

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



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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		



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 generates from EUT, the test system was pre-scanning testing based on the consideration of following EUT operation mode or test configuration mode which possible 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	$\pm 1.0\text{dB}$
Power Spectral Density, conducted	$\pm 2.2\text{dB}$
Radio Frequency	$\pm 1 \times 10^{-6}$
Bandwidth	$\pm 1.5 \times 10^{-6}$
Time	$\pm 2\%$
Duty Cycle	$\pm 2\%$
Temperature	$\pm 1^{\circ}\text{C}$
Humidity	$\pm 5\%$
DC and low frequency voltages	$\pm 3\%$
Conducted Emissions (150kHz~30MHz)	$\pm 3.64\text{dB}$
Radiated Emission(30MHz~1GHz)	$\pm 5.03\text{dB}$
Radiated Emission(1GHz~25GHz)	$\pm 4.74\text{dB}$

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)

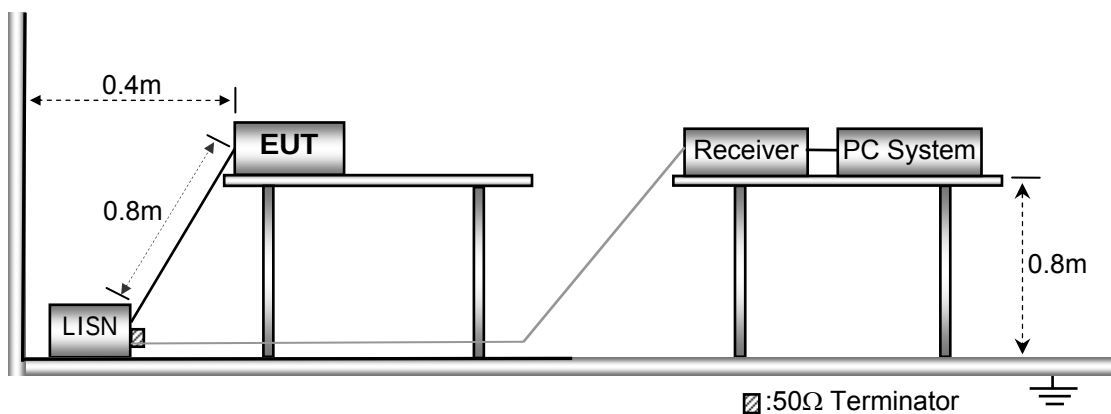
5.1 E.U.T. Operation

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

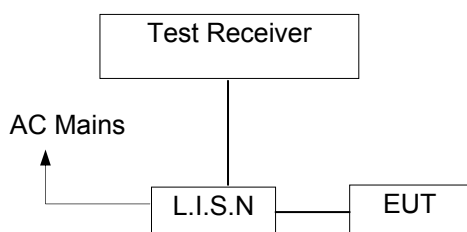
5.2 EUT Setup

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

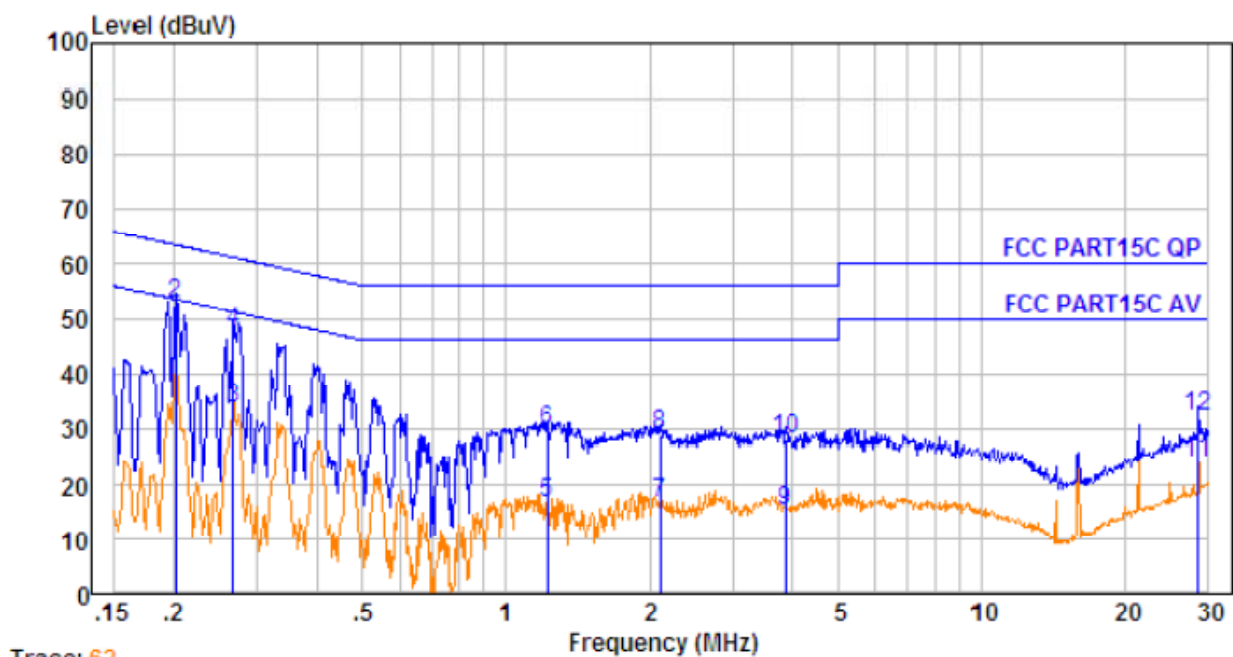
Please find the following pages.



