

TEST REPORT

Applicant	Ningbo Yilin Aguatech Co., Ltd.
Address	No. 158, Duantang West Road, Ningbo China

Manufacturer or Supplier	Ningbo Yilin Aguatech Co., Ltd.
Address	No. 158, Duantang West Road, Ningbo China
Product	Wireless rain/Freeze sensor
Brand Name	N/A
Model	HRC-100-RS-RF
Additional Model & Model Difference	04008, 57071, see items 3.1
Date of tests	May 27, 2022 ~ Jul. 19, 2022

the tests have been carried out according to the requirements of the following standards:

FCC Part 15, Subpart C, Section 15.231

CONCLUSION: The submitted sample was found to COMPLY with the test requirement

Tested by Andrew Sha
Project Engineer / EMC Department

Approved by Glyn He
Assistant Manager / EMC Department




Date: Aug. 03, 2022

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Test Report No.: RF2205WDG0272

RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
RF2205WDG0272	Original release	Aug. 03, 2022

Bureau Veritas Shenzhen Co., Ltd.
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1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC PART 15, SUBPART C (SECTION 15.231)			
STANDARD SECTION	TEST TYPE AND LIMIT	RESULT	REMARK
§15.203	Antenna Requirement	PASS	No antenna connector is used
§15.207 (a)	AC Power Conducted Emission	N/A	EUT is powered by battery
§15.209 §15.231(b)	Radiated Emission	PASS	Compliant
§15.231 (a)	Deactivation time measurement	PASS	Compliant
§15.231(c)	Emission Bandwidth Measurement	PASS	Compliant

2 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

MEASUREMENT	FREQUENCY	UNCERTAINTY
Radiated emissions	9KHz ~ 30MHz	2.16dB
	30MHz ~ 1GHz	3.76dB
	1GHz ~ 18GHz	4.84dB
	18GHz ~ 40GHz	4.96dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k = 2$.

3 GENERAL INFORMATION

3.1 GENERAL DESCRIPTION OF EUT

PRODUCT	Wireless rain/Freeze sensor
MODEL NO.	HRC-100-RS-RF
ADDITIONAL MODEL	04008, 57071
FCC ID	2APCK-RX2
NOMINAL VOLTAGE	Transmitter: DC 6V (3V*CR2032*2) from Battery
MODULATION TYPE	OOK
OPERATING FREQUENCY	315MHz
NUMBER OF CHANNEL	1
ANTENNA TYPE	Wire Antenna, with 10dBi Gain
I/O PORTS	Refer to the user's manual

NOTES:

1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.
2. For the test results, the EUT had been tested with all conditions, but only the worst case was shown in test report.
3. Please refer to the EUT photo document (Reference No.:2205WDG0272) for detailed product photo.
4. Additional models 04008, 57071 are identical with the test model HRC-100-RS-RF except the model name for marketing purpose.

3.2 DESCRIPTION OF TEST MODES

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports. The worst case was found when positioned on X plane for radiated emission. Following channel(s) was (were) selected for the final test as listed below:

FREQUENCY	TEST MODES
315MHz	Transmitting

3.3 TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL

EUT CONFIGURE MODE	APPLICABLE TO					DESCRIPTION
	RE ≥ 1G	RE < 1G	PLC	EB	DT	
-	√	√	-	√	√	Power by New Battery

Where **RE ≥ 1G**: Radiated Emission above 1GHz **RE < 1G**: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **EB**: 20dB Bandwidth measurement
DT: Deactivation Time measurement

RADIATED EMISSION TEST (ABOVE 1 GHz):

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations.
- Following channel(s) was (were) selected for the final test as listed below.

FREQUENCY	TESTED CHANNEL	MODULATION TYPE
315MHz	1	OOK

RADIATED EMISSION TEST (BELOW 1 GHz):

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations.
- Following channel(s) was (were) selected for the final test as listed below.

