

**ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT  
INTENTIONAL RADIATOR CERTIFICATION TO  
FCC PART 15 SUBPART C  
REQUIREMENT T**

*OF*

Humidity-Temperature Tag

MODEL No.: R156

Trademark: N/A

FCC ID: P6FZ

REPORT NO: ES141225315E

ISSUE DATE: April 13, 2015

*Prepared for*

RF Code, Inc.

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*Prepared by*

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## VERIFICATION OF COMPLIANCE

Applicant:	RF Code, Inc. 9229 Waterford Centre Blvd. Suite 500, Austin, TX 78758-7511, United States
Manufacturer:	RF Code, Inc. 9229 Waterford Centre Blvd. Suite 500, Austin, TX 78758-7511, United States
Product Description:	Humidity-Temperature Tag
Model Number:	R156
Serial Number:	N/A
File Number:	ES141225315E
Date of Test:	December 26, 2014 to January 28, 2015

APPLICABLE STANDARDS	
STANDARD	TEST RESULT
FCC 47 CFR Part 15, Subpart C	PASS

We hereby certify that:

The above equipment was tested by SHENZHEN EMTEK CO., LTD. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.4 (2014) and the energy emitted by the sample EUT tested as described in this report is in compliance with radiated emission limits of FCC Rules Part 15.231 REQUIREMENTS.

The test results of this report relate only to the tested sample identified in this report.

Date of Test : \_\_\_\_\_ December 26, 2014 to January 28, 2015

Prepared by : \_\_\_\_\_  
 Jack Li/Editor

Reviewer : \_\_\_\_\_  
 Joe Xia/Supervisor

Approve & Authorized Signer : \_\_\_\_\_  
 Lisa Wang/Manager

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## **1. GENERAL INFORMATION**

### **1.1. Product Description**

Humidity-Temperature Tag (referred to as the EUT in this report), it is designed by way of utilizing the OOK modulation achieves the system operating.

A major technical descriptions of EUT is described as following:

- A). Operation Frequency: 433.92MHz
- B). Modulation: OOK
- C). Antenna Type: Loop antenna
- D). Antenna Gain: -26dBi
- E).Power Supply: DC 3V from Lithium Battery
- F). HW Version:02546 REV 00
- G). SW Version:Ver.1.0

### **1.2. Related Submittal(s) / Grant (s)**

This submittal(s) (test report) is intended for FCC ID: P6FZ filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules

### **1.3. Test Methodology**

The radiated testing was performed according to the procedures in ANSI C63.4 (2014). Radiated testing was performed at an antenna to EUT distance 3 meters.

### **1.4. Special Accessories**

Not available for this EUT intended for grant.

### **1.5. Equipment Modifications**

Not available for this EUT intended for grant.

## 1.6. Measurement Uncertainty

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Fundamental Fieldstrength	Not Applicable	95%	$\pm 2.94\text{dB}$
Transmitter 20 dB Bandwidth	Not Applicable	95%	$\pm 0.92\text{PPm}$
Radiated Spurious Emissions	30 MHz to 40 GHz	95%	$\pm 3.00\text{dB}$
Conducted Emission	0.15MHz to 0.50MHz	95%	$\pm 2.0\text{dB}$

## 1.7. Test Facility

### Site Description

#### EMC Lab.

: Accredited by CNAS, 2013.10.29  
The certificate is valid until 2016.10.28  
The Laboratory has been assessed and proved to be in compliance with CNAS/CL01:2006(identical to ISO/IEC17025: 2005)  
The Certificate Registration Number is L2291

Accredited by TUV Rheinland Shenzhen 2010.5.25  
The Laboratory has been assessed according to the requirements ISO/IEC 17025

Accredited by FCC, April 17, 2014  
The Certificate Registration Number is 406365.

Accredited by Industry Canada, March 5, 2010  
The Certificate Registration Number is 4480A-2.

#### Name of Firm

: SHENZHEN EMTEK CO., LTD

#### Site Location

: Bldg 69, Majialong Industry Zone,  
Nanshan District, Shenzhen, Guangdong, China

## 2. SYSTEM TEST CONFIGURATION

### 2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

### 2.2. EUT Exercise

The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

### 2.3. Test Procedure

#### 2.3.1 Radiated Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. Emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 13.1.4.1 of ANSI C63.4-2014.

### 2.4. Description of test modes

The EUT (Humidity-Temperature Tag) has been tested under normal operating condition. Let EUT transmit during test, and the result was reported.