PRECISE TESTING

Report No.: PTCHX07170802301E-FC01

Test Phase: Line:



Trace: 62

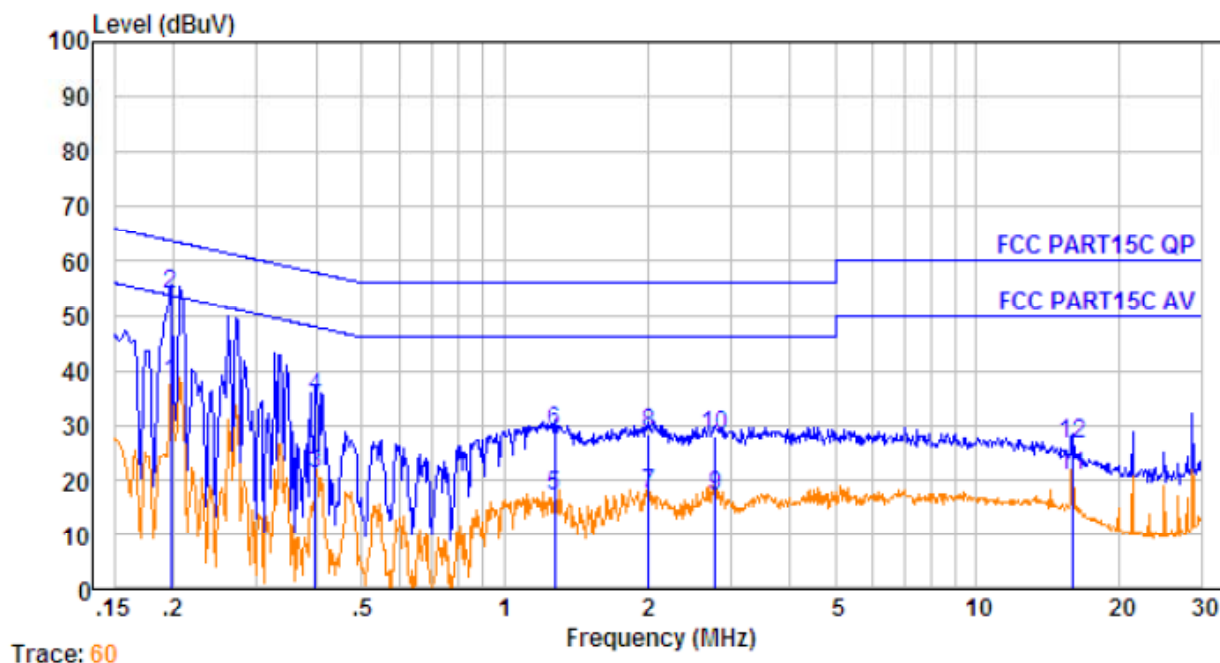
No.	Freq MHz	Cable Loss dB	AMN Factor dB	Receiver Reading dBuV	Emission Level dBuV	Limit dBuV	Over Limit dB	Remark
1.	0.202	10.61	0.60	27.44	38.65	53.54	-14.89	Average
2.	0.202	10.61	0.60	41.44	52.65	63.54	-10.89	QP
3.	0.266	10.62	0.60	22.25	33.47	51.25	-17.78	Average
4.	0.266	10.62	0.60	36.25	47.47	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



PRECISE TESTING

Report No.: PTCHX07170802301E-FC01

Test Phase: Neutral



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) = $20\log$ 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, $\mu\text{V/m}$ at 3 meters = $56.81818(F)-6136.3636$;

For the Band 260-470MHz, $\mu\text{V/m}$ 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

