

FCC 47 CFR PART 15 SUBPART C

CERTIFICATION TEST REPORT

OF

Button

MODEL No.: ZW166

Trademark: **Aeotec**

FCC ID: 2AOGIZW166

REPORT NO: ES180920011W

ISSUE DATE: December 14, 2018

Prepared for

Aeotec Limited

FLAT/RM 704, 7/F, BRIGHT WAY TOWER, 33 MONG KOK ROAD, MONG KOK,
KL, HK

Prepared by

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TEST RESULT CERTIFICATION

| | |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applicant: | Aeotec Limited FLAT/RM 704, 7/F, BRIGHT WAY TOWER, 33 MONG KOK ROAD, MONG KOK, KL, HK |
| Manufacturer: | Fantem Technologies (Shenzhen) Co., Ltd. 5th Floor, Yingtang Building South 5th rd, High Technology Park, Nanshan District Shenzhen, Guangdong, China |
| Product Description: | Button |
| Model Number: | ZW166 |
| Trade Mark: |  |
| File Number: | ES180920011W |

Measurement Procedure Used:

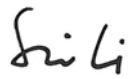
| APPLICABLE STANDARDS | |
|---------------------------------------------------------------|-------------|
| STANDARD | TEST RESULT |
| FCC 47 CFR Part 2, Subpart J FCC 47 CFR Part 15, Subpart C | PASS |

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 C63.10 (2013) and the energy emitted by the sample EUT tested as described in this report is in compliance with the requirements of FCC Rules Part 2 and Part 15.231 REQUIREMENTS.

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

Date of Test : October 08, 2018 to December 14, 2018

Prepared by : 
Sevin Li/Editor

Reviewer : 
Joe Xia/Supervisor


Approve & Authorized Signer : 
Lisa Wang/Manager



Table of Contents

| | | |
|----------|--------------------------------------------------|-----------|
| 1 | EUT TECHNICAL DESCRIPTION | 4 |
| 2 | SUMMARY OF TEST RESULT | 5 |
| 3 | TEST METHODOLOGY | 6 |
| 3.1 | GENERAL DESCRIPTION OF APPLIED STANDARDS | 6 |
| 3.2 | MEASUREMENT EQUIPMENT USED | 6 |
| 3.3 | DESCRIPTION OF TEST MODES | 6 |
| 4 | FACILITIES AND ACCREDITATIONS | 7 |
| 4.1 | FACILITIES | 7 |
| 4.2 | LABORATORY ACCREDITATIONS AND LISTINGS | 7 |
| 5 | TEST SYSTEM UNCERTAINTY | 8 |
| 6 | SETUP OF EQUIPMENT UNDER TEST | 9 |
| 6.1 | RADIO FREQUENCY TEST SETUP 1 | 9 |
| 6.2 | RADIO FREQUENCY TEST SETUP 2 | 9 |
| 6.3 | CONDUCTED EMISSION TEST SETUP | 11 |
| 6.4 | BLOCK DIAGRAM CONFIGURATION OF TEST SYSTEM | 12 |
| 6.5 | SUPPORT EQUIPMENT | 12 |
| 7 | TEST REQUIREMENTS | 13 |
| 7.1 | 20DB BANDWIDTH | 13 |
| 7.2 | FREQUENCY STABILITY | 15 |
| 7.3 | RADIATED SPURIOUS EMISSION | 17 |
| 7.4 | TRANSMISSION TIME REQUIREMENT | 28 |
| 7.5 | CONDUCTED EMISSION TEST | 30 |
| 7.6 | ANTENNA APPLICATION | 31 |

1 EUT TECHNICAL DESCRIPTION

| Characteristics | Description |
|--------------------------------------|----------------------------------------------------------------------|
| Modulation: | ASK modulation |
| Operating Frequency Range(s): | 433.92MHz |
| Number of Channels: | 1 channel |
| Antenna Type : | Internal Antenna |
| Antenna Gain: | 2.0dBi |
| Power supply: | <input checked="" type="checkbox"/> DC 3V via CR2450 Lithium Battery |

Note: for more details, please refer to the User's manual of the EUT.

2 SUMMARY OF TEST RESULT

| FCC Part Clause | Test Parameter | Verdict | Remark |
|-----------------------------|-------------------------------|---------|--------|
| 15.231(c) | 20dB Bandwidth | PASS | |
| 15.231(d) | Frequency stability | PASS | |
| 15.231(b) | Radiated Spurious Emissions | PASS | |
| 15.231(b) | Transmission Time Requirement | PASS | |
| 15.203 | Antenna Requirement | PASS | |
| 15.207(a) | Conducted Emission | N/A | |
| NOTE1: N/A (Not Applicable) | | | |

RELATED SUBMITTAL(S) / GRANT(S):

This submittal(s) (test report) is intended for FCC ID: 2AOGIZW166 filing to comply with Section 15.231 of the FCC Part 15, Subpart C Rules

3 TEST METHODOLOGY

3.1 GENERAL DESCRIPTION OF APPLIED STANDARDS

According to its specifications, the EUT must comply with the requirements of the following standards:

FCC 47 CFR Part 2, Subpart J

FCC 47 CFR Part 15, Subpart C

3.2 MEASUREMENT EQUIPMENT USED

1.1.1. Radiated Emission Test Equipment

| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | DUE CAL. |
|-------------------|-----------------|--------------|---------------|--------------|--------------|
| EMI Test Receiver | Rohde & Schwarz | ESU | 1302.6005.26 | May 20, 2018 | May 19, 2019 |
| Pre-Amplifier | HP | 8447F | 2944A07999 | May 19, 2018 | May 18, 2019 |
| Bilog Antenna | Schwarzbeck | VULB9163 | 142 | May 19, 2018 | May 18, 2019 |
| Loop Antenna | ARA | PLA-1030/B | 1029 | May 19, 2018 | May 18, 2019 |
| Horn Antenna | Schwarzbeck | BBHA 9170 | BBHA9170399 | May 20, 2018 | May 19, 2019 |
| Horn Antenna | Schwarzbeck | BBHA 9120 | D143 | May 19, 2018 | May 18, 2019 |
| Cable | Schwarzbeck | AK9513 | ACRX1 | May 20, 2018 | May 19, 2019 |
| Cable | Rosenberger | N/A | FP2RX2 | May 20, 2018 | May 19, 2019 |
| Cable | Schwarzbeck | AK9513 | CRPX1 | May 20, 2018 | May 19, 2019 |
| Cable | Schwarzbeck | AK9513 | CRRX2 | May 20, 2018 | May 19, 2019 |

1.1.2. Radio Frequency Test Equipment

| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LASTCAL. | DUE CAL. |
|-------------------|---------|--------------|---------------|--------------|--------------|
| Spectrum Analyzer | Agilent | E4407B | 88156318 | May 20, 2018 | May 19, 2019 |
| Signal Analyzer | Agilent | N9010A | My53470879 | May 20, 2018 | May 19, 2019 |

Remark: Each piece of equipment is scheduled for calibration once a year.

