# FCC RF Test Report

| | | |
|---|---|---|
| APPLICANT | : | Microstrip LLC |
| EQUIPMENT | : | Digital Media Receiver |
| MODEL NAME | : | DW84JL |
| FCC ID | : | 2ANZL-2474 |
| STANDARD | : | FCC Part 15 Subpart C §15.247 |
| CLASSIFICATION | : | (DTS) Digital Transmission System |

**The testing was completed on May 05, 2018. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.**

**The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.**

**Reviewed by: Joseph Lin / Supervisor**

**Approved by: Jones Tsai / Manager**

Testing Laboratory
1190

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# REVISION HISTORY

| REPORT NO. | VERSION | DESCRIPTION | ISSUED DATE |
|---|---|---|---|
| FR7D0544-01C | Rev. 01 | Initial issue of report | May 17, 2018 |
| FR7D0544-01C | Rev. 02 | Revising the channel typo in section 1.3, and add the conduction emission test data. | Jun. 21, 2018 |
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# SUMMARY OF TEST RESULT

| Report Section | FCC Rule | Description | Limit | Result |
|---|---|---|---|---|
| 3.1 | 15.247(a)(2) | 6dB Bandwidth | ≥ 0.5MHz | Pass |
| 3.1 | - | 99% Bandwidth | - | Pass |
| 3.2 | 15.247(b)(3) | Peak Output Power | ≤ 30dBm | Pass |
| 3.3 | 15.247(e) | Power Spectral Density | ≤ 8dBm/3kHz | Pass |
| 3.4 | 15.247(d) | Conducted Band Edges and Spurious Emission | ≤ 20dBc | Pass |
| 3.5 | 15.247(d) | Radiated Band Edges and Spurious Emission | 15.209(a) & 15.247(d) | Pass |
| 3.6 | 15.207 | AC Conducted Emission | 15.207(a) | Pass |
| 3.7 | 15.203 & 15.247(b) | Antenna Requirement | N/A | Pass |

# 1 General Description

## 1.1 Applicant

**Microstrip LLC**
83 Wooster Heights Rd, Suite 125, Danbury, Connecticut, 06810

## 1.2 Product Feature of Equipment Under Test

| Product Feature | |
|---|---|
| **Equipment** | Digital Media Receiver |
| **Model Name** | DW84JL |
| **FCC ID** | 2ANZL-2474 |
| **EUT supports Radios application** | Zigbee<br>WLAN 11b/g/n HT20<br>WLAN 11a/n HT20/HT40<br>WLAN 11ac VHT20/VHT40/VHT80<br>Bluetooth BR/EDR/LE |

## 1.3 Product Specification of Equipment Under Test

| Standards-related Product Specification | |
|---|---|
| **Tx/Rx Frequency Range** | 2405 MHz ~ 2480 MHz |
| **Number of Channels** | 16 |
| **Channel Spacing** | 5 MHz |
| **Maximum Output Power to Antenna** | 18.91 dBm (0.0778 W) |
| **99% Occupied Bandwidth** | 2.250MHz |
| **Antenna Type / Gain** | Fixed Internal Antenna type with gain 2.31 dBi |
| **Type of Modulation** | 250 kbps |

## 1.4 Modification of EUT

No modifications are made to the EUT during all test items.

## 1.5 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW1190 and TW0007 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

| | | |
|---|---|---|
| **Test Site** | SPORTON INTERNATIONAL INC. | |
| **Test Site Location** | No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park,<br>Kwei-Shan District, Tao Yuan City, Taiwan, R.O.C.<br>TEL: +886-3-327-3456<br>FAX: +886-3-328-4978 | |
| **Test Site No.** | **Sporton Site No.** | |
| | TH05-HY | CO05-HY |

**Note:** The test site complies with ANSI C63.4 2014 requirement.

| | |
|---|---|
| **Test Site** | SPORTON INTERNATIONAL INC. |
| **Test Site Location** | No.58, Aly. 75, Ln. 564, Wenhua 3rd Rd. Guishan Dist,<br>Taoyuan City, Taiwan (R.O.C.)<br>TEL: +886-3-327-0868<br>FAX: +886-3-327-0855 |
| **Test Site No.** | **Sporton Site No.** |
| | 03CH11-HY |

**Note:** The test site complies with ANSI C63.4 2014 requirement.

## 1.6 Applicable Standards

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

- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- ANSI C63.10-2013

**Remark:** All test items were verified and recorded according to the standards and without any deviation during the test.

# 2 Test Configuration of Equipment Under Test

## 2.1 Carrier Frequency Channel

| Frequency Band | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|---|---|---|---|---|
| 2400-2483.5 MHz | 11 | 2405 | 19 | 2445 |
| | 12 | 2410 | 20 | 2450 |
| | 13 | 2415 | 21 | 2455 |
| | 14 | 2420 | 22 | 2460 |
| | 15 | 2425 | 23 | 2465 |
| | 16 | 2430 | 24 | 2470 |
| | 17 | 2435 | 25 | 2475 |
| | 18 | 2440 | 26 | 2480 |

## 2.2 Descriptions of Test Mode

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).

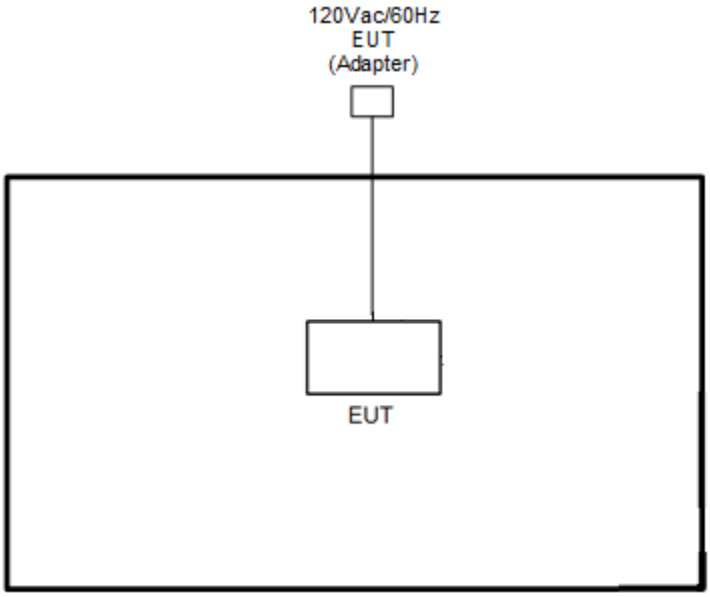
b. AC power line Conducted Emission was tested under maximum output power.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

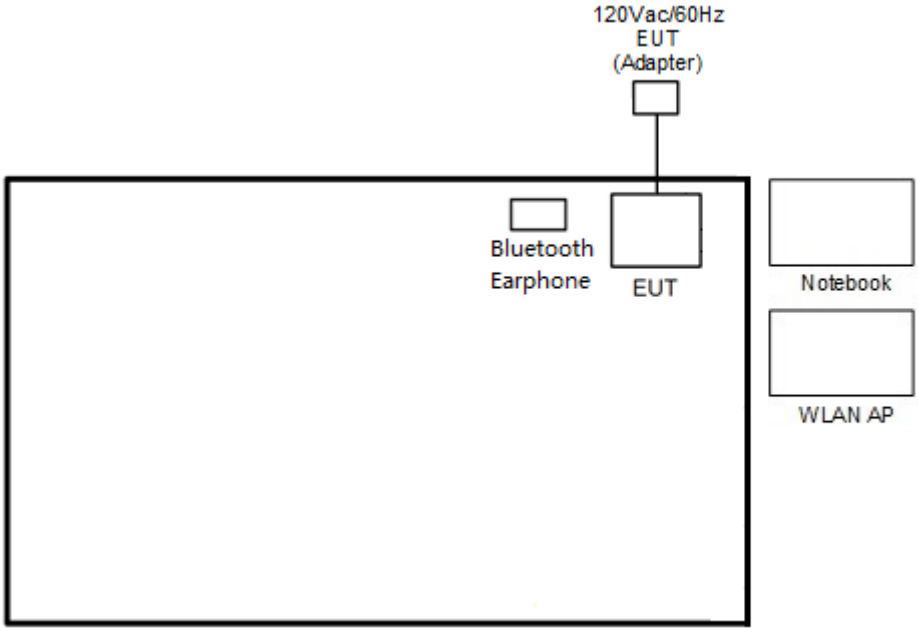
| Summary table of Test Cases | |
|---|---|
| **Test Item** | **Data Rate / Modulation** |
| | **250kbps / Zigbee** |
| **Conducted TCs** | Mode 1: Zigbee Tx CH11_2405 MHz<br>Mode 2: Zigbee Tx CH17_2435 MHz<br>Mode 3: Zigbee Tx CH25_2475 MHz<br>Mode 4: Zigbee Tx CH26_2480 MHz |
| **Radiated TCs** | Mode 1: Zigbee Tx CH11_2405 MHz<br>Mode 2: Zigbee Tx CH17_2435 MHz<br>Mode 3: Zigbee Tx CH25_2475 MHz<br>Mode 4: Zigbee Tx CH26_2480 MHz |
| **AC Conducted Emission** | Mode 1 :Bluetooth Link + WLAN (2.4GHz) Link + Music Streaming + Adapter<br>Mode 2 :Zigbee Link + Adapter |

