RF Exposure Calculation

M2Smart®SE + M2UHF-RFID Midrange (2035)
V1.03

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Dieses Dokument darf ohne Zustimmung weder vervielfältigt noch Dritten zugänglich gemacht werden.

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1 Test Standard

KDB 447498 D01 v06

RSS-102 Issue 6, December 2023

2 Description of the product:

The M2UHF-RFID is a plug-on Module for the mobile handheld Computer M2Smart®SE.
It contains a UHF RFID Module which uses frequencies from 902.75 MHz to 927.25 MHz.

The host M2Smart®SE without any plug-on Module is certified FCC ID: O2FM2SMARTSE and IC: 9137A-M2SMARTSE. This report refers to that and adds the M2UHF-RFID Midrange plug-on Module.

After plugging on the M2UHF-RFID Midrange Module to the M2Smart®SE the M2Smart®SE will recognize the module but won´t power up the UHF-RFID part. While starting the ACD M2UHF-RFID App the UHF-RFID part will be powered up and initialized, the RF part is still not active.
To activate the RF part the user has to navigate into the “Scan” Menu and press a “Start” button to read a tag. If the user forgets to deactivate the reading, it will be automatically turned off after 118 seconds.

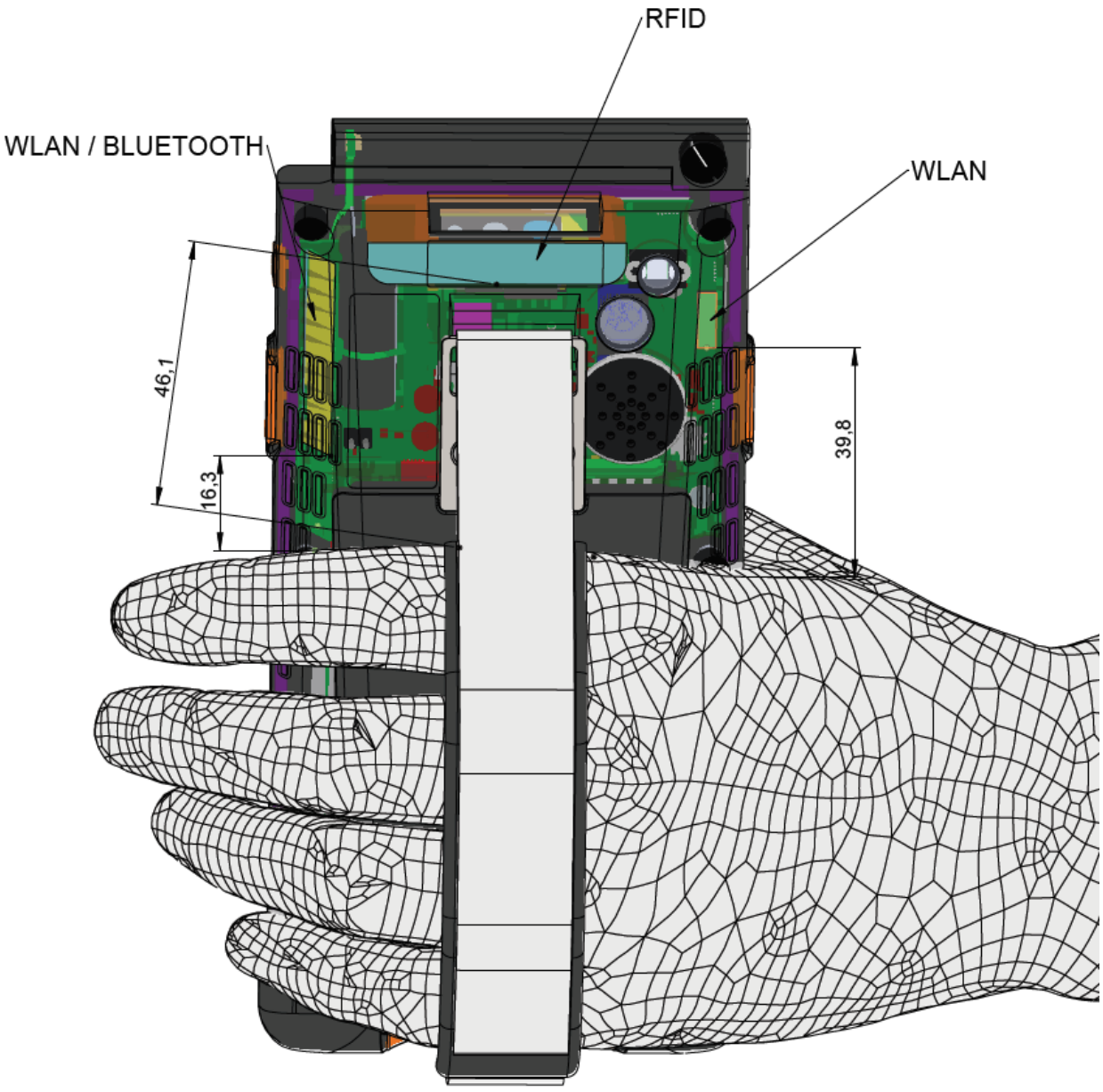
The M2Smart®SE in combination with the M2UHF-RFID Midrange Module does not have a bag, holster or any other accessory, that is sold in any FCC or IC relevant country, which brings the device closer to the human body than stated in this report.