3.3 DESCRIPTION OF TEST MODES

The EUT has been tested under its typical operating condition.

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

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

Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting mode is programmed.

The new batteries were used in the test

Frequency and Channel list:

| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|---------|-----------------|
| 0 | 433.92 | | | ... | ... |

Test Frequency and Channel list:

| Lowest Frequency | | Middle Frequency | | Highest Frequency | |
|------------------|-----------------|------------------|-----------------|-------------------|-----------------|
| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
| 0 | 433.92 | | | | |

4 FACILITIES AND ACCREDITATIONS

4.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

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

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.10 and CISPR Publication 22.

4.2 LABORATORY ACCREDITATIONS AND LISTINGS

Site Description

EMC Lab.

- : Accredited by CNAS, 2016.10.24
The certificate is valid until 2022.10.28
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, 2016.5.19
The Laboratory has been assessed according to the requirements ISO/IEC 17025.
- : Accredited by FCC, August 06, 2018
The certificate is valid until August 07, 2020
Designation Number: CN1204
Test Firm Registration Number: 882943
- : Accredited by Industry Canada, November 09, 2018
The Conformity Assessment Body Identifier is CN0008.

5 TEST SYSTEM UNCERTAINTY

The following measurement uncertainty levels have been estimated for tests performed on the apparatus:

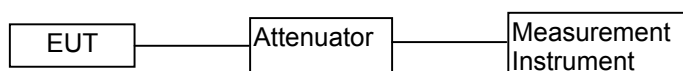
| Parameter | Uncertainty |
|--------------------------|---------------------------|
| Radio Frequency | $\pm 1 \times 10^{-5}$ |
| Conducted Emissions Test | $\pm 2.0\text{dB}$ |
| Radiated Emission Test | $\pm 2.0\text{dB}$ |
| 20dB Bandwidth Test | $\pm 1.0\text{dB}$ |
| All emission, radiated | $\pm 3\text{dB}$ |
| Temperature | $\pm 0.5^{\circ}\text{C}$ |
| Humidity | $\pm 3\%$ |

Measurement Uncertainty for a level of Confidence of 95%

6 SETUP OF EQUIPMENT UNDER TEST

6.1 RADIO FREQUENCY TEST SETUP 1

The component's antenna ports(s) of the EUT are connected to the measurement instrument per an appropriate attenuator. The EUT is controlled by PC/software to emit the specified signals for the purpose of measurements.



6.2 RADIO FREQUENCY TEST SETUP 2

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.10. The test distance is 3m. The setup is according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 and CAN/CSA-CEI/IEC CISPR 22.

The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

Below 30MHz:

The EUT is placed on a turntable 0.8 meters above the ground in the chamber, 3 meter away from the antenna (loop antenna). The Antenna should be positioned with its plane vertical at the specified distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. The center of the loop shall be 1 m above the ground. For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT.

Above 30MHz:

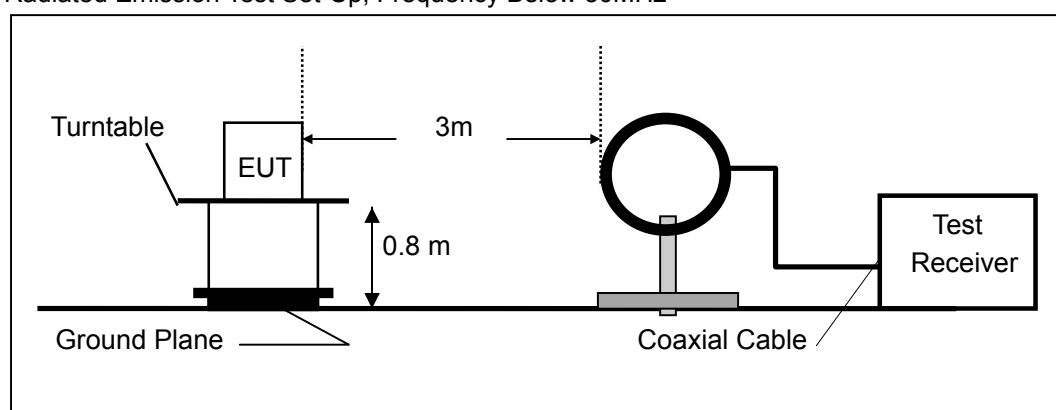
The EUT is placed on a turntable 0.8 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

Above 1GHz:

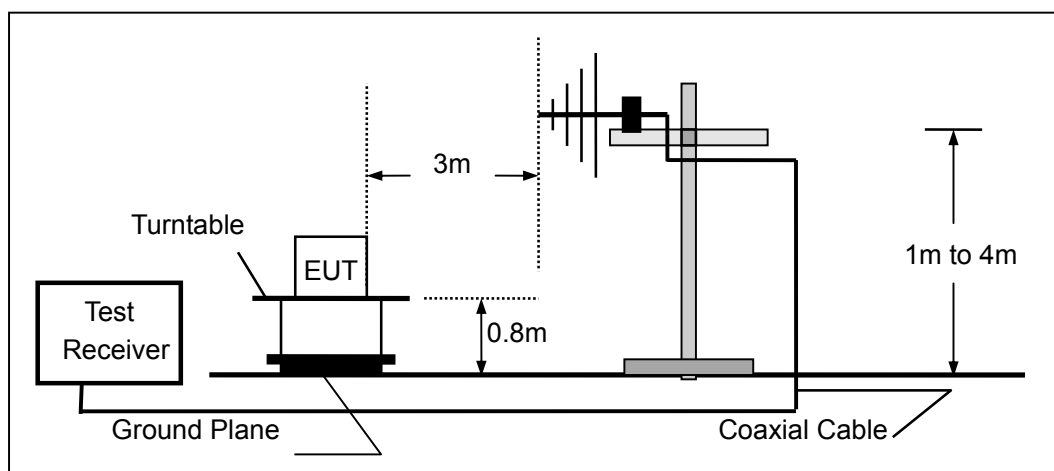
(Note: the FCC's permission to use 1.5m as an alternative per TCBC Conf call of Dec. 2, 2014.)

