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Project No: CB10508381

Maximum Permissible Exposure Report

Applicant's company	Tembo Systems, Inc.
Applicant Address	2933 Bunker Hill lane, Suite 100, Santa Clara, CA 95054 U.S.A
FCC ID	2AGMRTRM9995G
Manufacturer's company	Tembo Systems, Inc.
Manufacturer Address	2933 Bunker Hill lane, Suite 100, Santa Clara, CA 95054 U.S.A

Product Name	802.11ac WiFi Radio Module
Model Name	TRM9995G
Ref. Standard(s)	47 CFR FCC Part 2 Subpart J, section 2.1091
Received Date	May 27, 2016
Final Test Date	Aug. 19, 2016
Submission Type	Class II Change

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SPORTON INTERNATIONAL INC.





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1. GENERAL DESCRIPTION

1.1. EUT General Information

RF General Information			
Evaluation Mode	Frequency Range (MHz)	Operating Frequency (MHz)	Modulation Type
5GHz WLAN	5150-5250 5250-5350 5470-5725 5725-5850	5180-5240 5260-5320 5500-5700 5745-5825	802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)

Note: <OMNI Antenna>

The EUT is a limited module which only limited to the host (model: AP1004WRe series).

The EUT was installed to the host (model: AP1004WRe series) to perform all the tests.

<Directional Antenna>

The EUT is a limited module which only limited to the host (model: AP1004NRe series).

The EUT was installed to the host (model: AP1004NRe series) to perform all the tests.

1.2. Table for Class II Change

This product is an extension of original one reported under Sporton project number: FA650411

Below is the table for the change of the product with respect to the original one.

Modifications
Add 5GHz Band 2 and Band 3 (5250 to 5350 MHz, 5470 to 5725 MHz) are only available in 20 MHz and 40 MHz for this device, and it evaluated for Maximum Permissible Exposure.

1.3. Testing Location

Testing Location		
<input type="checkbox"/>	HWA YA	ADD : No. 52, Hwa Ya 1st Rd., Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL : 886-3-327-3456 FAX : 886-3-327-0973
<input checked="" type="checkbox"/>	JHUBEI	ADD : No.8, Lane 724, Bo-ai St., Jhubei City, HsinChu County 302, Taiwan, R.O.C. TEL : 886-3-656-9065 FAX : 886-3-656-9085

2. MAXIMUM PERMISSIBLE EXPOSURE

2.1. Limit of Maximum Permissible Exposure

(A) Limits for Occupational / Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842 / f	4.89 / f	(900 / f)*	6
30-300	61.4	0.163	1.0	6
300-1500			F/300	6
1500-100,000			5	6

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

2.2. MPE Calculation Method

The MPE was calculated at 20 cm for this 5GHz device and 33 cm for system device to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d} \quad \text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

E = Electric field (V/m)

P = Peak RF output power (W)

G = EUT Antenna numeric gain (numeric)

d = Separation distance between radiator and human body (m)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$

2.3. Calculated Result and Limit

Exposure Environment: General Population / Uncontrolled Exposure

<Module> FCC ID: 2AGMRTRM9995G

For Band 1 and Band 4

Antenna Type: OMNI antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT20): 24.98dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
20	5230	-0.84	0.8241	24.98	315.1254	0.0517	1	Complies

Antenna Type: Directional antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT40): 22.99dBm

Distance (cm)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
20	5795	13.00	19.9526	22.99	199.2448	0.7913	1	Complies

For Band 2 and Band 3

Antenna Type : OMNI antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT40): 22.42dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
20	5550	7.47	5.5847	22.42	174.3854	0.1938	1	Complies

Antenna Type: Directional antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT40): 22.99dBm

Distance (cm)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
20	5580	14.00	25.1189	15.97	39.5280	0.1976	1	Complies

Conclusion:

Both of the WLAN 2.4GHz Band and WLAN 5GHz Band can transmit simultaneously on the host system, the formula of calculated the MPE is:

$$\text{CPD1} / \text{LPD1} + \text{CPD2} / \text{LPD2} + \dots \text{etc.} < 1$$

CPD = Calculation power density

LPD = Limit of power density

<Host system>

Antenna Type : OMNI antenna

For 2.4GHz Band: FCC ID: 2AGMRTRM9992G

Conducted Power for IEEE 802.11ac VHT20: 24.67 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	2437	8.54	7.1450	24.67	293.2438	0.1531	1	Complies

For 5GHz Band: FCC ID: 2AGMRTRM9995G

5GHz Band 1 + Band 2

Conducted Power for IEEE 802.11ac VHT40: 24.98 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	5230	-0.84	0.8241	24.98	315.1254	0.0190	1	Complies

5GHz Band 3

Conducted Power for IEEE 802.11ac VHT40: 22.42 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	5550	7.47	5.5847	22.42	174.3854	0.0712	1	Complies

5GHz Band 4

Conducted Power for IEEE 802.11ac VHT40: 25.26 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	5755	-1.87	0.6501	25.26	335.9313	0.0160	1	Complies

The host system will install four radios, 2.4GHz radio*1, 5GHz band 1/2 radio*1, 5GHz band 3 radio*1, 5GHz band 4 radio*1.

Therefore, the worst-case situation is $0.1531/1 + 0.0190/1 + 0.0712/1 + 0.0160/1 = 0.2593$, which is less than "1". This confirmed that the device complies.

Conclusion:

Both of the WLAN 2.4GHz Band and WLAN 5GHz Band can transmit simultaneously on the host system, the formula of calculated the MPE is:

$$\text{CPD1} / \text{LPD1} + \text{CPD2} / \text{LPD2} + \dots \text{etc.} < 1$$

CPD = Calculation power density

LPD = Limit of power density

<Host system>

Antenna Type : Directional Antenna

For 2.4GHz Band: FCC ID: 2AGMRTRM9992G

Conducted Power for IEEE 802.11g: 22.89 dBm

Distance (cm)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	2437	13.00	19.9526	22.89	194.3288	0.2834	1	Complies

For 5GHz Band: FCC ID: 2AGMRTRM9995G

5GHz Band 1 + Band 2

Conducted Power for IEEE 802.11ac VHT40: 22.98 dBm

Distance (cm)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	5230	13.00	19.9526	22.98	198.4107	0.2894	1	Complies

5GHz Band 3

Conducted Power for IEEE 802.11ac VHT20: 14.97 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	5500	15.00	31.6228	14.97	31.3935	0.0725	1	Complies

5GHz Band 4

Conducted Power for IEEE 802.11ac VHT40: 22.99 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
				(dBm)	(mW)			
33	5795	13.00	19.9526	22.99	199.2448	0.2906	1	Complies

The host system will install four radios, 2.4GHz radio*1, 5GHz band 1/2 radio*1, 5GHz band 3 radio*1, 5GHz band 4 radio*1.

Therefore, the worst-case situation is $0.2834/1 + 0.2894/1 + 0.0725/1 + 0.2906/1 = 0.9359$, which is less than "1". This confirmed that the device complies.