InterLab®

FCC Measurement/Technical Report on

SPRINGCARD
Prox'N'Roll HSP

FPF16209-AD PCSC

and

FPF16210-AD RFID scanner

Report Reference: MDE_SPRING_1601_FCCa

FCC ID: TYQ-PRNHSP01
IC ID: 21625-PNRHSP01

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-01

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0 Summary

0.1 Technical Report Summary

Type of Authorization
Certification for an intentional radiator operating at 13.56 MHz

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-14 Edition) and 15 (10-1-14 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.205 Restricted bands of operation

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.215 Additional provisions to the general radiated emission limitations

§ 15.225 Operation within the band 13.110-14.010 MHz

ANSI C63.10-2013 is applied

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

0.2 Measurement Summary

FCC Part 15, Subpart C	**§ 15.207**		
Conducted Emissions AC Power line			
The measurement was performed according to ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	USB port	passed

FCC Part 15, Subpart C	**§15.209**		
Radiated Emissions			
The measurement was performed according to ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_02	enclosure	passed

FCC Part 15, Subpart C	**§ 15.215**		
Occupied Bandwidth			
The measurement was performed according to ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	enclosure	passed

FCC Part 15, Subpart C	**§ 15.225**		
Spectrum Mask			
The measurement was performed according to ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_02	enclosure	passed

FCC Part 15, Subpart C	**§ 15.225**		
Frequency Tolerance			
The measurement was performed according to ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 2	Setup_01	enclosure	passed

Responsible for Accreditation Scope: MARCO KULLIK 2016.07.25 16:26:40 +02'00'

Responsible for Test Report: DOBRIN TODOROV DOBRINOV 2016.07.25 15:42:10 +02'00'

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers GmbH
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

This facility has been fully described in a report submitted to the IC and accepted under the registration number: Site# 3699A-1.

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Andreas Petz Dipl. Ing. Marco Kullik
Report Template Version:	2015-08-24

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Dobrin Dobrinov
Date of Test(s):	2016-04-01 to 2016-05-17
Date of Report:	2016-07-19

1.3 Applicant Data

Company Name:	SpringCard
Address:	13 Voie la Cardon Parc Gutenberg 91120 Palaiseau France
Contact Person:	Mr. Jèrôme Chalbot

1.4 Manufacturer Data

Company Name:	please see applicant data
Address:	
Contact Person:	

2 Test object Data

2.1 General EUT Description

Equipment under Test	USB contactless 13.56 MHz PC/SC coupler and RFID/NFC scanner
Type Designation:	Prox'N'Roll HSP FPF16209-AD PCSC and FPF16210-AD RFID scanner
Kind of Device:	NFC transceiver at 13.56 MHz
(optional)	
Voltage Type:	DC via USB port
Voltage level:	5.0 V

General product description:

Prox'N'Roll HSP FPF16209-AD PCSC and FPF16210-AD RFID scanner are highly configurable devices which could read the serial number or virtually any data from any RFID/NFC tag or contactless smartcards in the 13.56 MHz ICS frequency range.

Specific product description for the EUT:

According to the applicant, there is no difference between the two modules (FPF162209-AD and FPF16210-AD), regarding NFC configuration and functionality.

The EUT provides the following ports:

Ports

- USB port
- enclosure

The main components of the EUT are listed and described in Chapter 2.2.

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	Date of Receipt
EUT A (Code: DE1136002aa01)	Prox'N'Roll HSP PCSC	FPF16209-AD	AC0F417E	H663	2.04	-
Remark: EUT A has an integrated antenna.						
EUT B (Code: DE1136002ai05)	Prox'N'Roll HSP RFID scanner	FPF16210-AD	315C1BAE7	H663	1.66	-
Remark: EUT B has an integrated antenna.						

Both, EUT A and EUT B have installed as an integrated part
a 1. 80 m shielded USB cable - Part. No: FSE16213-AA,
equipped with ferrite - Typ 74271111S (Würt ElektronikeiSos GmbH & Co. KG),
mounted over the cable at a distance of 200 mm from the USB connector.

NOTE: The short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	FCC ID
AE 1	DE1136002 card01	contactless tag MIFARE 4K	RFID 044E186AB12D80	–	–	–

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status	FCC ID
AUX 1	"Laptop RE"	Fujitsu E Series E781	DSCK013817	–	Win 7 Pro	–
AUX 2	AC/DC adapter	Fujitsu Limited ADP-80NB A	13300281B	PJW1942NA	–	–
AUX 3	Keyboard	CHERRY RS 6000 USB ON	G 0000273 2P28	–	–	–
AUX 4	Optical mouse	Logitech M-BT58	HC60915A2XC	–	–	–
AUX 5	TFT monitor	LG Flatron L1730BSNHM-ALEUR	412WAPL0U560		–	–

2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup No.	Combination of EUTs	Description and Rationale
Setup_01	EUT A + AE1 + AUX1 + AUX2	Setup for Frequency Tolerance test, and Occupied BW tests
Setup_02	EUT A + AE1 + AUX1 to AUX5	Setup for Spectrum Mask, Radiated emissions tests and AC Power Line test

2.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

Op. Mode	Description of Operating Modes	Remarks
op-mode 1	modulated carrier signal	EUT is transmitting a periodic modulated signal and is continuously reading card information.
op-mode 2	CW carrier signal	EUT is transmitting a non-modulated signal

2.7 Special software used for testing

Using an external PC, connected to the bottom EUT interface connector and a Marvell software provided by the applicant, it is possible to set the EUT into the CW operating mode for performing the Frequency tolerance test.