The EUT is placed on a turntable 1.5 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

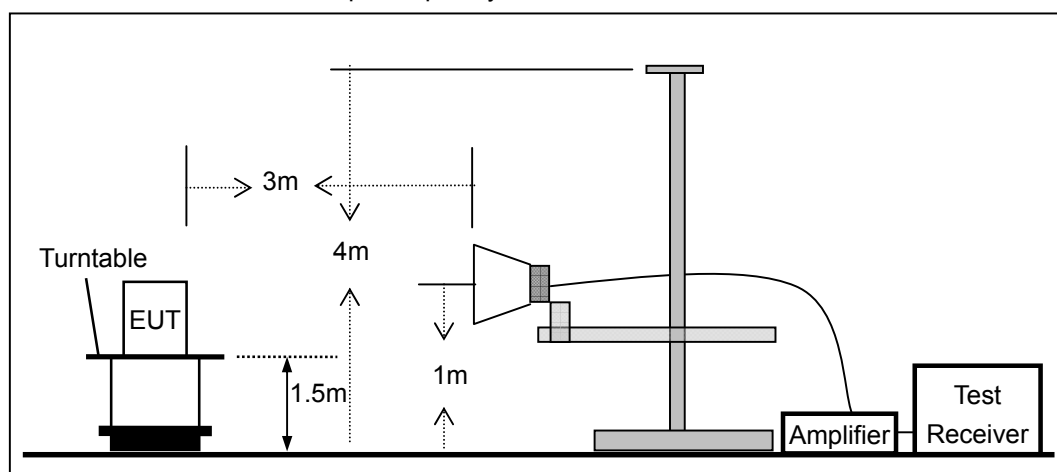
(a) Radiated Emission Test Set-Up, Frequency Below 30MHz



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



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

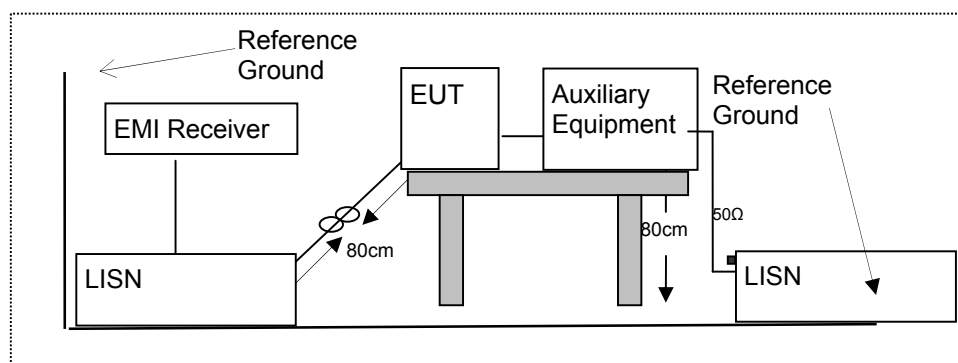


6.3 CONDUCTED EMISSION TEST SETUP

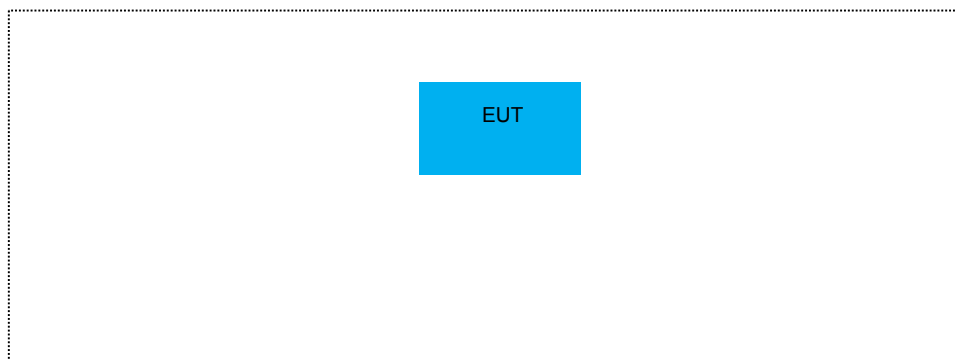
The mains cable of the EUT (Button) must be connected to LISN. The LISN shall be placed 0.8 m from the boundary of EUT and bonded to a ground reference plane for LISN mounted on top of the ground reference plane. This distance is between the closest points of the LISN and the EUT. All other units of the EUT and associated equipment shall be at least 0.8m from the LISN.

Ground connections, where required for safety purposes, shall be connected to the reference ground point of the LISN and, where not otherwise provided or specified by the manufacturer, shall be of same length as the mains cable and run parallel to the mains connection at a separation distance of not more than 0.8 m.

According to the requirements in ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-Peak and average detector mode.



6.4 BLOCK DIAGRAM CONFIGURATION OF TEST SYSTEM



6.5 SUPPORT EQUIPMENT

| Item | Equipment | Mfr/Brand | Model/Type No. | Series No. | Note |
|------|-----------|-----------|----------------|------------|------|
| | | | | | |
| | | | | | |
| | | | | | |

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

7 TEST REQUIREMENTS

7.1 20DB BANDWIDTH

7.1.1 Applicable Standard

According to FCC Part 2.1049 and part 15.231(c)

7.1.2 Conformance 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 20 dB down from the modulated carrier.

7.1.3 Test Configuration

Test according to clause 6.1 radio frequency test setup 1

7.1.4 Test Procedure

The EUT was operating in transmit mode and controlled its channel. Printed out the test result from the spectrum by hard copy function.

The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.

Set to the maximum power setting and enable the EUT transmit continuously

Set RBW =100 kHz.

Set the video bandwidth (VBW) ≥ 3 RBW.

Set Span= approximately 2 to 3 times the occupied bandwidth

Set Detector = Peak.

Set Trace mode = max hold.

Set Sweep = auto couple.

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the markerdelta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.

If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation.

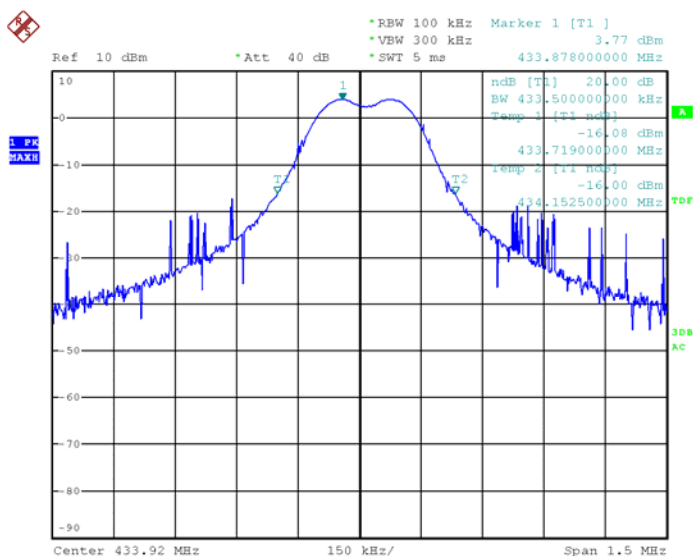
Measure and record the results in the test report.