FREQUENCY	TESTED CHANNEL	MODULATION TYPE
315MHz	1	OOK

EMISSION BANDWIDTH MEASUREMENT:

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations.
- Following channel(s) was (were) selected for the final test as listed below.

FREQUENCY	TESTED CHANNEL	MODULATION TYPE
315MHz	1	OOK

DEACTIVATION TIME MEASUREMENT:

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations.
- Following channel(s) was (were) selected for the final test as listed below.

FREQUENCY	TESTED CHANNEL	MODULATION TYPE
315MHz	1	OOK

TEST CONDITION:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	TEST VOLTAGE	TESTED BY
RE \geq 1G	23deg. C, 54%RH	DC 6.0V from New Battery	Jelly
RE $<$ 1G	23deg. C, 54%RH	DC 6.0V from New Battery	Jelly
EB	25deg. C, 60%RH	DC 6.0V from New Battery	Hugo
DT	25deg. C, 60%RH	DC 6.0V from New Battery	Hugo

3.4 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C Section 15.231
ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

3.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together without other necessary accessories or support units.

4. TEST TYPES AND RESULTS

4.1 RADIATED EMISSION MEASUREMENT

4.1.1 LIMITS OF RADIATED EMISSION MEASUREMENT

Emissions radiated outside of the specified bands, shall be according to the general radiated limits in 15.209 as following:

FREQUENCIES (MHz)	FIELD STRENGTH (microvolts/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
Above 960	500	3

According to §15.231(b), the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emission (microvolts/meter)
40.66–40.70	2,250	225
70–130	1,250	125
130–174	¹ 1,250 to 3,750	¹ 125 to 375
174–260	3,750	375
260–470	¹ 3,750 to 12,500	¹ 375 to 1,250
Above 470	12,500	1,250

NOTES:

- ¹ Linear interpolations.
- The lower limit shall apply at the transition frequencies.
- Emission level (dBuV/m) = 20 log Emission level (uV/m).
- As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESU40	100449	Feb. 22, 23
Signal and Spectrum Analyzer	Rohde&Schwarz	FSV7	102331	May 09, 22
Active Loop Antenna (9KHz -30MHz)	SCHWARZBECK	FMZB 1519B	1519B-045	May 20, 22
Amplifier (9KHz -1GHz)	Burgeon	BPA-530	100210	Mar. 08, 23
Trilog-Broadband Antenna(20M-2G)	SCHWARZBECK	VULB 9168	01263	Sep. 30, 22
Horn Antenna (1GHz -18GHz)	ETS -Lindgren	3117	00062558	May 21, 22
Horn Antenna (18GHz -40GHz)	SCHWARZBECK	BBHA 9170	BBHA9170147	May 14, 22
3m Semi-anechoic Chamber	ETS-LINDGREN	9m*6m*6m	NSEMC003	May 22, 22
Test Software	ADT	ADT_Radiated_V7.6.15.9.2	N/A	N/A
Broadband Preamplifier (1GHz~18GHz)	SCHWARZBECK	BBV9718	305	May 12, 22
Pre-Amplifier (18GHz-40GHz)	EMCI	EMC 184045	980102	Jan. 10, 23
Test Software	ADT	ADT_Radiated_V7.6.15.9.2	N/A	N/A
BLUETOOTH TESTER	Rohde&Schwarz	CBT32	100811	N/A

NOTES:

1. The test was performed in 966 Chamber. (Chenwu)
2. The calibration interval of the above test instruments are 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.
3. The horn antenna is used only for the measurement of emission frequency above 1GHz if tested.
4. The FCC Site Registration No. is 749762.

