EMI – TEST REPORT

- FCC Part 15B -

Type / Model Name	:	ROTALIGN touch
Product Description	:	Handheld measurement device
Applicant	:	PRÜFTECHNIK Condition Monitoring GmbH
Address	:	Oskar-Messter-Straße 19-21 85737 ISMANING, GERMANY
Manufacturer	:	PRÜFTECHNIK AG
Address	:	Oskar-Messter-Straße 19-21 85737 ISMANING, GERMANY
Type / Model Name	:	ROTALIGN touch

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Test Report No. : T39732-03-00GK	13. January 2016 Date of issue

DAkkS Deutsche Akkreditierungsstelle D-PL-12030-01-01 D-PL-12030-01-02

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15 Subpart A - General (September, 2014)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15 Subpart B - Unintentional Radiators (September, 2014)

Part 15, Subpart B, Section 15.107	AC Line conducted emission ☒ Class A device ☐ Class B device
Part 15, Subpart B, Section 15.109	Radiated emission, general requirements
Part 15, Subpart B, Section 15.111	Antenna power conduction
ANSI C63.4: 2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-4-2: 2011 EN 55016-4-2: 2011	Uncertainty in EMC measurement
CISPR 22: 2008 EN 55022: 2010	Information technology equipment

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

2.2 Equipment type, category

Portable equipment with four RF technologies.

2.3 Short description of the equipment under test (EUT)

The Rotalign Touch is a handheld measurement device with four integrated RF-technologies. The RF- technologies are Bluetooth, Bluetooth low energy, WLAN and NFC. The device has only integrated antennas.

Number of tested samples: 1
Serial number: 50200012
EUT configuration:
(The CDF filled by the applicant can be viewed at the test laboratory.)

2.4 Variants of the EUT

None

2.5 Operation frequency and channel plan

TX 1: NFC 13.553 MHz - 13.567 MHz
Note: According to the test report T39732-00-05GK of the test laboratory CSA Group Bayern GmbH

TX 2: WLAN 2400 MHz – 2483.5 MHz
Note: re-measurement shown in clause 5.1 of this test report
Additional: According to the test report 266892-1 of the test laboratory SGS

TX 3: Bluetooth 2400 MHz – 2483.5 MHz
Note: According to the test report UL-RPT-RP90575JD03A V2.0 of the test laboratory RFI Global Services Ltd

TX 4: Bluetooth low energy 2400 MHz – 2483.5 MHz
Note: According to the test report UL-RPT-RP90575JD03B of the test laboratory RFI Global Services Ltd

2.6 Transmit operating modes

TX 1: NFC 13.56 MHz

TX 2: WLAN 2412 MHz

TX 3: Bluetooth 2441 MHz

TX 4: Bluetooth low energy 2440 MHz

1.1 Antennas

The following antennas shall be used with the EUT:

TX 1: NFC	integrated antenna
TX 2: WLAN	integrated antenna; Gain 0.5 dBi
TX 3: Bluetooth	integrated antenna; Gain 0.5 dBi
TX 4: Bluetooth low energy	integrated antenna; Gain 0.5 dBi

2.7 Transmit operating modes

The equipment under test was operated during the measurement under the following conditions:

- All RF technologies off, active USB connection

-

2.8 Power supply system utilised

Power supply voltage: Battery powered 3.6 V (Lithium-Ion rechargeable battery)
100-240 V AC 50/60 Hz 1-phase (only for charging)

2.9 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- Laptop Model : Fujitsu Siemens Lifebook E Series
- Model :
- Model :

2.10 Determination of worst case conditions for final measurement

2.10.1 Test Jig

No test jig is used.

2.10.2 Test software

3 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 22 October 2015

Testing concluded on : 02 December 2015

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this document
2016.01.13 13:57:09 +01'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Konrad Graßl
I am the author of this document
2016.01.13 13:43:05 +01'00'

Konrad Graßl
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement protocol for FCC

4.4.1 General information

4.4.1.1 Test methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.

4.4.1.2 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.2 Details of test procedures

4.4.2.1 General standard information

The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.3 Conducted emission

4.4.3.1 Description of measurement

The final level, expressed in dBµV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC limit or to the CISPR limit.

