

FCC TEST REPORT

FCC ID: OXGZW97

Product : Outdoor Smart Plug
Model Name : ZW97, ZW96, ZW98, ZW99
Brand : **showhome**TM
Report No. : PTCHX07170802301E-FC01

Prepared for

Willis Electric Co., Ltd.

No.504-1, Chung-Hua Road, Sec.4 Hsin Chu, Taiwan

Prepared by

Dongguan Precise Testing & Certification Corp., Ltd.

Building D, Baoding Technology Park, Guangming Road 2, Guangming Community, Dongcheng District, Dongguan, Guangdong, China



1 TEST RESULT CERTIFICATION

Applicant's name : Willis Electric Co., Ltd.
 Address : No.504-1, Chung-Hua Road, Sec.4, Hsin Chu, Taiwan
 Manufacture's name : Kupoint (DongGuan) Electric Co., Ltd
 Address : Huai De Industrial Humen Town Dong Guan City Guang Dong Province
 Product name : Outdoor Smart Plug
 Model name : ZW97, ZW96, ZW98, ZW99
 Standards : FCC CFR47 Part 15 Section 15.231
 Test procedure : ANSI C63.10:2013
 Test Date : July 03, 2017 to July 10, 2017
 Date of Issue : July 12, 2017
 Test Result : Pass

This device described above has been tested by PTC, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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Testing Engineer

August Qiu

Technical Manager

Hack Ye

Authorized Signatory

Chris Du



Contents

| | Page |
|---|-------------|
| 1 TEST RESULT CERTIFICATION..... | 2 |
| 2 TEST SUMMARY..... | 5 |
| 3 GENERAL INFORMATION..... | 6 |
| 3.1 GENERAL DESCRIPTION OF E.U.T..... | 6 |
| 3.2 TEST MODE..... | 7 |
| 3.3 TEST SITE..... | 8 |
| 4 EQUIPMENT DURING TEST..... | 9 |
| 4.1 EQUIPMENTS LIST..... | 9 |
| 4.2 MEASUREMENT UNCERTAINTY..... | 10 |
| 5 CONDUCTED EMISSION..... | 11 |
| 5.1 E.U.T. OPERATION..... | 11 |
| 5.2 EUT SETUP..... | 11 |
| 5.3 TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)..... | 12 |
| 5.4 MEASUREMENT PROCEDURE:..... | 12 |
| 5.5 CONDUCTED EMISSION LIMIT..... | 12 |
| 5.6 MEASUREMENT DESCRIPTION..... | 12 |
| 5.7 CONDUCTED EMISSION TEST RESULT..... | 12 |
| 6 RADIATED SPURIOUS EMISSIONS..... | 15 |
| 6.1 EUT OPERATION..... | 16 |
| 6.2 TEST SETUP..... | 17 |
| 6.3 SPECTRUM ANALYZER SETUP..... | 18 |
| 6.4 TEST PROCEDURE..... | 19 |
| 6.5 SUMMARY OF TEST RESULTS..... | 19 |
| 7 20DB BANDWIDTH MEASUREMENT..... | 22 |
| 7.1 TEST PROCEDURE..... | 22 |
| 7.2 TEST RESULT..... | 22 |
| 8 TRANSMITTER TIMEOUT..... | 23 |
| 8.1 REQUIREMENTS..... | 23 |



PRECISE TESTING

Report No.: PTCHX07170802301E-FC01

| | | |
|----|--------------------------|----|
| 9 | ANTENNA REQUIREMENT..... | 25 |
| 10 | TEST SETUP..... | 26 |
| 11 | EUT PHOTOS..... | 28 |



2 Test Summary

| Test Items | Test Requirement | Result |
|--------------------------------|----------------------------------|--------|
| Conducted Emissions | 15.207 | PASS |
| Radiated Emission | 15.231(a) 15.209 15.205(a) | PASS |
| Occupied Bandwidth | 15.231(a) 15.205 15.209 | PASS |
| Transmitter Timeout | 15:215(c) 15.231 | PASS |
| Antenna Requirement | 15.203 | PASS |
| Remark: N/A: Not Applicable | | |



PRECISE TESTING

Report No.: PTCHX07170802301E-FC01

3 General Information

3.1 General Description of E.U.T.

Product Name : Outdoor Smart Plug

Model Name : ZW97, ZW96, ZW98, ZW99

Model Description : The samples are the same except appearance and model number.

Operation Frequency: : 908.42MHz

Antenna installation: : Integrated PCB Antenna

Antenna Gain: : 0dBi

Type of Modulation : ASK

Hardware Version : ZW97_V1

Software Version : ZW97_V10

Power supply : AC 120V/60Hz



3.2 Test Mode

To investigate the maximum EMI emission characteristics generated from EUT, the test system was pre-scanning testing based on the consideration of following EUT operation mode or test configuration mode which possibly have effect on EMI emission level. Each of these EUT operation mode or test configuration mode mentioned above was evaluated respectively.

| Pretest Mode | Description |
|--------------|-------------|
| Mode 1 | TX |

| For Conducted Emission | |
|------------------------|-------------|
| Final Test Mode | Description |
| Mode 1 | TX |

| For Radiated Emission | |
|-----------------------|-------------|
| Final Test Mode | Description |
| Mode 1 | TX |



PRECISE TESTING

Report No.: PTCHX07170802301E-FC01

3.3 Test Site

| | |
|-------------------------|--|
| Site | Dongguan Precise Testing & Certification Corp., Ltd. |
| Location | Building D, Baoding Technology Park, Guangming Road 2, Guangming Community, Dongcheng District, Dongguan, Guangdong, China |
| FCC Registration No. | 371540 |
| IC Registration Number: | 12191A-1 |



4 Equipment During Test

4.1 Equipments List

RF Conducted Test

| Name of Equipment | Manufacturer | Model | Serial No. | Calibration Due |
|-----------------------------|--------------|---------|------------|-----------------|
| MXG Signal Analyzer | Agilent | N9020A | MY56070279 | Apr 7, 18 |
| MIMO4TX-1 | / | MIMO4TX | TW5451101 | Apr 7, 18 |
| MXG Vector Signal Generator | Agilent | N5182A | MY50143410 | Apr 7, 18 |
| MXG Analog Signal Generator | KEYSIGHT | N5181B | MY53050432 | Apr 7, 18 |

Radiated Emissions

| Name of Equipment | Manufacturer | Model | Serial No. | Calibration Due |
|------------------------------|---------------|----------|------------|-----------------|
| EMI Test Receiver | Rohde&Schwarz | ESCI | 101417 | Sep. 03, 2018 |
| Bilog Antenna | SCHWARZBECK | VULB9160 | 9160-3355 | Aug 31, 2018 |
| Preamplifier (low frequency) | SCHWARZBECK | BBV 9475 | 9745-0013 | Sep. 03, 2018 |
| Spectrum Analyzer | Agilent | E4407B | MY45109572 | Oct. 13, 2017 |
| Horn Antenna | SCHWARZBECK | 9120D | 9120D-1246 | Aug. 31, 2018 |
| LOW NOISE AMPLIFIER | ZHINAN | ZN3380C | 15002 | Sep 03, 2018 |

Conducted Emissions

| Name of Equipment | Manufacturer | Model | Serial No. | Calibration Due |
|--------------------------|---------------|--------|------------|-----------------|
| EMI Test Receiver | Rohde&Schwarz | ESCI | 101417 | Sep. 03, 2018 |
| Artificial Mains Network | Rohde&Schwarz | L2-16B | 000WX31025 | Sep. 03, 2018 |
| Artificial Mains Network | Rohde&Schwarz | ENV216 | 101342 | Sep. 03, 2018 |



4.2 Measurement Uncertainty

| Parameter | Uncertainty |
|------------------------------------|--------------------------|
| RF output power, conducted | ±1.0dB |
| Power Spectral Density, conducted | ±2.2dB |
| Radio Frequency | ± 1 x 10 ⁻⁶ |
| Bandwidth | ± 1.5 x 10 ⁻⁶ |
| Time | ±2% |
| Duty Cycle | ±2% |
| Temperature | ±1°C |
| Humidity | ±5% |
| DC and low frequency voltages | ±3% |
| Conducted Emissions (150kHz~30MHz) | ±3.64dB |
| Radiated Emission(30MHz~1GHz) | ±5.03dB |
| Radiated Emission(1GHz~25GHz) | ±4.74dB |



