

APPLICATION CERTIFICATION
On Behalf of
Fine Offset Electronics Co., Ltd.

Soil Moisture Sensor
Model No.: WH51

FCC ID: WA5WH51

Prepared for : Fine Offset Electronics Co., Ltd.
Address : 2/F., Building no.3, Ping Shan Minqi Industrial Park, Xili
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Report Number : ATE20180640
Date of Test : May 3-May 4, 2018
Date of Report : May 7, 2018

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Test Report Certification

Applicant : Fine Offset Electronics Co., Ltd.
Manufacturer : Fine Offset Electronics Co., Ltd.
EUT Description : Soil Moisture Sensor
Model No. : WH51

Measurement Procedure Used:

**FCC Rules and Regulations Part 15 Subpart C Section 15.231e
ANSI C63.10-2013**

The device described above is tested by Shenzhen Accurate Technology Co., Ltd. to determine the maximum emission levels emanating from the device. The maximum emission levels are compared to the FCC Part 15 Subpart C Section 15.231a. The measurement results are contained in this test report and Shenzhen Accurate Technology Co., Ltd. is assumed full responsibility for the accuracy and completeness of these measurements. Also, this report shows that the Equipment Under Test (EUT) is to be technically compliant with the FCC requirements.

This report applies to above tested sample only. This report shall not be reproduced in part without written approval of Shenzhen Accurate Technology Co., Ltd.

Date of Test : May 3-May 4, 2018
Date of Report : May 7, 2018

Prepared by : _____
(St. Yang Engineer)

Approved & Authorized Signer : _____
(Sean Liu, Manager)



1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT	:	Soil Moisture Sensor
Model Number	:	WH51
Power Supply	:	DC 1.5V (Powered by battery)
Modulation Mode	:	FSK
Operation Frequency	:	433.92MHz
Antenna type	:	Integral Antenna
Antenna gain	:	2.15dBi
RF power setting in test	:	Max power
Applicant	:	Fine Offset Electronics Co., Ltd.
Address	:	2/F., Building no.3, Ping Shan Minqi Industrial Park, Xili Town, Nanshan District, Shenzhen City, China
Manufacturer	:	Fine Offset Electronics Co., Ltd.
Address	:	2/F., Building no.3, Ping Shan Minqi Industrial Park, Xili Town, Nanshan District, Shenzhen City, China
Date of sample received	:	April 24, 2018
Date of Test	:	May 3-May 4, 2018

1.2. Accessory and Auxiliary Equipment

N/A

1.3. Description of Test Facility

EMC Lab	:	Recognition of accreditation by Federal Communications Commission (FCC) The Designation Number is CN1189 The Registration Number is 708358
		Listed by Innovation, Science and Economic Development Canada (ISED) The Registration Number is 5077A-2
		Accredited by China National Accreditation Service for Conformity Assessment (CNAS) The Registration Number is CNAS L3193
		Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 4297.01
Name of Firm	:	Shenzhen Accurate Technology Co., Ltd.
Site Location	:	1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China

1.4. Measurement Uncertainty

Conducted Emission Expanded Uncertainty	=	2.23dB, k=2
Radiated emission expanded uncertainty (9kHz-30MHz)	=	3.08dB, k=2
Radiated emission expanded uncertainty (30MHz-1000MHz)	=	4.42dB, k=2
Radiated emission expanded uncertainty (Above 1GHz)	=	4.06dB, k=2

2. MEASURING DEVICE AND TEST EQUIPMENT

Table 1: List of Test and Measurement Equipment

Kind of equipment	Manufacturer	Type	S/N	Calibrated dates	Cal. Interval
EMI Test Receiver	Rohde&Schwarz	ESCS30	100307	Jan. 06, 2018	One Year
EMI Test Receiver	Rohde&Schwarz	ESPI3	101526/003	Jan. 06, 2018	One Year
Spectrum Analyzer	Agilent	E7405A	MY45115511	Jan. 06, 2018	One Year
Pre-Amplifier	Rohde&Schwarz	CBLU118354 0-01	3791	Jan. 06, 2018	One Year
Loop Antenna	Schwarzbeck	FMZB1516	1516131	Jan. 12, 2018	One Year
Bilog Antenna	Schwarzbeck	VULB9163	9163-323	Jan. 12, 2018	One Year
Horn Antenna	Schwarzbeck	BBHA9120D	9120D-655	Jan. 12, 2018	One Year
Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1067	Jan. 12, 2018	One Year
LISN	Rohde&Schwarz	ESH3-Z5	100305	Jan. 06, 2018	One Year
LISN	Schwarzbeck	NSLK8126	8126431	Jan. 06, 2018	One Year
Highpass Filter	Wainwright Instruments	WHKX3.6/18 G-10SS	N/A	Jan. 06, 2018	One Year
Band Reject Filter	Wainwright Instruments	WRCG2400/2 485-2375/2510 -60/11SS	N/A	Jan. 06, 2018	One Year

3. SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
Section 15.207	Conducted Emission	N/A
Section 15.231(e)	Radiated Emission	Compliant
Section 15.231(c)	20dB Bandwidth	Compliant
Section 15.231(e)	Release Time Measurement	Compliant
Section 15.203	Antenna Requirement	Compliant

The product is a automatic operated Soil Moisture Sensor.

Note: The power supply mode of the EUT is DC 1.5V, According to the FCC standard requirements, conducted emission is not applicable

All normal using modes of the normal function were tested but only the worst test data of the worst mode is recorded by this report.

