



RF - TEST REPORT

- Human Exposure -

Type / Model Name : M2Smart®SE

Product Description : Mobile handheld computer with battery

Applicant : ACD Elektronik GmbH

Address : Engelberg 2

88480 ACHSTETTEN, GERMANY

Manufacturer : ACD Elektronik GmbH

Address : Engelberg 2

88480 ACHSTETTEN, GERMANY

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

POSITIVE

Test Report No. :

T47042-00-03SK

04. October 2021

Date of issue



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

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ATTACHMENT A as separate supplement

FCC ID: O2FM2SMARTSE

IC: 9137A-M2SMARTSE

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 2.1091	Radiofrequency radiation exposure evaluation: mobile devices.
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable devices .
KDB 447498 D01 v06	RF Exposure procedures and equipment authorisation policies for mobile and portable devices, October 23, 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
ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2

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2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 Photo documentation of the EUT – See ATTACHMENT A

2.4 Equipment type, category

WLAN, BLE and RFID device, portable equipment.

2.5 Short description of the equipment under test (EUT)

The EUT is a mobile handheld computer for mobile acquisition and transmission of data. It is equipped with a WLAN/BT5 2x2 MU-MIMO module SPB228 (802.11 ac/a/b/g/n, BLE 5.0) and RFID (13.56 MHz). The EUT can be charged in a docking station.

There are also different slide on UHF RFID devices available for use of the device as handheld terminal. It is powered by the EUT and can operate simultaneously with the integrated 13.56 MHz transceiver. For evaluation of the slide on devices and simultaneous transmission please refer to the corresponding test reports.

Number of tested samples: 1
Serial number: 193600000151
Firmware version WLAN/BT: 16.68.10.p16

2.6 Variants of the EUT

There are no variants.

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2.7 Operation frequency and channel plan

Operating range 2400 MHz to 2483.5 MHz:

Channel plan BLE

Channel	Frequency	Channel	Frequency
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

Channel plan WLAN Standard 802.11b, g, n HT 20:

Channel	Frequency (MHz)
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462

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Channel plan WLAN Standard 802.11n HT 40:

Channel, HT40 up	Channel, HT40 down	Frequency (MHz)
1 up	5 down	2422
2 up	6 down	2427
3 up	7 down	2432
4 up	8 down	2437
5 up	9 down	2442
6 up	10 down	2447
7 up	11 down	2452

Operating range 5150 MHz to 5850 MHz.

Channel plan WLAN Standard 802.11a, n HT20, ac VHT20:

Channel	Frequency (MHz)
36	5180
40	5200
44	5220
48	5240

Channel	Frequency (MHz)
52	5260
56	5280
60	5300
64	5320

Channel	Frequency (MHz)
100	5500
104	5520
108	5540
112	5560
116	5580
120	5600
124	5620
128	5640
132	5660
136	5680
140	5700
144	5720

Channel	Frequency (MHz)
149	5745
153	5765
157	5785
161	5805
165	5825

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Channel plan WLAN Standard 802.11a, n HT40, ac VHT40:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
36up	5190	40down	5190
44up	5230	48down	5230

Channel	Frequency (MHz)	Channel	Frequency (MHz)
52up	5270	56down	5270
60up	5310	64down	5310

Channel	Frequency (MHz)	Channel	Frequency (MHz)
100up	5510	104down	5510
108up	5550	112down	5550
132up	5670	136down	5670
140up	5710	142down	5710

Channel	Frequency (MHz)	Channel	Frequency (MHz)
149up	5755	153down	5755
161up	5815	165down	5815

Channel plan WLAN Standard 802.11ac VT80:

Channel	Frequency (MHz)
42	5210

Channel	Frequency (MHz)
56	5210

Channel	Frequency (MHz)
106	5530
122	5610
138	5690

Channel	Frequency (MHz)
155	5775

Note: the marked frequencies are determined for final testing.

