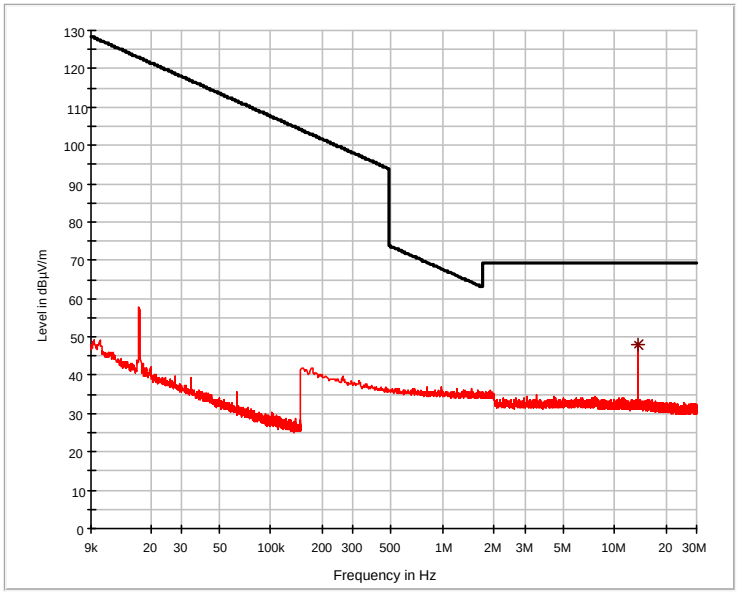
Sample calculation of final values:

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

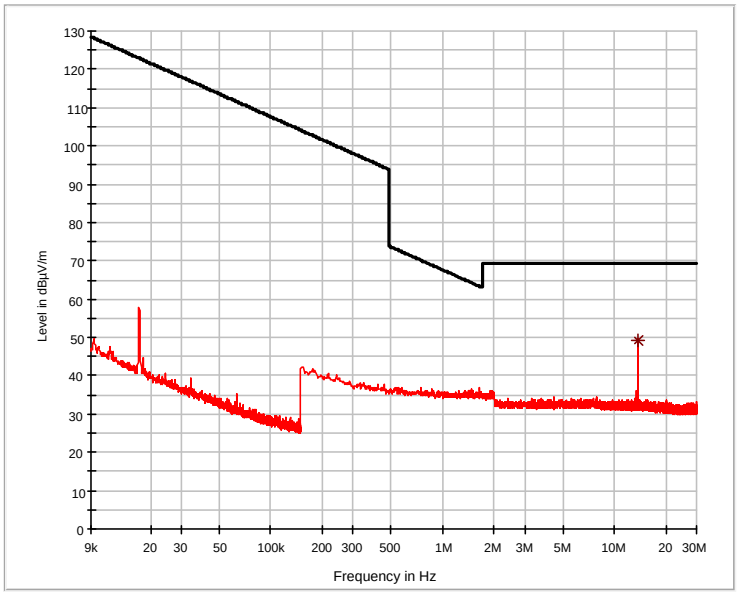
Final Value (dBµV/m) = Reading Value d_1 (dBµV) + Correction Factor (dB/m) + Extrapolation Factor (dB) + Pulse Train Correction (dB)

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





Preview Result 1H-PK+ FCC 15.209 mag (3 m) Final_Result QPK



Preview Result 1H-PK+ FCC 15.209 mag (3 m) Final_Result QPK

8.7 Radiated Emission Measurement 30 MHz to 1 GHz

Rules and specifications:	CFR 47 Part 15, sections 15.205(b) and 15.225(d)		
Guide:	ANSI C63.10		
Limit:	Frequency of Emission (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)
	30 - 88	100	40.0
	88 - 216	150	43.5
	216 - 960	200	46.0
	Above 960	500	54.0
	Additionally, the level of any unwanted emissions shall not exceed the level of the fundamental emission.		
Measurement procedures:	Radiated Emission in Fully or Semi Anechoic Room (6.4) Radiated Emission at Alternative Test Site (6.5)		

Comment:	
Test site:	Semi-anechoic room, cabin no. 8 Fully anechoic room, cabin no. 2 (Prescans)
Test distance:	3 meters

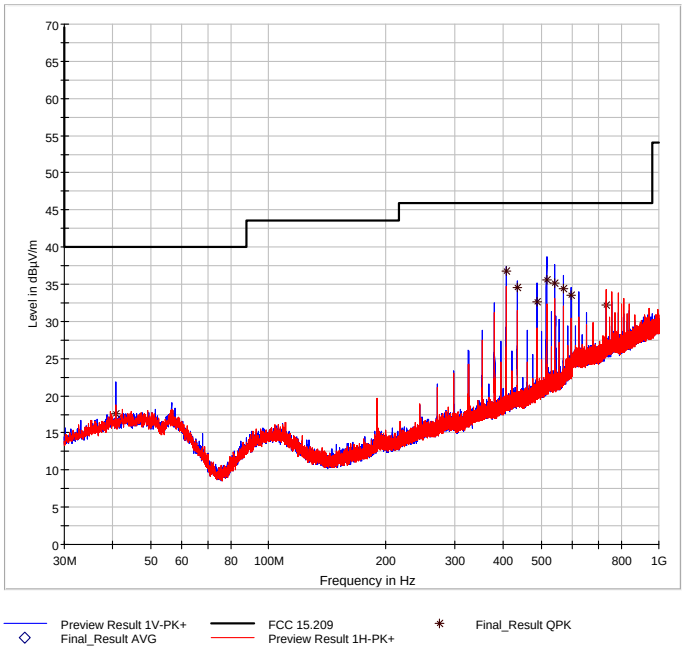
Test Result:	Test passed

Comment:	Final test for mode “APP ISO14443A @ 106 kBit/s” in second position.
Date of test:	2015-03-19
Test Result:	Test passed

Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
40.690	vertical	Quasi-Peak	1.9	15.7		17.6	40.0	22.4
406.840	vertical	Quasi-Peak	19.4	17.4		36.8	46.0	**9.2**
433.920	vertical	Quasi-Peak	16.6	17.9		34.5	46.0	11.5
488.170	vertical	Quasi-Peak	14.0	18.7		32.7	46.0	13.4
515.290	vertical	Quasi-Peak	16.2	19.3		35.5	46.0	10.5
542.400	vertical	Quasi-Peak	15.7	19.5		35.2	46.0	10.9
569.560	vertical	Quasi-Peak	14.3	20.1		34.4	46.0	11.6
596.680	vertical	Quasi-Peak	12.6	21.0		33.6	46.0	12.5
732.280	horizontal	Quasi-Peak	9.4	22.8		32.2	46.0	13.8