2.8 Product labelling

2.8.1 FCC ID label

FCC ID: TYQ-PRNHSP01

2.8.2 IC ID label

IC ID: 21625-PNRHSP01
NVIN: FPF16209-AD and
FPF16210-AD

2.8.3 Location of the label on the EUT

Please refer to the customer documentation.

3 Test Results

3.1 Conducted Emissions AC Power line

Standard FCC Part 15, 10-1-14 Edition Subpart C

The test was performed according to: ANSI C63.10–2013 + KDB 174176 D01

3.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.10
The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50µH || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into the EMI test software EMC-32 from R&S.

Step 1: Preliminary scan
Intention of this step is, to determine the conducted EMI-profile of the EUT.
EMI receiver settings:
- Detector: Peak – Maxhold & Average
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 2.5 kHz
- IF–Bandwidth: 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)
- Measurement on phase + neutral lines of the power cords

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement
Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.
EMI receiver settings:
- Detector: Quasi-Peak
- IF Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:
1) Neutral lead - reference ground (PE grounded)
2) Phase lead - reference ground (PE grounded)
3) Neutral lead - reference ground (PE floating)
4) Phase lead - reference ground (PE floating)

The highest value is reported.

KDB 174176 D01, Q5. Devices Operating Below 30 MHz

For a device with a permanent or detachable antenna operating at or below 30 MHz, the FCC will accept measurements performed with a suitable dummy load in lieu of the antenna under the following conditions:
(1) perform the AC power-line conducted tests with the antenna connected to determine compliance with Section 15.207 limits outside the transmitter's fundamental emission band;
(2) retest with a dummy load in lieu of the antenna to determine compliance with Section 15.207 limits within the transmitter's fundamental emission band.
For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network which simulates the antenna in the fundamental frequency band.

3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.207

Frequency Range (MHz)	QP Limit (dBµV)	AV Limit (dBµV)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

Used conversion factor: Limit (dBµV) = 20 log (Limit (µV)/1µV).

3.1.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1010 hPa
Humidity: 35 %

Op. Mode	Setup	Port
op-mode 1	Setup_02	USB port (power line)

Measurements are performed according to KDB 174176 D01

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.152250	52.03	---	65.88	13.85	9.000	N	FLO	10.1
13.560000	---	49.45	50.00	0.55	9.000	N	FLO	10.7
13.560000	53.09	---	60.00	6.91	9.000	N	FLO	10.7

Remark: Please see annex for the measurement plots.

The conducted emission found in the table above corresponds clearly to the fixed transmitter frequency of the EUT = 13.56 MHz. It was determined that this emission on the AC mains is based on radiated coupling into the test setup. Therefore, for the assessment of the test result, the fixed transmitter frequency of the EUT is not considered.

The chosen operating mode is selected as representative mode to generate "worst-case" conditions, i.e. high power consumption.

3.2 Spurious radiated emissions

Standard FCC Part 15, 10-1-11 Edition Subpart C

The test was performed according to: ANSI C63.10–2013

3.2.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered from a DC power source.

1. Measurement up to 30 MHz
The Loop antenna HFH2-Z2 is used.

Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz
- IF–Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 0.2 - 10 kHz
- Measuring time / Frequency step: 1 s

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz

- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
Step 2:
Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°

EMI receiver settings (for all steps):
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak / Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

3.2.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (d)
... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

3.2.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

3.2.3.1 Measurement up to 30 MHz

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Polarisation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
0°	–	–	–	–	–	–	–	–	–
90°	–	–	–	–	–	–	–	–	–

Remark: No spurious emissions in the range 20 dB below the limit found therefore step 2 was not performed. Please refer to the plot in the annex.

3.2.3.2 Measurement above 30 MHz

Op. Mode	Setup	Port
op-mode 1	Setup_02	Enclosure

Polarisation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Horizontal	40.480	37.96	–	–	40.0	–	–	2.04	–

Remarks: No further spurious emissions in the range 20 dB below the limit found. Please refer to the plot in the annex.

A USB cable ferrite shielding was implemented. Please see the separate photo report.
The ferrite should be considered as an integral part of the USB connection cable.
Used ferrite is: Box A4, Type 742 711 11 S of
Würt Elektronik GmbH (www.we-online.de).

3.2.4 Test result: Spurious radiated emissions

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed

3.3 Occupied bandwidth

Standard FCC Part 15, 10-1-14 Edition Subpart C

The test was performed according to: FCC §15.31

3.3.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produces the worst-case (widest) occupied bandwidth.

3.3.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.215 (c)
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. …

3.3.3 Test Protocol

Temperature: 22 °C
Air Pressure: 1010 hPa
Humidity: 39 %

Op. Mode	Setup	Port
op-mode 1	Setup_02	Enclosure

20 dB bandwidth kHz	99% bandwidth kHz	Remarks
434.18	1065.123	The 20 dB bandwidth from 13.34322 MHz to 13.77618 MHz is contained within the designated frequency band 13.110 MHz to 14.010 MHz.

Remark: Please see annex for the measurement plot.

3.3.4 Test result: Occupied bandwidth

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed

3.4 Spectrum mask

Standard FCC Part 15, 10-1-14 Edition Subpart C

The test was performed according to: FCC §15.225

3.4.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.10–2013. The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
The radiated emissions measurements were made in a typical installation configuration.
The measurement procedure is implemented into the EMI test software ES-K1 from R&S.
The Loop antenna HFH2-Z2 is used.

- Anechoic chamber
- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 13.06 – 14.06 MHz
- Frequency steps: 5 kHz
- IF–Bandwidth:10 kHz
- Measuring time / Frequency step: 100 ms

3.4.2 Test Limits

FCC Part 15, Subpart C, §15.225 (a-d), and §15.209, corrected by the means of the extrapolation of §15.31 due to the reduced measuring distance from 30 m to 3 m with an inverse linear distance extrapolation factor (40 dB/decade).

