# FCC TEST REPORT

| | | |
|---|---|---|
| Client Name | : | Hangzhou CHNSPEC Technology CO.,LTD |
| Address | : | No.166, Wenyuan North Road, Jianggan District, Hangzhou City, China |
| Product Name | : | Colorimeter |
| Date | : | Apr. 08, 2021 |

**Shenzhen Anbotek Compliance Laboratory Limited**

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# TEST REPORT

| | | |
|---|---|---|
| Applicant | : | Hangzhou CHNSPEC Technology CO.,LTD |
| Manufacturer | : | Hangzhou CHNSPEC Technology CO.,LTD |
| Product Name | : | Colorimeter |
| Model No. | : | See page 5 |
| Trade Mark | : | N.A. |
| Rating(s) | : | Input: DC 5V, 1A(wtih DC 3.7V, 760mAh battery inside) |

| | | |
|---|---|---|
| **Test Standard(s)** | : | **FCC Part15 Subpart C, Section 15.247** |
| **Test Method(s)** | : | **ANSI C63.10: 2013, KDB558074 D01 DTS Meas Guidance v05r02** |

The device described above is tested by Shenzhen Anbotek Compliance Laboratory Limited to determine the maximum emission levels emanating from the device and the severe levels of the device can endure and its performance criterion. The measurement results are contained in this test report and Shenzhen Anbotek Compliance Laboratory Limited is assumed full of responsibility for the accuracy and completeness of these measurements. Also, this report shows that the EUT (Equipment Under Test) is technically compliant with the FCC Part 15 Subpart C requirements.

This report applies to above tested sample only and shall not be reproduced in part without written approval of Shenzhen Anbotek Compliance Laboratory Limited.

| | |
|---|---|
| Date of Receipt | Mar. 09, 2021 |
| Date of Test | Mar. 09~29, 2021 |
| Prepared By | Ella Liang<br>(Engineer /Ella Liang) |
| Reviewer | Bibo Zhang<br>(Supervisor / Bibo Zhang) |
| Approved & Authorized Signer | Kingkong Jin<br>(Manager / Kingkong Jin) |

# 1. General Information

## 1.1. Client Information

| | | |
|---|---|---|
| Applicant | : | Hangzhou CHNSPEC Technology CO.,LTD |
| Address | : | No.166, Wenyuan North Road, Jianggan District, Hangzhou City, China |
| Manufacturer | : | Hangzhou CHNSPEC Technology CO.,LTD |
| Address | : | No.166, Wenyuan North Road, Jianggan District, Hangzhou City, China |
| Factory | : | Hangzhou CHNSPEC Technology CO.,LTD |
| Address | : | No.166, Wenyuan North Road, Jianggan District, Hangzhou City, China |

## 1.2. Description of Device (EUT)

| | | | |
|---|---|---|---|
| Product Name | : | Colorimeter | |
| Model No. | : | ColorMeter Pro, ColorMeter, ColorMeter SE, ColorMeter MAX, DigiColor SE, DigiColor Pro, DigiColor MAX, DigiSpec SE, DigiSpec Pro, DigiSpec MAX, ColorMeter1, ColorMeter2, ColorMeter3, ColorMeter4, ColorMeter5, ColorMeter6, ColorMeter7, ColorMeter8, ColorMeter9, ColorMeterX ColorSpec, ColorSpec SE, ColorSpec ProX, ColorSpec 1, ColorSpec 2, ColorSpec 3, ColorSpec 4, ColorSpec 5, ColorSpec 6, ColorSpec 7, ColorSpec 8, ColorSpec 9, ColorSpec X, GlossMeter, GlossMeter Pro, GlossMeter X, GlossMeter SE, CS-390, CS-391, CS-392, CS-393, CS-394, CS-395, CS-396, CS-397, CS-398, CS-399, CS-300, CS-380, CS-600, CS-610, CS-620, CS-630, CS-640, CS-650, CS-660, CS-670, CS-680, CS-690, CS-500, CS-510, CS-520, CS-530, CS-540, CS-550, CS-560, CS-570, CS-580, CS-590, CS-700, CS-710, CS-720, CS-730, CS-740, CS-750, CS-760, CS-770, CS-780, CS-790, CS-800, CS-801, CS-802, CS-803, CS-804, CS-805, CS-806, CS-807, CS-808, CS-809, CS-810, CS-811, CS-812, CS-813, CS-814, CS-815, CS-816, CS-817, CS-818, CS-819, CS-820, CS-821, CS-822, CS-823, CS-824, CS-825, CS-826, CS-827, CS-828N, CS-829<br>(Note: All samples are the same except the model name and the appearance, so we prepare "ColorMeter Pro" for test only.) | |
| Trade Mark | : | N.A. | |
| Test Power Supply | : | AC 120V, 60Hz for adapter / AC 240V, 60Hz for adapter<br>DC 3.7V battery inside | |
| Test Sample No. | : | 1-2-1(Normal Sample), 1-2-2(Engineering Sample) | |
| Product | : | Operation Frequency: | 2402-2480MHz |

| | | | |
|---|---|---|---|
| Description | | Transfer Rate: | 1 Mbits/s |
| | | Number of Channel: | 40 Channels |
| | | Modulation Type: | GFSK |
| | | Antenna Type: | PCB Antenna |
| | | Antenna Gain(Peak): | -3 dBi |
| **Remark:** 1) For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual. | | | |

## 1.3. Auxiliary Equipment Used During Test

| | | |
|---|---|---|
| Adapter | : | Manufacturer: ZTE |
| | | M/N: STC-A2050I1000USBA-C<br>S/N: 201202102100876<br>Input: 100-240V~ 50/60Hz, 0.3A<br>Output: DC 5V, 1000mA |

## 1.4. Description of Test Modes

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

| Pretest Mode | Description | |
|---|---|---|
| Mode 1 | CH00 | TX+ Charging Mode/TX Only |
| Mode 2 | CH19 | |
| Mode 3 | CH39 | |

Note:

(1) The measurements are performed at the highest, middle, lowest available channels.

(2)The data rate was set in 1Mbps for radiated emission due to the highest RF output power.

## 1.5. List of channels

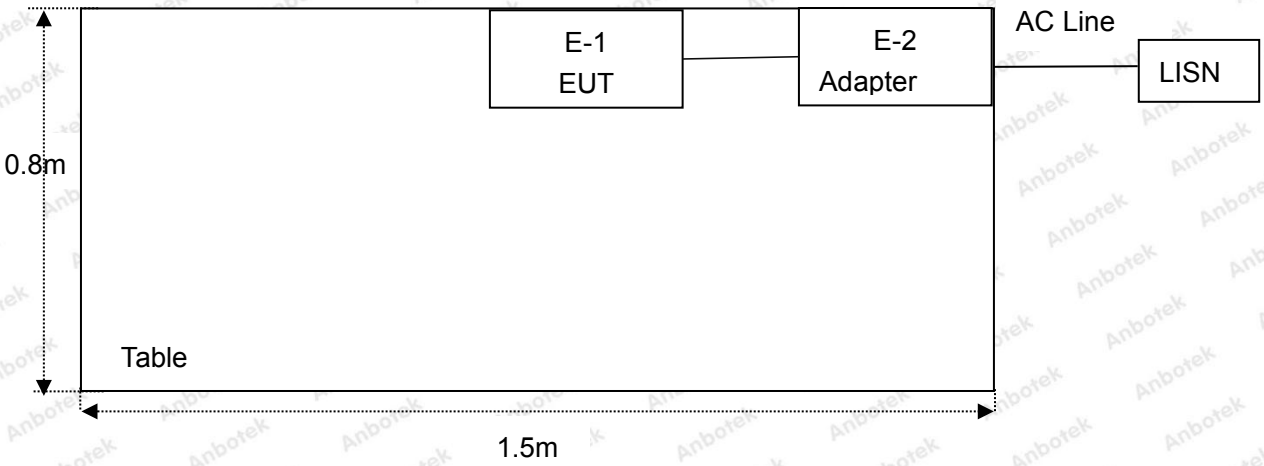
| Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|---|---|---|---|---|---|---|---|---|---|
| 00 | 2402 | 09 | 2420 | 18 | 2438 | 27 | 2456 | 36 | 2474 |
| 01 | 2404 | 10 | 2422 | 19 | 2440 | 28 | 2458 | 37 | 2476 |
| 02 | 2406 | 11 | 2424 | 20 | 2442 | 29 | 2460 | 38 | 2478 |
| 03 | 2408 | 12 | 2426 | 21 | 2444 | 30 | 2462 | 39 | 2480 |
| 04 | 2410 | 13 | 2428 | 22 | 2446 | 31 | 2464 | | |
| 05 | 2412 | 14 | 2430 | 23 | 2448 | 32 | 2466 | | |
| 06 | 2414 | 15 | 2432 | 24 | 2450 | 33 | 2468 | | |
| 07 | 2416 | 16 | 2434 | 25 | 2452 | 34 | 2470 | | |
| 08 | 2418 | 17 | 2436 | 26 | 2454 | 35 | 2472 | | |

Note:

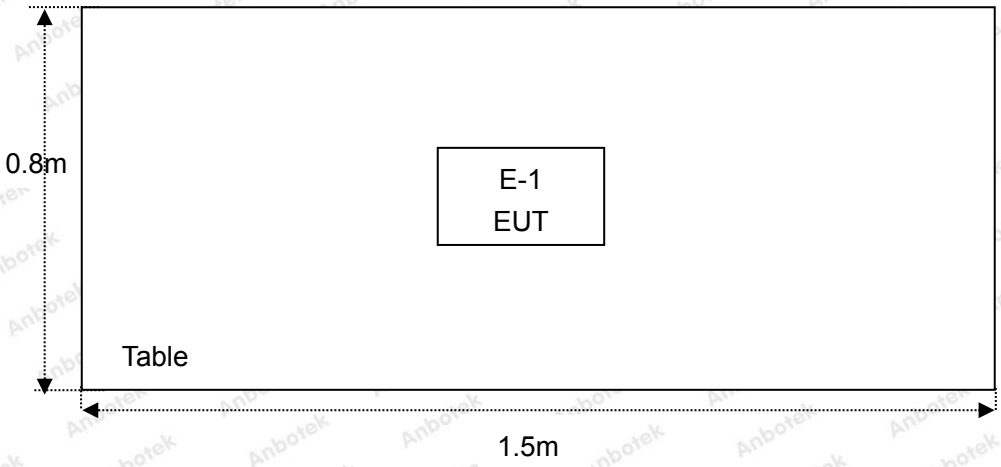
1. The engineering test program was provided and the EUT was programmed to be in continuously transmitting mode.
2. EUT built-in battery-powered, fully-charged battery use of the test battery.

## 1.6. Description Of Test Setup

CE




RE



## 1.7. Test Equipment List

| Item | Equipment | Manufacturer | Model No. | Serial No. | Last Cal. | Cal. Interval |
|---|---|---|---|---|---|---|
| 1. | L.I.S.N. Artificial Mains Network | Rohde & Schwarz | ENV216 | 100055 | Oct. 26, 2020 | 1 Year |
| 2. | EMI Test Receiver | Rohde & Schwarz | ESCI | 100627 | Oct. 26, 2020 | 1 Year |
| 3. | EMI Test Receiver | Rohde & Schwarz | ESR26 | 101481 | Oct. 26, 2020 | 1 Year |
| 4. | RF Switching Unit | Compliance Direction | RSU-M2 | 38303 | Oct. 26, 2020 | 1 Year |
| 5. | MAX Spectrum Analysis | Agilent | N9020A | MY51170037 | Oct. 26, 2020 | 1 Year |
| 6. | Preamplifier | SKET Electronic | BK1G18G30 D | KD17503 | Oct. 26, 2020 | 1 Year |
| 7. | Double Ridged Horn Antenna | Instruments corporation | GTH-0118 | 351600 | Nov. 02, 2020 | 2 Year |
| 8. | Bilog Broadband Antenna | Schwarzbeck | VULB9163 | VULB 9163-289 | Nov. 02, 2020 | 2 Year |
| 9. | Loop Antenna | Schwarzbeck | FMZB1519B | 00053 | Nov. 02, 2020 | 2 Year |
| 10. | Horn Antenna | A-INFO | LB-180400-K F | J211060628 | Nov. 02, 2020 | 2 Year |
| 11. | Pre-amplifier | SONOMA | 310N | 186860 | Oct. 26, 2020 | 1 Year |
| 12. | EMI Test Software EZ-EMC | SHURPLE | N/A | N/A | N/A | N/A |
| 13. | RF Test Control System | YIHENG | YH3000 | 2017430 | Oct. 26, 2020 | 1 Year |
| 14. | Power Sensor | DAER | RPR3006W | 15I00041SN045 | Oct. 26, 2020 | 1 Year |
| 15. | Power Sensor | DAER | RPR3006W | 15I00041SN046 | Oct. 26, 2020 | 1 Year |
| 16. | MXA Spectrum Analysis | Agilent | N9020A | MY51170037 | Oct. 26, 2020 | 1 Year |
| 17. | MXG RF Vector Signal Generator | Agilent | N5182A | MY48180656 | Oct. 26, 2020 | 1 Year |
| 18. | Signal Generator | Agilent | E4421B | MY41000743 | Oct. 26, 2020 | 1 Year |
| 19. | DC Power Supply | IVYTECH | IV3605 | 1804D360510 | Oct. 26, 2020 | 1 Year |
| 20. | Constant Temperature Humidity Chamber | ZHONGJIAN | ZJ-KHWS80 B | N/A | Oct. 26, 2020 | 1 Year |

## 1.8. Measurement Uncertainty

| | | |
|---|---|---|
| Radiation Uncertainty | : | Ur = 3.9 dB (Horizontal) |
| | | Ur = 3.8 dB (Vertical) |
| | | |
| Conduction Uncertainty | : | Uc = 3.4 dB |

## 1.9. Description of Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

**FCC-Registration No.: 184111**

Shenzhen Anbotek Compliance Laboratory Limited, EMC Laboratory has been registed and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No. 184111, September 30, 2020.

**ISED-Registration No.: 8058A**

Shenzhen Anbotek Compliance Laboratory Limited, EMC Laboratory has been registered and fully described in a report filed with the (ISED) Innovation, Science and Economic Development Canada. The acceptance letter from the ISED is maintained in our files. Registration 8058A, September 30, 2020.

**Test Location**

Shenzhen Anbotek Compliance Laboratory Limited.
1/F, Building D, Sogood Science and Technology Park, Sanwei community, Hangcheng Street, Bao'an District, Shenzhen, Guangdong, China.518102

# 2. Summary of Test Results

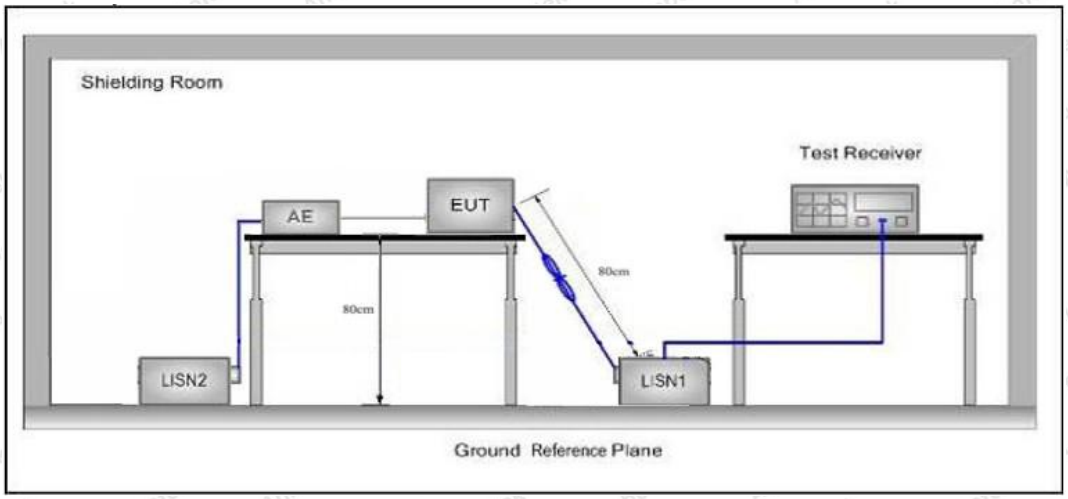
| Standard Section | Test Item | Result |
|---|---|---|
| 15.203/15.247(c) | Antenna Requirement | PASS |
| 15.207 | Conducted Emission | PASS |
| 15.205/15.209 | Spurious Emission | PASS |
| 15.247(b)(3) | Conducted Peak Output Power | PASS |
| 15.247(a)(2) | 6dB Occupied Bandwidth | PASS |
| 15.247(e) | Power Spectral Density | PASS |
| 15.247(d) | Band Edge | PASS |
| **Remark:** “N/A” is an abbreviation for Not Applicable. | | |

# 3. Conducted Emission Test

## 3.1. Test Standard and Limit

| Test Standard | FCC Part15 Section 15.207 | | |
|---|---|---|---|
| Test Limit | Frequency | Maximum RF Line Voltage (dBuV) | |
| | | Quasi-peak Level | Average Level |
| | 150kHz~500kHz | 66 ~ 56 * | 56 ~ 46 * |
| | 500kHz~5MHz | 56 | 46 |
| | 5MHz~30MHz | 60 | 50 |
| **Remark:** (1) *Decreasing linearly with logarithm of the frequency.<br>(2) The lower limit shall apply at the transition frequency. | | | |

## 3.2. Test Setup




## 3.3. Test Procedure

The EUT system is connected to the power mains through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm coupling impedance for the EUT system. Please refer the block diagram of the test setup and photographs. Both sides of AC line are checked to find out the maximum conducted emission. In order to find the maximum emission levels, the relative positions of equipment and all of the interface cables shall be changed according to FCC ANSI C63.10-2013 on Conducted Emission Measurement.

The bandwidth of test receiver (ESCI) set at 9kHz.