Sample calculation of final values:

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

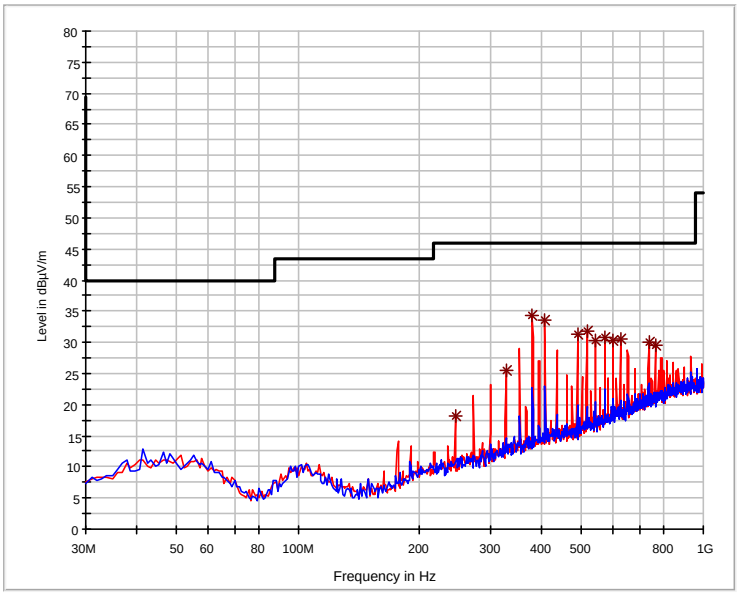


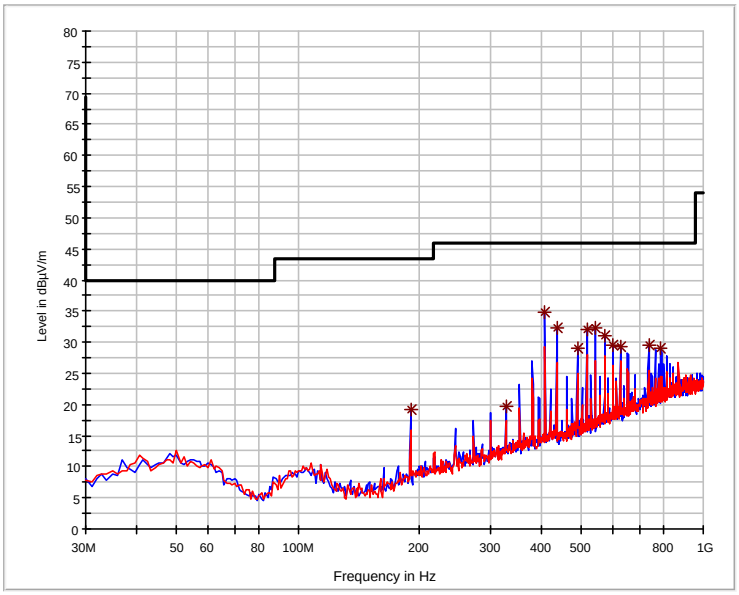
Comment:	Prescan for mode “APP ISO14443A @ 424 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis.
Date of test:	2015-03-16
Test Result:	Prescan

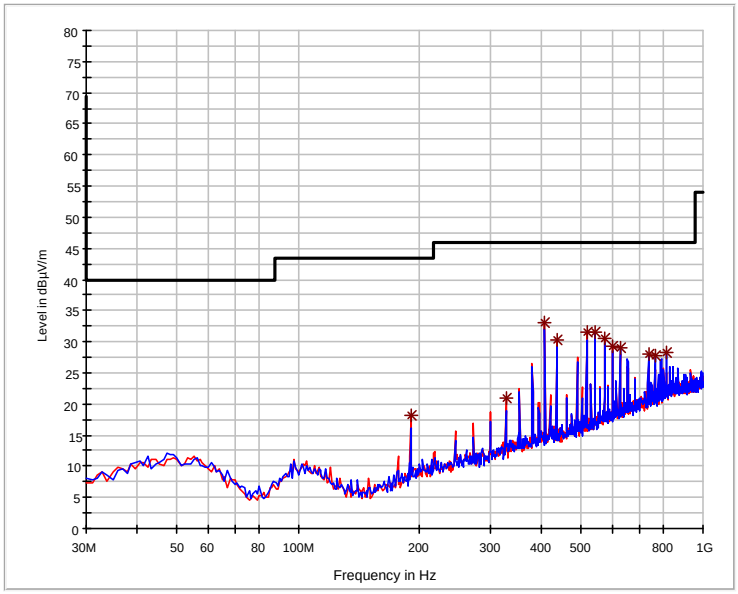
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
190.050	vertical	Peak	38.4	-19.2		19.2	43.5	24.3
244.370	horizontal	Peak	35.5	-17.4		18.1	46.0	27.9
325.850	horizontal	Peak	41.0	-15.6		25.4	46.0	20.6
379.200	horizontal	Peak	48.9	-14.5		34.4	46.0	11.6
407.330	vertical	Peak	48.7	-13.8		34.9	46.0	**11.1**
434.490	vertical	Peak	45.8	-13.5		32.3	46.0	13.7
488.810	horizontal	Peak	43.7	-12.4		31.3	46.0	14.7
515.970	vertical	Peak	44.2	-12.0		32.2	46.0	13.8
543.130	vertical	Peak	43.7	-11.5		32.2	46.0	13.8
570.290	vertical	Peak	42.0	-10.8		31.2	46.0	14.9
597.450	horizontal	Peak	40.8	-10.4		30.4	46.0	15.7
623.640	horizontal	Peak	40.4	-10.0		30.4	46.0	15.6
733.250	horizontal	Peak	38.2	-8.2		30.0	46.0	16.0
760.410	horizontal	Peak	37.3	-7.8		29.5	46.0	16.5
786.600	vertical	Peak	36.4	-7.4		29.0	46.0	17.0
814.730	vertical	Peak	35.2	-7.0		28.2	46.0	17.8

Sample calculation of final values:

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


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


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

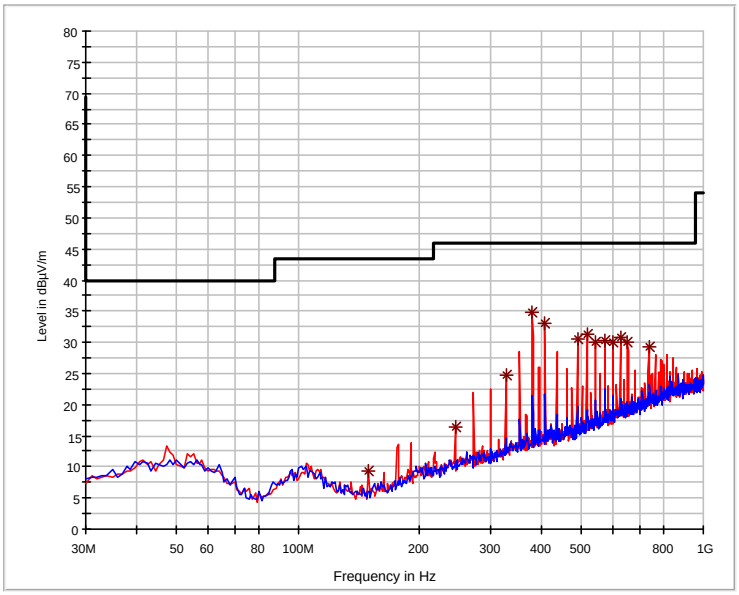

Level in dBµV/m
Frequency in Hz
30M
50
60
80
100M
200
300
400
500
800
1G
Preview Result 1H-PK+
Preview Result 1V-PK+
FCC 15.209
Final_Result PK+

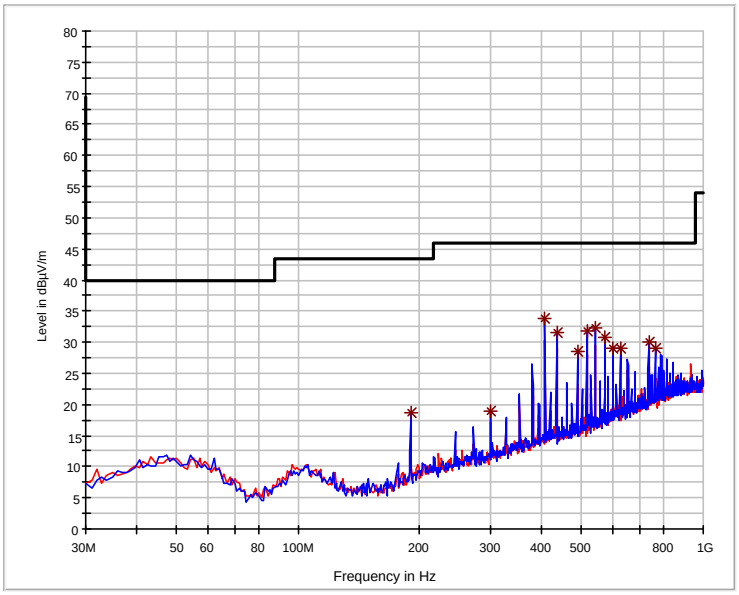
Comment:	Prescan for mode “APP ISO14443A @ 106 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis.
Date of test:	2015-03-16
Test Result:	Prescan

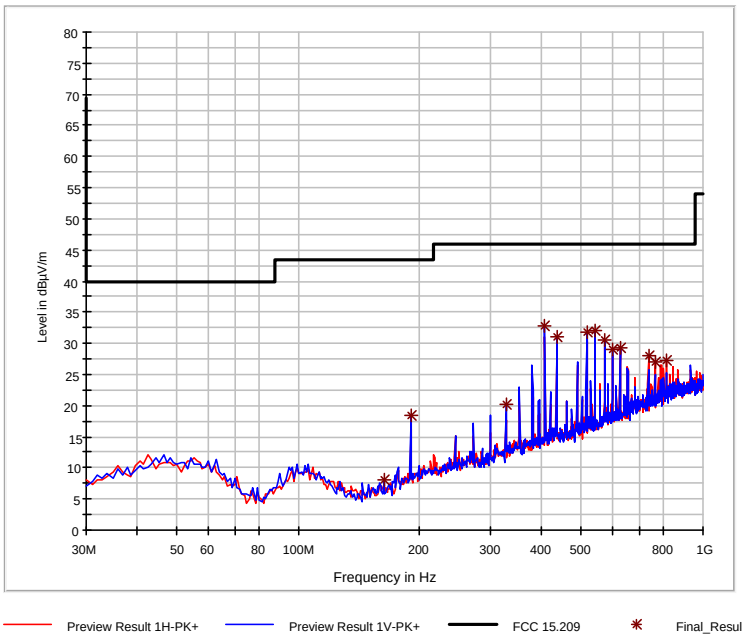
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
149.310	horizontal	Peak	31.1	-21.8		9.3	43.5	34.2
162.890	vertical	Peak	29.3	-21.2		8.1	43.5	35.4
190.050	vertical	Peak	38.0	-19.2		18.8	43.5	24.8
244.370	horizontal	Peak	33.9	-17.4		16.5	46.0	29.5
298.690	vertical	Peak	35.3	-16.3		19.0	46.0	27.0
325.850	horizontal	Peak	40.2	-15.6		24.6	46.0	21.4
379.200	horizontal	Peak	49.2	-14.5		34.7	46.0	**11.3**
407.330	vertical	Peak	47.5	-13.8		33.7	46.0	12.3
434.490	vertical	Peak	45.1	-13.5		31.6	46.0	14.4
488.810	horizontal	Peak	43.0	-12.4		30.6	46.0	15.4
515.970	vertical	Peak	43.9	-12.0		31.9	46.0	14.1
543.130	vertical	Peak	43.7	-11.5		32.2	46.0	13.8
570.290	vertical	Peak	41.6	-10.8		30.8	46.0	15.2
597.450	horizontal	Peak	40.5	-10.4		30.1	46.0	15.9
623.640	horizontal	Peak	40.8	-10.0		30.8	46.0	15.2
650.800	horizontal	Peak	39.6	-9.6		30.0	46.0	16.0
733.250	vertical	Peak	38.3	-8.2		30.1	46.0	16.0
760.410	vertical	Peak	36.8	-7.8		29.0	46.0	17.1
814.730	horizontal	Peak	34.2	-7.0		27.2	46.0	18.8