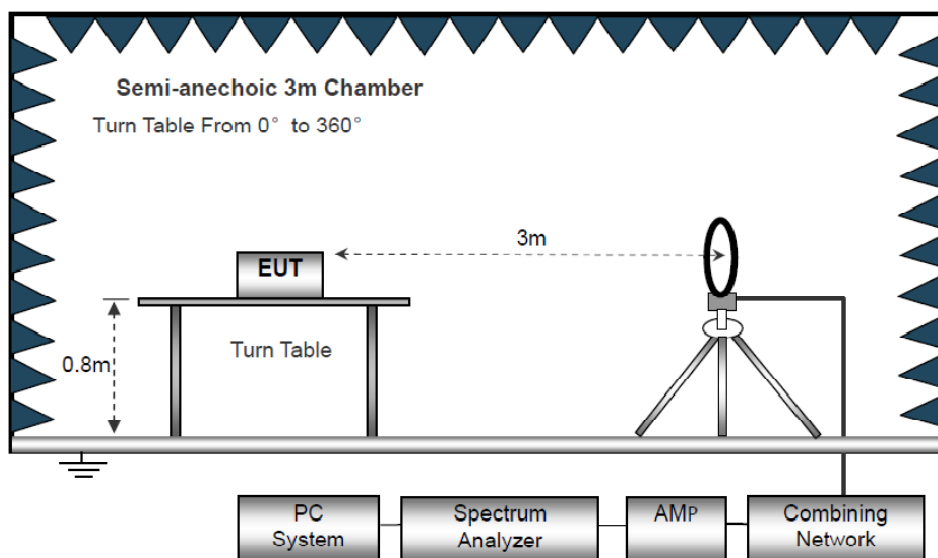
Atmospheric Pressure: : 101.2kPa

EUT Operation : : Refer to section 3.3

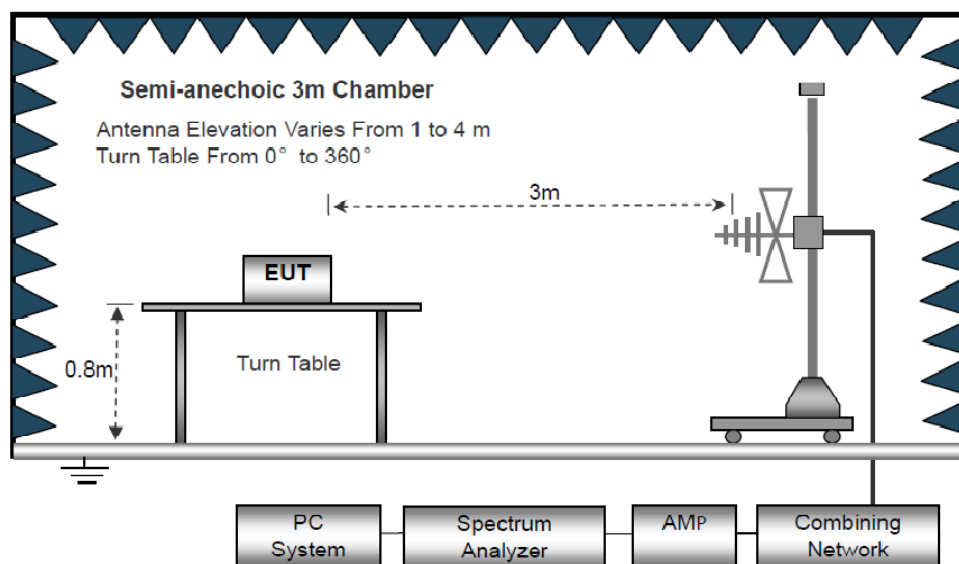
6.2 Test Setup

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

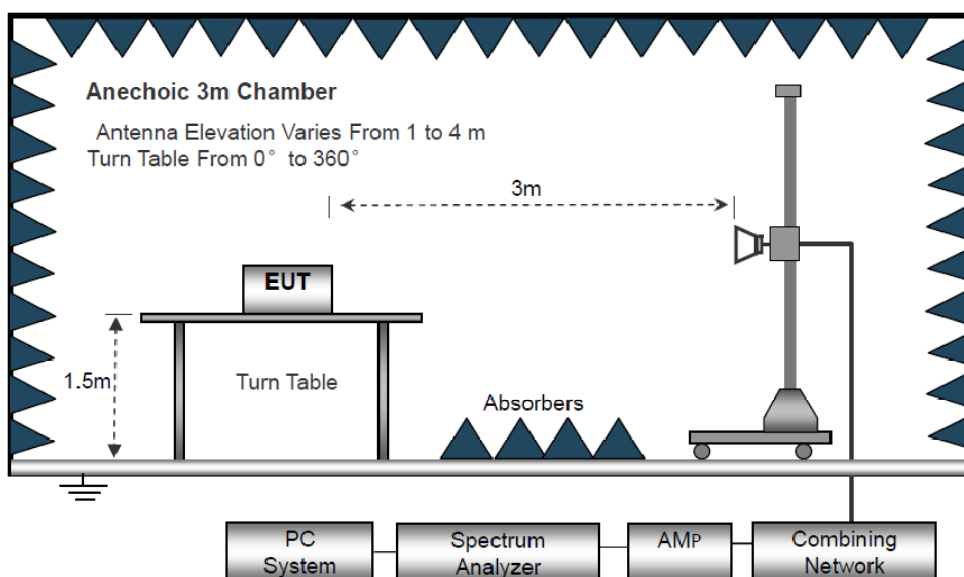
The test setup for emission measurement below 30MHz



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)	(dBμV)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/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.