3.4.3 Test Protocol

Temperature: 22 °C
Air Pressure: 1013 hPa
Humidity: 40 %

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Maximum value dBµV/m @ 30m	Limit dBµV/m @ 30m	Remarks
12.14	84.0	measuring distance 3 m

Remark: Please see annex for the measurement plot.

3.4.4 Test result: Spectrum mask

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed

3.5 Frequency tolerance

Standard FCC Part 15, 10-1-14 Edition Subpart C

The test was performed according to: FCC §15.225

3.5.1 Test Description

The Equipment Under Test (EUT) is placed in a temperature chamber.
The frequency drift during temperature and voltage variation is measured by the means of a spectrum analyzer with frequency counter function.
The temperature was varied from –20 °C to +70 °C. At +20 °C the extreme power supply voltages of 4.5 V and 5.5 V are applied. After reaching each target temperature and waiting sufficient time allowing the temperature to stabilize, one measurement is performed immediately after powering on the EUT, and three further measurements are performed after 2, 5 and 10 minutes continuous operation of EUT.

3.5.2 Test Limits

FCC Part 15, Subpart C, §15.225 (e): The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees 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 degrees C.

3.5.3 Test Protocol

Temperature: -20°C to +70°C
Air Pressure: 1009 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Temperature / °C	Voltage / V	Time / min.	Frequency / MHz	Delta / Hz	Verdict
50	5.0	0	13.560507	507	Passed
50	5.0	2	13.560503	503	Passed
50	5.0	5	13.560502	502	Passed
50	5.0	10	13.560502	502	Passed
40	5.0	0	13.560541	541	Passed
40	5.0	2	13.560522	522	Passed
40	5.0	5	13.560527	527	Passed
40	5.0	10	13.560519	519	Passed
30	5.0	0	13.560578	578	Passed
30	5.0	2	13.560563	563	Passed
30	5.0	5	13.560556	556	Passed
30	5.0	10	13.560552	552	Passed
20	5.5	0	13.560639	639	Passed
20	5.5	2	13.560617	617	Passed
20	5.5	5	13.560614	614	Passed
20	5.5	10	13.560599	599	Passed
20	5.0	0	13.560641	641	Passed
20	5.0	2	13.560616	616	Passed
20	5.0	5	13.560614	614	Passed
20	5.0	10	13.560599	599	Passed
20	4.5	0	13.560640	640	Passed
20	4.5	2	13.560615	615	Passed
20	4.5	5	13.560613	613	Passed
20	4.5	10	13.560600	600	Passed
10	5.0	0	13.560667	667	Passed
10	5.0	2	13.560651	651	Passed
10	5.0	5	13.560644	644	Passed
10	5.0	10	13.560640	640	Passed
0	5.0	0	13.560710	710	Passed
0	5.0	2	13.560694	694	Passed
0	5.0	5	13.560687	687	Passed
0	5.0	10	13.560683	683	Passed
-10	5.0	0	13.560727	727	Passed
-10	5.0	2	13.560718	718	Passed
-10	5.0	5	13.560714	714	Passed
-10	5.0	10	13.560713	713	Passed
-20	5.0	0	13.560734	734	Passed
-20	5.0	2	13.560733	733	Passed
-20	5.0	5	13.560731	731	Passed
-20	5.0	10	13.560144	144	Passed

Continue on the next page

Additional measurements to prove the EUT working ability to +70° C

Temperature / °C	Voltage / V	Time / min.	Frequency / MHz	Delta / Hz	Verdict
70	5.0	0	13.560496	496	Passed
70	5.0	2	13.560505	505	Passed
70	5.0	5	13.560510	510	Passed
70	5.0	10	13.560517	517	Passed
60	5.0	0	13.560500	500	Passed
60	5.0	2	13.560503	503	Passed
60	5.0	5	13.560505	505	Passed
60	5.0	10	13.560507	507	Passed

Remark: The limit is a delta of max. ±1356 Hz (0.01 %).

3.5.4 Test result: Frequency tolerance

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 2	passed

4 Test equipment

1 Conducted Emissions

Shielded Room 02

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	ESH 3-Z5	Two-Line V-Network	Rohde & Schwarz	828304/029	2015-03	2017-03
	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2014-11	2016-11
	EP 1200/B, NA/B1	Amplifier with integrated variable Oscillator	Spitzenberger & Spieß	B6278	2015-07	2018-07
	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
	Opus10 THI (8152.00)	ThermoHygro Datalogger 02 (Environ)	Lufft Mess- und Regeltechnik GmbH	7489	2015-02	2017-02
	ESH 3-Z5	Two-Line V-Network	Rohde & Schwarz	829996/002	2015-03	2017-03
	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2015-02	2017-02
	CMD 55	Digital Radio Communication Tester	Rohde & Schwarz	831050/020	2014-12	2017-12
	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
	CMW 500	CMW 500	Rohde & Schwarz	107500	2015-07	2017-07