Sample calculation of final values:

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


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


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

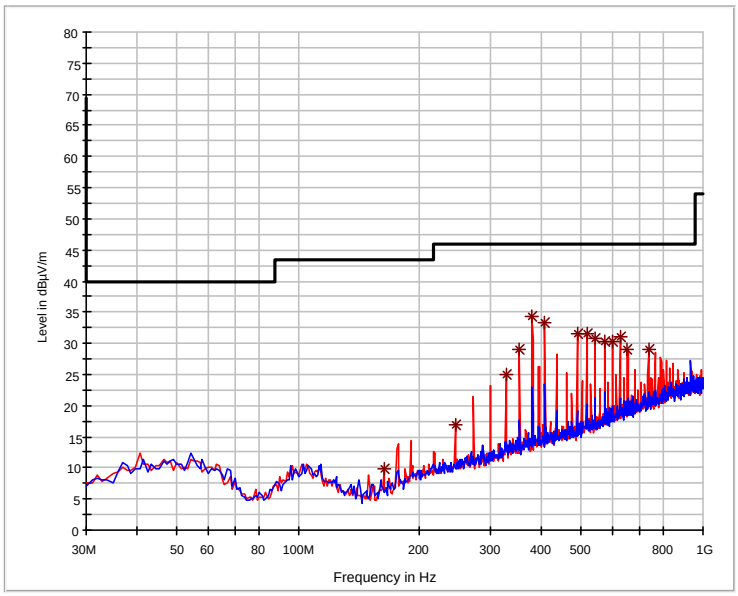

Level in dBµV/m
Frequency in Hz
30M
50
60
80
100M
200
300
400
500
800
1G
Preview Result 1H-PK+
Preview Result 1V-PK+
FCC 15.209
Final_Result PK+

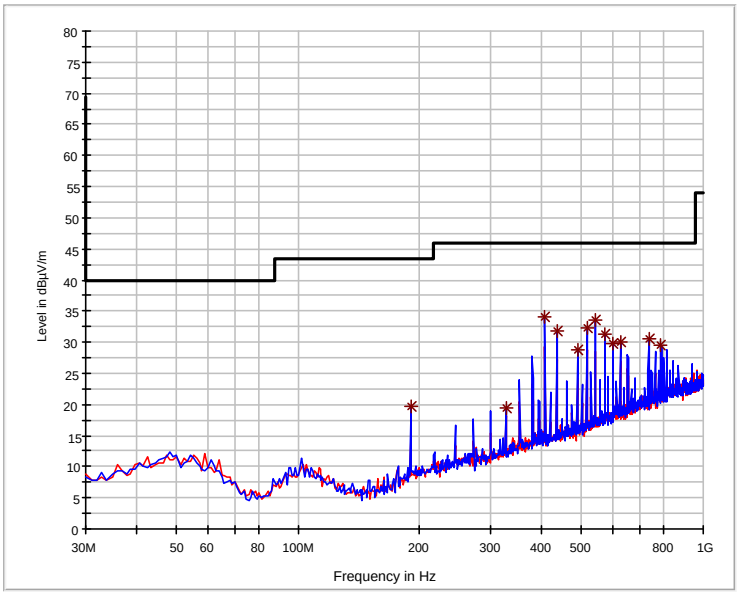
Comment:	Prescan for mode “APP ISO15693” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis.
Date of test:	2015-03-16
Test Result:	Prescan

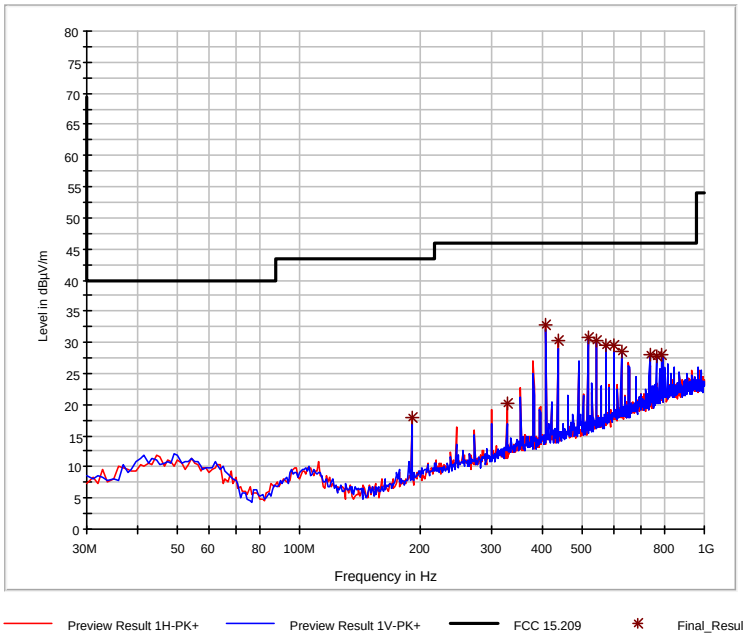
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
162.890	horizontal	Peak	30.9	-21.2		9.7	43.5	33.8
190.050	vertical	Peak	38.9	-19.2		19.7	43.5	23.8
244.370	horizontal	Peak	34.4	-17.4		17.0	46.0	29.0
325.850	horizontal	Peak	40.6	-15.6		25.0	46.0	21.1
353.010	horizontal	Peak	44.0	-14.9		29.1	46.0	16.9
379.200	horizontal	Peak	48.9	-14.5		34.4	46.0	**11.6**
407.330	vertical	Peak	48.0	-13.8		34.2	46.0	11.9
434.490	vertical	Peak	45.3	-13.5		31.8	46.0	14.2
488.810	horizontal	Peak	43.9	-12.4		31.5	46.0	14.5
515.970	vertical	Peak	44.2	-12.0		32.2	46.0	13.8
543.130	vertical	Peak	45.0	-11.5		33.5	46.0	12.5
570.290	vertical	Peak	42.2	-10.8		31.4	46.0	14.6
597.450	horizontal	Peak	40.8	-10.4		30.4	46.0	15.6
623.640	horizontal	Peak	41.2	-10.0		31.2	46.0	14.8
650.800	horizontal	Peak	38.7	-9.6		29.1	46.0	16.9
733.250	vertical	Peak	38.7	-8.2		30.5	46.0	15.5
760.410	vertical	Peak	35.6	-7.8		27.8	46.0	18.2
786.600	vertical	Peak	36.9	-7.4		29.5	46.0	16.5

