# FCC TEST REPORT

# FOR

# CILICO MICROELECTRONICS LIMITED

# 2D Barcode Scanner

# Test Model: CT80

# Additional Model NO.: CT80X,CT80H, CT80S, IOT600, IOT600S, IOT800, IOT800S

| | | |
|---|---|---|
| Prepared for | : | CILICO MICROELECTRONICS LIMITED |
| Address | : | #10406 4th floor, Unit1, Building 1, Huixin IBC, south of zhangba east Rd., Hi-tech Zone, Xi'an, China |

| | | |
|---|---|---|
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| | | |
|---|---|---|
| Date of receipt of test sample | : | June 22, 2017 |
| Number of tested samples | : | 1 |
| Sample number | : | A17051505 |
| Date of Test | : | June 22, 2017- July 10, 2017 |
| Date of Report | : | July 10, 2017 |

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# FCC TEST REPORT

## FCC CFR 47 PART 15 C(15.249)

| | | |
|---|---|---|
| **Report Reference No. .....** | **:** | **LCS170622011AE** |
| Date of Issue ..... | : | July 10, 2017 |
| **Testing Laboratory Name.....** | **:** | **Shenzhen LCS Compliance Testing Laboratory Ltd.** |
| Address ..... | : | 1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China |
| Testing Location/ Procedure..... | : | Full application of Harmonised standards ■<br>Partial application of Harmonised standards ☐<br>Other standard testing method ☐ |
| **Applicant's Name .....** | **:** | **CILICO MICROELECTRONICS LIMITED** |
| Address ..... | : | #10406 4th floor, Unit1, Building 1, Huixin IBC, south of zhangba east Rd., Hi-tech Zone, Xi'an, China |
| **Test Specification** | | |
| Standard..... | : | FCC CFR 47 PART 15 C(15.249) / ANSI C63.10: 2013 |
| Test Report Form No..... | : | LCSEMC-1.0 |
| TRF Originator ..... | : | Shenzhen LCS Compliance Testing Laboratory Ltd. |
| Master TRF..... | : | Dated 2011-03 |

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| | | |
|---|---|---|
| **Test Item Description. .....** | **:** | **2D Barcode Scanner** |
| Trade Mark ..... | : | CILICO |
| Test Model..... | : | CT80 |
| Ratings..... | : | DC 3.7V by battery (1800mAh)<br>Charging voltage: 5.0V⎓, 500mA |
| **Result .....** | **:** | **Positive** |

| **Compiled by:** | **Supervised by:** | **Approved by:** |
|---|---|---|
| Dick Su | | |
| Dick Su / File administrators | Glin Lu/ Technique principal | Gavin Liang/ Manager |

# FCC -- TEST REPORT

| | |
|---|---|
| **Test Report No. : LCS170622011AE** | July 10, 2017<br>Date of issue |

| | |
|---|---|
| Test Model..... | : CT80 |
| EUT..... | : 2D Barcode Scanner |
| **Applicant.....** | **: CILICO MICROELECTRONICS LIMITED** |
| Address..... | : #10406 4th floor, Unit1, Building 1, Huixin IBC, south of zhangba east Rd., Hi-tech Zone, Xi'an, China |
| Telephone..... | : / |
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| **Manufacturer.....** | **: CILICO MICROELECTRONICS LIMITED** |
| Address..... | : #10406 4th floor, Unit1, Building 1, Huixin IBC, south of zhangba east Rd., Hi-tech Zone, Xi'an, China |
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| Fax..... | : / |
| **Factory.....** | **: CILICO MICROELECTRONICS LIMITED** |
| Address..... | : #10406 4th floor, Unit1, Building 1, Huixin IBC, south of zhangba east Rd., Hi-tech Zone, Xi'an, China |
| Telephone..... | : / |
| Fax..... | : / |

| | |
|---|---|
| **Test Result** | **Positive** |

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

# Revision History

| Revision | Issue Date | Revisions | Revised By |
|---|---|---|---|
| 00 | July 10, 2017 | Initial Issue | Gavin Liang |
| | | | |
| | | | |

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# 1. GENERAL INFORMATION

## 1.1. Description of Device (EUT)

| | | |
|---|---|---|
| EUT | : | 2D Barcode Scanner |
| Test Model | : | CT80 |
| Additional Model NO. | : | CT80X,CT80H, CT80S, IOT600, IOT600S, IOT800, IOT800S |
| Model Declaration | | PCB board, structure and internal of these model(s) are the same, So no additional models were tested. |
| Hardware Version | : | CT1602_V1.1 |
| Software Version | : | V0.15 |
| Power Supply | : | DC 3.7V by battery (1800mAh)<br>Charging voltage: 5.0V⎓, 500mA |
| 2.4G | | |
| Frequency Range | : | 2407.00-2477.00MHz(2407MHz, 2408MHz, 2410MHz, 2414MHz, 2421MHz, 2428MHz, 2440MHz, 2437MHz, 2440MHz, 2441MHz, 2442MHz, 2449MHz, 2455MHz, 2467MHz, 2468MHz, 2477MHz, ) |
| Channel Number | : | 16 channels |
| Modulation Type | : | GFSK |
| Antenna Description | : | Internal Antenna, 1.5dBi(Max.) |
| Bluetooth | | |
| Frequency Range | | 2402.00-2480.00MHz |
| Channel Number | | 40 channels for Bluetooth V4.0 (DTS) |
| Channel Spacing | | 2MHz for Bluetooth V4.0 (DTS) |
| Modulation Type | | GFSK for Bluetooth V4.0 (DTS) |
| Bluetooth Version | | V4.0 |
| Antenna Description | | Internal Antenna, 1.5dBi(Max.) |

## 1.2. Support Equipment List

| Manufacturer | Description | Model | Serial Number | Certificate |
|---|---|---|---|---|
| -- | -- | -- | -- | -- |

## 1.3. External I/O

| I/O Port Description | Quantity | Cable |
|---|---|---|
| USB Port | 1 | 0.8m |