## 2.3 Connection Diagram of Test System

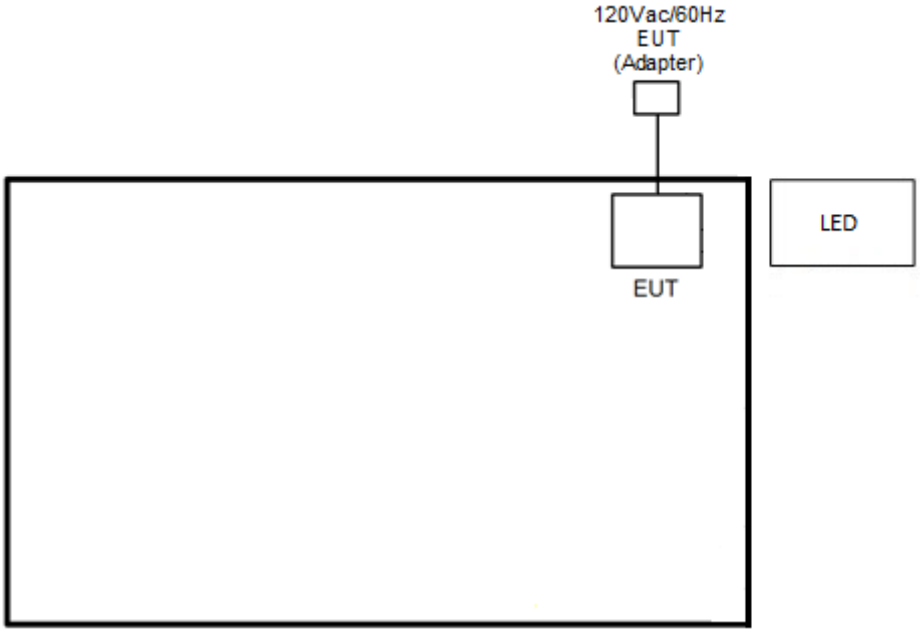
**<Zigbee Tx Mode>**




**<AC Conducted Emission Mode>**



**<AC Conducted Emission with Zigbee Link Mode>**



## 2.4 Support Unit used in test configuration and system

| Item | Equipment | Trade Name | Model Name | FCC ID | Data Cable | Power Cord |
|---|---|---|---|---|---|---|
| 1. | WLAN AP | ASUS | RT-AC66U | MSQ-RTAC66U | N/A | Unshielded, 1.8 m |
| 2. | Bluetooth Earphone | Sony Ericsson | MW600 | PY7DDA-2029 | N/A | N/A |
| 3. | Notebook | DELL | Latitude E6320 | FCC DoC/ Contains FCC ID: QDS-BRCM1054 | N/A | AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m |
| 4. | LED | OSRAM | HPQA P0-2 43ZB | DZO-IQHOME | N/A | N/A |

## 2.5 EUT Operation Test Setup

The RF test items, utility “special software tool” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

## 2.6 Measurement Results Explanation Example

**For all conducted test items:**

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

*Offset = RF cable loss + attenuator factor.*

Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

*Offset(dB) = RF cable loss(dB) + attenuator factor(dB).*

= 4.2 + 10 = 14.2 (dB)

# 3 Test Result

## 3.1 6dB and 99% Bandwidth Measurement

### 3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

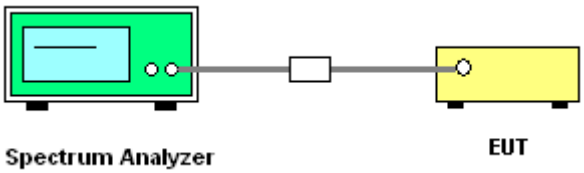
### 3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

### 3.1.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. 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.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 30kHz and set the Video bandwidth (VBW) = 100kHz.
6. Measure and record the results in the test report.

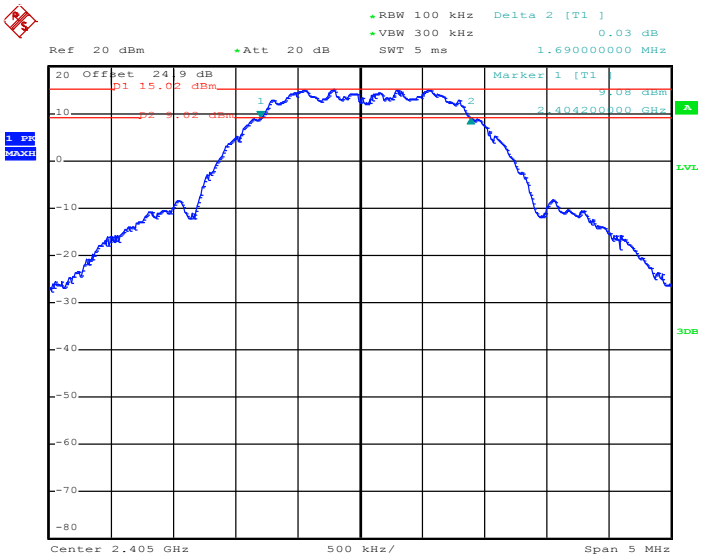
### 3.1.4 Test Setup



### 3.1.5 Test Result of 6dB Bandwidth

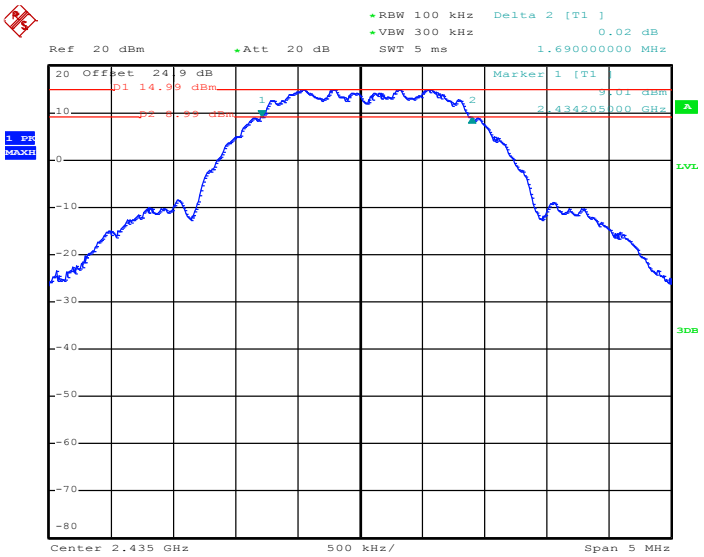
Test data refer to Appendix A.

**6 dB Bandwidth Plot on Channel 11**




Date: 5.MAY.2018 04:57:07

**6 dB Bandwidth Plot on Channel 17**

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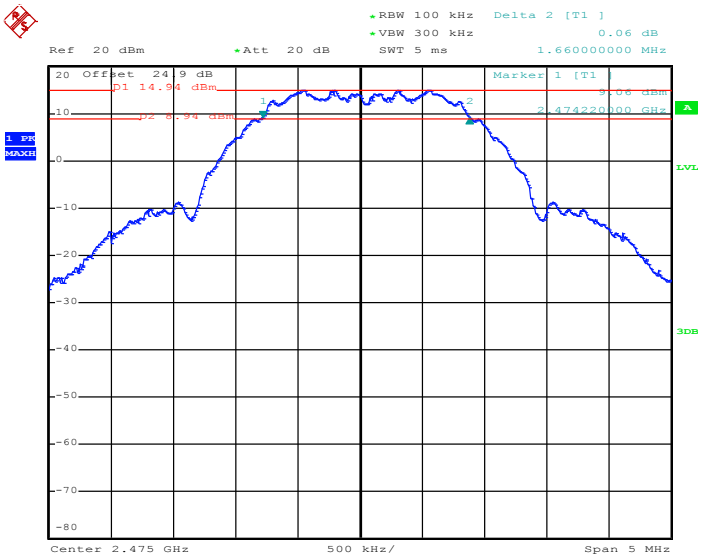
## 6 dB Bandwidth Plot on Channel 25

