

1 Test Sample Description:

Product Name: Headshot

Functional Description: The headshot is a low-power transmitter, attached to the back of a helmet. It gathers impact sensing data from its onboard accelerometer during sporting/rigorous activity and transmits that information via its BLE radio to user's mobile device for storage/display.

Power supply: Internal Battery

Bluetooth:

Frequency Range: 2402 – 2480 MHz

Mode of operation: BLE (DTS)

Antenna Description: PCB Max Gain: 1.5 dBi

Transmitter Category: Portable (A transmitting device designed to be used in other than fixed locations and to generally be used in such a way that the RF source's radiating structure(s) is/are within 20 centimeters of the body of the user.)

Reference Standards

§ 1.1310: Radiofrequency radiation exposure limits.

§ 2.1093: Radiofrequency radiation exposure evaluation: portable devices.

§ 1.1307(b)(3)(i)(b): For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section)

KDB 447498 D01 General RF Exposure Guidance v06

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2 § 1.1307 (3): Determination of exemption.

(i) For single RF sources (*i.e.*, any single fixed RF source, mobile device, or portable) device is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Table 1 to § 1.1307(b)(3)(i)(C)- Single RF Sources Subject to Routine Environmental Evaluation				
RF Source frequency (MHz)		Minimum Distance		Threshold ERP (watts)
FL	FH	$\lambda L/2\pi$	$\lambda H/2\pi$	
0.3	1.34	159 m	35.6m	$1,920 R^2$
1.34	30	35.6 m	1.6m	$3,450 R^2/f^2$
30	300	1.6 m	0.159 m	$3.83 R^2$
300	1,500	0.159 m	0.0318 m	$0.0128 R^2 f$
1,500	100,000	0.0318 m	0.0005 m	$19.2R^2$

R= minimum separation distance in meter

f= frequency in MHz

3 Max Average output conducted power test result:

TX (Mode)	Frequency (MHz)	Max Conducted RF Output power with correction factors (dBm)	Max. antenna gain (dBi)	Max. antenna gain (dBd)	ERP (dBm)	ERP (mW)	ERP Exemption limit	Simultaneous transmission mode
BLE	2402	-1.48	1.5	-0.65	-3.13	0.5	2.72 mW = 4.35 dBm	NO
	2440	-1.48	1.5	-0.65	-3.13	0.5		
	2480	-1.56	1.5	-0.65	-3.21	0.48		
Maximum output power limitation for BLE (After filter/antenna LC network attenuation)		4.8	1.5	-0.65	4.15	2.6002	2.72 mW = 4.35 dBm	NO

Note: Power limit for exemption calculated with linear interpolation using frequency 2480 MHz for worse case. The filter/antenna LC network attenuation between radio and transmit antenna is approximately 1.2dB. In real life application the transmitting duty cycle is 1%.

4 Separation distance:

The minimum test separation distance of 5mm is used from the antenna and radiating structures or outer surface of the headshot to any part of the body or extremity of a user or bystander to calculate the exemption limit. In the real life application, the headshot will be mounted on the helmet, which will provide the separation distance of more than 5mm from any part of the user body.

As per KDB 447498 D01 When the minimum test separation distance is < 5 mm, a distance of 5 mm according to KDB clause 4.1 (f) is applied to determine SAR test exclusion.

5 Calculation Results: 1.1307

Using equation i(B) to determine the exemption limit.

$$ERP_{20cm} \text{ (mW)} = 3060 \text{ (Frequencies} = 1.5\text{GHz} \leq f \leq 6 \text{ GHz)}$$

$$ERP_{20cm} \text{ (mW)} = 3060$$

$$ERP_{20cm} = 3060 \text{ (mW)}$$

$$x = -\log_{10} (60 / ERP_{20cm} \sqrt{f}) \text{ (f in GHz)}$$

$$x = -\log_{10} (60 / 3060 \sqrt{2.480})$$

$$x = 1.904796017$$

$$P_{th} \text{ (mW)} = ERP_{20cm} (d / 20 \text{ cm})^x$$

$$P_{th} \text{ (mW)} = 3060 (0.5\text{cm} / 20 \text{ cm})^{1.904796017}$$

$$P_{th} = 2.7172145778 \text{ (mW)}$$

$$P_{th} = 2.72 \text{ (mW)} = 4.35 \text{ dBm}$$

6 Calculation Results: KDB447498 4.3.1(a)

For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR,}$$

Where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz.

Max. BLE TX Power [Absolute Max (After filter/antenna LC network attenuation)] : 5.8 dBm + 1.5 dBi (antenna Gain)

$$\text{Max. BLE TX Power} : 6.3 \text{ dBm} = 4.27 \text{ mW}$$

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR}$$

$$[(4.27 / 5)] \times [\sqrt{(2.480)}] \leq 3.0 \text{ for 1-g SAR}$$

$$1.344880545 \leq 3.0 \text{ for 1-g SAR}$$

$$1.35 \leq 3.0 \text{ for 1-g SAR}$$

4 Conclusion:

EUT meet SAR exemption limit