5 Conducted Emission

- Test Requirement: : FCC CFR 47 Part 15 Section 15.207
- Test Method: : ANSI C63.10:2013
- Test Result: : PASS
- Frequency Range: : 150kHz to 30MHz
- Class/Severity: : Class B
- Detector: : Peak for pre-scan (9kHz Resolution Bandwidth)

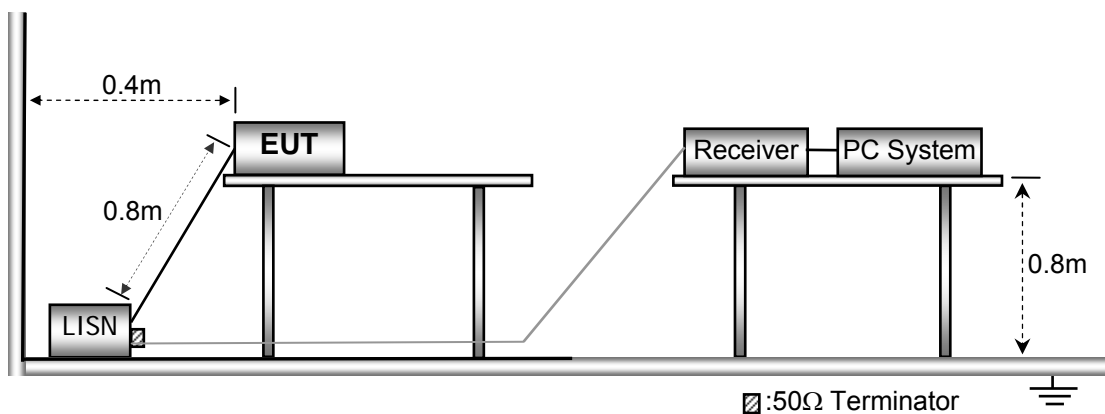
5.1 E.U.T. Operation

Operating Environment :

- Temperature: : 25.5 °C
- Humidity: : 51 % RH
- Atmospheric Pressure: : 101.2kPa
- EUT Operation : : Refer to section 3.3
- Test Voltage : : AC 120V/60Hz

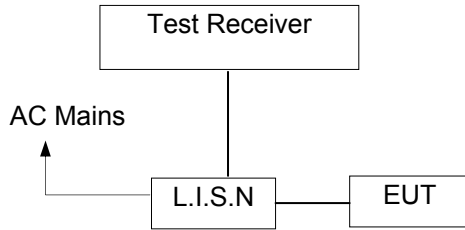
5.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10: 2013.





5.3 Test SET-UP (Block Diagram of Configuration)



5.4 Measurement Procedure:

1. The EUT was placed on a table, which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured was complete.

5.5 Conducted Emission Limit

Conducted Emission

| Frequency(MHz) | Quasi-peak | Average |
|----------------|------------|---------|
| 0.15-0.5 | 66-56 | 56-46 |
| 0.5-5.0 | 56 | 46 |
| 5.0-30.0 | 60 | 50 |

Note:

1. The lower limit shall apply at the transition frequencies
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

5.6 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

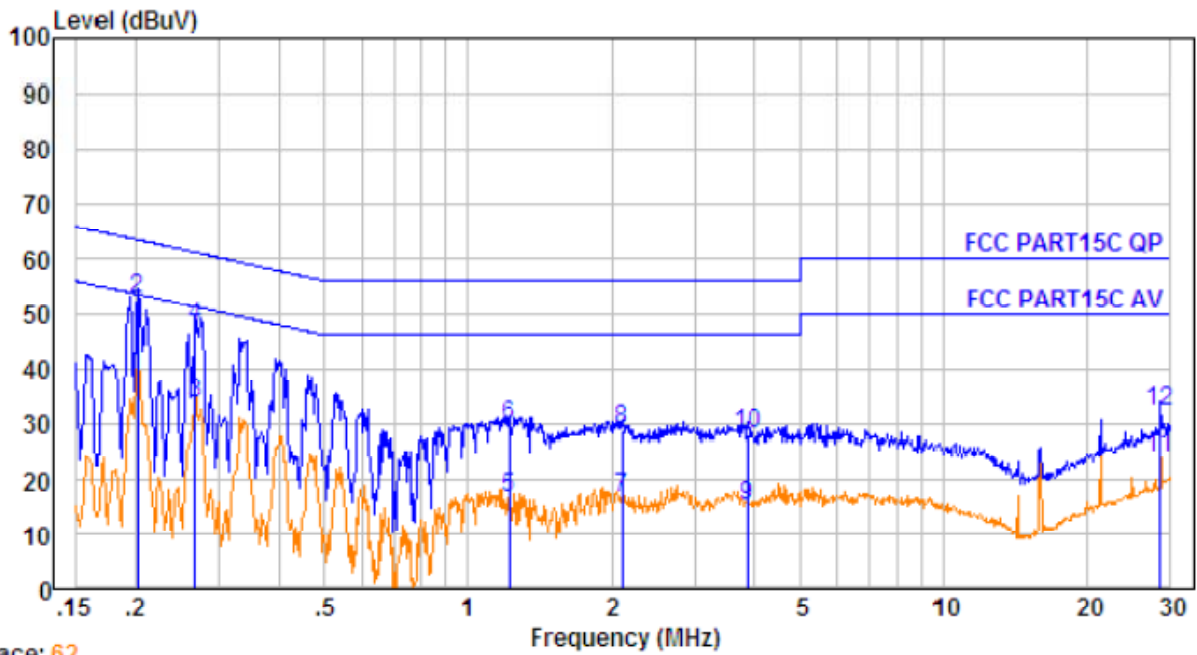
5.7 Conducted Emission Test Result

Pass

Please find the following pages.



Test Phase: Line:

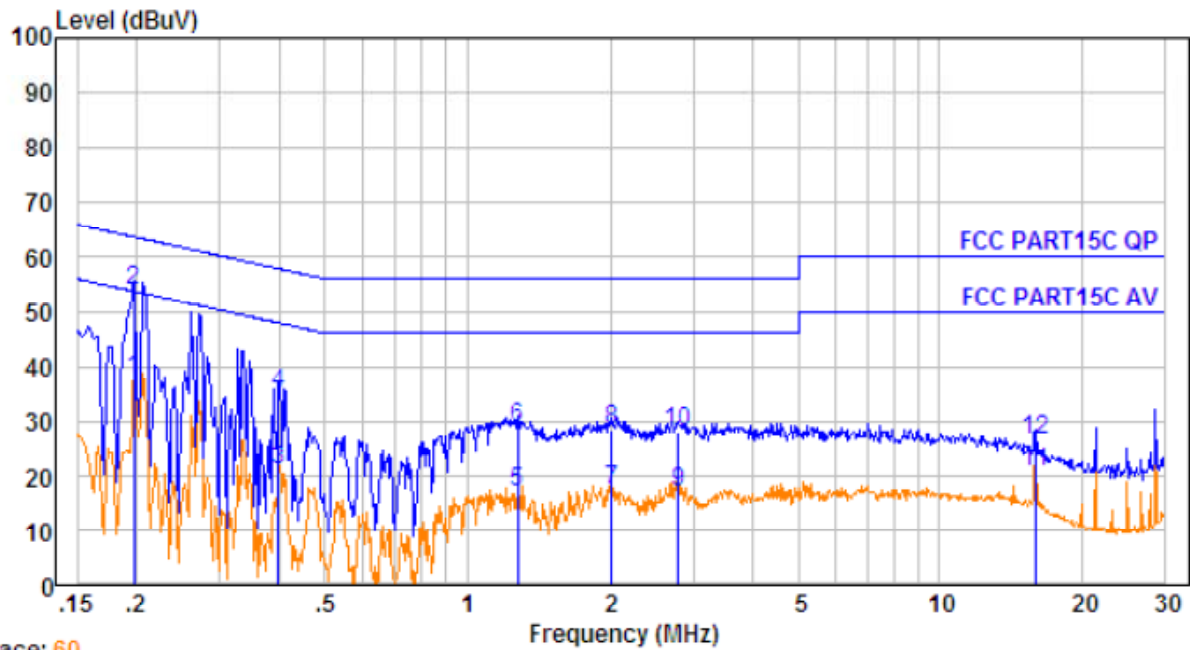


Trace: 62

| No. | Freq MHz | Cable Loss dB | AMN Factor dB | Receiver Reading dBUV | Emission Level dBUV | Limit dBUV | Over Limit dB | Remark |
|-----|----------|---------------|---------------|-----------------------|---------------------|------------|---------------|---------|
| 1. | 0.202 | 10.61 | 0.60 | 27.44 | 38.65 | 53.54 | -14.89 | Average |
| 2. | 0.202 | 10.61 | 0.60 | 41.44 | 52.65 | 63.54 | -10.89 | QP |
| 3. | 0.266 | 10.62 | 0.60 | 22.25 | 33.47 | 51.25 | -17.78 | Average |
| 4. | 0.266 | 10.62 | 0.60 | 36.25 | 47.47 | 61.25 | -13.78 | QP |
| 5. | 1.229 | 10.68 | 0.60 | 5.17 | 16.45 | 46.00 | -29.55 | Average |
| 6. | 1.229 | 10.68 | 0.60 | 18.17 | 29.45 | 56.00 | -26.55 | QP |
| 7. | 2.110 | 10.70 | 0.60 | 5.34 | 16.64 | 46.00 | -29.36 | Average |
| 8. | 2.110 | 10.70 | 0.60 | 17.34 | 28.64 | 56.00 | -27.36 | QP |
| 9. | 3.881 | 10.72 | 0.60 | 3.87 | 15.19 | 46.00 | -30.81 | Average |
| 10. | 3.881 | 10.72 | 0.60 | 16.87 | 28.19 | 56.00 | -27.81 | QP |
| 11. | 28.603 | 10.80 | 0.60 | 12.64 | 24.04 | 50.00 | -25.96 | Average |
| 12. | 28.603 | 10.80 | 0.60 | 20.64 | 32.04 | 60.00 | -27.96 | QP |



Test Phase: Neutral



Trace: 60

| No. | Freq MHz | Cable Loss dB | AMN Factor dB | Receiver Reading dBUV | Emission Level dEuV | Limit dBUV | Over Limit dB | Remark |
|-----|----------|---------------|---------------|-----------------------|---------------------|------------|---------------|---------|
| 1. | 0.198 | 10.61 | 0.60 | 26.53 | 37.74 | 53.71 | -15.97 | Average |
| 2. | 0.198 | 10.61 | 0.60 | 42.53 | 53.74 | 63.71 | -9.97 | QP |
| 3. | 0.398 | 10.64 | 0.60 | 9.93 | 21.17 | 47.90 | -26.73 | Average |
| 4. | 0.398 | 10.64 | 0.60 | 23.93 | 35.17 | 57.90 | -22.73 | QP |
| 5. | 1.276 | 10.68 | 0.60 | 5.60 | 16.88 | 46.00 | -29.12 | Average |
| 6. | 1.276 | 10.68 | 0.60 | 17.60 | 28.88 | 56.00 | -27.12 | QP |
| 7. | 2.012 | 10.70 | 0.60 | 6.22 | 17.52 | 46.00 | -28.48 | Average |
| 8. | 2.012 | 10.70 | 0.60 | 17.22 | 28.52 | 56.00 | -27.48 | QP |
| 9. | 2.779 | 10.71 | 0.60 | 5.57 | 16.88 | 46.00 | -29.12 | Average |
| 10. | 2.779 | 10.71 | 0.60 | 16.57 | 27.88 | 56.00 | -28.12 | QP |
| 11. | 15.970 | 10.78 | 0.60 | 9.18 | 20.56 | 50.00 | -29.44 | Average |
| 12. | 15.970 | 10.78 | 0.60 | 15.18 | 26.56 | 60.00 | -33.44 | QP |



6 Radiated Spurious Emissions

Test Requirement: : FCC CFR47 Part 15 Section 15.231 & 15.207 & 15.205

Test Method: : ANSI C63.10:2013

Test Result: : PASS

Measurement Distance: : 3m

Limit: : See the follow table

| Frequency (MHz) | Field Strength | | Field Strength Limit at 3m Measurement Dist | |
|-----------------|-----------------------|--------------|---|---------------------------------------|
| | uV/m | Distance (m) | uV/m | dBuV/m |
| 0.009 ~ 0.490 | $2400/F(\text{kHz})$ | 300 | $10000 * 2400/F(\text{kHz})$ | $20\log^{(2400/F(\text{kHz}))} + 80$ |
| 0.490 ~ 1.705 | $24000/F(\text{kHz})$ | 30 | $100 * 24000/F(\text{kHz})$ | $20\log^{(24000/F(\text{kHz}))} + 40$ |
| 1.705 ~ 30 | 30 | 30 | $100 * 30$ | $20\log^{(30)} + 40$ |
| 30 ~ 88 | 100 | 3 | 100 | $20\log^{(100)}$ |
| 88 ~ 216 | 150 | 3 | 150 | $20\log^{(150)}$ |
| 216 ~ 960 | 200 | 3 | 200 | $20\log^{(200)}$ |
| Above 960 | 500 | 3 | 500 | $20\log^{(500)}$ |

Note:

1. The tighter limit applies at the band edges.
2. Emission level (dBuV/m)=20log Emission level(uV/m)



Limits of Radiated Emission Measurement (FCC 15.231)

| Frequency (MHz) | Field Strength of Fundamental (Microvolts/meters) | Field Strength of Unwanted Emissions (Microvolts/meters) |
|-----------------|---|--|
| 40.66-40.70 | 2250.00 | 225.00 |
| 70-130 | 1250.00 | 125.00 |
| 130-174 | 1250 to 3750** | 125 to 375** |
| 174-260 | 3750 | 375 |
| 260-470 | 3750 to 12500** | 375 to 1250** |
| Above 470 | 12500 | 1250 |

Note:

** linear interpolations. Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows:

For the Band 130-174MHz, uV/m at 3 meters = 56.81818(F)-6136.3636;

For the Band 260-470MHz, uV/m at 3 meters = 41.6667(F)-7083.3333;

The maximum permitted unwanted emission level is 20dB below the maximum permitted fundamental level.

The limited on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in 93 section 15.209, whichever limit permits a higher field strength.

6.1 EUT Operation

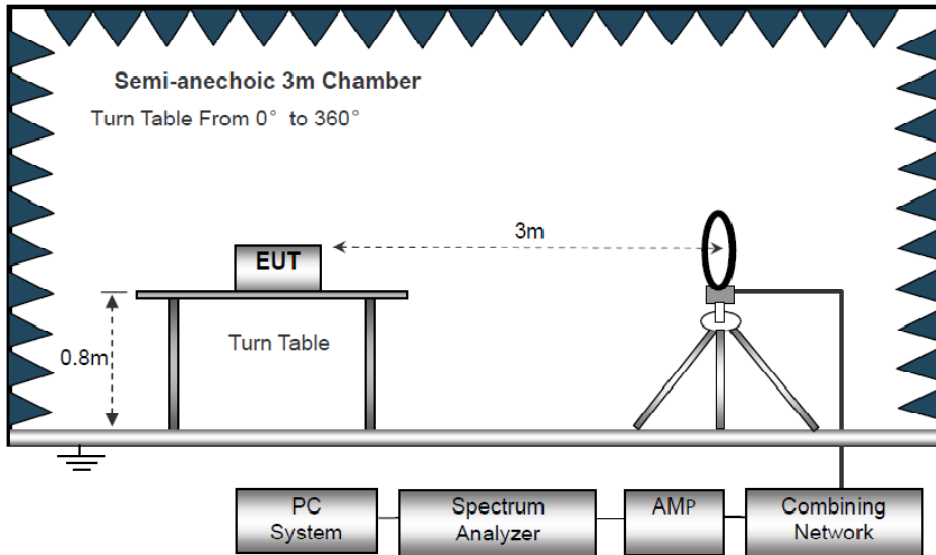
Operating Environment :

- Temperature: : 23.5 °C
- Humidity: : 51.1 % RH
- Atmospheric Pressure: : 101.2kPa
- EUT Operation : : Refer to section 3.3