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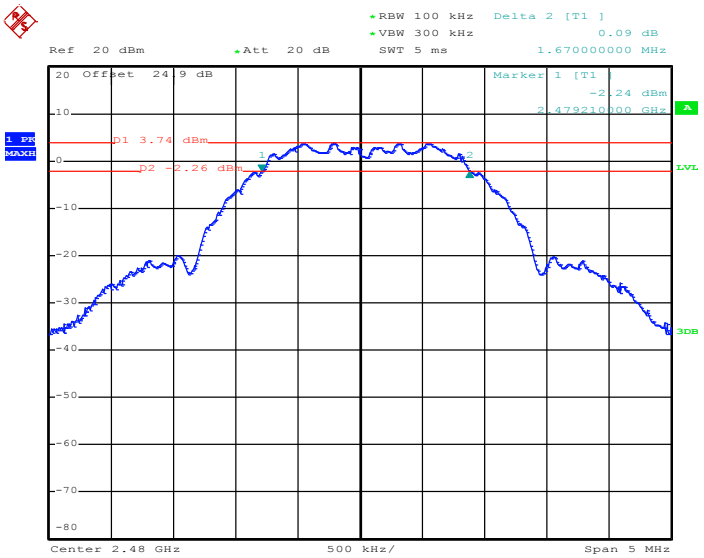
## 6 dB Bandwidth Plot on Channel 26

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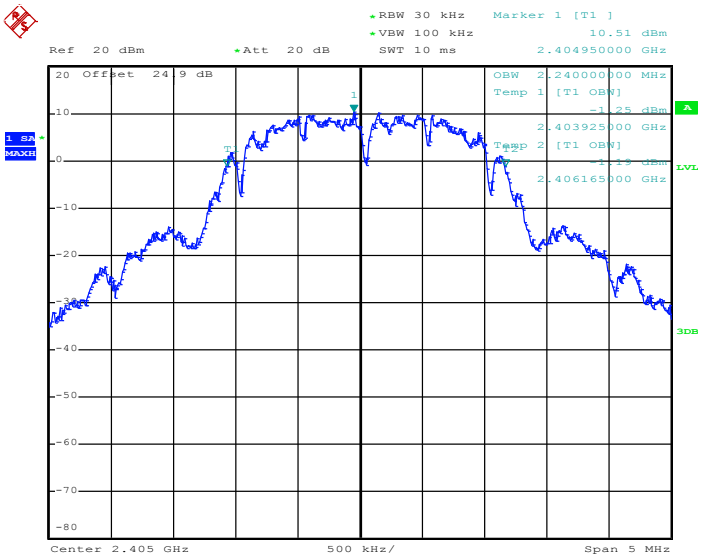
### 3.1.6 Test Result of 99% Occupied Bandwidth

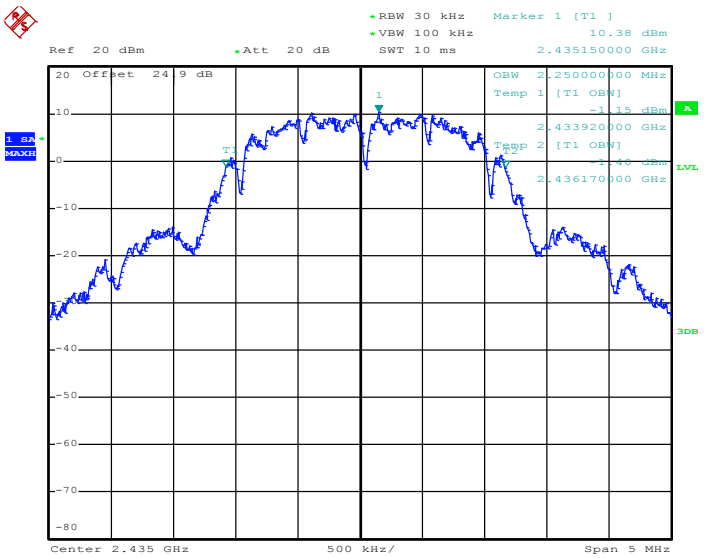
Test data refer to Appendix A.

**99% Bandwidth Plot on Channel 11**




Date: 5.MAY.2018 05:05:36

**99% Occupied Bandwidth Plot on Channel 17**

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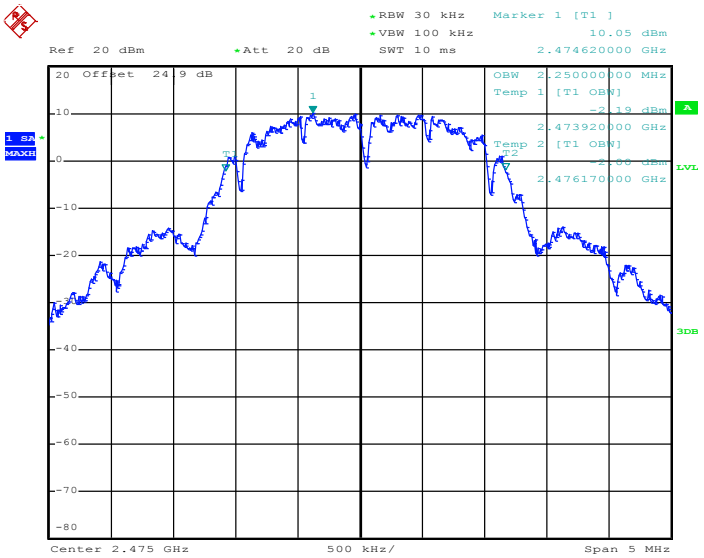
### 99% Occupied Bandwidth Plot on Channel 25

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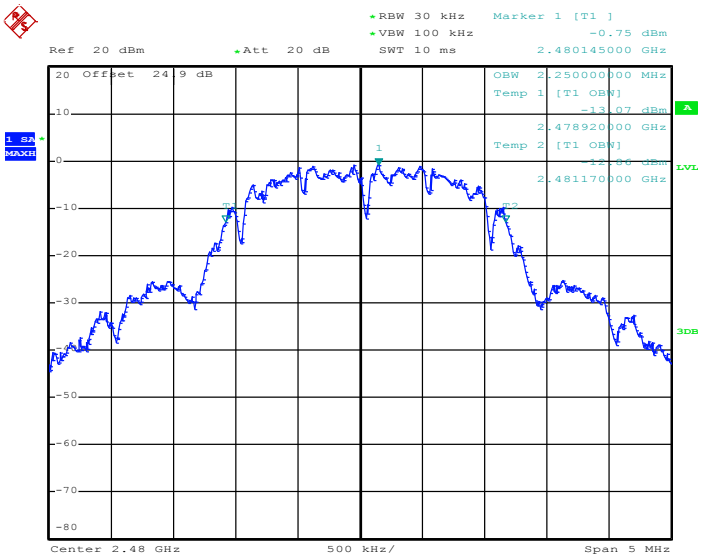
### 99% Occupied Bandwidth Plot on Channel 26

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Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

## 3.2 Output Power Measurement

### 3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

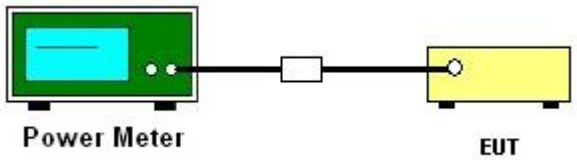
### 3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

### 3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.1.3 PKPM1 Peak power meter method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

### 3.2.4 Test Setup




### 3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

### 3.2.6 Test Result of Average output Power (Reporting Only)

Please refer to Appendix A.

## 3.3 Power Spectral Density Measurement

### 3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

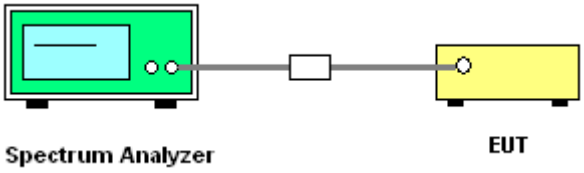
### 3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

### 3.3.3 Test Procedures

1. The testing follows Measurement Procedure 10.2 Method PKPSD of FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
2. 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.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

### 3.3.4 Test Setup

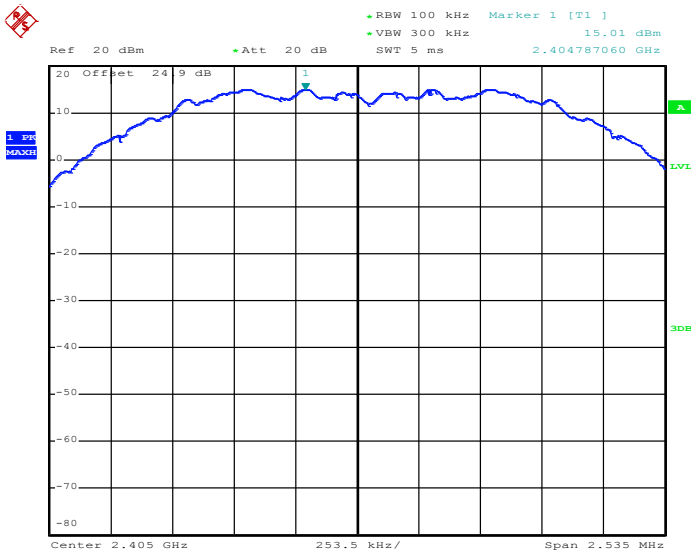



### 3.3.5 Test Result of Power Spectral Density

Test data refers to Appendix A.