4. THE FIELD STRENGTH OF RADIATION EMISSION

4.1. Block Diagram of Test Setup

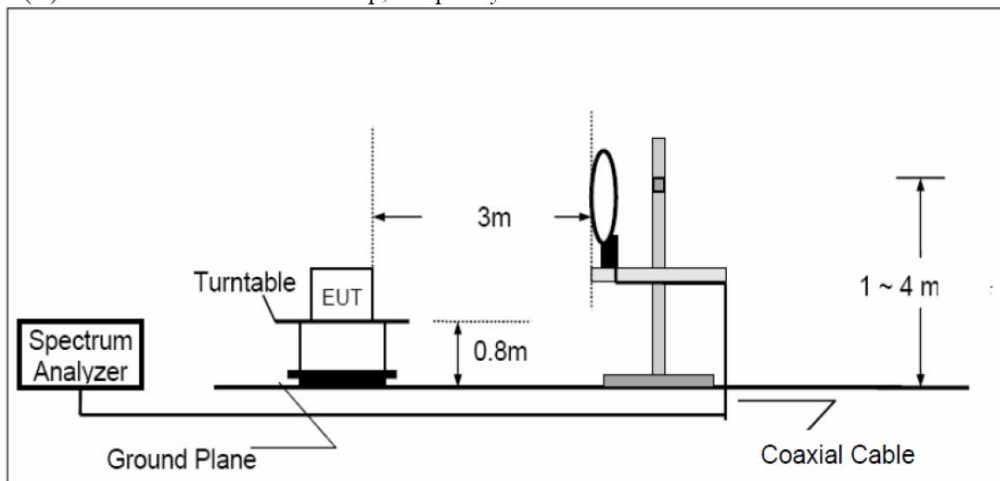
4.1.1. Block diagram of connection between the EUT and simulators



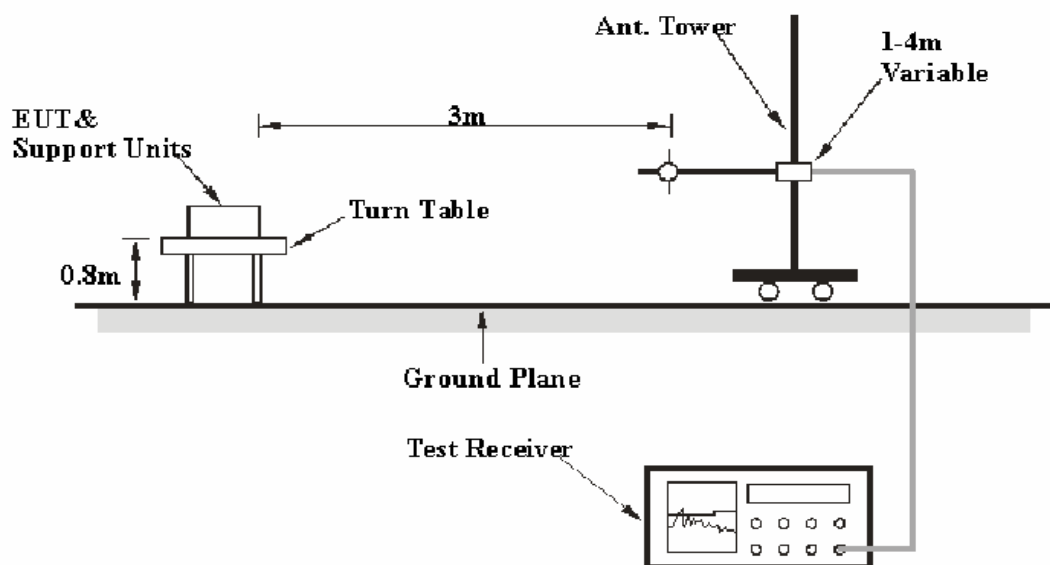
(EUT: Soil Moisture Sensor)

4.1.2. Semi-Anechoic Chamber Test Setup Diagram

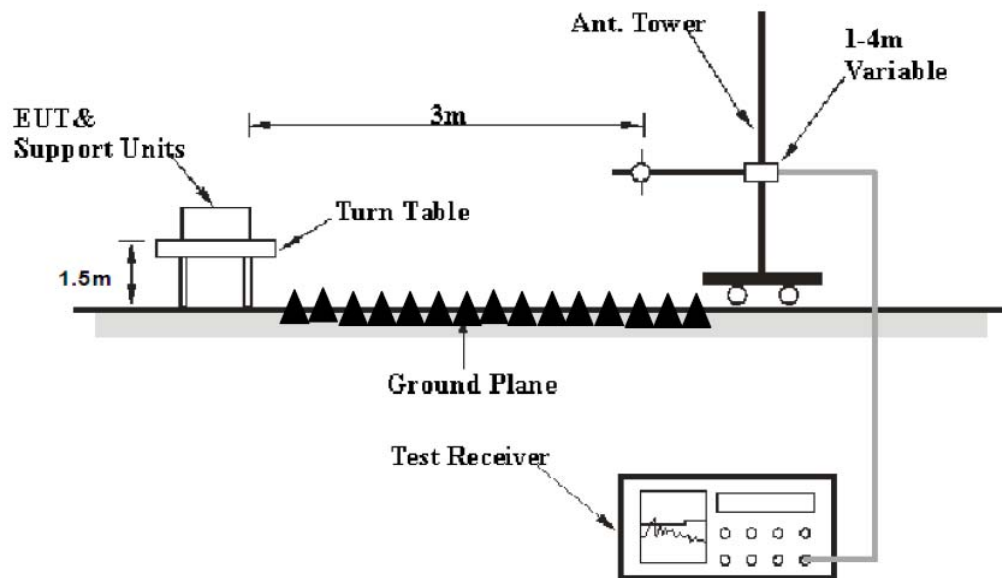
(A) Radiated Emission Test Set-Up, Frequency below 30MHz