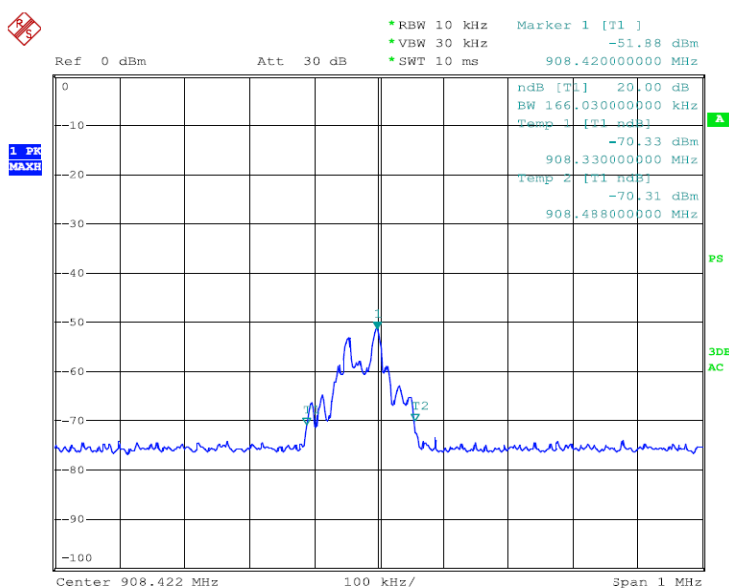
7.1 Test Procedure

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.

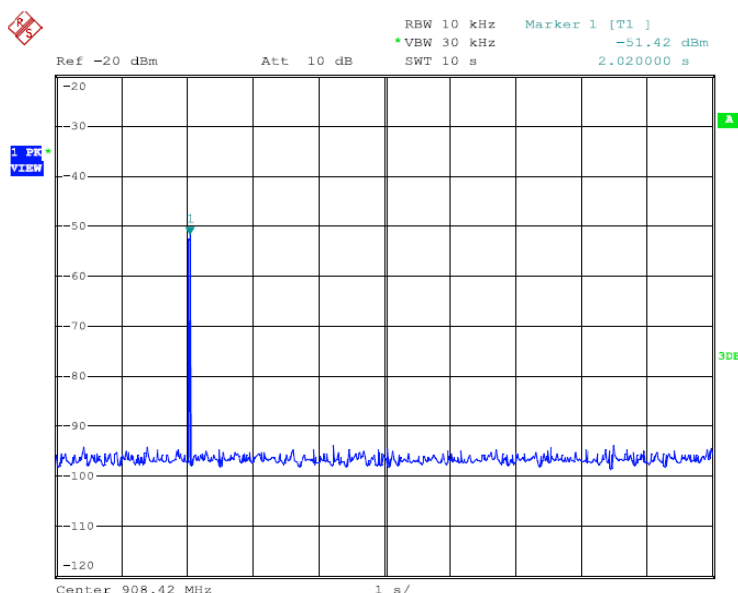
Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than 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.

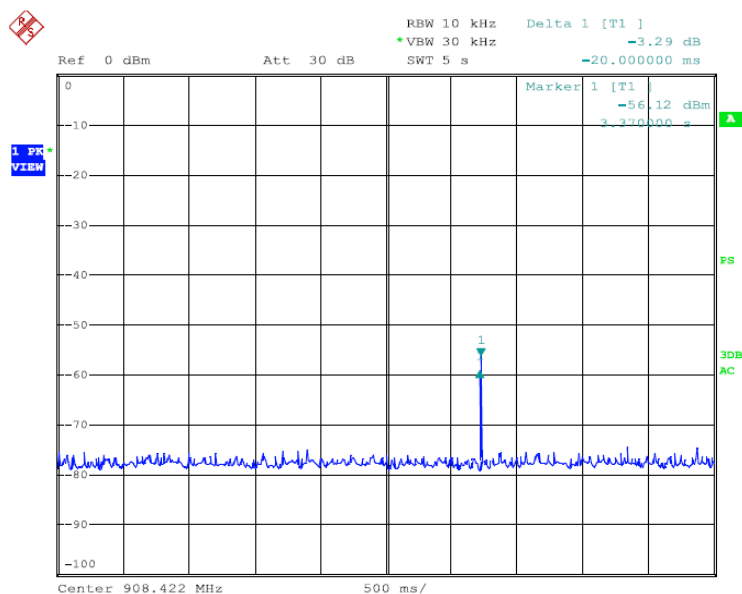
The Duration of Each Transmission	Limit	Result
2.02s	<5s	Pass





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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.