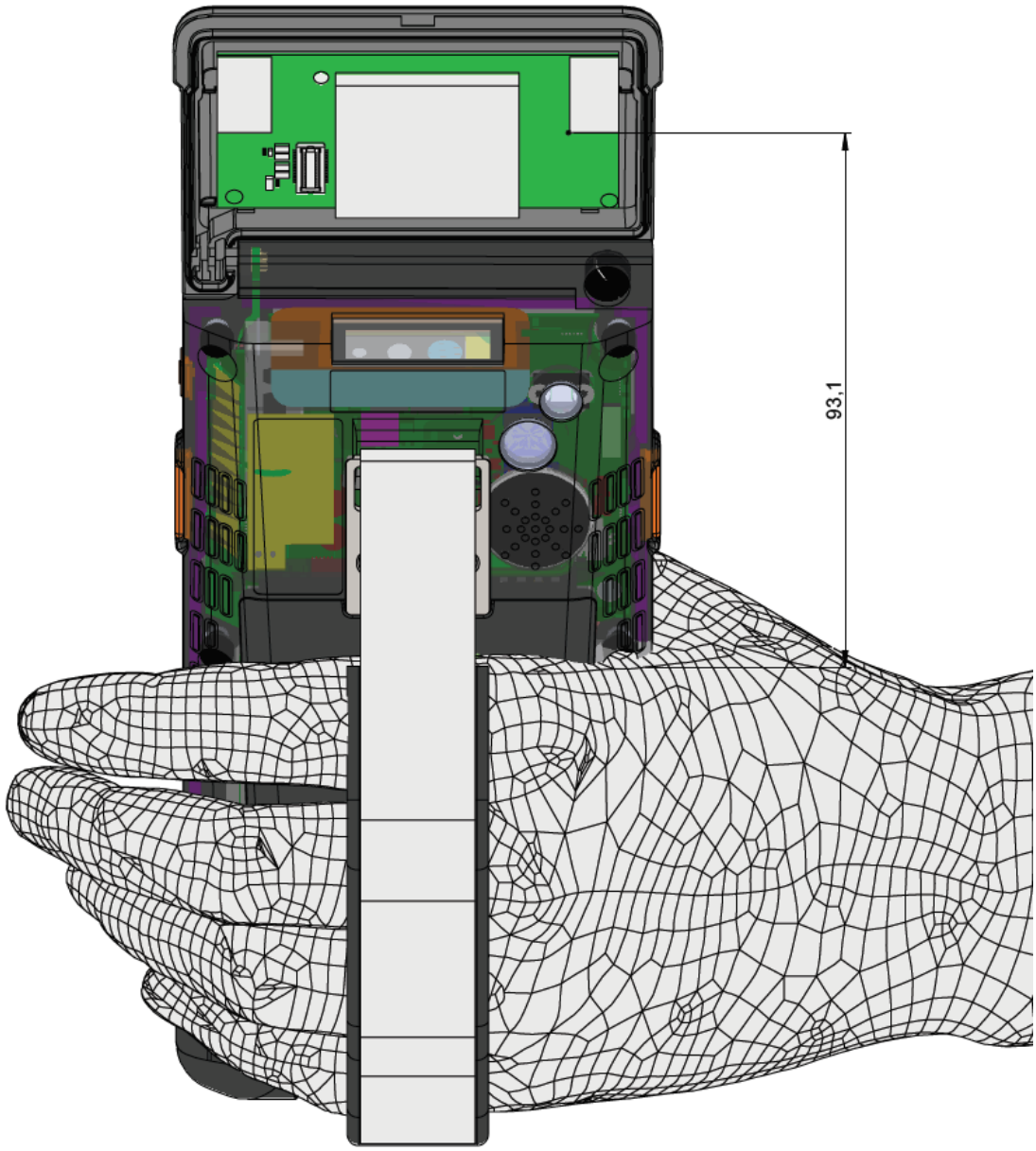
3 SAR test exclusion considerations

3.1 Evaluation according to KDB 447498 D01 v06

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.

3.1.1 Determination of the SAR test exclusion threshold





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	-
D	UHF RFID	93.1	0.09

The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g us determined.

Formula under 4.3.1 b) for 100 MHz to 6 GHz for standalone equipment is used:

Step a):
[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 7.5 for 10-g extremity SAR

Step b):
{[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW, for 100 MHz to 1500 MHz

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

step a):
{[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]*[√f(0.1 GHz)]} ≤ 7.5 for 10-g extremity SAR;

Step b):
{[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)*(f(100 MHz)/150)] * [1 + log(100/f(MHz))]} mW

BLE 5.0 (Antenna B):

Power allowed at numeric threshold for 16.3 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √2.480 * 16.3} mW
= 77.63 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 5.0 mW is much lower than the limit of 77.63 mW, thus SAR measurement is NOT necessary.

WLAN 2.4 GHz – Antenna A:

Power allowed at numeric threshold for 39.8 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √2.480 * 39.8} mW
= 189.55 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 50.4 mW is much lower than the limit of 189.55 mW, thus SAR measurement is NOT necessary.

WLAN 2.4 GHz – Antenna B:

Power allowed at numeric threshold for 16.3 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √2.480 * 16.3} mW
= 77.63 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 50.4 mW is much lower than the limit of 77.63 mW, thus SAR measurement is NOT necessary.

WLAN 5 GHz – Antenna A:

Power allowed at numeric threshold for 39.8 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √5.825 * 39.8} mW
= 123.68 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 39.7 mW is much lower than the limit of 123.68 mW, thus SAR measurement is NOT necessary.

WLAN 5 GHz – Antenna B:

Power allowed at numeric threshold for 16.3 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √5.825 * 16.3} mW
= 50.65 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 39.7 mW is much lower than the limit of 50.65 mW, thus SAR measurement is NOT necessary.

RFID (Antenna C):

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.