### 3.3.6 Test Result of Power Spectral Density Plots (100kHz)

**PSD 100kHz Plot on Channel 11**

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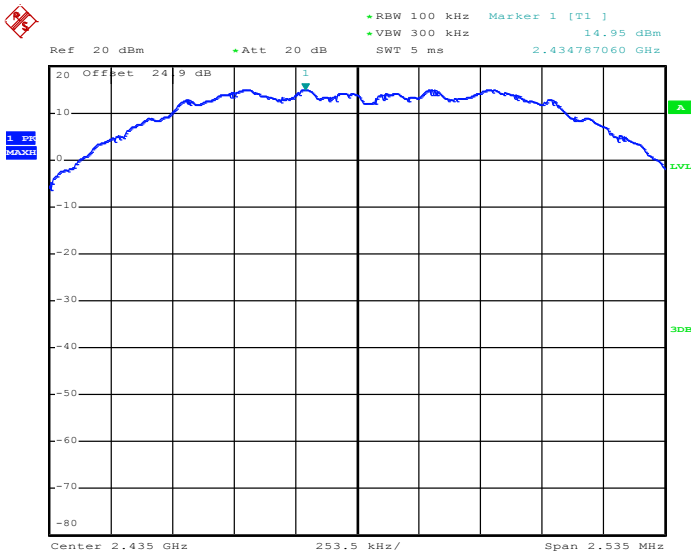
**PSD 100kHz Plot on Channel 17**

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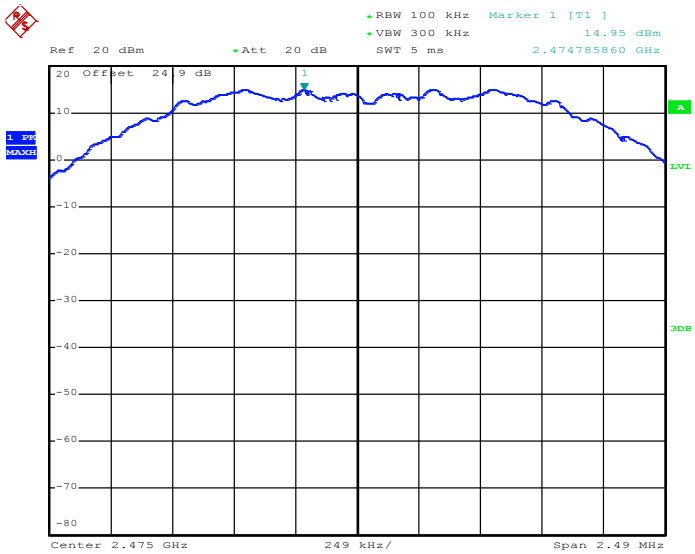
## PSD 100kHz Plot on Channel 25

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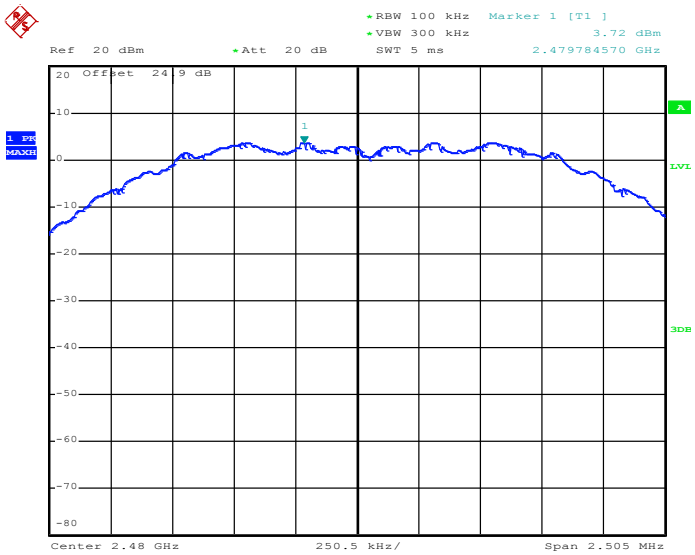
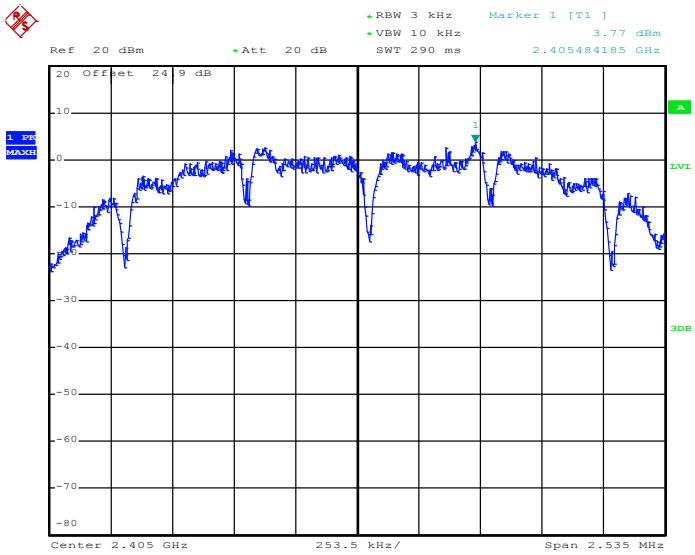
## PSD 100kHz Plot on Channel 26




Date: 5.MAY.2018 05:37:35

## 3.3.7 Test Result of Power Spectral Density Plots (3kHz)

### PSD 3kHz Plot on Channel 11

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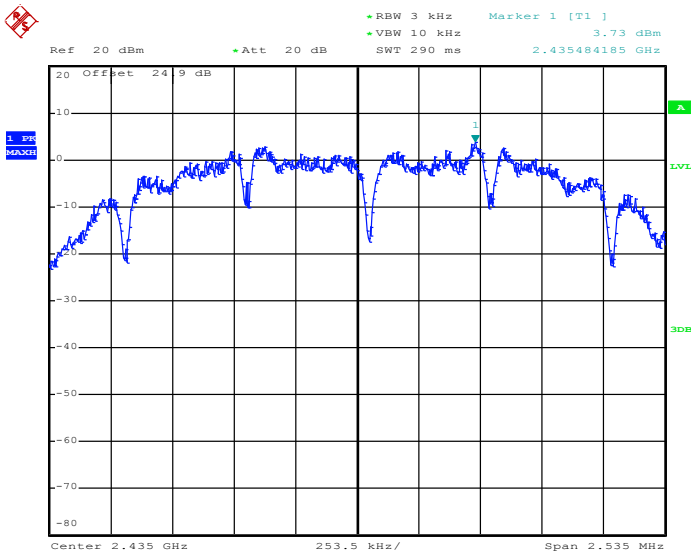
### PSD 3kHz Plot on Channel 17

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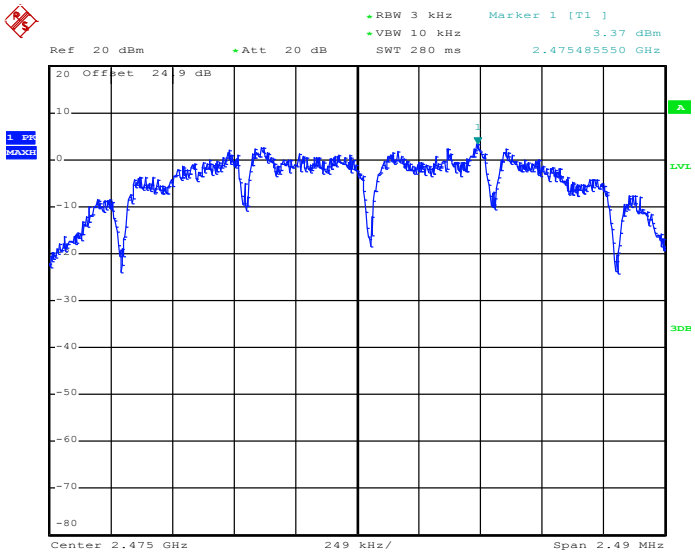
## PSD 3kHz Plot on Channel 25

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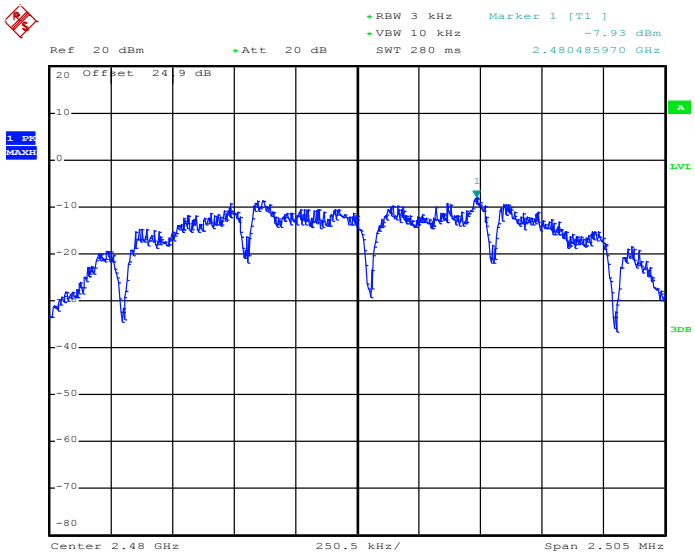
## PSD 3kHz Plot on Channel 26