Test Results

| | | | |
|--------------|------|----------|-----------|
| Temperature: | 24°C | Test By: | King Kong |
| Humidity: | 53 % | | |

| Modulation Mode | Channel Number | Channel Frequency (MHz) | Measurement Bandwidth (kHz) | Limit (kHz) | Verdict |
|-----------------------------------------------------------------------|----------------|-------------------------|-----------------------------|-------------|---------|
| ASK | 00 | 433.92 | 433.5 | ≤ 1045 | PASS |
| Note: Limit=0.25% of the center frequency=433.92MHz * 0.25% = 1045kHz | | | | | |

| | | |
|------------|--------------------------------------------|----------------|
| Test Model | Occupied Bandwidth Channel 0: 433.92MHz | ASK Modulation |
|------------|--------------------------------------------|----------------|



7.2 FREQUENCY STABILITY

7.2.1 Applicable Standard

According to FCC Part 2.1055 and part 15.231(d)

7.2.2 Conformance Limit

According to part 15.231(d), For devices operating within the frequency band 40.66-40.70 MHz, the bandwidth of the emission shall be confined within the band edges and the frequency tolerance of the carrier shall be $\pm 0.01\%$. This frequency tolerance shall be maintained for a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery

7.2.3 Test Configuration

Test according to clause 6.1 radio frequency test setup

7.2.4 Test Procedures

Connect the EUT to frequency analyzer via the antenna connector.

EUT was placed at temperature chamber and connected to an external power supply.

Temperature and voltage condition shall be tested to confirm frequency stability.

(a) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short-term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(b) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point, which shall be specified by the manufacturer.

7.2.5 Test Results

| Operation Mode | Channel Number | Test Condition | | Channel Frequency (MHz) | Freq.Dev. (Hz) | Deviation (ppm) | Limit (ppm) |
|---------------------------------------------------------------------------------------|----------------|----------------|-----------|-------------------------|----------------|-----------------|-------------|
| | | Voltage (V) | Temp (°C) | | | | |
| ASK | CH0 | Vnom | -20 | - | - | - | 10 |
| | | | -10 | - | - | - | 10 |
| | | | 0 | - | - | - | 10 |
| | | | 10 | - | - | - | 10 |
| | | | 20 | - | - | - | 10 |
| | | | 30 | - | - | - | 10 |
| | | | 40 | - | - | - | 10 |
| | | | 50 | - | - | - | 10 |
| | | 85% Vnom | 20 | - | - | - | 10 |
| | | 115% Vnom | 20 | - | - | - | 10 |
| VERDICT | | | | PASS | | | |
| Note: Not applicable, the device operating without the frequency band 40.66-40.70MHz. | | | | | | | |

7.3 RADIATED SPURIOUS EMISSION

7.3.1 Applicable Standard

According to FCC Part 15.231(b) and 15.209

7.3.2 Conformance Limit

In addition to the provisions of §15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

| 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 | 2250 | 67 | | |
| 70-130 | 1250 | 62 | | |
| 130-174 | 1250 to 3750* | 62 to 71.5* | | |
| 174-260 | 3750 | 71.5 | | |
| 260-470 | 3750 to 12500* | 71.5 to 81.9* | 10996 | 80.8 |
| Above 470 | 12500 | 81.94 | | |

* 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 | 225 | 47 | | |
| 70-130 | 125 | 41.9 | | |
| 130-174 | 125 to 375* | 41.9 to 51.5* | | |
| 174-260 | 375 | 51.5 | | |
| 260-470 | 375 to 1250* | 51.5 to 61.9* | 1099 | 60.8 |
| Above 470 | 1250 | 61.94 | | |

* Linear interpolation

The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions

The FCC specified emission limits were calculated according to the EUT operating frequency and obtained by following linear interpolation equations:

(a) For fundamental frequency:

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

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

(b) For spurious frequencies:

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

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

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)=20log Emission level (uV/m).

| FCC Part15 (15.231) , Subpart C | | |
|---------------------------------|--------------------------------|--------------------------------------|
| Fundamental Frequency | Field Strength Of Fundamental | Field Strength of Spurious Emissions |
| 433.92MHz | AV:80.8 dBuV/m at 3m distance | AV:60.8 dBuV/m at 3m distance |
| | PK:100.8 dBuV/m at 3m distance | PK:80.8 dBuV/m at 3m distance |

According to the 15.33

The test Frequency Range is 9 kHz to the tenth harmonic of the fundamental transmitter frequency (5GHz)

According to FCC Part15.205, Restricted bands

| MHz | MHz | MHz | GHz |
|-------------------|---------------------|---------------|-------------|
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| 10.495-0.505 | 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 | 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 | (2) |
| 13.36-13.41 | | | |

According to FCC Part15.205, the level of any transmitter spurious emission in Restricted bands shall not exceed the level of the emission specified in the following table

| Restricted Frequency(MHz) | Field Strength (μV/m) | Field Strength (dBμV/m) | Measurement Distance |
|---------------------------|-----------------------|-------------------------|----------------------|
| 0.009~0.490 | 2400/F(KHz) | 300 | See the remark |
| 0.490~1.705 | 24000/F(KHz) | 30 | |
| 1.705~30.0 | 30 | 30 | |
| 30-88 | 100 | 40 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46 | 3 |
| Above 960 | 500 | 54 | 3 |

Remark :1. Emission level in dBuV/m=20 log (uV/m)

2. Measurement was performed at an antenna to the closed point of EUT distance of meters.

3. Distance extrapolation factor =40log(Specific distance/ test distance)(dB);

Limit line=Specific limits(dBuV) + distance extrapolation factor.

for the frequency ranges below 30 MHz, a narrower RBW is used for these ranges but the measured value should add a RBW correction factor (RBWCF) where RBWCF [dB] =10*Ig(100 [kHz]/narrower RBW [kHz]). , the narrower RBW is 1 kHz and RBWCF is 20 dB for the frequency 9 kHz to 150 kHz, and the narrower RBW is 10 kHz and RBWCF is 10 dB for the frequency 150 kHz to 30 MHz.

7.3.3 Test Configuration

Test according to clause 6.2 radio frequency test setup 2

7.3.4 Test Procedure

This test is required for any spurious emission that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

The EUT was placed on a turn table which is 0.8m above ground plane.

Maximum procedure was performed on the highest emissions to ensure EUT compliance.