Sample calculation of final values:

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


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


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

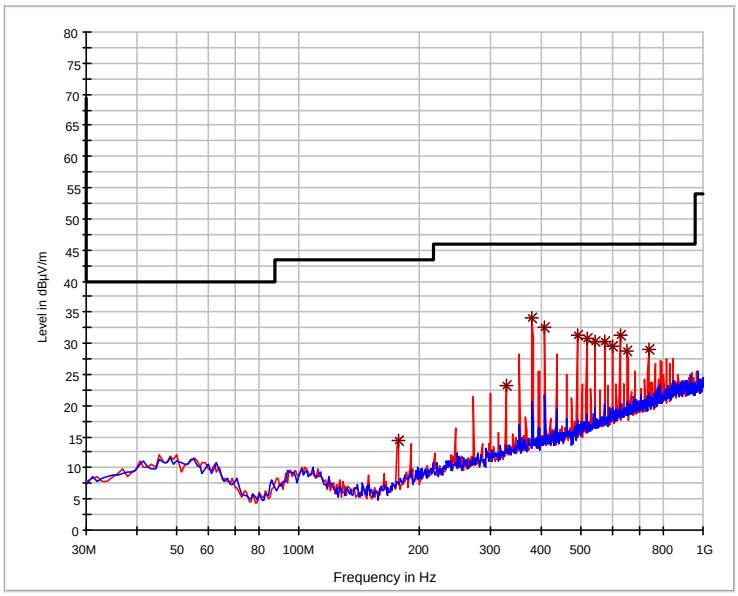

Level in dBµV/m
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
30M
50
60
80
100M
200
300
400
500
800
1G
Frequency in Hz
Preview Result 1H-PK+
Preview Result 1V-PK+
FCC 15.209
Final_Result PK+

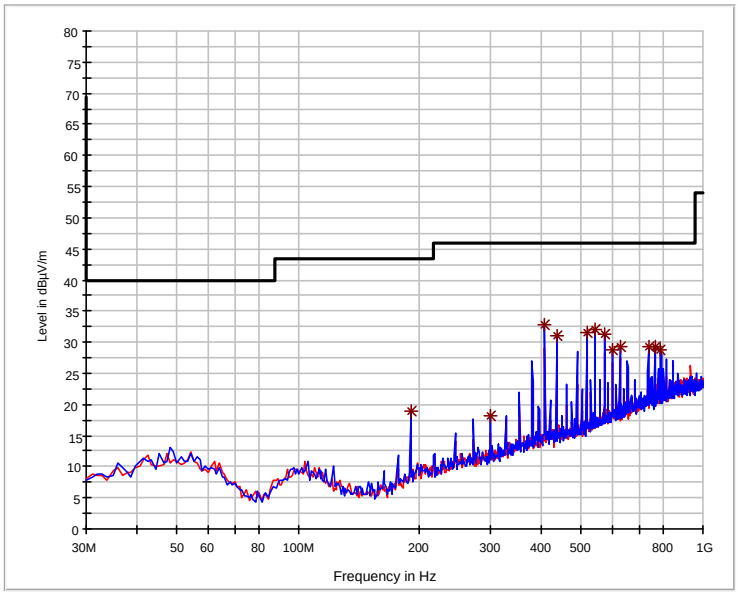
Comment:	Prescan for mode “APP FELICA @ 424 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis.
Date of test:	2015-03-16
Test Result:	Prescan

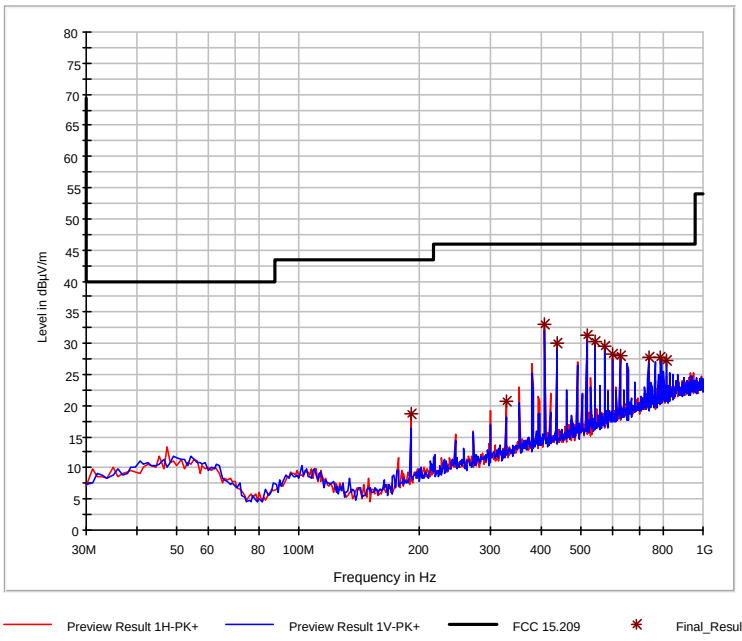
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
176.470	horizontal	Peak	35.0	-20.5		14.5	43.5	29.0
190.050	vertical	Peak	38.1	-19.2		18.9	43.5	24.6
298.690	vertical	Peak	34.5	-16.3		18.2	46.0	27.8
325.850	horizontal	Peak	38.8	-15.6		23.2	46.0	22.9
379.200	horizontal	Peak	48.7	-14.5		34.2	46.0	**11.8**
407.330	horizontal	Peak	46.8	-13.8		33.0	46.0	13.0
434.490	vertical	Peak	44.5	-13.5		31.0	46.0	15.0
488.810	horizontal	Peak	43.7	-12.4		31.3	46.0	14.7
515.970	vertical	Peak	43.7	-12.0		31.7	46.0	14.4
543.130	vertical	Peak	43.6	-11.5		32.1	46.0	13.9
570.290	vertical	Peak	42.0	-10.8		31.2	46.0	14.8
597.450	horizontal	Peak	40.1	-10.4		29.7	46.0	16.4
623.640	horizontal	Peak	41.3	-10.0		31.3	46.0	14.7
650.800	horizontal	Peak	38.5	-9.6		28.9	46.0	17.1
733.250	vertical	Peak	37.4	-8.2		29.2	46.0	16.8
760.410	vertical	Peak	37.2	-7.8		29.4	46.0	16.6
786.600	vertical	Peak	36.2	-7.4		28.8	46.0	17.2
814.730	vertical	Peak	34.2	-7.0		27.2	46.0	18.8