Field strength at a test distance of 3 m: 60.1 dBµV/m

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

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

EIRP = (0.001012 x 3)* 2 / 30 W = **921 nW**

Power allowed at numeric threshold for 46.1 mm:
max. power = {7.5 / √f(GHz) [min. test separation distance (mm)]} mW
= {7.5 / √0.1 * 46.1} mW
= 1093.36 mW

The max xonducted average power is according the equipment:

Maximum EIRP:	-30.4 dBm	**921.0 nW**
Minimum distance r:	46.1 mm	

Conclusion: The maximum output power, 921.0 nW is much lower than the limit of 1093.36 mW, thus SAR measurement is NOT necessary.

UHF-RFID (Antenna D):

Power allowed at numeric threshold for 50 mm in step a):
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √0.90275 * 50.0} mW
= 394.68 mW

Power allowed for 93.1 mm separation distance:
{[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW
= [394.68 + (93.1-50.0)*(902.75/150) mW
= 654.07 mW

The max conducted average power is according the equipment:

Rated output power:	25.6 dBm	363.1 mW
Tune-up tolerance:	1.0 dBm	
Maximum output power:	26.6 dBm	**457.1 mW**

Antenna gain max: 0.09 dBi

Conclusion: The maximum output power, 457.1 mW is lower than the limit of 654.07 mW, thus SAR measurement is NOT necessary.

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

3.1.2 Determinition of the SAR test exclusion threshold for simultaneous transmission

Simultaneous transmission SAR test exclusion considerations according to KDB 447498 4.3.2

Formulas according to KDB 447498 4.3.2 b)

1) [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)/x] W/kg, for test separation distances ≤ 50 mm;
where x = 7.5 for 1-g SAR and x = 18.75 for 10-g SAR

2) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distance is > 50 mm

BLE:
[(5 mW) / 16.3 mm)]·[√f(2.480 GHz)/18.75]=**0.026 W/Kg**

WIFI 2.4 GHz:
[(50.4 mW) / 16.3 mm)]·[√f(2.480 GHz)/18.75]=**0.26 W/Kg**

WIFI 5 GHz:
[(39.7 mW) / 16.3 mm)]·[√f(5.825 GHz)/18.75]=**0.31 W/Kg**

HF-RFID:
[(0.921 mW) / 50 mm)]·[√f(0.1 GHz)/18.75]=**0.0003 W/Kg**

UHF-RFID:
[(457.1 mW) / 50 mm)]·[√f(0.90275 GHz)/18.75]=**0.46 W/Kg**

Summary:

BLE + WIFI +HF-RFID + UHF-RFID	= 0.026 W/Kg + 0.31 W/Kg + 0.0003 W/Kg + 0.46 W/Kg **= 0.7963 W/Kg**

0.9763 W/Kg is under the limit of 1 W/Kg for 10-g SAR.

The requirements are **FULFILLED**.

Remarks: BLE (antenna B) can only be in simultaneous transmission for WLAN with antenna A.
WIFI power level refers to the total power on both antenna ports (antenna A + antenna B). WIFI 2.4 GHz and WIFI 5 GHz are not working simultaneously.
Worst case for WIFI is total power to Antenna B at 5 GHz.

3.2 Evaluation according to RSS-102 Issue 6, item 6

Frequency (MHz)	≤ 5 mm (mW)	10 mm (mW)	15 mm (mW)	20 mm (mW)	25 mm (mW)	30 mm (mW)	35 mm (mW)	40 mm (mW)	45 mm (mW)	> 50 mm (mW)
≤ 300	45	116	139	163	189	216	246	280	319	362
450	32	71	87	104	124	147	175	208	248	296
835	21	32	41	54	72	96	129	172	228	298
1900	6	10	18	33	57	92	138	194	257	323
2450	3	7	16	32	56	89	128	170	209	245
3500	2	6	15	29	50	72	94	114	134	158
5800	1	5	13	23	32	41	54	74	102	128