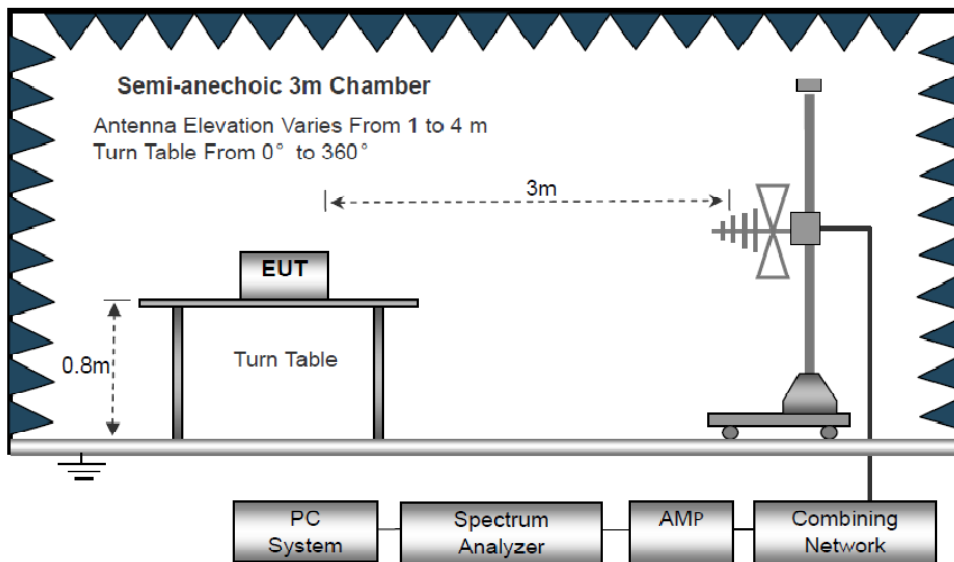
6.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site

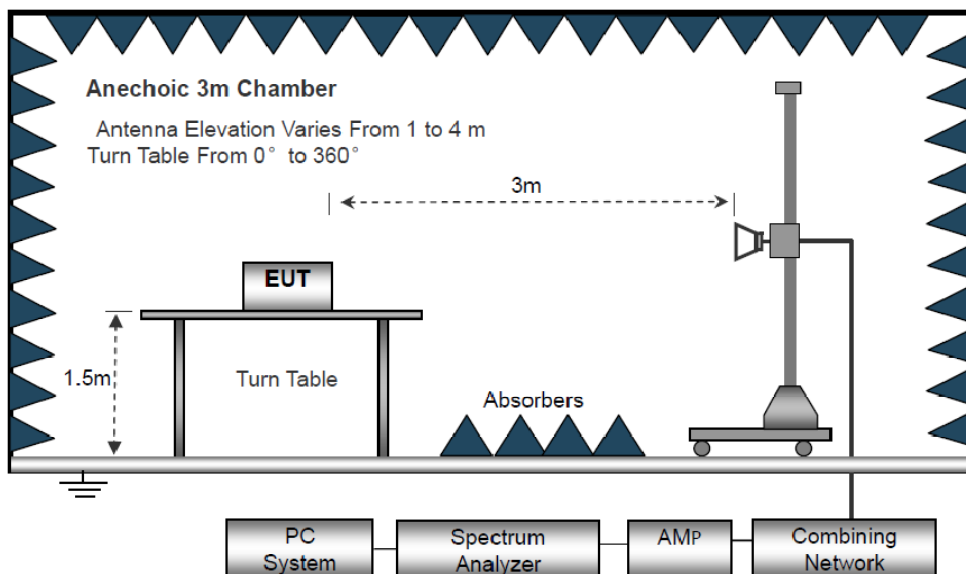
The test setup for emission measurement below 30MHz



The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz



6.3 Spectrum Analyzer Setup

| Spectrum Parameter | Setting |
|---------------------------------------|--|
| Attenuation | Auto |
| Start Frequency | 1000 MHz |
| Stop Frequency | 10th carrier harmonic |
| RB / VB (emission in restricted band) | 1 MHz / 1 MHz for Peak, 1 MHz / 10Hz for Average |

| Receiver Parameter | Setting |
|------------------------|----------------------------------|
| Attenuation | Auto |
| Start ~ Stop Frequency | 9kHz~150kHz / RB 200Hz for QP |
| Start ~ Stop Frequency | 150kHz~30MHz / RB 9kHz for QP |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB 120kHz for QP |



6.4 Test Procedure

1. Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The test above 1GHz must be use the fully anechoic room, and the test below 1GHz use the half anechoic room

6.5 Summary of Test Results

Test Frequency: Below 30MHz

The measurements were more than 20 dB below the limit and not reported.



Test Frequency: 30MHz ~ 5GHz

Note: Due to the PK results are lower than the AV limits already, the Duty Cycle evaluation and AV measurement are not required for this case.

| | | | |
|--------------|--------------------|---------------|--------------|
| EUT: | Outdoor Smart Plug | Model Number: | ZW97 |
| Temperature: | 20°C | Humidity: | 48% |
| Pressure: | 101Hpa | Test Voltage: | AC 120V/60Hz |
| Test Mode: | TX | | |

| Frequency | Polar | Cable Loss | ANT Factor | Reading | Corrected Factor | Emission Level | Limit | Margin | Detector Type |
|-----------|-------|------------|------------|---------|------------------|----------------|----------|--------|---------------|
| (MHz) | (H/V) | (dB) | (dB/m) | (dBμV) | (dB) | (dBμV/m) | (dBμV/m) | (dB) | |
| 63.536 | V | 1.73 | 11.93 | 35.27 | 30.23 | 18.70 | 40.00 | -21.30 | QP |
| 127.218 | V | 2.36 | 12.47 | 37.57 | 30.47 | 21.93 | 43.50 | -21.57 | QP |
| 159.225 | V | 2.57 | 13.88 | 35.51 | 30.55 | 21.41 | 43.50 | -22.09 | QP |
| 239.147 | V | 2.93 | 11.67 | 38.19 | 30.69 | 22.10 | 46.00 | -23.90 | QP |
| 262.896 | V | 3.02 | 12.23 | 36.55 | 30.73 | 21.07 | 46.00 | -24.93 | QP |
| 79.521 | H | 1.94 | 8.87 | 34.89 | 30.31 | 15.39 | 40.00 | -24.61 | QP |
| 143.326 | H | 2.47 | 13.54 | 32.16 | 30.51 | 17.66 | 43.50 | -25.84 | QP |
| 159.225 | H | 2.57 | 13.88 | 35.93 | 30.55 | 21.83 | 43.50 | -21.67 | QP |
| 262.896 | H | 3.02 | 12.23 | 37.55 | 30.73 | 22.07 | 46.00 | -23.93 | QP |
| 440.196 | H | 3.49 | 16.21 | 30.75 | 30.90 | 19.55 | 46.00 | -26.45 | QP |

Note:

Emission Level= Cable Loss + ANT Factor + Reading – Corrected Factor

Margin=Emission Level – Limit



| Frequency | Reading | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | FCC Part 15.231/209/205 | |
|-----------|--------------|------------------|------------|-------|------------------|---------------------|-------------------------|--------|
| | | | Height | Polar | | | Limit | Margin |
| (MHz) | (dB μ V) | Degree | (m) | (H/V) | (dB) | (dB μ V/m) | (dB μ V/m) | (dB) |
| 908.42 | 78.13 | 299 | 2 | H | -11.02 | 67.11 | 82 | -14.89 |
| 908.42 | 79.62 | 217 | 2.3 | V | -11.02 | 68.6 | 82 | -13.4 |
| 1816.84 | 46.35 | 210 | 1.7 | H | -8.43 | 37.92 | 54 | -16.08 |
| 1816.84 | 45.15 | 327 | 2.3 | V | -8.43 | 36.72 | 54 | -17.28 |
| 2725.26 | 42.08 | 102 | 1.5 | H | -9.05 | 33.03 | 54 | -20.97 |
| 2725.26 | 41.69 | 339 | 2 | V | -9.05 | 32.64 | 54 | -21.36 |
| 3633.68 | 40.53 | 51 | 1.6 | H | -7.42 | 33.11 | 54 | -20.89 |
| 3633.68 | 39.51 | 47 | 1.3 | V | -7.42 | 32.09 | 54 | -21.91 |
| 4542.10 | 45.08 | 84 | 1.5 | H | -7.42 | 37.66 | 54 | -16.34 |
| 4542.10 | 46.29 | 106 | 1.9 | V | -7.42 | 38.87 | 54 | -15.13 |

Note:

1. Emissions attenuated more than 20dB below the permissible value are not reported.
2. *: denotes restricted band of operation. Measurements were made using a peak detector and average detector. Any emission falling within the restricted bands of FCC Part 15Section 15.205 ere compliance with the emission limit of FCC Part 15 Section 15.209.
3. FCC Limit for Average Measurement= $20\log 12500=82\text{dB}\mu\text{V/m}$.



