SAR Exclusion Calculation

Project: G4062

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Customer Details

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Equipment Under Test: R-Link Wearable Watch

Operating frequency bands: BLE: 2400MHz to 24835MHz

RFID: 13.56MHz

UWB: 6489.6MHz and 7987.2MHz

SAR Exclusion Calculation - FCC

The calculation is according to the FCC Knowledge Database (KDB) document KDB 447498 D01 General RF Exposure Guidance V06.

Section 4.3.1 General SAR Test Exclusion Bands was applied. Section 4.3.1 a) for 100MHz to 6GHz and test separation distances ≤50mm was specifically applied. According to this section the SAR test exclusion thresholds are determined by the following:

$$\text{Threshold} = \left[\frac{P(mW)}{d(mm)} \right] \cdot \sqrt{f(GHz)}$$

Where

P is the maximum power of the channel including tune-up tolerance in mW

d is the minimum test separation distance in mm

f is the RF channel frequency in GHz

The minimum test separation distance was considered to be 11.7mm for the Bluetooth, 12,7mm for the UWB and 13.1mm for the RFID in consultation with Section 4.2.2 *Body-worn accessory exposure conditions.*

This evaluation of the threshold is compared to the threshold limit.

   a. Limit for 1-g head or body worn devices: threshold limit ≤3

   b. Limit for 10-g extremity worn devices: threshold limit ≤7.5

Since the device is head worn the limit a applies.

Bluetooth Low Energy

For this apparatus, the calculated threshold was evaluated using a distance of 11.7mm, and the results are tabulated in the table below. The power level values are taken from the RF modules FCC grant, FCC ID: VPYLB2AB.

Frequency (GHz)	Power (mW)	Dist (mm)	Calculated Threshold	Threshold Limit
2.402	4.04	11.7	0.535	7.5
2.442	4.68	11.7	0.625	7.5
2.480	5.04	11.7	0.678	7.5

Table 1 Calculation of threshold BLE

Notes:

Power and distance were rounded to the nearest mW and mm before calculation

RFID (13.56MHz)

For equipment operating below 100MHz section 4.3.1 c) for <100MHz and test separation distances ≤50mm was specifically applied. According to this section the SAR test exclusion thresholds are determined by the following:

$$\text{Threshold} = 0.5. \left[\frac{P(mW).\sqrt{f(GHz)}}{d(mm)} + \frac{(d(mm) - 50).f(MHz)}{150} \right]$$
$$. \left[1 + \log\left(\frac{100}{f(MHz)}\right) \right]$$

Where

P is the maximum power of the channel including tune-up tolerance in mW

d is the minimum test separation distance in mm

f is the RF channel frequency in GHz

For this apparatus, the calculated threshold was evaluated using a distance of 13.1mm, and the results are tabulated in the table below. The power level values are taken from testing report C15087TR1.

Frequency (MHz)	Power (mW)	Dist (mm)	Calculated Threshold	Threshold Limit
13.56	1.9	13.1	0.066	7.5

Table 3 Calculation of threshold RFID

Notes:

Power and distance were rounded to the nearest mW and mm before calculation

UWB

Above 6GHz MPE limits for RF exposure are applied.

FCC rule part:47CFR2.1091(3)

Power density (S) relates to Equivalent Isotropic Radiated power (EIRP) according to the following:

$$S = \frac{EIRP}{4\pi R^2}$$

Where,
R is the distance to the centre of radiation of the antenna (cm)

For this apparatus, the calculated threshold was evaluated using a distance of 12.7mm, and the results are tabulated in the table below. The power level values are taken from the RF modules FCC grant, FCC ID: VPYLB2AB. The Power density (S) is calculated as:

Frequency (MHz)	Maximum EIRP (mW)	Power density (S) (mW/cm²)	Power density limit (S) (mW/cm²) 47CFR1.1310 Table 1
6489.6	0.23	0.011	1.0
7987.2	0.34	0.017	1.0

Table 4 Calculation of RF exposure for UWB

Determination of the SAR test exclusion for simultaneous transmission

Simultaneous transmission SAR test exclusion considerations are calculated according to 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

BLE

[(5.04 mW) / 11.7 mm)]·[√f(2.480 GHz)/18.75]=0.0360 W/Kg

RFID

[(1.9 mW) / 13.1 mm)]·[√f(0.01356 GHz)/18.75]=0.0009 W/Kg

UWB

[(0.34 mW) / 12.7 mm)]·[√f(7.9872 GHz)/18.75]=0.0040 W/Kg

BLE+RFID+UWB = 0.0409 W/Kg

0.0409 W/Kg is under the limit of 1 W/Kg for 10-g SAR.

Conclusion

For the required stated distances the apparatus met the exclusion requirements for SAR testing (FCC).

SAR Exclusion Calculation - ISED

Standard:
RSS-102 Radio Frequency (RF) ~Exposure Compliance of Radio communication Apparatus (All Frequency Bands)
Issue 5 March 2015

From RSS-102: 2.5.1 Exemption Limits for Routine Evaluation — SAR Evaluation

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	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 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

BLE

The power level values are taken from the RF modules FCC grant, FCC ID: VPYLB2AB.

Frequency (GHz)	Measured power (mW)	Dist (mm)	Exemption Limit (mW)*	SAR Test required
2.402	4.04	10mm	6	No
2.442	4.68	10mm	6	No
2.480	5.04	10mm	6	No

*7mW at 2450MHz, 6mW at 3500MHz

RFID

The power level values are taken from testing report C15087TR1.

Frequency (GHz)	Measured power (mW)	Dist (mm)	Exemption Limit (mW)*	SAR Test required
0.01356	1.9	10mm	101	No

*101mW at <300MHz

UWB

According to RSS Notice: Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz power density is the correct metric to assess RF exposure compliance above 6GHz. The limit is taken as 20 W/m^2.

Power density (S) relates to Equivalent Isotropic Radiated power (EIRP) in Watts according to the following:

$$S = \frac{EIRP}{4\pi R^2}$$

Where,
R is the distance to the centre of radiation of the antenna (m)

Frequency (MHz)	Maximum EIRP (mW)	Power density (S) (W/m^2)	Power density limit (S) (W/m^2)
6489.6	0.23	0.114	20
7987.2	0.34	0.168	20

Simultaneous transmission of BLE and RFID

The SAR exemption limits outlined in clause 2.5.1 of RSS-102 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 estimated 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.

The SAR limit for Localized Limbs is 4 W/kg.

Maximum ratio BLE (W/kg)	Maximum ratio RFID (W/kg)	Maximum ratio UWB (W/kg)	Sum of exposure ratios (W/kg)	Limit of exposure ratios (W/kg)	Requirement
0.840	0.019	0.340	1.199	4	Pass

Note: for this calculation the UWB power level limit was taken from the table to be 1mW for a separation distance <5mm and frequency 5800MHz.

Conclusion

For the required stated distances, the apparatus met the exclusion requirements for SAR testing (ISED).

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