Date: 5.MAY.2018 05:37:01

## 3.4 Conducted Band Edges and Spurious Emission Measurement

### 3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

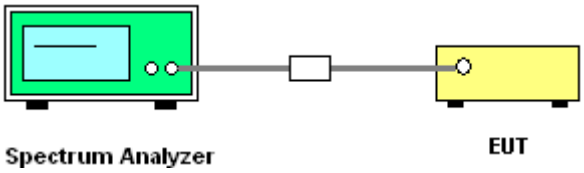
### 3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

### 3.4.3 Test Procedure

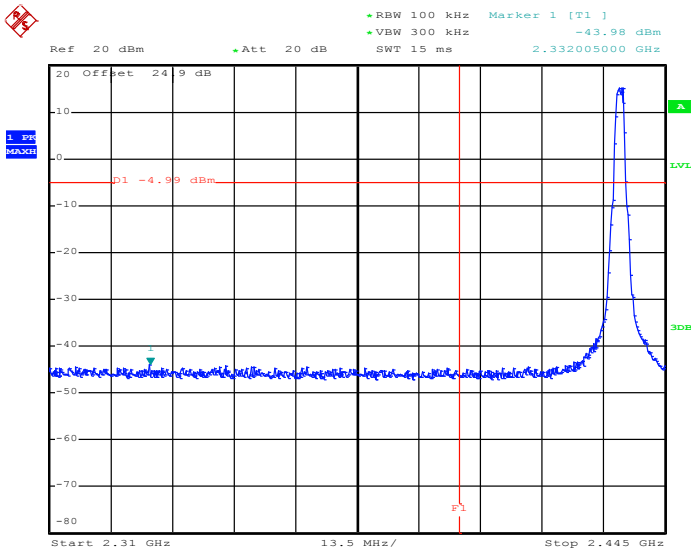
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

### 3.4.4 Test Setup



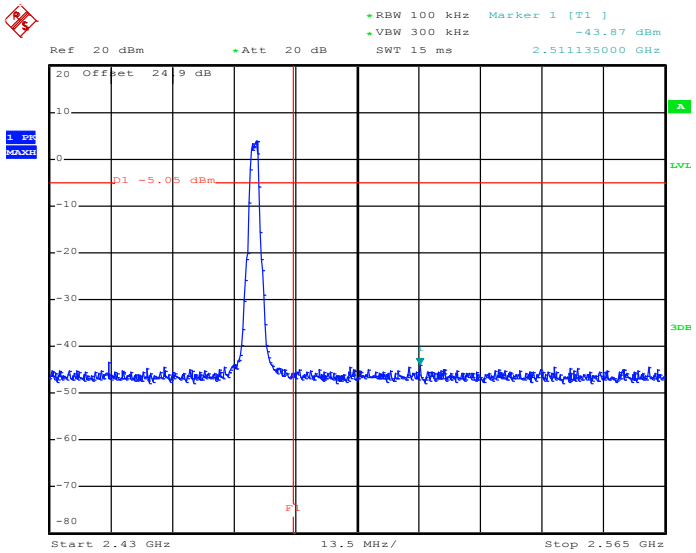
## 3.4.5 Test Result of Conducted Band Edges Plots

### Low Band Edge Plot on Channel 11



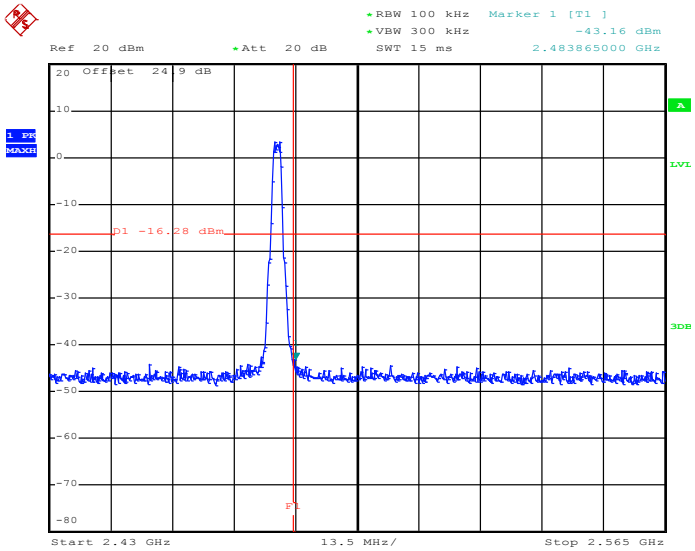

Date: 5.MAY.2018 05:57:28

### High Band Edge Plot on Channel 25




Date: 5.MAY.2018 06:06:00

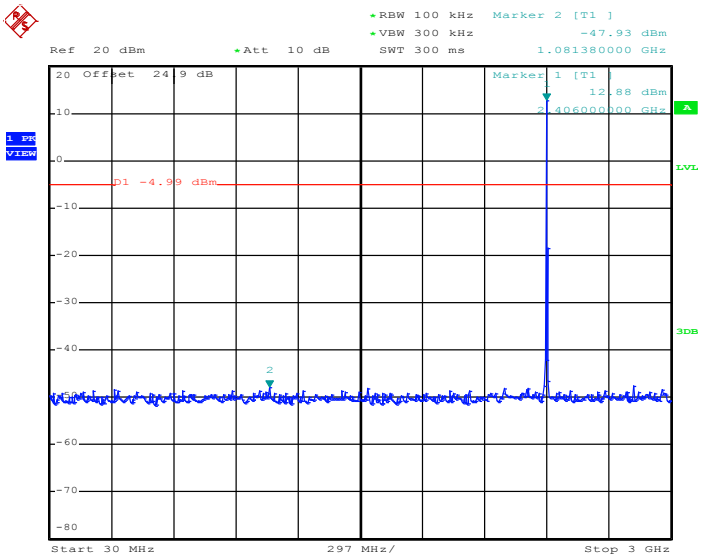
## High Band Edge Plot on Channel 26




Date: 5.MAY.2018 06:01:27

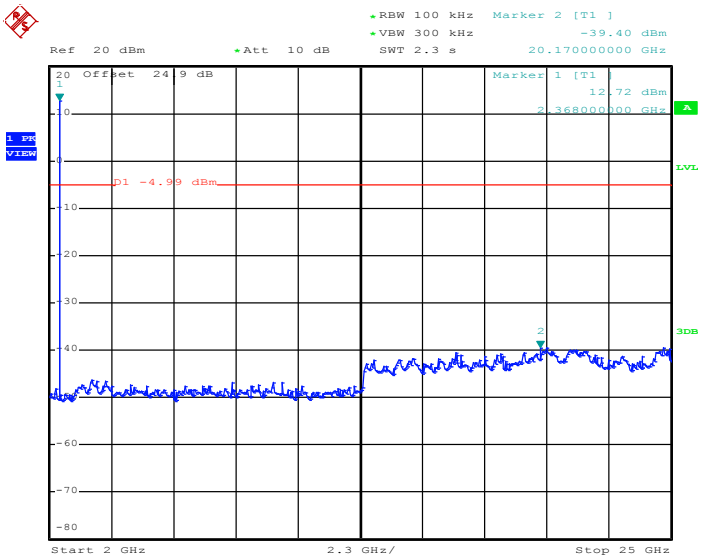
## 3.4.6 Test Result of Conducted Spurious Emission Plots

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 11**




Date: 5.MAY.2018 05:04:53

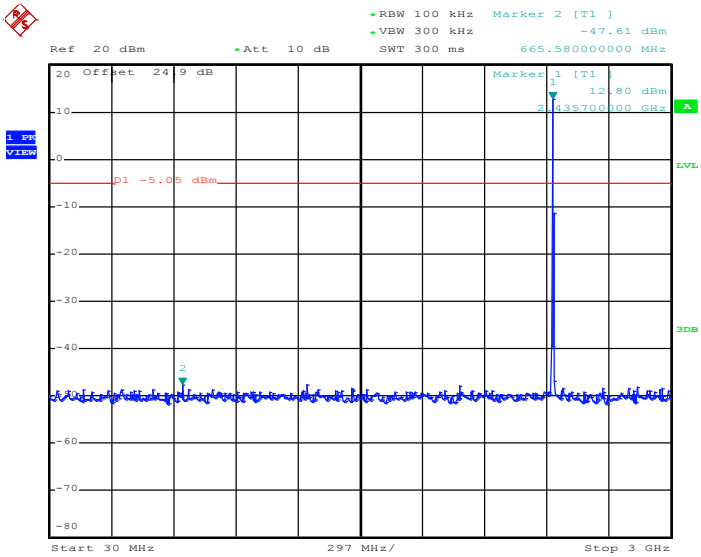
**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 11**