4.1.3 TEST PROCEDURES

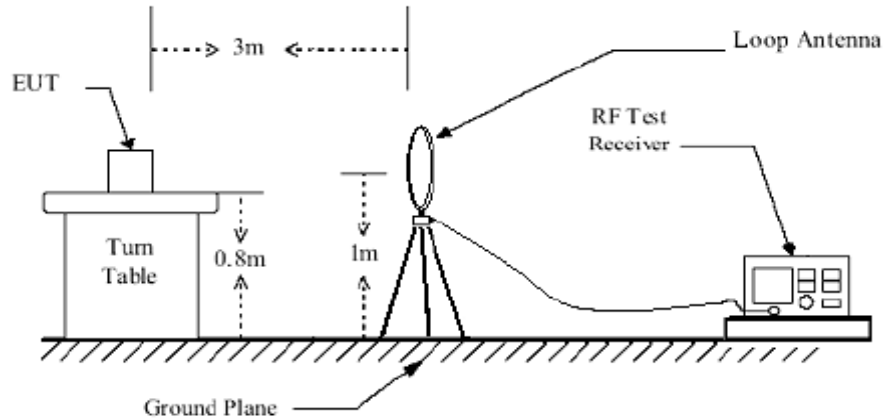
- a. The EUT was placed on the top of a rotating table 1.5 meters (above 1GHz) and 0.8 meters (below 1GHz) above the ground at a 3 meters semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position Y, manipulating interconnecting cables, For battery operated equipment, the equipment tests shall be perform using new battery. The turntable was rotated to maximize the emission level.
- h. For below 30MHz, a loop antenna with its vertical plane is place 3m from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. And the centre of the loop shall be 1m above the ground.

NOTES:

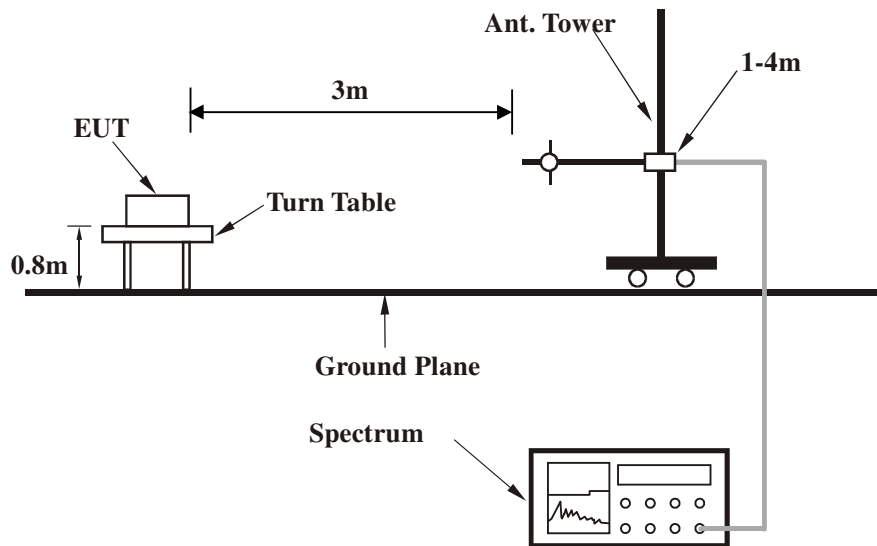
1. The resolution bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz for Peak detection at frequency above 1GHz.
3. Emission level(dBuV/m)=Raw Value(dBuV) + Correction Factor(dB/m)
4. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
5. Margin value = Emission level – Limit value.
6. Fundamental AV value =PK Emission +AV Factor.