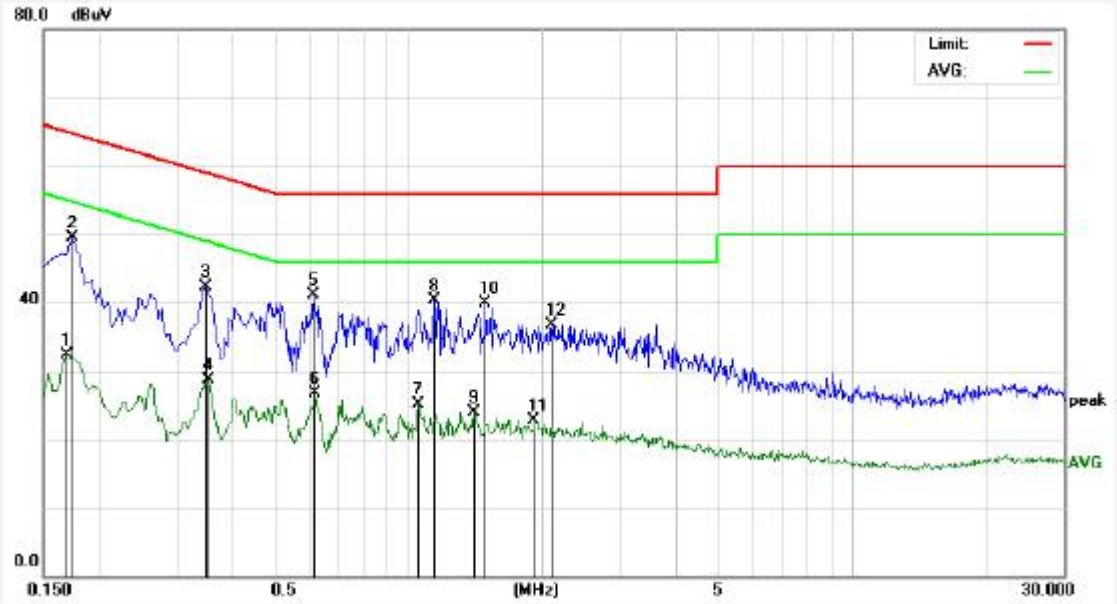
The frequency range from 150kHz to 30MHz is checked.

## 3.4. Test Data

During the test, pre-scan all modes, and found the “Middle CH” which is the worst case, only the worst case is recorded in the report.

**Conducted Emission Test Data**

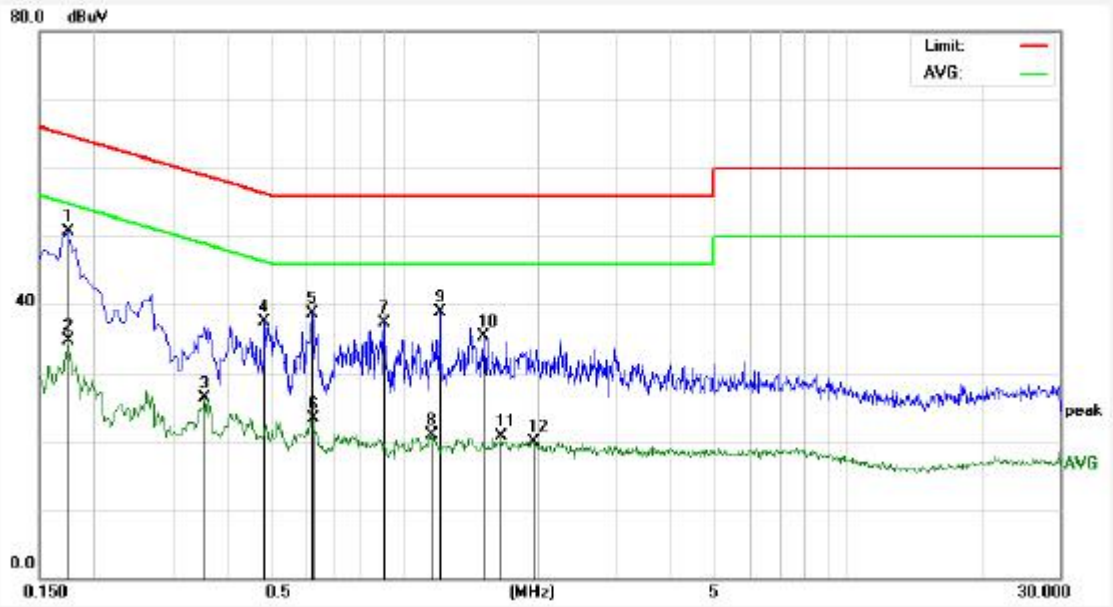
Test Site: 1# Shielded Room
Operating Condition: Mode 2
Test Specification: AC 120V, 60Hz for adapter
Comment: Live Line
Tem.: 21.6℃ Hum.: 50%




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit (dBuV) | Over Limit (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1700 | 12.40 | 19.90 | 32.30 | 54.96 | -22.66 | AVG | |
| 2 | 0.1740 | 29.66 | 19.90 | 49.56 | 64.76 | -15.20 | QP | |
| 3 | 0.3500 | 22.34 | 19.91 | 42.25 | 58.96 | -16.71 | QP | |
| 4 | 0.3540 | 8.70 | 19.91 | 28.61 | 48.87 | -20.26 | AVG | |
| 5 | 0.6100 | 21.11 | 20.01 | 41.12 | 56.00 | -14.88 | QP | |
| 6 | 0.6140 | 6.77 | 20.01 | 26.78 | 46.00 | -19.22 | AVG | |
| 7 | 1.0540 | 4.99 | 20.12 | 25.11 | 46.00 | -20.89 | AVG | |
| 8 | 1.1460 | 20.17 | 20.12 | 40.29 | 56.00 | -15.71 | QP | |
| 9 | 1.4100 | 3.75 | 20.13 | 23.88 | 46.00 | -22.12 | AVG | |
| 10 | 1.4900 | 19.87 | 20.13 | 40.00 | 56.00 | -16.00 | QP | |
| 11 | 1.9260 | 2.62 | 20.14 | 22.76 | 46.00 | -23.24 | AVG | |
| 12 | 2.1099 | 16.65 | 20.14 | 36.79 | 56.00 | -19.21 | QP | |

**Conducted Emission Test Data**

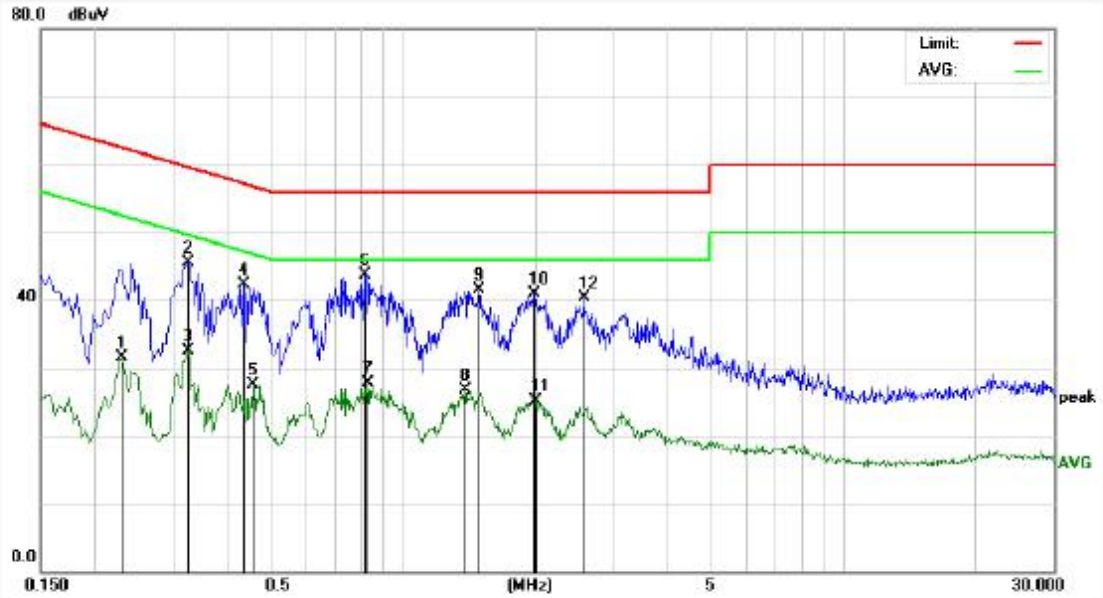
Test Site: 1# Shielded Room
Operating Condition: Mode 2
Test Specification: AC 120V, 60Hz for adapter
Comment: Neutral Line
Tem.: 21.6℃ Hum.: 50%




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit (dBuV) | Over Limit (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1740 | 30.84 | 19.90 | 50.74 | 64.76 | -14.02 | QP | |
| 2 | 0.1740 | 14.82 | 19.90 | 34.72 | 54.76 | -20.04 | AVG | |
| 3 | 0.3540 | 6.39 | 19.91 | 26.30 | 48.87 | -22.57 | AVG | |
| 4 | 0.4860 | 17.52 | 19.97 | 37.49 | 56.24 | -18.75 | QP | |
| 5 | 0.6180 | 18.70 | 20.02 | 38.72 | 56.00 | -17.28 | QP | |
| 6 | 0.6220 | 3.19 | 20.02 | 23.21 | 46.00 | -22.79 | AVG | |
| 7 | 0.9020 | 17.21 | 20.09 | 37.30 | 56.00 | -18.70 | QP | |
| 8 | 1.1580 | 0.74 | 20.12 | 20.86 | 46.00 | -25.14 | AVG | |
| 9 | 1.2020 | 18.79 | 20.12 | 38.91 | 56.00 | -17.09 | QP | |
| 10 | 1.5060 | 15.16 | 20.13 | 35.29 | 56.00 | -20.71 | QP | |
| 11 | 1.6540 | 0.62 | 20.13 | 20.75 | 46.00 | -25.25 | AVG | |
| 12 | 1.9540 | -0.15 | 20.14 | 19.99 | 46.00 | -26.01 | AVG | |

**Conducted Emission Test Data**

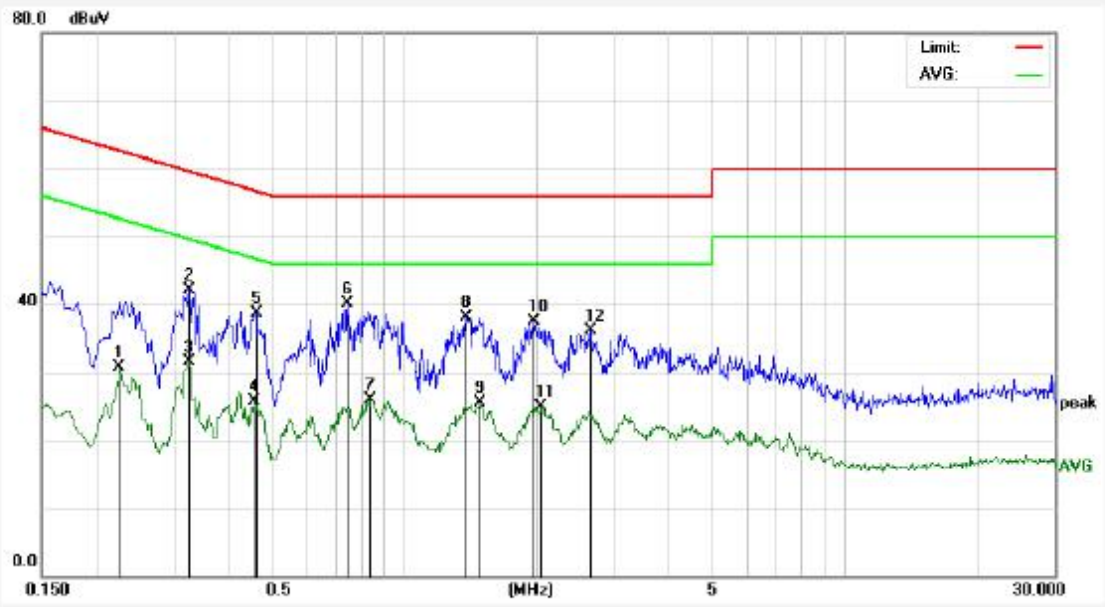
Test Site: 1# Shielded Room
Operating Condition: Mode 2
Test Specification: AC 240V, 60Hz for adapter
Comment: Live Line
Tem.: 21.6℃ Hum.: 50%




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit (dBuV) | Over Limit (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.2300 | 11.54 | 19.89 | 31.43 | 52.45 | -21.02 | AVG | |
| 2 | 0.3260 | 25.70 | 19.90 | 45.60 | 59.55 | -13.95 | QP | |
| 3 | 0.3260 | 12.60 | 19.90 | 32.50 | 49.55 | -17.05 | AVG | |
| 4 | 0.4340 | 22.39 | 19.95 | 42.34 | 57.18 | -14.84 | QP | |
| 5 | 0.4580 | 7.63 | 19.96 | 27.59 | 46.73 | -19.14 | AVG | |
| 6 | 0.8260 | 23.72 | 20.07 | 43.79 | 56.00 | -12.21 | QP | |
| 7 | 0.8340 | 7.66 | 20.08 | 27.74 | 46.00 | -18.26 | AVG | |
| 8 | 1.3860 | 6.56 | 20.13 | 26.69 | 46.00 | -19.31 | AVG | |
| 9 | 1.4900 | 21.45 | 20.13 | 41.58 | 56.00 | -14.42 | QP | |
| 10 | 1.9860 | 20.82 | 20.14 | 40.96 | 56.00 | -15.04 | QP | |
| 11 | 1.9940 | 5.05 | 20.14 | 25.19 | 46.00 | -20.81 | AVG | |
| 12 | 2.5780 | 20.22 | 20.15 | 40.37 | 56.00 | -15.63 | QP | |

**Conducted Emission Test Data**

Test Site: 1# Shielded Room
Operating Condition: Mode 2
Test Specification: AC 240V, 60Hz for adapter
Comment: Neutral Line
Tem.: 21.6℃ Hum.: 50%




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit (dBuV) | Over Limit (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.2260 | 10.76 | 19.89 | 30.65 | 52.59 | -21.94 | AVG | |
| 2 | 0.3260 | 22.12 | 19.90 | 42.02 | 59.55 | -17.53 | QP | |
| 3 | 0.3260 | 11.54 | 19.90 | 31.44 | 49.55 | -18.11 | AVG | |
| 4 | 0.4580 | 5.65 | 19.96 | 25.61 | 46.73 | -21.12 | AVG | |
| 5 | 0.4620 | 18.71 | 19.96 | 38.67 | 56.66 | -17.99 | QP | |
| 6 | 0.7460 | 20.03 | 20.05 | 40.08 | 56.00 | -15.92 | QP | |
| 7 | 0.8420 | 5.89 | 20.08 | 25.97 | 46.00 | -20.03 | AVG | |
| 8 | 1.3860 | 18.07 | 20.13 | 38.20 | 56.00 | -17.80 | QP | |
| 9 | 1.4900 | 5.38 | 20.13 | 25.51 | 46.00 | -20.49 | AVG | |
| 10 | 1.9780 | 17.41 | 20.14 | 37.55 | 56.00 | -18.45 | QP | |
| 11 | 2.0540 | 4.83 | 20.14 | 24.97 | 46.00 | -21.03 | AVG | |
| 12 | 2.6580 | 15.95 | 20.15 | 36.10 | 56.00 | -19.90 | QP | |

# 4. Radiation Spurious Emission and Band Edge

## 4.1. Test Standard and Limit

| Test Standard | FCC Part15 C Section 15.209 and 15.205 | | | | |
|---|---|---|---|---|---|
| Test Limit | Frequency (MHz) | Field strength (microvolt/meter) | Limit (dBuV/m) | Remark | Measurement distance (m) |
| | 0.009MHz~0.490MHz | 2400/F(kHz) | - | - | 300 |
| | 0.490MHz-1.705MHz | 24000/F(kHz) | - | - | 30 |
| | 1.705MHz-30MHz | 30 | - | - | 30 |
| | 30MHz~88MHz | 100 | 40.0 | Quasi-peak | 3 |
| | 88MHz~216MHz | 150 | 43.5 | Quasi-peak | 3 |
| | 216MHz~960MHz | 200 | 46.0 | Quasi-peak | 3 |
| | 960MHz~1000MHz | 500 | 54.0 | Quasi-peak | 3 |
| | Above 1000MHz | 500 | 54.0 | Average | 3 |
| | | - | 74.0 | Peak | 3 |

**Remark:**
(1)The lower limit shall apply at the transition frequency.
(2) 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

