

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

*OF*

**Transmitter**

**MODEL No.: LM121**

**Trademark: N/A**

**FCC ID: VW5-LM121**

**REPORT NO: SCT2014071022**

**ISSUE DATE: July 09, 2014**

*Prepared for*

**HANGZHOU SANFORD TOOLS CO., LTD**

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*Prepared by*

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## VERIFICATION OF COMPLIANCE

Applicant:	HANGZHOU SANFORD TOOLS CO., LTD NO.8 , Sheng Di Road, Yuhang Town, Hangzhou, 311121, China
Manufacturer:	HANGZHOU SANFORD TOOLS CO., LTD NO.8 , Sheng Di Road, Yuhang Town, Hangzhou, 311121, China
Product Description:	Transmitter
Model Number:	LM121
Serial Number:	N/A
Power Supply:	12V DC(Supplied by Lithium battery)
File Number:	SCT2014071022
Date of Test:	July 01, 2014 to July 09, 2014

### We hereby certify that:

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 (2009) and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits of FCC Rules Part 15.231.

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

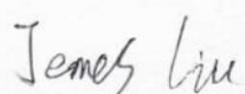
Date of Test : July 01, 2014 to July 09, 2014

Testing Engineer:



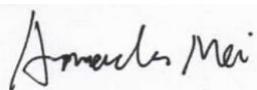
(Jack xie)

Technical Manager :



(Jemes liu)

Authorized Signatory :



(Amanda mei)

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## 8 GENERAL INFORMATION

### 8.1 Product Description

Hangzhou Sanford Tools Co., Ltd

Transmitter (referred to as the EUT in this report) LM121, It is designed by way of utilizing the FSK modulation achieves the system operating.

A major technical descriptions of EUT is described as following:

- A). Operation Frequency: 433.92MHz
- B). Modulation: FSK
- C). Antenna Type: PCB Printed antenna
- D). Antenna Gain: 0.5dBi
- E).Power Supply: 12V DC(Supplied by Lithium battery)

### 8.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for FCC ID: VW5-LM121 filing to comply with Section 15.231 of the FCC Part 15, Subpart C Rules.

### 8.3 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10 (2009). Radiated testing was performed at an antenna to EUT distance 3 meters.

### 8.4 Special Accessories

Not available for this EUT intended for grant.

### 8.5 Equipment Modifications

Not available for this EUT intended for grant.

## 8.6 Measurement Uncertainty

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±3.00dB
Fundamental Fieldstrength	Not Applicable	95%	±2.94dB
Transmitter 20 dB Bandwidth	Not Applicable	95%	±0.92PPm
Radiated Spurious Emissions	30 MHz to 40 GHz	95%	±3.00dB

## 8.7 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, October 28, 2010 The Certificate Registration Number is 406365.
	Accredited by Industry Canada, March 5, 2010 The Certificate Registration Number is 46405-4480.
Name of Firm	: SHENZHEN EMTEK CO., LTD
Site Location	: Bldg 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China

## **9 SYSTEM TEST CONFIGURATION**

### **9.1 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.

### **9.2 EUT Exercise**

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

### **9.3 Test Procedure**

#### **2.3.1 Conducted Emissions**

The EUT is placed on a turn table which is 0.8 m above ground plane. According to the requirements in Section 13.1.4.1 of ANSI C63.4-2009 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-Peak and average detector mode.

#### **2.3.2 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 C63.4-2009.

#### 9.4 Description of test modes

The EUT (Transmitter) has been tested under normal operating condition. Let EUT transmit during test, and the result was reported; Two buttons had been investigated for all the test, and the test results were same, only one case was presented in this report.