## 1.4. Description of Test Facility

CNAS Registration Number. is L4595.
FCC Registration Number. is 899208.
Industry Canada Registration Number. is 9642A-1.
ESMD Registration Number. is ARCB0108.
UL Registration Number. is 100571-492.
TUV SUD Registration Number. is SCN1081.
TUV RH Registration Number. is UA 50296516-001

## 1.5. List Of Measuring Equipments

| Instrument | Manufacturer | Model No. | Serial No. | Characteristics | Cal Date | Due Date |
|---|---|---|---|---|---|---|
| EMC Receiver | R&S | ESCS 30 | 100174 | 9kHz – 2.75GHz | June 18,2017 | June 17,2018 |
| Signal analyzer | Agilent | E4448A(External mixers to 40GHz) | US44300469 | 9kHz~40GHz | July 16,2016 | July 15,2017 |
| LISN | MESS Tec | NNB-2/16Z | 99079 | 9KHz-30MHz | June 18,2017 | June 17,2018 |
| LISN (Support Unit) | EMCO | 3819/2NM | 9703-1839 | 9KHz-30MHz | June 18,2017 | June 17,2018 |
| RF Cable-CON | UTIFLEX | 3102-26886-4 | CB049 | 9KHz-30MHz | June 18,2017 | June 17,2018 |
| ISN | SCHAFFNER | ISN ST08 | 21653 | 9KHz-30MHz | June 18,2017 | June 17,2018 |
| 3m Semi Anechoic Chamber | SIDT FRANKONIA | SAC-3M | 03CH03-HY | 30M-1GHz 3m | June 18,2017 | June 17,2018 |
| Amplifier | SCHAFFNER | COA9231A | 18667 | 9kHz-2GHzz | June 18,2017 | June 17,2018 |
| Amplifier | Agilent | 8449B | 3008A02120 | 1GHz-26.5GHz | July 16,2016 | July 15,2017 |
| Amplifier | MITEQ | AMF-6F-260400 | 9121372 | 26.5GHz-40GHz | July 16,2016 | July 15,2017 |
| Spectrum Analyzer | Agilent | E4407B | MY41440292 | 9k-26.5GHz | July 16,2016 | July 15,2017 |
| MAX Signal Analyzer | Agilent | N9020A | MY50510140 | 20Hz~26.5GHz | Oct. 27, 2016 | Oct. 26, 2017 |
| Loop Antenna | R&S | HFH2-Z2 | 860004/001 | 9k-30MHz | June 18,2017 | June 17,2018 |
| By-log Antenna | SCHWARZBECK | VULB9163 | 9163-470 | 30MHz-1GHz | June 10,2016 | June 09,2018 |
| Horn Antenna | EMCO | 3115 | 6741 | 1GHz-18GHz | June 10,2016 | June 09,2018 |
| Horn Antenna | SCHWARZBECK | BBHA9170 | BBHA9170154 | 15GHz-40GHz | June 10,2016 | June 09,2018 |
| RF Cable-R03m | Jye Bao | RG142 | CB021 | 30MHz-1GHz | June 18,2017 | June 17,2018 |
| RF Cable-HIGH | SUHNER | SUCOFLEX 106 | 03CH03-HY | 1GHz-40GHz | June 18,2017 | June 17,2018 |
| Power Meter | R&S | NRVS | 100444 | DC-40GHz | June 18,2017 | June 17,2018 |
| Power Sensor | R&S | NRV-Z51 | 100458 | DC-30GHz | June 18,2017 | June 17,2018 |
| Power Sensor | R&S | NRV-Z32 | 10057 | 30MHz-6GHz | June 18,2017 | June 17,2018 |
| RF CABLE-1m | JYE Bao | RG142 | CB034-1m | 20MHz-7GHz | June 18,2017 | June 17,2018 |
| RF CABLE-2m | JYE Bao | RG142 | CB035-2m | 20MHz-1GHz | June 18,2017 | June 17,2018 |
| EMC Test software | Audix | E3 | N/A | N/A | N/A | N/A |
| *Note: All equipment through GRGT EST calibration* | | | | | | |

## 1.6. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. To CISPR 16 – 4 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements" and is documented in the LCS quality system acc. To DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

## 1.7. Measurement Uncertainty

| Test Item | | Frequency Range | Uncertainty | Note |
|---|---|---|---|---|
| Radiation Uncertainty | : | 9KHz~30MHz | 3.10dB | (1) |
| | | 30MHz~200MHz | 2.96dB | (1) |
| | | 200MHz~1000MHz | 3.10dB | (1) |
| | | 1GHz~26.5GHz | 4.00dB | (1) |
| Conduction Uncertainty | : | 150kHz~30MHz | 1.63dB | (1) |
| Power disturbance | : | 30MHz~300MHz | 1.60dB | (1) |

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

## 1.8. Description Of Test Modes

The EUT operates in the unlicensed ISM band at 2.4GHz. The following operating modes were applied for the related test items.

All test modes were tested, only the result of the worst case was recorded in the report. It was pre-tested on the positioned of each 3 axis. The worst case was found positioned on X-plane.

| Mode of Operations | Transmitting Frequency (MHz) |
|---|---|
| GFSK | 2407 |
| | 2440 |
| | 2477 |
| For Conducted Emission | |
| Test Mode | TX Mode |
| For Radiated Emission | |
| Test Mode | TX Mode |

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be TX-High Channel(2477MHz).

Pre-test AC conducted emission at charge from PC mode, recorded worst case.
Pre-test AC conducted emission at both voltage AC 120V/60Hz and AC 240V/50Hz, recorded worst case.

***Note: Using a temporary antenna connector for the EUT when the conducted measurements are performed.

# 2. TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10: 2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen LCS Compliance Testing Laboratory Ltd..

## 2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

## 2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.249 under the FCC Rules Part 15 Subpart C.

## 2.3. General Test Procedures

### 2.3.1 Conducted Emissions

According to the requirements in Section 6.2 of ANSI C63.10: 2013, AC power-line conducted emissions shall be measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

### 2.3.2 Radiated Emissions

The EUT is placed on a turn table and the turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10: 2013

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# 3. CONNECTION DIAGRAM OF TEST SYSTEM

## 3.1. Justification

The system was configured for testing in a continuous transmit condition.