To convert between dBµV and µV, the following conversions apply:

$$dB\mu V = 20*\log(\mu V)$$
$$\mu V = 10\text{^}(dB\mu V/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50 Ω / 50 µH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

4.4.4 Radiated emission (electrical field 30 MHz - 1 GHz)

4.4.4.1 Description of measurement

Spurious emission from the EUT is measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.4. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. The antenna is positioned in horizontal polarisation and is repeated vertically. To locate maximum emission from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees.
The final level in dBµV/m is calculated by add the antenna correction factor and cable loss factor (dB) on the reading from the EMI receiver (dBµV). The FCC or CISPR limit is subtracted from this result in order to provide the delta to limit listed in the measurement protocol.

Example:

Frequency		Reading level		Correction Factor		Level		CISPR Limit		Delta
(MHz)		(dBµV)		(dB/m)		(dBµV/m)		(dBµV/m)		(dB)
719.0	+	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

4.4.5 Radiated emission (electrical field 1 GHz - 40 GHz)

4.4.5.1 Description of measurement

Radiated emission from the EUT are measured in the frequency range 1 GHz up to the maximum frequency as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is following set out in ANSI C63.4. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyser set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak and 10 Hz for average measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to detect emission under better uncertainty and is calculated to the specified test distance.

5 TEST CONDITIONS AND RESULTS

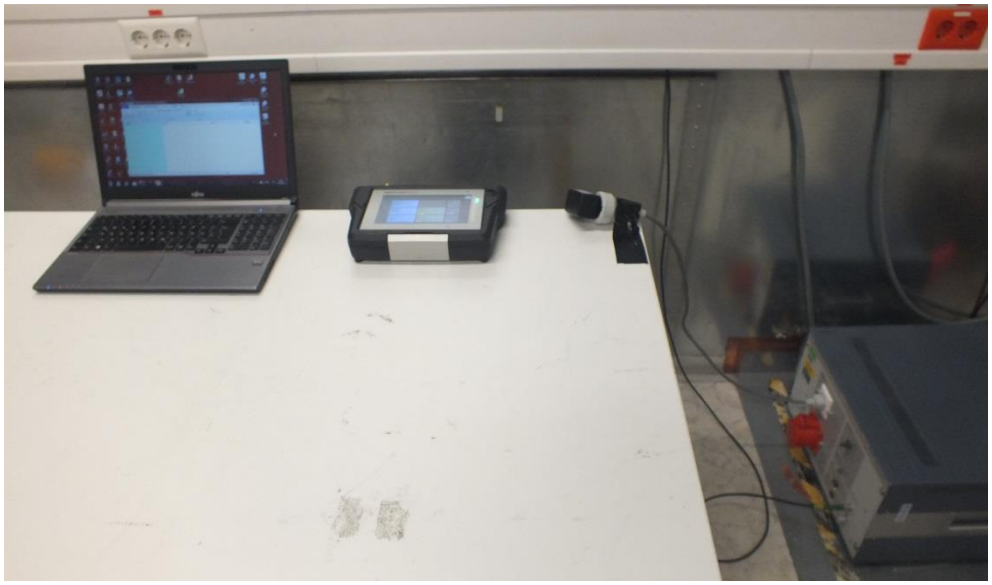
5.1 Conducted emission

For test instruments and accessories used see section 6 Part **A 4.**

5.1.1 Description of the test location

Test location: Shielded Room S2
Used software:

5.1.2 Photo documentation of the test set-up



5.1.3 Applicable standard

According to FCC Part 15, Section 15.107(a):
Except for Class A devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.4. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin 2.97 dB at 0.195 MHz

Limit according to FCC Part 15, Section 15.107(a) Class B:

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

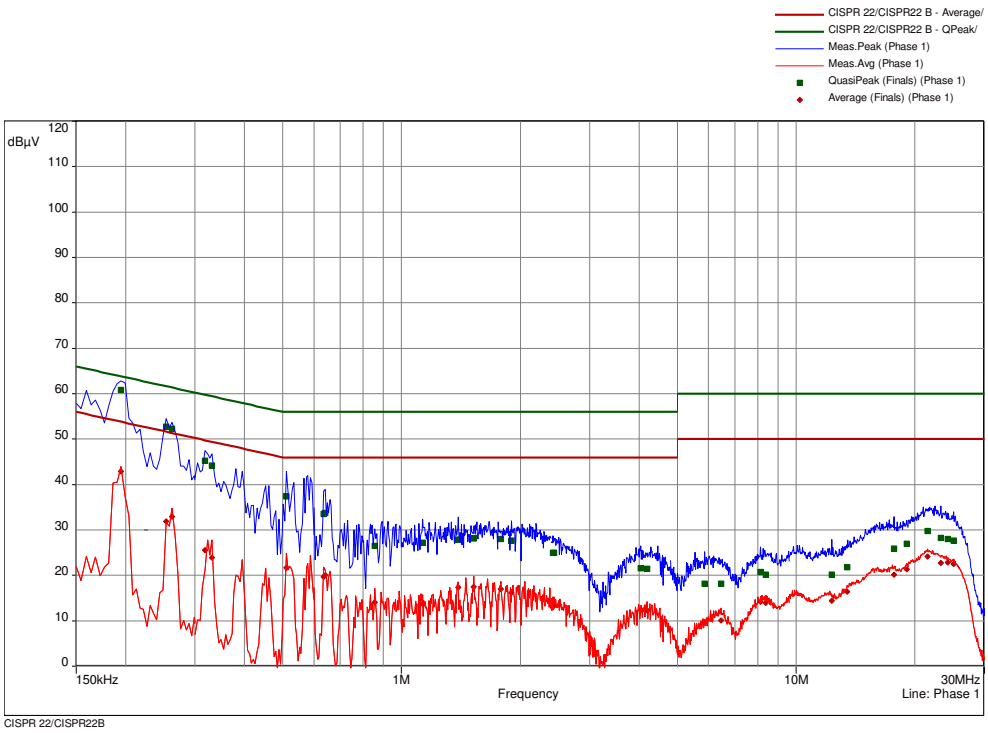
The requirements are **FULFILLED.**

Remarks: For detailed test result please refer to following test protocols

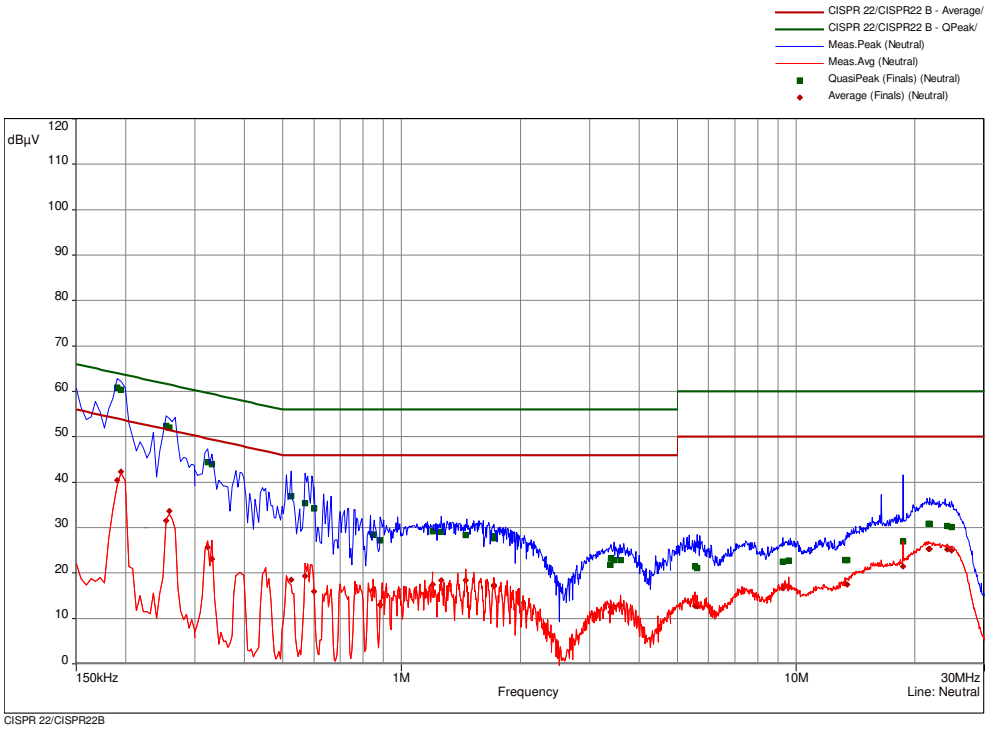
5.1.6 Test protocol

All RF technologies off, active USB connection
Power supply voltage: 115 V / 60 Hz