## 4.2. Test Setup

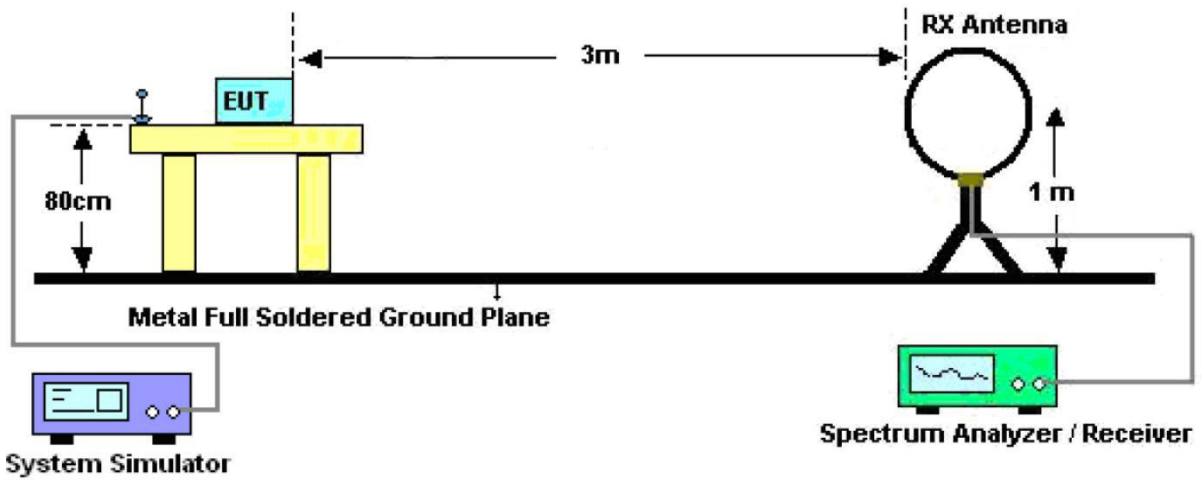



Figure 1. Below 30MHz

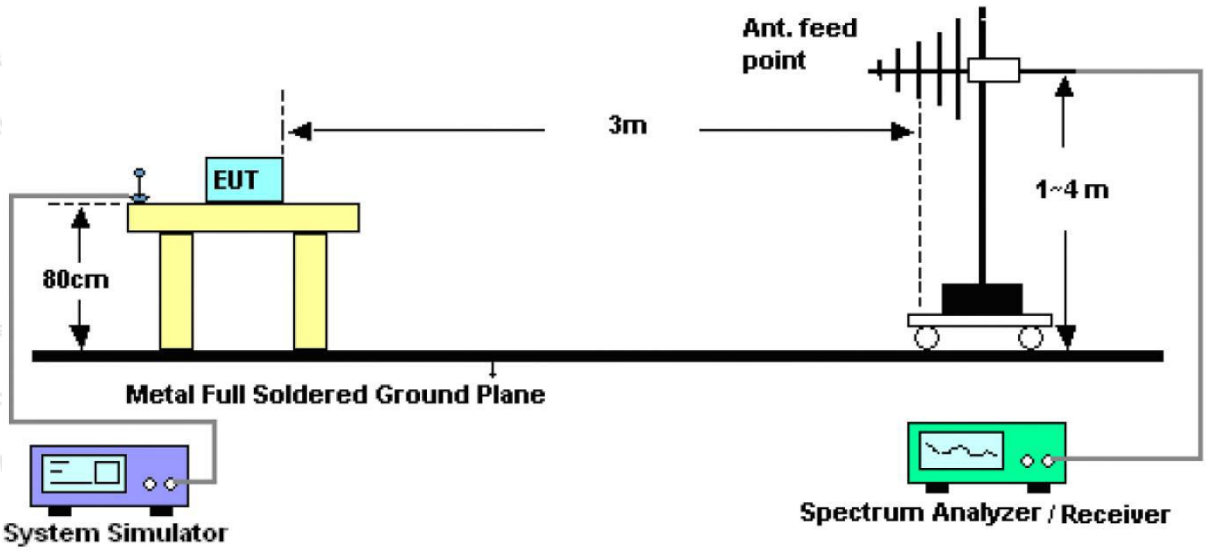



Figure 2. 30MHz to 1GHz

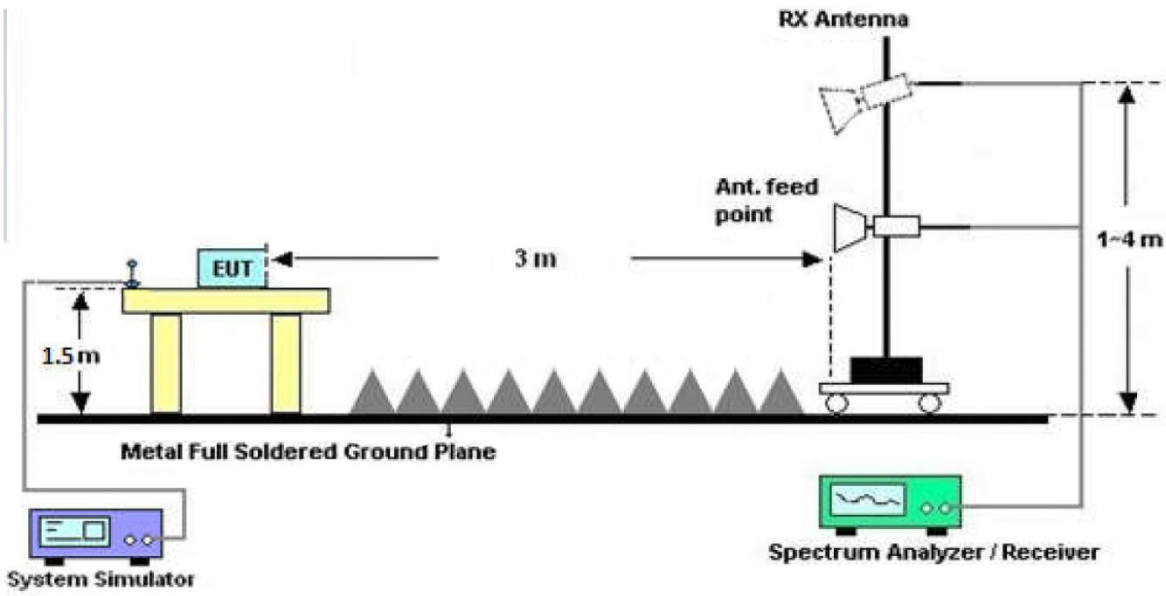



Figure 3. Above 1 GHz

## 4.3. Test Procedure

For below 1GHz: The EUT is placed on a turntable, which is 0.8m above the ground plane.
For above 1GHz: The EUT is placed on a turntable, which is 1.5m above the ground plane.
The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT is set 3 meters away from the receiving antenna which is mounted on a antenna tower. The antenna can be moved up and down from 1 to 4 meters to find out the maximum emission level. Rotated the EUT through three orthogonal axes to determine the maximum emissions, both horizontal and vertical polarization of the antenna are set on test. The EUT is tested in 9*6*6 Chamber. The device is evaluated in xyz orientation.

For the radiated emission test above 1GHz:
Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

For 9kHz to 150kHz, Set the spectrum analyzer as:
RBW = 200Hz, VBW =1kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 150kHz to 30MHz, Set the spectrum analyzer as:
RBW = 9KHz, VBW =30kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 30MHz to 1000MHz, Set the spectrum analyzer as:
RBW = 100kHz, VBW =300kHz,Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For above 1GHz,Set the spectrum analyzer as:
RBW =1MHz, VBW =1MHz, Detector= Peak, Trace mode= Max hold, Sweep- auto couple.
RBW =1MHz, VBW =10Hz, Detector= Average, Trace mode= Max hold, Sweep- auto couple.

## 4.4. Test Data

**PASS**

During the test, pre-scan all the modes, and found the Middle channel (TX Only) which is the worst case, only the worst case is recorded in the report.

The test results of 9kHz-30MHz was attenuated more than 20dB below the permissible limits, so the results don't record in the report.

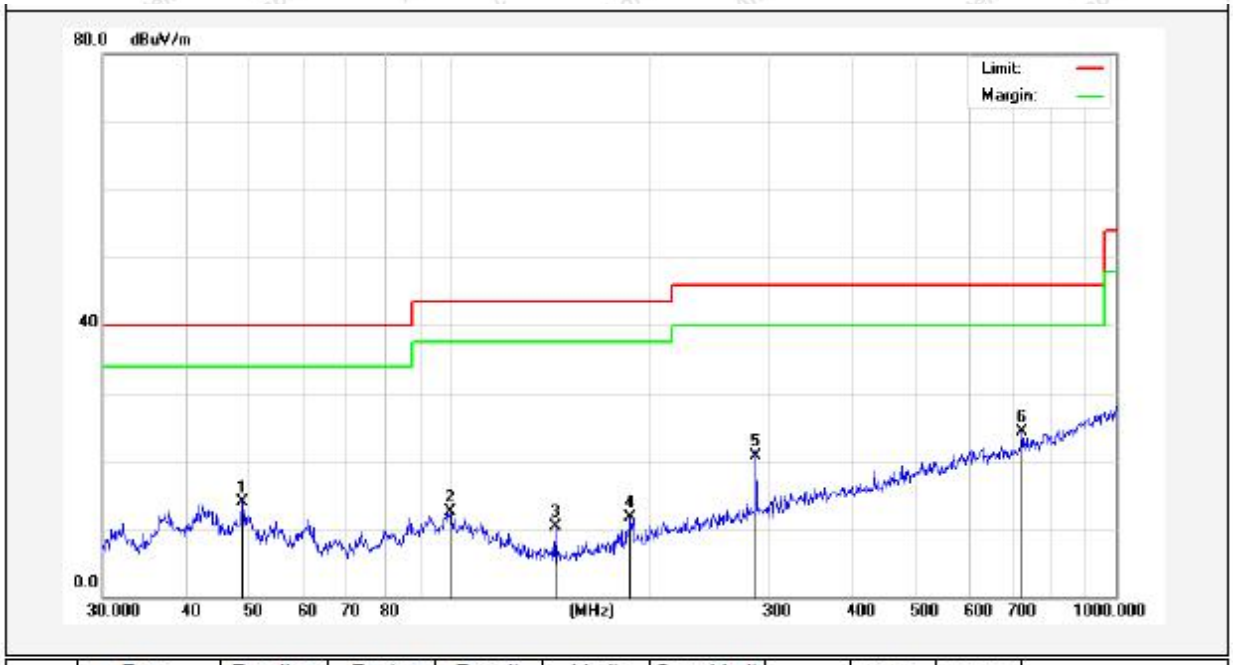
**Test Results (30~1000MHz)**

Test Mode: Mode 2

Power Source: DC 3.7V battery inside

Polarization: Horizontal

Temp.(℃)/Hum.(%RH): 22.0℃/50%RH




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Height (cm) | degree (deg) | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 48.6719 | 28.52 | -14.69 | 13.83 | 40.00 | -26.17 | QP | 100 | 360 | |
| 2 | 99.8777 | 31.88 | -19.39 | 12.49 | 43.50 | -31.01 | QP | 100 | 0 | |
| 3 | 143.8295 | 31.15 | -20.84 | 10.31 | 43.50 | -33.19 | QP | 100 | 360 | |
| 4 | 186.4409 | 32.31 | -20.52 | 11.79 | 43.50 | -31.71 | QP | 100 | 0 | |
| 5 | 287.9904 | 36.01 | -15.39 | 20.62 | 46.00 | -25.38 | QP | 100 | 360 | |
| 6 | 721.7259 | 29.98 | -5.67 | 24.31 | 46.00 | -21.69 | QP | 100 | 0 | |

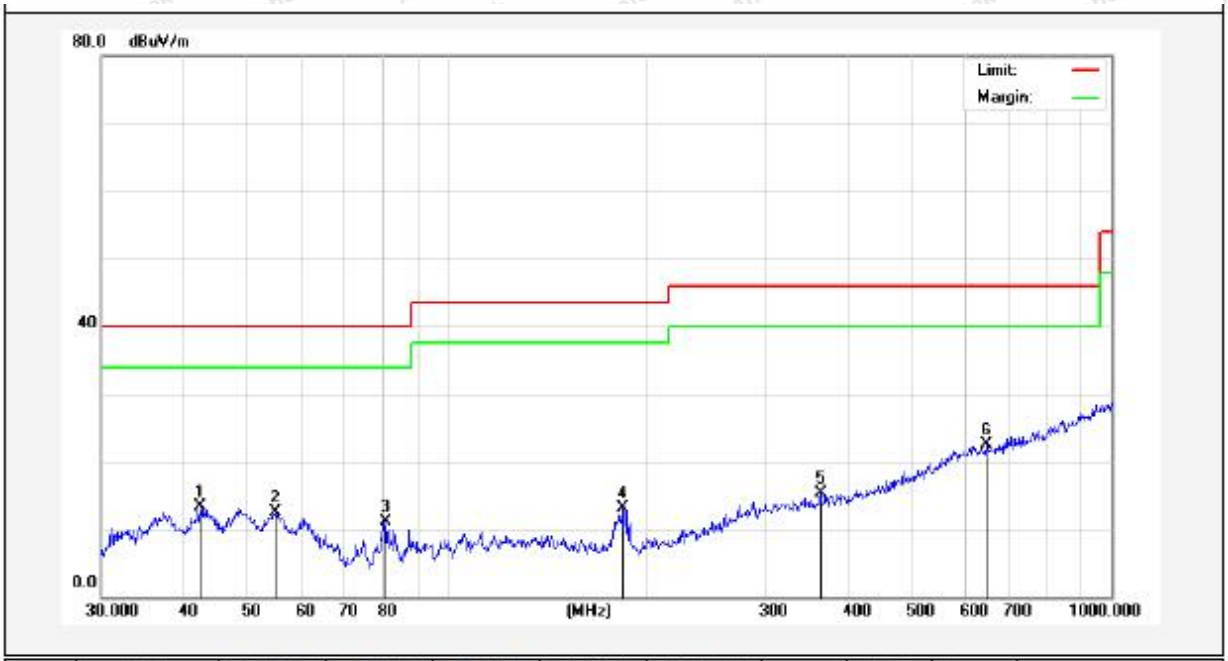
**Test Results (30~1000MHz)**

Test Mode: Mode 2

Power Source: DC 3.7V battery inside

Polarization: Vertical

Temp.(℃)/Hum.(%RH): 22.0℃/50%RH




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Height (cm) | degree (deg) | Remark |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 42.3022 | 27.11 | -13.82 | 13.29 | 40.00 | -26.71 | QP | 100 | 360 | |
| 2 | 55.0274 | 29.03 | -16.53 | 12.50 | 40.00 | -27.50 | QP | 100 | 0 | |
| 3 | 80.6442 | 28.67 | -17.57 | 11.10 | 40.00 | -28.90 | QP | 100 | 360 | |
| 4 | 183.8440 | 31.06 | -18.05 | 13.01 | 43.50 | -30.49 | QP | 100 | 0 | |
| 5 | 364.2595 | 27.02 | -11.78 | 15.24 | 46.00 | -30.76 | QP | 100 | 360 | |
| 6 | 647.3856 | 29.26 | -6.82 | 22.44 | 46.00 | -23.56 | QP | 100 | 0 | |

**Test Results (1GHz-25GHz)**

| Test Mode: CH00 | | | | | Test channel: Lowest | | | |
|---|---|---|---|---|---|---|---|---|
| Peak Value | | | | | | | | |
| Frequency (MHz) | Read Level (dBuV) | Antenna Factor (dB/m) | Cable Loss (dB) | Preamp Factor (dB) | Level (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Pol. |
| 4804.00 | 40.54 | 34.04 | 6.58 | 34.09 | 47.07 | 74.00 | -26.93 | V |
| 7206.00 | 33.97 | 37.11 | 7.73 | 34.50 | 44.31 | 74.00 | -29.69 | V |
| 9608.00 | 33.38 | 39.31 | 9.23 | 34.79 | 47.13 | 74.00 | -26.87 | V |
| 12010.00 | * | | | | | 74.00 | | V |
| 14412.00 | * | | | | | 74.00 | | V |
| 4804.00 | 45.48 | 34.04 | 6.58 | 34.09 | 52.01 | 74.00 | -21.99 | H |
| 7206.00 | 36.02 | 37.11 | 7.73 | 34.50 | 46.36 | 74.00 | -27.64 | H |
| 9608.00 | 33.11 | 39.31 | 9.23 | 34.79 | 46.86 | 74.00 | -27.14 | H |
| 12010.00 | * | | | | | 74.00 | | H |
| 14412.00 | * | | | | | 74.00 | | H |
| Average Value | | | | | | | | |
| Frequency (MHz) | Read Level (dBuV) | Antenna Factor (dB/m) | Cable Loss (dB) | Preamp Factor (dB) | Level (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Pol. |
| 4804.00 | 28.74 | 34.04 | 6.58 | 34.09 | 35.27 | 54.00 | -18.73 | V |
| 7206.00 | 22.29 | 37.11 | 7.73 | 34.50 | 32.63 | 54.00 | -21.37 | V |
| 9608.00 | 21.17 | 39.31 | 9.23 | 34.79 | 34.92 | 54.00 | -19.08 | V |
| 12010.00 | * | | | | | 54.00 | | V |
| 14412.00 | * | | | | | 54.00 | | V |
| 4804.00 | 33.33 | 34.04 | 6.58 | 34.09 | 39.86 | 54.00 | -14.14 | H |
| 7206.00 | 24.68 | 37.11 | 7.73 | 34.50 | 35.02 | 54.00 | -18.98 | H |
| 9608.00 | 21.17 | 39.31 | 9.23 | 34.79 | 34.92 | 54.00 | -19.08 | H |
| 12010.00 | * | | | | | 54.00 | | H |
| 14412.00 | * | | | | | 54.00 | | H |

| Test Mode: CH19 | | | | | Test channel: Middle | | | |
|---|---|---|---|---|---|---|---|---|
| Peak Value | | | | | | | | |
| Frequency (MHz) | Read Level (dBuV) | Antenna Factor (dB/m) | Cable Loss (dB) | Preamp Factor (dB) | Level (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Pol. |
| 4880.00 | 41.46 | 34.38 | 6.69 | 34.09 | 48.44 | 74.00 | -25.56 | V |
| 7320.00 | 34.58 | 37.22 | 7.78 | 34.53 | 45.05 | 74.00 | -28.95 | V |
| 9760.00 | 33.92 | 39.46 | 9.35 | 34.80 | 47.93 | 74.00 | -26.07 | V |
| 12200.00 | * | | | | | 74.00 | | V |
| 14640.00 | * | | | | | 74.00 | | V |
| 4880.00 | 46.59 | 34.38 | 6.69 | 34.09 | 53.57 | 74.00 | -20.43 | H |
| 7320.00 | 36.70 | 37.22 | 7.78 | 34.53 | 47.17 | 74.00 | -26.83 | H |
| 9760.00 | 33.73 | 39.46 | 9.35 | 34.80 | 47.74 | 74.00 | -26.26 | H |
| 12200.00 | * | | | | | 74.00 | | H |
| 14640.00 | * | | | | | 74.00 | | H |
| Average Value | | | | | | | | |
| Frequency (MHz) | Read Level (dBuV) | Antenna Factor (dB/m) | Cable Loss (dB) | Preamp Factor (dB) | Level (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Pol. |
| 4880.00 | 29.52 | 34.38 | 6.69 | 34.09 | 36.50 | 54.00 | -17.50 | V |
| 7320.00 | 22.82 | 37.22 | 7.78 | 34.53 | 33.29 | 54.00 | -20.71 | V |
| 9760.00 | 21.64 | 39.46 | 9.35 | 34.80 | 35.65 | 54.00 | -18.35 | V |
| 12200.00 | * | | | | | 54.00 | | V |
| 14640.00 | * | | | | | 54.00 | | V |
| 4880.00 | 34.21 | 34.38 | 6.69 | 34.09 | 41.19 | 54.00 | -12.81 | H |
| 7320.00 | 25.27 | 37.22 | 7.78 | 34.53 | 35.74 | 54.00 | -18.26 | H |
| 9760.00 | 21.71 | 39.46 | 9.35 | 34.80 | 35.72 | 54.00 | -18.28 | H |
| 12200.00 | * | | | | | 54.00 | | H |
| 14640.00 | * | | | | | 54.00 | | H |