Sample calculation of final values:

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


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


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

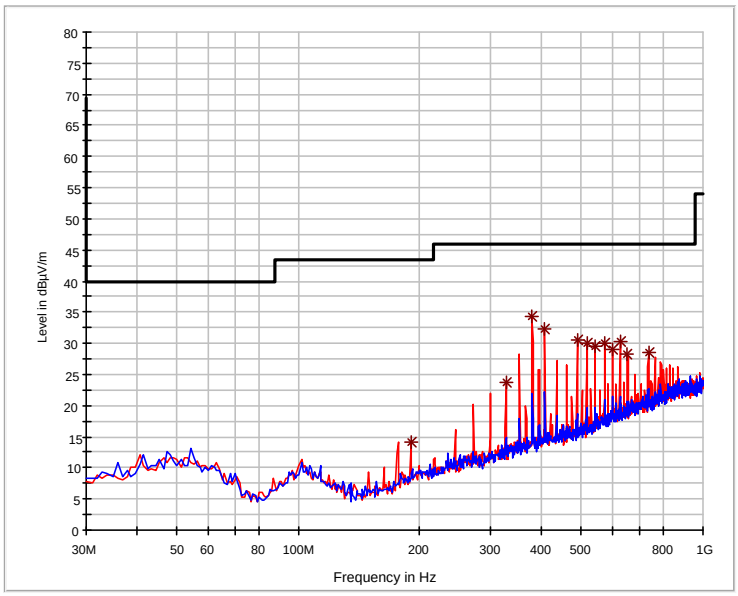

Level in dBµV/m
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
30M
50
60
80
100M
200
300
400
500
800
1G
Frequency in Hz
Preview Result 1H-PK+
Preview Result 1V-PK+
FCC 15.209
Final_Result PK+

Comment:	Prescan for mode “APP ISO14443B @ 424 kBit/s” for three orthogonal axes Table shows results for prescans in three orthogonal axes, plots show single measurement for each axis.
Date of test:	2015-03-16
Test Result:	Prescan

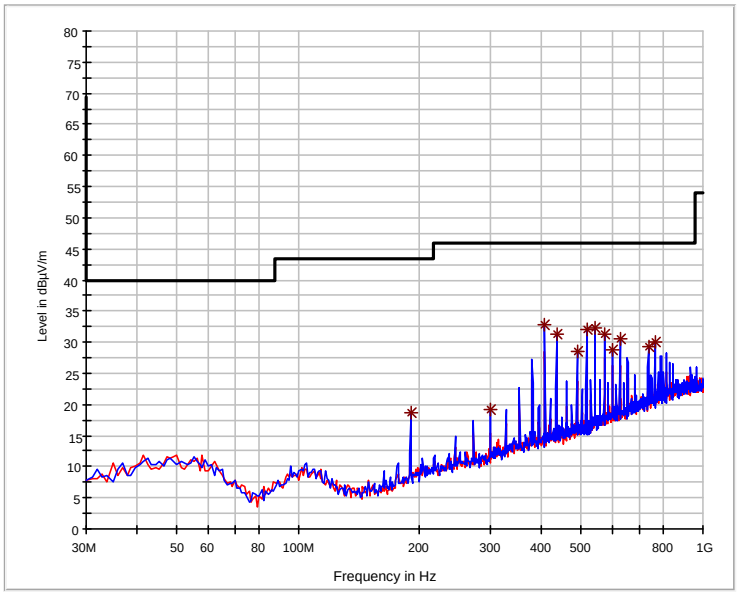
Frequency (MHz)	Antenna Polarization	Detector	Receiver Reading (dBµV)	Correction Factor (dB/m)	Pulse Train Correction (dB)	Final Value (dBµV/m)	Limit (dBµV/m)	Margin (dB)
190.050	vertical	Peak	38.0	-19.2		18.8	43.5	24.7
298.690	vertical	Peak	35.5	-16.3		19.2	46.0	26.8
325.850	horizontal	Peak	39.3	-15.6		23.7	46.0	22.3
379.200	horizontal	Peak	48.8	-14.5		34.3	46.0	**11.7**
407.330	vertical	Peak	46.6	-13.8		32.8	46.0	13.2
434.490	vertical	Peak	44.8	-13.5		31.3	46.0	14.7
488.810	horizontal	Peak	42.9	-12.4		30.5	46.0	15.5
515.970	vertical	Peak	44.0	-12.0		32.0	46.0	14.0
543.130	vertical	Peak	43.7	-11.5		32.2	46.0	13.8
570.290	vertical	Peak	42.1	-10.8		31.3	46.0	14.7
597.450	horizontal	Peak	39.5	-10.4		29.1	46.0	16.9
623.640	vertical	Peak	40.4	-10.0		30.4	46.0	15.6
650.800	horizontal	Peak	38.0	-9.6		28.4	46.0	17.6
733.250	vertical	Peak	37.5	-8.2		29.3	46.0	16.7
760.410	vertical	Peak	37.8	-7.8		30.0	46.0	16.0
786.600	vertical	Peak	34.7	-7.4		27.3	46.0	18.7

Sample calculation of final values:

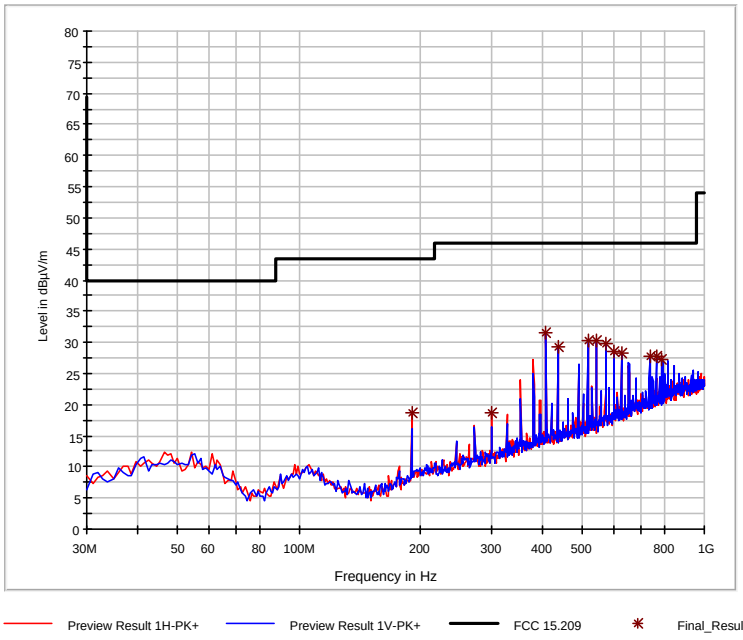
Final Value (dBµV/m) = Reading Value (dBµV) + Correction Factor (dB/m) + Pulse Train Correction (dB)