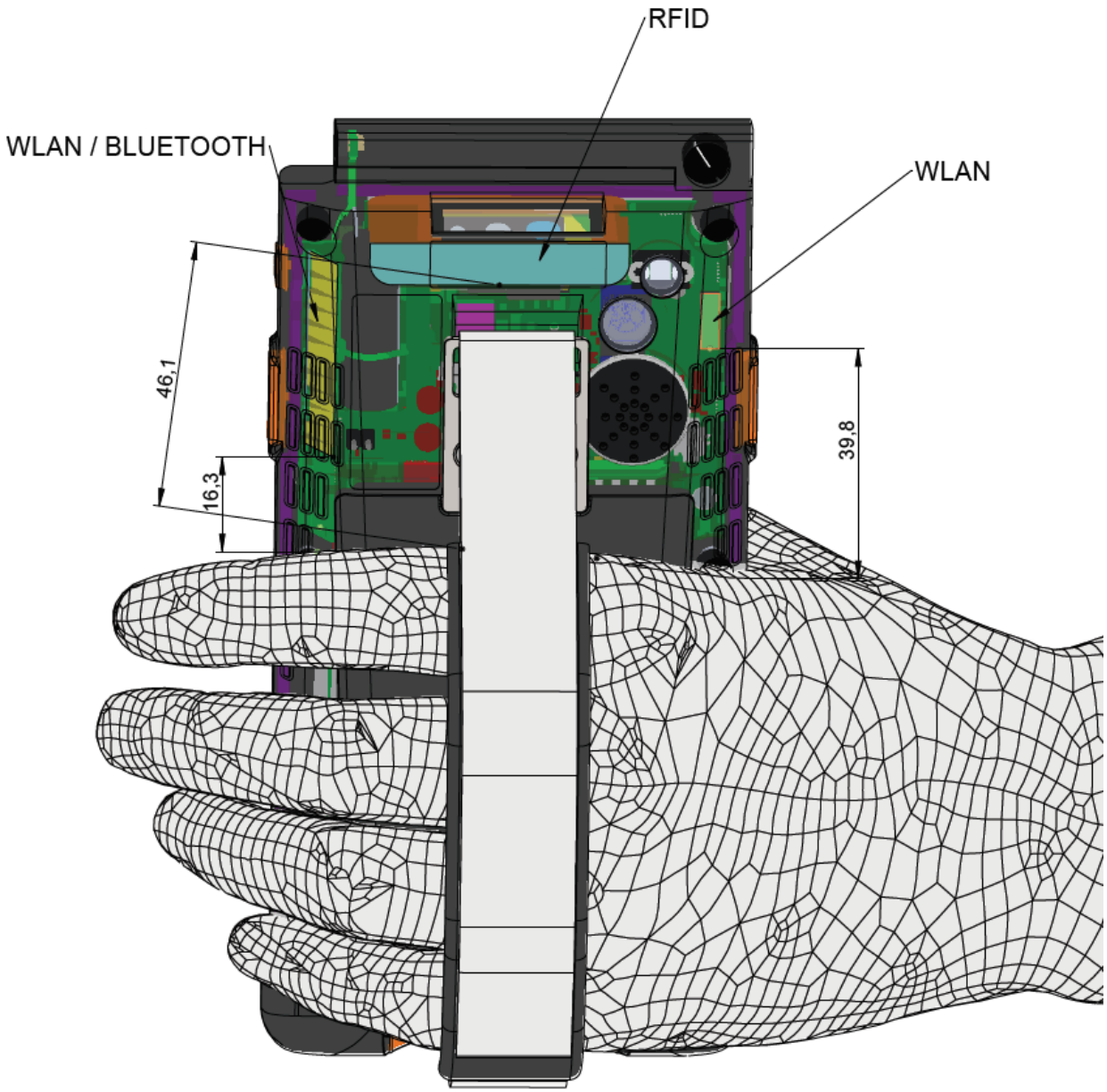
Bluetoot, WIFI and RFID are working continuously the user has no intention to deactivate one of tese RF tranceivers, therefore being classified as Limb-Worn Device the exemption Limits will be miltiplied by a factor of 2.5.

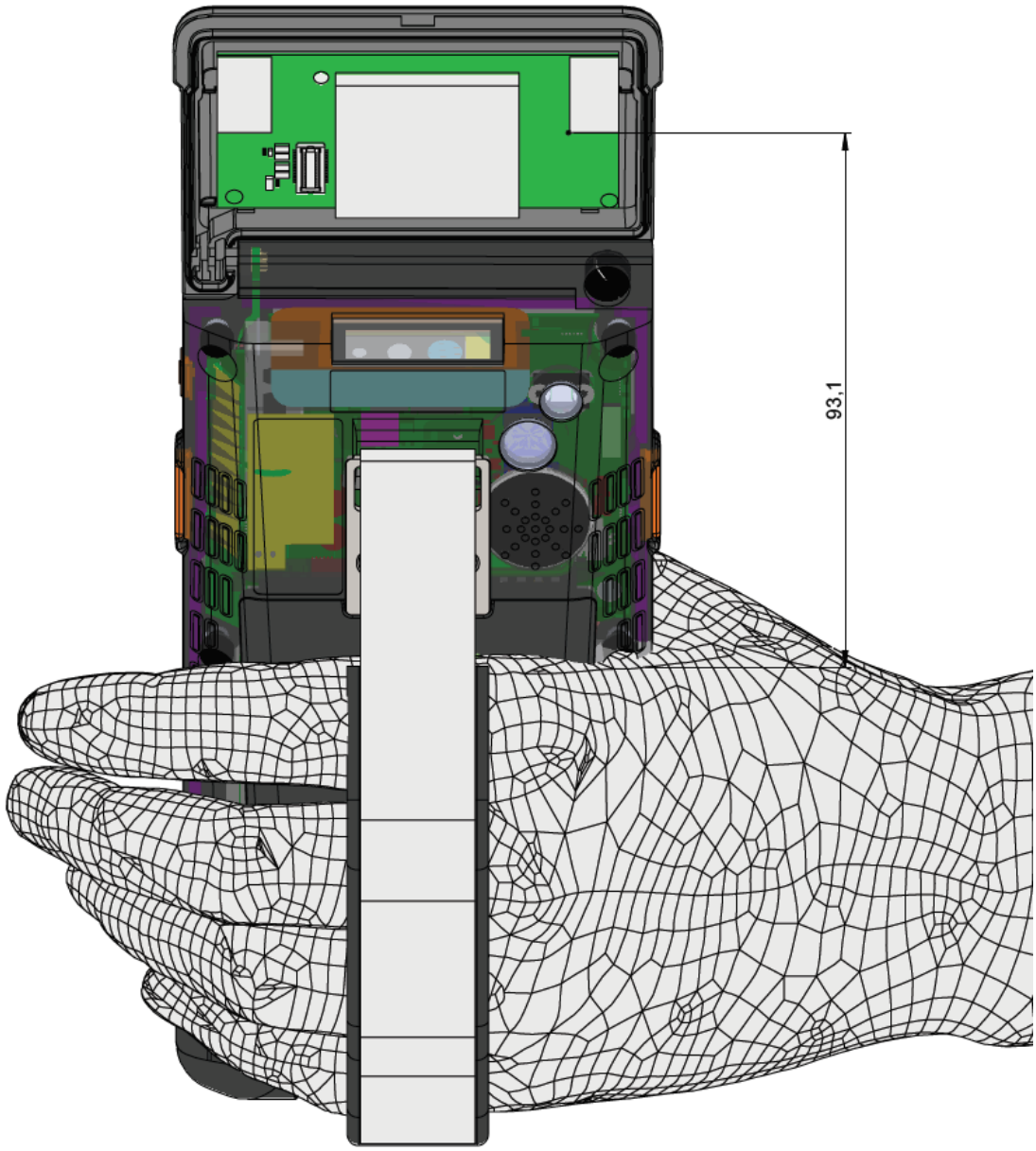
The UHF-RFID part (902.25 MHz) is directly controlled by the user as described on page 2.
Due the user manual the user is fully aware of the exposure and can control it.
Therefore these limits will be multiplied by a factor of 5 for controlled use.