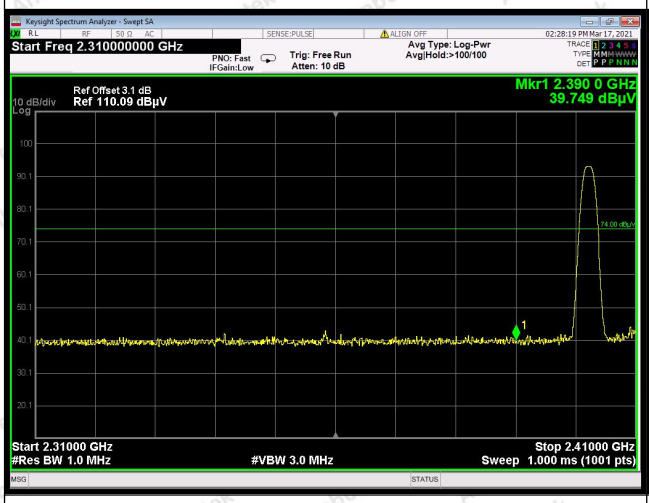
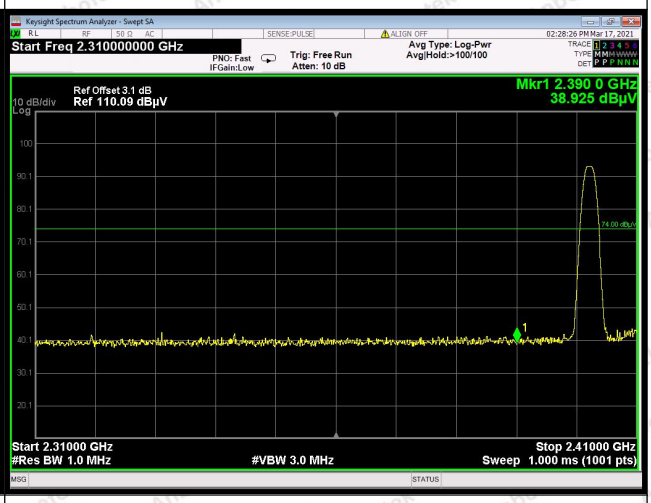
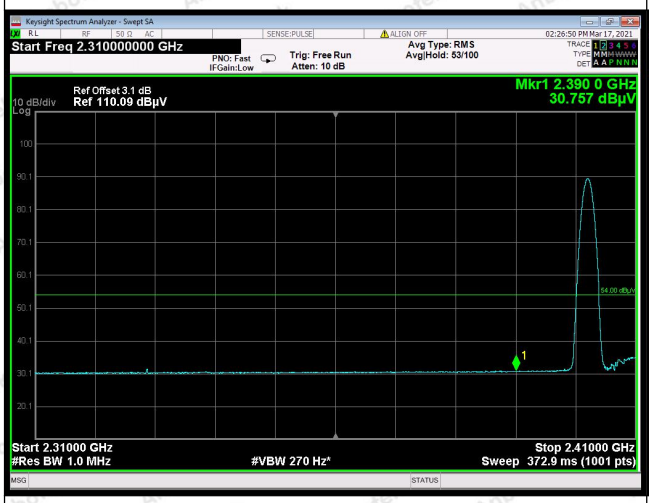
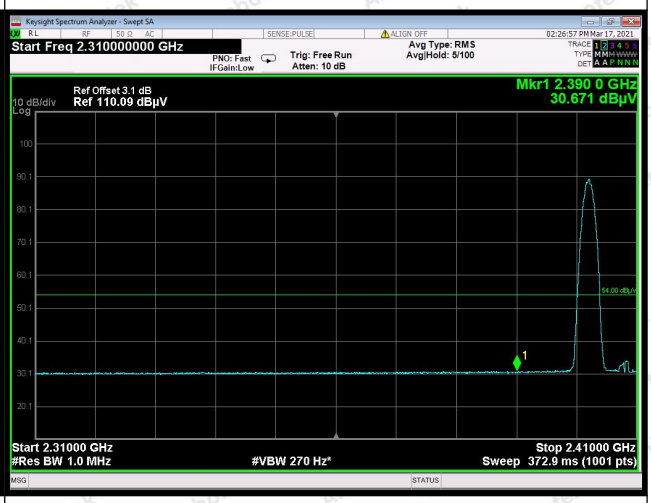
| Test Mode: CH39 | | | | | Test channel: Highest | | | |
|---|---|---|---|---|---|---|---|---|
| Peak Value | | | | | | | | |
| Frequency (MHz) | Read Level (dBuV) | Antenna Factor (dB/m) | Cable Loss (dB) | Preamp Factor (dB) | Level (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Pol. |
| 4960.00 | 40.48 | 34.72 | 6.79 | 34.09 | 47.90 | 74.00 | -26.10 | V |
| 7440.00 | 33.94 | 37.34 | 7.82 | 34.57 | 44.53 | 74.00 | -29.47 | V |
| 9920.00 | 33.35 | 39.62 | 9.46 | 34.81 | 47.62 | 74.00 | -26.38 | V |
| 12400.00 | * | | | | | 74.00 | | V |
| 14880.00 | * | | | | | 74.00 | | V |
| 4960.00 | 45.42 | 34.72 | 6.79 | 34.09 | 52.84 | 74.00 | -21.16 | H |
| 7440.00 | 35.97 | 37.34 | 7.82 | 34.57 | 46.56 | 74.00 | -27.44 | H |
| 9920.00 | 33.07 | 39.62 | 9.46 | 34.81 | 47.34 | 74.00 | -26.66 | H |
| 12400.00 | * | | | | | 74.00 | | H |
| 14880.00 | * | | | | | 74.00 | | H |
| Average Value | | | | | | | | |
| Frequency (MHz) | Read Level (dBuV) | Antenna Factor (dB/m) | Cable Loss (dB) | Preamp Factor (dB) | Level (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Pol. |
| 4960.00 | 28.88 | 34.72 | 6.79 | 34.09 | 36.30 | 54.00 | -17.70 | V |
| 7440.00 | 22.39 | 37.34 | 7.82 | 34.57 | 32.98 | 54.00 | -21.02 | V |
| 9920.00 | 21.26 | 39.62 | 9.46 | 34.81 | 35.53 | 54.00 | -18.47 | V |
| 12400.00 | * | | | | | 54.00 | | V |
| 14880.00 | * | | | | | 54.00 | | V |
| 4960.00 | 33.49 | 34.72 | 6.79 | 34.09 | 40.91 | 54.00 | -13.09 | H |
| 7440.00 | 24.79 | 37.34 | 7.82 | 34.57 | 35.38 | 54.00 | -18.62 | H |
| 9920.00 | 21.27 | 39.62 | 9.46 | 34.81 | 35.54 | 54.00 | -18.46 | H |
| 12400.00 | * | | | | | 54.00 | | H |
| 14880.00 | * | | | | | 54.00 | | H |

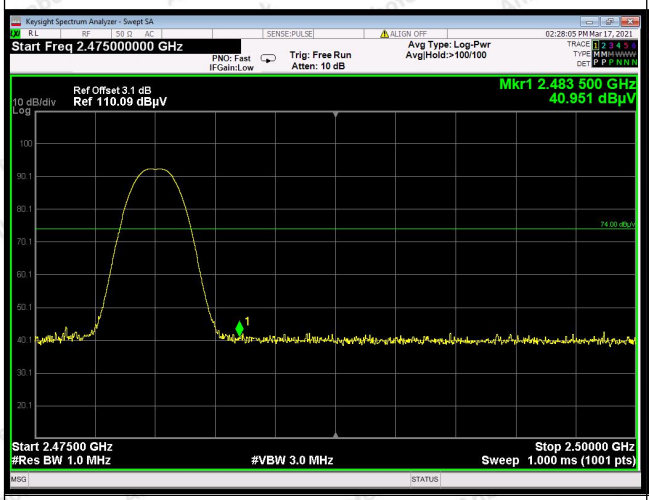
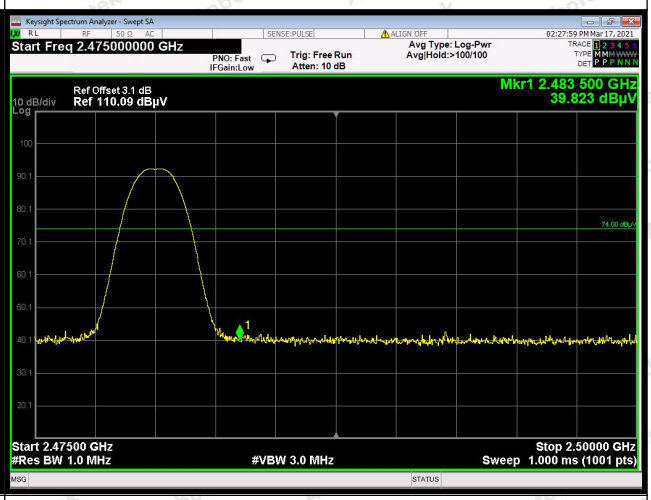
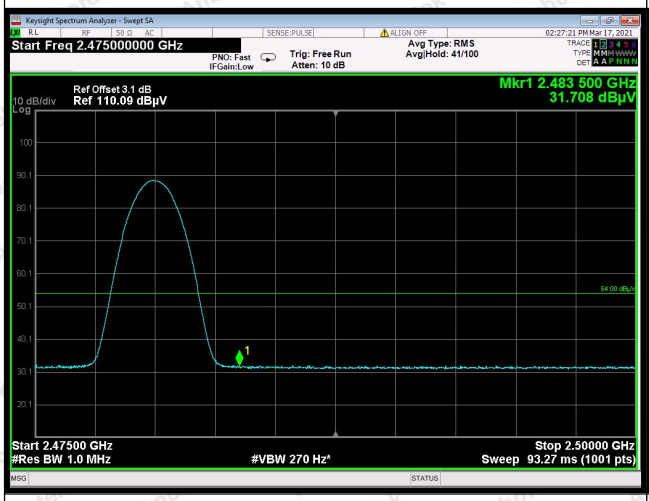
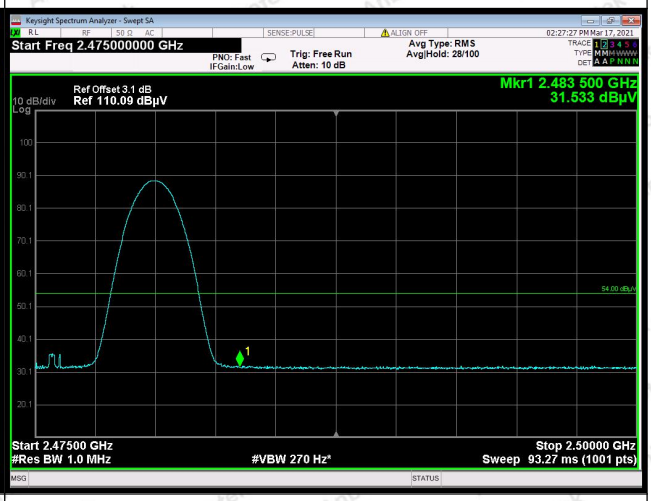
Remark:

1. Level =Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor

2. "*" means the test results were attenuated more than 20dB below the permissible limits, so the results don't record in the report.

**Radiated Band Edge:**

| Test Mode: CH00 | Test channel: Lowest |
|---|---|
|   |   |
| Peak Value(Vertical) | Peak Value(Horizontal) |
|   |   |
| Average Value(Vertical) | Average Value(Horizontal) |

| Test Mode: CH39 | Test channel: Highest |
|---|---|
|  |  |
| Peak Value(Vertical) | Peak Value(Horizontal) |
|  |  |
| Average Value(Vertical) | Average Value(Horizontal) |









Remark:

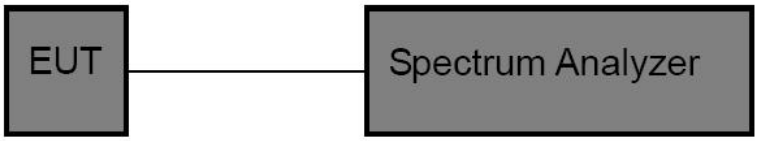
1. Level =Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor
2. This Report only show the test plots of the worst case.

# 5. Maximum Peak Output Power Test

## 5.1. Test Standard and Limit

| | |
|---|---|
| Test Standard | FCC Part15 C Section 15.247 (b)(3) |
| Test Limit | 30dBm |

## 5.2. Test Setup




## 5.3. Test Procedure

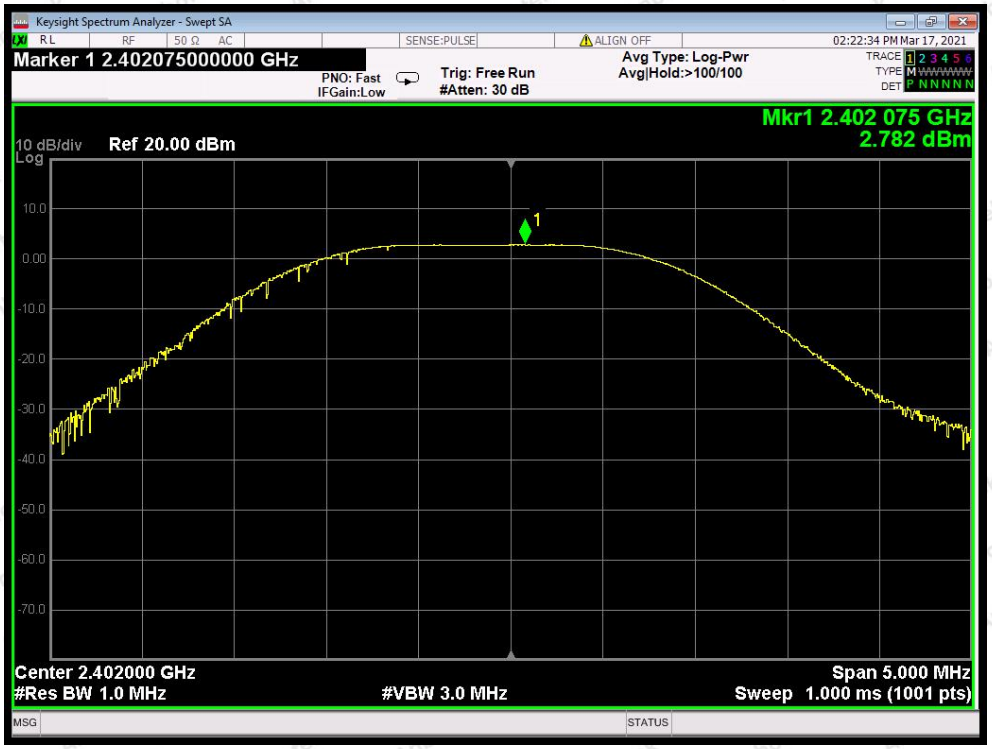
This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

1. Set the RBW ≥DTS bandwidth.
2. Set the VBW≥3*RBW.
3. Set the span≥ 3*RBW.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.

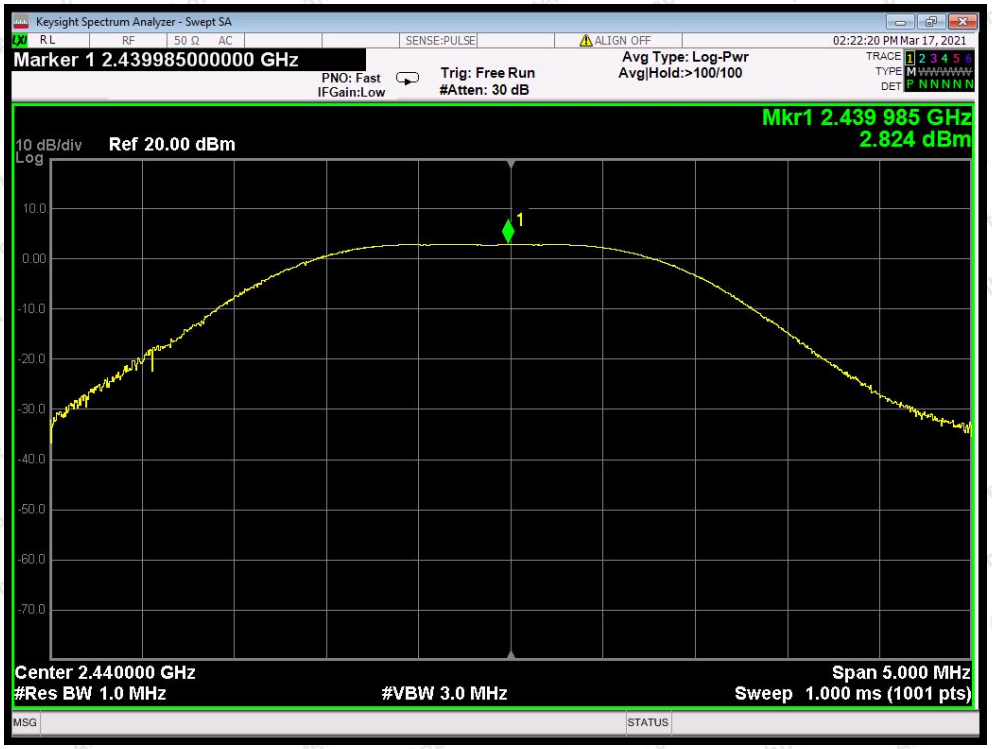
## 5.4. Test Data

| | | | | | |
|---|---|---|---|---|---|
| Test Item | : | Max. peak output power | Test Mode | : | CH Low ~ CH High |
| Test Voltage | : | DC 3.7V battery inside | Temperature | : | 22.9℃ |
| Test Result | : | PASS | Humidity | : | 51 % |

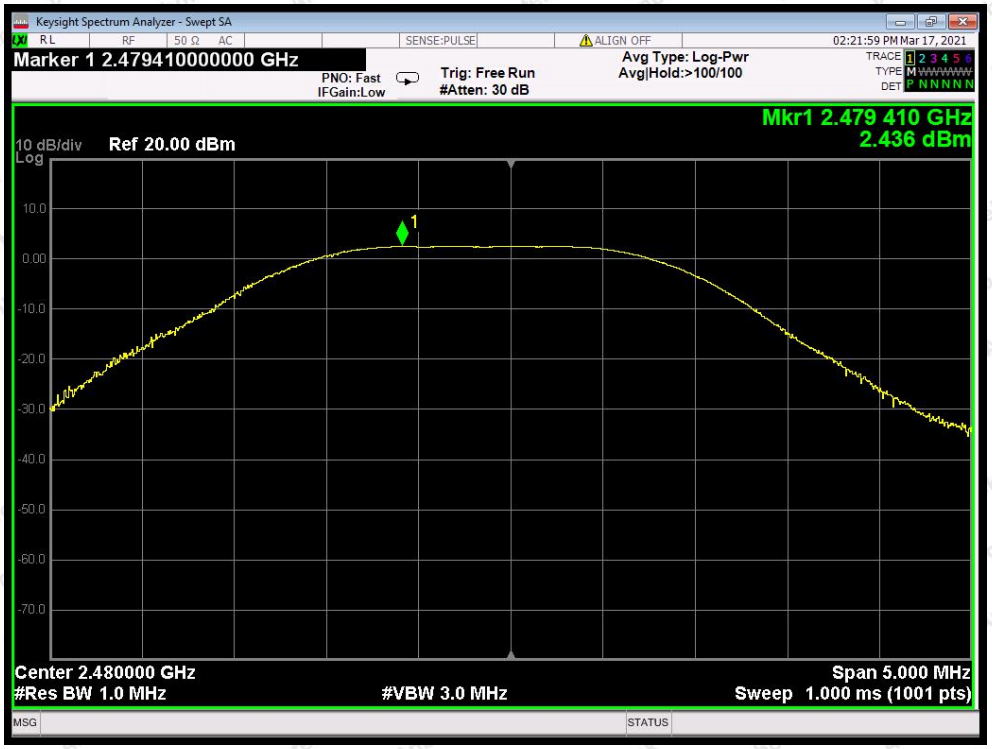
| Channel Frequency (MHz) | Peak Power output (dBm) | Limit (dBm) | Results |
|---|---|---|---|
| 2402 | 2.782 | 30 | PASS |
| 2440 | **2.824** | 30 | PASS |
| 2480 | 2.436 | 30 | PASS |