4.1.4 TEST SETUP

Below 30MHz test setup

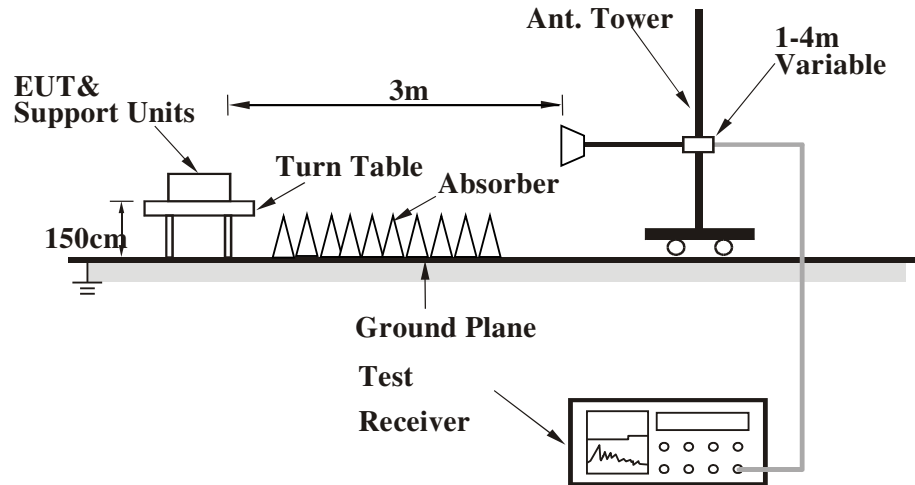


Below 1GHz test setup



Note: For the actual test configuration, please refer to the attached file (Test Setup Photo).

Above 1GHz test setup



Note: For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.5 DEVIATION FROM TEST STANDARD

No deviation.

4.1.6 EUT OPERATING CONDITIONS

- a. Placed the EUT on the testing table.
- b. Enable EUT under transmission condition continuously at specific channel frequency.

4.1.7 TEST RESULTS

BELOW 1GHz WORST-CASE DATA:

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3M								
No.	Freq. (MHz)	Correction Factor (dB/m)	Raw Value (dBuV)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Table Angle (Degree)
1	*315.01 PK	16.07	68.03	83.10	95.62	-12.52	100	269
2	*315.01 AV	-11.34	-	71.76	75.62	-3.86	100	269
3	#630.06 PK	23.73	10.16	33.89	75.62	-41.73	100	203
4	#630.06 AV	-11.34	-	22.55	55.62	-33.07	100	203
5	#945.12 PK	28.13	10.65	38.78	75.62	-36.84	100	163
6	#945.12 AV	-11.34	-	27.44	55.62	-28.18	100	163
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3M								
No.	Freq. (MHz)	Correction Factor (dB/m)	Raw Value (dBuV)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Table Angle (Degree)
1	*315.03 PK	16.07	66.21	82.28	95.62	-13.34	100	126
2	*315.03 AV	-11.34	-	70.94	75.62	-4.62	100	126
3	#630.10 PK	23.73	12.12	35.85	75.62	-39.77	100	112
4	#630.10 AV	-11.34	-	24.51	55.62	-31.11	100	112
5	#945.08 PK	28.13	12.15	40.28	75.62	-35.34	100	223
6	#945.08 AV	-11.34	-	28.94	55.62	-26.68	100	223

NOTES:

1. The resolution bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) at frequency below 1GHz.
2. Emission level(dBuV/m)=Raw Value(dBuV) + Correction Factor(dB/m)
3. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
4. Margin value = Emission level – Limit value.
5. " * ": Fundamental frequency.
6. " # ": Harmonic frequency
7. Fundamental AV value =PK Emission +20*log(duty cycle)Where the duty factor is calculated from following formula:20 log (Duty cycle) = 20Log(27.10%)= -11.34dB, Please see page 17~18 for plotted duty.