7 20dB Bandwidth Measurement

Test Requirement : FCC Part15.231(c)
 Test Method : FCC Part15.231(c)
 Test Mode : Refer to section 3.3

Limit : The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20dB down from the modulated carrier.

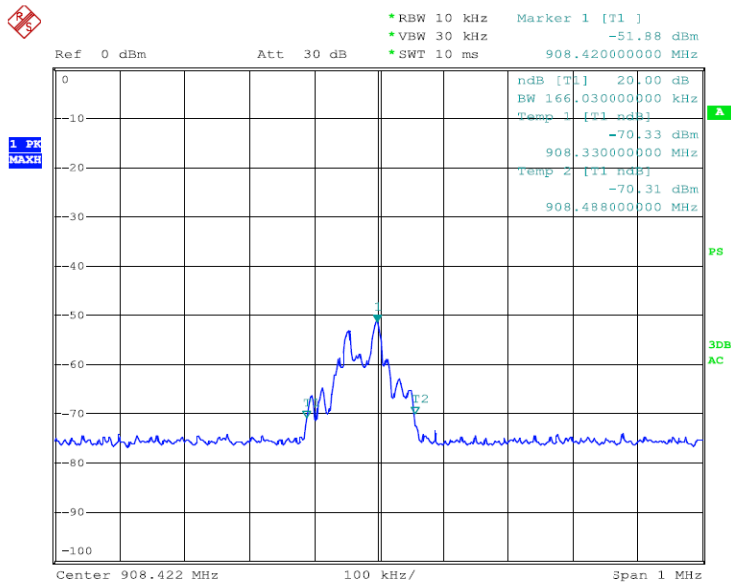
7.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 10 kHz, VBW = 30kHz,

7.2 Test Result

| Test Frequency (MHz) | Bandwidth (kHz) | Limit (kHz) | Result |
|----------------------|-----------------|-------------|--------|
| 908.42 | 166.03 | 4542 | pass |

Test plots





8 Transmitter Timeout

8.1 Requirements

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

Result: The EUT has a manually activated transmitter, please refer to below detail data.

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

Result: The EUT does not have a automatically activated transmitter.

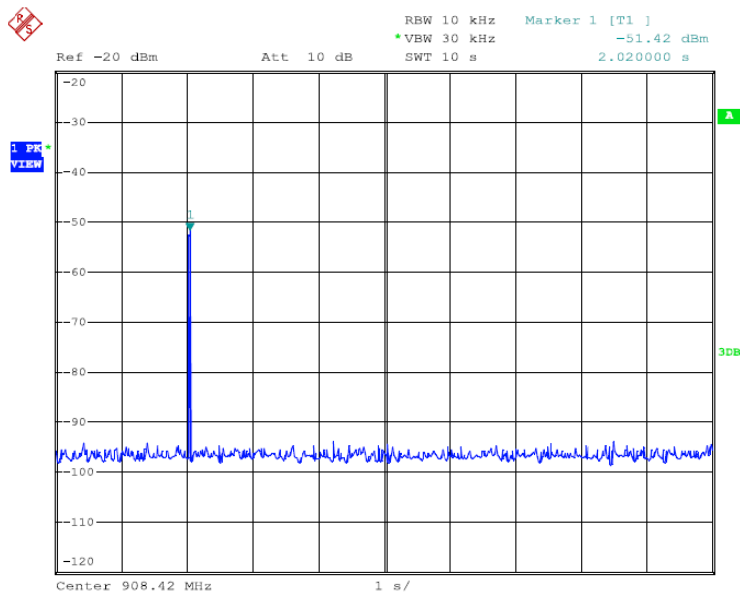
Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

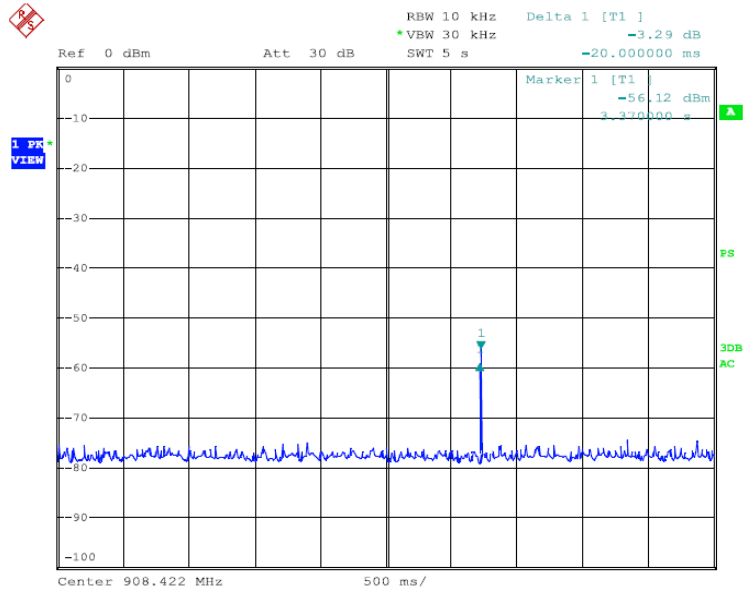
Result: The EUT does not employ periodic transmission.

Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

Result: The section is not applicable to EUT.

| The Duration of Each Transmission | Limit | Result |
|-----------------------------------|-------|--------|
| 2.02s | <5s | Pass |







PRECISE TESTING

Report No.: PTCHX07170802301E-FC01

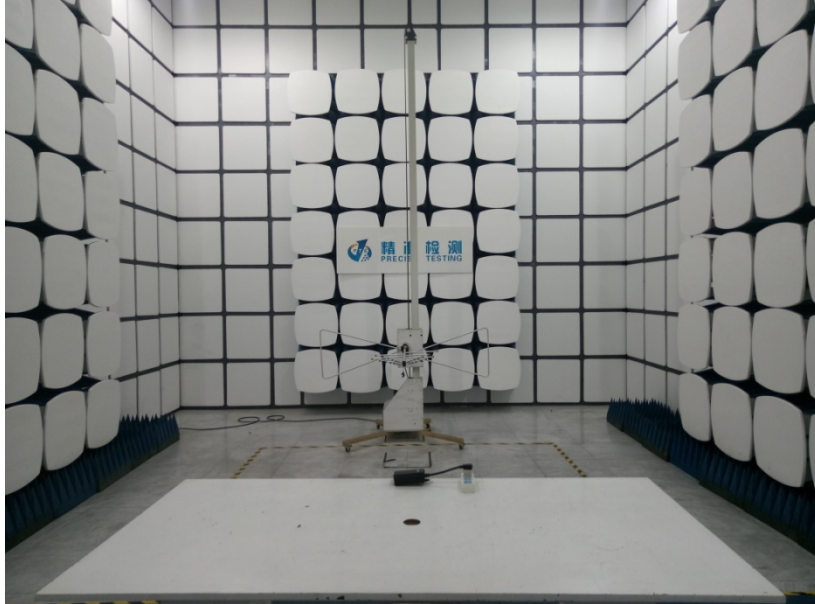
9 Antenna Requirement

According to the FCC part15.203, a transmitter can only be sold or operated with antennas with which it was approved. This product has an internal permanent antenna which meet the requirement of this section.