### 2.5. Summary of Test Results

Standard Section	Test Item	Result
FCC Part Clause		
15.231(a)	Transmission Requirement	Pass
15.231(b), 15.209(a)	Radiated Emission	Pass
15.231(c)	20dB/99% Bandwidth	Pass
15.207(a)	Conducted Emission	N/A
15.203	Antenna Requirement	Pass

Note: (1) "N/A" denotes test is not applicable in this test report.

### 2.6. Description of Support Units

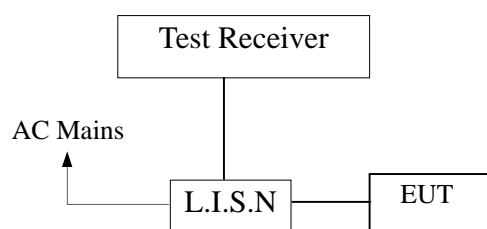
Equipment	Mfr/Brand	Model/Type No.	FCC ID	Series No.	Note
Humidity-Temperature Tag	N/A	R156	P6FZ	N/A	EUT

### 3. Conducted Emissions Test

#### 3.1. 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 were complete.

#### 3.2. Test SET-UP (Block Diagram of Configuration)



#### 3.3. Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Test Receiver	Rohde & Schwarz	ESCS30	828985/018	05/17/2014	05/16/2015
L.I.S.N	Rohde & Schwarz	ESH2-Z5	834549/005	05/17/2014	05/16/2015
50ΩCoaxial Switch	Anritsu	MP59B	M20531	05/17/2014	05/16/2015

#### 3.4. Conducted Emission Limit

(7)	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
	<b>Note:</b>		
	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.		

#### 3.5. Measurement Result:

Not Applicable (EUT power supply is DC 3V)



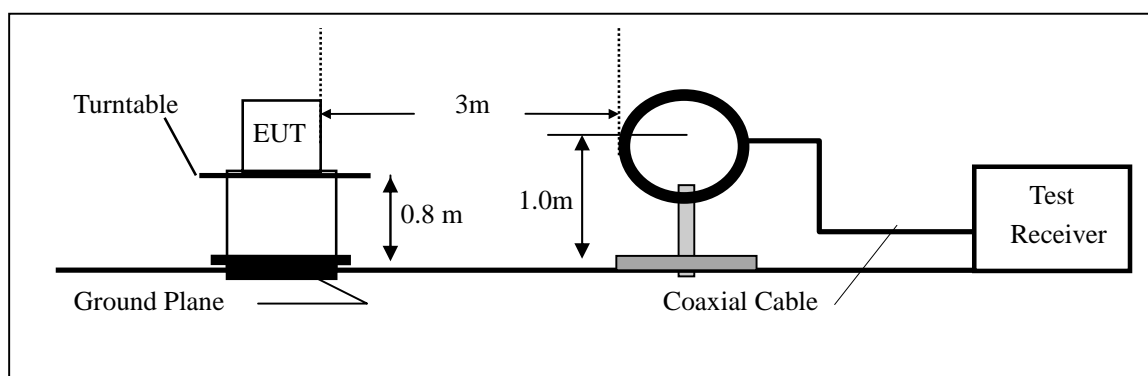
## 4. RADIATED EMISSION TEST

### 4.1. Measurement Procedure

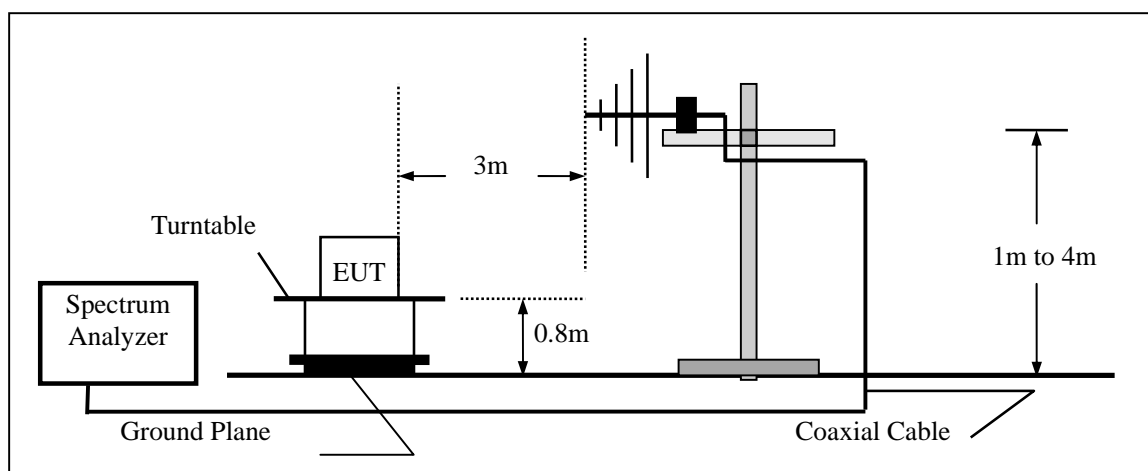
- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter Semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(below 1GHz)
- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter Semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(above 1GHz)
- The height of the equipment or of the substitution antenna shall be 0.8 m; the height of the test Antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- The initial step in collecting conducted emission data is a spectrum analyzer peak detector Mode pre-scanning the measurement frequency range. Significant peaks are then marked and then AV detector mode re-measured.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.

