EMI – TEST REPORT

- Human Exposure -

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

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

Test Report No. : T39732-00-07GK	28. January 2016 Date of issue

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 1, Subpart I - Procedures Implementing the National Environmental Policy Act of 1969

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable device

OET Bulletin 65, 65A, 65B Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

KDB 447498 D01 v06	Mobile and portable devices RF Exposure procedures and equipment authorisation policies, October 23, 2015.
KDB 865664 D01	SAR Measurement Requirements for 100 MHz to 6 GHz, August 7, 2015.
ANSI C95.1: 2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – 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: 50200013
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 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)

2.8 Peripheral devices and interface cables

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

- _____ Model : _____
- _____ Model : _____
- _____ Model : _____

2.9 Final measurement conditions

TX 1: NFC	13.56 MHz	EIRP = 53.6 dB µV/m at 3 meters – 95.2 = -41.6 dBm = 69 nW
TX 2: WLAN	2412 MHz	EIRP = 15.1 dBm = 32.4 mW
TX 3: Bluetooth	2441 MHz	EIRP = 7.7 dBm = 5.88 mW
TX 4: Bluetooth low energy	2440 MHz	EIRP = 8.8 dBm = 7.59 mW

2.9.1 Test jig

None

2.9.2 Test software

The RF parameters are set into test mode by means of the software “Teraterm” and “UNI test”

3 TEST RESULT SUMMERY

Operating in the 2400 MHz – 2483.5 MHz and 13.56 MHz range:

FCC Rule Part	RSS Rule Part	Description	Result
15.247(i)	RSS 102, 2.5.2	MPE	not applicable
KDB 447498	RSS 102, 2.5.1	SAR exclusion consideration	passed
OET Bulletin 65	RSS102, 3.2	Co-location, Co-transmission	not applicable

The mentioned RSS Rule Parts in the above table are related to:
RSS 102, Issue 5, March 2015

3.1 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 : 16 October 2015

Testing concluded on : 20 November 2015

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this document
2016.01.28 11:11:54 +01'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Konrad Graßl
I am the author of this document
2016.01.28 10:21:27 +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 and IC

4.4.1 General information

4.4.1.1 Test methodology

The Open Area test site is a listed Open Site under the Canadian Test-Sites File-No:

IC 3009A-1

In compliance with RSS 102 testing for RSS compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

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.

4.4.1.3 Details of test procedures

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.

5 TEST CONDITIONS AND RESULTS

5.1 Maximum peak radiated power

For test instruments and accessories used see section 6 Part **CPC 3**.

5.1.1 Description of the test location

Test location: Anechoic chamber 1

5.1.2 Photo documentation of the test set-up

5.1.3 Applicable standard

According to FCC Part 15, Section 15.247(b)(3):
For systems using digital modulation in the 2400-2483.5 MHz and 5725 – 5850 MHz bands, the maximum peak output power of the transmitter shall not exceed 1 Watt. The limit is based on transmitting antennas of directional gain that do not exceed 6 dBi. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

5.1.4 Description of Measurement

The maximum peak radiated power is measured using a spectrum analyzer following the procedure set out in KDB 558074 D01 v03r03 June9,2015, item 9.1.1. The EUT is set in TX continuous mode while measuring.

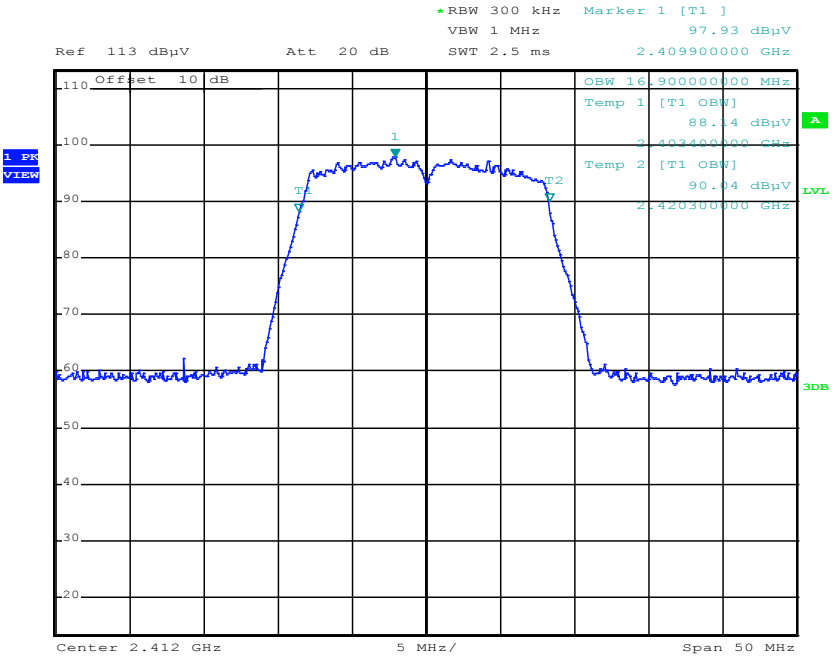
5.1.5 Test result

Pre-measurements have shown that the highest power is obtained in modulation g with data rate 6 Mbit/s

