

Analysis Report

(13.56MHz)

The EUT powered by 4*1.5V AA battery is a music gaming board which is designed to operate with mobile app. After connecting to the mobile device via BLE (2402MHz – 2480MHz with 2MHz of channel spacing), user can place RFID tags (cards) on the music board (RFID reader operating at 13.56MHz), and then the board will be able to recognize the card and flash the specific color, meanwhile the app will play corresponding music.

Antenna Type: Internal antenna

Antenna Gain: 0dBi

Nominal rated field strength: 57.7dB 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 60.7 dB μ V/m at 3m in frequency 13.56MHz, thus;

The EIRP = $[(FS \cdot D)^2 \cdot 1000 / 30] = 0.00035mW$

Conducted power = Radiated Power (EIRP) – Antenna Gain

So;

Conducted Power = 0.00035mW.

The SAR Exclusion Threshold Level for 13.56MHz when the minimum test separation distance is < 50mm:

= $[474 \cdot (1 + \log_{10}(f(\text{MHz}))) / 2]$

= 442.7mW

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.

(2.4GHz)

The EUT powered by 4*1.5V AA battery is a music gaming board which is designed to operate with mobile app. After connecting to the mobile device via BLE (2402MHz – 2480MHz with 2MHz of channel spacing), user can place RFID tags (cards) on the music board (RFID reader operating at 13.56MHz), and then the board will be able to recognize the card and flash the specific color, meanwhile the app will play corresponding music.

Antenna Type: Internal integral antenna

Antenna Gain: 0dBi

Nominal rated field strength: 97.3dB 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 100.3dB μ V/m at 3m in frequency 2.4GHz, thus;

The EIRP = $[(FS \cdot D)^2 \cdot 1000 / 30] = 3.215\text{mW}$

Conducted power = Radiated Power (EIRP) – Antenna Gain

So;

Conducted Power = 3.215mW.

The SAR Exclusion Threshold Level:

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

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

= 9.53 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.

Simultaneous Transmission SAR exclusion considerations

Since the RFID 13.56MHz 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 RFID operation,

Maximum Time-averaged Conducted Power of this device = **0.00035 mW**

Therefore, the Estimated SAR will be determined as follow,

$$\begin{aligned} \text{Estimated SAR} &= (\sqrt{F(\text{GHz})} / 7.5) \times (P_{\text{max}} / TD) \\ &= \mathbf{0.0000011 \text{ W/kg}} \end{aligned}$$

where $P_{\text{max}} = 0.00035 \text{ mW}$, $TD = 5 \text{ mm}$ and $F(\text{GHz}) = 0.01356 \text{ GHz}$

For Bluetooth 4.0 BLE operation,

Maximum Time-averaged Conducted Power of this device = **3.215 mW**

Therefore, the Estimated SAR will be determined as follow,

$$\begin{aligned} \text{Estimated SAR} &= (\sqrt{F(\text{GHz})} / 7.5) \times (P_{\text{max}} / TD) \\ &= \mathbf{0.135 \text{ W/kg}} \end{aligned}$$

where $P_{\text{max}} = 3.215 \text{ mW}$, $TD = 5 \text{ mm}$ and $F(\text{GHz}) = 2.480 \text{ GHz}$

Simultaneous Transmission Analysis

NFC SAR (W/kg)	Bluetooth SAR (W/kg)	Σ SAR (W/kg)	Simultaneous SAR Required
0.0000011	0.135	0.135	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.