## 3.2. EUT Exercise Software

The system was configured for testing in a continuous transmits condition and change test channels by software (MP_Kit_Smart Tool) provided by application.

## 3.3. Special Accessories

| Equipment | Manufacturer | Model No. | Serial No. | Length | shielded/ unshielded | Notes |
|---|---|---|---|---|---|---|
| PC | Lenovo | Ideapad | A131101550 | / | / | DOC |
| Power adapter | Lenovo | CPA-A090 | 36200414 | 1.00m | unshielded | DOC |

## 3.4. Block Diagram/Schematics

Please refer to the related document

## 3.5. Equipment Modifications

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

## 3.6. Test Setup

Please refer to the test setup photo.

# 4. SUMMARY OF TEST RESULTS

| FCC Rules | Description Of Test | Result |
|---|---|---|
| §15.203 | Antenna Requirement | Compliant |
| §15.207(a) | Power Line Conducted Emissions | Compliant |
| §15.205(a), §15.209(a), §15.249(a), §15.249(c) | Radiated Emissions Measurement | Compliant |
| §15.249 | Band Edges Measurement | Compliant |
| §15.249, §15.215 | 20 dB Bandwidth | Compliant |

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# 5. ANTENNA REQUIREMENT

## 5.1. Standard Applicable

According to § 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.

## 5.2. Antenna Connected Construction

The antenna used for transmitting is permanently attached and no consideration of replacement. Please see EUT photo for details.

Result: Compliance.

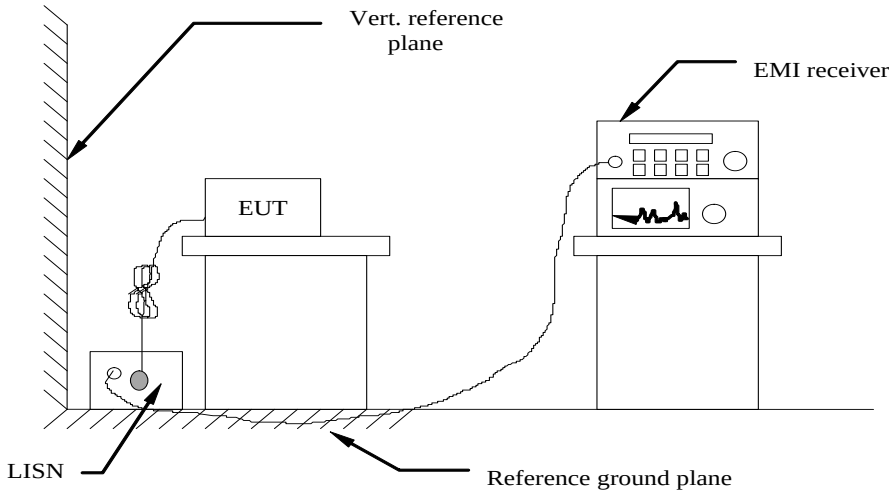
# 6. POWER LINE CONDUCTED EMISSIONS

## 6.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

| Frequency Range (MHz) | Limits (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

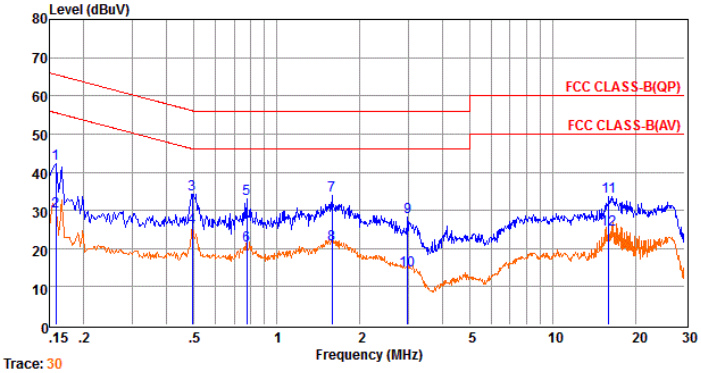
## 6.2 Block Diagram of Test Setup




## 6.3 Test Results

PASS.