Date: 5.MAY.2018 05:05:19

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps**

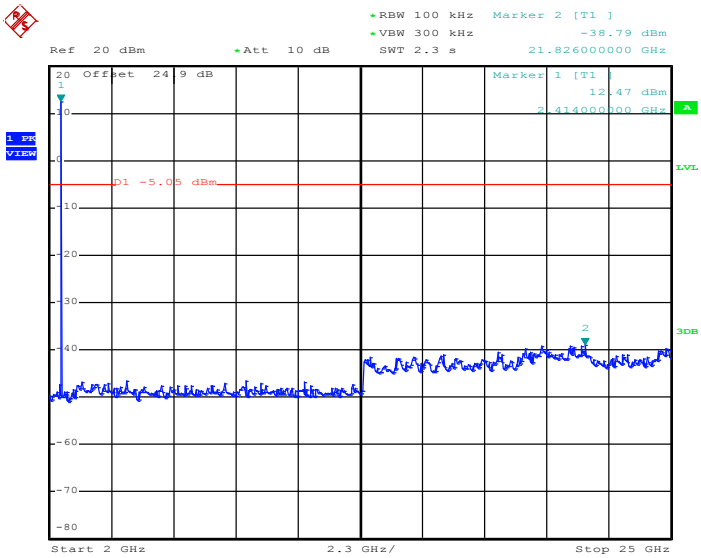
**GFSK Channel 17**




Date: 5.MAY.2018 05:09:33

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps**

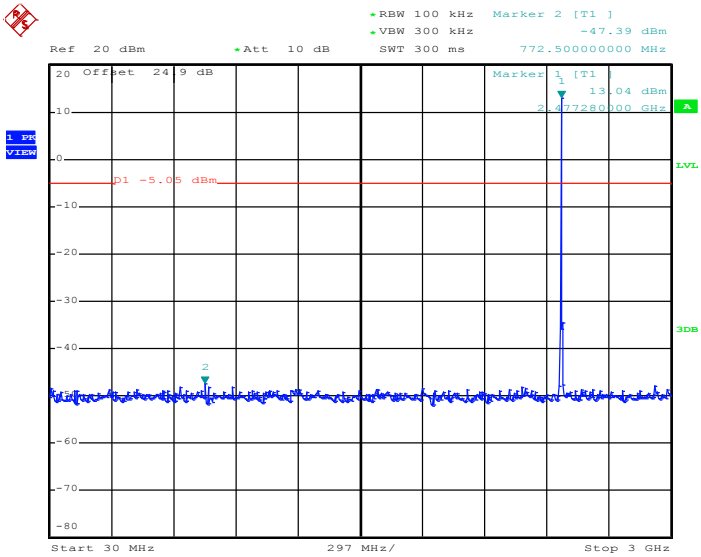
**GFSK Channel 17**




Date: 5.MAY.2018 05:09:56

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps**

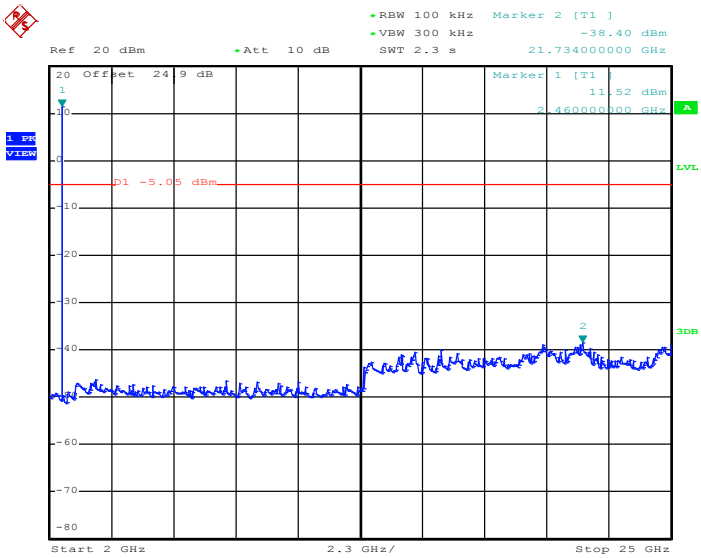
**GFSK Channel 25**




Date: 5.MAY.2018 05:44:17

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps**

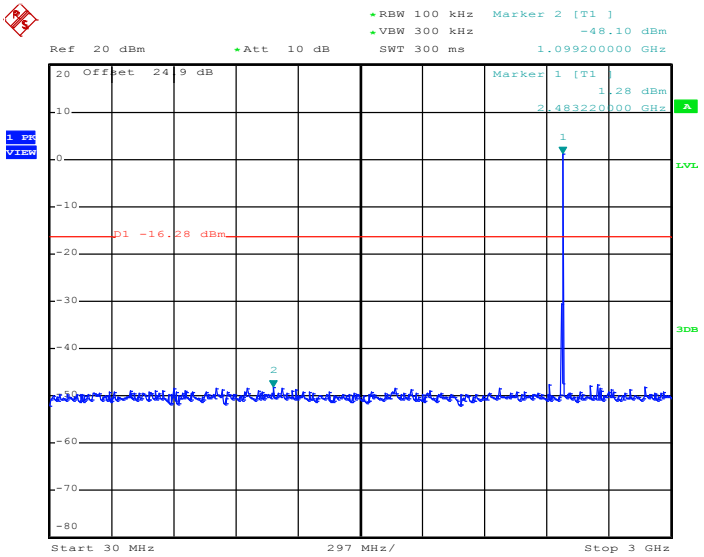
**GFSK Channel 25**




Date: 5.MAY.2018 05:44:31

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps**

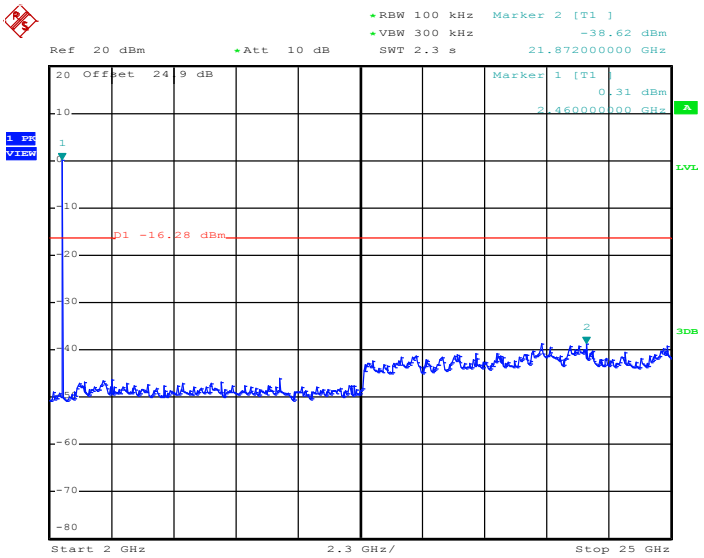
**GFSK Channel 26**




Date: 5.MAY.2018 05:39:05

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps**

**GFSK Channel 26**




Date: 5.MAY.2018 05:39:19

## 3.5 Spurious Emission Measurement in the Restricted Band

### 3.5.1 Limit of Spurious Emission Measurement in the Restricted Band

Emissions which fall in the restricted bands must also comply with the limits as below.

| Frequency (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 |

### 3.5.2 Measuring Instruments

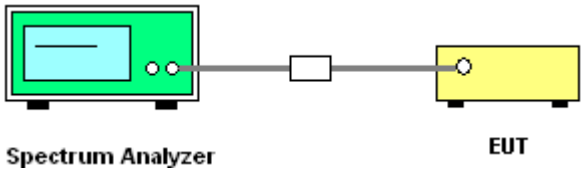
The measuring equipment is listed in the section 4 of this test report.