Span = wide enough to fully capture the emission being measured

RBW = 100 kHz for $f < 1$ GHz (30MHz to 1GHz), 200Hz for $f < 150$ KHz (9KHz to 150KHz), 9KHz for $f < 30$ MHz (150KHz to 30MHz), 1MHz for $f < 5$ GHz

VBW \geq RBW Sweep = auto

Detector function = peak

Trace = max hold

Follow the guidelines in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.

Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{dwell time}/100 \text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

- 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 = $20\log(\text{duty cycle})$

Where the duty factor is calculated from following formula:

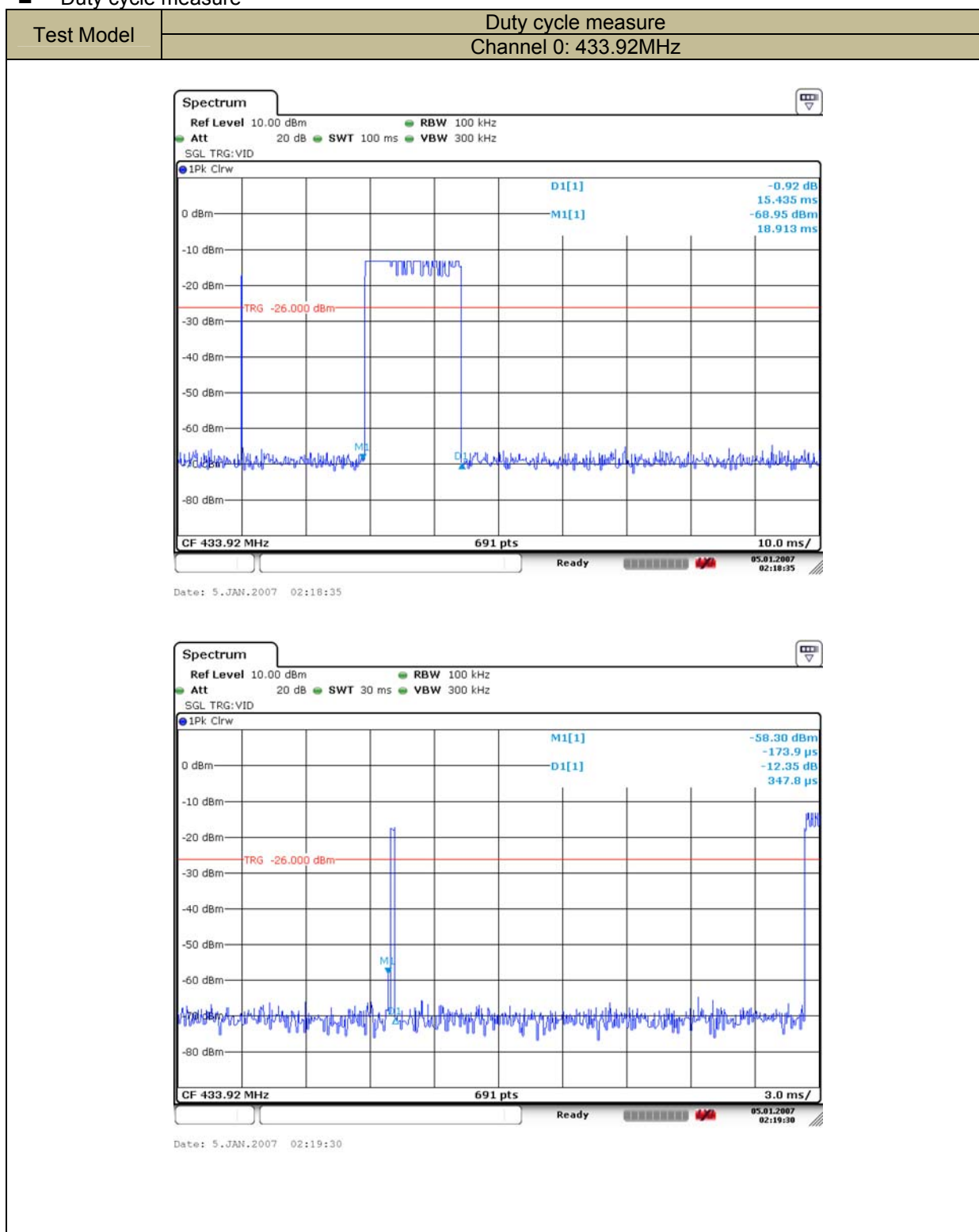
$$20\log(\text{Duty cycle}) = 20\log[(15.435 + 0.3478)/100] = -16.04\text{dB}$$

Therefore, the averaging factor is -16.04dB.

Repeat above procedures until all frequency measured was complete.

7.3.5 Test Results

■ Duty cycle measure



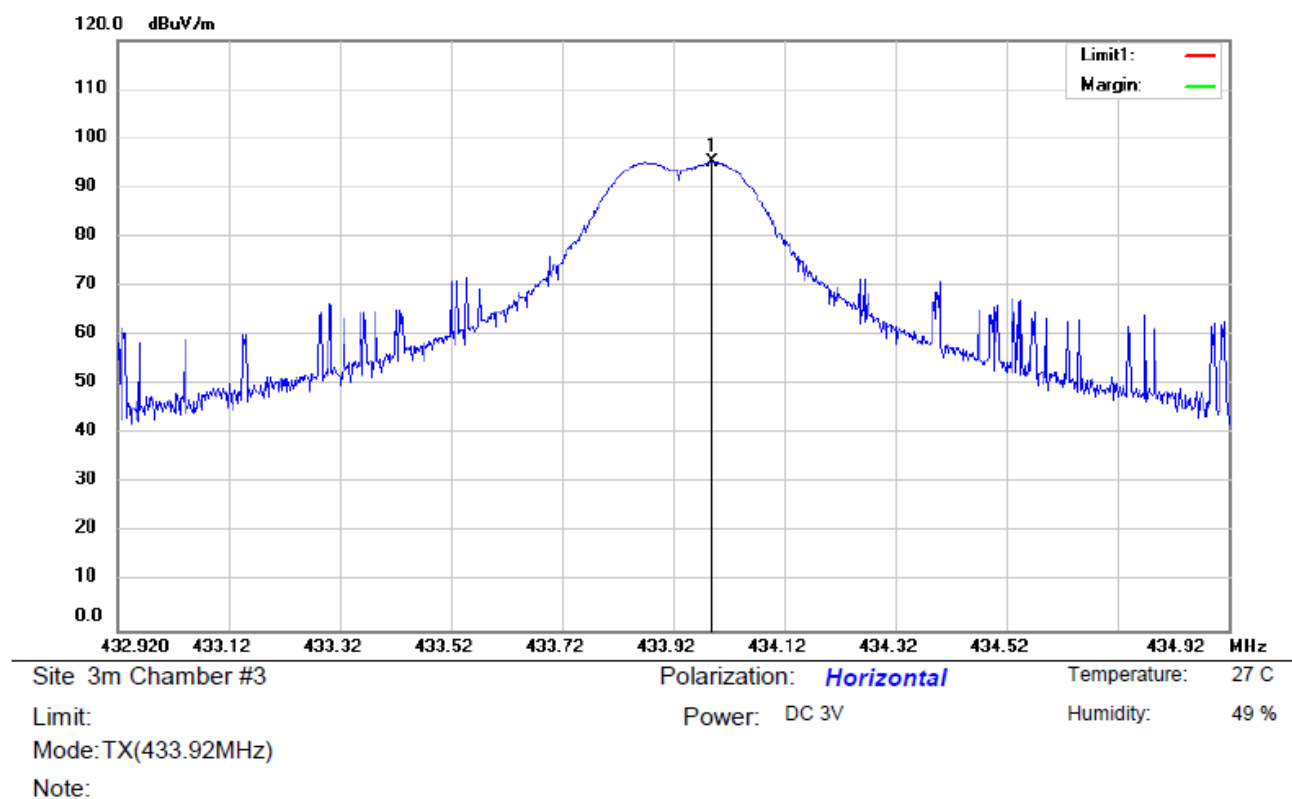
■ Field Strength of the fundamental signal