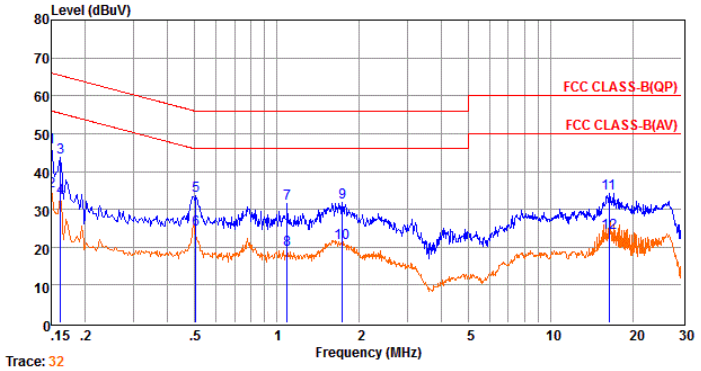
### *Test result for AC 120V/60Hz*




Trace: 30
Env. Ins: 24*/56%
Pol: LINE

| | Freq MHz | Reading dBuV | LISNFac dB | CabLos dB | Aux2Fac dB | Measured dB | Limit dBuV | Over dBuV | Remark dB |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.16 | 22.56 | 9.58 | 0.02 | 10.00 | 42.16 | 65.56 | -23.40 | QP |
| 2 | 0.16 | 10.29 | 9.58 | 0.02 | 10.00 | 29.89 | 55.55 | -25.66 | Average |
| 3 | 0.49 | 14.53 | 9.62 | 0.04 | 10.00 | 34.19 | 56.10 | -21.91 | QP |
| 4 | 0.49 | 6.01 | 9.62 | 0.04 | 10.00 | 25.67 | 46.10 | -20.43 | Average |
| 5 | 0.78 | 13.26 | 9.64 | 0.04 | 10.00 | 32.94 | 56.00 | -23.06 | QP |
| 6 | 0.78 | 1.06 | 9.64 | 0.04 | 10.00 | 20.74 | 46.00 | -25.26 | Average |
| 7 | 1.59 | 14.18 | 9.64 | 0.05 | 10.00 | 33.87 | 56.00 | -22.13 | QP |
| 8 | 1.59 | 1.46 | 9.64 | 0.05 | 10.00 | 21.15 | 46.00 | -24.85 | Average |
| 9 | 2.98 | 8.54 | 9.64 | 0.06 | 10.00 | 28.24 | 56.00 | -27.76 | QP |
| 10 | 2.98 | -5.43 | 9.64 | 0.06 | 10.00 | 14.27 | 46.00 | -31.73 | Average |
| 11 | 15.97 | 13.84 | 9.72 | 0.11 | 10.00 | 33.67 | 60.00 | -26.33 | QP |
| 12 | 15.97 | 5.12 | 9.72 | 0.11 | 10.00 | 24.95 | 50.00 | -25.05 | Average |

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.




Trace: 32
Env. Ins: 24*/56%
Pol: NEUTRAL

| | Freq MHz | Reading dBuV | LISNFac dB | CabLos dB | Aux2Fac dB | Measured dB | Limit dBuV | Over dBuV | Remark dB |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.15 | 26.74 | 9.70 | 0.02 | 10.00 | 46.46 | 66.00 | -19.54 | QP |
| 2 | 0.15 | 14.95 | 9.70 | 0.02 | 10.00 | 34.67 | 55.99 | -21.32 | Average |
| 3 | 0.16 | 24.10 | 9.67 | 0.02 | 10.00 | 43.79 | 65.34 | -21.55 | QP |
| 4 | 0.16 | 13.23 | 9.67 | 0.02 | 10.00 | 32.92 | 55.33 | -22.41 | Average |
| 5 | 0.50 | 13.95 | 9.62 | 0.04 | 10.00 | 33.61 | 56.00 | -22.39 | QP |
| 6 | 0.50 | 4.95 | 9.62 | 0.04 | 10.00 | 24.61 | 46.00 | -21.39 | Average |
| 7 | 1.09 | 11.76 | 9.63 | 0.05 | 10.00 | 31.44 | 56.00 | -24.56 | QP |
| 8 | 1.09 | -0.42 | 9.63 | 0.05 | 10.00 | 19.26 | 46.00 | -26.74 | Average |
| 9 | 1.73 | 12.10 | 9.63 | 0.05 | 10.00 | 31.78 | 56.00 | -24.22 | QP |
| 10 | 1.74 | 1.45 | 9.63 | 0.05 | 10.00 | 21.13 | 46.00 | -24.87 | Average |
| 11 | 16.31 | 14.27 | 9.75 | 0.11 | 10.00 | 34.13 | 60.00 | -25.87 | QP |
| 12 | 16.31 | 4.03 | 9.75 | 0.11 | 10.00 | 23.89 | 50.00 | -26.11 | Average |

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

*Note: Pre-scan all modes and recorded the worst case(TX-2477MHz) result in this report.*

# 7. RADIATED EMISSION MEASUREMENT

## 7.1. Standard Applicable

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) and 15.249 limit in the table below has to be followed.

| Fundamental Frequency | Field Strength of fundamental (millivolts/meter) | Field Strength of harmonics (microvolts/meter) |
|---|---|---|
| 902-928MHz | 50 | 500 |
| 2400-2483.5MHz | 50 | 500 |
| 5725-5875MHz | 50 | 500 |
| 24.0-24.25GHz | 250 | 2500 |

| Frequencies (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009~0.490 | 2400/F(KHz) | 300 |
| 0.490~1.705 | 24000/F(KHz) | 30 |
| 1.705~30.0 | 30 | 30 |
| 30~88 | 100 | 3 |
| 88~216 | 150 | 3 |
| 216~960 | 200 | 3 |
| Above 960 | 500 | 3 |

## 7.2. Instruments Setting

The following table is the setting of spectrum analyzer and receiver.

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Start ~ Stop Frequency | 9kHz~150kHz / RB 200Hz for QP |
| Start ~ Stop Frequency | 150kHz~30MHz / RB 9kHz for QP |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB 120kHz for QP |

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Start Frequency | 1000 MHz |
| Stop Frequency | 10th carrier harmonic |
| RB / VB (Emission in restricted band) | 1MHz / 1MHz for Peak, 1 MHz / 10Hz for Average |
| RB / VB (Emission in non-restricted band) | 1000KHz / 1000KHz for peak |

## 7.3. Test Procedure

**1) Sequence of testing 9 kHz to 30 MHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

**Premeasurement:**

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 0.8 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

**Final measurement:**

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

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**2) Sequence of testing 30 MHz to 1 GHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

**Premeasurement:**

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

**Final measurement:**

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

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**3) Sequence of testing 1 GHz to 18 GHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

**Premeasurement:**

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

**Final measurement:**

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

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**4) Sequence of testing above 18 GHz**