2.8 Transmit operating modes

The EUT use DSSS or OFDM modulation and may operate under operating mode 2 and provide following data rates with auto-fall-back:

- 802.11b mode	11, 5.5, 2, 1 Mbps	(Mbps = megabits per second)
- 802.11g mode	54, 48, 36, 24, 18, 12, 9, 6 Mbps	(Mbps = megabits per second)
- 802.11a	54, 48, 36, 24, 18, 12, 9, 6 Mbps	(Mbps = megabits per second)
- 802.11n	HT20, MCS 0 - 7	
- 802.11n	HT40, MCS 0 - 7	
- 802.11ac	VT20, MCS 0 - 9	
- 802.11ac	VT40, MCS 0 - 9	
- 802.11ac	VT80, MCS 0 - 9	

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2.9 Antennas

The following antennas shall be used with the EUT:

Number	Characteristic	Model number	Plug	Frequency range (MHz)	Gain (dBi)
A	omnidirectional	W3006 Pulse LarsenAntenna	MHF4L	2400-2485 5150-5850	3.2 4.2
B	omnidirectional	1001932PT AVX ethertronics	MHF4L	2400-2485 5150-5825	2.5 4.4
C	inductive loop	80001909 ACD Elektronik GmbH	-	13.56	-

2.10 Power supply system utilised

Power supply voltage : 3.8 V/DC (battery pack)
Power supply voltage (alternative) : 15.0 V/DC (docking station)

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3 TEST RESULT SUMMARY

WLAN, BLE and RFID device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz and 5725 MHz – 5850 MHz band:

FCC Rule Part	RSS Rule Part	Description	Result
KDB 447498, 7.1	RSS 102, 2.5.2	MPE	not applicable
KDB 447498, 4.3.1	RSS 102, 2.5.1	SAR exclusion consideration	passed
KDB 447498, 7.2	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 fulfils the requirements cited in clause 1 test standards.

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

Testing commenced on : 27 January 2021

Testing concluded on : 28 January 2021

Checked by:

Tested by:

Klaus Gegenfurtner
Radio Team

Sabine Kugler
Radio Team

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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 / 2011 + A1 / 2014 „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 Conformity Decision Rule

The conformity decision rule is based on the ILAC G8 published at the time of reporting.

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5 HUMAN EXPOSURE

5.1 RF output power

RFID 13.56 MHz:

The calculation of the EIRP level of the fundamental frequency is done according to KDB 412172 D01 subclause 1.3.1 formula (1). The used field strength is taken from the test report T47042-00-02SK issued by CSA Group Bayern GmbH.

Fieldstrength at a test distance of 3m: 60.1 dB μ V/m

$$\text{EIRP} = (E \times d)^2 / 30$$

where EIRP = equivalent isotropically radiated power in Watts
E = electrical field strength in V/m
d = measurement distance in metres

$$\text{EIRP} = (0.001012 \times 3)^2 / 30 \text{ W} = 307 \text{ nW}$$

Remarks: As worst case the power values are not averaged over time.

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5.2 Maximum permissible exposure (MPE)

Remarks: Not applicable, EUT is portable equipment (separation distance is below 20 cm).
Therefore, SAR test exclusion consideration is applicable.

5.3 Co-location and Co-transmission

Remarks: Not applicable, EUT is portable equipment (separation distance is below 20 cm).
Therefore, SAR test exclusion consideration for simultaneous transmission is applicable.

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5.4 SAR test exclusion considerations