#### 9.5 Summary of Test Results

FCC Part15, Subpart C		
Standard Section	Test Item	Result
FCC		
15.207	Conducted Emission	N/A
15.231(a)(1)	Transmission Requirement	Pass
15.231(b)	Radiated Emission	Pass
15.231(c)	20dB Bandwidth	Pass

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

#### 9.6 CONFIGURATION OF TESTED SYSTEM

**Fig. 2-1 Configuration of Tested System**



#### 9.7 DESCRIPTION OF SUPPORT UNITS

Equipment	Mfr/Brand	Model/Type No.	FCC ID / IC	Series No.	Note
Transmitter	N/A	LM121	VW5-LM121	N/A	EUT

## 10 CONDUCTED EMISSIONS TEST

### 10.1 Measurement Procedure:

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

### 12.1 Test SET-UP (Block Diagram of Configuration)



### 12.2 Measurement Equipment Used:

Conducted Emission Test Site # 1					
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
L.I.S.N	Rohde & Schwarz	ENV216	834549/005	05/17/2014	05/16/2015
50ΩCoaxial Switch	Anritsu	MP59B	M20531	05/17/2014	05/16/2015
Cable	Rohde & Schwarz	AK9513	N/A	05/17/2014	05/16/2015

### 12.3 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

#### 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.

### 12.4 Measurement Result:

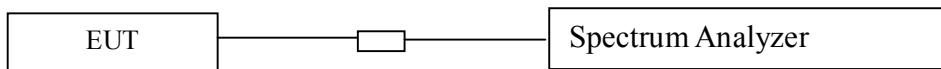
Note: Not applicable, the EUT power supply from DC 12V battery.

## 13 Transmission Requirement

### 13.1 Requirement

Per 15.231(a) (1), a manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

### 13.2 Test SET-UP



### 13.3 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

### 13.4 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	50S

- 14 The transmitter output (antenna port) was connected to the spectrum analyzer.
- 15 Set RBW of spectrum analyzer to 100KHz and VBW to 300KHz, Set Detector to Peak, Trace to Max Hold.
- 16 Set the span to 0Hz and the sweep time to 50s and record the value.
- 17 Pressed button 50s during test.