**Setup:**

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

**Premeasurement:**

--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

**Final measurement:**

--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

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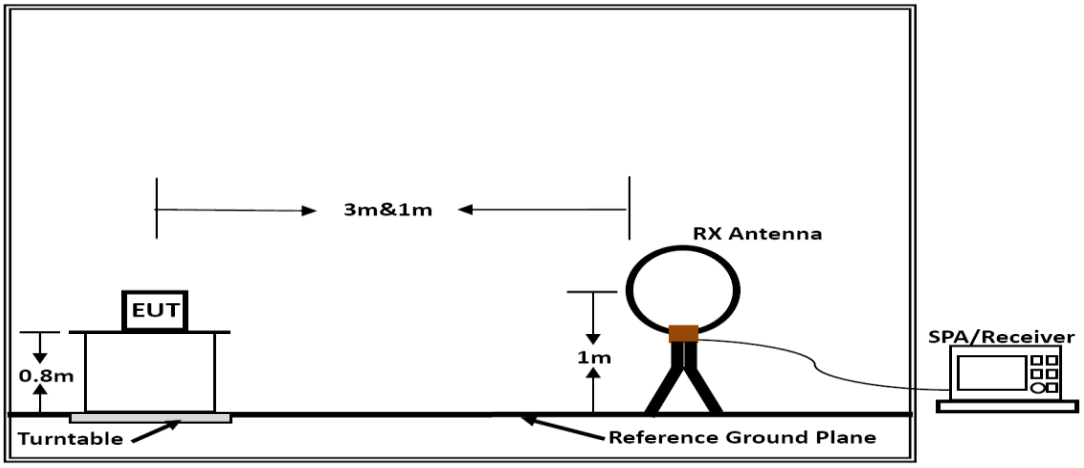
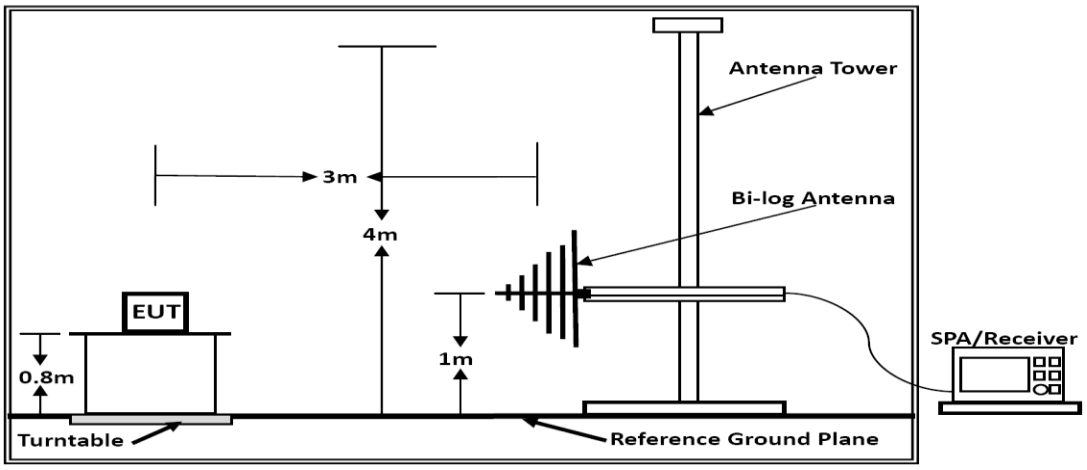
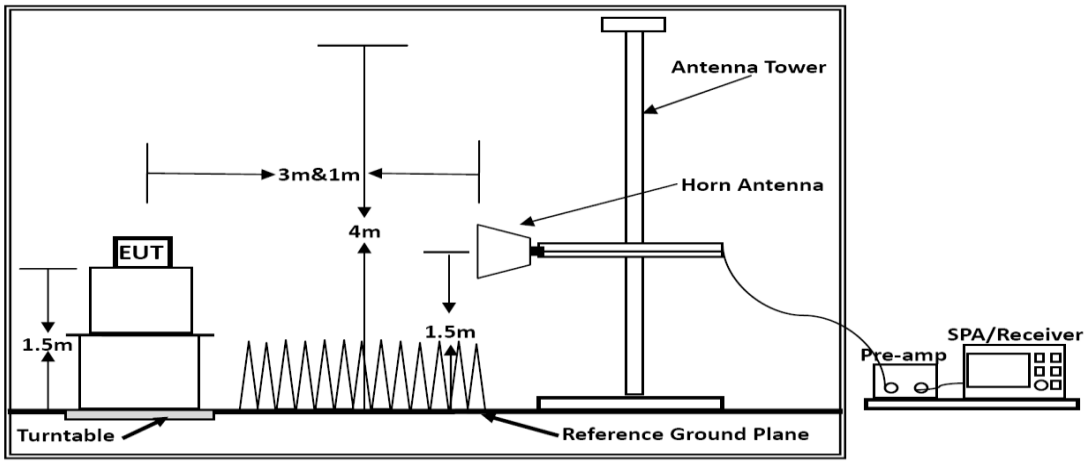
## 7.4. Block Diagram of Test Setup




**Below 30MHz**




**Below 1GHz**




**Above 1GHz**

## 7.5. Test Results

Results of Radiated Emissions (9kHz~30MHz)

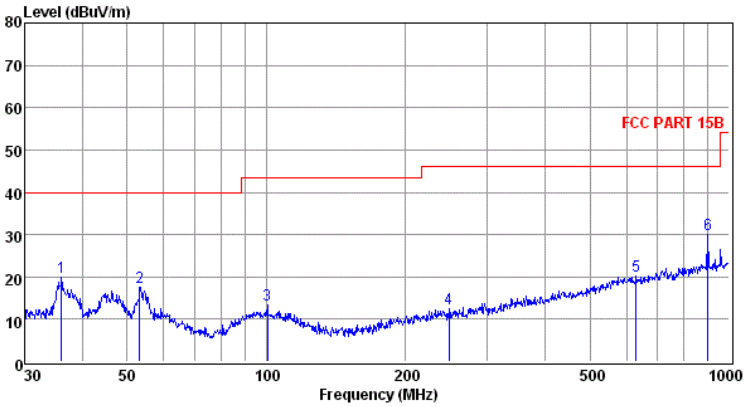
| Frequency (MHz) | Level (dBuV) | Over Limit (dB) | Over Limit (dBuV) | Remark |
|---|---|---|---|---|
| - | - | - | - | See Note |

Note:

The radiated emissions from 9kHz to 30MHz are at least 20dB below the official limit and no need to report.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor.