ABOVE 1GHz WORST-CASE DATA:

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTI ON FACTOR (dB/m)
1	1260.00PK	40.12	74.00	-33.88	1.76 H	157	40.63	-0.51
2	1260.00 AV	28.78	54.00	-25.22	1.76 H	157	-	-11.34
3	1575.00 PK	42.85	74.00	-31.15	2.57 H	124	43.42	-0.57
4	1575.00 AV	31.51	54.00	-22.49	2.57 H	124	-	-11.34
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTI ON FACTOR (dB/m)
1	1260.00PK	42.10	74.00	-31.90	1.58 V	134	42.10	-0.51
2	1260.00 AV	30.76	54.00	-23.24	1.58 V	134	-	-11.34
3	1575.00 PK	43.10	74.00	-30.90	2.10 V	220	43.10	-0.57
4	1575.00 AV	31.76	54.00	-22.24	2.10 V	220	-	-11.34

NOTES:

- 1 The resolution bandwidth of test receiver/spectrum analyzer is 1MHz for Peak detection (PK) at frequency above 1GHz.
- 2 Emission level(dBuV/m)=Raw Value(dBuV) + Correction Factor(dB/m)
- 3 Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
- 4 Margin value = Emission level – Limit value.
- 5 The emission levels of other frequencies were less than 20dB margin against the limit.
- 6 Fundamental AV value =PK Emission +20*log(duty cycle)Where the duty factor is calculated from following formula:20 log (Duty cycle) = 20Log(27.10%)=-11.34dB, Please see page 17~18 for plotted duty.

Duty Cycle:

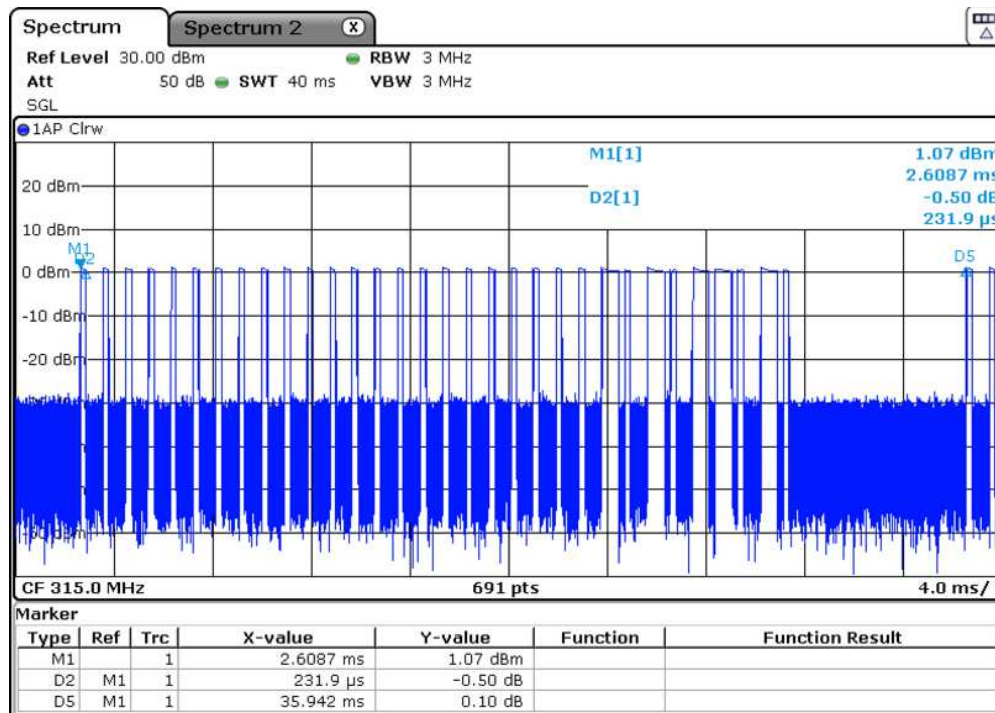
$$T_p = 35.942\text{ms}$$

$$T_{on} = T_{on1} * \text{Number} + T_{on2} * \text{Number} = 0.2319 * 27 + 0.6957 * 5 = 9.7398\text{ms}$$