(B) Radiated Emission Test Set-Up, Frequency 30-1000MHz



(C) Radiated Emission Test Set-Up, Frequency above 1GHz



4.2. The Field Strength of Radiation Emission Measurement Limits

4.2.1. Radiation Emission Measurement Limits According to FCC Part 15 Section 15.231(e)

Funda-mental fre- quency (MHz)	Field strength of fun- damental (microvolts/ meter)	Field strength of spu- rious emission (microvolts/meter)
40.66– 40.70.	1,000	100
70–130	500	50
130–174	500 to 1,500 ¹	50 to 150 ¹
174–260	1,500	150
260–470	1,500 to 5,000 ¹	150 to 500 ¹
Above 470	5,000	500

¹ 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 130-174 MHz, uV/m at 3 meters = 22.73(F) – 2454.55; for the band 260-470 MHz, uV/m at 3 meters = 16.67(F) - 2833.33 The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.

4.2.2. Restricted Band Radiation Emission Measurement Limits According to FCC part 15 Section 15.205 and Section 15.209.

4.3. Configuration of EUT on Measurement

The equipment is installed on Radiated Emission Measurement to meet the commission requirements and operating regulations in a manner which tends to maximize its emission characteristics in normal application.

4.4. Operating Condition of EUT

4.4.1. Setup the EUT and simulator as shown as Section 4.1.

4.4.2. Turn on the power of all equipment.

4.4.3. Let the EUT work in TX mode measure it.

4.5. Test Procedure

The EUT and its simulators are placed on a turntable, which is 0.8 meter high above ground (Below 1GHz). The EUT and its simulators are placed on a turntable, which is 1.5 meter high above ground (Above 1GHz). The turntable can rotate 360 degrees to determine the position of the maximum emission level. EUT is set 3.0 meters away from the receiving antenna, which is mounted on an antenna tower. The antenna can be moved up and down between 1.0 meter and 4 meters to find out the maximum emission level. Broadband antenna (calibrated bi-log antenna) is used as receiving antenna. Both horizontal and vertical polarizations of the antenna are set on measurement. In order to find the maximum emission levels, all of the EUT location must be manipulated according to ANSI C63.10:2013 on radiated emission measurement. This EUT was tested in 3 orthogonal positions and the worst case position data was reported.

The bandwidth of test receiver is set at 120 kHz in 30-1000 MHz, and 1 MHz in 1000 MHz.

4.6. The Field Strength of Radiation Emission Measurement Results

PASS.

The frequency range from 30 MHz to 10GHz is checked.

EUT : Soil Moisture Sensor		Model No. : WH51		Power Supply : DC 1.5V						
Test Mode : TX		Test Engineer : Frank								
Frequency (MHz)	Reading (dBμV/m)	Factor Corr.	Average Factor	Result(dBμV/m)		Limit(dBμV/m)		Margin(dB)		Polarization
	PEAK	(dB)	(dB)	AV	PEAK	AV	PEAK	AV	PEAK	
433.92	93.16	-13.51	-12.62	67.03	79.65	72.87	92.87	-5.84	-13.22	Horizontal
867.8446	48.65	-5.01	-12.62	31.02	43.64	52.87	72.87	-21.85	-29.23	
1735.689	46.88	-10.33	-12.62	23.93	36.55	52.87	72.87	-28.94	-36.32	
433.92	95.63	-13.51	-12.62	69.50	82.12	72.87	92.87	-3.37	-10.75	Vertical
867.8445	48.83	-5.01	-12.62	31.20	43.82	52.87	72.87	-21.67	-29.05	
1735.689	48.67	-10.33	-12.62	25.72	38.34	52.87	72.87	-27.15	-34.53	

Note:

1. Emissions attenuated more than 20 dB below the permissible value are not reported.
2. The field strength is calculated by adding the antenna factor, high pass filter loss(if used) and cable loss, and subtracting the amplifier gain(if any)from the measured reading. The basic equation calculation is as follows:

$$\text{Result} = \text{Reading} + \text{Corrected Factor}$$

$$\text{Where Corrected Factor} = \text{Antenna Factor} + \text{Cable Loss} + \text{High Pass Filter Loss} - \text{Amplifier Gain}$$

$$3. \text{FCC Limit for Average Measurement} = 16.67 * (433.92) - 2833.33 = 4400.1164 \mu\text{V/m} = 72.87 \text{ dB}\mu\text{V/m}$$