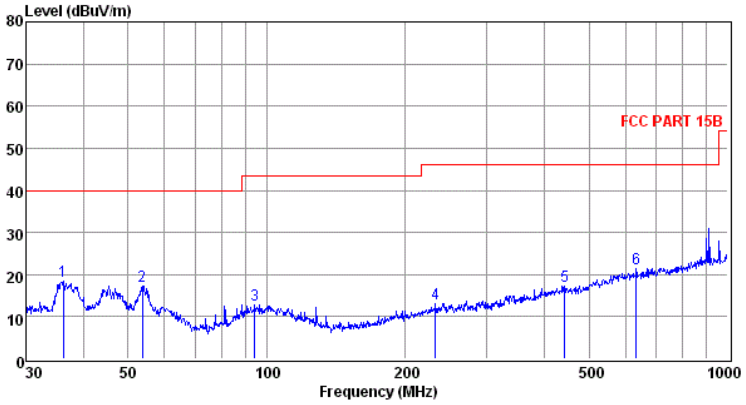
Results of Radiated Emissions (30MHz~1000MHz)




Env./Ins: 24℃/56%
pol: HORIZONTAL

| | Freq | Reading | CabLos | Antfac | Measured | Limit | Over | Remark |
|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dB/m | dBuV/m | dBuV/m | dB | |
| 1 | 36.00 | 6.99 | 0.41 | 12.56 | 19.96 | 40.00 | -20.04 | QP |
| 2 | 53.13 | 3.92 | 0.46 | 13.11 | 17.49 | 40.00 | -22.51 | QP |
| 3 | 100.58 | -0.21 | 0.60 | 13.11 | 13.50 | 43.50 | -30.00 | QP |
| 4 | 247.68 | -0.57 | 0.97 | 12.07 | 12.47 | 46.00 | -33.53 | QP |
| 5 | 629.48 | 0.21 | 1.60 | 18.56 | 20.37 | 46.00 | -25.63 | QP |
| 6 | 900.15 | 7.00 | 1.88 | 21.09 | 29.97 | 46.00 | -16.03 | QP |

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported




Env./Ins: 24℃/56%
pol: VERTICAL

| | Freq | Reading | CabLos | Antfac | Measured | Limit | Over | Remark |
|---|---|---|---|---|---|---|---|---|
| | MHz | dBuV | dB | dB/m | dBuV/m | dBuV/m | dB | |
| 1 | 36.13 | 5.44 | 0.41 | 12.59 | 18.44 | 40.00 | -21.56 | QP |
| 2 | 53.69 | 3.80 | 0.46 | 13.08 | 17.34 | 40.00 | -22.66 | QP |
| 3 | 94.10 | -0.44 | 0.58 | 12.67 | 12.81 | 43.50 | -30.69 | QP |
| 4 | 232.53 | 0.44 | 0.98 | 11.76 | 13.18 | 46.00 | -32.82 | QP |
| 5 | 443.29 | 0.35 | 1.25 | 15.56 | 17.16 | 46.00 | -28.84 | QP |
| 6 | 633.91 | 1.32 | 1.50 | 18.57 | 21.39 | 46.00 | -24.61 | QP |

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

****Note: Pre-scan all mode and recorded the worst case results in this report (TX- 2477MHz).*

## 7.6. Results for Radiated Emissions (Above 1GHz)

| Field Strength Of Fundamental (TX-2404MHz) | | | | | | |
|---|---|---|---|---|---|---|
| Frequency (MHz) | Pol. | Measure Result (PK, dBuV/m) | Measure Result (AVG, dBuV/m) | Peak Limit (dBuV/m) | AVG Limit (dBuV/m) | Result |
| 2407 | H | 85.42 | 79.47 | 114 | 94 | Pass |
| 2407 | V | 88.76 | 81.20 | 114 | 94 | Pass |

| Freq. MHz | Reading Level dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4814.00 | 45.70 | 33.06 | 35.04 | 3.94 | 47.66 | 74 | -26.34 | Peak | Horizontal |
| 4814.00 | 36.58 | 33.06 | 35.04 | 3.94 | 38.54 | 54 | -15.46 | Average | Horizontal |
| 4814.00 | 46.63 | 33.06 | 35.04 | 3.94 | 48.59 | 74 | -25.41 | Peak | Vertical |
| 4814.00 | 36.79 | 33.06 | 35.04 | 3.94 | 38.75 | 54 | -15.25 | Average | Vertical |

| Field Strength Of Fundamental (TX-2441MHz) | | | | | | |
|---|---|---|---|---|---|---|
| Frequency (MHz) | Pol. | Measure Result (PK, dBuV/m) | Measure Result (AVG, dBuV/m) | Peak Limit (dBuV/m) | AVG Limit (dBuV/m) | Result |
| 2440.00 | H | 82.52 | 79.41 | 114 | 94 | Pass |
| 2440.00 | V | 85.33 | 80.36 | 114 | 94 | Pass |

| Freq. MHz | Reading Level dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4880.00 | 44.11 | 33.16 | 35.15 | 3.96 | 46.08 | 74 | -27.92 | Peak | Horizontal |
| 4880.00 | 36.19 | 33.16 | 35.15 | 3.96 | 38.16 | 54 | -15.84 | Average | Horizontal |
| 4880.00 | 48.93 | 33.16 | 35.15 | 3.96 | 50.90 | 74 | -23.10 | Peak | Vertical |
| 4880.00 | 39.98 | 33.16 | 35.15 | 3.96 | 41.95 | 54 | -12.05 | Average | Vertical |

| Field Strength Of Fundamental (TX-2478MHz) | | | | | | |
|---|---|---|---|---|---|---|
| Frequency (MHz) | Pol. | Measure Result (PK, dBuV/m) | Measure Result (AVG, dBuV/m) | Peak Limit (dBuV/m) | AVG Limit (dBuV/m) | Result |
| 2477.00 | H | 87.55 | 83.33 | 114 | 94 | Pass |
| 2477.00 | V | 89.32 | 85.51 | 114 | 94 | Pass |

| Freq. MHz | Reading Level dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4954.00 | 45.23 | 33.26 | 35.14 | 3.98 | 47.33 | 74 | -26.67 | Peak | Horizontal |
| 4954.00 | 37.37 | 33.26 | 35.14 | 3.98 | 39.47 | 54 | -14.53 | Average | Horizontal |
| 4954.00 | 51.21 | 33.26 | 35.14 | 3.98 | 53.31 | 74 | -20.69 | Peak | Vertical |
| 4954.00 | 39.78 | 33.26 | 35.14 | 3.98 | 41.88 | 54 | -12.12 | Average | Vertical |