### 17.1 Test Data

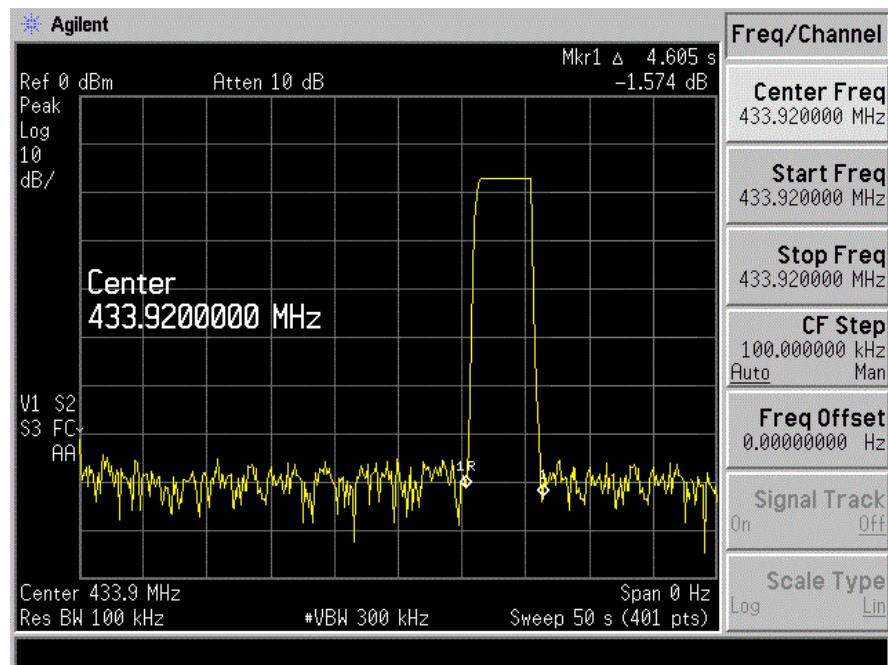
#### Environmental Conditions

Temperature:	25 °C
Relative Humidity:	52%
ATM Pressure:	1032mbar

Test Mode: Transmitting

Transmitting time	Limit (Second)	Result
4.605S	5	PASS

Refer to the attached plot



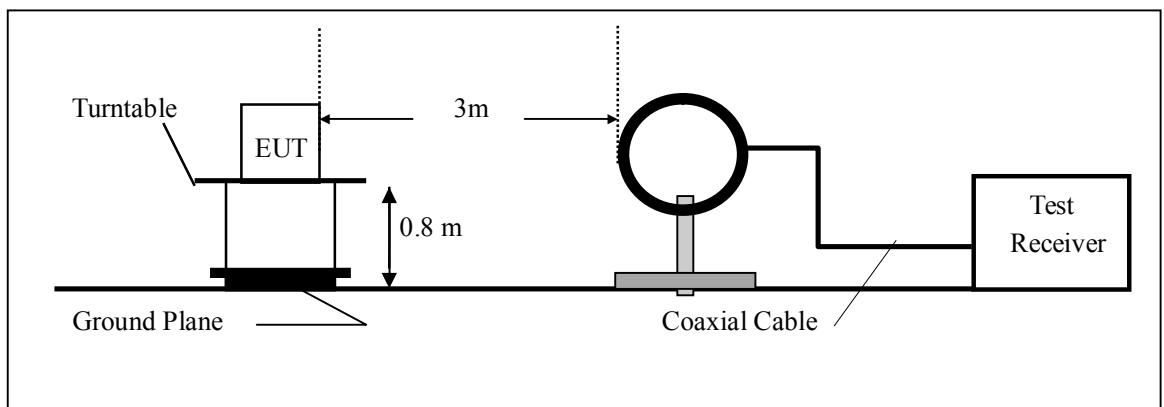
## 18 RADIATED EMISSION TEST

### 18.1 Measurement Procedure

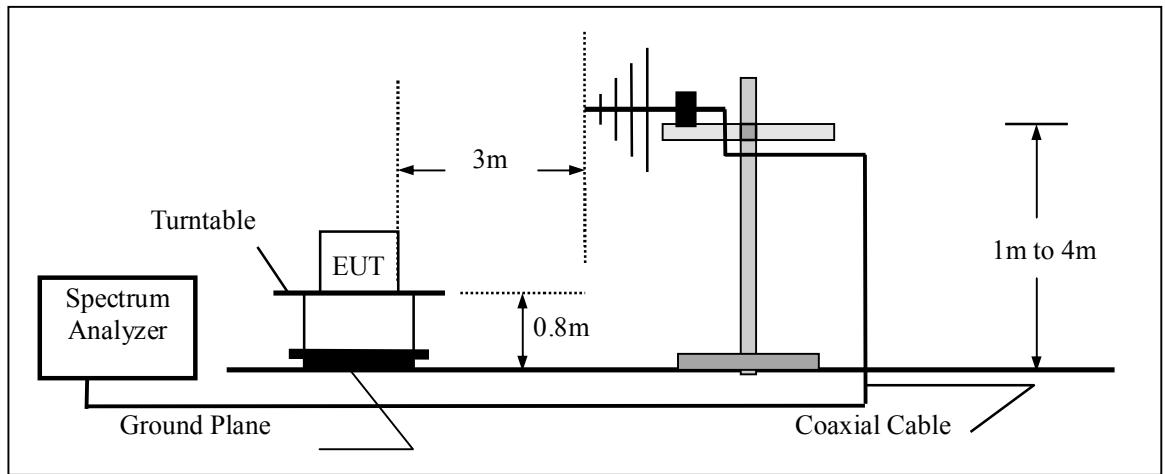
- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter Semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(below 1GHz)
- b. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter Semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(above 1GHz)
- c. 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.
- d. 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.
- e. 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.