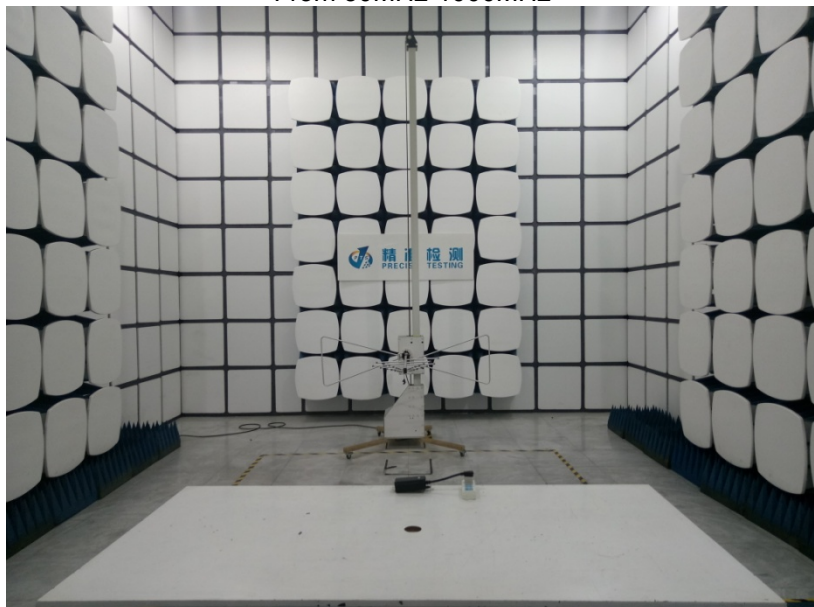


PRECISE TESTING

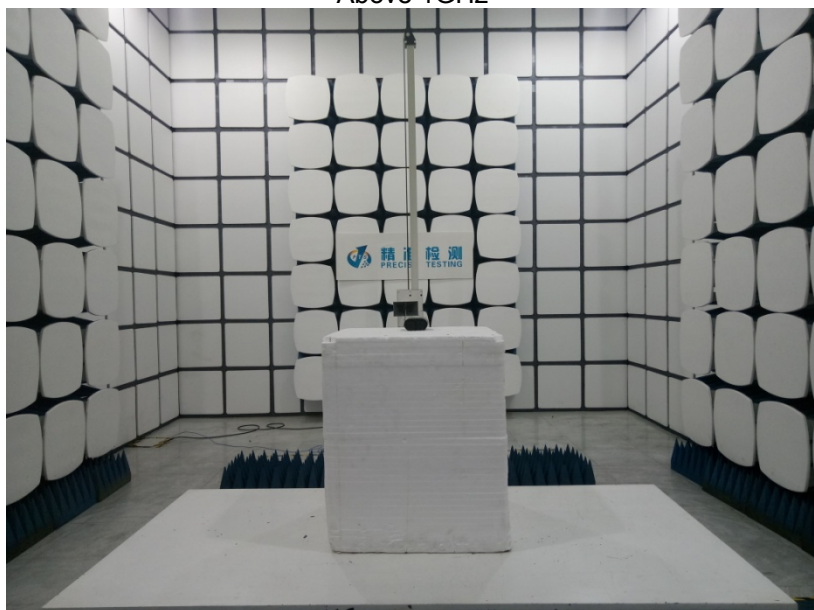
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10 Test Setup