***Notes:***

1. *Measuring frequencies from 9k~10th harmonic (ex. 26GHz), No emission found between lowest internal used/generated frequency to 30MHz.*
2. *Radiated emissions measured in frequency range from 9k~10th harmonic (ex. 26GHz) were made with an instrument using Peak detector mode.*
3. *No emission was be recorded above 18GHz means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.*

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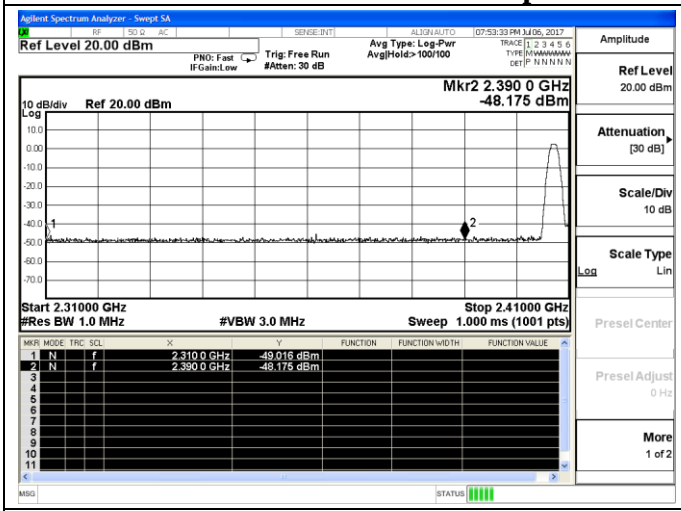
## 7.7. Results for Band edge Testing

Only record the worst test case as following:

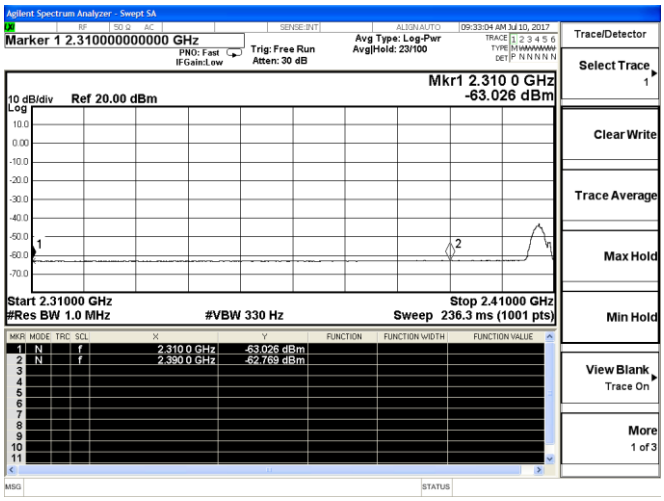
| GFSK | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Conducted Power (dBm) | Antenna Gain (dBi) | Ground Reflection Factor (dB) | Covert Radiated E Level At 3m (dBuV/m) | Detector | Limit (dBuV/m) | Verdict |
| 2310.000 | -49.016 | 2.0 | 0.0 | 48.244 | Peak | 74.00 | PASS |
| 2310.000 | -63.026 | 2.0 | 0.0 | 34.234 | AV | 54.00 | PASS |
| 2390.000 | -48.175 | 2.0 | 0.0 | 49.085 | Peak | 74.00 | PASS |
| 2390.000 | -62.769 | 2.0 | 0.0 | 34.491 | AV | 54.00 | PASS |
| 2483.500 | -48.364 | 2.0 | 0.0 | 48.896 | Peak | 74.00 | PASS |
| 2483.500 | -62.541 | 2.0 | 0.0 | 34.719 | AV | 54.00 | PASS |
| 2500.000 | -48.753 | 2.0 | 0.0 | 48.507 | Peak | 74.00 | PASS |
| 2500.000 | -62.472 | 2.0 | 0.0 | 34.788 | AV | 54.00 | PASS |

NOTE: Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.
Please refer to following test plots;

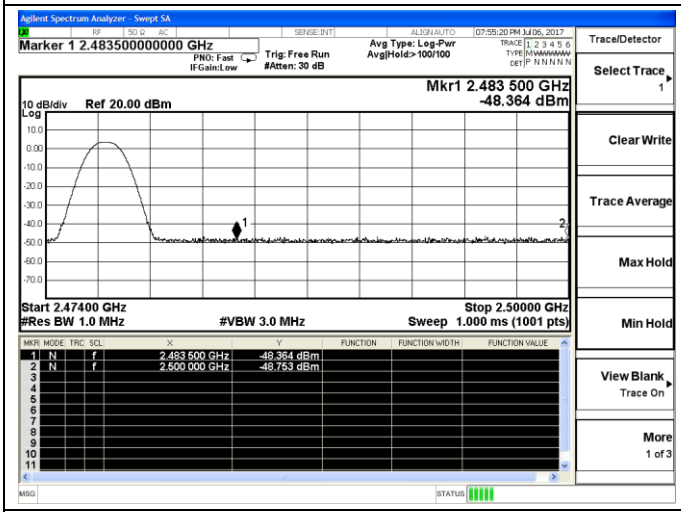
## Test plot of Band Edge (Radiated)



