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1. Radio Frequency Exposure

RESULT:

Pass

Test standard : FCC Part 2: Section 2.1091
RSS-102 Issue 5
KDB 447498 D01 General RF Exposure Guidance v06

1.1 Product Technical Information

The EUT is a Robomaster TT Minor Controller, which supports Bluetooth LE, 2.4G Wi-Fi 802.11 b/g/n and 5.8G Wi-Fi 802.11a/n wireless technology.

Technical Specification	Value
Product Name	Robomaster TT Minor Controller
Model	RMTTOC
FCC ID	SS3-RMTTOC2010
IC	11805A-RMTTOC2010
HVIN	RMTTOC
Operating Frequency Range	2400-2483.5MHz 5725-5850MHz
Operating Frequency / Channels / Protocol	Bluetooth BLE: 2402-2480MHz, 40CHs 2.4GHz Wi-Fi: 2412-2462MHz, 11CHs, 802.11b/g/n20 5.8GHz Wi-Fi: 5745-5825MHz, 7CHs, 802.11 a/n20/n40
Channel Spacing	2MHz, 5MHz, 20MHz, 40MHz
Modulation	DSSS (DBPSK, DQPSK, CCK) OFDM (BPSK, QPSK, 16QAM, 64QAM) GFSK
Type of Product	Adaptive equipment and does not support non-adaptive mode; LBT based Detect and Avoid (load based equipment)
Antenna Number	Bluetooth: 1 2.4GHz Wi-Fi and 5.8GHz Wi-Fi: 1
Antenna Type	Integral antenna
Antenna Gain	Bluetooth LE: 0.95 dBi max. 2.4GHz Wi-Fi: 0.95 dBi max. 5.8GHz Wi-Fi: 1.51 dBi max.
Operation Voltage	DC 5V from USB

1.2 Product Classification

This device defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at 20 cm is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.

1.3 Radio Frequency Exposure Limit

For FCC:

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)
300-1,500	--	--	f/1500
1,500-100,000	--	--	1.0

For IC:

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ f ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ f ^{0.25}	0.1540/ f ^{0.25}	8.944/ f ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 f ^{0.3417}	0.008335 f ^{0.3417}	0.02619 f ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ f ^{1.2}
150000-300000	0.158 f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/ f ^{1.2}

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

1.4 Radio Frequency Exposure Calculation Formula

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

where: S = power density (in appropriate units, e.g. mW/cm²)
P = power input to the antenna (in appropriate units, e.g., mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

or:

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

where: EIRP = equivalent (or effective) isotropically radiated power

1.5 Calculation Result

1.5.1 Stand-alone transmission MPE

Mode	*Measured RF Output Power (mW)	Antenna Gain (dBi)	Distance (cm)	Power Density (mW/cm ²)	Power Density (W/m ²)	FCC Limit (mW/cm ²)	IC Limit (W/m ²)
Bluetooth	9.5	0.95	20	0.0024	0.0235	1.0	5.35
2.4G Wi-Fi	213.8	0.95	20	0.0530	0.5294	1.0	5.37
5.8G Wi-Fi	29.4	1.51	20	0.0083	0.0828	1.0	9.71

Note:

- *Bluetooth RF Output Power: Refer to 60430331 001
- *2.4GHz Band RF Output Power: Refer 60430331 001
- *5.8GHz Bands RF Output Power: Refer 60430331 002 Appendix B

1.5.2 Simultaneous transmission MPE

1.5.2.1 Per KDB 447498 D01 v06, simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density, is ≤ 1.0 .

Simultaneous transmission Scenarios

No.	Simultaneous transmission Scenarios
1	Bluetooth + 2.4GHz Wi-Fi
2	Bluetooth + 5.8GHz Wi-Fi

1) For Bluetooth + 2.4GHz Wi-Fi:

The MPE ratio for Bluetooth can be calculated as follow:

$$= \frac{\text{The power density at 20cm distance}}{\text{MPE limit}}$$

$$= \frac{0.0024 \text{ mW/cm}^2}{1 \text{ mW/cm}^2}$$

$$= 0.0024$$

The MPE ratio for 2.4GHz WiFi can be calculated as follow:

$$= \frac{\text{The power density at 20cm distance}}{\text{MPE limit}}$$

$$= \frac{0.0530 \text{ mW/cm}^2}{1 \text{ mW/cm}^2}$$

$$= 0.0530$$

The sum of the MPE ratios for all simultaneous transmitting antennas:

$$= 0.0024 + 0.0530$$

$$= 0.0554 < 1.0$$

As the sum of MPE ratios for all simultaneous transmitting antennas is ≤ 1.0 , simultaneous transmission MPE test exclusion will be applied.

2) For Bluetooth + 5.8GHz Wi-Fi:

The MPE ratio for Bluetooth can be calculated as follow:

$$= \frac{\text{The power density at 20cm distance}}{\text{MPE limit}}$$

$$= \frac{0.0024 \text{ mW/cm}^2}{1 \text{ mW/cm}^2}$$

$$= 0.0024$$

The MPE ratio for 5.8GHz WiFi can be calculated as follow:
=The power density at 20cm distance/MPE limit
=0.0083 mW/cm²/1 mW/cm²
=0.0083

The sum of the MPE ratios for all simultaneous transmitting antennas:
=0.0024+0.0089
= 0.0107<1.0

As the sum of MPE ratios for all simultaneous transmitting antennas is ≤ 1.0, simultaneous transmission MPE test exclusion will be applied.

1.5.2.2 RSS-102 Issue 5, simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density, is ≤ 1.0.

Simultaneous transmission Scenarios

No.	Simultaneous transmission Scenarios
1	Bluetooth + 2.4GHz Wi-Fi
2	Bluetooth + 5.8GHz Wi-Fi

1) For Bluetooth + 2.4GHz Wi-Fi:

The MPE ratio for Bluetooth can be calculated as follow:
=The power density at 20cm distance/MPE limit
=0.0235 W/m²/5.35 W/m²
=0.0044

The MPE ratio for 2.4GHz WiFi can be calculated as follow:
=The power density at 20cm distance/MPE limit
=0.5294 mW/m²/5.37 W/m²
=0.0986

The sum of the MPE ratios for all simultaneous transmitting antennas:
=0.0044+0.0986
= 0.1030<1.0

As the sum of MPE ratios for all simultaneous transmitting antennas is ≤ 1.0, simultaneous transmission MPE test exclusion will be applied.

2) For Bluetooth + 5.8GHz Wi-Fi:

The MPE ratio for Bluetooth can be calculated as follow:
=The power density at 20cm distance/MPE limit
=0.0235 W/m²/5.35 W/m²
=0.0044

The MPE ratio for 5.8GHz WiFi can be calculated as follow:
=The power density at 20cm distance/MPE limit
=0.0828 W/m²/9.71 W/m²
=0.0085

The sum of the MPE ratios for all simultaneous transmitting antennas:
=0.0044+0.0085
= 0.0129<1.0

As the sum of MPE ratios for all simultaneous transmitting antennas is ≤ 1.0, simultaneous transmission MPE test exclusion will be applied.

1.5.3 Conclusion

Therefore the maximum calculations result of above are meet the requirement of Radio Frequency Exposure (MPE) limit.