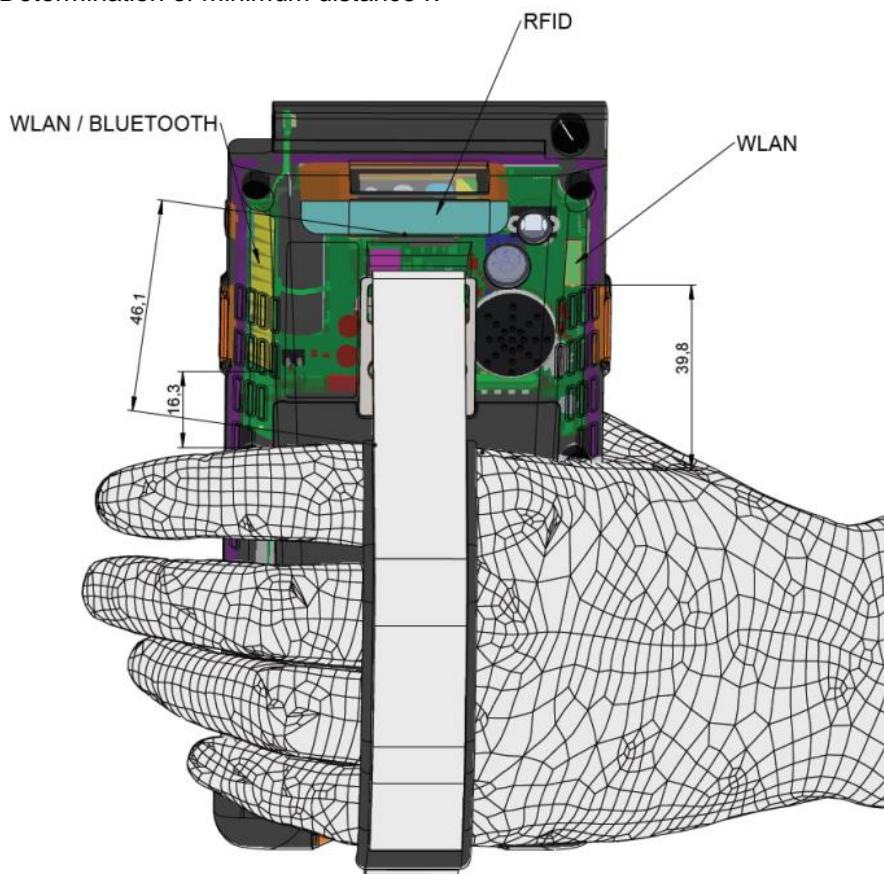
5.4.1 Applicable standard

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.

5.4.2 Determination of the standalone SAR test exclusion threshold

Determination of minimum distance r :



Antenna	Technology	Distance r (mm)	Gain (dBi)
A	WLAN	39.8	3.2 (2.4 GHz) 4.2 (5 GHz)
B	WLAN/ BLE	16.3	2.5 (2.4 GHz) 4.4 (5 GHz)
C	RFID	46.1	-

The minimum separation distance results from the application of the EUT which is handled by hand. This distance is assumed to be ≤ 50 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.

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The formula under 4.3.1 a) for 100 MHz to 6 GHz for standalone equipment is used:

$P_d = \{[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})]*[\sqrt{f(\text{GHz})}]\} \leq 7.5$ for 10-g extremity SAR;

BLE 5.0 (Antenna B):

Rated output power:	4.0 mW	6.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	7.0 dBm	5.0 mW
Antenna gain max:	2.5 dBi	
Minimum distance r:	16.3 mm	

Channel frequency (MHz)	A (mW)	Threshold level	Limit 10g	Margin 10g
2402	5	0.5	7.5	-7.0
2440	5	0.5	7.5	-7.0
2480	5	0.5	7.5	-7.0

WLAN 2.4 GHz - Antenna A:

Rated output power:	40.0 mW	16.0
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	17.0 dBm	50.4
Antenna gain max:	3.2 dBi	
Minimum distance r:	39.8 mm	

Channel frequency (MHz)	A (mW)	Threshold level	Limit 10g	Margin 10g
2412	50	2.0	7.5	-5.5
2437	50	2.0	7.5	-5.5
2462	50	2.0	7.5	-5.5

WLAN 2.4 GHz - Antenna B:

Rated output power:	40.0 mW	16.0
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	17.0 dBm	50.4
Antenna gain max:	2.5 dBi	
Minimum distance r:	16.3 mm	

Channel frequency (MHz)	A (mW)	Threshold level	Limit 10g	Margin 10g
2412	50	4.9	7.5	-2.6
2437	50	4.9	7.5	-2.6
2462	50	4.9	7.5	-2.6

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WLAN 5 GHz - Antenna A:

Rated output power: 31.5 mW 15.0 dBm
 Tune-up tolerance: 1.0 dB / -3.0 dB
 Maximum output power: 16.0 dBm 39.7 mW
 Antenna gain max: 4.2 dBi
 Minimum distance r: 39.8 mm

Channel frequency (MHz)	A (mW)	Threshold level	Limit 10g	Margin 10g
5200	40	2.3	7.5	-5.2
5400	40	2.3	7.5	-5.2
5700	40	2.4	7.5	-5.1

WLAN 5 GHz - Antenna B:

Rated output power: 31.5 mW 15.0 dBm
 Tune-up tolerance: 1.0 dB / -3.0 dB
 Maximum output power: 16.0 dBm 39.7 mW
 Antenna gain max: 4.4 dBi
 Minimum distance r: 16.3 mm