4. The spectral diagrams in appendix I display the measurement of peak values.

5. Average value= PK value + Average Factor (duty factor)

6. If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

7. The EUT is tested radiation emission in three axes(X,Y,Z). The worst emissions are reported in three axes.

8. Pulse Desensitization Correction Factor

$$\text{Pulse Width (PW)} = 23.4\text{ms}$$

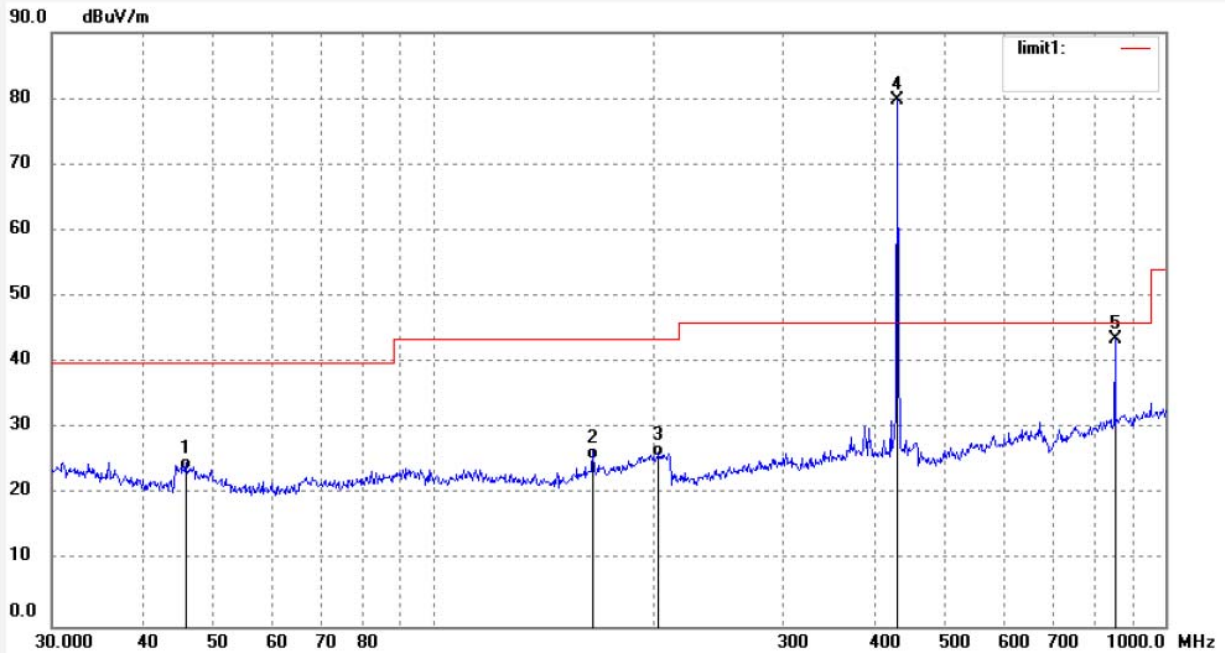
$$2/\text{PW} = 2/23.4\text{ms} = 0.085\text{kHz}$$

$$\text{RBW (100kHz)} > 2/\text{PW (5kHz)}$$

Therefore PDCF is not needed.

Job No.: frank2018 #651	Polarization: Horizontal
Standard: FCC Class C 3M Radiated	Power Source: DC 1.5V
Test item: Radiation Test	Date: 18/05/03/
Temp.(C)/Hum.(%) 25 C / 55 %	Time: 15/46/06
EUT: Soil Moisture Sensor	Engineer Signature:
Mode: TX	Distance: 3m
Model: WH51	
Manufacturer: Fine Offset Electronics Co., Ltd	

Note: Report NO.:ATE20180640

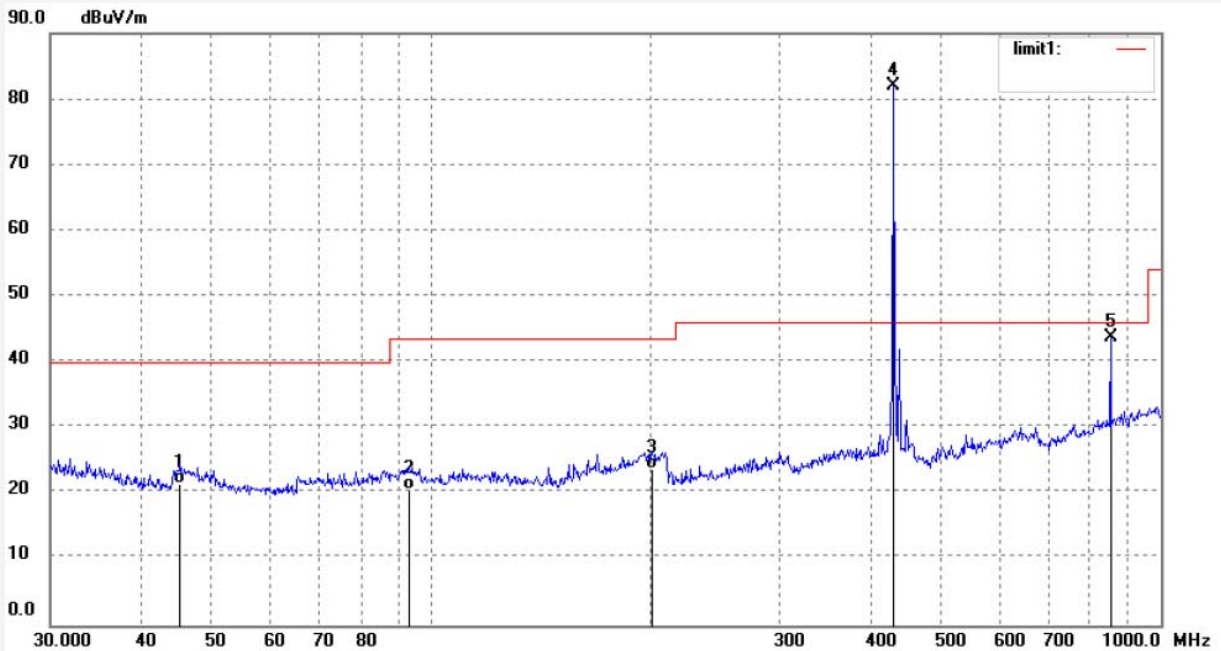


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	45.7332	43.21	-19.58	23.63	40.00	-16.37	QP	200	182	
2	164.8911	46.12	-20.83	25.29	43.50	-18.21	QP	200	136	
3	202.8745	44.35	-18.60	25.75	43.50	-17.75	QP	200	252	
4	433.9252	93.16	-13.51	79.65			peak	200	104	
5	867.8446	48.65	-5.01	43.64			peak	200	61	