CH: Low




CH: Middle


Keysight Spectrum Analyzer - Swept SA
Marker 1 2.479410000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
02:21:59 PM Mar 17, 2021
Mkr1 2.479 410 GHz
2.436 dBm
10 dB/div
Log
Ref 20.00 dBm
Center 2.480000 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Span 5.000 MHz
Sweep 1.000 ms (1001 pts)

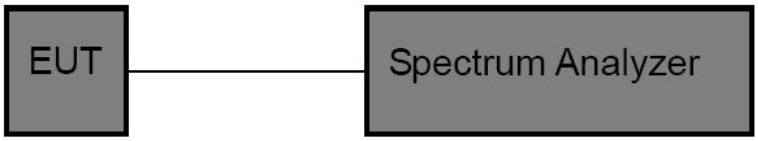
CH: High

# 6. 6DB Occupy Bandwidth Test

## 6.1. Test Standard and Limit

| | |
|---|---|
| Test Standard | FCC Part15 C Section 15.247 (a)(2) |
| Test Limit | >500kHz |

## 6.2. Test Setup



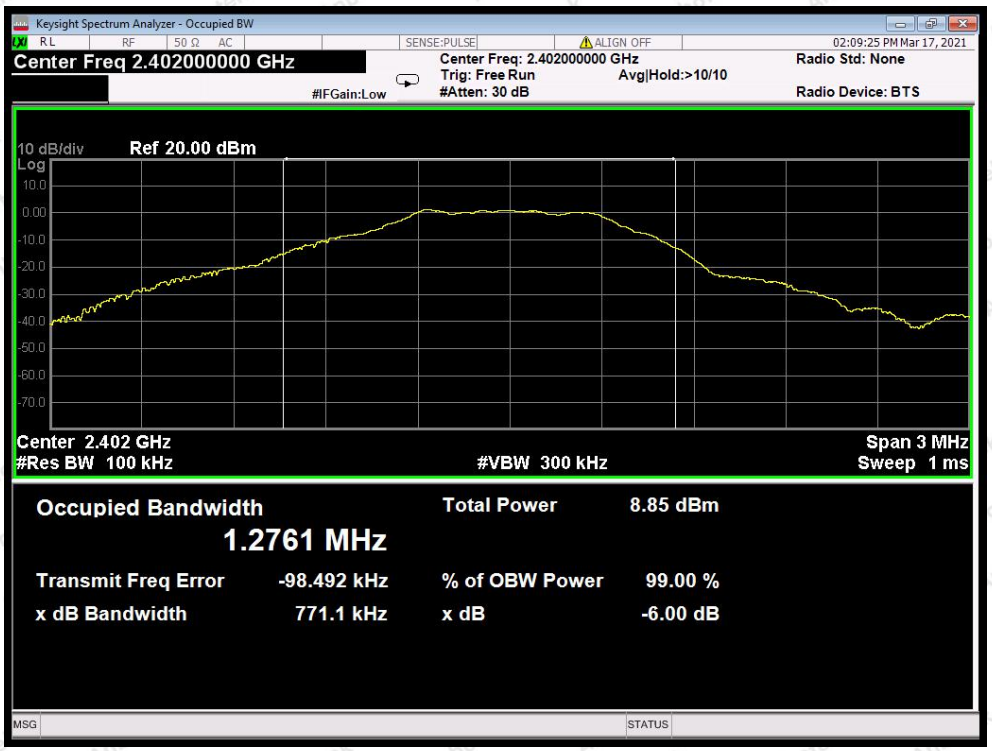

## 6.3. Test Procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as:
RBW = 100kHz, VBW≥3*RBW =300kHz,
Detector= Peak
Trace mode= Max hold.
Sweep- auto couple.
4. Mark the peak frequency and –6dB (upper and lower) frequency.
5. Repeat until all the rest channels are investigated.

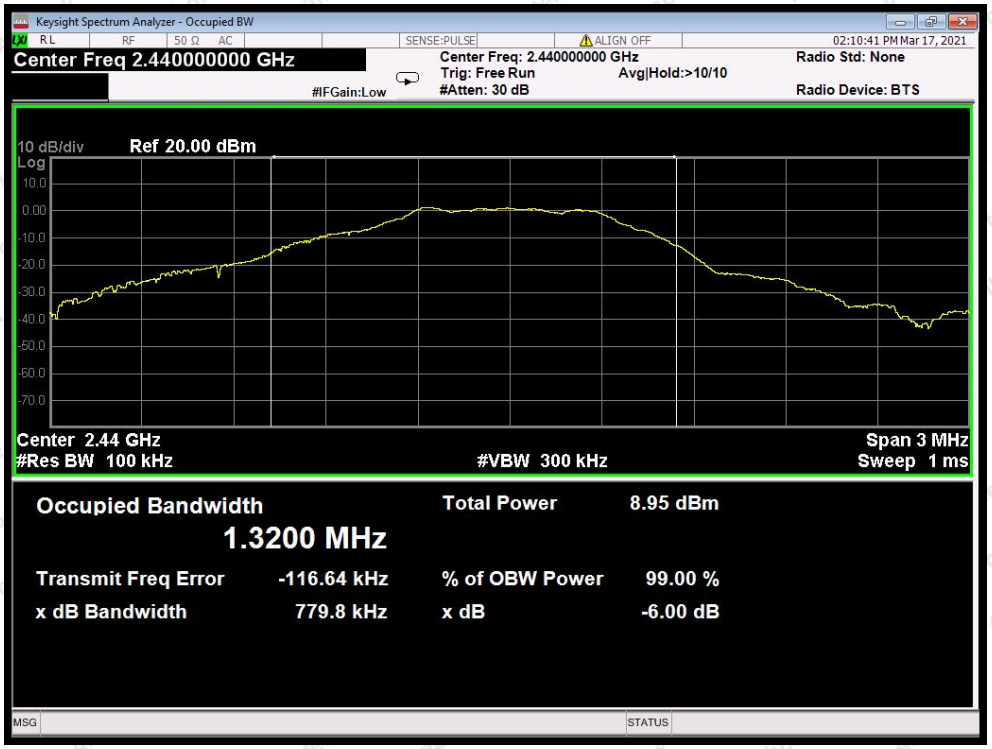
## 6.4. Test Data

| | | | | | |
|---|---|---|---|---|---|
| Test Item | : | 6dB Bandwidth | Test Mode | : | CH Low ~ CH High |
| Test Voltage | : | DC 3.7V battery inside | Temperature | : | 22.9℃ |
| Test Result | : | PASS | Humidity | : | 51 % |

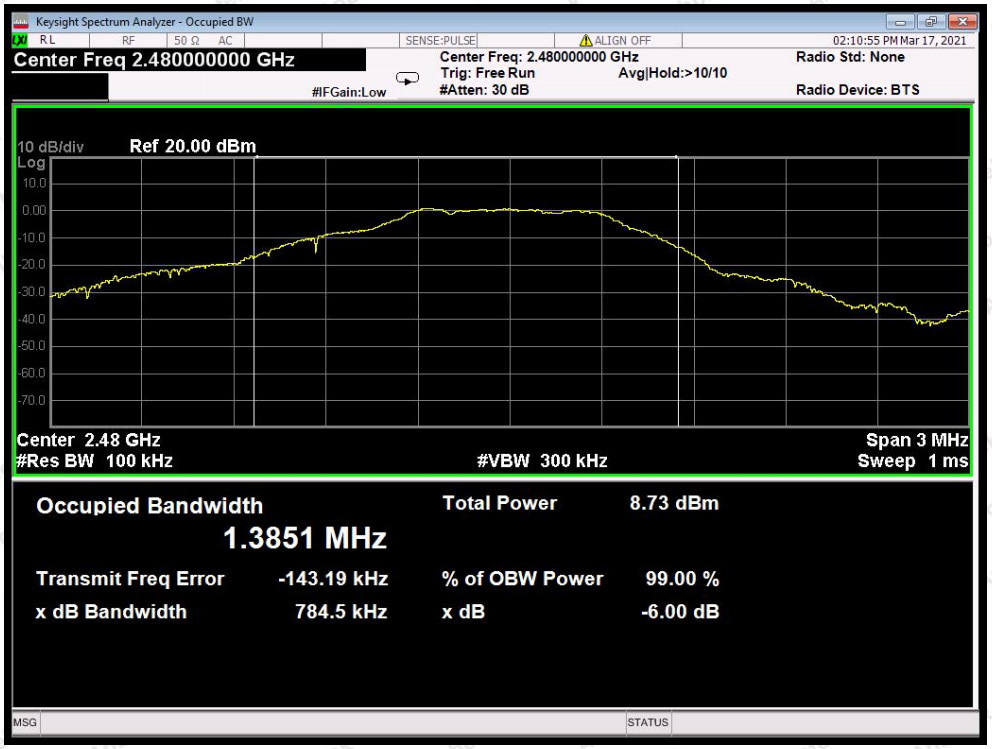
| Channel | Frequency(MHz) | Bandwidth (kHz) | Limit (kHz) | Results |
|---|---|---|---|---|
| Low | 2402 | 771.1 | >500 | PASS |
| Middle | 2440 | 779.8 | | PASS |
| High | 2480 | 784.5 | | PASS |




CH: Low




CH: Middle


Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω AC
SENSE:PULSE
ALIGN OFF
02:10:55 PM Mar 17, 2021
Center Freq 2.480000000 GHz
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
#IFGain:Low
Radio Std: None
Radio Device: BTS
10 dB/div
Ref 20.00 dBm
Log
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
Center 2.48 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 3 MHz
Sweep 1 ms
Occupied Bandwidth
1.3851 MHz
Total Power 8.73 dBm
Transmit Freq Error -143.19 kHz
% of OBW Power 99.00 %
x dB Bandwidth 784.5 kHz
x dB -6.00 dB
MSG
STATUS

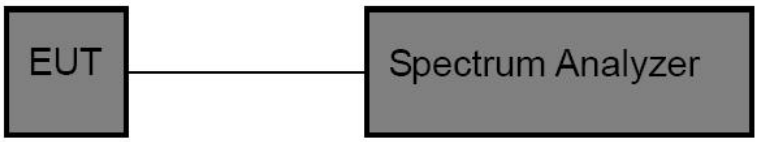
CH: High

# 7. Power Spectral Density Test

## 7.1. Test Standard and Limit

| | |
|---|---|
| Test Standard | FCC Part15 C Section 15.247 (e) |
| Test Limit | 8dBm/3KHz |

## 7.2. Test Setup



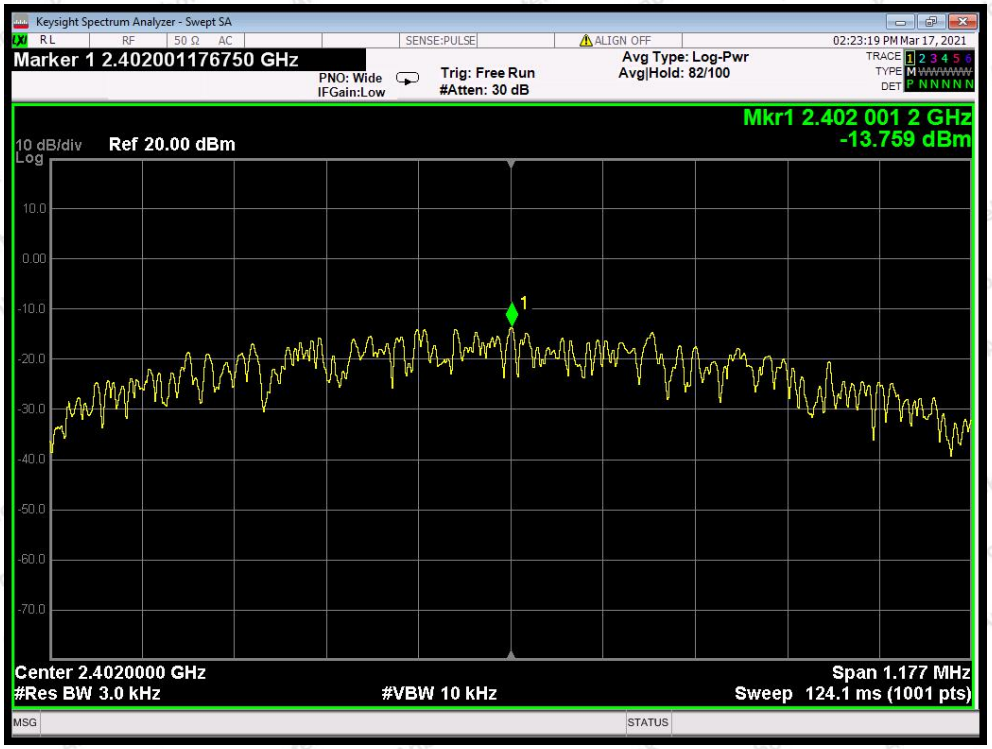

## 7.3. Test Procedure

1. Place the EUT on the table and set it in transmitting mode. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set the spectrum analyzer as RBW = 3kHz, VBW = 10kHz, Span = 1.5xDTS BW
3. Record the max. reading.
4. Repeat the above procedure until the measurements for all frequencies are completed.

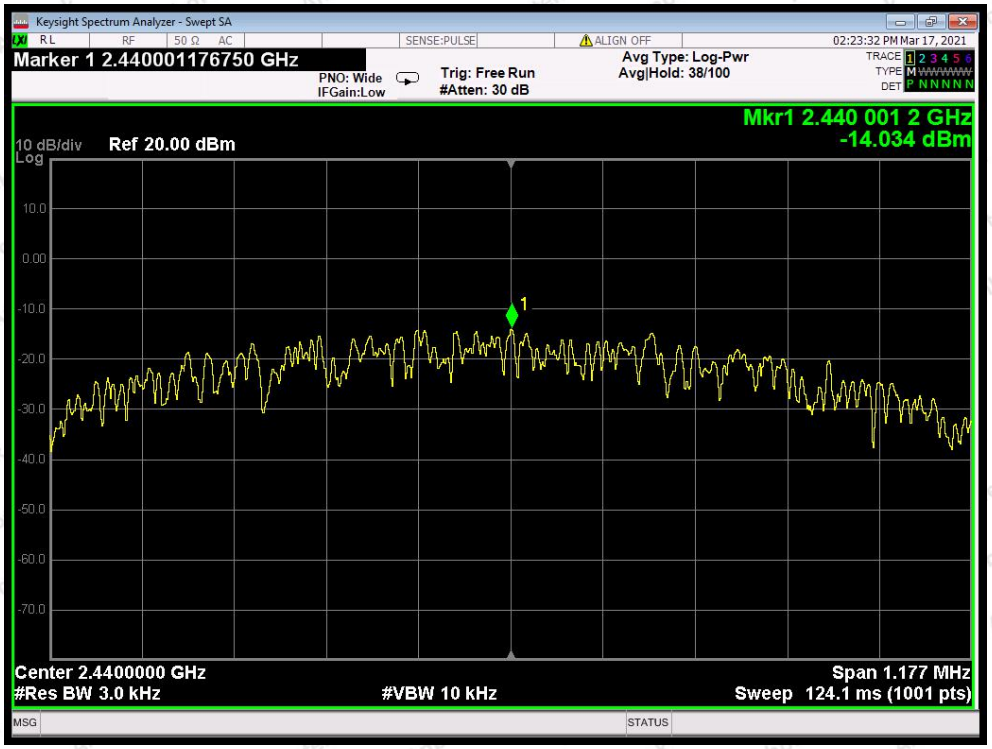
## 7.4. Test Data

| | | | | | |
|---|---|---|---|---|---|
| Test Item | : | Power Spectral Density | Test Mode | : | CH Low ~ CH High |
| Test Voltage | : | DC 3.7V battery inside | Temperature | : | 22.9℃ |
| Test Result | : | PASS | Humidity | : | 51 % |

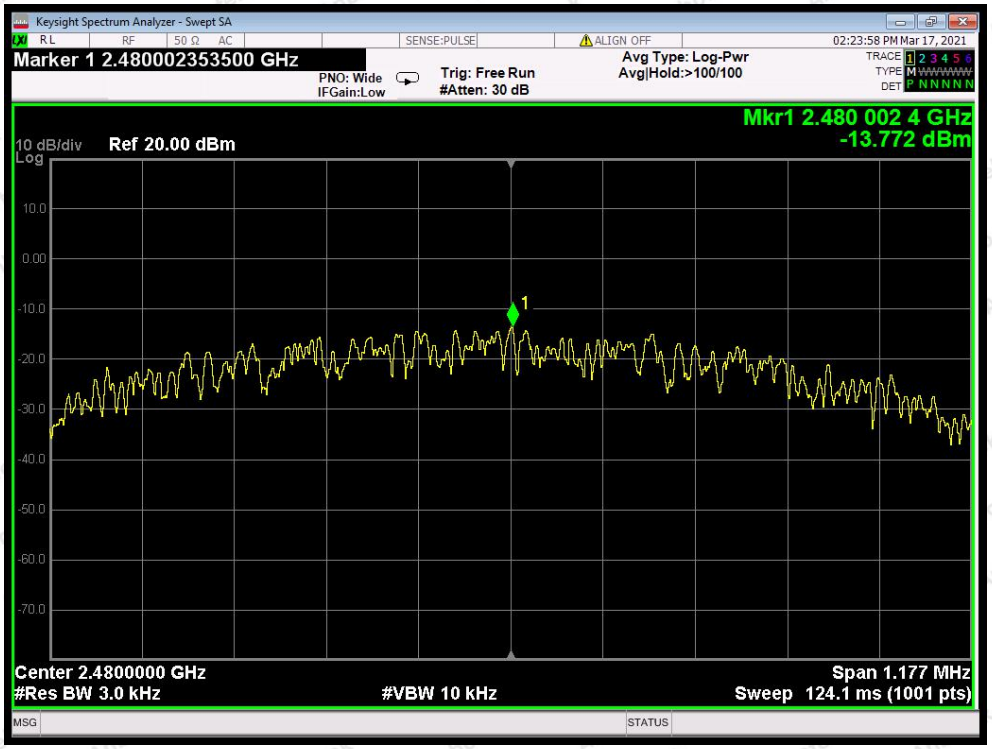
| Channel | Frequency (MHz) | PSD (dBm/3KHz) | Limit (dBm/3KHz) | Results |
|---|---|---|---|---|
| Low | 2402 | -13.759 | 8.00 | PASS |
| Middle | 2440 | -14.034 | 8.00 | PASS |
| High | 2480 | -13.772 | 8.00 | PASS |