### 18.2 Test SET-UP (Block Diagram of Configuration)

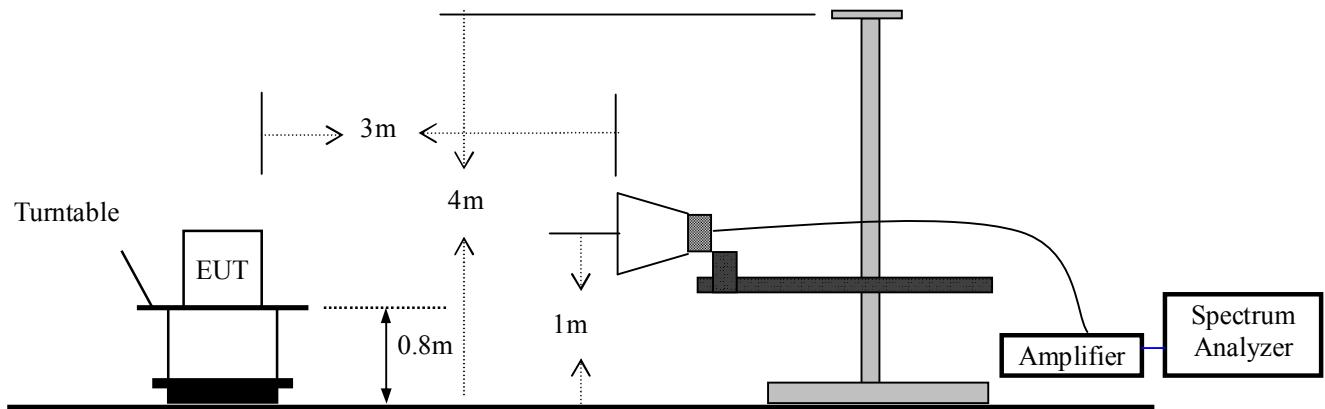
#### 19 Radiated Emission Test Set-Up, Frequency Below 30MHz



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



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



### 19.1 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	05/10/2014	05/09/2015
Loop Antenna	ARA	PLA-1030/B	1029	05/10/2014	05/09/2015
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170399	05/10/2014	05/09/2015
Horn Antenna	Schwarzbeck	BBHA 9120	D143	05/10/2014	05/09/2015
Cable	Rosenberger	AK9512	N/A	05/10/2014	05/09/2015
Cable	Schwarzbeck	AK9513	N/A	05/10/2014	05/09/2015
Cable	Schwarzbeck	AK9514	N/A	05/10/2014	05/09/2015

## 19.2 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
960~1000500	3	
Above 1GHz	74 dBuV/m (PEAK) 54 dBuV/m (AVERAGE)	

## 15.231 Limited

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66 - 40.70	2,250	225
70 - 130	1,250	125
130 - 174	1,250 to 3,750 **	125 to 375 **
174 - 260	3,750	375
260 - 470	3,750 to 12,500 **	375 to 1,250 **
Above 470	12,500	1,250

\*\* linear interpolations

The field intensity in micro-volts per meter can then be determined by the following equation:  
 $FI(V/m) = 10FI(dBV/m) / 20$  The FCC specified emission limits were calculated according the EUT operating frequency and obtained by following linear interpolation equations:

## 19.3 For fundamental frequency:

$$f_{EUT} : \text{EUT Operating Frequency Emission Limit (V/m)}$$

$$= [f_{EUT}(\text{MHz}) - 260(\text{MHz})] \times \frac{12500(\text{V/m}) - 3750(\text{V/m})}{470(\text{MHz}) - 260(\text{MHz})} + 3750(\text{V/m})$$

## 19.4 For spurious frequencies:

$$f_{EUT} : \text{EUT Operating Frequency Emission Limit (V/m)}$$

$$= [f_{EUT}(\text{MHz}) - 260(\text{MHz})] \times \frac{1250(\text{V/m}) - 375(\text{V/m})}{470(\text{MHz}) - 260(\text{MHz})} + 375(\text{V/m})$$

Other emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or comply with the radiated emissions limits specified in section 15.209(a) limit in the table below has to be followed.

Note:

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

FCC Part15 (15.231) , Subpart C		
Fundamental Frequency	Field Strength Of Fundamental	Field Strength of Spurious Emissions
433.92MHz	AV:80.82 dBuV/m at 3m distance	AV:60.82 dBuV/m at 3m distance
	PK:100.82dBuV/m at 3m distance	PK:80.82 dBuV/m at 3m distance