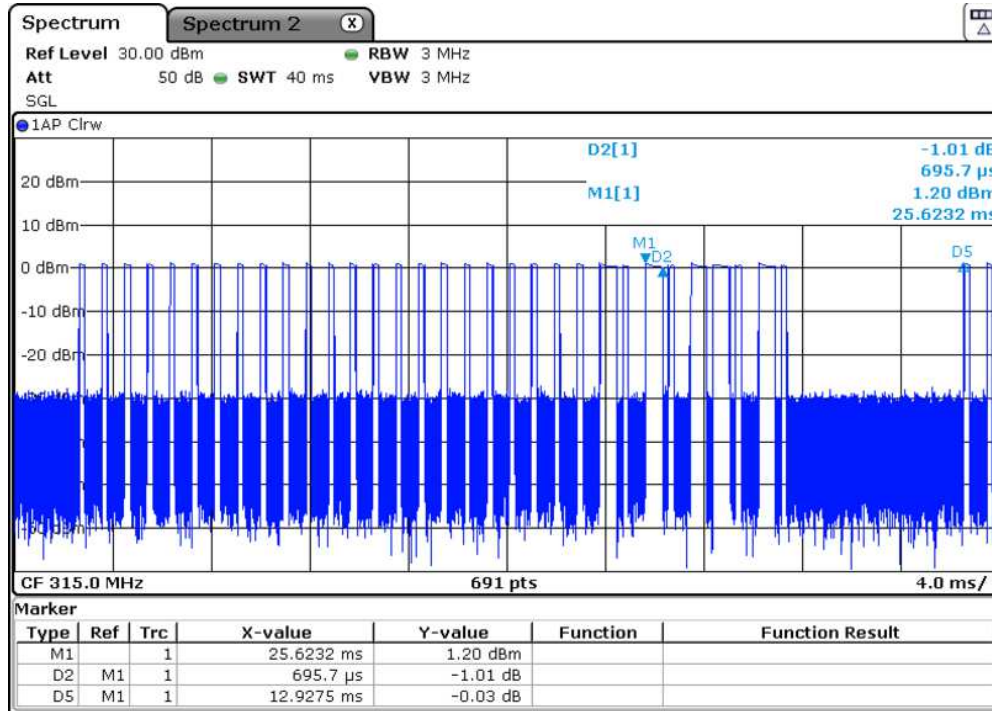
$$\text{Duty Cycle} = T_{on} / T_p * 100\% = 9.7398 / 35.942 * 100\% = 27.10\%$$

$$\text{Factor} = 20\text{Log}(\text{Duty Cycle}) = 20\text{Log}(27.10\%) = -11.34\text{dB}$$

T_p = 35.942ms



$$Ton = Ton1 * Number + Ton2 * Number = 0.2319 * 27 + 0.6957 * 5 = 9.7398ms$$



4.2 20dB BANDWIDTH MEASUREMENT

4.2.1 LIMITS OF 20dB BANDWIDTH MEASUREMENT

According to FCC 15.231(c), 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. Bandwidth is determined at the points 20 dB down from the modulated carrier.

$$\text{Limit} = \text{Fundamental Frequency} \times 0.25\% = 315\text{MHz} \times 0.25\% = 787.5 \text{ kHz}$$

4.2.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
Power Sensor	Keysight	U2021XA	MY57320002	Feb. 23, 23
Power Sensor	Keysight	U2021XA	MY55060018	May 09, 22
Digital Multimeter	FLUKE	15B	A1220010DG	N/A
Humid & Temp Programmable Tester	Haida	HD-225T	110807201	Nov. 03, 22
Oscilloscope	Agilent	DSO9254A	MY51260160	Aug. 11, 22
Signal and Spectrum Analyzer	Rohde&Schwarz	FSV40	101094	Jan. 16, 23
Signal Generator	Agilent	N5183A	MY50140980	Sep. 18, 22
MXG-B RF Vector Signal Generator	Keysight	N5182B	MY56200288	Sep. 14, 22
BLUETOOTH TESTER	Rohde&Schwarz	CBT32	100811	N/A
Attenuator	MINI	BW-S10W2+	S130129FGE2	N/A
DC Source	Keysight	E3642A	MY56146098	N/A
Test software	ADT	ADT_RF Test Software V6.6.5.3	N/A	N/A