### 4.2. Test SET-UP (Block Diagram of Configuration)

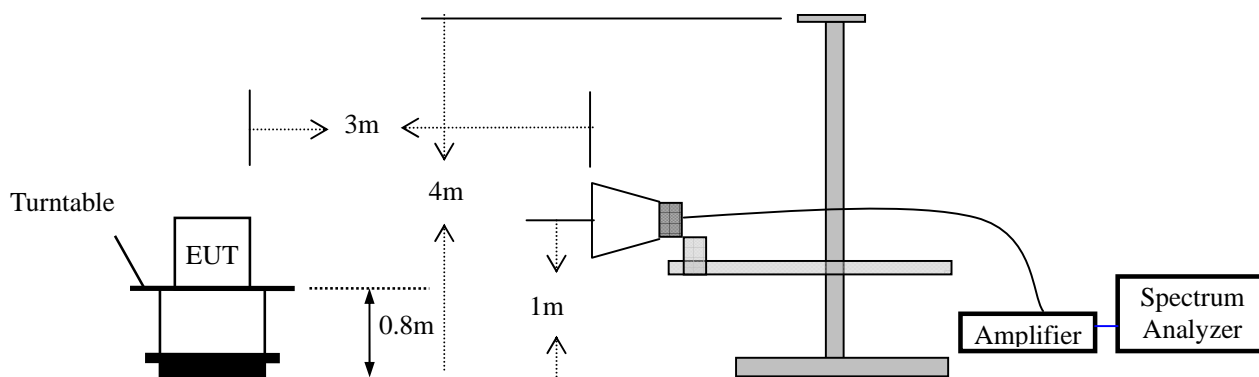
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



(B) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(C) Radiated Emission Test Set-Up, Frequency above 1000MHz



### 4.3. Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Rohde & Schwarz	FSP7	839511/010	05/17/2014	05/16/2015
Spectrum Analyzer	HP	E4407B	839840481	05/17/2014	05/16/2015
EMI Test Receiver	Rohde & Schwarz	ESCS30	828985/018	05/17/2014	05/16/2015
Pre-Amplifier	HP	8447D	2944A07999	05/17/2014	05/16/2015
Bilog Antenna	Schwarzbeck	VULB9163	142	05/17/2014	05/16/2015
Loop Antenna	ARA	PLA-1030/B	1029	05/17/2014	05/16/2015
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170399	05/17/2014	05/16/2015
Horn Antenna	Schwarzbeck	BBHA 9120	D143	05/17/2014	05/16/2015

### 4.4. Radiated Emission Limit

FCC 15.205 Restricted frequency band

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
<sup>1</sup> 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	( <sup>2</sup> )

# FCC 15.209 Limited

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
960~1000	500	3
Above 1GHz	74 dBuV/m (PEAK) 54 dBuV/m (AVERAGE)	

# 15.231 Limited

Frequencies (MHz)	Field strength of fundamental @3m		Effective limit for 433.92MHz	
	(uV/m)	dB(uV/m)	(uV/m)	dB(uV/m)
40.66-40.70	1000	60		
70-130	500	54		
130-174	500 to 1500*	54 to 63.5*		
174-260	1500	63.5		
<b>260-470</b>	<b>1500 to 5000*</b>	<b>63.5 to 74*</b>	<b>4398.67</b>	<b>92.87</b>
Above 470	5000	81.9		

\* Linear interpolation

Frequencies (MHz)	Field strength of Spurious emissions @3m		Effective limit for 433.92MHz	
	(uV/m)	dB(uV/m)	(uV/m)	dB(uV/m)
40.66-40.70	100	40		
70-130	50	34		
130-174	50 to 150*	34 to 43.5*		
174-260	150	43.5		
<b>260-470</b>	<b>150 to 500*</b>	<b>51.4 to 54*</b>	<b>439.867</b>	<b>72.87</b>
Above 470	500	54		

\* Linear interpolation

#### 4.5. Calculation of Average factor

The output field strengths of specification in accordance with the FCC rules specify measurements with an average detector. During the test, a spectrum analyzer incorporating a peak detector was used. Therefore, a reduction factor can be applied to the resultant peak signal level and compared to the limit for measurement instrumentation incorporating an average detector.