Preview Result 1H-PK+ Preview Result 1V-PK+ FCC 15.209 Final_Result PK+



Preview Result 1H-PK+ Preview Result 1V-PK+ FCC 15.209 Final_Result PK+

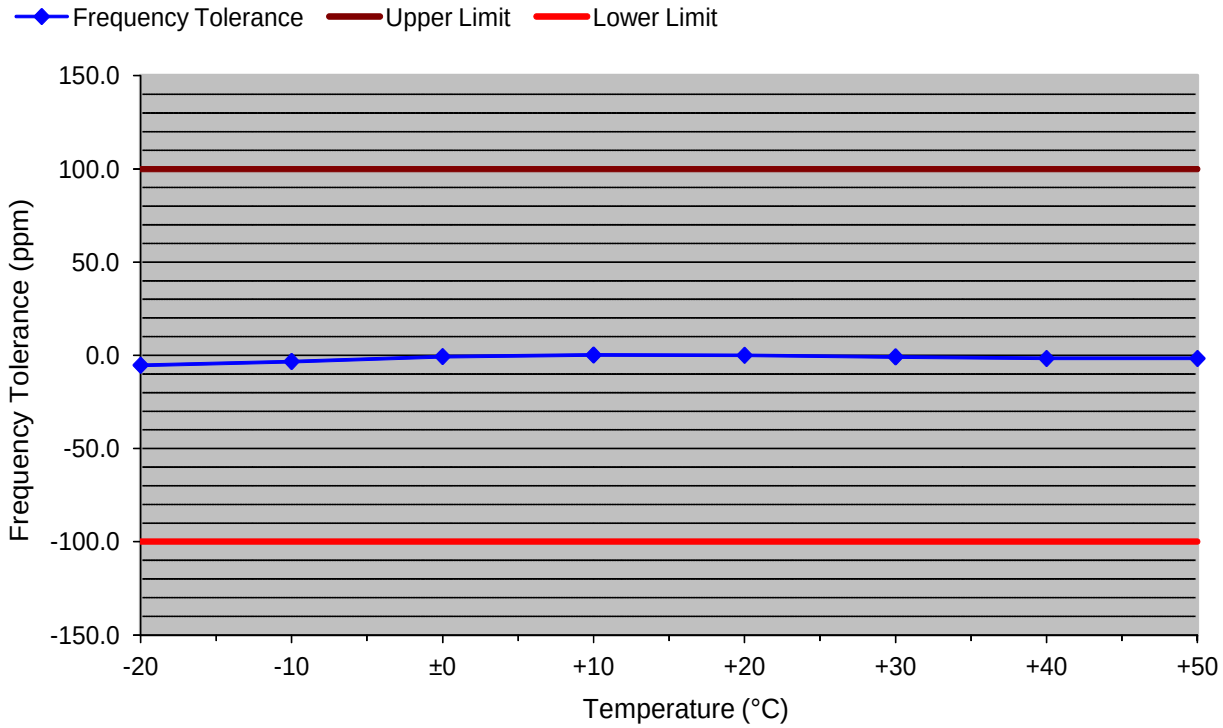

Level in dBµV/m
Frequency in Hz
30M
50
60
80
100M
200
300
400
500
800
1G
Preview Result 1H-PK+
Preview Result 1V-PK+
FCC 15.209
Final_Result PK+

8.8 Carrier Frequency Stability

Rules and specifications:	CFR 47 Part 15, section 15.225(e)
Guide:	ANSI C63.10
Limit:	The frequency tolerance of the carrier signal shall be maintained within ±0.01 % (±100 ppm) of the carrier frequency under nominal conditions.
Temperature range: Voltage range:	-20°C to +50°C (at normal supply voltage) 85% to 115% of the rated supply voltage (at a temperature of +20°C)
Measurement procedure:	Carrier Frequency Stability (6.6)