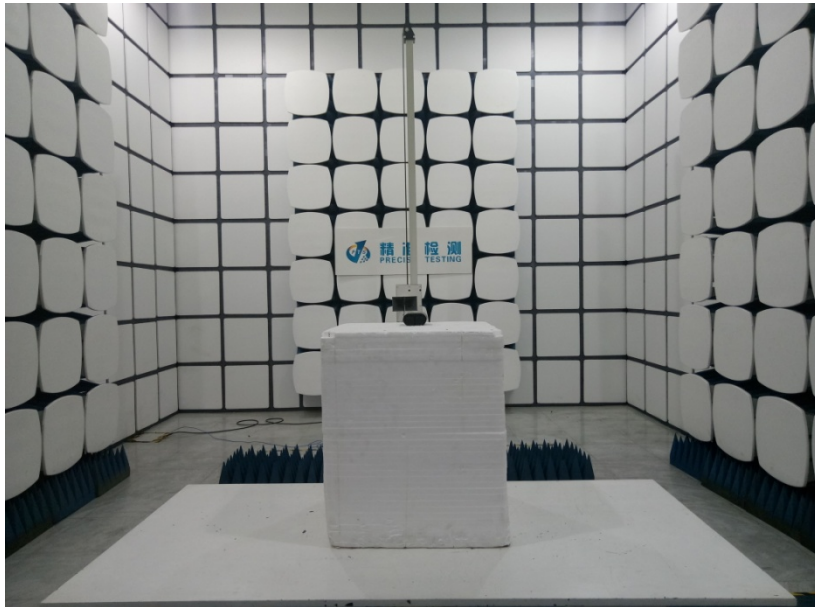


10 Test Setup

Radiated Spurious Emissions
From 30MHz-1000MHz



Above 1GHz





Conducted Emission





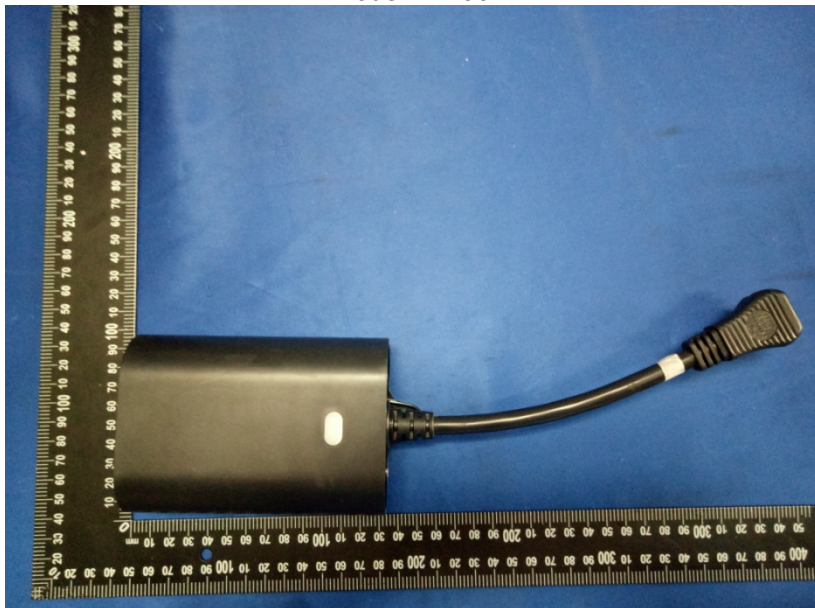
PRECISE TESTING

Report No.: PTCHX07170802301E-FC01

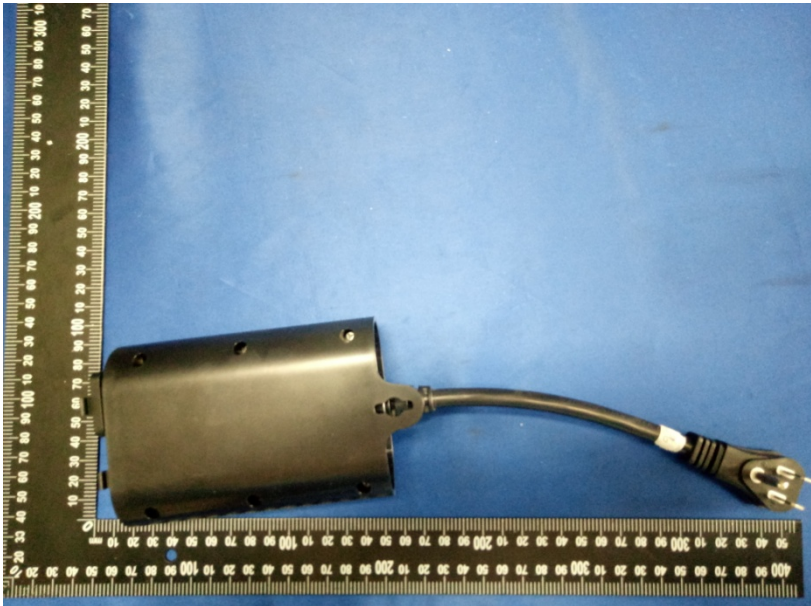
11 EUT Photos



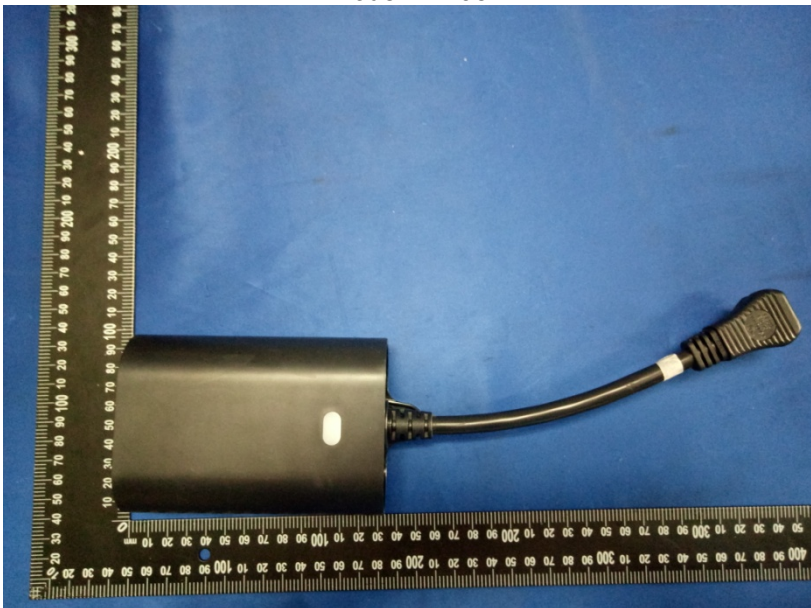
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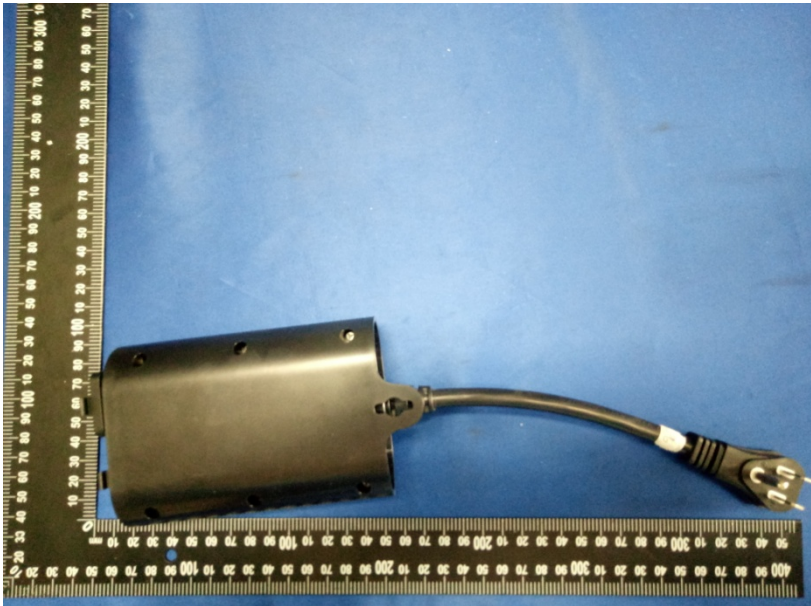
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Model: ZW98