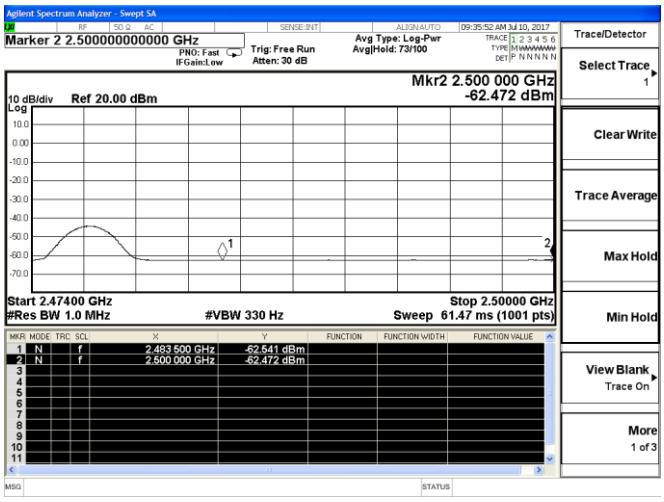

**Low Channel / 2407MHz - Peak**




**Low Channel / 2407MHz – Average**




**High Channel / 2477MHz - Peak**



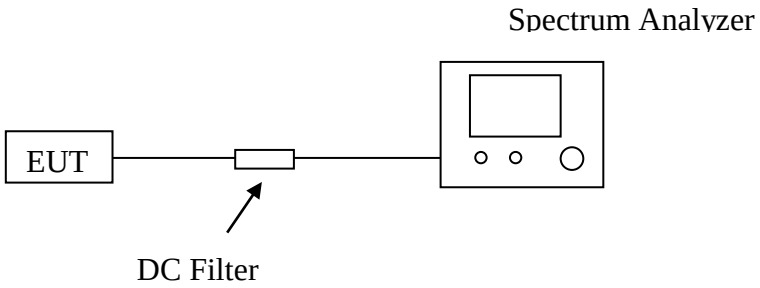

**High Channel / 2477MHz – Average**

# 8. 20 DB BANDWIDTH MEASUREMENT

## 8.1. Standard Applicable

According to §15.215

## 8.2. Block Diagram of Test Setup




## 8.3. Test Procedure

Use the following spectrum analyzer settings:

Span = 3MHz

RBW = 30KHz

VBW = 100KHz

Sweep = auto

Detector function = peak

Trace = max hold

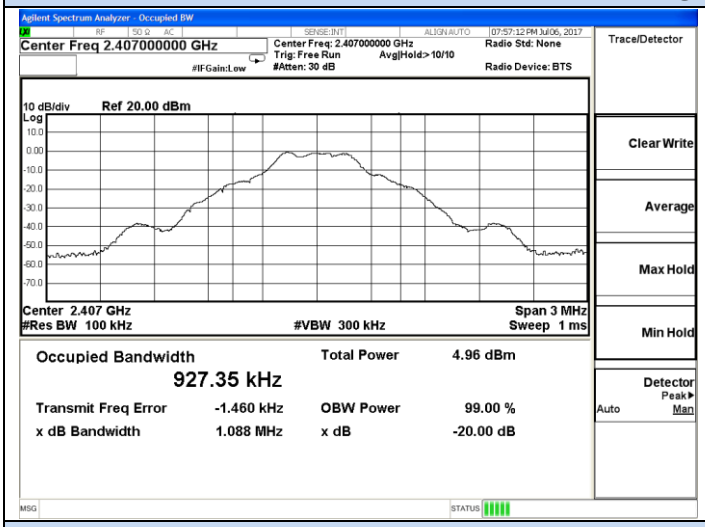
The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the 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. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

## 8.4. Test Results

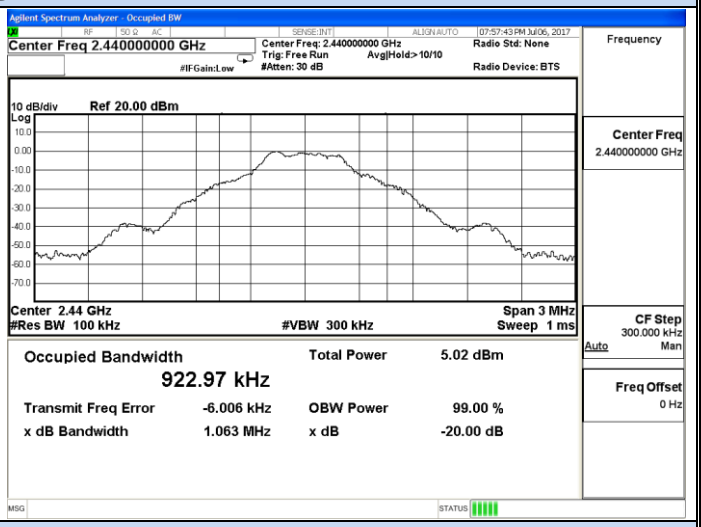
| Test Result Of 20dB Bandwidth Measurement | | |
|---|---|---|
| Test Frequency (MHz) | 20dB Bandwidth (MHz) | Limit (MHz) |
| 2407 | 1.088 | Non-Specified |
| 2440 | 1.063 | |
| 2477 | 1.081 | |

**Test Plot of Test Result**

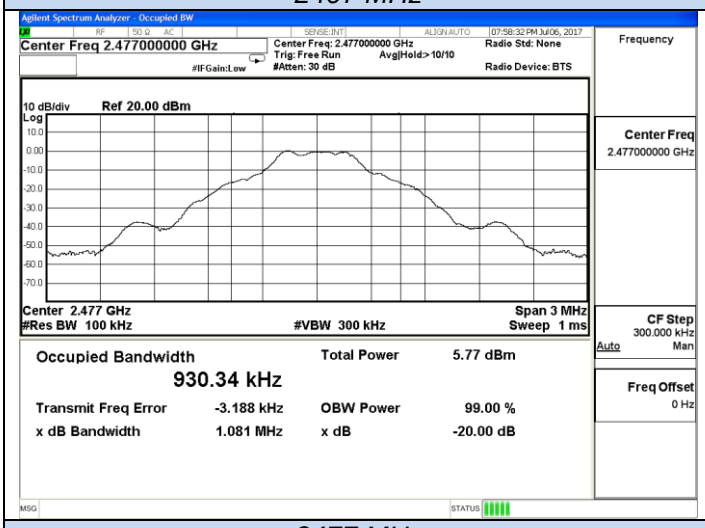
*GFSK*




*2407 MHz*




*2440 MHz*




*2477 MHz*

# 9. ANTENNA REQUIREMENTS

## 9.1 Standard Applicable

According to antenna requirement of §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 re-placed 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 Sections 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 Section 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.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

## 9.2 Antenna Connected Construction

### 9.2.1. Standard Applicable

According to § 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.

### 9.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 1.50dBi, and the antenna is an External PCB antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

### 9.2.3. Results: Compliance.

----------THE END OF TEST REPORT----------