For Bluetooth, WIFI and RFID the stringent limits of the table above are used because the benefetis of using linear interpolation would be negligible since the exemption limits of the next step are nearly the same.

For UHF-RFID Linear Interpolation is used:
Linear Interpolation to 902.25 MHz for separation distance of ≥50 mm:
= 299.55 mW, for controlled use devices it will be multiplied by a factor 5 = **1497.75 mW**

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	45.1	-
D	UHF RFID	93.1	0.09

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**.

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 **307.5 mW**.

Antenna B:

For Operation in Canada (IC) the rated output power of antenna B at 2.4 GHz is reduced to 12 dBm = 15.85 mW

Rated output power:	15.8 mW	12.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	13.0 dBm	20.0 mW
Antenna gain max:	2.5 dBi	
Maximum EIRP:	15.5 dBm	**35.5 mW**
Minimum distance r:	16.3 mm	

Maximum EIRP at 2450 MHz, **35.5 mW**, is lower than the Exemption Limit of **37.5 mW**.

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 **177.5 mW**.
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Antenna B:

For Operation in Canada (IC) the rated output power of antenna B at 5 GHz is reduced to 10 dBm = 10 mW

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**.

RFID 13.56 MHz:

Maximum EIRP:	-30.4 dBm	921.0 nW
Minimum distance r:	49.9 dBm	

Maximum EIRP at ≤ 300MHz, **921.0 nW**, is lower than the Exemption Limit of **787.5 mW**.

UHF-RFID:

Rated output power:	25.6 dBm	363.1 mW
Tune-up tolerance:	1.0 dBm	
Antenna gain max:	0.09 dBi	
Maximum EIRP	26.6 dBm	**457.1 mW**
Minumum distance r:	93.1 mm	

Maximum EIRP at 902.25 MHz, **457.1 mW**, is lower than Exemption Limit of **1497.75 mW**.

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

3.2.1 Simultaneous transmission

The SAR exemption limits outlined in clause 6 of RSS-102 Issue 6 have been derived based on an approximate SAR value of 0.4 W/kg using half-wave dipole antennas. As such, when simultaneous transmitter SAR evaluations include transmitters that have been exempt from routine SAR evaluation, the SAR must be estimating based on the ratio between the maximum tune-up tolerance limit of the transmitter that has been exempt and the exemption limit at the specific distance and frequency for that transmitter. This ratio must be multiplied by 0.4 W/kg(2.0 W/kg for controlled use and 1.0 W/kg for limb worn devices) in order to calculate the estimated SAR level.

The estimate SAR value is calculated based the following equation:

(maximum power level including tune-up tolerance for transmitter A / maximum power level of exemption at the same frequency and distance) * (0.4W/kg* 2.5)
For limb worn devices.

Maximum ration BLE	Maximum ration WLAN	Maximum ratio HF-RFID	Maximum ratio UHF-RFID	Sum of exposure ratios	Limit of exposure ratios	Margin
mW/kg	mW/kg	mW/kg	mW/kg	mW/kg	mW/kg	mW/kg
240.00	755.63	1.17	305.19	1301.99	4000	2698.01