Phase 1



Neutral



freq	SR	QP	margin	limit	AV	margin	limit	line
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB	
0.195	1	60.85	2.97	63.82	42.95	10.87	53.82	Phase 1
0.2535	1	52.75	8.89	61.64	31.87	19.78	51.64	Phase 1
0.2625	1	52.27	9.08	61.35	32.95	18.40	51.35	Phase 1
0.318	2	45.27	14.49	59.76	25.52	24.24	49.76	Phase 1
0.3315	2	44.19	15.22	59.41	23.89	25.52	49.41	Phase 1
0.5115	2	37.36	18.64	56.00	21.68	24.32	46.00	Phase 1
0.636	3	33.48	22.52	56.00	19.75	26.25	46.00	Phase 1
0.6405	3	33.71	22.29	56.00	20.09	25.91	46.00	Phase 1
0.8565	3	26.52	29.48	56.00	14.02	31.98	46.00	Phase 1
1.131	3	27.17	28.83	56.00	13.77	32.23	46.00	Phase 1
1.3935	4	27.94	28.06	56.00	17.33	28.67	46.00	Phase 1
1.524	4	28.19	27.81	56.00	17.51	28.49	46.00	Phase 1
1.785	4	28.01	27.99	56.00	17.01	28.99	46.00	Phase 1
1.8975	4	27.64	28.36	56.00	16.15	29.85	46.00	Phase 1
2.4225	5	25.02	30.98	56.00	13.18	32.82	46.00	Phase 1
2.436	5	24.92	31.08	56.00	13.33	32.67	46.00	Phase 1
4.0335	5	21.62	34.38	56.00	12.46	33.54	46.00	Phase 1
4.1955	5	21.46	34.54	56.00	12.36	33.64	46.00	Phase 1
5.862	6	18.18	41.82	60.00	9.65	40.35	50.00	Phase 1
6.4515	6	18.21	41.79	60.00	10.07	39.93	50.00	Phase 1
8.121	6	20.70	39.30	60.00	14.20	35.80	50.00	Phase 1
8.3775	6	20.22	39.78	60.00	13.91	36.09	50.00	Phase 1
12.3045	7	20.12	39.88	60.00	14.39	35.61	50.00	Phase 1
13.479	7	21.75	38.25	60.00	16.42	33.58	50.00	Phase 1
17.682	7	25.85	34.15	60.00	20.11	29.89	50.00	Phase 1
19.0905	7	26.97	33.03	60.00	21.33	28.67	50.00	Phase 1
21.5535	8	29.76	30.24	60.00	24.16	25.84	50.00	Phase 1
23.259	8	28.27	31.73	60.00	22.69	27.31	50.00	Phase 1
24.186	8	28.06	31.94	60.00	22.89	27.11	50.00	Phase 1
25.068	8	27.68	32.32	60.00	22.48	27.52	50.00	Phase 1
0.1905	9	60.88	3.14	64.01	40.49	13.52	54.01	Neutral
0.195	9	60.33	3.49	63.82	42.31	11.51	53.82	Neutral
0.2535	9	52.40	9.24	61.64	31.48	20.16	51.64	Neutral
0.258	9	52.04	9.45	61.50	33.63	17.87	51.50	Neutral
0.3225	10	44.40	15.25	59.64	25.68	23.96	49.64	Neutral
0.3315	10	43.93	15.49	59.41	23.10	26.31	49.41	Neutral
0.525	10	36.92	19.08	56.00	18.49	27.51	46.00	Neutral
0.57	10	35.46	20.54	56.00	19.33	26.67	46.00	Neutral
0.6	11	34.27	21.73	56.00	15.96	30.04	46.00	Neutral
0.8475	11	28.46	27.54	56.00	16.28	29.72	46.00	Neutral
0.8835	11	27.22	28.78	56.00	12.98	33.02	46.00	Neutral
1.1985	11	29.19	26.81	56.00	17.47	28.53	46.00	Neutral
1.263	12	29.07	26.93	56.00	18.41	27.59	46.00	Neutral
1.4565	12	28.35	27.65	56.00	18.42	27.58	46.00	Neutral
1.713	12	28.09	27.91	56.00	17.08	28.92	46.00	Neutral