2 Radiated Emissions and radiolab

Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2014-11	2016-11
	TT 1.5 WI	Turn Table	Maturo GmbH	-		
	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2014-01	2017-01
	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/37907 09		
	5HC2700/1275 0-1.5-KK	High Pass Filter	Trilithic	9942012		
	AS 620 P	Antenna mast	HD GmbH	620/37		
	4HC1600/1275 0-1.5-KK	High Pass Filter	Trilithic	9942011		
	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
	HL 562	Ultralog new biconicals	Rohde & Schwarz GmbH & Co. KG	830547/003	2015-06	2018-06
	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2015-03	2017-03
	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
	HFH2-Z2	Loop Antenna	Rohde & Schwarz GmbH & Co. KG	829324/006	2014-11	2017-11
	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz GmbH & Co. KG	100609	2016-04	2019-04
	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
	HF 907	Double-ridged horn	Rohde & Schwarz GmbH & Co. KG	102444	2015-05	2018-05
	SMIQ03B	Options: B5 B11 B19 B20 B50 Battery Pack	Rohde & Schwarz GmbH & Co. KG	832870/017	2013-07	2016-07
	Datum MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2015-08	2016-08

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
	FSIQ26	IL BT RF Test Solution Ratingen 1119.6001.26	Rohde & Schwarz GmbH & Co. KG	832695/007	2014-08	2016-08
	Opus10 THI (8152.00)	T/H Logger 15	Lufft Mess- und Regeltechnik GmbH	13985	2015-03	2017-03
	ADU 200 Relay Box 7	used for automated testing (EMMI) only	Ontrak Control Systems Inc	A04380		
	KWP 120/70	Temperature Chamber Weiss 01	Weiss	5922601219001 0	2016-03	2018-03
	SMP02	Signal Generator	Rohde & Schwarz GmbH & Co. KG	829076/017	2013-07	2016-07
	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz GmbH & Co. KG	101158	2015-08	2016-08
	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2015-02	2017-02
	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz GmbH & Co. KG	107695	2014-06	2017-06
	VT 4002	Climatic Chamber	Vötsch	5856600215001 0	2016-03	2018-03
	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2016-02	2018-02
	Voltcraft M-3860M	Digital Multimeter 01 (Multimeter)	Voltcraft	IJ096055		
	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
	Datum, Model: MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2015-06	2016-06

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

Antenna Factors, Cable Loss and Sample Calculations

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

Antenna R&S HFH2-Z2 (9 kHz – 30 MHz)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0,009	20,50	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,01	20,45	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,015	20,37	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,02	20,36	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,025	20,38	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,03	20,32	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,05	20,35	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,08	20,30	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,1	20,20	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,2	20,17	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,3	20,14	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,49	20,12	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,490001	20,12	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,5	20,11	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,8	20,10	-39,6	0,1	0,1	0,1	0,1	-40	30	3
1	20,09	-39,6	0,1	0,1	0,1	0,1	-40	30	3
2	20,08	-39,6	0,1	0,1	0,1	0,1	-40	30	3
3	20,06	-39,6	0,1	0,1	0,1	0,1	-40	30	3
4	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
5	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
6	20,02	-39,5	0,2	0,1	0,1	0,1	-40	30	3
8	19,95	-39,5	0,2	0,1	0,1	0,1	-40	30	3
10	19,83	-39,4	0,2	0,1	0,2	0,1	-40	30	3
12	19,71	-39,4	0,2	0,1	0,2	0,1	-40	30	3
14	19,54	-39,4	0,2	0,1	0,2	0,1	-40	30	3
16	19,53	-39,3	0,3	0,1	0,2	0,1	-40	30	3
18	19,50	-39,3	0,3	0,1	0,2	0,1	-40	30	3
20	19,57	-39,3	0,3	0,1	0,2	0,1	-40	30	3
22	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
24	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
26	19,54	-39,3	0,3	0,1	0,2	0,1	-40	30	3
28	19,46	-39,2	0,3	0,1	0,3	0,1	-40	30	3
30	19,73	-39,1	0,4	0,1	0,3	0,1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

Antenna R&S HL562 (30 MHz – 1 GHz)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18,6	0,6	0,29	0,04	0,23	0,02	0,0	3	3
50	6,0	0,9	0,39	0,09	0,32	0,08	0,0	3	3
100	9,7	1,2	0,56	0,14	0,47	0,08	0,0	3	3
150	7,9	1,6	0,73	0,20	0,59	0,12	0,0	3	3
200	7,6	1,9	0,84	0,21	0,70	0,11	0,0	3	3
250	9,5	2,1	0,98	0,24	0,80	0,13	0,0	3	3
300	11,0	2,3	1,04	0,26	0,89	0,15	0,0	3	3
350	12,4	2,6	1,18	0,31	0,96	0,13	0,0	3	3
400	13,6	2,9	1,28	0,35	1,03	0,19	0,0	3	3
450	14,7	3,1	1,39	0,38	1,11	0,22	0,0	3	3
500	15,6	3,2	1,44	0,39	1,20	0,19	0,0	3	3
550	16,3	3,5	1,55	0,46	1,24	0,23	0,0	3	3
600	17,2	3,5	1,59	0,43	1,29	0,23	0,0	3	3
650	18,1	3,6	1,67	0,34	1,35	0,22	0,0	3	3
700	18,5	3,6	1,67	0,42	1,41	0,15	0,0	3	3
750	19,1	4,1	1,87	0,54	1,46	0,25	0,0	3	3
800	19,6	4,1	1,90	0,46	1,51	0,25	0,0	3	3
850	20,1	4,4	1,99	0,60	1,56	0,27	0,0	3	3
900	20,8	4,7	2,14	0,60	1,63	0,29	0,0	3	3
950	21,1	4,8	2,22	0,60	1,66	0,33	0,0	3	3
1000	21,6	4,9	2,23	0,61	1,71	0,30	0,0	3	3

