



# SPORTON International Inc.

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Project No: CB10506079

## Maximum Permissible Exposure Report

|                        |  |
|------------------------|--|
| Applicant's company    | TP-LINK TECHNOLOGIES CO., LTD.   |
| Applicant Address      | Building 24 (floors 1,3,4,5) and 28 (floors1-4) Central Science and Technology Park, Nanshan, Shenzhen, 518057 China |
| FCC ID                 | TE7C5400   |
| Manufacturer's company | TP-LINK TECHNOLOGIES CO., LTD.   |
| Manufacturer Address   | Building 24 (floors 1,3,4,5) and 28 (floors1-4) Central Science and Technology Park, Nanshan, Shenzhen, 518057 China |

|                  |  |
|------------------|--|
| Product Name     | AC5400 Wirelesss Tri-Band MU-MIMO Gigabit Router |
| Brand Name       | TP-LINK  |
| Model Name       | Archer C5400                                     |
| Ref. Standard(s) | 47 CFR FCC Part 2 Subpart J, section 2.1091      |
| Received Date    | Oct. 28, 2015                                    |
| Final Test Date  | May 20, 2016                                     |
| Submission Type  | Class II Change                                  |

  
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SPORTON INTERNATIONAL INC.





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## History of This Test Report

| REPORT NO.  | VERSION | DESCRIPTION             | ISSUED DATE   |
|-------------|---------|-------------------------|---------------|
| FA5N0101-01 | Rev. 01 | Initial issue of report | Jul. 13, 2016 |
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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   |
| 2.4GHz WLAN            | 2400-2483.5            | 2412-2462                 | 802.11b: DSSS (DBPSK, DQPSK, CCK)<br>802.11g/n: OFDM (BPSK, QPSK, 16QAM, 64QAM)<br>802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM) |
| 5GHz WLAN              | 5150-5250<br>5725-5850 | 5180-5240<br>5745-5825    | 802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM)<br>802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM)                                      |

### 1.2. Table for Class II Change

This product is an extension of original one reported under Sporton project number: FA5N0101

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

| Modifications  | Performance Checking            |
|--|---------------------------------|
| 1. Adding an adapter (Model name: HKA0012050-7G).  | Do not effect the test results. |
| 2. Removing Repeater function.   |                                 |
| 3. Adding beam-forming function for 802.11n/ac.  | Maximum Permissible Exposure.   |
| 4. Updating test rule of 5GHz Band 4 to "15.407 (b)(4)(i) of New Rules (ET Docket No. 13-49; FCC 16-24)" from "Old Rules". | Maximum Permissible Exposure.   |

Note: Maximum Permissible Exposure of 2.4GHz and 5GHz Band1 Non-beamforming is based on original 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.<br>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.<br>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 31 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 5GHz Band 1

For Non-Beamforming Mode:

Antenna Type : PCB Antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT40): 29.94dBm

| Distance (cm) | Test Freq. (MHz) | Antenna 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)     |   |  |             |
| 31            | 5230             | 1.80               | 1.5136                 | 29.9446                                   | 987.3149 | 0.1238                                  | 1  | Complies    |

For Beamforming Mode:

Antenna Type : PCB Antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT40): 28.10dBm

| 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)     |   |  |             |
| 31            | 5230             | 7.82                   | 6.0542                 | 28.10                                     | 646.2108 | 0.3241                                  | 1  | Complies    |

Note:  $DirectionalGain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right] = 7.82 \text{ dBi}$

For 5GHz Band 4

For Non-Beamforming Mode:

Antenna Type : PCB Antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT40): 29.92dBm

| Distance (cm) | Test Freq. (MHz) | Antenna 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)     |   |  |             |
| 31            | 5795             | 1.80               | 1.5136                 | 29.92                                     | 981.5266 | 0.1231                                  | 1  | Complies    |

For Beamforming Mode:

Antenna Type : PCB Antenna

Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT40): 28.12dBm

| 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)     |   |  |             |
| 31            | 5795             | 7.82                   | 6.0542                 | 28.12                                     | 648.9395 | 0.3255                                  | 1  | Complies    |

Note:  $DirectionalGain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right] = 7.82 \text{ dBi}$

**For 2.4GHz Band**

**For Non-Beamforming Mode:**

**Antenna Type : PCB Antenna**

**Conducted Power for IEEE 802.11b: 29.97dBm**

| Distance (cm) | Test Freq. (MHz) | Antenna 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)     |   |  |             |
| 31            | 2437             | 1.80               | 1.5136                 | 29.9725                                   | 993.6857 | 0.1246                                  | 1  | Complies    |

**For Beamforming Mode:**

**Antenna Type : PCB Antenna**

**Conducted Power for IEEE 802.11ac MCS0/Nss1 (VHT20): 28.14dBm**

| 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)     |   |  |             |
| 31            | 2437             | 7.82                   | 6.0542                 | 28.14                                     | 652.2950 | 0.3271                                  | 1  | Complies    |

Note:  $DirectionalGain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right] = 7.82 \text{ dBi}$

**Conclusion:**

Both of the WLAN 2.4GHz WLAN function, 5GHz band 1 WLAN function and 5GHz band 4 WLAN function can transmit simultaneously, the formula of calculated the MPE is:

**CPD1 / LPD1 + CPD2 / LPD2 + .....etc. < 1**

**CPD = Calculation power density**

**LPD = Limit of power density**

Therefore, the worst-case situation is 0.3271/1 + 0.3241/1 + 0.3255/1 = 0.9767, which is less than "1". This confirmed that the device complies.