The duty cycle is measured in 100ms or the repetition cycle period, whichever is a shorter time frame, the duty cycle is measured by placing the spectrum analyzer to set zero span at 100kHz resolution bandwidth.

Averaging factor in dB=20log(duty cycle)

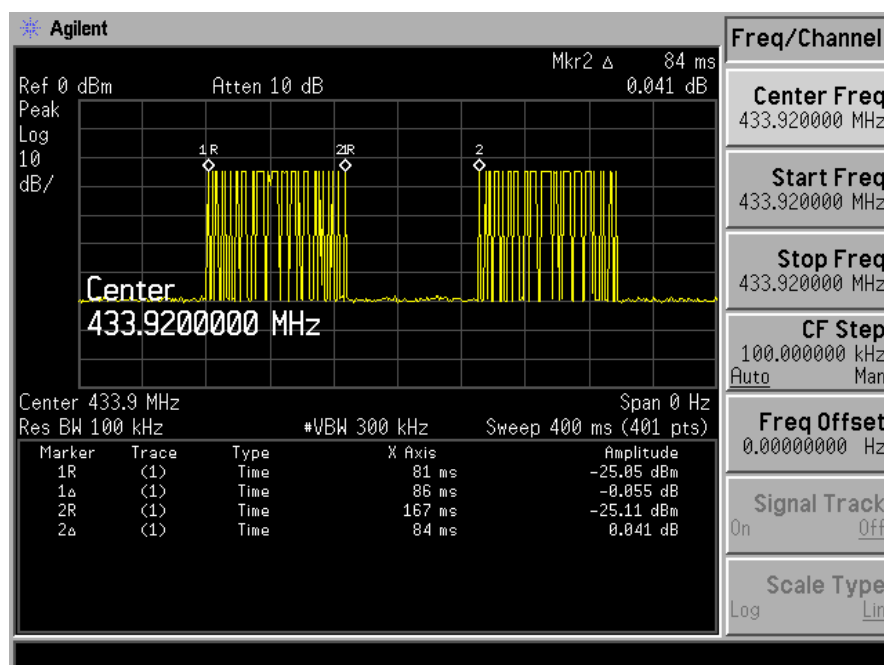
Where the duty factor is calculated from following formula:

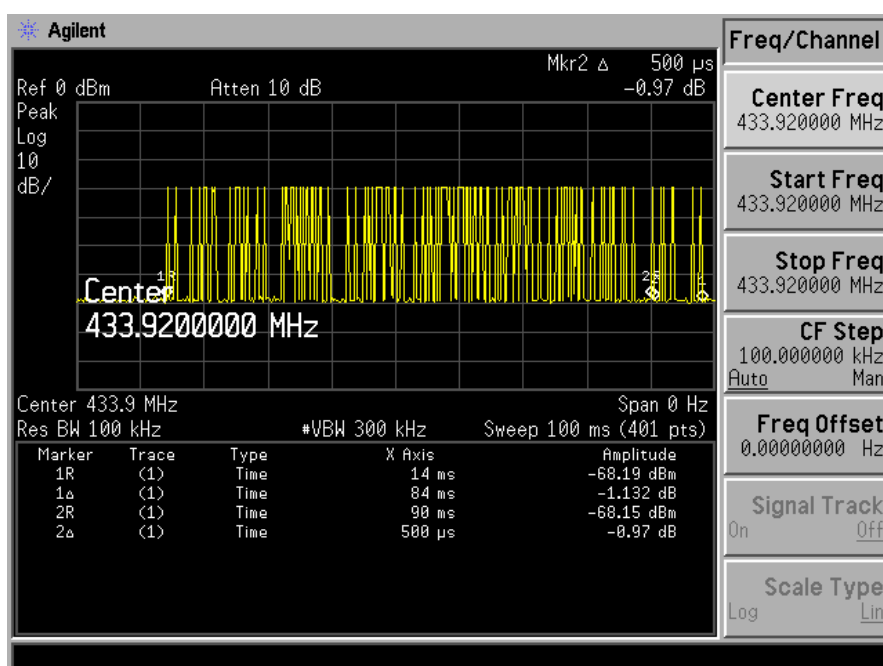
$$20\log(\text{Duty cycle})=20\log(39.5\text{ms}/100\text{ms})=-8.07 \text{ dB}$$

(Note: 39.5ms=0.5ms\*79;)