| | | | |
|--------------|------|------------|---------|
| Temperature: | 24℃ | Test By: | KK |
| Humidity: | 53 % | Test mode: | TX Mode |

| Freq. (MHz) | Ant.Pol. H/V | Emission Level(dBuV/m) | | Limit 3m(dBuV/m) | | Over(dB) | |
|----------------|-----------------|---------------------------|-------|------------------|------|----------|-------|
| | | PK | AV | PK | AV | PK | AV |
| 433.92 | V | 95.20 | 79.16 | 100.8 | 80.8 | -5.60 | -1.64 |
| 433.92 | H | 72.44 | 56.40 | 100.8 | 80.8 | -28.36 | -24.4 |

Note: (1) Correct Factor= Antenna Factor +Cable Loss- Amplifier Gain
(2) Peak Emission Level= Reading Level + Probe Factor +Cable Loss
(3) AV Value =Peak Emission Level + Duty Cycle Correction Factor
(4) DF= Duty Cycle Correction Factor
(5) Duty Cycle Correction Factor (dB) = $20\log(\text{Duty cycle}) = 20\log[(15.435+0.3478)/100] = -16.04\text{dB}$
(6) Average results= Peak results + DF

Fundamental signal-H

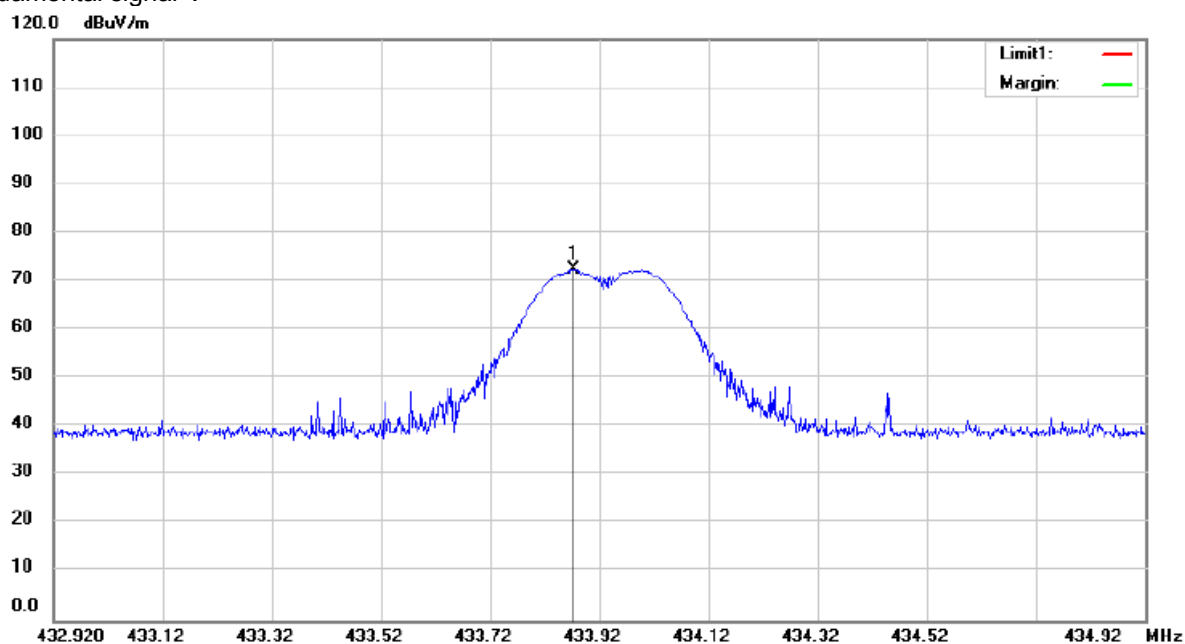


| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | Antenna Height | Table Degree | |
|-----|-----|----------|---------------|----------------|--------------|--------|------|----------------|--------------|---------|
| | | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | Detector | cm | degree |
| 1 | * | 433.9894 | 104.59 | -9.39 | 95.20 | | | peak | | Comment |

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

Operator: ZL

Fundamental signal-V



Site 3m Chamber #3

Polarization: Vertical

Temperature: 27 C

Limit:

Power: DC 3V

Humidity: 49 %

Mode: TX(433.92MHz)

Note:

| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | Antenna Height | Table Degree | |
|-----|-----|----------|---------------|----------------|--------------|--------|------|----------------|--------------|---------|
| | | MHz | dBuV | dB | dBuV/m | dBuV/m | dB | Detector | cm | degree |
| 1 | * | 433.8720 | 81.83 | -9.39 | 72.44 | | | peak | | Comment |

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

Operator: ZL

■ Spurious Emission below 30MHz (9KHz to30MHz)

| | | | |
|--------------|------|------------|---------|
| Temperature: | 24℃ | Test By: | KK |
| Humidity: | 53 % | Test mode: | TX Mode |

| Freq. (MHz) | Ant.Pol. H/V | Emission Level(dBuV/m) | | Limit 3m(dBuV/m) | | Over(dB) | |
|----------------|-----------------|---------------------------|----|------------------|----|----------|----|
| | | PK | AV | PK | AV | PK | AV |
| -- | -- | -- | -- | -- | -- | -- | -- |