The requirements are **FULFILLED.**

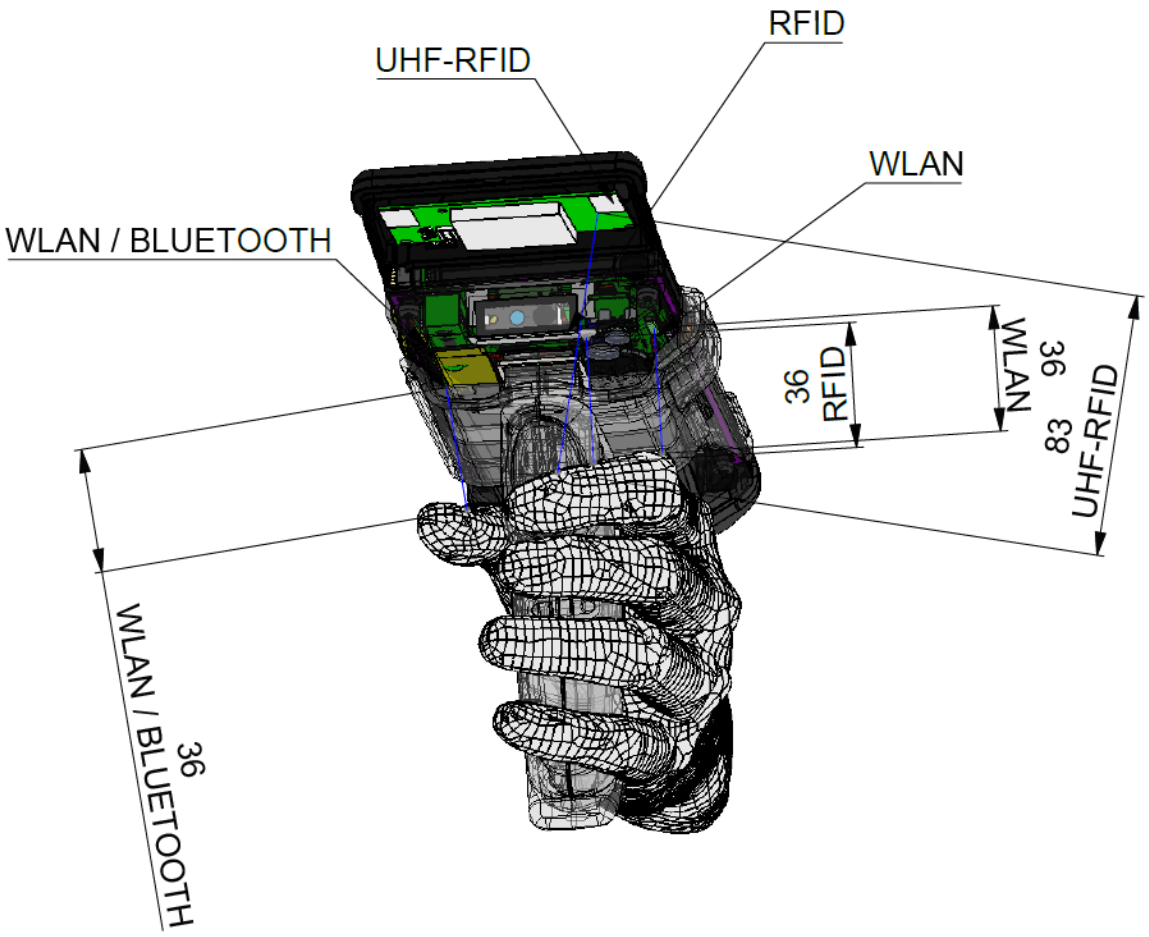
Remarks: BLE (Antenna B) can only be in simultaneous transmission for WLAN (Antenna A)
WIFI power level refers to the total power on both antenna ports (antenna A + antenna B).
Worst case for Wifi: total power to Antenna B at 2.4 GHz.

4 SAR test exclusion considerations with M2Grip5

4.1 Evaluation according to KDB 447498 D01 v06

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.

4.1.1 Determination of the SAR test exclusion threshold



Antenna	Technology	Distance r (mm)	Gain (dBi)
A	WLAN	36	3.2 (2.4 GHz) 4.2 (5 GHz)
B	WLAN / BLE	36	2.5 (2.4 GHz) 4.4 (5 GHz)
C	RFID	36	-
D	UHF RFID	83	0.09

The hand of the user is the nearest extremity of a human being therefore the threshold for 10-g us determined.

Formula under 4.3.1 b) for 100 MHz to 6 GHz for standalone equipment is used:

Step a):
[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 7.5 for 10-g extremity SAR

Step b):
{[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW, for 100 MHz to 1500 MHz

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

step a):
{[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]*[√f(0.1 GHz)]} ≤ 7.5 for 10-g extremity SAR;

Step b):
{[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)*(f(100 MHz)/150)] * [1 + log(100/f(MHz))]} mW

BLE 5.0 (Antenna B):

Power allowed at numeric threshold for 36 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √2.480 * 36} mW
= 171.45 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 5.0 mW is much lower than the limit of 171.45 mW, thus SAR measurement is NOT necessary.

WLAN 2.4 GHz – Antenna A:

Power allowed at numeric threshold for 36 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √2.480 * 36} mW
= 171.45 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 50.4 mW is much lower than the limit of 171.45 mW, thus SAR measurement is NOT necessary.

WLAN 2.4 GHz – Antenna B:

Power allowed at numeric threshold for 36 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √2.480 * 36} mW
= 171.45 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 50.4 mW is much lower than the limit of 171.45 mW, thus SAR measurement is NOT necessary.

WLAN 5 GHz – Antenna A:

Power allowed at numeric threshold for 36 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √5.825 * 36} mW
= 105.66 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 39.7 mW is much lower than the limit of 111.87 mW, thus SAR measurement is NOT necessary.

WLAN 5 GHz – Antenna B:

Power allowed at numeric threshold for 36 mm:
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √5.825 * 36} mW
= 121.19 mW

The max conducted average power is according the equipment:

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	

Conclusion: The maximum output power, 39.7 mW is much lower than the limit of 111.87 mW, thus SAR measurement is NOT necessary.

RFID (Antenna C):

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.

Field strength at a test distance of 3 m: 60.1 dBµV/m

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

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

EIRP = (0.001012 x 3)* 2 / 30 W = **921 nW**

Power allowed at numeric threshold for 34 mm:
max. power = {7.5 / √f(GHz) [min. test separation distance (mm)]} mW
= {7.5 / √0.1 * 36} mW
= 853.81 mW

The max conducted average power is according the equipment:

Maximum EIRP:	-30.4 dBm	**921.0 nW**
Minimum distance r:	46.1 mm	

Conclusion: The maximum output power, 921.0 nW is much lower than the limit of 853.81 mW, thus SAR measurement is NOT necessary.