CH: Low




CH: Middle


Keysight Spectrum Analyzer - Swept SA
Marker 1 2.480002353500 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
02:23:58 PM Mar 17, 2021
Mkr1 2.480 002 4 GHz
-13.772 dBm
10 dB/div
Ref 20.00 dBm
Log
Center 2.4800000 GHz
#Res BW 3.0 kHz
#VBW 10 kHz
Span 1.177 MHz
Sweep 124.1 ms (1001 pts)

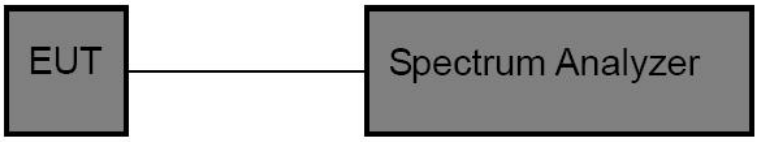
CH: High

# 8. 100kHz Bandwidth of Frequency Band Edge Requirement

## 8.1. Test Standard and Limit

| | |
|---|---|
| Test Standard | FCC Part15 C Section 15.247 (d) |
| Test Limit | in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in15.209(a). |

## 8.2. Test Setup



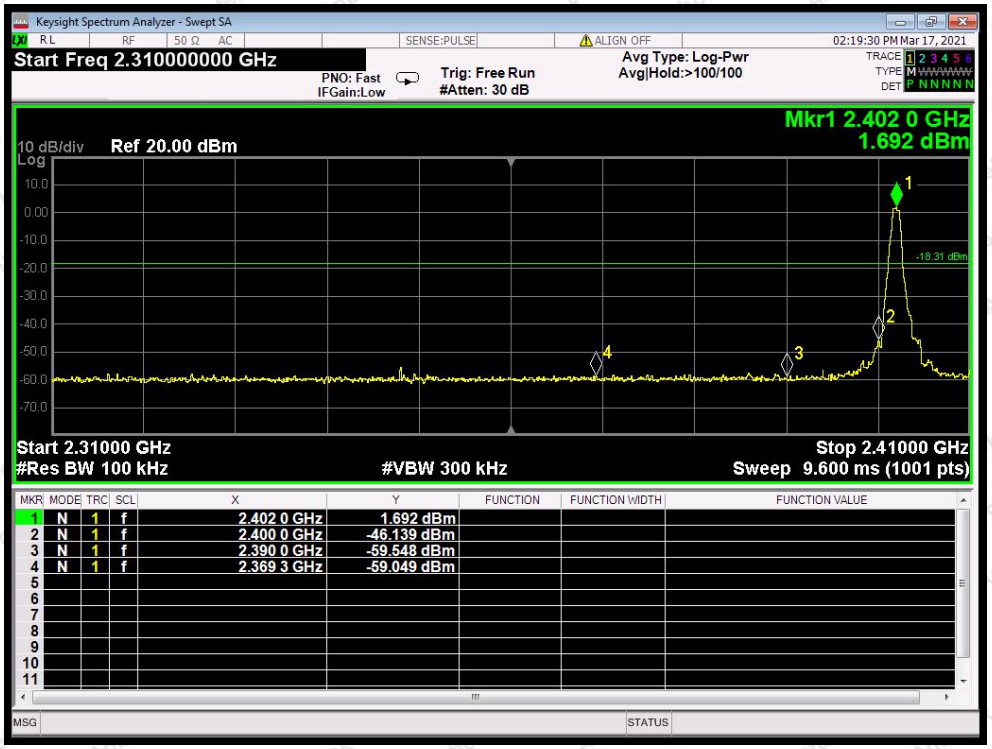

## 8.3. Test Procedure

Using the following spectrum analyzer setting:

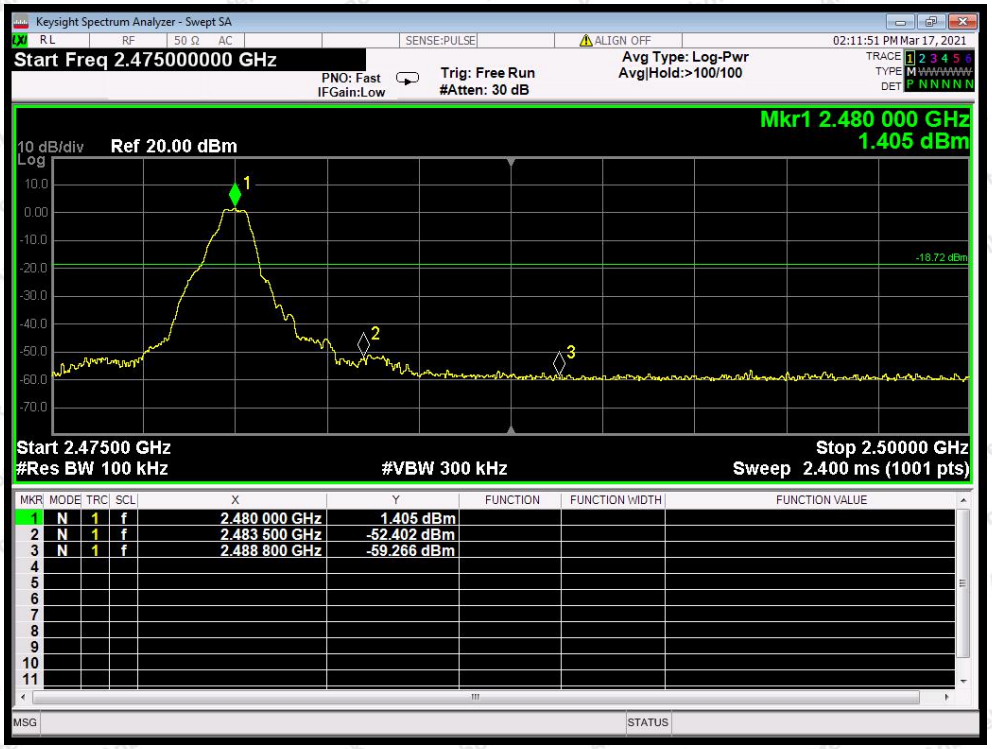
1. Set the RBW = 100KHz.
2. Set the VBW = 300KHz.
3. Sweep time = auto couple.
4. Detector function = peak.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.

## 8.4. Test Data

| | | | | | |
|---|---|---|---|---|---|
| Test Item | : | Band edge | Test Mode | : | CH Low ~ CH High |
| Test Voltage | : | DC 3.7V battery inside | Temperature | : | 22.9℃ |
| Test Result | : | PASS | Humidity | : | 51 % |

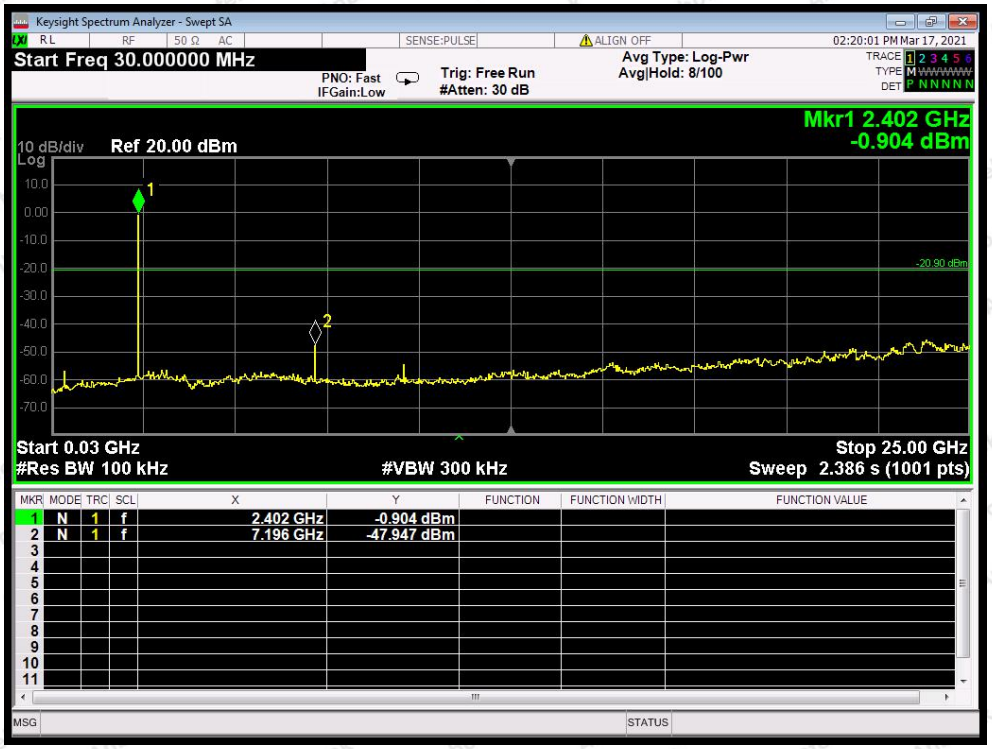



CH: Low

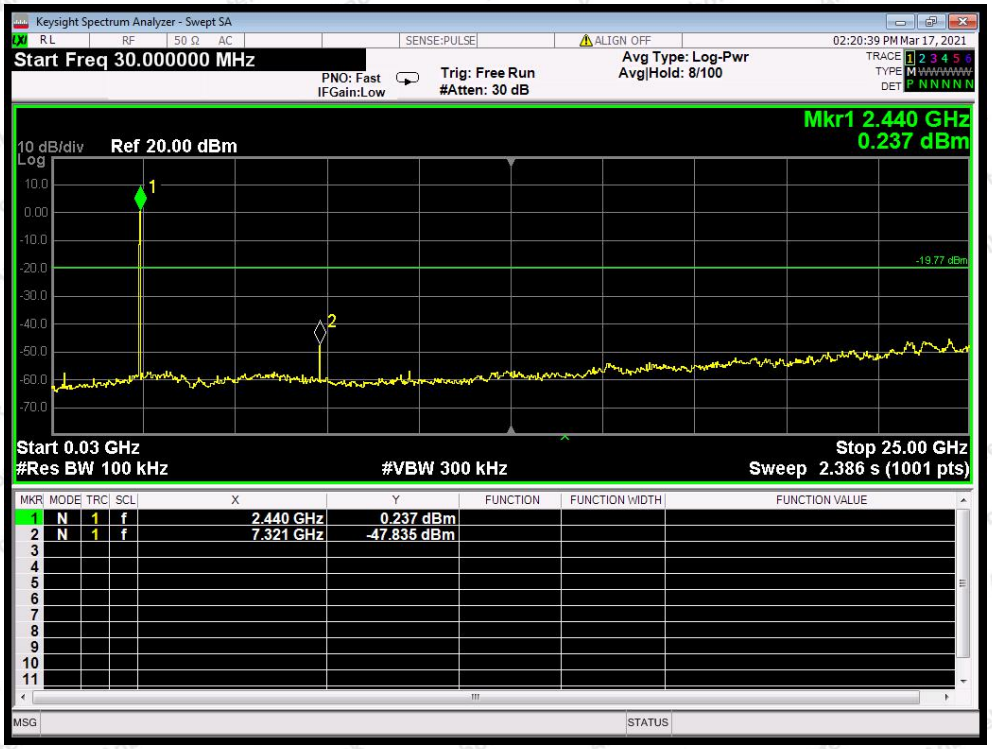



CH: High

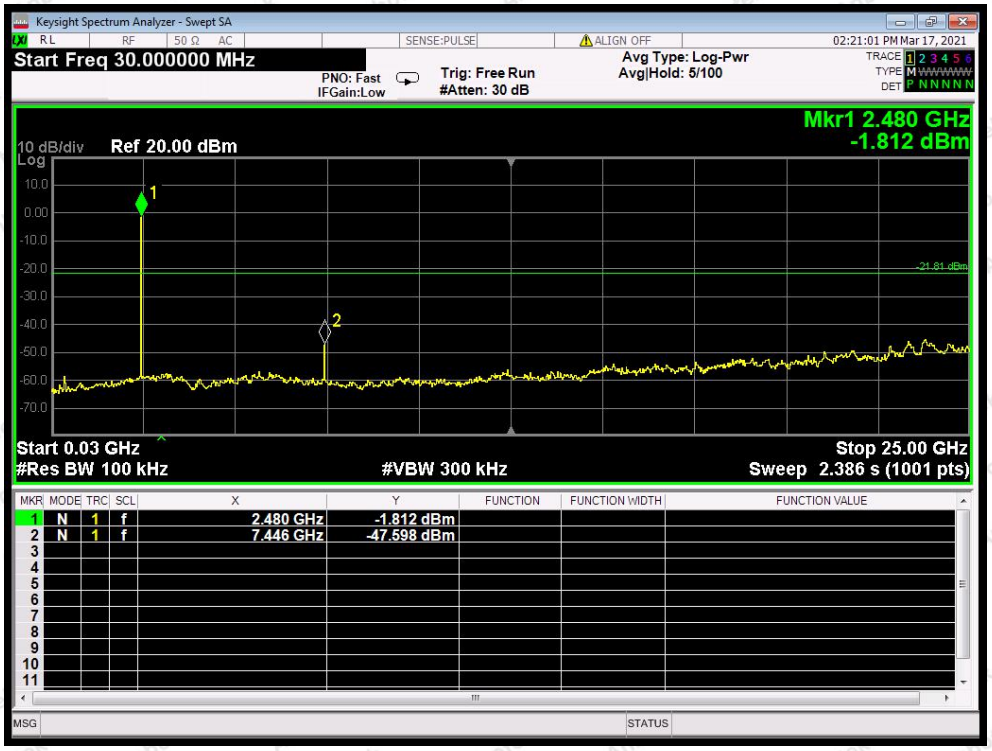
Conducted Emission Method




CH: Low




CH: Middle


Keysight Spectrum Analyzer - Swept SA
Start Freq 30.000000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold: 5/100
02:21:01 PM Mar 17, 2021
Mkr1 2.480 GHz
-1.812 dBm
10 dB/div
Ref 20.00 dBm
-21.81 dBm
Start 0.03 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.386 s (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.480 GHz -1.812 dBm
2 N 1 f 7.446 GHz -47.598 dBm
MSG
STATUS

CH: High

# 9. Antenna Requirement

## 9.1. Test Standard and Requirement

| | |
|---|---|
| Test Standard | FCC Part15 Section 15.203 /247(c) |
| Requirement | 1) 15.203 requirement:<br>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, 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.<br>2) 15.247(c) (1)(i) requirement:<br>Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. |

## 9.2. Antenna Connected Construction

The antenna is a PCB Antenna which permanently attached, and the best case gain of the antenna is -3 dBi. It complies with the standard requirement.