Job No.: frank2018 #650
Standard: FCC Class C 3M Radiated
Test item: Radiation Test
Temp.(C)/Hum.(%) 25 C / 55 %
EUT: Soil Moisture Sensor
Mode: TX
Model: WH51
Manufacturer: Fine Offset Electronics Co., Ltd

Polarization: Vertical
Power Source: DC 1.5V
Date: 18/05/03/
Time: 15/43/31
Engineer Signature:
Distance: 3m

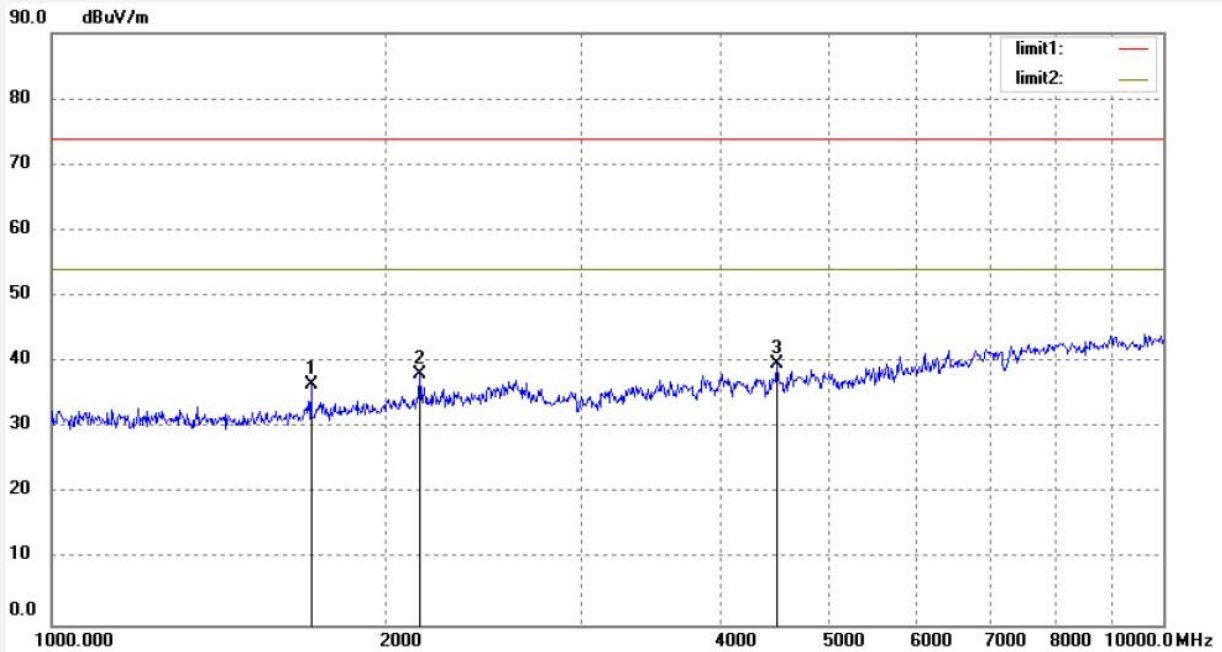
Note: Report NO.:ATE20180640



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	45.2536	41.02	-19.45	21.57	40.00	-18.43	QP	100	129	
2	93.3247	42.31	-21.62	20.69	43.50	-22.81	QP	100	354	
3	200.7471	42.41	-18.68	23.73	43.50	-19.77	QP	100	51	
4	433.9252	95.63	-13.51	82.12			peak	100	190	
5	867.8445	48.83	-5.01	43.82			peak	100	246	

Job No.: frank2018 #648	Polarization: Horizontal
Standard: FCC PK	Power Source: DC 1.5V
Test item: Radiation Test	Date: 18/05/03/
Temp.(C)/Hum.(%) 25 C / 55 %	Time: 15/36/24
EUT: Soil Moisture Sensor	Engineer Signature:
Mode: TX	Distance: 3m
Model: WH51	
Manufacturer: Fine Offset Electronics Co., Ltd	

Note: Report NO.:ATE20180640



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	1735.689	46.88	-10.33	36.55			peak	250	60	
2	2144.466	46.72	-8.64	38.08	74.00	-35.92	peak	200	197	
3	4493.327	43.06	-3.31	39.75	74.00	-34.25	peak	250	56	



ACCURATE TECHNOLOGY CO., LTD.

