



# SPORTON International Inc.

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Project No: CB10412158

## Maximum Permissible Exposure Report

Applicant's company	Zebra Technologies, Corp.
Applicant Address	1 Zebra Plaza Holtsville, NY 11742 USA
FCC ID	UZ7AP8533I
Manufacturer's company	Wistron NeWeb Corporation
Manufacturer Address	20 Park Avenue II, Hsinchu Science Park, Hsinchu 308 Taiwan

Product Name	802.11AC MU-MIMO, TRI Radio, INT ANT
Brand Name	ZEBRA
Model Name	AP-8533I
Ref. Standard(s)	47 CFR FCC Part 2 Subpart J, section 2.1091
Received Date	Oct. 29, 2015
Final Test Date	Dec. 31, 2015
Submission Type	Original Equipment

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SPORTON INTERNATIONAL INC.



Testing Laboratory  
1190

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## History of This Test Report

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA592302-05	Rev. 01	Initial issue of report	Feb. 02, 2016

## 1. GENERAL DESCRIPTION

### 1.1. EUT General Information

RF General Information			
Evaluation Mode	Frequency Range (MHz)	Operating Frequency (MHz)	Modulation Type
2.4GHz WLAN	2400-2483.5	2412-2462	802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g/n: OFDM (BPSK, QPSK, 16QAM, 64QAM)
5GHz WLAN	5150-5250 5250-5350 5470-5725 5725-5850	5180-5240 5260-5320 5500-5720 5745-5825	802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)
Bluetooth	2400-2483.5	2402-2480	BR / EDR: FHSS (GFSK / $\pi/4$ -DQPSK / 8DPSK) LE: DSSS (GFSK)

### 1.2. Table for Multiple List

There are two SKUs for AP-8533I, please refer to the table below:

Model Name	EUT	SKU	CPU	Antenna Type	WLAN			BT
					Radio 1	Radio 2	Radio 3	Radio 4
AP-8533I	EUT 1	Cedar3I	BCM58525	Internal	Internal	Internal	Internal	Internal
	EUT 2	Cedar3PI	BCM58535	Internal	Internal	Internal	Internal	Internal

From the above models, EUT 1 was selected as representative model for the test and its data was recorded in this report.

### 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 <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> 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 <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> 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 40 cm 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

For Radio 4 Bluetooth Function:

For BT2.1 + EDR:

Antenna Type : Monopole Antenna

Conducted Power for BR (GFSK) 1 Mbps: 7.87 dBm

Distance (cm)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
40	2441	7.70	5.8884	7.8682	6.1209	0.001794	1	Complies

For BT4.0:

Antenna Type : Monopole Antenna

Conducted Power: 6.39 dBm

Distance (cm)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
40	2480	7.70	5.8884	6.3900	4.3551	0.001276	1	Complies

### Conclusion:

Both of the Radio 1 (2.4GHz TX/RX+5GHz RX WLAN function FCC ID: UZ7CDR2G) + Radio 2 (5GHz WLAN function FCC ID: UZ7CDR5G) + Radio 3 (2.4/5GHz WLAN function FCC ID: UZ7CDRDB) + Radio 4 (BT function FCC ID: UZ7AP8533I) can transmit simultaneously, the formula of calculated the MPE is:

For Radio 1 (2.4GHz WLAN function FCC ID: UZ7CDR2G):

Antenna Type : Monopole antenna

Conducted Power for IEEE 802.11n MCS0 (HT20): 25.71 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
40	2437	10.20	10.4815	25.7107	372.4510	0.194260	1	Complies

Note:

$$Directional\ Gain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

For Radio 2 (5GHz WLAN function FCC ID: UZ7CDR5G)

Antenna Type : Monopole antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 4TX (VHT20): 23.40dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
40	5785	12.53	17.8966	23.4013	218.8429	0.194891	1	Complies

Note:

$$Directional\ Gain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

For Radio 3 (2.4/5GHz WLAN function FCC ID: UZ7CDRDB)

For 5GHz Band:

Antenna Type : Monopole Antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 3TX (VHT20): 22.66dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
40	5785	10.51	11.2402	22.6632	184.6371	0.103272	1	Complies

Note:

$$Directional\ Gain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right] = 10.51\text{dBi.}$$

For 2.4GHz Band:

Antenna Type : Monopole Antenna

Conducted Power for IEEE 802.11n MCS0 3TX (HT20): 26.28 dBm

Distance (cm)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
40	2437	9.07	8.0767	26.2836	424.9752	0.170801	1	Complies

Note:

$$Directional\ Gain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right] = 9.07\text{dBi.}$$

For Radio 4 (Bluetooth Function FCC ID: UZ7AP8533I)

For BT2.1 + EDR:

Antenna Type : Monopole Antenna

Conducted Power for BR (GFSK) 1 Mbps: 7.87 dBm

Distance (cm)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
40	2441	7.70	5.8884	7.8682	6.1209	0.001794	1	Complies

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

CPD = Calculation power density

LPD = Limit of power density

Mode 1:

Radio 1 (2.4GHz TX/RX+5GHz RX WLAN function FCC ID: UZ7CDR2G) + Radio 2 (5GHz WLAN function FCC ID: UZ7CDR5G) + Radio 3 (2.4GHz WLAN function FCC ID: UZ7CDRDB) + Radio 4 (BT function FCC ID: UZ7AP8533I)

Therefore, the worst-case situation is  $0.194260 / 1 + 0.194891 / 1 + 0.170801 / 1 + 0.001794 / 1 = 0.561746$ , which is less than "1". This confirmed that the device complies.

Mode 2:

Radio 1 (2.4GHz TX/RX+5GHz RX WLAN function FCC ID: UZ7CDR2G) + Radio 2 (5GHz WLAN function FCC ID: UZ7CDR5G) + Radio 3 (5GHz WLAN function FCC ID: UZ7CDRDB) + Radio 4 (BT function FCC ID: UZ7AP8533I)

Therefore, the worst-case situation is  $0.194260 / 1 + 0.194891 / 1 + 0.103272 / 1 + 0.001794 / 1 = 0.494217$ , which is less than "1". This confirmed that the device complies.