WLAN Standard 802.11g

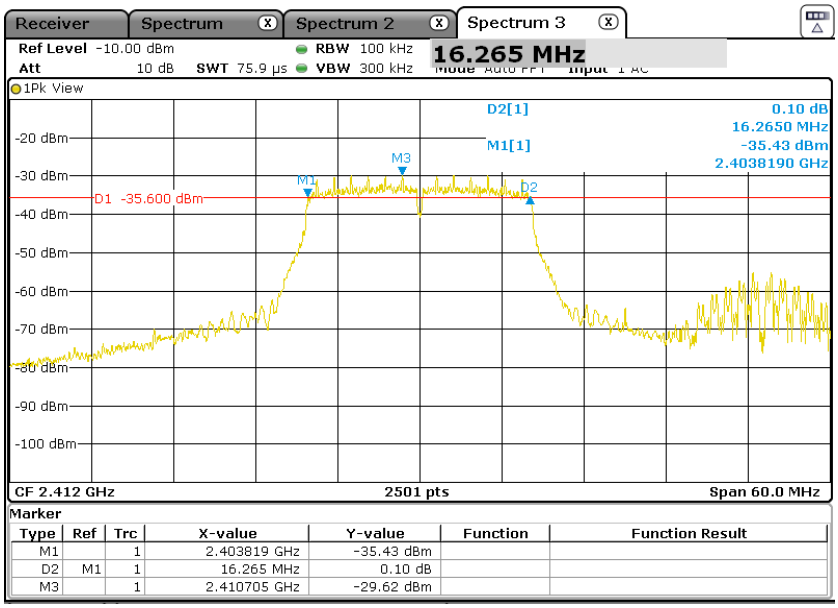
Occupied bandwidth at 2412 MHz

OBW = 16.9 MHz



DTS-Bandwidth at 2412 MHz

DTS-BW=16.3 MHz



Radiated fieldstrength measurement

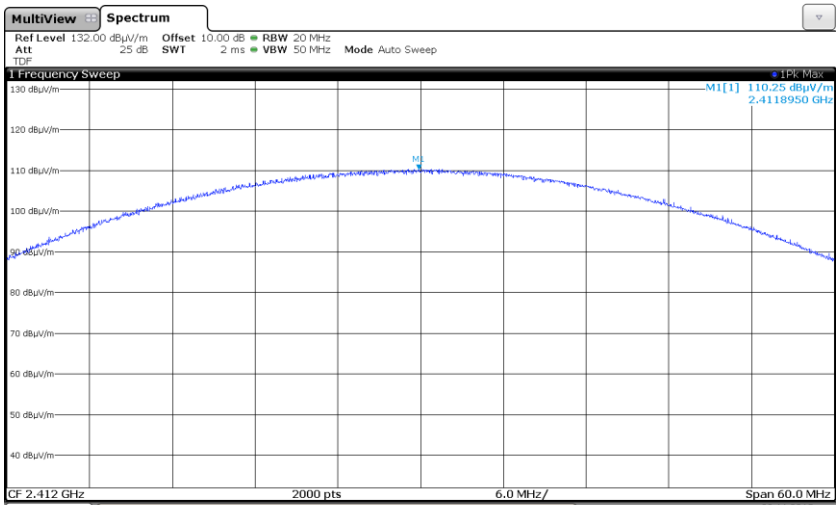
Analyser settings: RBW=20 MHz, VBW=50 MHz,

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
2412.00	110.3	131.2	-20.9
2442.00	108.3	131.2	-22.9
2462.00	109.8	131.2	-21.4

Note:

EIRP at 2412 MHz (worst case) = Fieldstrength at 3m – 95.2 = 110.3 dBµV/m – 95.2 = **15.1 dBm = 32.4 mW**

For reference the plot of the measurement at 2412 MHz



Peak Power radiated Limit according to FCC Part 15, Section 15.247(b)(3):