Model: ZW98



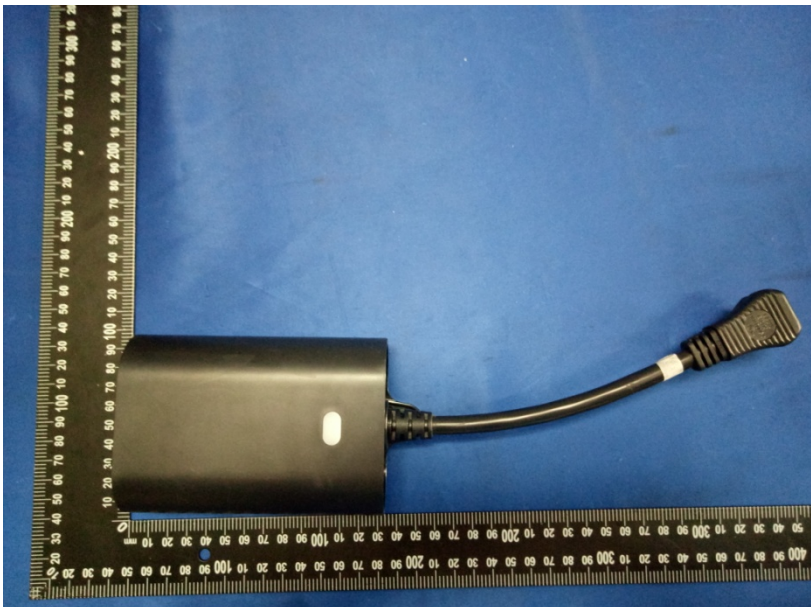
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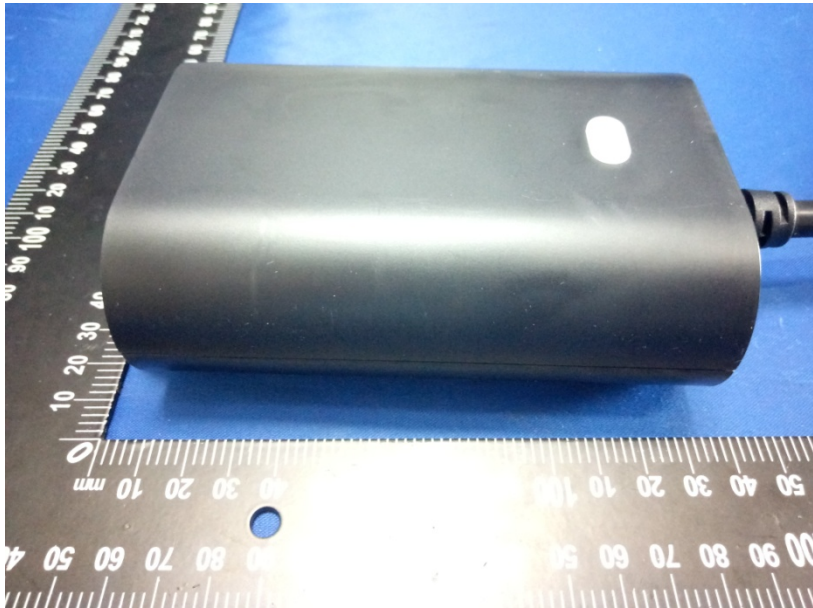
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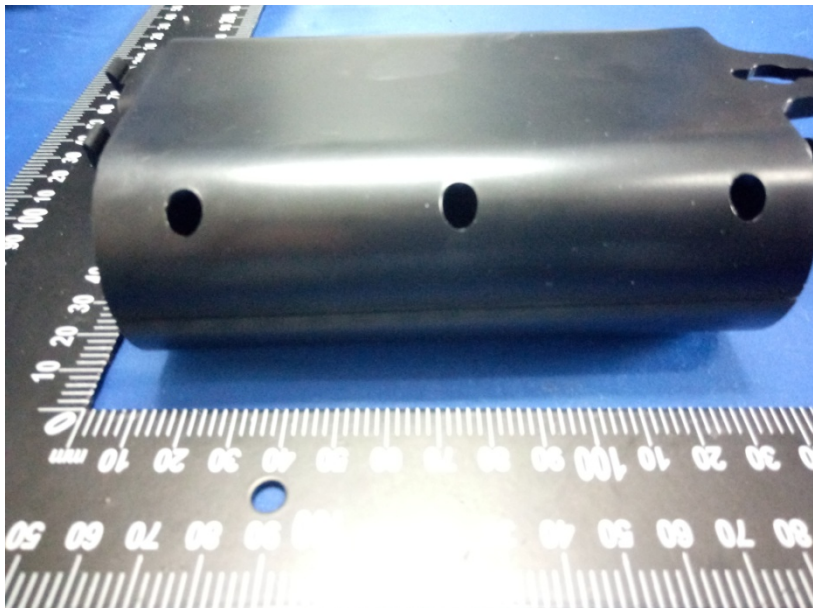
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Model: ZW97