### 3.5.3 Test Procedures

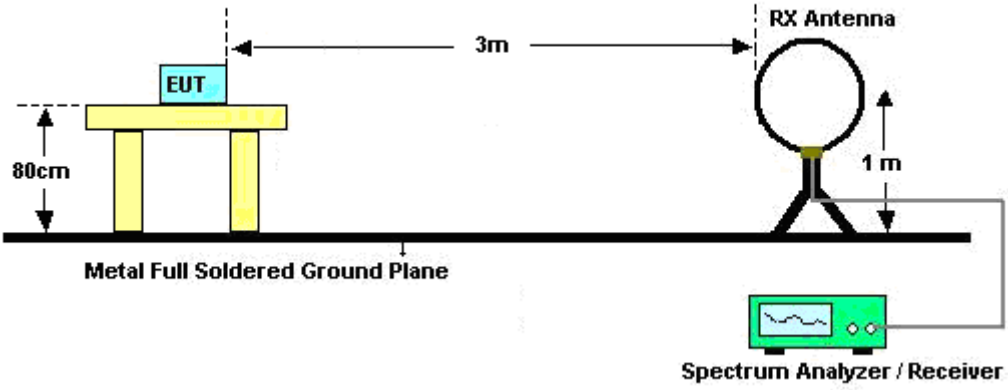
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For conducted spurious emission measurement in the restricted band, 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.
7. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
8. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
9. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

### 3.5.4 Test Setup

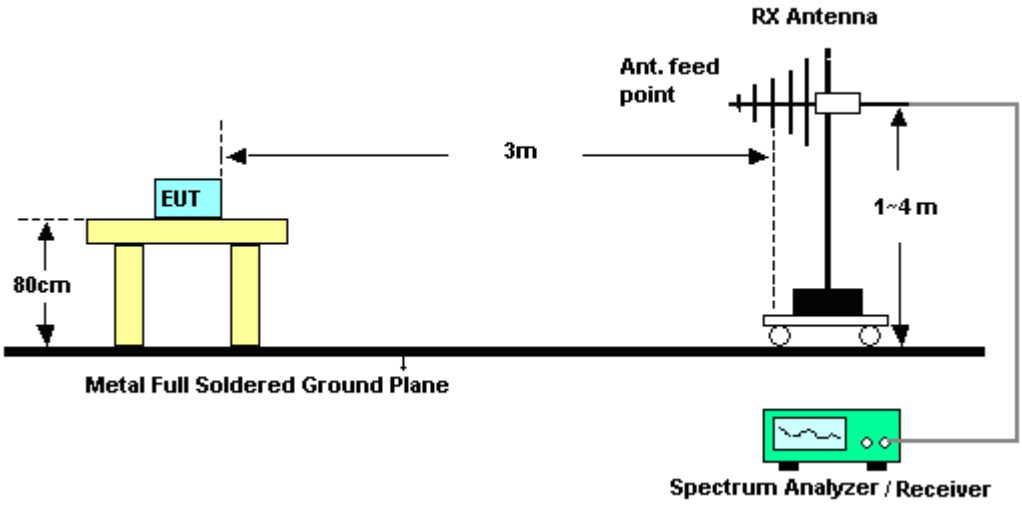
**For Conducted Measurement:**



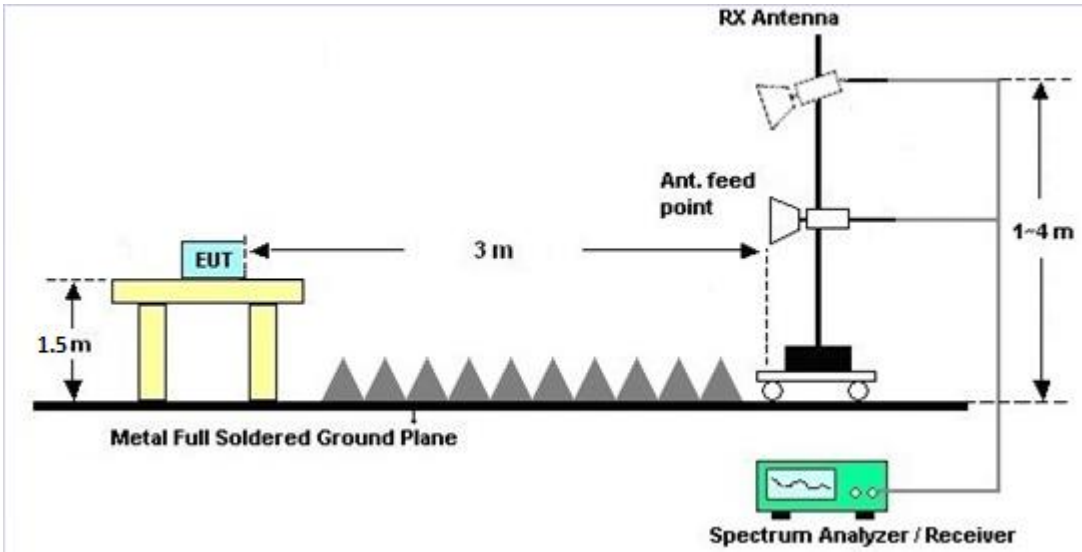

**For radiated emissions below 30MHz**




**For radiated emissions from 30MHz to 1GHz**



**For radiated emissions above 1GHz**




### 3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

### 3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

### 3.5.7 Duty Cycle

Please refer to Appendix E.

### 3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10$^{th}$ Harmonic)

Please refer to Appendix C and D.

## 3.6 AC Conducted Emission Measurement

### 3.6.1 Limit of AC Conducted Emission

For equipment that 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 the limits in the following table.

| Frequency of emission (MHz) | Conducted limit (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

*Decreases with the logarithm of the frequency.

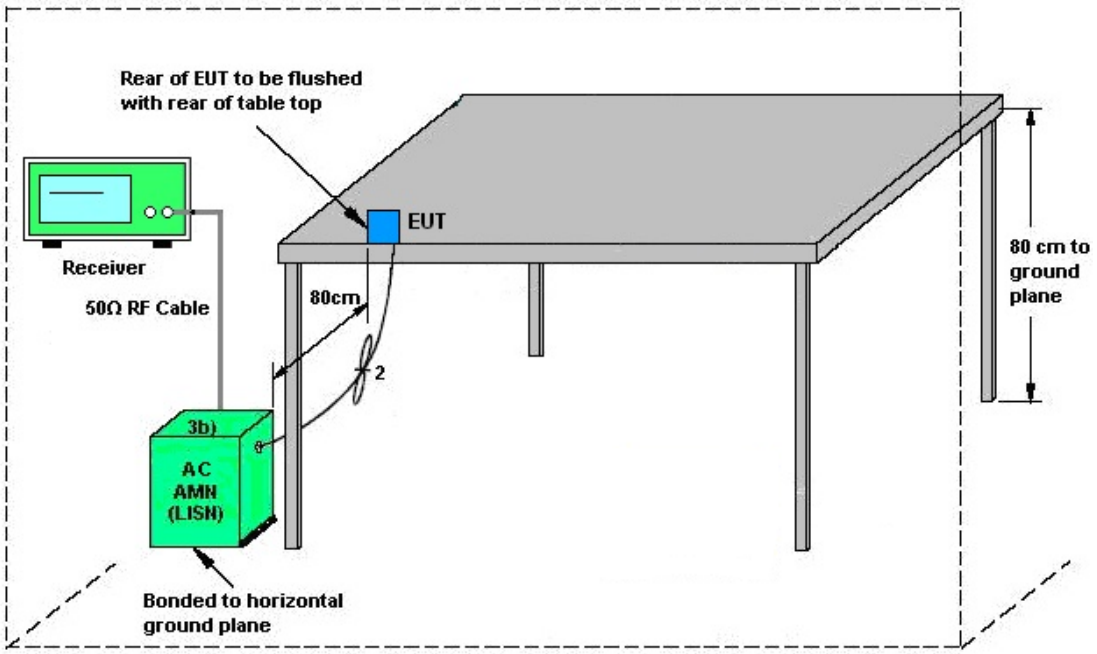
### 3.6.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

### 3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

### 3.6.4 Test Setup




AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

### 3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

## 3.7 Antenna Requirements

### 3.7.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. 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 rule.