Note: the amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

Distance extrapolation factor = $40 \log (\text{Specific distance/ test distance})$ (dB);

Limit line=Specific limits (dBuV) + distance extrapolation factor

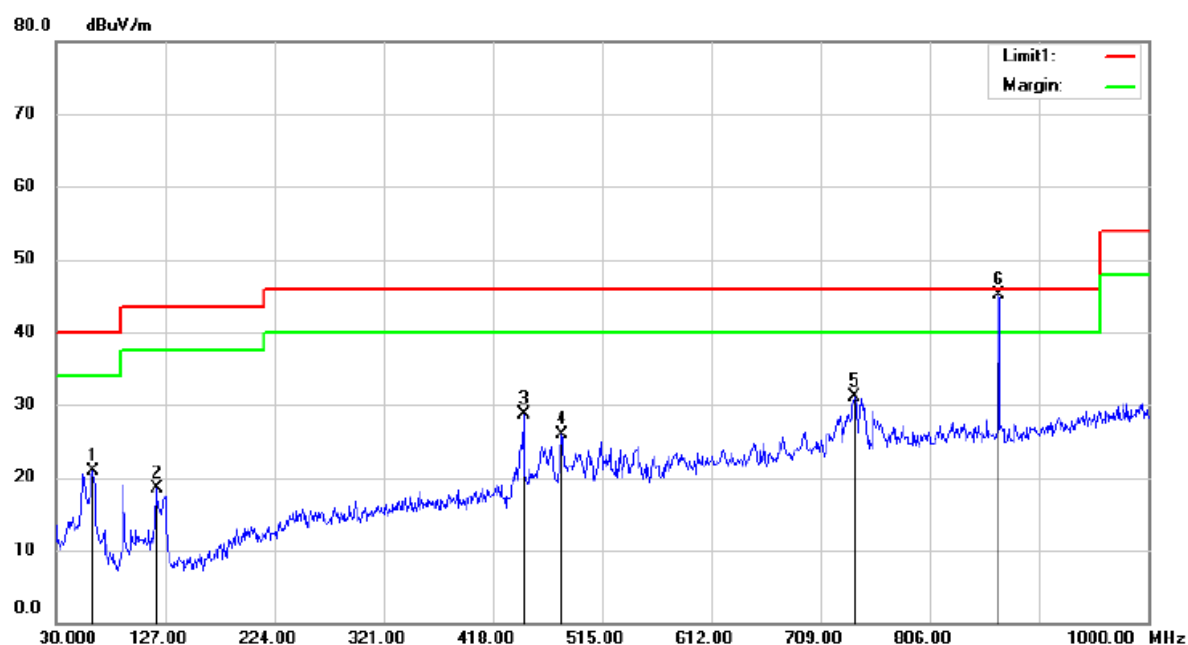
■ Radiated spurious emission above 1GHz

| | | | |
|--------------------|--------------|---------------|-----------|
| Operation Mode: | 433.92MHz | Temperature : | 24℃ |
| Frequency Range: | 1000~5000MHz | Humidity : | 53 % |
| Test Result: | PASS | Test By: | King Kong |
| Measured Distance: | 3m | | |

| Freq. (MHz) | Ant.Pol. H/V | Emission Level(dBuV/m) PK | Limit 3m(dBuV/m) PK | Limit 3m(dBuV/m) AV | Margin (dB) |
|----------------|-----------------|---------------------------------|---------------------------|---------------------------|----------------|
| | | | | | |
| 1301.76* | V | 40.08 | 74.00 | 54.00 | -13.92 |
| 1735.68 | V | 36.48 | 80.80 | 60.80 | -24.32 |
| 2169.60 | V | 40.23 | 80.80 | 60.80 | -20.57 |
| 2603.52* | V | 40.55 | 74.00 | 54.00 | -13.45 |
| 3037.44 | V | 42.42 | 80.80 | 60.80 | -18.38 |
| 3905.28* | V | 44.04 | 74.00 | 54.00 | -9.96 |
| 1301.76* | H | 43.17 | 74.00 | 54.00 | -10.83 |
| 1735.68 | H | 52.72 | 80.80 | 60.80 | -8.08 |
| 2169.60 | H | 44.61 | 80.80 | 60.80 | -16.19 |
| 2603.52* | H | 47.41 | 74.00 | 54.00 | -6.59 |
| 3037.44 | H | 50.25 | 80.80 | 60.80 | -10.55 |
| 3905.28* | H | 44.43 | 74.00 | 54.00 | -9.57 |

- 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) AV True Value =Peak Emission Level + Duty Cycle Correction Factor
 - (5) DF= Duty Cycle Correction Factor
 - (6) Duty Cycle Correction Factor (dB) = $20 \log (\text{Duty cycle}) = 20 \log [(15.435+0.3478)/100] = -16.04 \text{ dB}$
 - (7) Margin = Peak Emission Level – AV limit (The Peak Emission Level is less than AV limit; the AV value is no need to present)
 - (8) The “*” means restricted bands frequency
 - (8) All the x/y/z orientation has been investigated, and only worst case is presented in this report.

■ Radiated spurious emission below 1GHz



Site 3m Chamber #3

Polarization: **Vertical**

Temperature: 27 C

Limit: (RE)FCC PART 15C

Power: DC 3V

Humidity: 49 %

Mode: TX(433.92MHz)

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 | Detector | Comment |
|-----|-----|--------------|--------------------------|-------------------------|----------------------------|-----------------|------------|-------------------------|-----------------|----------|---------|
| 1 | | 63.2710 | 36.74 | -15.83 | 20.91 | 40.00 | -19.09 | | | QP | |
| 2 | | 120.0160 | 35.89 | -17.34 | 18.55 | 43.50 | -24.95 | | | QP | |
| 3 | | 445.5480 | 37.93 | -9.27 | 28.66 | 46.00 | -17.34 | | | QP | |
| 4 | | 479.9830 | 34.44 | -8.58 | 25.86 | 46.00 | -20.14 | | | QP | |
| 5 | | 739.4580 | 34.39 | -3.36 | 31.03 | 46.00 | -14.97 | | | QP | |
| 6 | * | 867.9830 | 46.47 | -1.40 | 45.07 | 80.80 | -35.73 | | | peak | |

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

Operator: ZL



Site 3m Chamber #3

Polarization: **Horizontal**

Temperature: 27 C

Limit: (RE)FCC PART 15C

Power: DC 3V

Humidity: 49 %

Mode: TX(433.92MHz)