NOTES:

1. The test was performed in RF Oven room. (Chenwu)
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

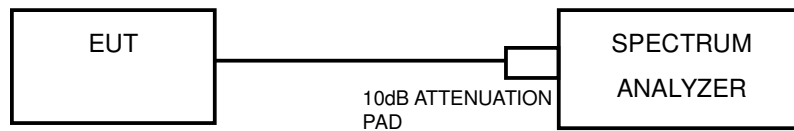
4.2.3 TEST PROCEDURE

The spectrum analyzer was receiving the maximum emission level. The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

4.2.4 DEVIATION FROM TEST STANDARD

No deviation.

4.2.5 TEST SETUP



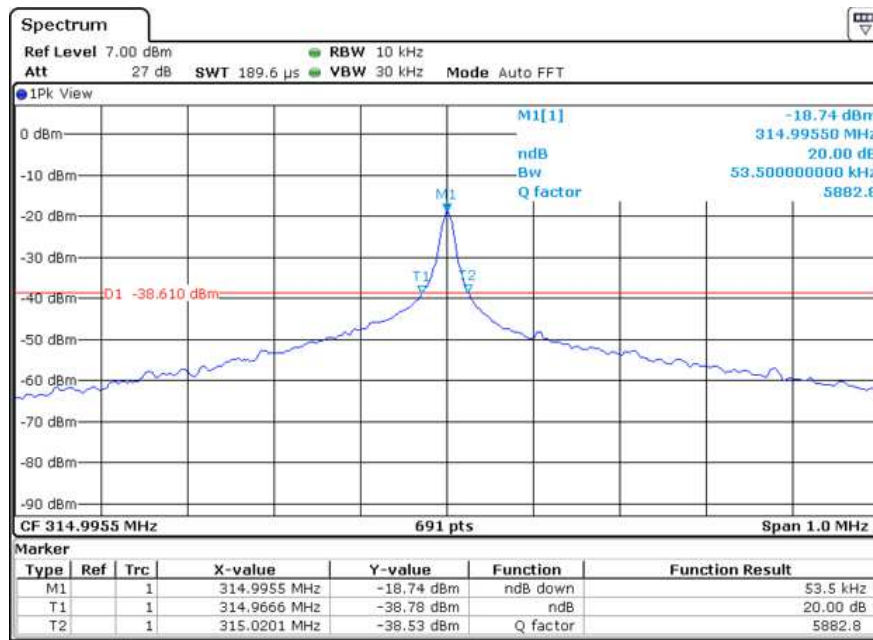
4.2.6 EUT OPERATING CONDITIONS

- a) Turned on the power of all equipment.
- b) EUT was operated according to the type used was description in manufacturer's specifications or the User's Manual.

4.2.7 TEST RESULTS

FREQUENCY (MHz)	20dB BANDWIDTH (kHz)	MAXIMUM LIMIT (kHz)	PASS/FAIL
315	53.50	787.5	PASS

Test Data:



4.3 DEACTIVATION TIME MEASUREMENT

4.3.1 LIMITS OF DEACTIVATION TIME MEASUREMENT

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.