Frequency (MHz)	Peak Power Limit	
	(dBm)	(Watt)
902-928	30	1.0
2400-2483.5	**36**	**4.0**
5725-5850	30	1.0

Calculated contacted power

Calculated contacted power = Radiated power – Gain = 15.1 dBm – 0.5 dBi = **14.6 dBm**

Peak Power Limit according to FCC Part 15, Section 15.247(b)(3):

Frequency (MHz)	Peak Power Limit	
	(dBm)	(Watt)
902-928	30	1.0
2400-2483.5	**30**	**1.0**
5725-5850	30	1.0

The requirements are **FULFILLED.**

Remarks: _____

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6 HUMAN EXPOSURE

6.1 Maximum permissible exposure (MPE)

For test instruments and accessories used see section 6 Part **CPC 3**.

6.1.1 Description of the test location

Test location: NONE

Remarks:

6.2 Co-location and Co-transmission

Applicable standard:
OET Bulletin 65, Edition 97-01, Section 2: Multiple-transmitter sites and Complex Environments

The FCC's MPE limits vary with frequency. Therefore, in mixed or broadband RF fields where several sources and frequencies are involved, the fraction of the recommended limit (in terms of power density or square of the electric or magnetic field strength) incurred within each frequency interval should be determined, and the sum of all fractional contributions should not exceed 1.0, or 100 % in terms of percentage.

Remarks: Not applicable.

Simultaneous transmissions are considered in clauses 6.3.3 and 6.4.3 in this test report.

6.3 SAR test exclusion considerations

6.3.1 Applicable standard

According to RF exposure guidance:
Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

6.3.2 Determination of the standalone SAR test exclusion threshold

Note: The device is handheld and is perhaps pushed against the body with the front part of the device.

a) For NFC device:

Minimum distances from the antenna element to
Front (display): 47.9 mm
Left side: 32.76 mm
Bottom: 130 mm
Top: 11.9 mm
Back: < 5 mm

The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to <5 mm from antenna to the hand of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.

The formula under 4.3.1 c) for frequencies below 100 MHz is used:

The max power is according the equipment:

Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	Limit 10-g SAR (mW)	Percentage %
13.56	-41.6	0.0000692	1106.0	0.0000063

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

b) For WLAN device:

Minimum distances from the antenna element to
Front (display): 15.44 mm , rounded 15 mm (Display surface) , nearest distance to the extremities
Left side: 19.82 mm
Bottom: 36.65 mm , rounded 36 mm , nearest distance to the body
Top: 110 mm
Back: 32 mm

The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to 15 mm from the antenna to the hand of the user and additional 36 mm from the antenna to the body of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.
Hand:
The formula under 4.3.1 1) for 100 MHz to 6 GHz for standalone equipment is used:
[(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]*[√f(GHz)] ≤ 7.5;

Body:
The formula under 4.3.1 1) for 100 MHz to 6 GHz for standalone equipment is used:
[(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]*[√f(GHz)] ≤ 3;

The max power is according the equipment:

Extremities, distance 15 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	10-g SAR	Limit 10-g SAR	Percentage %
15	2412	15.1	32.36	3.35	7.5	44.7

Body, distance 36 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	1-g SAR	Limit 1-g SAR	Percentage %
36	2412	15.1	32.36	1.40	3.0	46.5

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

c) For Bluetooth device:

Minimum distances from the antenna element to
Front (display): 20.80 mm
Right side: 31.50 mm
Bottom: 130.00 mm
Top: 14.5 mm , rounded 14 mm , nearest distance to the extremities
Back: 27.00 mm

The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to 14 mm from the antenna to the hand of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.

The formula under 4.3.1 1) for 100 MHz to 6 GHz for standalone equipment is used:
[(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]*[√f(GHz)] ≤ 7.5;

The max power is according the equipment:

Extremities, distance 14 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	10-g SAR	Limit 10-g SAR	Percentage %
14	2441	7.7	5.89	0.66	7.5	8.8

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

d) For Bluetooth low energy device:

Minimum distances from the antenna element to
Front (display): 20.80 mm
Right side: 31.50 mm
Bottom: 130.00 mm
Top: 14.5 mm , rounded 14 mm , nearest distance to the extremities
Back: 27.00 mm

The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to 14 mm from the antenna to the hand of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.

The formula under 4.3.1 1) for 100 MHz to 6 GHz for standalone equipment is used:
[(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]*[√f(GHz)] ≤ 7.5;

The max power is according the equipment:

Extremities, distance 14 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	10-g SAR	Limit 10-g SAR	Percentage %
14	2440	8.8	7.59	0.85	7.5	11.3

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

6.3.3 Determination of the SAR test exclusion threshold for simultaneous transmission

Remark: WLAN, Bluetooth and Bluetooth low energy are forced by software not to transmit simultaneously, only NFC is able to transmit simultaneously with one of these three technologies.

