

INTERTEK TESTING SERVICES

RF Exposure

The equipment under test (EUT) is a UHF transmitter operating in 917~922.2MHz band. It contains two modules that have already been certified. One certified module is operating at 2.4GHz band and subjected to FCC ID:XRSCRMXTIMO101, another certified Bluetooth module is subjected to FCC ID:A8TBM77SPPSYC2A. The EUT is powered by a 3.6VDC rechargeable battery which can be charged via a micro USB cable by an AC/DC adapter with the input of AC100-240V, 50/60Hz, and output of DC 5.0V, 1.5A. The EUT also has a 3.5" socket which can be used to connect to DMX controllers via an adapter cable that is 3.5" jack to 5-pin XLR male. When DMX port connected, the UHF transmitter will stop transmitting. In this condition, only 2.4GHz RF module and Bluetooth can be transmitted simultaneously. It can be classified as mobile device according to the manufacturer's specified and evaluated for MPE at a distance of 20cm. When DMX port is disconnected, the 2.4GHz RF module will stop transmitting. In this condition, only UHF transmitter and Bluetooth can be transmitted simultaneously. It can be classified as portable device because it can be powered by a rechargeable battery and subjected to body-worn exposure conditions. For more detail information please refer to the manual.

Antenna Type: Integral antenna.

Antenna Gain: 3dBi.

The normal radiated output power (e.i.r.p) is: 15.0dBm (tolerance: +/- 3dB).

The normal conducted output power is 12.0dBm (tolerance: +/- 3dB).

Modulation Type: GFSK

Exposure Condition: Body-worn (Portable Device)

Standalone SAR test exclusion considerations for UHF transmitter:

According to the KDB 447498:

The maximum conducted output power for the EUT is 12.95 dBm in the frequency 922.20MHz GFSK mode which is within the production variation.

The minimum conducted output power for the EUT is 12.90 dBm in the frequency 917.00MHz GFSK mode which is within the production variation.

The maximum conducted output power specified is 15dBm= 31.623mW

The source- based time-averaging conducted output power

=31.623* 0.2029(Duty cycle) mW =6.42mW (Duty cycle =20.29%)

The duty cycle is simply the on-time divided by the period:

The duration of one cycle = 100ms

Effective period of the cycle = 20290 μ s = 20.29ms

DC = 20.29ms / 100ms = 0.2029 or 20.29%

The SAR Exclusion Threshold Level:

= 3.0 * (min. test separation distance, mm) / sqrt(freq. in GHz)

= 3.0 * 5 / sqrt (0.9222) mW

= 15.62mW

Since the source-based time-averaging conducted output power is well below the SAR low threshold level, so the EUT is considered to comply with SAR requirement without testing.

Simultaneous transmission SAR test exclusion considerations

In body-worn exposure conditions, the 2.4GHz RF module will stop transmitting, only UHF transmitter and Bluetooth can be transmitted simultaneously. When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

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

The maximum conducted output power specified of UHF transmitter
= 6.42mW

The estimated 1-g SAR value of the UHF transmitter function
= $[6.42\text{mW}/5\text{mm}] \cdot [0.9222^{0.5}/7.5] \text{ W/kg}$
= 0.1644W/kg

Based on FCC ID: A8TBM77SPPSYC2A test report, the max. peak output power is 4.99dBm for Bluetooth transmitter. The standalone SAR value can be estimated as below:

The maximum conducted output power specified of Bluetooth transmitter
= 4.99dBm = 3.16mW

The estimated 1-g SAR value of the Bluetooth transmitter function
= $[3.16\text{mW}/5\text{mm}] \cdot [2.48^{0.5}/7.5] \text{ W/kg}$
= 0.1327W/kg

If the sum of ratios for all simultaneously transmitting antennas incorporated in a host device is less than 1, this device fulfils the simultaneous RF exposure of FCC requirement.

$$\begin{aligned} & (\text{SAR value of UHF transmitter/SAR limit}) + (\text{SAR value of Bluetooth/SAR limit}) \\ &= (0.1644/1.6) + (0.1327/1.6) = 0.186 < 1 \end{aligned}$$

Exposure Condition: Mobile Device

When DMX port connected to controller, the UHF transmitter will stop transmitting, only 2.4GHz RF module and Bluetooth can be transmitted simultaneously. It can be classified as mobile device according to the manufacturer's specified and evaluated for MPE at a distance of 20cm.

Based on FCC ID: A8TBM77SPPSYC2A test report, the max. peak output power is 4.99dBm for Bluetooth transmitter. The Bluetooth antenna gain is 1.6dBi.

According to FCC Part 2.1091, this unlicensed transmitting devices is categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization or use, According to the KDB 447498 and OET 65, the simple calculation as below:

$$\begin{aligned} \text{The source-based time averaged maximum radiated power} &= 4.99\text{dBm} + 1.6\text{dBi} = \\ &6.59\text{dBm} = 4.56\text{mW} \end{aligned}$$

From above data, the exposed power density at a distance (R) of 20cm from the center of radiation of the antenna for Bluetooth transmitter can be calculated according to OET 65 as follow:

$$\begin{aligned} &= 4.56\text{mW} / 4\pi R^2 \\ &= 0.001 \text{ mW/cm}^2 \\ &< 1\text{mW/cm}^2 \end{aligned}$$

Based on FCC ID: XRSCRMXTIMO101 test report, the exposed power density at a distance (R) of 20cm from the center of radiation of the antenna for 2.4GHz RF transmitter is 0.0736123 mW/cm², which is less than MPE limit(1.0 mW/cm²).

Simultaneous transmission SAR test exclusion considerations

If the sum of ratios for all simultaneously transmitting antennas incorporated in a host device is less than 1, this device fulfils the simultaneous RF exposure of FCC requirement.

$$\begin{aligned} \text{The sum of the ratios of the spatially averaged results to the applicable} \\ \text{frequency dependent MPE limits} &= 0.001/1 + 0.0736123/1 = 0.0746123 < 1 \end{aligned}$$