Note:

| No. | Mk. | Freq. MHz | Reading Level dBuV | Correct Factor dB | Measure- ment dBuV/m | Limit dBuV/m | Over dB | Detector | Antenna Height cm | Table Degree | Comment |
|-----|-----|--------------|--------------------------|-------------------------|----------------------------|-----------------|------------|----------|-------------------------|-----------------|---------|
| 1 | | 38.0510 | 32.65 | -15.41 | 17.24 | 40.00 | -22.76 | QP | | | |
| 2 | | 119.1430 | 35.43 | -17.22 | 18.21 | 43.50 | -25.29 | QP | | | |
| 3 | | 477.3640 | 36.15 | -8.67 | 27.48 | 46.00 | -18.52 | QP | | | |
| 4 | | 537.5040 | 33.31 | -7.31 | 26.00 | 46.00 | -20.00 | QP | | | |
| 5 | | 742.5620 | 38.60 | -3.36 | 35.24 | 46.00 | -10.76 | QP | | | |
| 6 | * | 867.9830 | 59.36 | -1.40 | 57.96 | 80.80 | -22.84 | peak | | | |

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

Operator: ZL

| Freq. (MHz) | Ant.Pol. H/V | Emission Level(dBuV/m) Peak | Limit 3m(dBuV/m) AV | Margin (dB) |
|----------------|-----------------|-----------------------------------|------------------------|----------------|
| 867.9830 | V | 45.07 | 60.80 | -15.73 |
| 867.9830 | H | 57.96 | 60.80 | -2.84 |

Note: Margin = Peak Emission Level – AV limit (The Peak Emission Level is less than AV limit; the AV value is no need to present)

7.4 TRANSMISSION TIME REQUIREMENT

7.4.1 Applicable Standard

According to FCC Part 15.231(a)

7.4.2 Conformance Limit

(a) The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

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

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

(3) 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.

(4) 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

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

7.4.3 Test Configuration

Test according to clause 6.2 radio frequency test setup 2

7.4.4 Test Procedure

The following table is the setting of spectrum analyzer.

| Spectrum analyzer | Setting |
|-------------------|----------|
| Attenuation | Auto |
| Span Frequency | 0Hz |
| RB | 100KHz |
| VB | 100KHz |
| Detector | Peak |
| Trace | Max hold |
| Sweep Time | 6S |

- The transmitter output (antenna port) was connected to the spectrum analyzer.
- Set RBW of spectrum analyzer to 100KHz and VBW to 100KHz, Set Detector to Peak, Trace to Max Hold.
- Set the span to 0Hz and the sweep time to 6s and record the value.

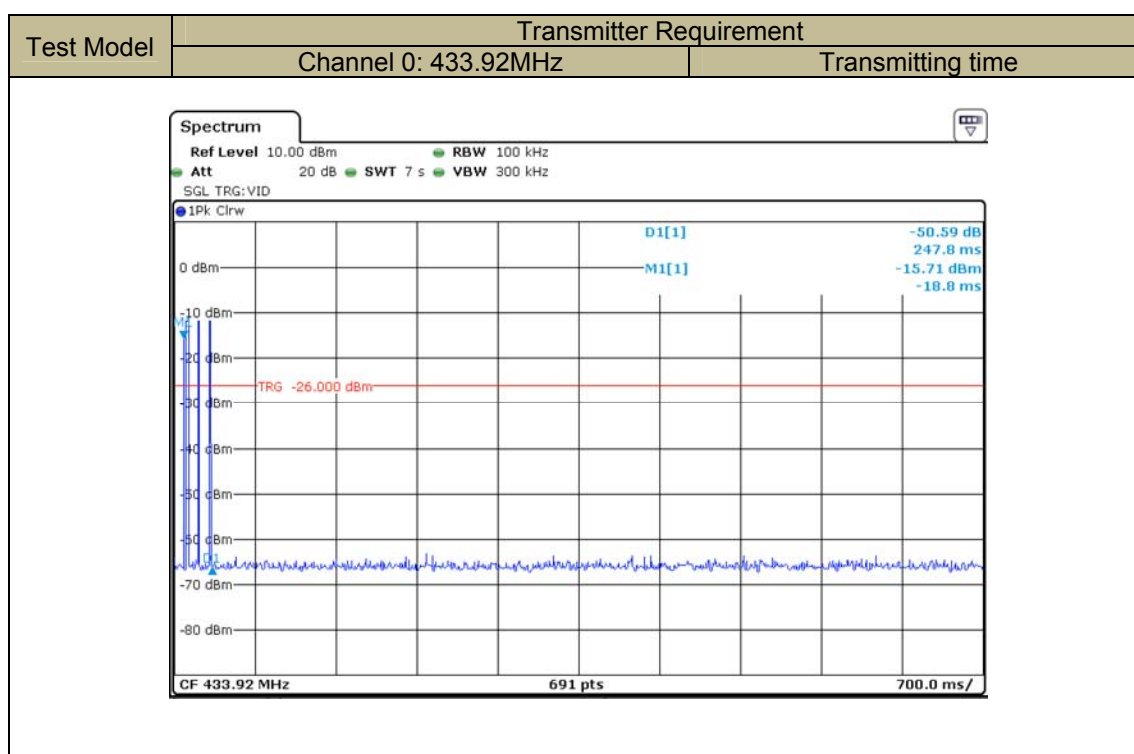
7.4.5 Test Results

| | | | |
|--------------|-------|------------|---------|
| Temperature: | 24 °C | Test By: | KK |
| Humidity: | 53 % | Test mode: | TX Mode |

| Frequency.(MHz) | Transmitting time | Limit | Verdict |
|-----------------|-------------------|-----------|---------|
| 418 | 0.2478 | 5 seconds | PASS |

Note1: The signal bandwidth was measured ($2/PW=2/0.0002478=8.07$ kHz) and less then 100KHz RBW so PDCF factor is not required

Note2: The PW data see the page 21.



7.5 CONDUCTED EMISSION TEST

7.5.1 Applicable Standard

According to FCC Part 15.207(a)

7.5.2 Conformance Limit

| Conducted Emission Limit | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|
| 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. | | |

7.5.3 Test Configuration

Test according to clause 7.3 conducted emission test setup

7.5.4 Test Procedure

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

7.5.5 Test Results

Not Applicable (EUT power supply is DC 3V)

7.6 Antenna Application

7.6.1 Antenna Requirement

| Standard | Requirement |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FCC CRF Part 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded. |

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.

7.6.2 Result

PASS.

The EUT has 1 antenna: External Monopole Antenna, the gain is 2.0 dBi;

- Note:
- ☐ Antenna use a permanently attached antenna which is not replaceable.
 - ☒ Not using a standard antenna jack or electrical connector for antenna replacement
 - ☐ The antenna has to be professionally installed (please provide method of installation)

which in accordance to section 15.203, please refer to the internal photos.

END OF REPORT