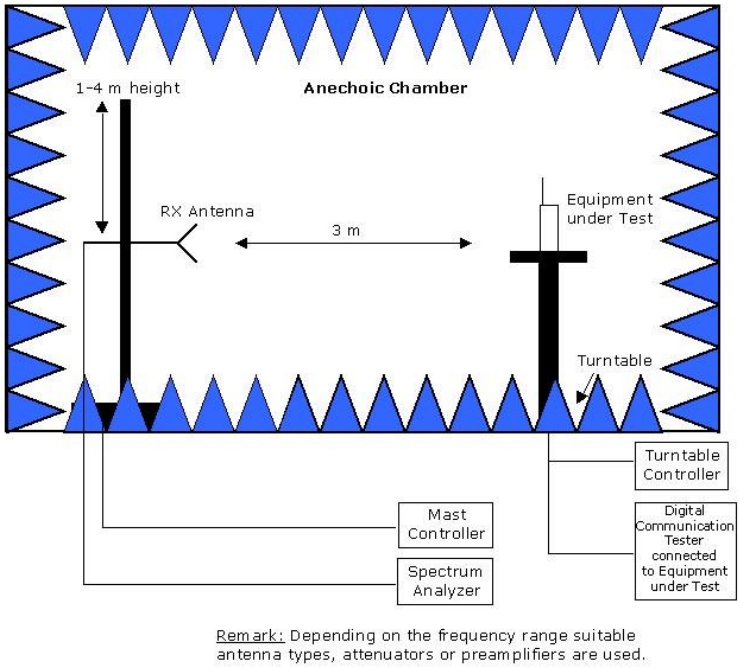
(d_{Limit} = 10 m)

30	18,6	-9,9	0,29	0,04	0,23	0,02	-10,5	10	3
50	6,0	-9,6	0,39	0,09	0,32	0,08	-10,5	10	3
100	9,7	-9,2	0,56	0,14	0,47	0,08	-10,5	10	3
150	7,9	-8,8	0,73	0,20	0,59	0,12	-10,5	10	3
200	7,6	-8,6	0,84	0,21	0,70	0,11	-10,5	10	3
250	9,5	-8,3	0,98	0,24	0,80	0,13	-10,5	10	3
300	11,0	-8,1	1,04	0,26	0,89	0,15	-10,5	10	3
350	12,4	-7,9	1,18	0,31	0,96	0,13	-10,5	10	3
400	13,6	-7,6	1,28	0,35	1,03	0,19	-10,5	10	3
450	14,7	-7,4	1,39	0,38	1,11	0,22	-10,5	10	3
500	15,6	-7,2	1,44	0,39	1,20	0,19	-10,5	10	3
550	16,3	-7,0	1,55	0,46	1,24	0,23	-10,5	10	3
600	17,2	-6,9	1,59	0,43	1,29	0,23	-10,5	10	3
650	18,1	-6,9	1,67	0,34	1,35	0,22	-10,5	10	3
700	18,5	-6,8	1,67	0,42	1,41	0,15	-10,5	10	3
750	19,1	-6,3	1,87	0,54	1,46	0,25	-10,5	10	3
800	19,6	-6,3	1,90	0,46	1,51	0,25	-10,5	10	3
850	20,1	-6,0	1,99	0,60	1,56	0,27	-10,5	10	3
900	20,8	-5,8	2,14	0,60	1,63	0,29	-10,5	10	3
950	21,1	-5,6	2,22	0,60	1,66	0,33	-10,5	10	3
1000	21,6	-5,6	2,23	0,61	1,71	0,30	-10,5	10	3

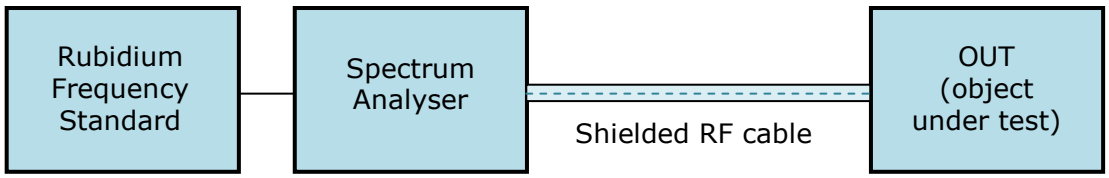
Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

Setup Drawings



Drawing 1: Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting groundplane.



Drawing 2: Setup for conducted radio tests.

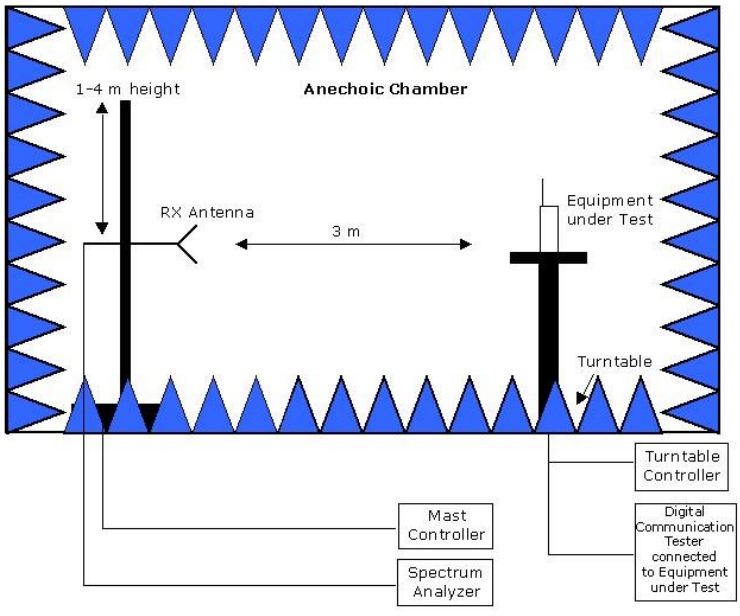
Measurement Uncertainties

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3.4 dB
Spectrum mask	Power	± 4.5 dB
Occupied bandwidth	Power Frequency:	± 4.5 dB ± 0.125 kHz
Spurious radiated emissions	Power Frequency:	± 4.5 dB ± 11.2 kHz
Frequency tolerance	Frequency	± 25 Hz

5 Photo Report

Photos are included in an external report.