1.7175	12	27.69	28.31	56.00	17.34	28.66	46.00	Neutral
3.381	13	21.86	34.14	56.00	11.34	34.66	46.00	Neutral
3.3945	13	23.23	32.77	56.00	12.60	33.40	46.00	Neutral
3.462	13	22.86	33.14	56.00	12.59	33.41	46.00	Neutral
3.5925	13	22.88	33.12	56.00	12.86	33.14	46.00	Neutral
5.547	14	21.49	38.51	60.00	12.78	37.22	50.00	Neutral
5.6055	14	21.07	38.93	60.00	12.70	37.30	50.00	Neutral
9.2505	14	22.50	37.50	60.00	16.61	33.39	50.00	Neutral
9.579	14	22.79	37.21	60.00	16.84	33.16	50.00	Neutral
13.299	15	22.87	37.13	60.00	17.75	32.25	50.00	Neutral
13.4655	15	22.84	37.16	60.00	17.53	32.47	50.00	Neutral
18.663	15	26.92	33.08	60.00	21.51	28.49	50.00	Neutral
21.6525	16	30.82	29.18	60.00	25.29	24.71	50.00	Neutral
21.7605	16	30.79	29.21	60.00	25.28	24.72	50.00	Neutral
24.1815	16	30.42	29.58	60.00	25.26	24.74	50.00	Neutral
24.735	16	30.14	29.86	60.00	24.92	25.08	50.00	Neutral

5.2 Radiated emission

For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

5.2.1 Description of the test location

Test location: OATS 1
Test distance: 10 m

Test location: Anechoic chamber 1
Test distance: 3 m

5.2.2 Photo documentation of the test setup

5.2.3 Applicable standard

According to FCC Part 15B, Section 15.109 (a):
Except for Class A digital devices, the field strength of radiated emission from unintentional radiators at a distance of 3 m shall not exceed the given limit.

5.2.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.4, Item 8 and 12. In the frequency range above 1 GHz a spectrum analyser is used. If the emission level in peak mode complies with the average limit, testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and both are reported. The EUT is measured in RX continuous mode under normal conditions.

Spectrum analyser settings:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 25 GHz: RBW: 1 MHz, VBW: 3 MHz, Sweep: Auto, Detector function: Peak

All RF technologies off, active USB connection
Power supply voltage: 115 V / 60 Hz

According to the manufacturer the highest frequency of the device is at 1 GHz (apart of the RF technologies), therefore measurement up to 5 GHz would be enough, but measurement was performed up to 12.75 GHz.