Channel frequency (MHz)	A (mW)	Threshold level	Limit 10g	Margin 10g
5200	40	5.7	7.5	-1.8
5400	40	5.8	7.5	-1.7
5700	40	5.9	7.5	-1.6

RFID 13.56 MHz:

The formula under 4.3.1 c) 2) for frequencies below 100 MHz is used:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(50)] * [\sqrt{f(0.1)}] [1 + \log(100/\sqrt{f(\text{MHz})})] * \frac{1}{2} \leq 7.5$ for 10-g extremity SAR;

Maximum EIRP: -35.1 dBm **307.0 nW**
 Minimum distance r: 46.1 mm

Channel frequency (MHz)	A (dBm)	A (nW)	Threshold level ($\times 10^{-9}$)	Limit 10g	Margin 10g
13.56	-35.1	307.0	1.813	7.5	-7.5

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5.4.3 Determination of the SAR test exclusion threshold for simultaneous transmission

When multiple devices are active the max threshold level has to be summed and the total threshold level is determined.

The formula under 4.3.2 b) 1) for test separation distances ≤ 50 mm is used:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] * [\sqrt{f(\text{GHz})} / x]$
with $x = 18.75$ for 10-g extremity SAR;

Standalone SAR value BLE	Standalone SAR value WLAN	Standalone SAR value RFID	Sum of SAR values	Limit	Margin
(W/kg)	(W/kg)	(W/kg)	(W/kg)	(W/kg)	(W/kg)
0.03	0.13	<0.01	0.16	0.40	-0.24

Conclusion: The summed SAR level is smaller than the limit, SAR measurement is NOT necessary. BLE, WLAN and RFID can be co-located without exceeding SAR limits.

The requirements are **FULFILLED**.

Remarks:	<u>BLE (antenna B) can only be in simultaneous transmission for WLAN antenna A.</u>
	<u>WLAN 2.4 GHz and WLAN 5 GHz are not working simultaneously.</u>
	<u>Worst case for WLAN is total power to antenna B at WLAN 5 GHz.</u>

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5.5 Exemption limits for routine evaluation - SAR evaluation

5.5.1 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

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤ 300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	88 mW	195 mW	213 mW
835	80 mW	92 mW	177 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

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.

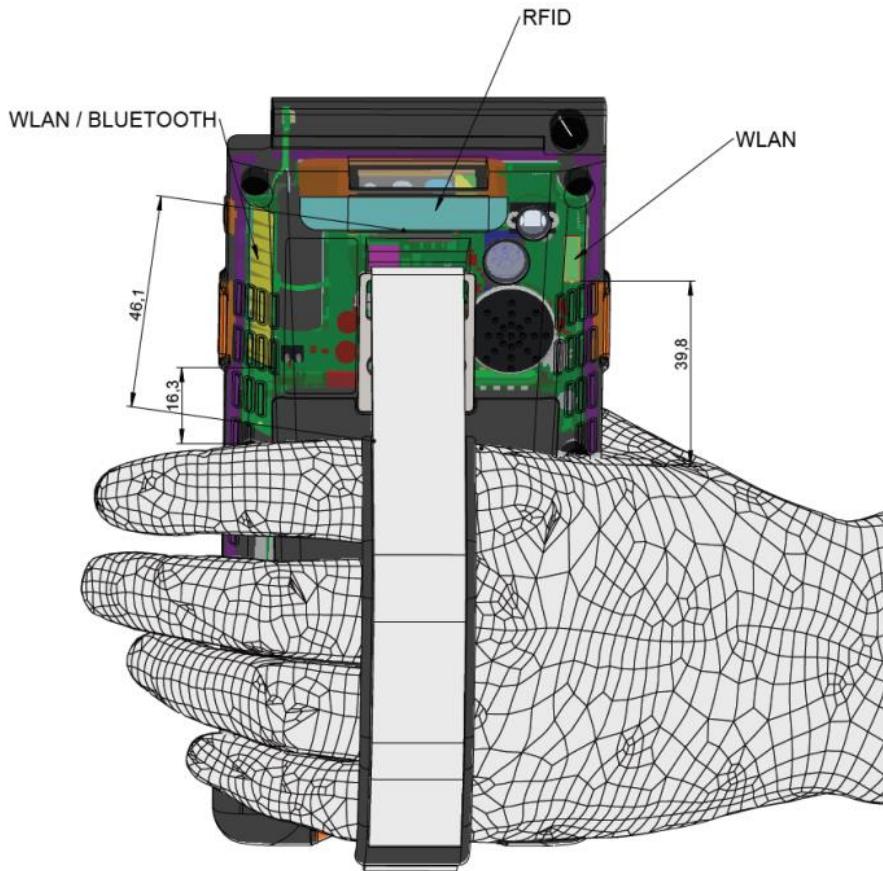
5 Transmitters operating between 0.003-10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

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5.5.2 Conclusion according RSS-102.