### 19.5 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)

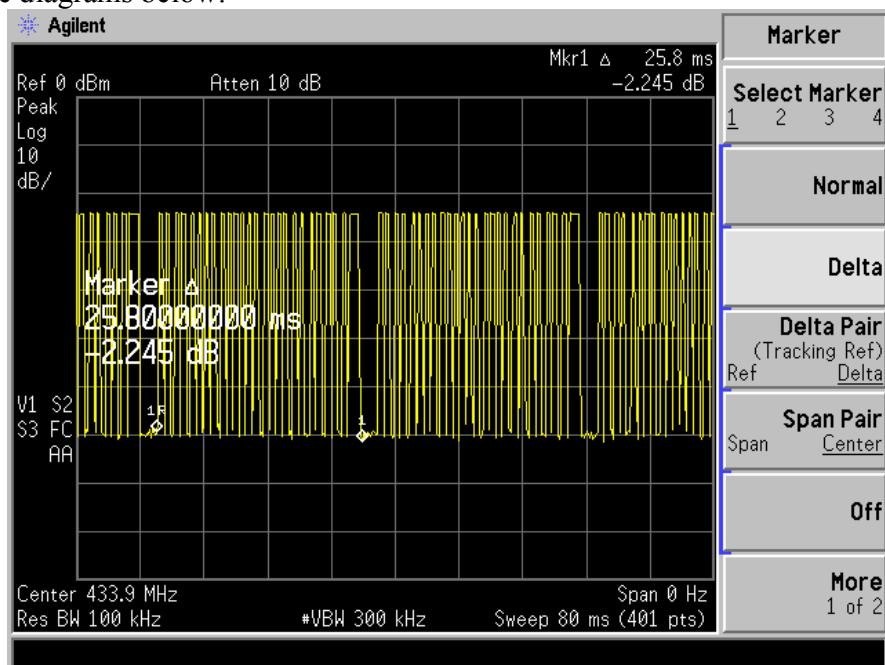
Where the duty factor is calculated from following formula:

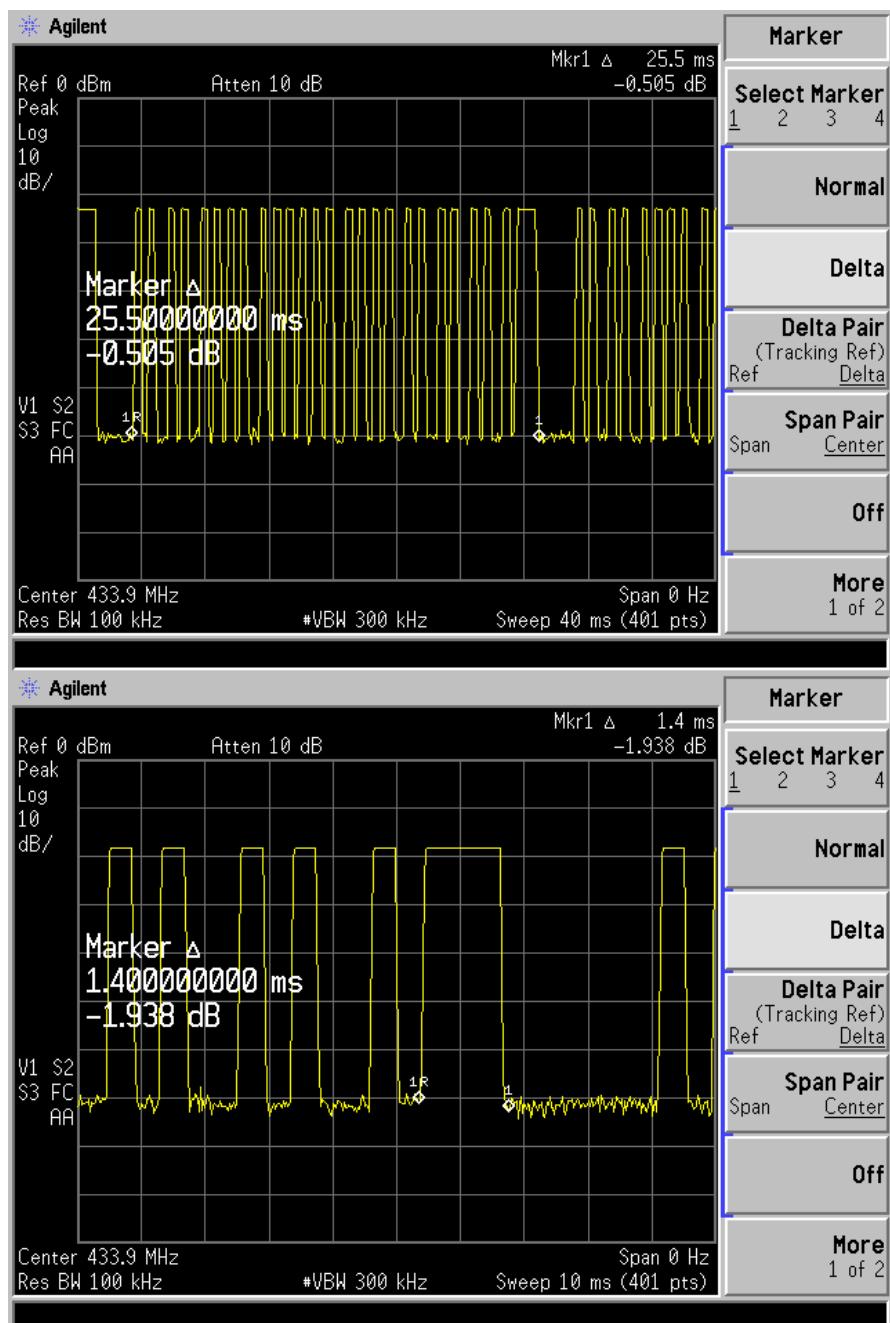
$$20\log(\text{Duty cycle})=20\log((1.4\text{ms}+0.475\text{ms}*25)/25.5\text{ms})=-5.67 \text{ dB}$$