6 Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

Drawing 1: Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces.

7 FCC and IC Correlation of measurement requirements

The following tables show the correlation of measurement requirements Radio equipment operating in the Band 13.110-14.010 MHz from FCC and IC.

Radio equipment

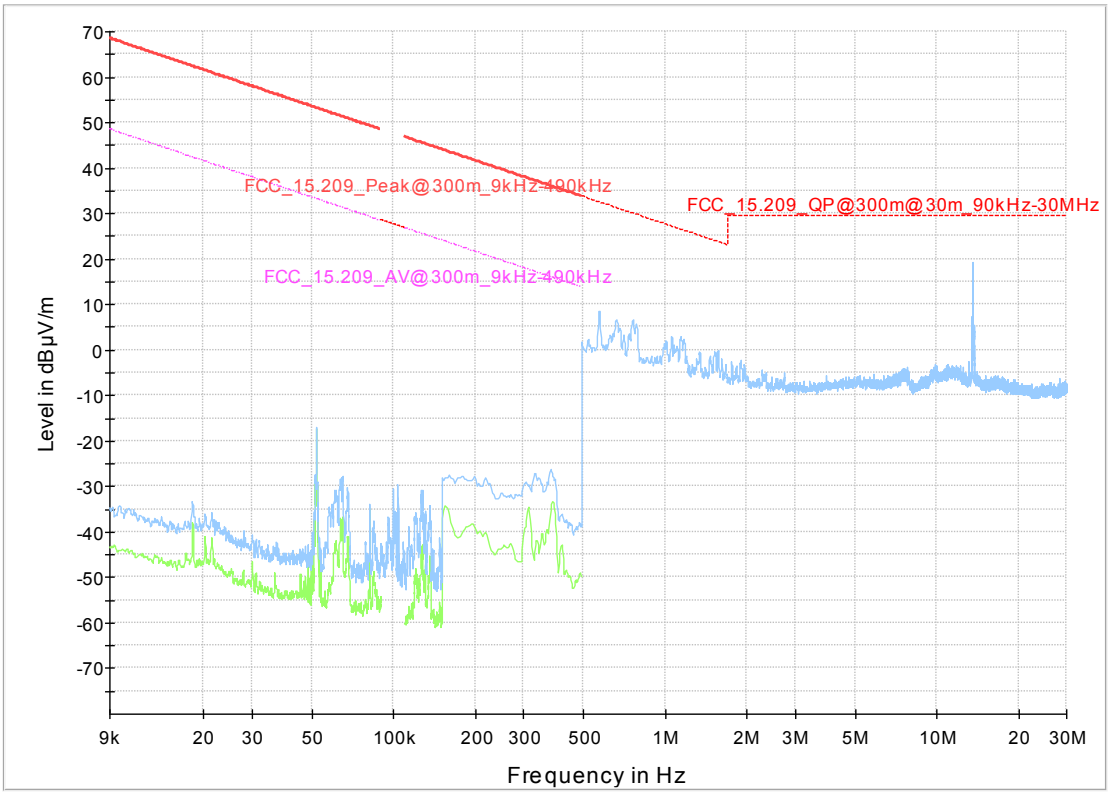
Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Additional provisions to the general radiated emission limitations	§ 15.215	RSS-Gen Issue 4: 6.6
Out-of-band emissions	§ 15.225 (d)	RSS Gen Issue 4: 6.13/8.9/8.10; RSS-210 Issue 8: A2.6
In-band emissions	§ 15.225 (a) / (b) / (c)	RSS-210 Issue 8: A2.6
Frequency Stability	§ 15.225 (e)	RSS-210 Issue 8: A2.6
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	RSS-210 Issue 8: 2.3; RSS Gen Issue 4: 5/7 *)
Handling of active and passive tag devices of RFID application	§ 15.225 (f)	RSS Gen Issue 4: 8.7

*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30–960 MHz or if these are scanner receivers.