Determination of minimum distance r :



Antenna	Technology	Distance r (mm)	Gain (dBi)
A	WLAN	39.8	3.2 (2.4 GHz) 4.2 (5 GHz)
B	WLAN/ BLE	16.3	2.5 (2.4 GHz) 4.4 (5 GHz)
C	RFID	46.1	-

BLE 5.0 (Antenna B):

Rated output power:	4.0 mW	6.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	7.0 dBm	5.0 mW
Antenna gain max:	2.5 dBi	
Maximum EIRP:	9.5 dBm	9.0 mW
Minimum distance r :	16.3 mm	

Maximum EIRP at 2450 MHz, **9.0 mW**, is lower than the Exemption Limit of **37.5 mW**.

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WLAN 2.4 GHz:**Antenna A:**

Rated output power:	40.0 mW	16.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	17.0 dBm	50.4 mW
Antenna gain max:	3.2 dBi	
Maximum EIRP:	20.2 dBm	105.2 mW
Minimum distance r:	39.8 mm	

Maximum EIRP at 2450 MHz, **105.2 mW**, is lower than the Exemption Limit of **432.5 mW**.

Antenna B:

Rated output power:	15.8 mW	12.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	13.0 dBm	19.9 mW
Antenna gain max:	2.5 dBi	
Maximum EIRP:	15.5 dBm	35.4 mW
Minimum distance r:	16.3 mm	

Maximum EIRP at 2450 MHz, **35.4 mW**, is lower than the Exemption Limit of **37.5 mW**.

Note: For operation in Canada (IC) the Rated Output Power for WLAN 2.4 GHz antenna B is reduced to 12 dBm.

WLAN 5 GHz:**Antenna A:**

Rated output power:	31.5 mW	15.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	16.0 dBm	39.7 mW
Antenna gain max:	4.2 dBi	
Maximum EIRP:	20.2 dBm	104.3 mW
Minimum distance r:	39.8 mm	

Maximum EIRP at 5800 MHz, **104.3 mW**, is lower than the Exemption Limit of **212.5 mW**.

Antenna B:

Rated output power:	10.0 mW	10.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	11.0 dBm	12.6 mW
Antenna gain max:	4.4 dBi	
Maximum EIRP:	15.4 dBm	34.7 mW
Minimum distance r:	16.3 mm	

Maximum EIRP at 5800 MHz, **34.7 mW**, is lower than the Exemption Limit of **37.5 mW**.

Note: For operation in Canada (IC) the Rated Output Power for WLAN 5 GHz antenna B is reduced to 10 dBm.

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RFID 13.56 MHz:

Maximum EIRP: -35.1 dBm **307.0 nW**
 Minimum distance r: 46.1 mm

Maximum EIRP at \leq 300 MHz, **307 nW**, is lower than the Exemption Limit of **787.5 mW**.

5.5.3 Simultaneous transmission

The formula under Notice 2016-DRS001 for limb worn devices is used:

*(maximum power level including tune-up tolerance for transmitter A / maximum power level of exemption at the same frequency and distance) * 1.0 W/kg*

Estimated SAR level BLE	Estimated SAR level WLAN	Estimated SAR level RFID	Sum of SAR levels	Limit	Margin
(W/kg)	(W/kg)	(W/kg)	(W/kg)	(W/kg)	(W/kg)
0.2	0.5	<0.1	0.7	4.0	-3.3

For the EUT SAR measurement is NOT necessary.

The requirements are **FULFILLED**.

Remarks:

- BLE (antenna B) can only be in simultaneous transmission for WLAN antenna A.
- WLAN 2.4 GHz and WLAN 5 GHz are not working simultaneously.
- For the handheld EUT the 10 gram value applies, therefore the exemption limit is multiplied by a factor of 2.5.

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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.
-	-	-	-	-	-	-

-End of test report-