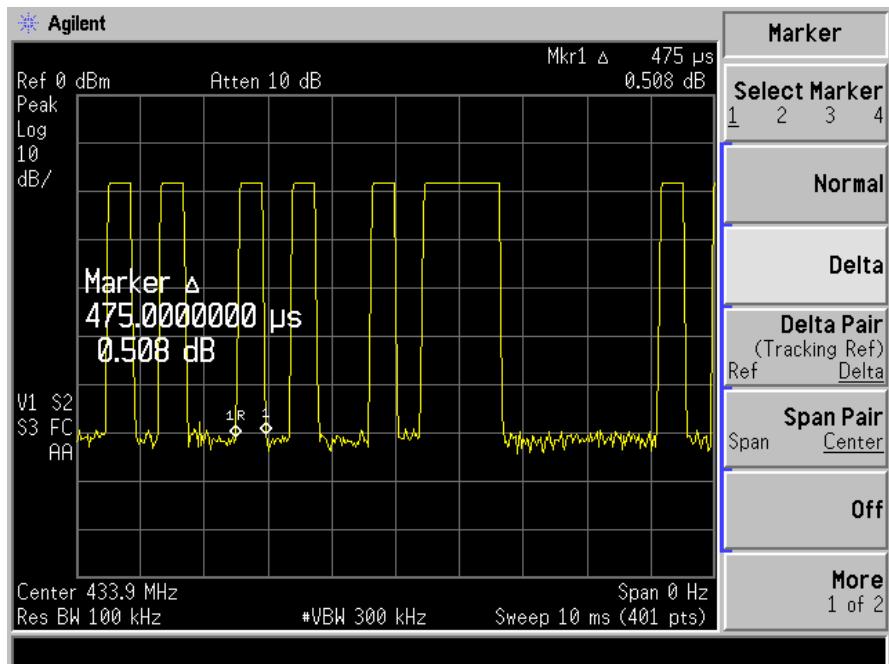
Therefore, the averaging factor is -5.67dB.

**The signal bandwidth was measured and less then 100KHz RBW so PDCF factor is not required**

Please see the diagrams below:







## 19.6 Measurement Result

Operation Mode: 433.92MHz Test Date : July 07, 2014  
 Frequency Range: 30~5000MHz Temperature : 24°C  
 Test Result: PASS Humidity : 55 %  
 Measured Distance: 3m Test By: Jack