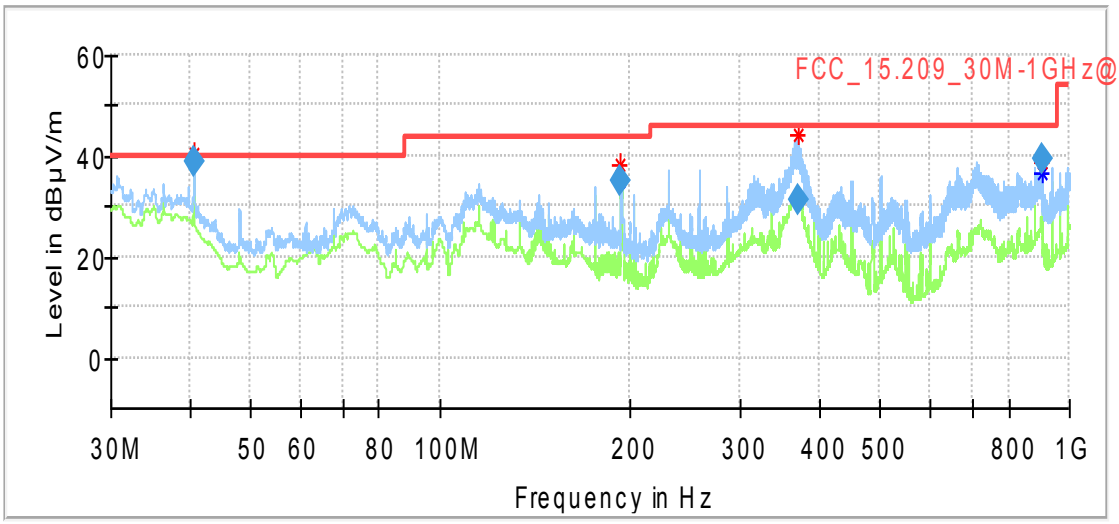
8 Annex measurement plots

8.1 Radiated emissions

8.1.1 Radiated emissions (f < 30 MHz)



8.1.2 Radiated emissions (f > 30 MHz)

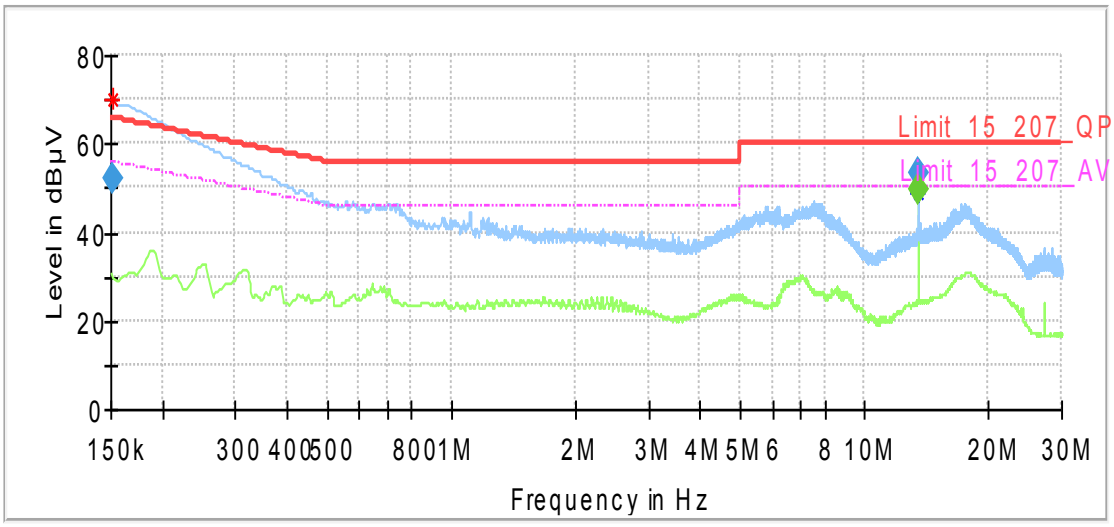


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.680000	38.63	40.00	1.37	1000.0	120.000	109.0	V	-66.0	13.3
193.650000	35.11	43.50	8.39	1000.0	120.000	100.0	V	-13.0	9.2
371.580000	31.40	46.00	14.60	1000.0	120.000	102.0	H	-191.0	15.7
908.550000	39.41	46.00	6.59	1000.0	120.000	200.0	H	-157.0	25.6

8.2 AC Mains conducted

Measurement performed with a real antenna.



Final_Result

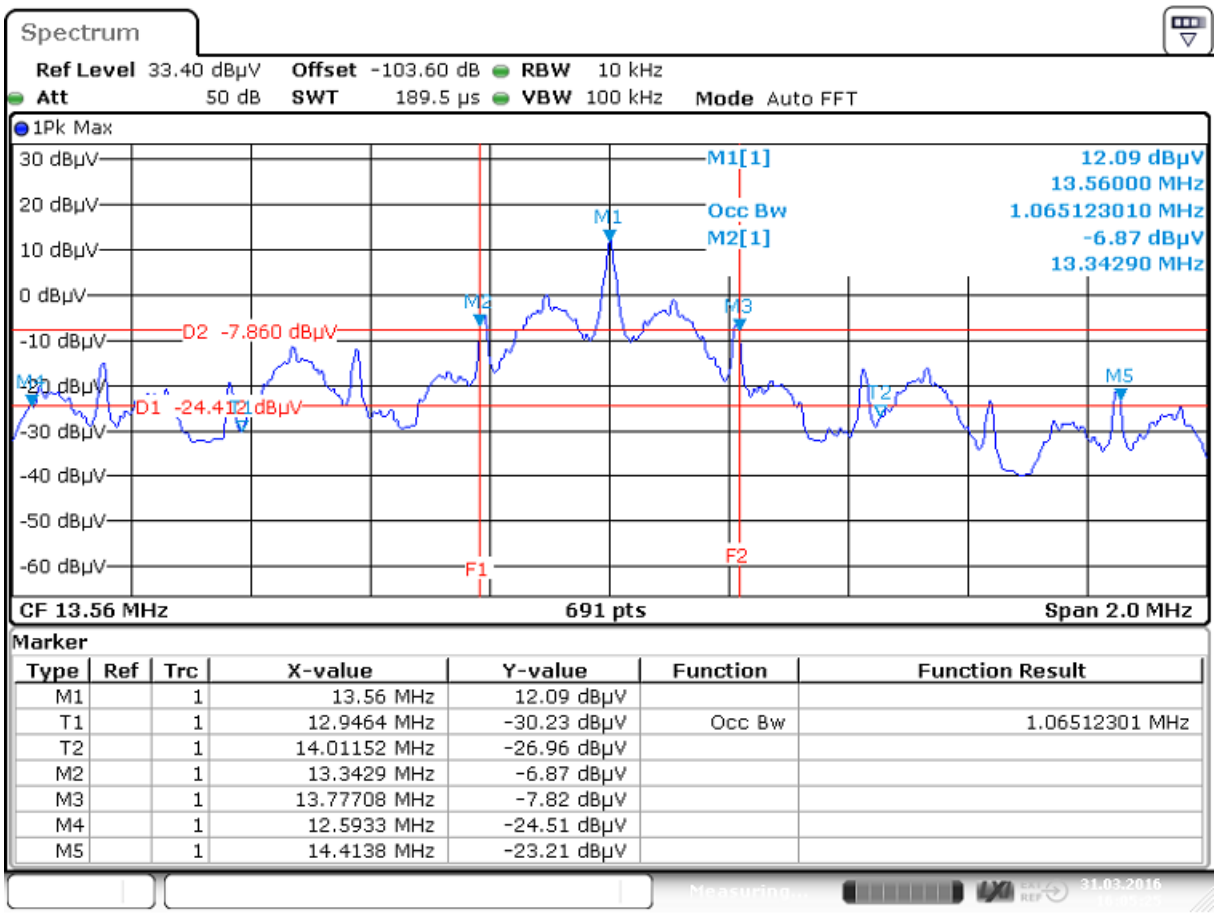
Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.152250	52.03	---	65.88	13.85	1000.0	9.000	N	FLO	10.1
13.560000	---	49.45	50.00	0.55	1000.0	9.000	N	FLO	10.7
13.560000	53.09	---	60.00	6.91	1000.0	9.000	N	FLO	10.7