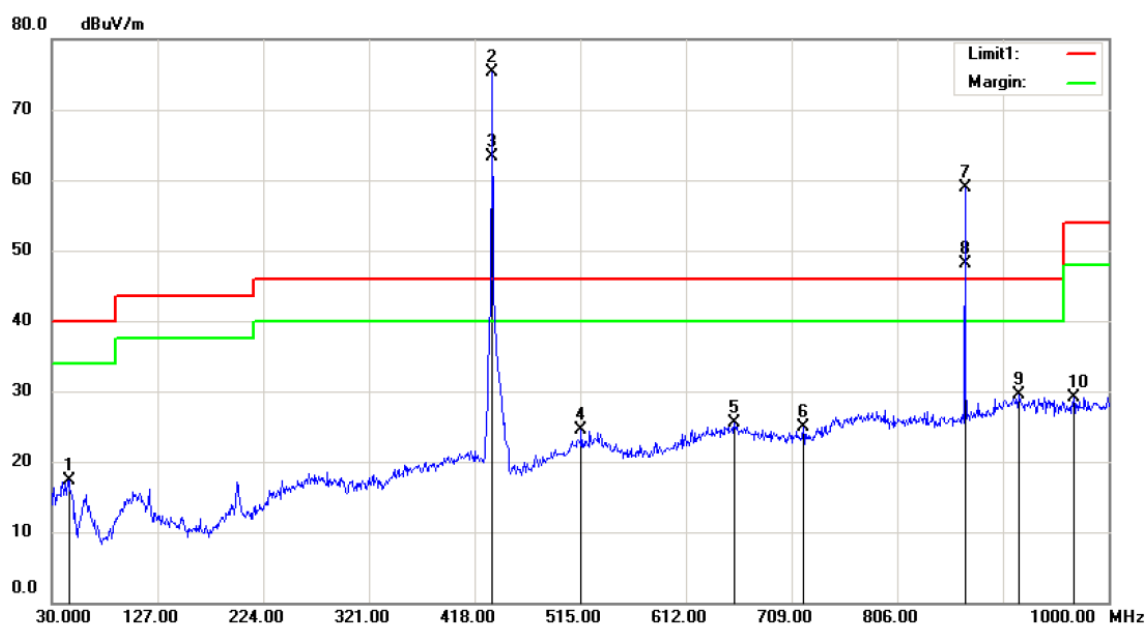
Therefore, the averaging factor is -8.07dB.

Please see the diagrams below:





#### 4.6. Measurement Result



Site 3m Chamber #1

Polarization: **Horizontal**

Temperature: 24 C

Limit: (RE)FCC PART 15 CLASS B

Power: DC 3V

Humidity: 53 %

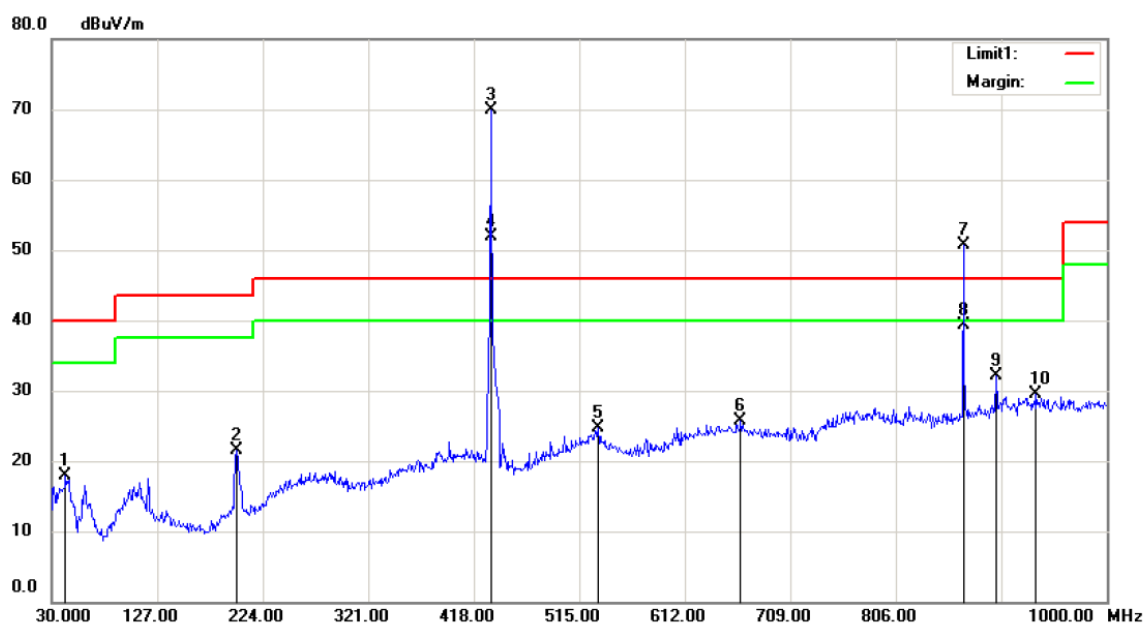
Mode: ON

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree degree	Comment
1		45.5200	29.72	-12.37	17.35	40.00	-22.65	QP		
2	*	433.9200	84.56	-9.34	75.22	92.87	-17.65	QP		
3	X	433.9200	76.49	-9.34	67.15	72.87	-5.72	AVG		
4		515.9700	30.92	-6.43	24.49	46.00	-21.51	QP		
5		656.6200	30.29	-4.81	25.48	46.00	-20.52	QP		
6		719.6700	30.88	-5.92	24.96	46.00	-21.04	QP		
7	X	867.8400	61.78	-2.81	58.97	72.87	-13.90	QP		
8	X	867.8400	51.71	-2.81	48.90	52.87	-3.97	AVG		
9		917.5500	30.39	-0.87	29.52	46.00	-16.48	QP		
10		967.9900	30.75	-1.62	29.13	54.00	-24.87	QP		

\*:Maximum data    x:Over limit    !:over margin

Operator: ZHL



Site 3m Chamber #1

Polarization: **Vertical**

Temperature: 24 C

Limit: (RE)FCC PART 15 CLASS B

Power: DC 3V

Humidity: 53 %

Mode: ON

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Antenna Height cm	Table Degree	Comment
1		42.6100	29.44	-11.57	17.87	40.00	-22.13	QP		
2		199.7500	37.09	-15.68	21.41	43.50	-22.09	QP		
3	*	433.9200	79.10	-9.26	69.84	92.87	-23.03	QP		
4	X	433.9200	71.03	-9.26	61.77	72.87	-11.10	AVG		
5		532.4600	30.77	-6.13	24.64	46.00	-21.36	QP		
6		663.4100	30.54	-4.86	25.68	46.00	-20.32	QP		
7	X	867.8400	53.56	-2.81	50.75	72.87	-22.12	QP		
8		867.8400	45.49	-2.81	42.68	52.87	-10.19	AVG		
9		898.1500	33.86	-1.69	32.17	46.00	-13.83	QP		
10		935.0100	30.69	-1.19	29.50	46.00	-16.50	QP		

\*:Maximum data    x:Over limit    !:over margin

Operator: ZHL

Operation Mode: 433.92MHz  
Frequency Range: 1000~5000MHz  
Test Result: PASS  
Measured Distance: 3m

Test Date : January 27, 2015  
Temperature : 24℃  
Humidity : 53 %  
Test By: King Kong

Freq. (MHz)	Ant.Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Margin(dB)	
		PK	AV	PK	AV	PK	AV
2320.00	V	38.63	28.60	74.00	54.00	-35.37	-25.40
2704.00	V	39.83	26.70	74.00	54.00	-34.17	-27.30
3652.00	V	43.41	28.90	74.00	54.00	-30.59	-25.10
4192.00	V	46.87	28.70	74.00	54.00	-27.13	-25.30
4516.00	V	49.31	30.60	74.00	54.00	-24.69	-23.40
4728.00	V	49.40	31.40	74.00	54.00	-24.60	-22.60
2508.00	H	40.30	32.50	74.00	54.00	-33.70	-21.50
2832.00	H	41.78	29.60	74.00	54.00	-32.22	-24.40
3104.00	H	43.42	31.80	74.00	54.00	-30.58	-22.20
3464.00	H	45.51	32.70	74.00	54.00	-28.49	-21.30
4460.00	H	46.53	32.50	74.00	54.00	-27.47	-21.50

- Note: (1) All Readings are Peak Value.  
(2) Correct Factor= Antenna Factor +Cable Loss- Amplifier Gain  
(3) Emission Level= Reading Level+Probe Factor +Cable Loss  
(4) True Value = Emission Level + Duty Cycle Correction Factor  
(5) DF= Duty Cycle Correction Factor  
(6) Duty Cycle Correction Factor (dB) =  $20 \times \log_{10} \text{Duty Cycle}$   
(7) Margin = TrueValue – limit(if margin is minus means under limit)  
(8) The “\*” means restricted bands  
(8) All the x/y/z orientation has been investigated, and only worst case is presented in this report.