Radiated Spurious Emissions
From 30MHz-1000MHz



Above 1GHz





PRECISE TESTING

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Conducted Emission





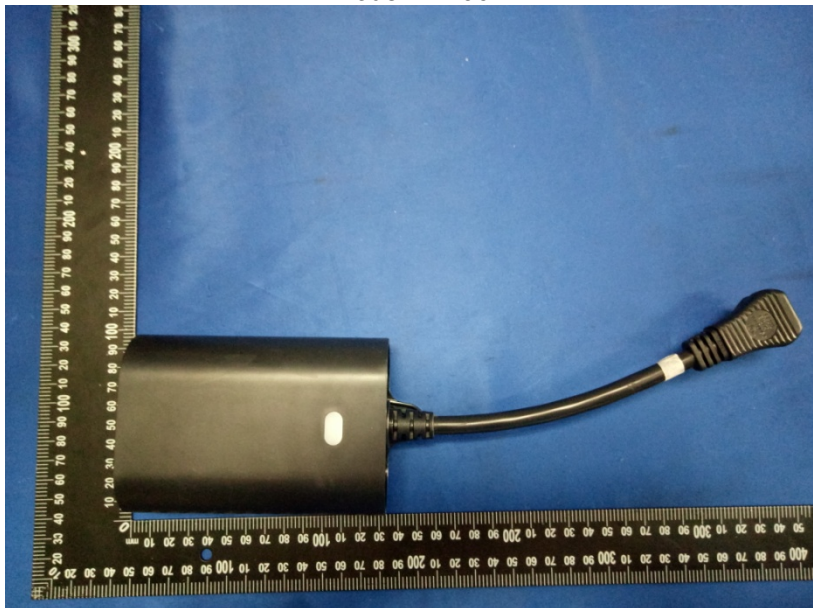
PRECISE TESTING

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11 EUT Photos



Model: ZW96



Model: ZW96

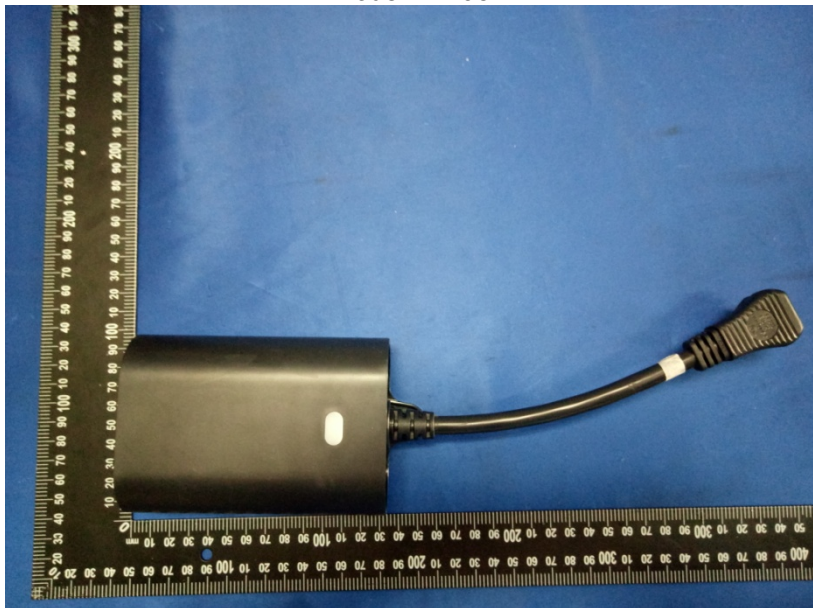


PRECISE TESTING

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Model: ZW98



Model: ZW98



Model: ZW99



Model: ZW99



PRECISE TESTING

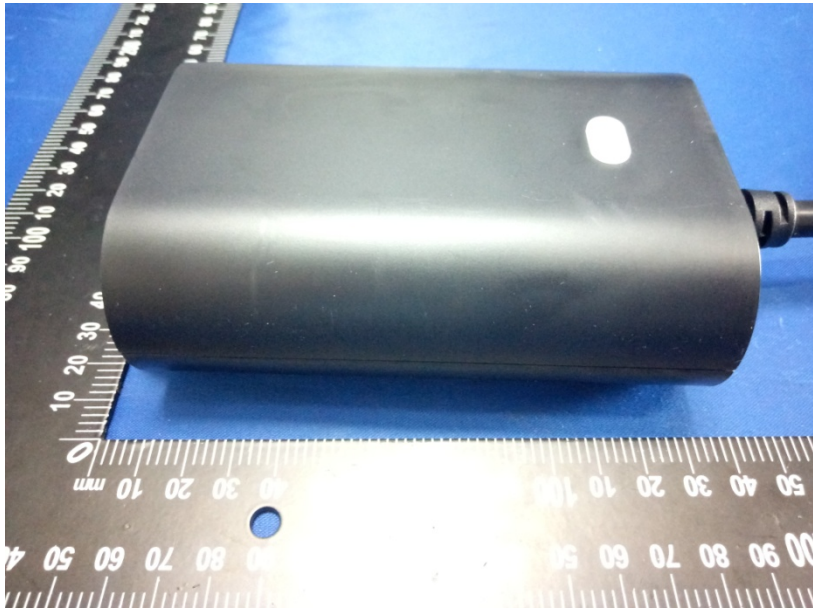
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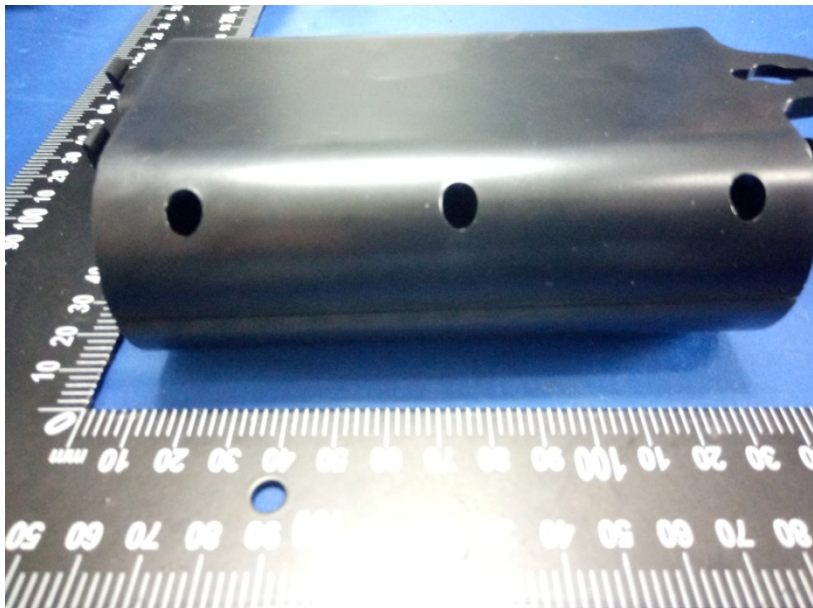
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Model: ZW97