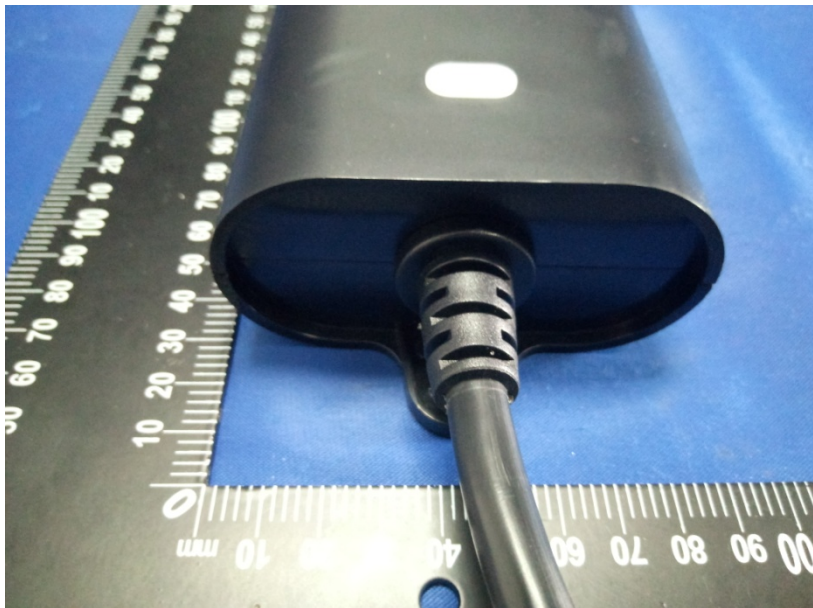
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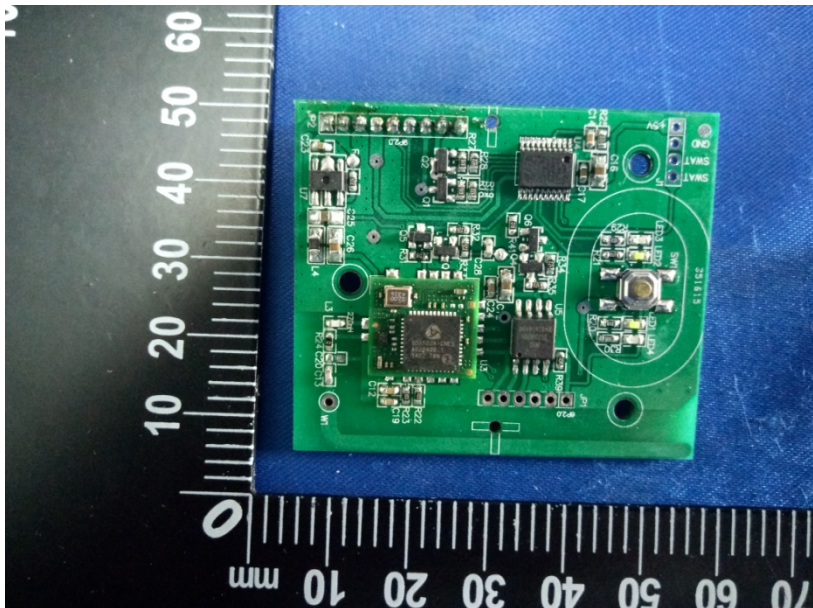
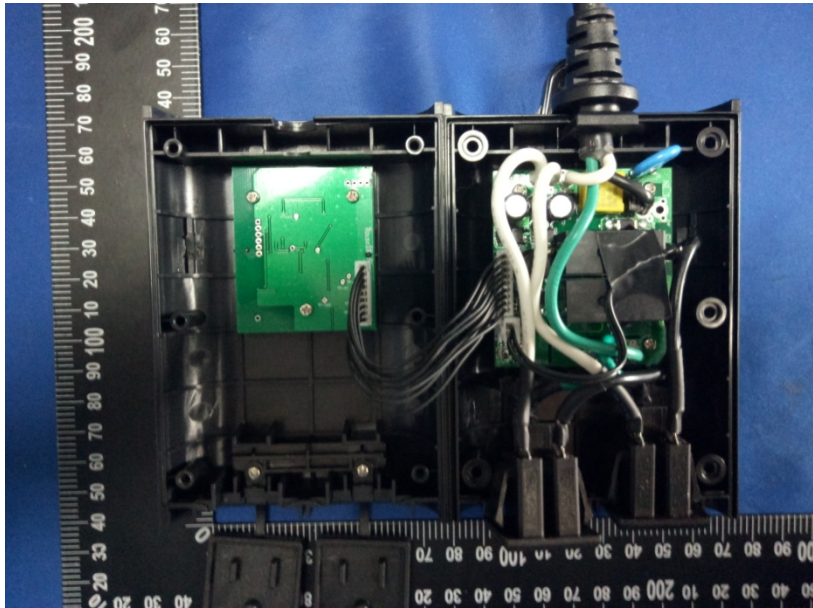
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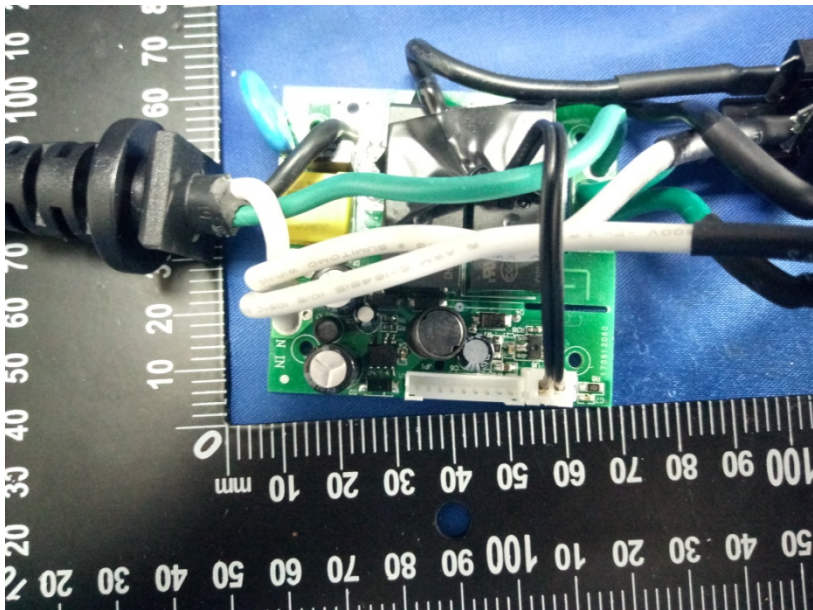
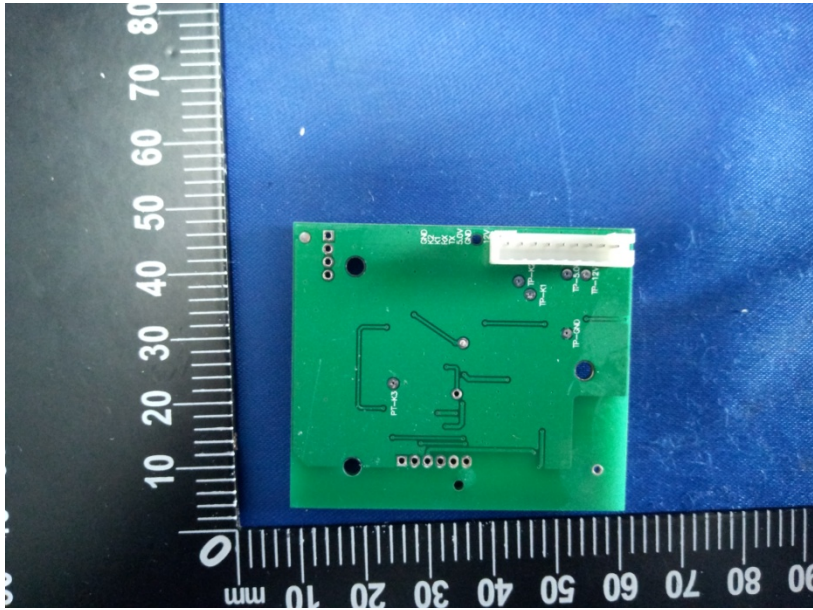


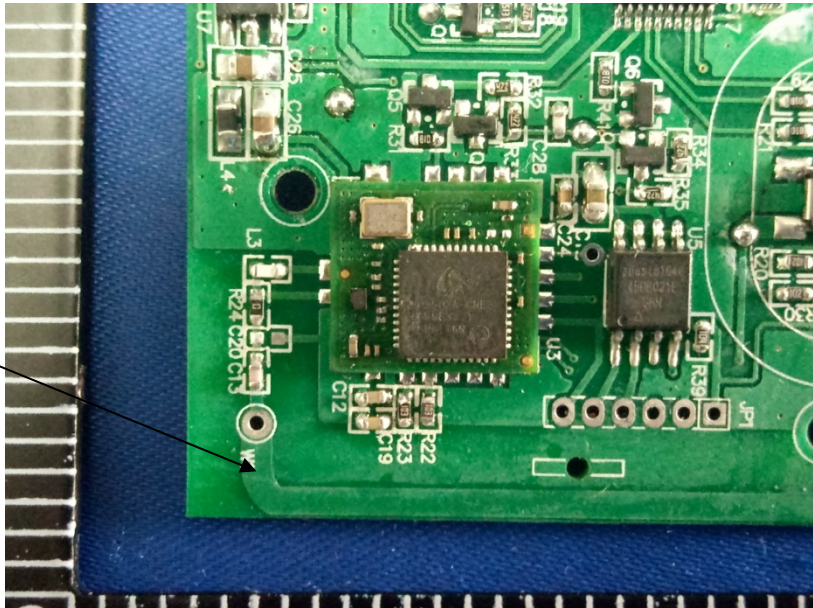
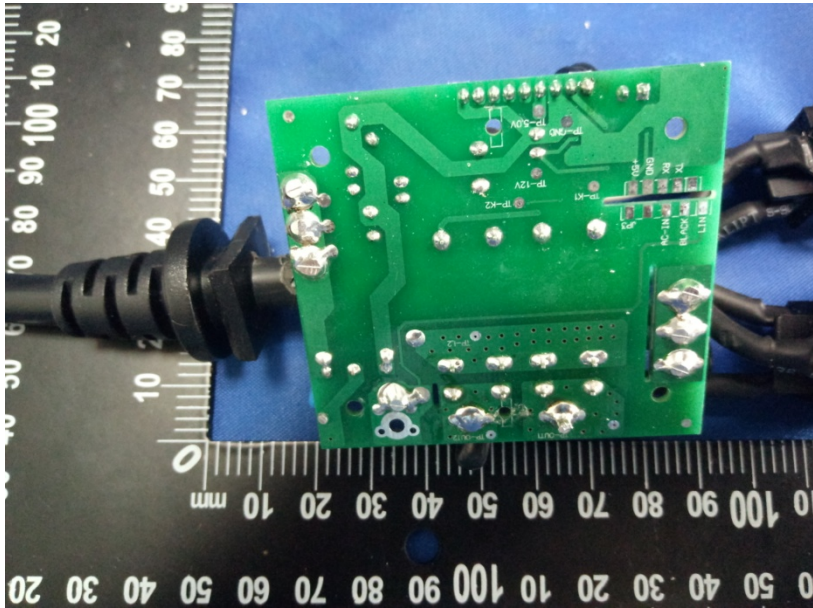
Model: ZW97



Model: ZW97







Antenna

*****THE END REPORT*****