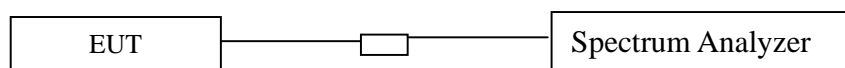
## 5. TRANSMISSION REQUIREMENT

### 5.1. Requirement

Per 15.231(e):

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

### 5.2. Test SET-UP



### 5.3. Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4407B	88156318	05/17/2014	05/16/2015

### 5.4. Test Procedure

The following table is the setting of spectrum analyzer.

Spectrum analyzer	Setting
Attenuation	Auto
Span Frequency	0Hz
RB	100KHz
VB	300KHz
Detector	Peak
Trace	Max hold
Sweep Time	10S

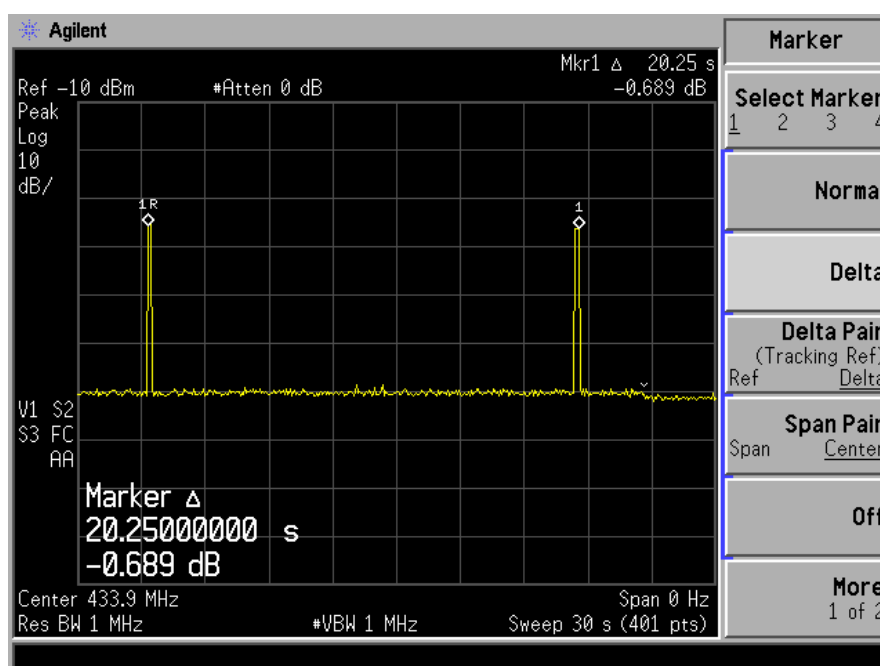
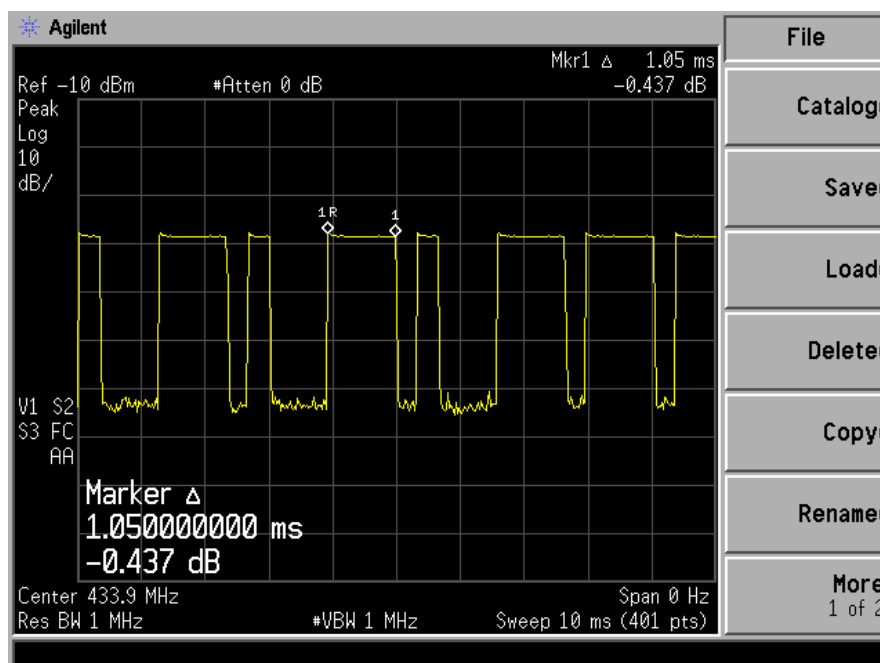
- The transmitter output (antenna port) was connected to the spectrum analyzer.
- Set RBW of spectrum analyzer to 100KHz and VBW to 300KHz, Set Detector to Peak, Trace to Max Hold.
- Set the span to 0Hz and the sweep time to 10s and record the value.