Model: ZW97



Model: ZW97



Model: ZW97

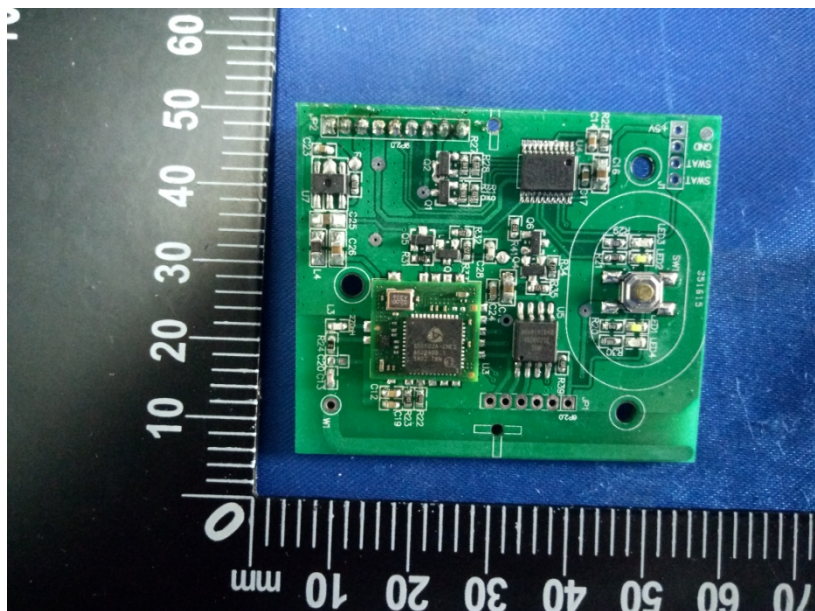
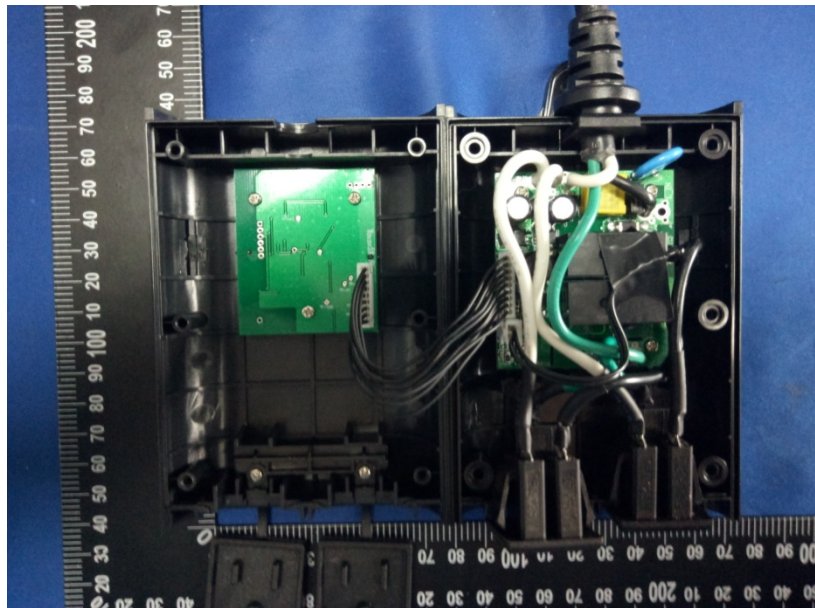


Model: ZW97



PRECISE TESTING

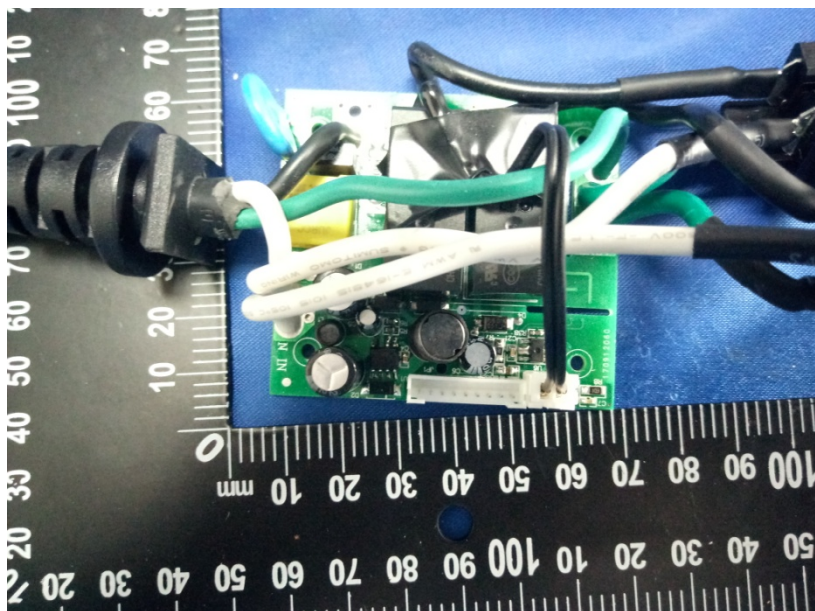
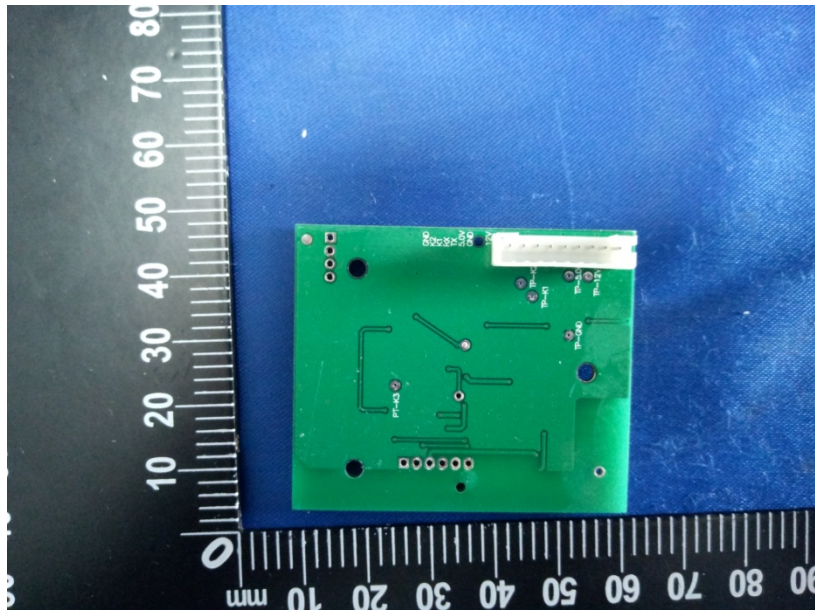
Report No.: PTCHX07170802301E-FC01