15.231 (a)(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

4.3.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
Power Sensor	Keysight	U2021XA	MY57320002	Feb. 23, 23
Power Sensor	Keysight	U2021XA	MY55060018	May 09, 22
Digital Multimeter	FLUKE	15B	A1220010DG	N/A
Humid & Temp Programmable Tester	Haida	HD-225T	110807201	Nov. 03, 22
Oscilloscope	Agilent	DSO9254A	MY51260160	Aug. 11, 22
Signal and Spectrum Analyzer	Rohde&Schwarz	FSV40	101094	Jan. 16, 23
Signal Generator	Agilent	N5183A	MY50140980	Sep. 18, 22
MXG-B RF Vector Signal Generator	Keysight	N5182B	MY56200288	Sep. 14, 22
BLUETOOTH TESTER	Rohde&Schwarz	CBT32	100811	N/A
Attenuator	MINI	BW-S10W2+	S130129FGE2	N/A
DC Source	Keysight	E3642A	MY56146098	N/A
Test software	ADT	ADT_RF Test Software V6.6.5.3	N/A	N/A

NOTES: 1. The test was performed in RF Oven room. (Chenwu)

2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

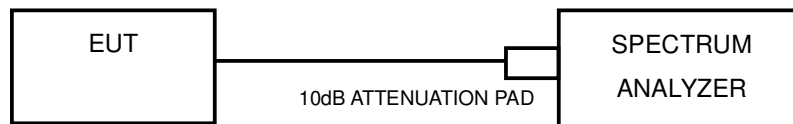
4.3.3 TEST PROCEDURE

With the EUT's antenna attached, the EUT's output signal was received by the test antenna, which was connected to the spectrum analyzer set the center frequency, than set the spectrum analyzer to Zero Span for the release time reading. During the testing, the transmission duration was measured and recorded.

4.3.4 DEVIATION FROM TEST STANDARD

No deviation.

4.3.5 TEST SETUP



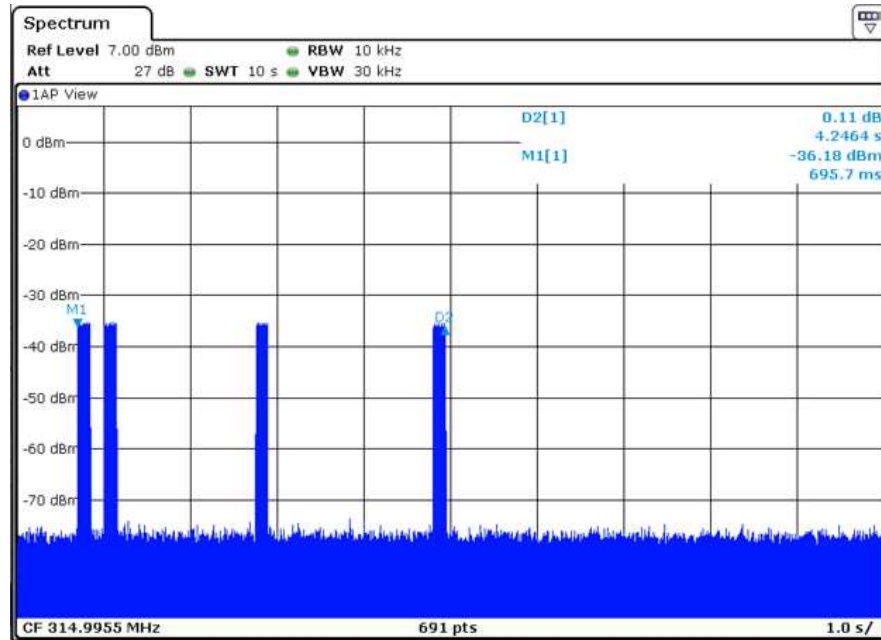
4.3.6 EUT OPERATING CONDITIONS

- c) Turned on the power of all equipment.
- d) EUT was operated according to the type used was description in manufacturer's specifications or the User's Manual.

4.3.7 TEST RESULTS

FREQUENCY (MHz)	MEASUREMENT RESULT (sec)	MAXIMUM LIMIT (sec)	PASS/FAIL
315	4.2464	5	PASS

The plots of test results are attached as below.





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5 PHOTOGRAPHS OF THE TEST CONFIGURATION

Please refer to the attached file (Test Setup Photo).



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6 APPENDIX A - MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No any modifications are made to the EUT by the lab during the test.

---END---