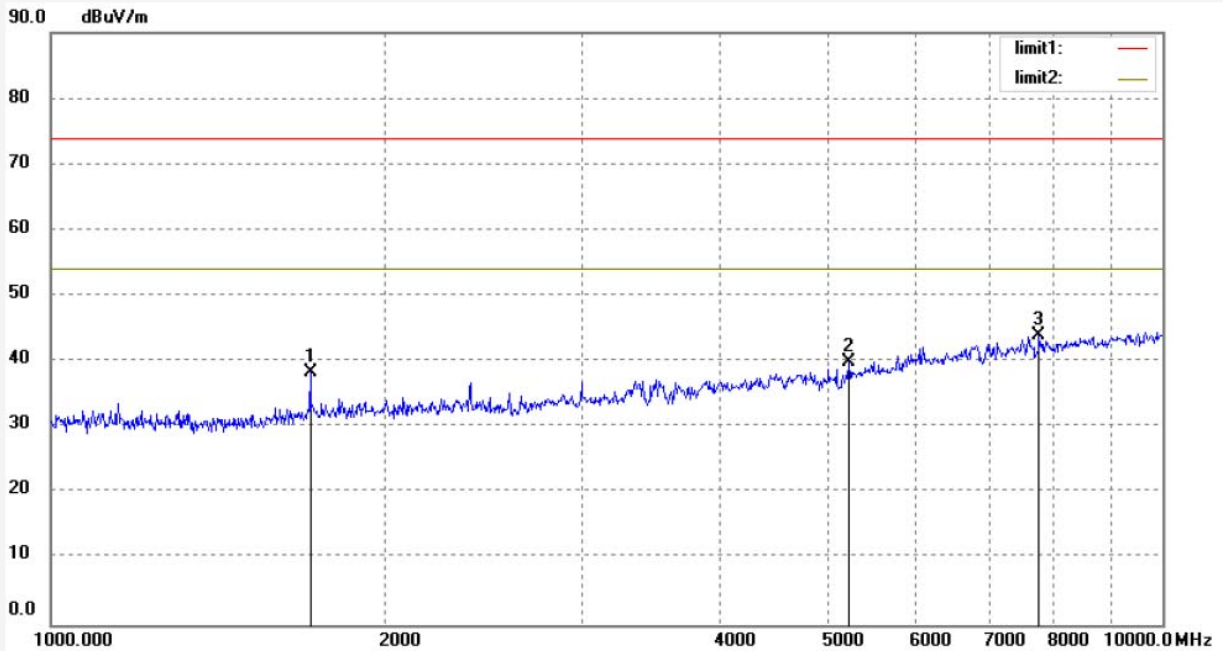
F1,Bldg,A,Changyuan New Material Port Keyuan Rd,
Science & Industry Park,Nanshan Shenzhen,P.R.China

Site: 1# Chamber
Tel:+86-0755-26503290
Fax:+86-0755-26503396

Job No.: frank2018 #649
Standard: FCC PK
Test item: Radiation Test
Temp.(C)/Hum.(%) 25 C / 55 %
EUT: Soil Moisture Sensor
Mode: TX
Model: WH51
Manufacturer: Fine Offset Electronics Co., Ltd

Polarization: Vertical
Power Source: DC 1.5V
Date: 18/05/03/
Time: 15/37/59
Engineer Signature:
Distance: 3m

Note: Report NO.:ATE20180640



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	1735.689	48.67	-10.33	38.34			peak	150	166	
2	5224.277	41.25	-1.26	39.99	74.00	-34.01	peak	150	268	
3	7748.624	41.02	2.93	43.95	74.00	-30.05	peak	150	99	

5. 20DB OCCUPIED BANDWIDTH

5.1. Block Diagram of Test Setup



(EUT: Soil Moisture Sensor)

5.2. The Bandwidth of Emission Limit According To FCC Part 15 Section

15.231(c)

The bandwidth of emission shall be no wider than 0.25% of the center frequency. Therefore, the bandwidth of the emission limit is $433.92\text{MHz} \times 0.25\% = 1.0848\text{MHz}$. Bandwidth is determined at the two points 20 dB down from the top of modulated carrier.

5.3. EUT Configuration on Measurement

The equipment are installed on the bandwidth of emission Measurement to meet the commission requirements and operating regulations in a manner which tends to maximize its emission characteristics in normal application.

5.4. Operating Condition of EUT

5.4.1. Setup the EUT and simulator as shown as Section 5.1.

5.4.2. Turn on the power of all equipment.

5.4.3. Let the EUT work in TX mode measure it.

5.5. Test Procedure

5.5.1. Set SPA Center Frequency = Fundamental frequency, RBW = 10 kHz, VBW = 30 kHz.

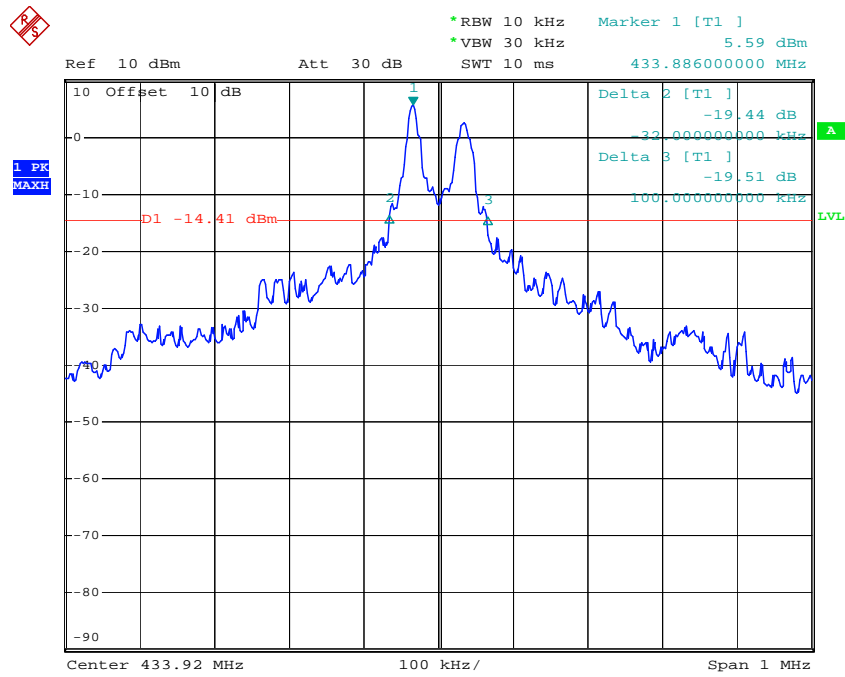
5.5.2. Set SPA Max hold, Mark peak, -20 dB.