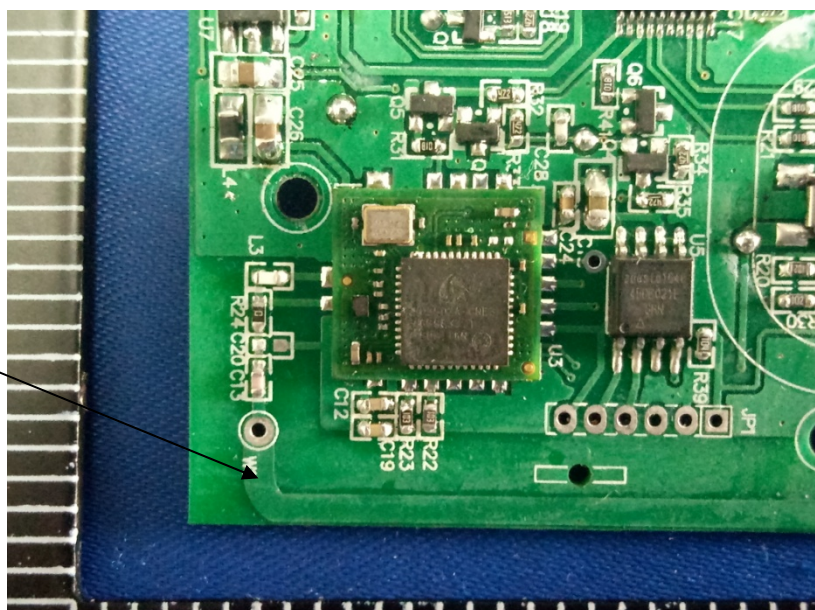
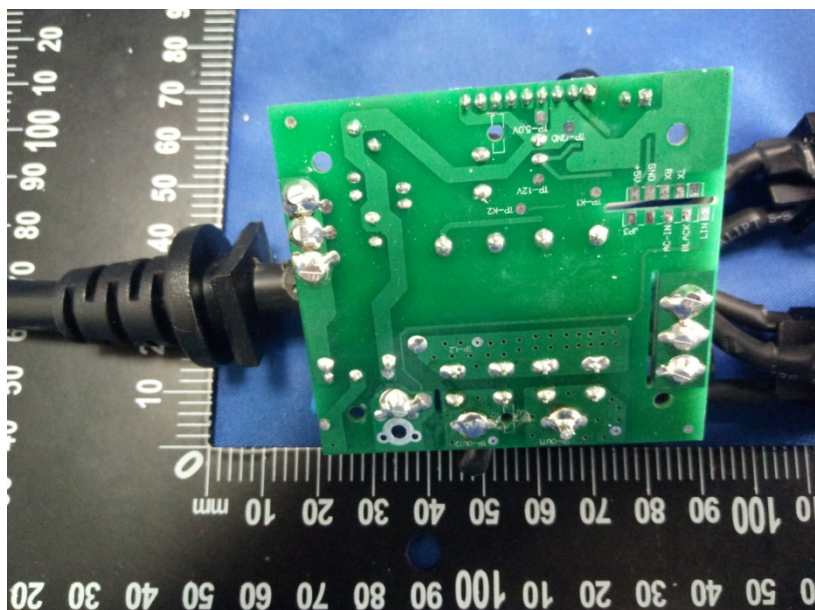




PRECISE TESTING

Report No.: PTCHX07170802301E-FC01





Antenna

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