# APPENDIX I -- TEST SETUP PHOTOGRAPH

Photo of Power Line Conducted Emission Test

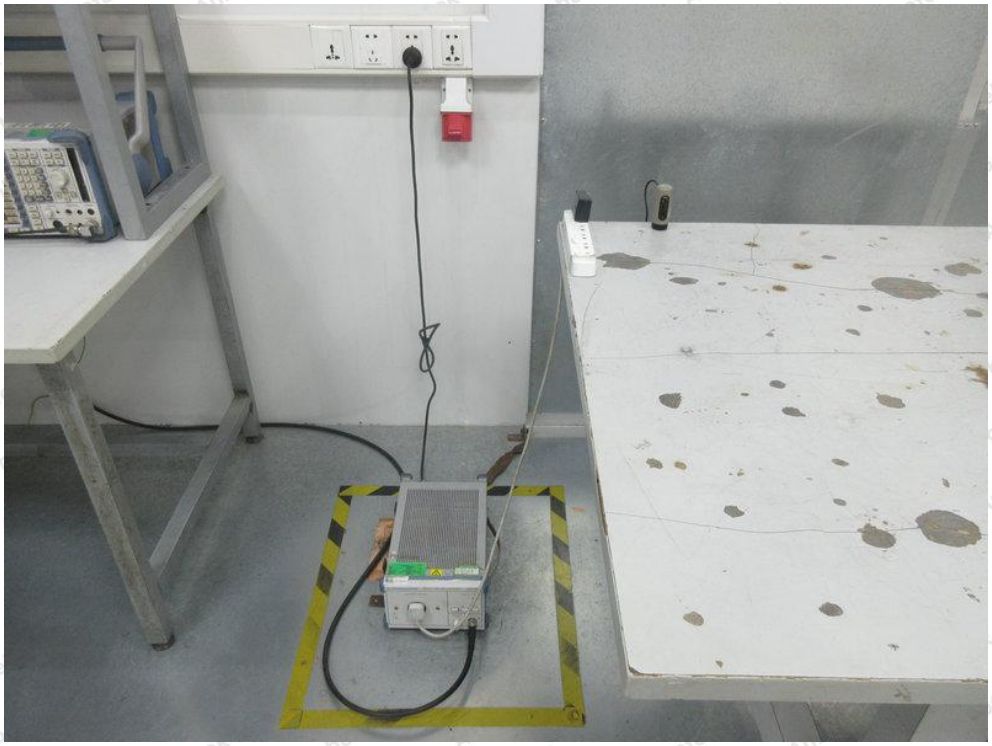
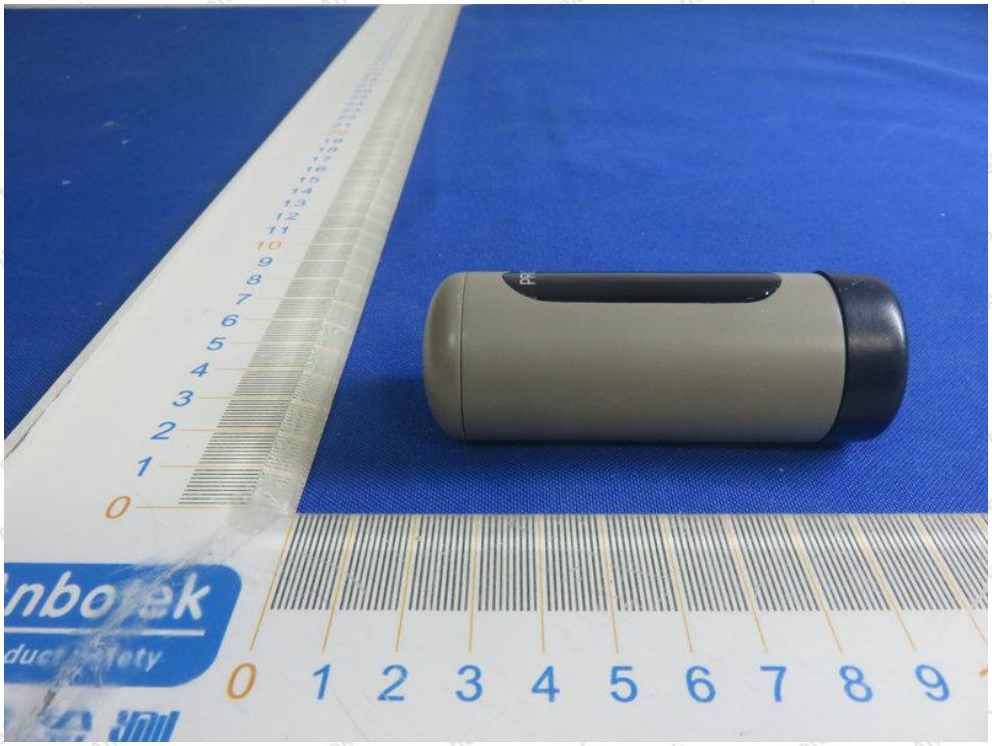
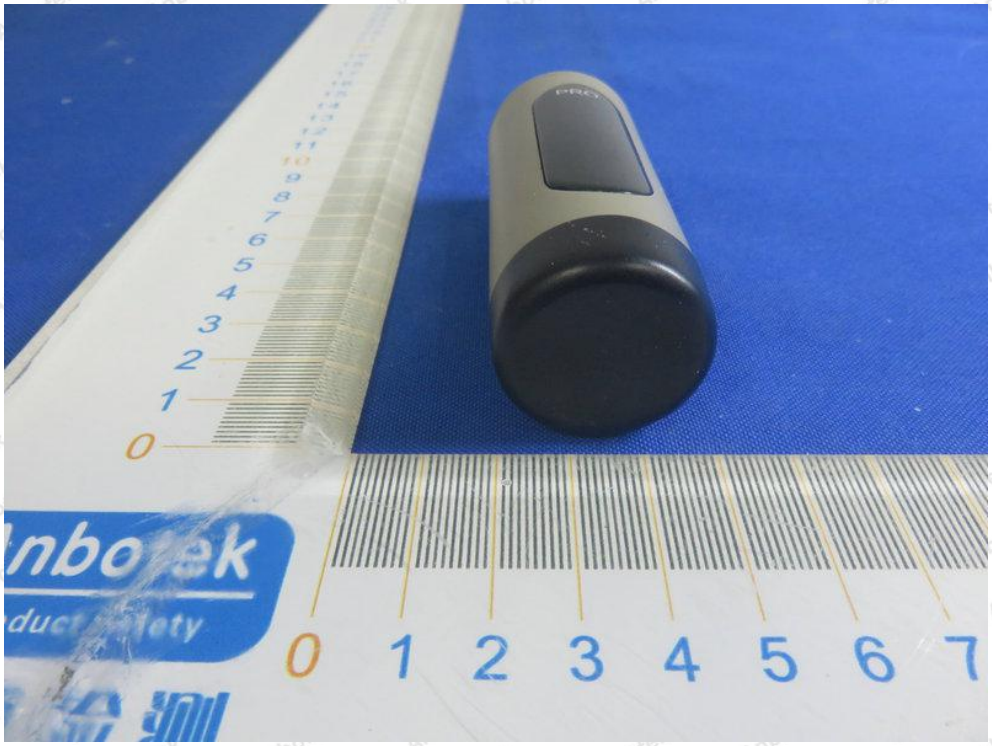
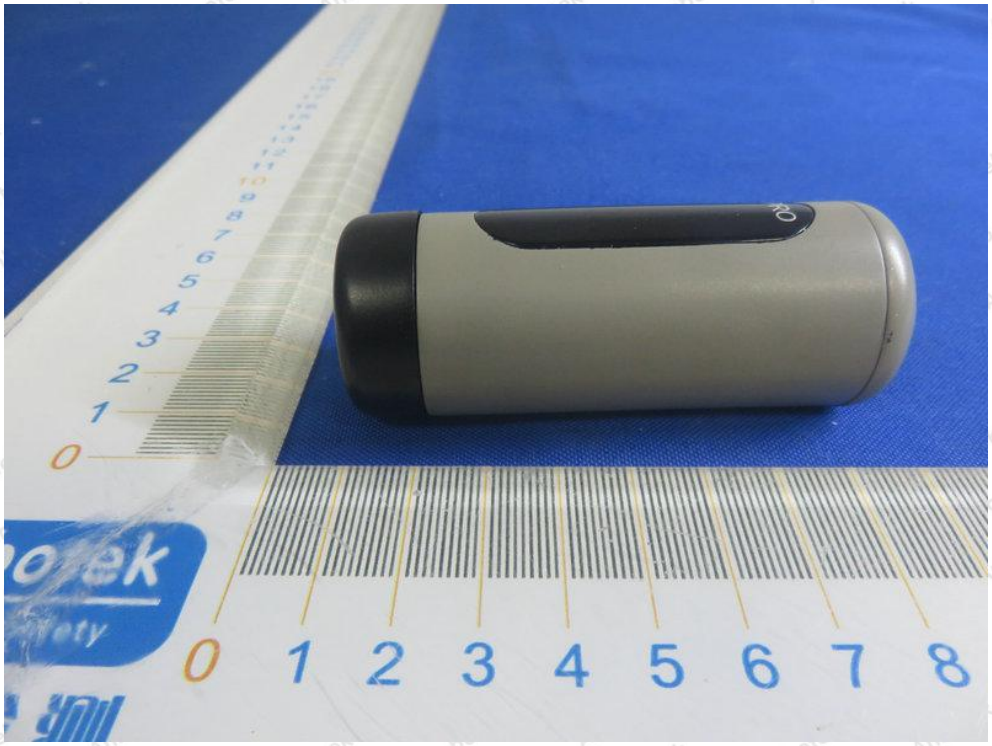