Comment:	Test performed with unmodulated carrier
Date of test:	2014-11-05

8.8.1 Carrier Frequency Stability vs. Temperature

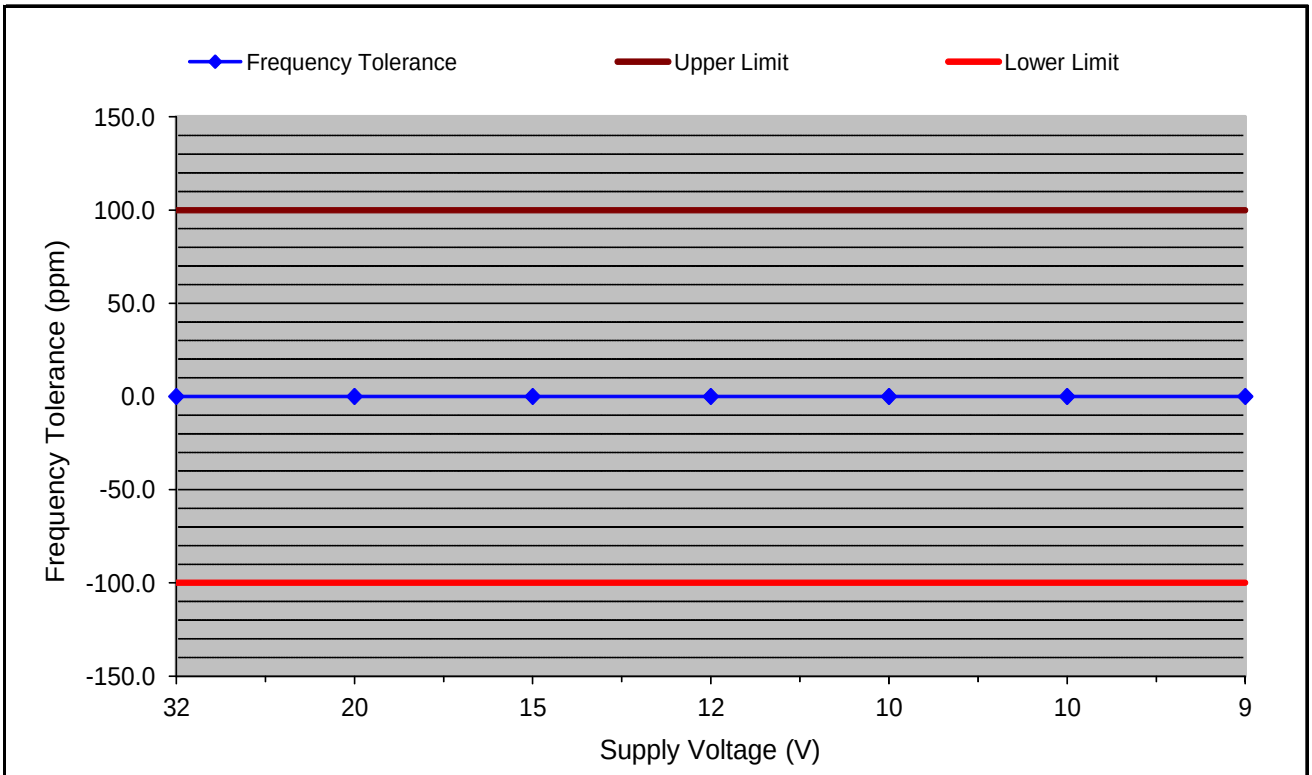


Supply voltage: 9 V Nominal frequency: 13.560561 MHz

Temperature (°C)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
-20	13.560489	-72	-5.3	+100.0	-100.0	**94.7**
-10	13.560516	-45	-3.3	+100.0	-100.0	96.7
±0	13.560552	-9	-0.7	+100.0	-100.0	99.3
+10	13.560563	2	0.1	+100.0	-100.0	99.9
+20	13.560561	0	0.0	+100.0	-100.0	100.0
+30	13.560550	-11	-0.8	+100.0	-100.0	99.2
+40	13.560538	-23	-1.7	+100.0	-100.0	98.3
+50	13.560538	-23	-1.7	+100.0	-100.0	98.3

Test Result:	Test passed

8.8.2 Carrier Frequency Stability vs. Supply Voltage



Temperature: +20 °C
Nominal frequency: 13.560552 MHz
Battery End Point: Not applicable

Supply Voltage (V)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
32	13.560552	0	0.0	+100.0	-100.0	**100.0**
20	13.560552	0	0.0	+100.0	-100.0	**100.0**
15	13.560552	0	0.0	+100.0	-100.0	**100.0**
12	13.560552	0	0.0	+100.0	-100.0	**100.0**
10	13.560552	0	0.0	+100.0	-100.0	**100.0**
10	13.560552	0	0.0	+100.0	-100.0	**100.0**
9	13.560552	0	0.0	+100.0	-100.0	**100.0**
9	13.560552	0	0.0	+100.0	-100.0	**100.0**
8	13.560552	0	0.0	+100.0	-100.0	**100.0**
8	13.560552	0	0.0	+100.0	-100.0	**100.0**
7	13.560552	0	0.0	+100.0	-100.0	**100.0**

Test Result:	Test passed

9 Referenced Regulations

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

☒	CFR 47 Part 2	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)	October 1, 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	June 7, 2009 (published on September 15, 2009)
☒	ANSI C63.10	American National Standard for Testing Unlicensed Wireless Devices	July 3, 2009 (published on September 10, 2009)
☒	CISPR 22	Third Edition of the International Special Committee on Radio Interference (CISPR), Pub. 22, “Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement”	1997
☐	CAN/CSA CISPR 22-10	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (Adopted IEC CISPR 22:2008, sixth edition, 2008-09)	2010
☒	TRC-43	Designation of Emissions, Class of Station and Nature of Service, published by Industry Canada	November 2012

10 Test Equipment List with Calibration Data

Type	*Inv.-No.*	*Type Designation*	*Serial Number*	*Manufacturer*	*Calibration Organization*	*Last Calibration*	*Next Calibration*
EMI test receiver	1711	ESPI7	836914/0002	Rohde & Schwarz	Rohde & Schwarz	05/2014	11/2015
EMI test receiver	1863	ESCI3	100008	Rohde & Schwarz	Rohde & Schwarz	09/2014	09/2015
EMI test receiver	2010	ESPI7	101018	Rohde & Schwarz	Rohde & Schwarz	06/2014	06/2015
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	1716	CPA9231A	3557	Schaffner EMC Systems	TÜV SÜD PS-EMC-STR	05/2014	11/2015
V-network	1059	ESH3-Z5	894785/005	Rohde & Schwarz	Rohde & Schwarz	08/2013	08/2015
Loop antenna	1016	HFH2-Z2	882964/0001	Rohde & Schwarz	Rohde & Schwarz	05/2014	05/2016
TRILOG Broadband Antenna	2058	VULB 9163	9163-408	Schwarzbeck	Rohde & Schwarz	06/2014	06/2015
TRILOG Broadband Antenna	2256	VULB 9162	9162-048	Schwarzbeck	Schwarzbeck	09/2013	03/2015
Multimeter	1975	Fluke 77 III	92370108	Fluke	ZMK	08/2013	08/2015
Temperature test chamber	1271	HT 4010	07065550	Heraeus	TÜV SÜD PS-EMC-STR	06/2013	06/2015
DC power supply	1267	NGSM 32/10	203	Rohde & Schwarz		see note 4	

Note 1: No calibration required.
Note 2: Not calibrated separately but with the whole test system when recording calibration data.
Note 3: No calibration required. Devices are checked before use.
Note 4: No calibration required. Devices are checked by calibrated equipment during test.

11 Revision History

Revision History			
Edition	*Date*	*Issued by*	*Modifications*
1	2014-11-13	M. Steindl (cb)	First Edition
2	2015-02-16	M. Steindl	Normative update to RSS-GEN, Issue 4.
3	2015-03-20	M. Steindl	Retest of radiated emissions 9 kHz – 1 GHz with shielded module for modular approval.
4	2015-05-07	M. Steindl	Update of dates of test. Clarification of test voltages, configuration of EUT (hostboard as test board) and external interference. Conducted emission test for configuration with antenna removed.
5	2015-05-19	M. Steindl	Normative update to ANSI C63.4:2009 and ANSI C63.10:2009 Added description of antenna used for tests.
6	2015-06-02	M. Steindl	Deleted references to IC standards and unused ANSI standards.