

Analysis Report

The Equipment Under Test (EUT) is a 2.4GHz toy (Bluetooth 4.0 BLE), which is operating from 2402MHz to 2480MHz with 2MHz channel spacing and there is a single channel frequency sending out from 211kHz to 258kHz for the LED on the head unit. The EUT is powered by 2 x 3.7VDC lithium batteries. After switched on the EUT and paired with the smartphone, the EUT can be controlled to move forward, backward, left and right.

For Bluetooth 4.0 BLE operation.

Antenna Type: Internal antenna

Antenna Gain: 0dBi

Nominal rated field strength: 88.0dBμV/m at 3m

Maximum allowed field strength of production tolerance: +/- 3dB

According to the KDB 447498:

Based on the Maximum allowed field strength of production tolerance was 91.0dBμV/m at 3m in frequency 2.4GHz, thus;

The EIRP = $[(FS \cdot D)^2 \cdot 1000 / 30]$ = 0.378mW

Conducted power = Radiated Power (EIRP) – Antenna Gain

So;

Conducted Power = 0.378mW.

The SAR Exclusion Threshold Level:

= $3.0 \cdot (\text{min. test separation distance, mm}) / \sqrt{\text{freq. in GHz}}$

= $3.0 \cdot 5 / \sqrt{2.480}$ mW

= 9.52 mW

Since the above conducted output power is well below the SAR Exclusion threshold level, so the EUT is considered to comply with SAR requirement without testing.

For 211kHz to 258kHz operation.

Antenna Type: Internal antenna

Antenna Gain: 0dBi

Nominal rated field strength: 53.6 dB μ V/m at 3m

Maximum allowed field strength of production tolerance: +/- 3dB

According to the KDB 447498:

Based on the Maximum allowed field strength of production tolerance was 56.6dB μ V/m at 3m in frequency 211kHz, thus;

The EIRP = $[(FS \cdot D)^2 \cdot 1000 / 30] = 0.00014\text{mW}$

Conducted power = Radiated Power (EIRP) – Antenna Gain

So;

Conducted Power = 0.00014mW.

In the frequency range below 100MHz and test separation distance $\leq 50\text{mm}$, the SAR Exclusion Threshold will be determined as follow,

$$\begin{aligned} &\text{The SAR exclusion threshold} \\ &= \left\{ \left[(3.0 \times 50) / \sqrt{0.1} \right] + (50 - 50) * [100 / 150] \right\} * \{1 + \log[100 / F(MHz)]\} * \{1 / 2\} \text{ Mw} \\ &= 474.34 * \{1 + \log[100 / F(MHz)]\} * \{1 / 2\} \text{ mW} \\ &= 871.8 \text{ mW} \end{aligned}$$

where $TD = 5 \text{ mm}$ and $F(MHz) = 0.211\text{MHz}$

Since the above conducted output power is well below the SAR Exclusion threshold level, so the EUT is considered to comply with SAR requirement without testing.

Simultaneous Transmission SAR exclusion considerations

Since the 211kHz-258kHz and Bluetooth 4.0 transmitters of this device may operate simultaneously, simultaneous transmission analysis is required. Per KDB 447498, simultaneous transmission SAR test exclusion can be applied when the sum of 1-g SAR of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit ($\leq 1.6\text{W/kg}$). When the standalone SAR test exclusion is applied, the standalone 1-g SAR must be estimated according to the following equation,

$$\text{Estimated SAR} = (\sqrt{F(\text{GHz})} / 7.5) \times (P_{\text{max}} / TD)$$

where

$F(\text{GHz})$ is the RF channel transmit frequency in GHz

P_{max} is the max. power of channel, including tune-up tolerance, mW

TD is the min. test separation distance, mm

For 211kHz-258kHz Operation,

Maximum Time-averaged Conducted Power of this device = **0.00014 mW**

Therefore, the Estimated SAR will be determined as follow,

$$\begin{aligned}\text{Estimated SAR} &= (\sqrt{F(\text{GHz})} / 7.5) \times (P_{\text{max}} / TD) \\ &= \mathbf{0.000000054 \text{ W/kg}}\end{aligned}$$

where $P_{\text{max}} = 0.00014 \text{ mW}$, $TD = 5 \text{ mm}$ and $F(\text{GHz}) = 0.000211 \text{ GHz}$

For Bluetooth 4.0 BLE operation,

Maximum Time-averaged Conducted Power of this device = **0.378 mW**

Therefore, the Estimated SAR will be determined as follow,

$$\begin{aligned}\text{Estimated SAR} &= (\sqrt{F(\text{GHz})} / 7.5) \times (P_{\text{max}} / TD) \\ &= \mathbf{0.016 \text{ W/kg}}\end{aligned}$$

where $P_{\text{max}} = 0.378\text{mW}$, $TD = 5 \text{ mm}$ and $F(\text{GHz}) = 2.480 \text{ GHz}$

Simultaneous Transmission Analysis

216kHz SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Simultaneous SAR Required
0.000000054	0.016	0.016000054	No

Conclusion

Since the above summed SAR result for all simultaneous transmission conditions were below the SAR limit (1.6 W/kg), SAR evaluation for simultaneous transmission configuration are not required