### 5.5. Test Data

Environmental Conditions

Temperature:	24°C
Relative Humidity:	53%
ATM Pressure:	1032mbar

Test Mode: Transmitting



TX on=1.05 ms

Tp=20.25 s

Silent period limit(which one is lower)=10s or

$1.05 \times 30 = 31.5$  ms

TX Silent period=20.25s-1.05ms=20.2395s

Pulse Width(PW)=Ton=0.5,  $2/PW = 2/0.5 = 4$  KHz, RBW=100KHz>4KHz,

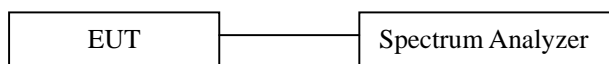
Therefore PDCF is not needed.

## 6. BANDWIDTH TEST

### 6.1. Measurement Procedure

The EUT was operated in hopping mode or could be controlled its channel. Print out the test result from the spectrum by hard copy function.

### 6.2. Test SET-UP (Block Diagram of Configuration)



The test setup used to transmitter bandwidth measurement was the same with duty cycle test, except there is no need for digital oscilloscope in the bandwidth test. For detailed description, please reference to section 5.1, 5.2, 5.3 and 5.4 on page 11 and 12 of this report.

The resolution bandwidth of the spectrum analyzer was set to 100KHz, which is greater 5 percent of the maximum permitted bandwidth that required by the ANSI C63.4 section 13. Bandwidth is determined at the point 20dB down from the modulator carrier. The maximum permitted bandwidth specified by the rule was 0.25% of the center frequency of the EUT, e.g.  $433.92\text{MHz} \times 0.25\% = 1.0848\text{MHz}$ . The detector function was set to peak and hold mode to clearly observe the components.

Industry Canada Occupied Bandwidth measured at 99% must be no wider than 0.25% of the fundamental frequency of 433.92MHz. Limit is 1.0848 MHz.

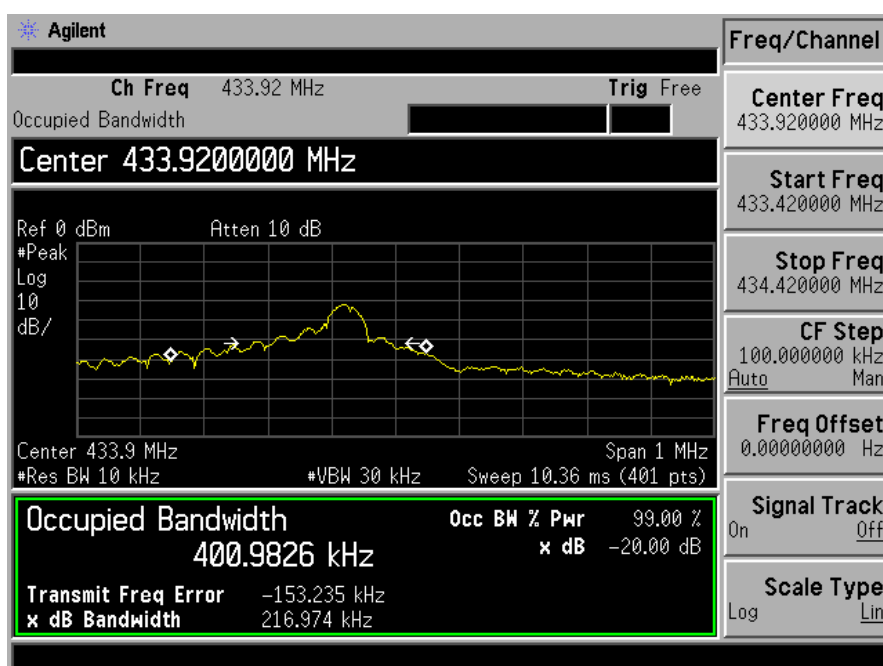
### 6.3. Measurement Equipment Used:

EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4407B	88156318	05/17/2014	05/16/2015

### 6.4. Measurement Results:

Spectrum Detector:	PK	Test Date:	January 27, 2015
Test By:	King Kong	Temperature:	24°C
Test Result:	PASS	Humidity:	53 %
Modulation:	OOK		

Channel frequency (MHz)	20dB Down BW(kHz)	99% BW(kHz)	Limit
433.92	216.974	400.9826	≤1084.8KHz



## **7. Antenna Application**

### **7.1. Antenna Requirement**

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

### **7.2. Result**

The EUT's antenna is Loop antenna, using a permanently attached antenna which is not replaceable. The antenna's gain is -26dBi and meets the requirement.

END OF REPORT