UHF-RFID (Antenna D):

Power allowed at numeric threshold for 50 mm in step a):
max. power = {7.5/ √f(GHz) * [min. test separation distance (mm)] mW
= {7.5/ √0.90275 * 50.0} mW
= 394.68 mW

Power allowed for 83 mm separation distance:
{[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW
= [394.68 + (83-50.0)*(902.75/150) mW
= 593.29 mW

The max conducted average power is according the equipment:

Rated output power:	25.6 dBm	363.1 mW
Tune-up tolerance:	1.0 dBm	
Maximum output power:	26.6 dBm	**457.1 mW**

Antenna gain max: 0.09 dBi

Conclusion: The maximum output power, 457.1 mW is lower than the limit of 593.29 mW, thus SAR measurement is NOT necessary.

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

4.1.2 Determinition of the SAR test exclusion threshold for simultaneous transmission

Simultaneous transmission SAR test exclusion considerations according to KDB 447498 4.3.2

Formulas according to KDB 447498 4.3.2 b)

1) [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)/x] W/kg, for test separation distances ≤ 50 mm;
where x = 7.5 for 1-g SAR and x = 18.75 for 10-g SAR

2) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distance is > 50 mm

BLE:
[(5 mW) / 16.3 mm)]·[√f(2.480 GHz)/18.75]=**0.026 W/Kg**

WIFI 2.4 GHz:
[(50.4 mW) / 16.3 mm)]·[√f(2.480 GHz)/18.75]=**0.26 W/Kg**

WIFI 5 GHz:
[(39.7 mW) / 16.3 mm)]·[√f(5.825 GHz)/18.75]=**0.31 W/Kg**

HF-RFID:
[(0.921 mW) / 50 mm)]·[√f(0.1 GHz)/18.75]=**0.0003 W/Kg**

UHF-RFID:
[(457.1 mW) / 50 mm)]·[√f(0.90275 GHz)/18.75]=**0.46 W/Kg**

Summary:

BLE + WIFI +HF-RFID + UHF-RFID	= 0.026 W/Kg + 0.31 W/Kg + 0.0003 W/Kg + 0.46 W/Kg **= 0.7963 W/Kg**

0.9763 W/Kg is under the limit of 1 W/Kg for 10-g SAR.

The requirements are **FULFILLED**.

Remarks: BLE (antenna B) can only be in simultaneous transmission for WLAN with antenna A.
WIFI power level refers to the total power on both antenna ports (antenna A + antenna B). WIFI 2.4 GHz and WIFI 5 GHz are not working simultaneously.
Worst case for WIFI is total power to Antenna B at 5 GHz.

4.2 Evaluation according to RSS-102 Issue 6, item 6

Frequency (MHz)	≤ 5 mm (mW)	10 mm (mW)	15 mm (mW)	20 mm (mW)	25 mm (mW)	30 mm (mW)	35 mm (mW)	40 mm (mW)	45 mm (mW)	> 50 mm (mW)
≤ 300	45	116	139	163	189	216	246	280	319	362
450	32	71	87	104	124	147	175	208	248	296
835	21	32	41	54	72	96	129	172	228	298
1900	6	10	18	33	57	92	138	194	257	323
2450	3	7	16	32	56	89	128	170	209	245
3500	2	6	15	29	50	72	94	114	134	158
5800	1	5	13	23	32	41	54	74	102	128

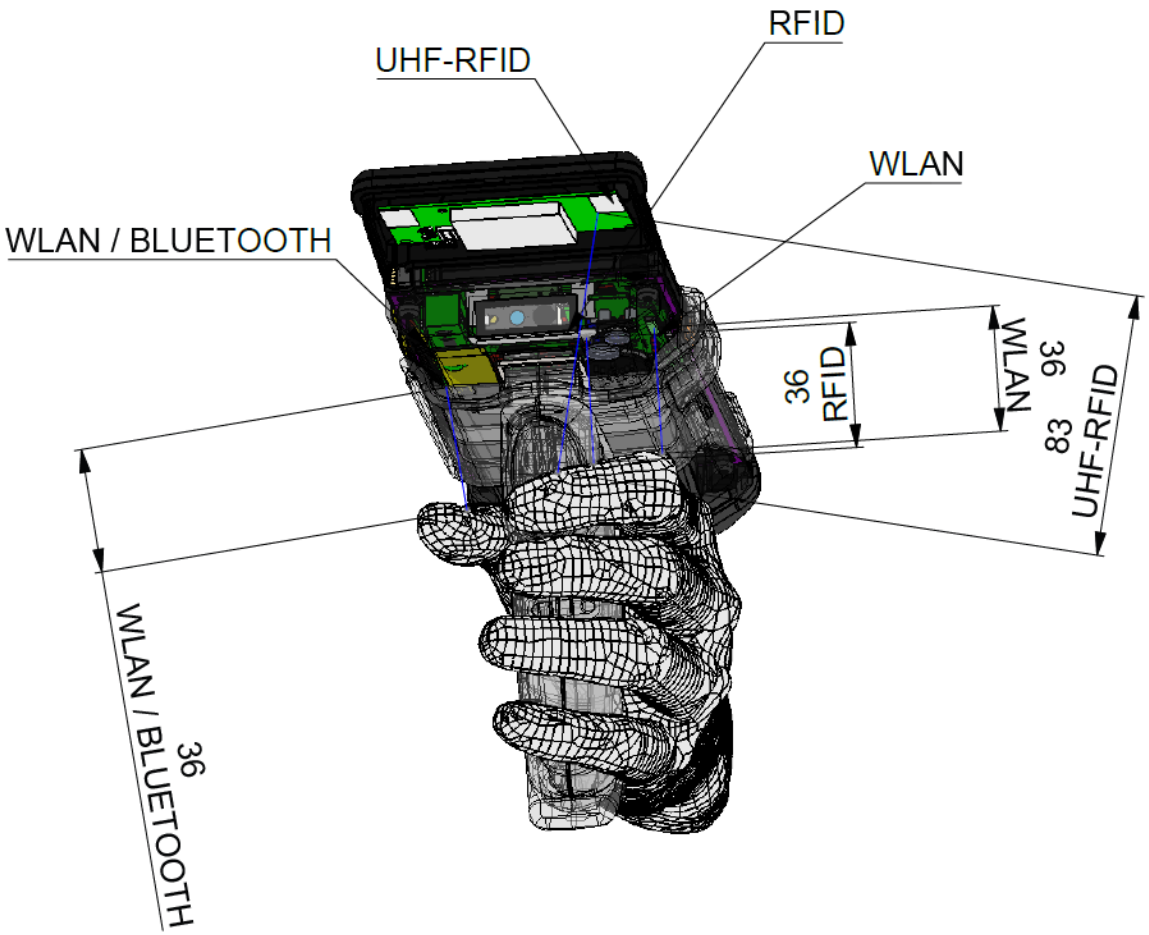
Bluetoot, WIFI and RFID are working continuously the user has no intention to deactivate one of tese RF tranceivers, therefore being classified as Limb-Worn Device the exemption Limits will be miltiplied by a factor of 2.5.