5.2.5 Test result

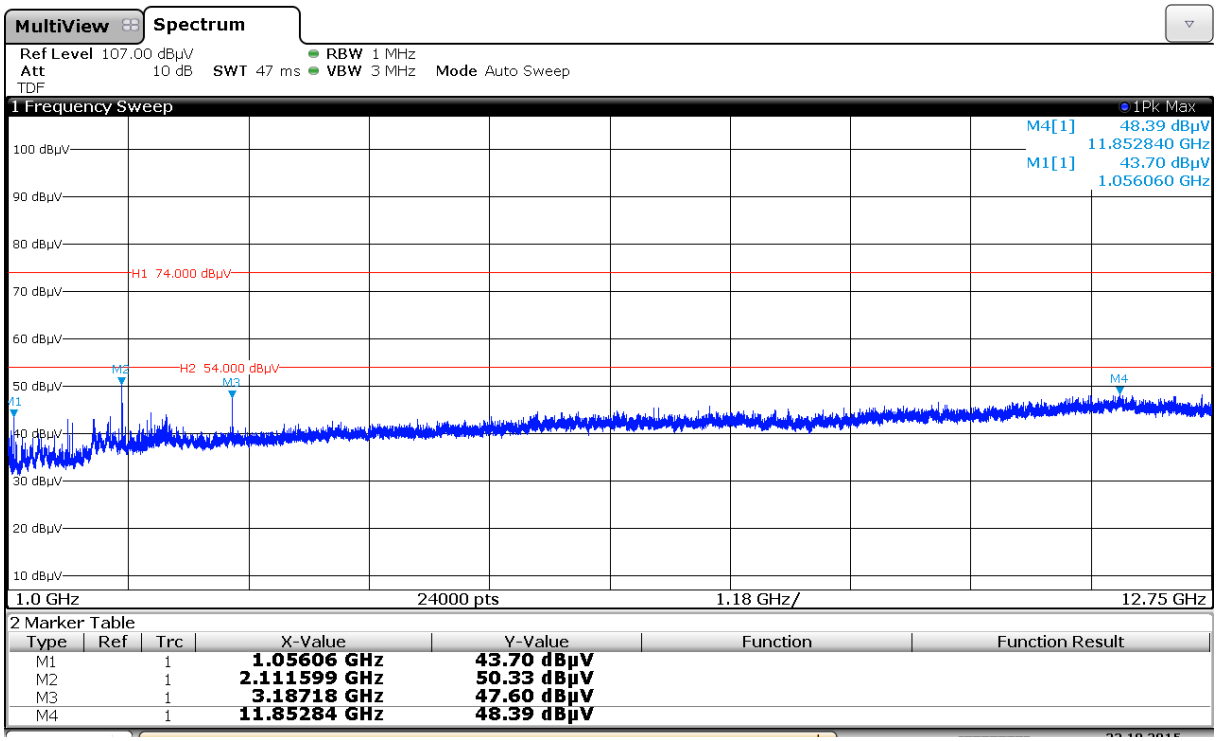
f < 1 GHz

Measurement at a distance of 10 m. Class A limits are applied.

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
44.45	8.3		14.9		23.2		39.0	-15.8
66.47	13.0		13.6		26.6		39.0	-12.4
72.00	13.3		12.8		26.1		39.0	-12.9
161.92	0.2		15.7		15.9		43.5	-27.6
269.98	21.2	19.2	15.2	15.6	36.4	34.8	46.5	-10.1
332.58	18.3		17.8		36.1		46.5	-10.4
377.94	15.9		19.2		35.1		46.5	-11.4
378.04		17.3		19.2		36.5	46.5	-10.0
431.99	14.1		20.7		34.8		46.5	-11.7
539.93	12.5		23.6		36.1		46.5	-10.4
702.02	9.3	9.4	26.9	26.9	36.2	36.3	46.5	-10.2
917.97	6.0	5.9	30.8	30.7	36.8	36.6	46.5	-9.7

f > 1 GHz

Measurement at a distance of 3 m. Class B limits are applied.



Note: The peak values fulfil the average limit, therefore an average measurement is not necessary.

Limit according to FCC Part 15B, Section 15.109(b) Class A:

Frequency (MHz)	Limit (µV/m)	Limit (dBµV/m)
30 - 88	90	39.0
88 - 216	150	43.5
216 - 960	210	46.5
Above 960	300	49.5

Limit according to FCC Part 15B, Section 15.109(a) Class B:

Frequency (MHz)	Limit (µV/m)	Limit (dBµV/m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

The requirements are **FULFILLED.**

Remarks: The measurement is performed according to FCC Part 15A, Section 15.33(b), up to the 5th harmonic. 2.4 GHz (WLAN, Bluetooth) is considered as highest frequency.

Below 1 GHz Class A and above 1 GHz Class B is fulfilled.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	ESHS 30	02-02/03-05-002	17/07/2016	17/07/2015		
	ESCI	02-02/03-15-001	15/05/2016	15/05/2015		
	ESH 2 - Z 5	02-02/20-05-004	26/10/2017	26/10/2015	21/01/2016	21/07/2015
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	ESH 3 - Z 2	02-02/50-05-155	06/11/2016	06/11/2015	06/05/2016	06/11/2015
	6430	02-02/50-13-014				
SER 2	ESVS 30	02-02/03-05-003	09/07/2016	09/07/2015		
	VULB 9168	02-02/24-05-005	17/04/2016	17/04/2015	29/02/2016	31/08/2015
	NW-2000-NB	02-02/50-05-113				
	SP 103 /3.5-60	02-02/50-05-182				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	FSW43	02-02/11-15-001	05/08/2016	05/08/2015		
	AFS4-00100600-13-10P-4	02-02/17-13-001				
	3117	02-02/24-05-009	12/05/2016	12/05/2015		
	SF104/11SMA/11N/1500MM	02-02/50-13-012				
	SF104/11SMA/11N/1500MM	02-02/50-13-013				