5.6.Measurement Result

The EUT does meet the FCC requirement.

-20 dB bandwidth =0.132MHz <1.0848MHz.

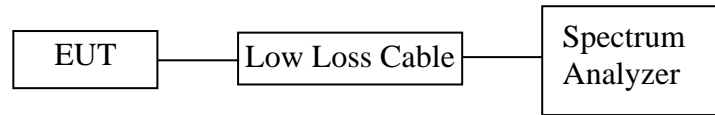
The spectral following.



Comment A:
Date: 4.MAY.2018 10:51:54

6. RELEASE TIME MEASUREMENT

6.1. Block Diagram of Test Setup



(EUT: Soil Moisture Sensor)

6.2. Release Time Measurement According To FCC Part 15 Section 15.231(e)

Section 15.231(e) 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.

6.3. EUT Configuration on Measurement

The equipment are installed on Release Time Measurement to meet the commission requirements and operating regulations in a manner which tends to maximize its emission characteristics in normal application.

6.4. Operating Condition of EUT

- 6.4.1. Setup the EUT and simulator as shown as Section 6.1.
- 6.4.2. Turn on the power of all equipment.
- 6.4.3. Let the EUT work in TX mode measure it.

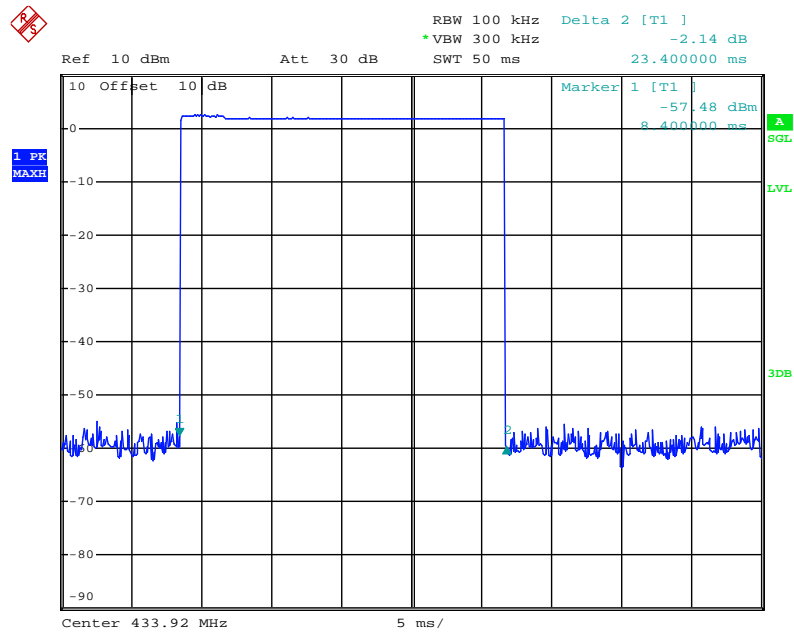
6.5. Test Procedure

- 6.5.1. Set SPA Center Frequency = Fundamental frequency, RBW = 100 kHz, VBW = 300 kHz, Span = 0 Hz.
- 6.5.2. Set EUT as normal operation and press Transmitter button.
- 6.5.3. Set SPA View. Delta Mark time.

6.6. Measurement Result

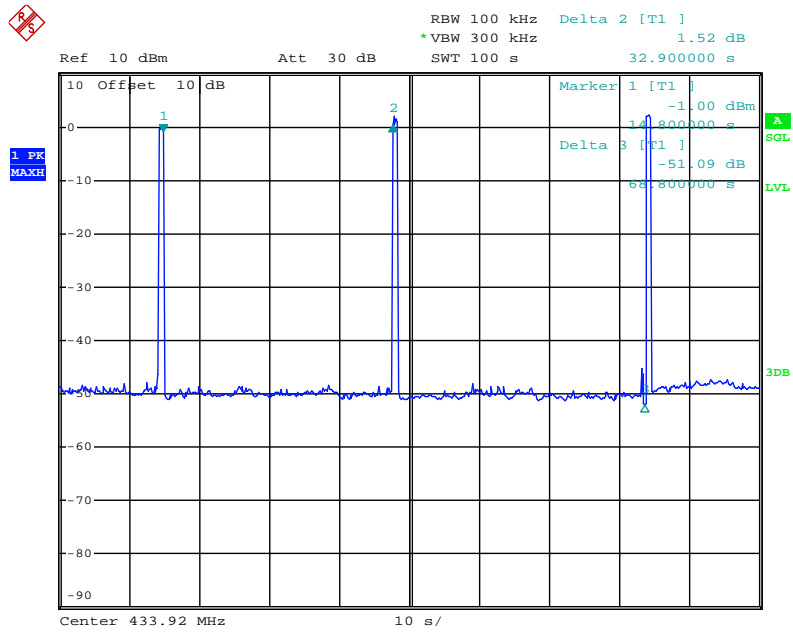
Test result: pass

Period Time = 32.9s
Duration time = 0.023s
Silent time = 32.9 - 0.023s = 32.877s > 10s
Silent time = 32.9s > 30 * 0.023s = 0.69s



Date: 4.MAY.2018 15:43:47

the duration of a transmission Time = 23.4ms

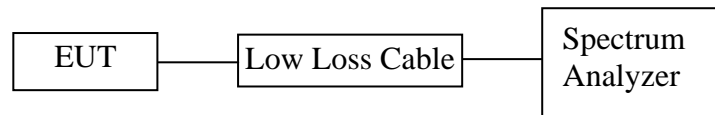


Date: 4.MAY.2018 15:26:13

the silent period between transmissions =32.9s

7. AVERAGE FACTOR MEASUREMENT

7.1. Block Diagram of Test Setup



(EUT: Soil Moisture Sensor)

7.2. Average factor Measurement according to ANSI C63.10-2013

ANSI C63.10-2013 Section 7.5 Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 s (100 ms). In cases where the pulse train exceeds 0.1 s, the measured field strength shall be determined during a 0.1 s interval.⁶⁴ The following procedure is an example of how the average value may be determined. The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown in Equation (10):

Average factor in dB = 20 log (duty cycle)

7.3. EUT Configuration on Measurement

The equipment are installed on average factor Measurement to meet the commission requirements and operating regulations in a manner which tends to maximize its emission characteristics in normal application.