The UHF-RFID part (902.25 MHz) is directly controlled by the user as described on page 2.
Due the user manual the user is fully aware of the exposure and can control it.
Therefore these limits will be multiplied by a factor of 5 for controlled use.

For Bluetooth, WIFI and RFID the stringent limits of the table above are used because the benefetis of using linear interpolation would be negligible since the exemption limits of the next step are nearly the same.

For UHF-RFID Linear Interpolation is used:
Linear Interpolation to 902.25 MHz for separation distance of ≥50 mm:
= 299.55 mW, for controlled use devices it will be multiplied by a factor 5 = **1497.75 mW**

Determination of minimum distance r:



Antenna	Technology	Distance r (mm)	Gain (dBi)
A	WLAN	36	3.2 (2.4 GHz) 4.2 (5 GHz)
B	WLAN / BLE	36	2.5 (2.4 GHz) 4.4 (5 GHz)
C	RFID	36	-
D	UHF RFID	83	0.09

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:	36 mm	

Maximum EIRP at 2450 MHz, **9.0 mW**, is lower than the Exemption Limit of **307.5 mW**.

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:	36 mm	

Maximum EIRP at 2450 MHz, **105.2 mW**, is lower than the Exemption Limit of **307.5 mW**.

Antenna B:

For Operation in Canada (IC) the rated output power of antenna B at 2.4 GHz is reduced to 12 dBm = 15.85 mW

Rated output power:	15.8 mW	12.0 dBm
Tune-up tolerance:	1.0 dB / -3.0 dB	
Maximum output power:	13.0 dBm	20.0 mW
Antenna gain max:	2.5 dBi	
Maximum EIRP:	15.5 dBm	**35.5 mW**
Minimum distance r:	36 mm	

Maximum EIRP at 2450 MHz, **35.5 mW**, is lower than the Exemption Limit of **307.5 mW**.

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:	36 mm	

Maximum EIRP at 5800 MHz, **104.3 mW**, is lower than the Exemption Limit of **177.5 mW**.
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Antenna B:

For Operation in Canada (IC) the rated output power of antenna B at 5 GHz is reduced to 10 dBm = 10 mW

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:	36 mm	

Maximum EIRP at 5800 MHz, **34.7 mW**, is lower than the Exemption Limit of **177.5 mW**.

RFID 13.56 MHz:

Maximum EIRP:	-30.4 dBm	921.0 nW
Minimum distance r:	49.9 dBm	

Maximum EIRP at ≤ 300MHz, **921.0 nW**, is lower than the Exemption Limit of **635 mW**.

UHF-RFID:

Rated output power:	26.5 dBm	363.1 mW
Tune-up tolerance:	1.0 dBm	
Antenna gain max:	0.09 dBi	
Maximum EIRP	26.6 dBm	**457.1 mW**
Minumum distance r:	83 mm	

Maximum EIRP at 902.25 MHz, **457.1 mW**, is lower than Exemption Limit of **1497.75 mW**.

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

4.2.1 Simultaneous transmission

The SAR exemption limits outlined in clause 6 of RSS-102 Issue 6 have been derived based on an approximate SAR value of 0.4 W/kg using half-wave dipole antennas. As such, when simultaneous transmitter SAR evaluations include transmitters that have been exempt from routine SAR evaluation, the SAR must be estimating based on the ratio between the maximum tune-up tolerance limit of the transmitter that has been exempt and the exemption limit at the specific distance and frequency for that transmitter. This ratio must be multiplied by 0.4 W/kg(2.0 W/kg for controlled use and 1.0 W/kg for limb worn devices) in order to calculate the estimated SAR level.

The estimate SAR value is calculated based the following equation:

(maximum power level including tune-up tolerance for transmitter A / maximum power level of exemption at the same frequency and distance) * (0.4W/kg* 2.5)
For limb worn devices.

Maximum ration BLE	Maximum ration WLAN	Maximum ratio HF-RFID	Maximum ratio UHF-RFID	Sum of exposure ratios	Limit of exposure ratios	Margin
mW/kg	mW/kg	mW/kg	mW/kg	mW/kg	mW/kg	mW/kg
29.27	587.61	1.45	305.19	923.52	4000	3076.48

The requirements are **FULFILLED.**

Remarks: BLE (Antenna B) can only be in simultaneous transmission for WLAN (Antenna A)
WIFI power level refers to the total power on both antenna ports (antenna A + antenna B).
Worst case for WIFI: total power to Antenna B at 2.4 GHz.