Worst case is the simultaneous transmission of WLAN and NFC.
According to 6.3.2 WLAN consumes 46.5 % of the limit and NFC consumes 0.0000063 % of the limit. Therefore the sum is below 100 % and the requirement is fulfilled.

The requirements are **FULFILLED.**

Remarks: _____

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6.4 Exemption limits for routine evaluation - SAR evaluation

6.4.1 Applicable standard

According to RSS-102, item 2.5.1:
SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance 4, 5

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

4 The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.
5 Transmitters operating between 0.003-10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

6.4.2 Conclusion according RSS-102.

Note: The device is handheld and is perhaps pushed against the body with the front part of the device.

a) For NFC device:

Minimum distances from the antenna element to
Front (display): 47.9 mm
Left side: 32.76 mm
Bottom: 130 mm
Top: 11.9 mm
Back: < 5 mm
The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to <5 mm from antenna to the hand of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.

Limit for ≤ 300 MHz and at a separation distance of <5 mm = 71 mW * 2.5 = 177.5 mW

Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	Limit 10-g SAR (mW)	Percentage %
13.56	-41.6	0.000069	177.5	0.000039

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

b) For WLAN device:

Minimum distances from the antenna element to
Front (display): 15.44 mm , rounded 15 mm (to display surface) , nearest distance to the extremities
Left side: 19.82 mm
Bottom: 36.65 mm , rounded 36 mm , nearest distance to the body
Top: 110 mm
Back: 32 mm

The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to 15 mm from the antenna to the hand of the user and additional 36 mm from the antenna to the body of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.

The limits are referred to RSS-102 and interpolated to the real distance.

Extremities, distance 15 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	Limit 10-g SAR (mW)	Percentage %
15	2412	15.1	32.36	37.5	86.3

Body, distance 36 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	Limit 1-g SAR (mW)	Percentage %
36	2412	15.1	32.36	123.0	26.3

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

c) For Bluetooth device:

Minimum distances from the antenna element to
Front (display): 20.80 mm
Right side: 31.50 mm
Bottom: 130.00 mm
Top: 14.5 mm , rounded 14 mm , nearest distance to the extremities
Back: 27.00 mm

The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to 14 mm from the antenna to the hand of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.

The limits are referred to RSS-102 and interpolated to the real distance.

Extremities, distance 14 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	Limit 10-g SAR (mW)	Percentage %
14	2441	7.7	5.89	37.5	15.7

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

d) For Bluetooth low energy device:

Minimum distances from the antenna element to
Front (display): 20.80 mm
Right side: 31.50 mm
Bottom: 130.00 mm
Top: 14.5 mm , rounded 14 mm , nearest distance to the extremities
Back: 27.00 mm

The minimum separation distance results from the application of the device which is handled by hand. This distance is assumed to 14 mm from the antenna to the hand of the user.
The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g is determined.

The limits are referred to RSS-102 and interpolated to the real distance.

Extremities, distance 14 mm

Separation distance (mm)	Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	Limit 10-g SAR (mW)	Percentage %
14	2440	8.8	7.59	37.5	20.2

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

6.4.3 Determination of the SAR test exclusion threshold for simultaneous transmission

Remark: WLAN, Bluetooth and Bluetooth low energy are forced by software not to transmit simultaneously, only NFC is able to transmit simultaneously with one of these three technologies.

Worst case is the simultaneous transmission of WLAN and NFC.
According to 6.4.2 WLAN consumes 86.3 % of the limit and NFC consumes 0.000039 % of the limit. Therefore the sum is below 100 % and the requirement is fulfilled.

For the EUT SAR measurement is NOT necessary

The requirements are **FULFILLED.**

Remarks: _____

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7 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.
CPR 3	ESR 7	02-02/03-13-001	29/05/2016	29/05/2015		
	FSP 30	02-02/11-05-001	01/10/2016	01/10/2015		
	FSW43	02-02/11-15-001	05/08/2016	05/08/2015		
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	AFS4-01000400-10-10P-4	02-02/17-13-002				
	AMF-4F-04001200-15-10P	02-02/17-13-003				
	3117	02-02/24-05-009	12/05/2016	12/05/2015		
	Sucoflex N-2000-SMA	02-02/50-05-075				
	SF104/11N/11N/1500MM	02-02/50-13-015				