7.4. Operating Condition of EUT

7.4.1. Setup the EUT and simulator as shown as Section 7.1.

7.4.2. Turn on the power of all equipment.

7.4.3. Let the EUT work in TX mode measure it.

7.5. Test Procedure

7.5.1. The time period over which the duty cycle is measured is 100 milliseconds, or the repetition cycle, whichever is a shorter time frame. The worst case (highest percentage on) duty cycle is used for the calculation.

7.5.2. Set SPA Center Frequency = Fundamental frequency, RBW = 100 kHz, VBW = 300 kHz, Span = 0 Hz.

7.5.3. Set EUT as normal operation.

7.5.4. Set SPA View. Delta Mark time.

7.6. Measurement Result

The duty cycle is simply the on time divided by the period:

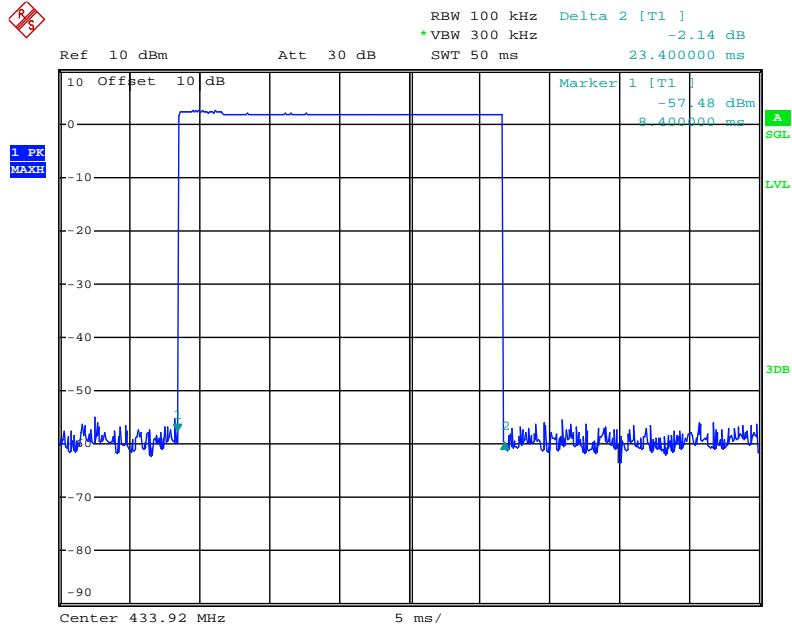
Effective period of the cycle = 23.4ms

DC = 23.4ms/100ms = 0.234%

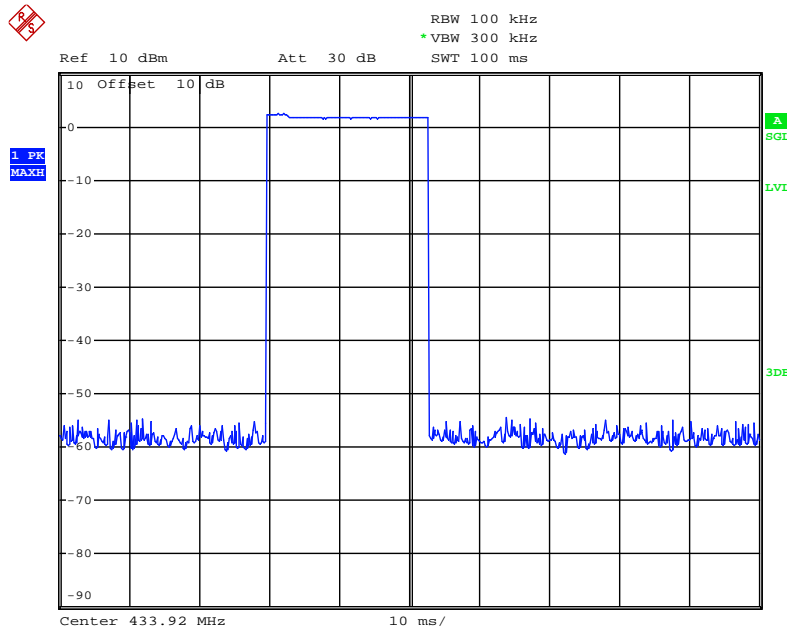
Therefore, the average factor is found by $20\log 0.234 = -12.62\text{dB}$

The spectral following.

The graph shows the duration of 'on' signal. From marker 1 to marker 2, duration is 23.4ms.



Date: 4.MAY.2018 15:43:47



Date: 4.MAY.2018 15:43:09

8. ANTENNA REQUIREMENT

8.1.The Requirement

According to 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.

8.2.Antenna Construction

Device is equipped with permanent attached antenna, which isn't displaced by other antenna. The Antenna gain of EUT is 2.15dBi. Therefore, the equipment complies with the antenna requirement of Section 15.203.



Antenna

***** End of Test Report *****