Hardware Setup: EMI_Conducted_EN_FCC_ESH3-Z5
Measurement Type: 2 Line LISN
Frequency Range: 150 kHz - 30 MHz
Graphics Level Range: 0 dBµV - 80 dBµV

Preview Measurements:
Scan Test Template: FCC_Part207_Pre_ESH3-Z5

Final Measurements:
Template for Single Meas.: FCC_Part207_Final_ESH3-Z5

8.3 Occupied bandwidth

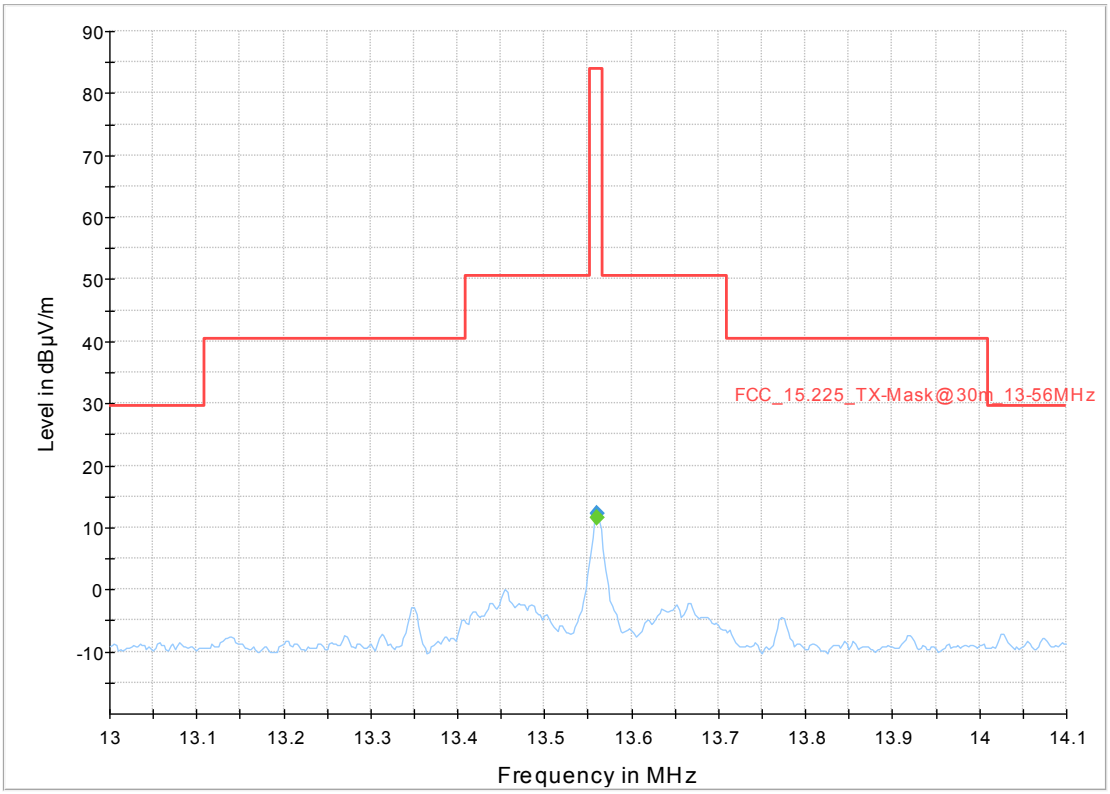


Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	13.56 MHz	12.09 dBµV		
T1		1	12.9464 MHz	-30.23 dBµV	Occ Bw	1.06512301 MHz
T2		1	14.01152 MHz	-26.96 dBµV		
M2		1	13.3429 MHz	-6.87 dBµV		
M3		1	13.77708 MHz	-7.82 dBµV		
M4		1	12.5933 MHz	-24.51 dBµV		
M5		1	14.4138 MHz	-23.21 dBµV		

Date:31.MAR.2016 16:05:26

Remark: D1 Line is at markers T which define 99% bandwidth.
D2 Line defines 20 dB bandwidth.

8.4 Spectrum mask



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
13.560000	---	11.46	84.00	72.54	1000.0	10.000	100.0	V	-136.0	-19.9
13.560000	12.14	---	84.00	71.86	1000.0	10.000	100.0	V	-136.0	-19.9