Freq. (MHz)	Ant.Pol. H/V	Emission Level (dBuV/m)	DF (dB)	TrueValue (dBuV/m)	Limit 3m (dBuV/m)	Margin (dB)
433.92	V	75.14	-5.67	69.47	80.82	-11.35
867.84	V	58.53	-5.67	52.86	60.82	-7.96
1301.76*	V	53.85	-5.67	48.18	54	-5.82
1735.68	V	55.55	-5.67	49.88	60.82	-10.94
2169.60	V	54.56	-5.67	48.89	60.82	-11.93
2603.52	V	47.61	-5.67	41.94	60.82	-18.88
433.92	H	77.16	-5.67	71.49	80.82	-9.33
867.84	H	63.53	-5.67	57.86	60.82	-2.96
1301.76*	H	63.06	-5.67	57.39	60.82	-3.43
1735.68	H	54.68	-5.67	49.01	54	-4.99
2169.60	H	53.21	-5.67	47.54	60.82	-13.28
2603.52	H	50.78	-5.67	45.11	60.82	-15.71

**Note:** (1) All Readings are Peak Value.

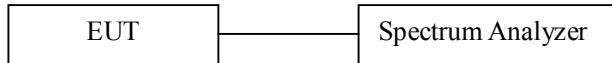
- (2) Emission Level= Reading Level+Probe Factor +Cable Loss
- (3) True Value = Emission Level + Duty Cycle Correction Factor
- (4) DF= Duty Cycle Correction Factor
- (5) Duty Cycle Correction Factor (dB) =  $20 \times \log_{10}$  Duty Cycle
- (6) Margin = TrueValue – limit(if margin is minus means under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

## 20 BANDWIDTH TEST

### 20.1 Measurement Procedure

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

### 20.2 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 section13. 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.  $433.92\text{MHz} * 0.25\% = 1.0848\text{MHz}$ . The detector function was set to peak and hold mode to clearly observe the components.

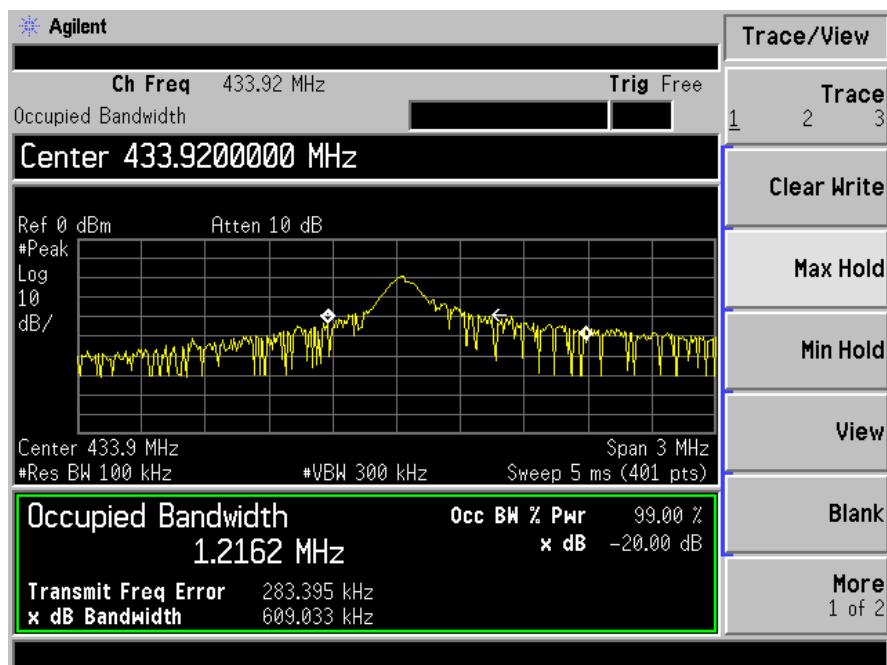
### 20.3 Measurement Equipment Used:

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

### 20.4 Measurement Results:

Spectrum Detector:	PK	Test Date:	July 07, 2014
Test By:	Andy	Temperature:	24 °C
Test Result:	PASS	Humidity:	55 %
Modulation:	FSK		

Channel number	Channel frequency (MHz)	20dB Down BW(kHz)	Limit
CH1	433.92	609.033	≤1084.8KHz



## **21 Antenna Application**

### **21.1 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.

### **21.2 Result**

The EUT'S antenna is PCB Printed antenna. The antenna's gain is 0.5dBi and meets the requirement.