Photo of Radiation Emission Test

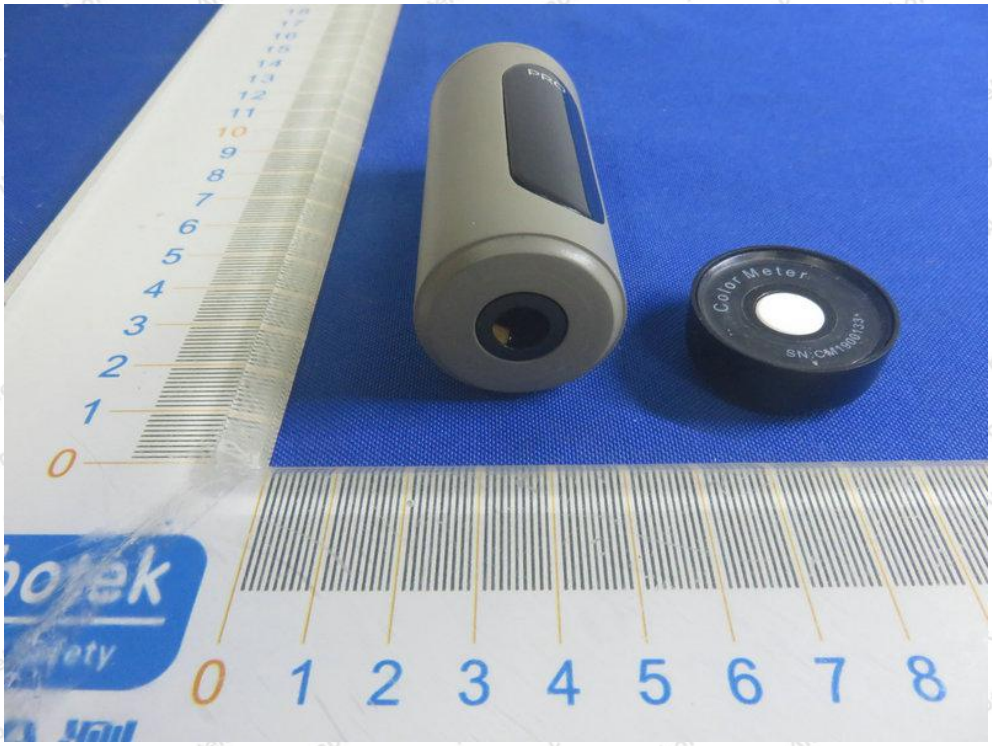
# APPENDIX II -- EXTERNAL PHOTOGRAPH

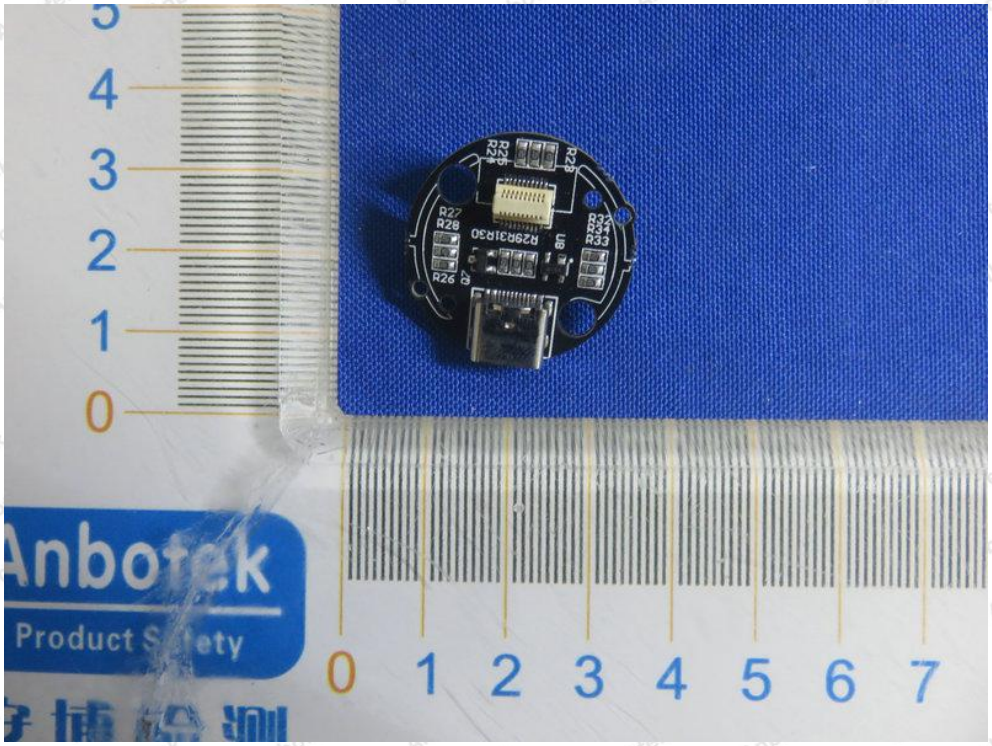


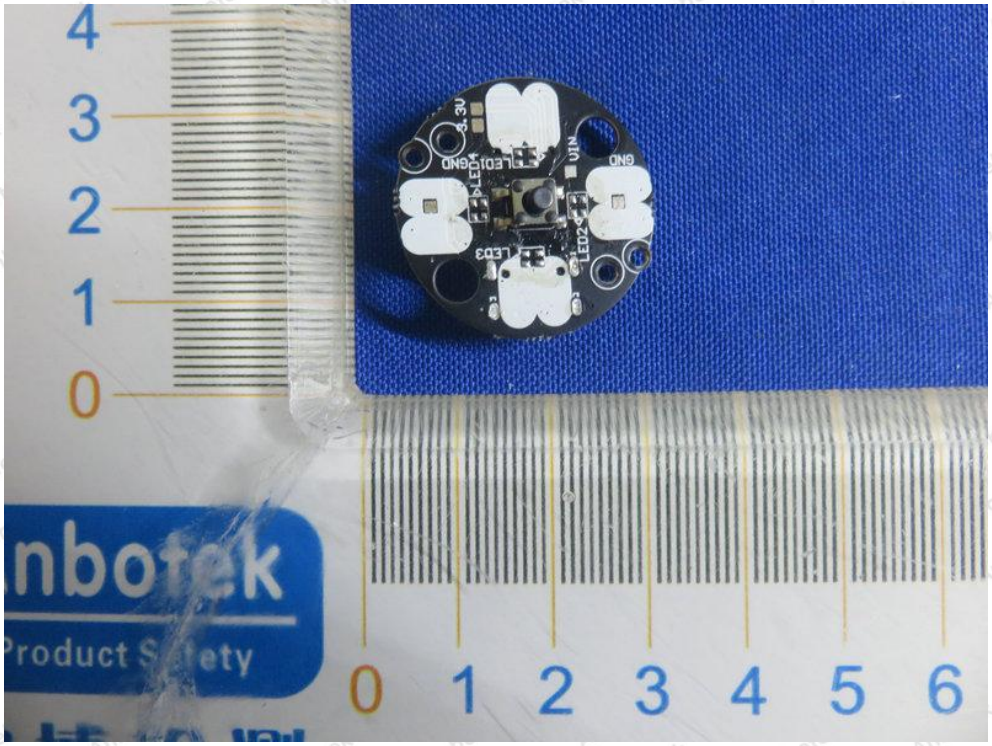


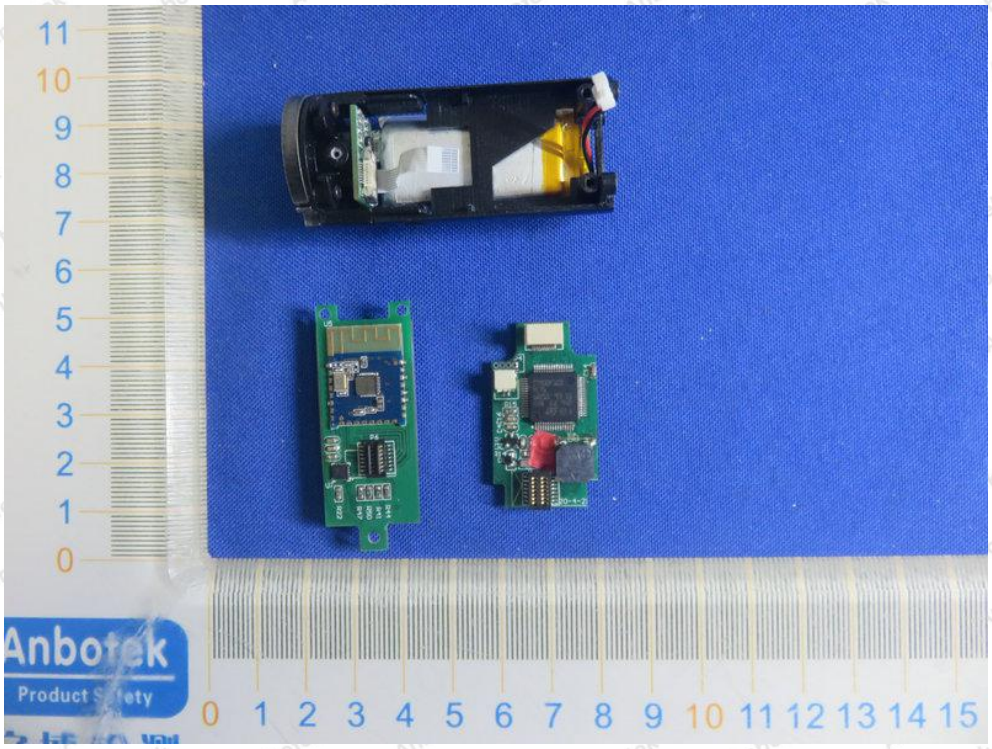


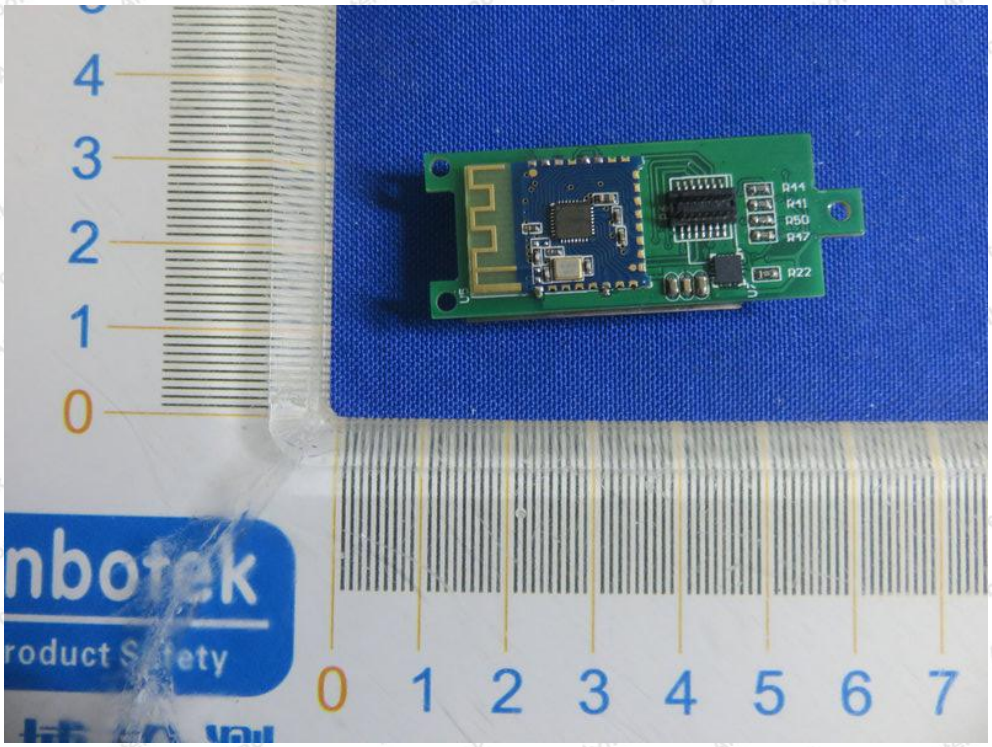
# APPENDIX III -- INTERNAL PHOTOGRAPH

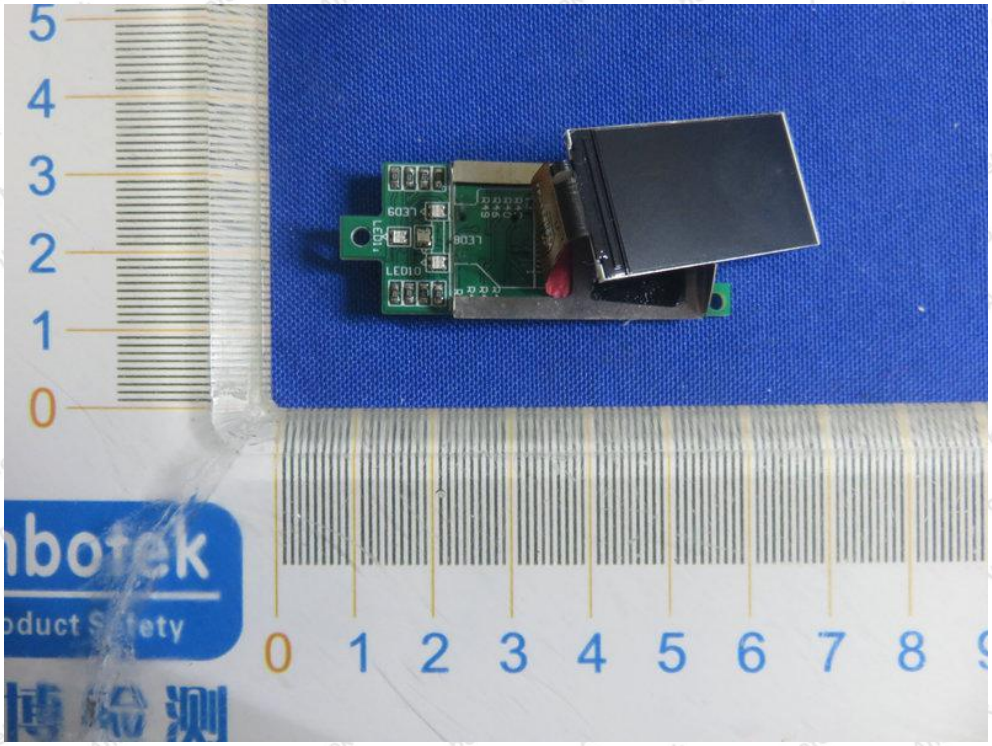


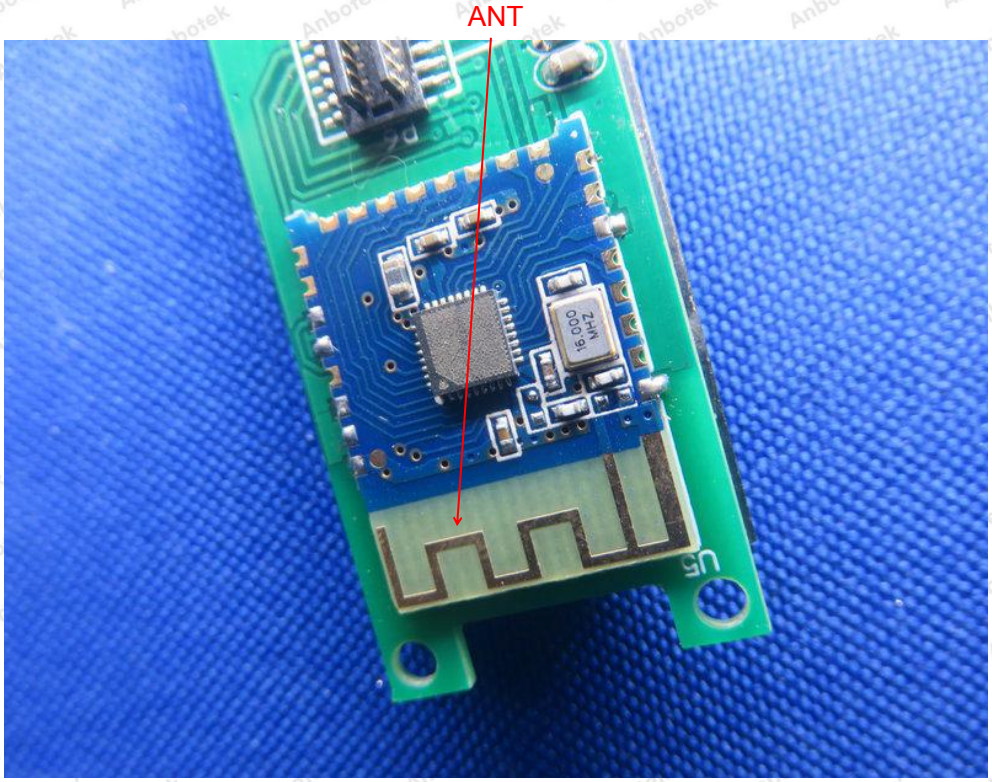


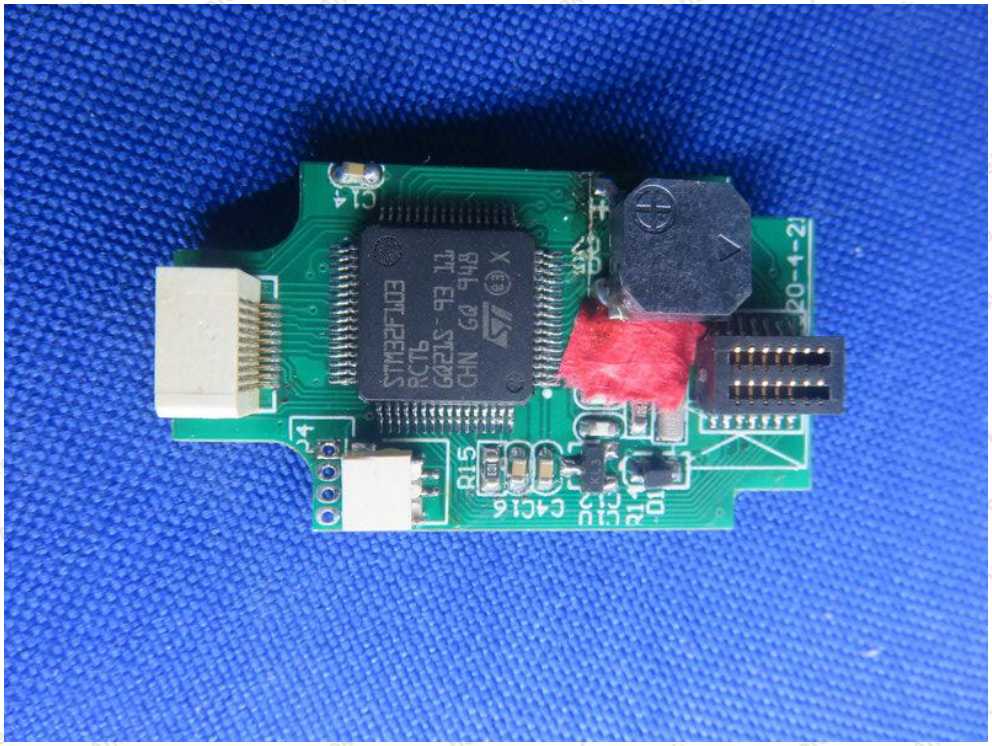


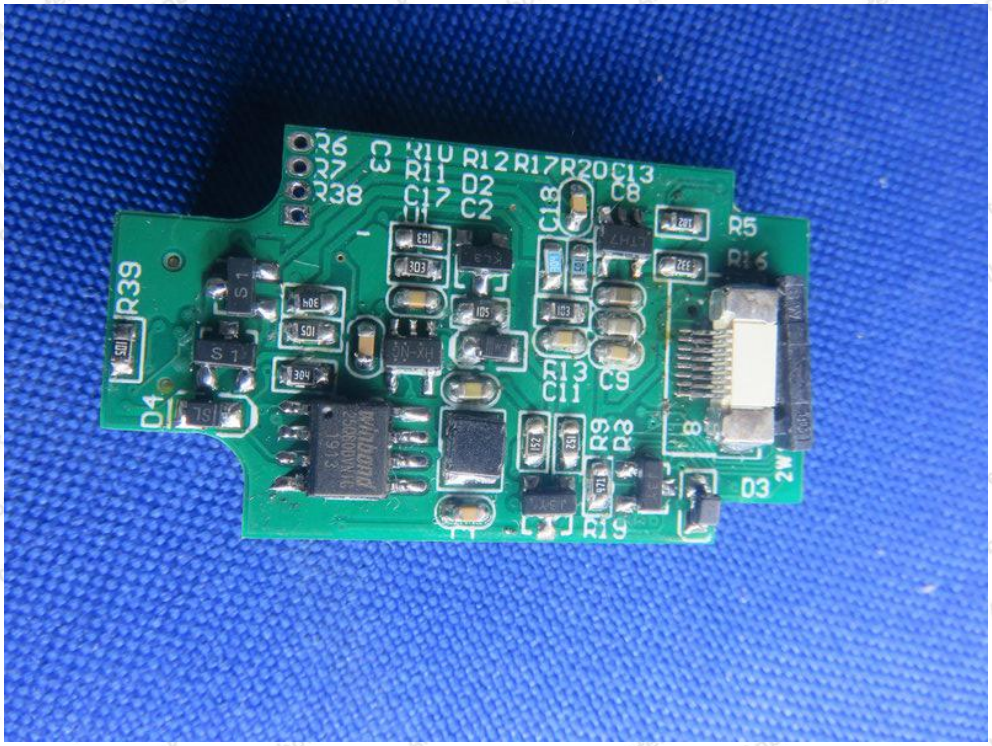


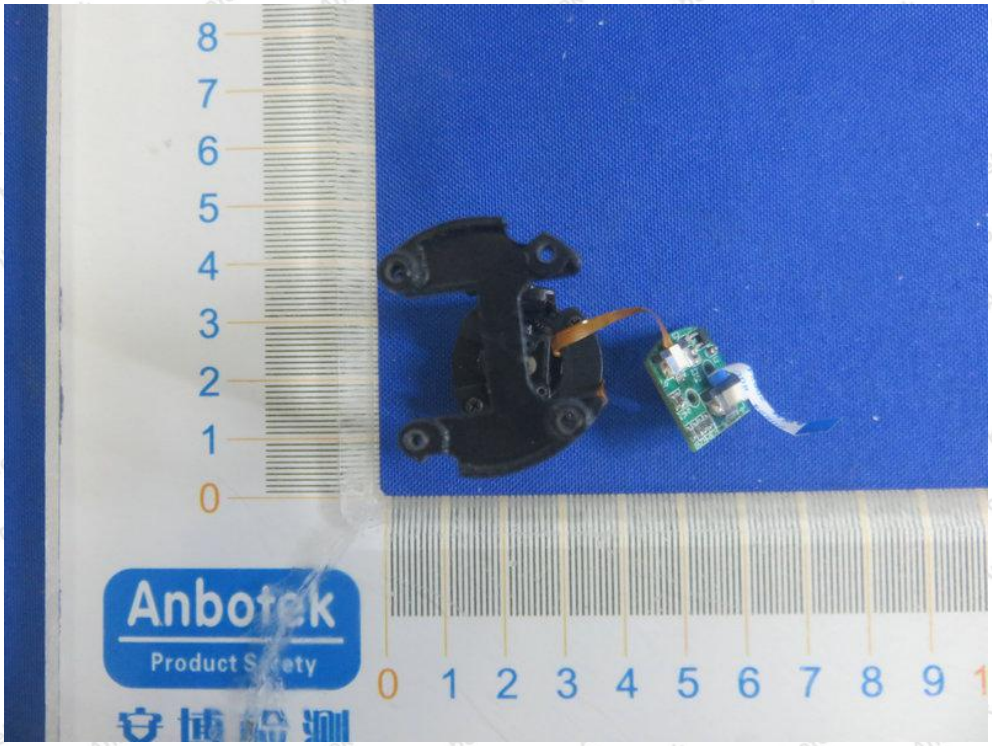

R44
R41
R50
R47
R22

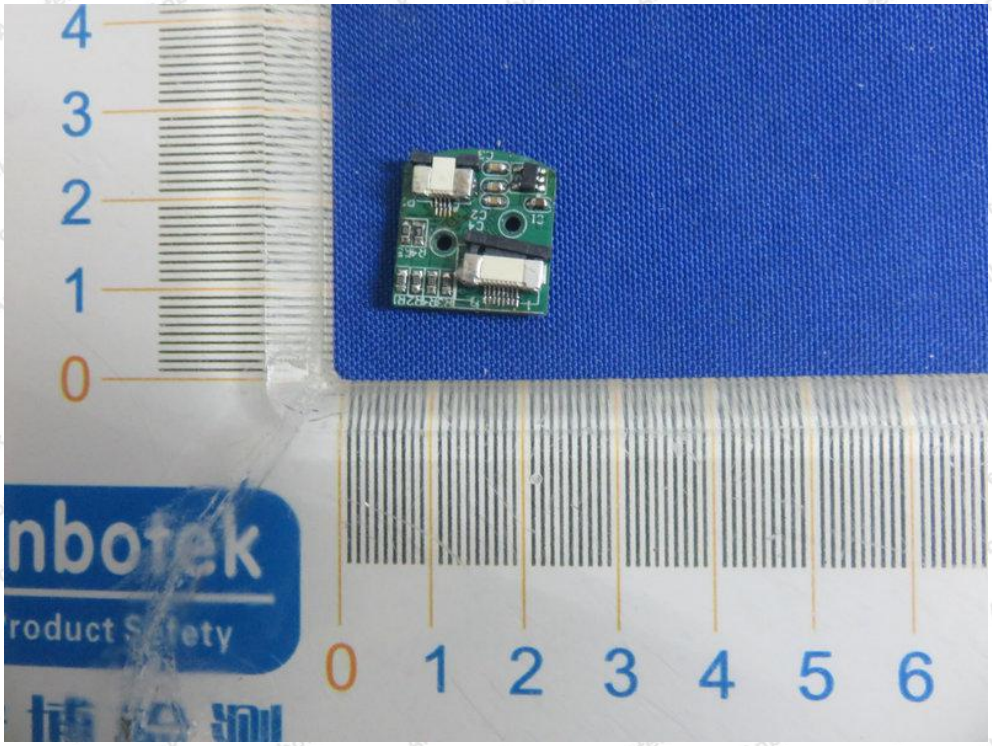


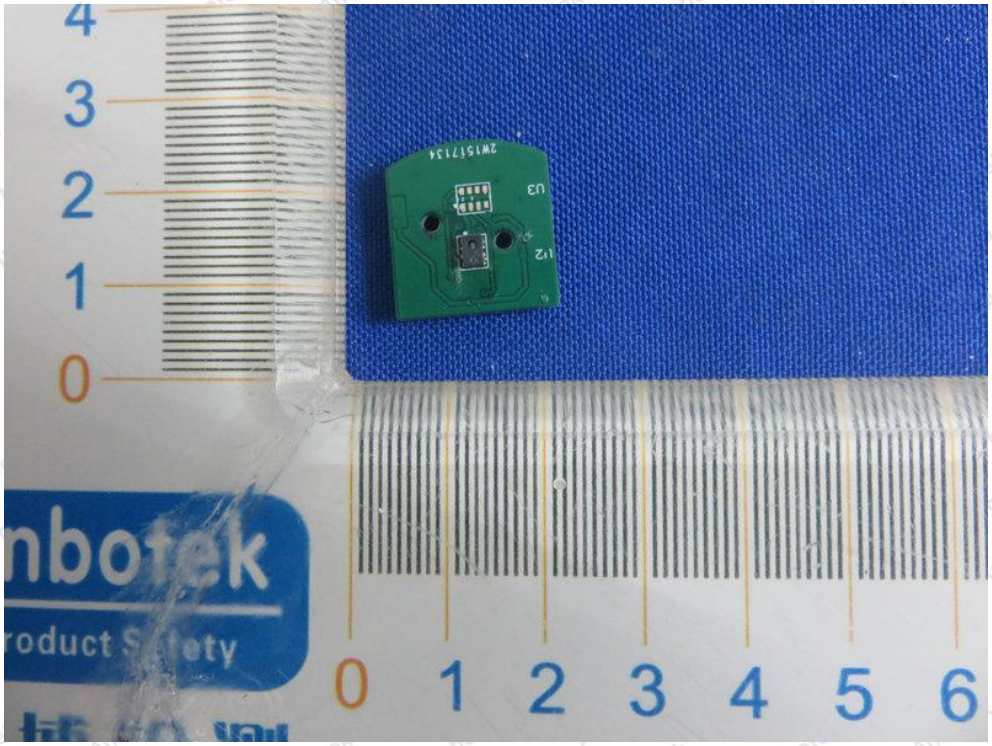

ANT

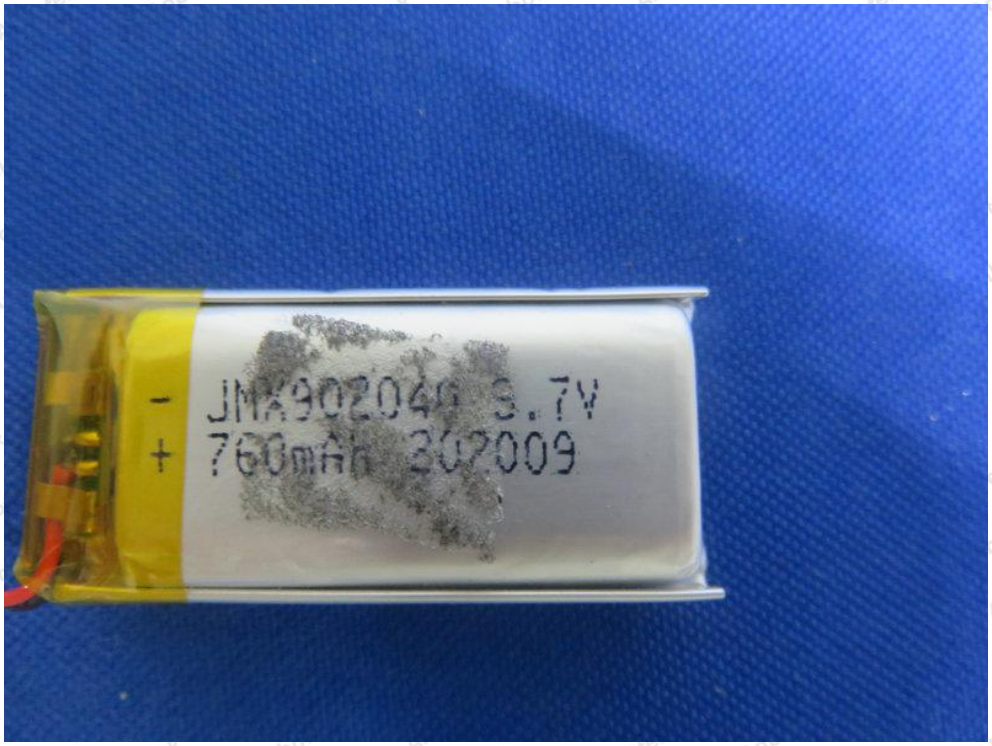

STM32F103
RCT6
C14
R15
C16
C12
R14
D1
J4
20-1-2


R6
R7
R38
C3
R10
R12
R17
R20
C13
R11
D2
C17
C2
C18
C8
R5
R16
R39
D4
R13
C11
C9
R9
R3
D3
R19








---------- End of Report ----------