### 3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

### 3.7.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

# 4 List of Measuring Equipment

| Instrument | Manufacturer | Model No. | Serial No. | Characteristics | Calibration Date | Test Date | Due Date | Remark |
|---|---|---|---|---|---|---|---|---|
| Power Meter | Agilent | E4416A | GB41292344 | N/A | Dec. 20, 2017 | Apr. 17, 2018 ~ May 05, 2018 | Dec. 19, 2018 | Conducted (TH05-HY) |
| Power Sensor | Agilent | E9327A | US40441548 | 50MHz~18GHz | Dec. 20, 2017 | Apr. 17, 2018 ~ May 05, 2018 | Dec. 19, 2018 | Conducted (TH05-HY) |
| Spectrum Analyzer | Rohde & Schwarz | FSP30 | 101067 | 9kHz ~ 30GHz | Nov. 13, 2017 | Apr. 17, 2018 ~ May 05, 2018 | Nov. 12, 2018 | Conducted (TH05-HY) |
| Switch Box & RF Cable | Burgeon | ETF-058 | EC1300484 | N/A | Mar. 01, 2018 | Apr. 17, 2018 ~ May 05, 2018 | Feb. 28, 2019 | Conducted (TH05-HY) |
| AC Power Source | ChainTek | APC-1000W | N/A | N/A | N/A | Apr. 21, 2018~ Apr. 22, 2018 | N/A | Conduction (CO05-HY) |
| EMI Test Receiver | Rohde & Schwarz | ESR3 | 102388 | 3.6GHz | Dec. 08, 2017 | Apr. 21, 2018~ Apr. 22, 2018 | Dec. 07, 2018 | Conduction (CO05-HY) |
| LISN | Rohde & Schwarz | ENV216 | 100080 | 9kHz~30MHz | Nov. 30, 2017 | Apr. 21, 2018~ Apr. 22, 2018 | Nov. 29, 2018 | Conduction (CO05-HY) |
| LISN | Rohde & Schwarz | ENV216 | 100081 | 9kHz~30MHz | Dec. 08, 2017 | Apr. 21, 2018~ Apr. 22, 2018 | Dec. 07, 2018 | Conduction (CO05-HY) |
| Software | Rohde & Schwarz | EMC32 V10.30 | N/A | N/A | N/A | Apr. 21, 2018~ Apr. 22, 2018 | N/A | Conduction (CO05-HY) |
| LF Cable | HUBER + SUHNER | RG-214/U | LF01 | N/A | Jan. 03, 2018 | Apr. 21, 2018~ Apr. 22, 2018 | Jan. 02, 2019 | Conduction (CO05-HY) |
| Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 100851 | N/A | Jan. 03, 2018 | Apr. 21, 2018~ Apr. 22, 2018 | Jan. 02, 2019 | Conduction (CO05-HY) |
| Amplifier | MITEQ | TTA1840-35-HG | 1871923 | 18GHz~40GHz, VSWR : 2.5:1 max | Jul. 18, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Jul. 17, 2018 | Radiation (03CH11-HY) |
| Amplifier | SONOMA | 310N | 187312 | 9kHz~1GHz | Jan. 16, 2018 | Apr. 20, 2018 ~ May 03, 2018 | Jan. 15, 2019 | Radiation (03CH11-HY) |
| Bilog Antenna | TESEQ | CBL 6111D&N-6-06 | 35414&AT-N0602 | 30MHz~1GHz | Oct. 14, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Oct. 13, 2018 | Radiation (03CH11-HY) |
| Horn Antenna | SCHWARZBECK | BBHA 9120 D | 9120D-1326 | 1GHz ~ 18GHz | Oct. 16, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Oct. 15, 2018 | Radiation (03CH11-HY) |
| Loop Antenna | Rohde & Schwarz | HFH2-Z2 | 100488 | 9 kHz~30 MHz | Nov. 23, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Nov. 22, 2018 | Radiation (03CH11-HY) |
| Preamplifier | Keysight | 83017A | MY53270080 | 1GHz~26.5GHz | Jan. 16, 2018 | Apr. 20, 2018 ~ May 03, 2018 | Jan. 15, 2020 | Radiation (03CH11-HY) |
| Spectrum Analyzer | Keysight | N9010A | MY54200486 | 10Hz ~ 44GHz | Oct. 19, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Oct. 18, 2018 | Radiation (03CH11-HY) |
| Antenna Mast | EMEC | AM-BS-4500-B | N/A | 1~4m | N/A | Apr. 20, 2018 ~ May 03, 2018 | N/A | Radiation (03CH11-HY) |
| Turn Table | EMEC | TT 2000 | N/A | 0~360 Degree | N/A | Apr. 20, 2018 ~ May 03, 2018 | N/A | Radiation (03CH11-HY) |
| Preamplifier | MITEQ | AMF-7D-00101800-30-10P | 1590074 | 1GHz~18GHz | May 22, 2017 | Apr. 20, 2018 ~ May 03, 2018 | May 21, 2018 | Radiation (03CH11-HY) |
| SHF-EHF Horn Antenna | SCHWARZBECK | BBHA 9170 | BBHA9170584 | 18GHz- 40GHz | Nov. 27, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Nov. 26, 2018 | Radiation (03CH11-HY) |

| Instrument | Manufacturer | Model No. | Serial No. | Characteristics | Calibration Date | Test Date | Due Date | Remark |
|---|---|---|---|---|---|---|---|---|
| Preamplifier | Jet-Power | JPA0118-55-303 | 1710001800054001 | 1GHz~18GHz | Apr. 16, 2018 | Apr. 20, 2018 ~ May 03, 2018 | Apr. 15, 2019 | Radiation (03CH11-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 104 | MY9837/4 | 9K-30M | Mar. 20, 2018 | Apr. 20, 2018 ~ May 03, 2018 | Mar. 19, 2019 | Radiation (03CH11-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 104 | MY9837/4 | 30M-18G | Mar. 15, 2018 | Apr. 20, 2018 ~ May 03, 2018 | Mar. 14, 2019 | Radiation (03CH11-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | MY2589/2 | 30M-18G | Mar. 15, 2018 | Apr. 20, 2018 ~ May 03, 2018 | Mar. 14, 2019 | Radiation (03CH11-HY) |
| Filter | Wainwright | WHKX12-2700-3000-18000-60SS | SN3 | 2.7G High Pass | Sep. 18, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Sep. 17, 2018 | Radiation (03CH11-HY) |
| Filter | Wainwright | WLK4-1000-1530-8000-40SS | SN11 | 1G Low Pass | Sep. 18, 2017 | Apr. 20, 2018 ~ May 03, 2018 | Sep. 17, 2018 | Radiation (03CH11-HY) |
| Test Software | Audix | E3 6.2009-8-24 | RK-001042 | N/A | N/A | Apr. 20, 2018 ~ May 03, 2018 | N/A | Radiation (03CH11-HY) |

# 5 Uncertainty of Evaluation

**Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)**

| | |
|---|---|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y)) | 2.7 |

**Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)**

| | |
|---|---|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y)) | 5.2 |

**Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)**

| | |
|---|---|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y)) | 5.5 |

**Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)**

| | |
|---|---|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y)) | 5.2 |

# Appendix A. Test Result of Conducted Test Items

| | | | | |
|---|---|---|---|---|
| Test Engineer: | Rebecca Li / Luffy Lin | Temperature: | 21~25 | °C |
| Test Date: | 2018/4/17~2018/05/05 | Relative Humidity: | 51~54 | % |

## TEST RESULTS DATA
## 6dB and 99% Occupied Bandwidth

| Mod. | Data Rate | $N_{TX}$ | CH. | Freq. (MHz) | 99% Occupied BW (MHz) | 6dB BW (MHz) | 6dB BW Limit (MHz) | Pass/Fail |
|---|---|---|---|---|---|---|---|---|
| Zigbee | 250K | 1 | 11 | 2405 | 2.240 | 1.690 | 0.50 | Pass |
| Zigbee | 250K | 1 | 17 | 2435 | 2.250 | 1.690 | 0.50 | Pass |
| Zigbee | 250K | 1 | 25 | 2475 | 2.250 | 1.660 | 0.50 | Pass |
| Zigbee | 250K | 1 | 26 | 2480 | 2.250 | 1.670 | 0.50 | Pass |

## TEST RESULTS DATA
## Peak Power Table

| Mod. | Data Rate | $N_{TX}$ | CH. | Freq. (MHz) | Peak Conducted Power (dBm) | Conducted Power Limit (dBm) | DG (dBi) | EIRP Power (dBm) | EIRP Power Limit (dBm) | Pass /Fail |
|---|---|---|---|---|---|---|---|---|---|---|
| Zigbee | 250K | 1 | 11 | 2405 | 18.91 | 30.00 | 2.31 | 21.22 | 36.00 | Pass |
| Zigbee | 250K | 1 | 17 | 2435 | 18.80 | 30.00 | 2.31 | 21.11 | 36.00 | Pass |
| Zigbee | 250K | 1 | 25 | 2475 | 18.76 | 30.00 | 2.31 | 21.07 | 36.00 | Pass |
| Zigbee | 250K | 1 | 26 | 2480 | 8.09 | 30.00 | 2.31 | 10.40 | 36.00 | Pass |

## TEST RESULTS DATA
## Average Power Table
## (Reporting Only)

| Mod. | Data Rate | $N_{TX}$ | CH. | Freq. (MHz) | Duty Factor (dB) | Average Conducted Power (dBm) |
|---|---|---|---|---|---|---|
| Zigbee | 250K | 1 | 11 | 2405 | 0.00 | 18.71 |
| Zigbee | 250K | 1 | 17 | 2435 | 0.00 | 18.60 |
| Zigbee | 250K | 1 | 25 | 2475 | 0.00 | 18.55 |
| Zigbee | 250K | 1 | 26 | 2480 | 0.00 | 7.82 |

## TEST RESULTS DATA
## Peak Power Density

| Mod. | Data Rate | $N_{TX}$ | CH. | Freq. (MHz) | Peak PSD (dBm /100kHz) | Peak PSD (dBm /3kHz) | DG (dBi) | Peak PSD Limit (dBm /3kHz) | Pass/Fail |
|---|---|---|---|---|---|---|---|---|---|
| Zigbee | 250K | 1 | 11 | 2405 | 15.01 | 3.77 | 2.31 | 8.00 | Pass |
| Zigbee | 250K | 1 | 17 | 2435 | 14.95 | 3.73 | 2.31 | 8.00 | Pass |
| Zigbee | 250K | 1 | 25 | 2475 | 14.95 | 3.37 | 2.31 | 8.00 | Pass |
| Zigbee | 250K | 1 | 26 | 2480 | 3.72 | -7.93 | 2.31 | 8.00 | Pass |

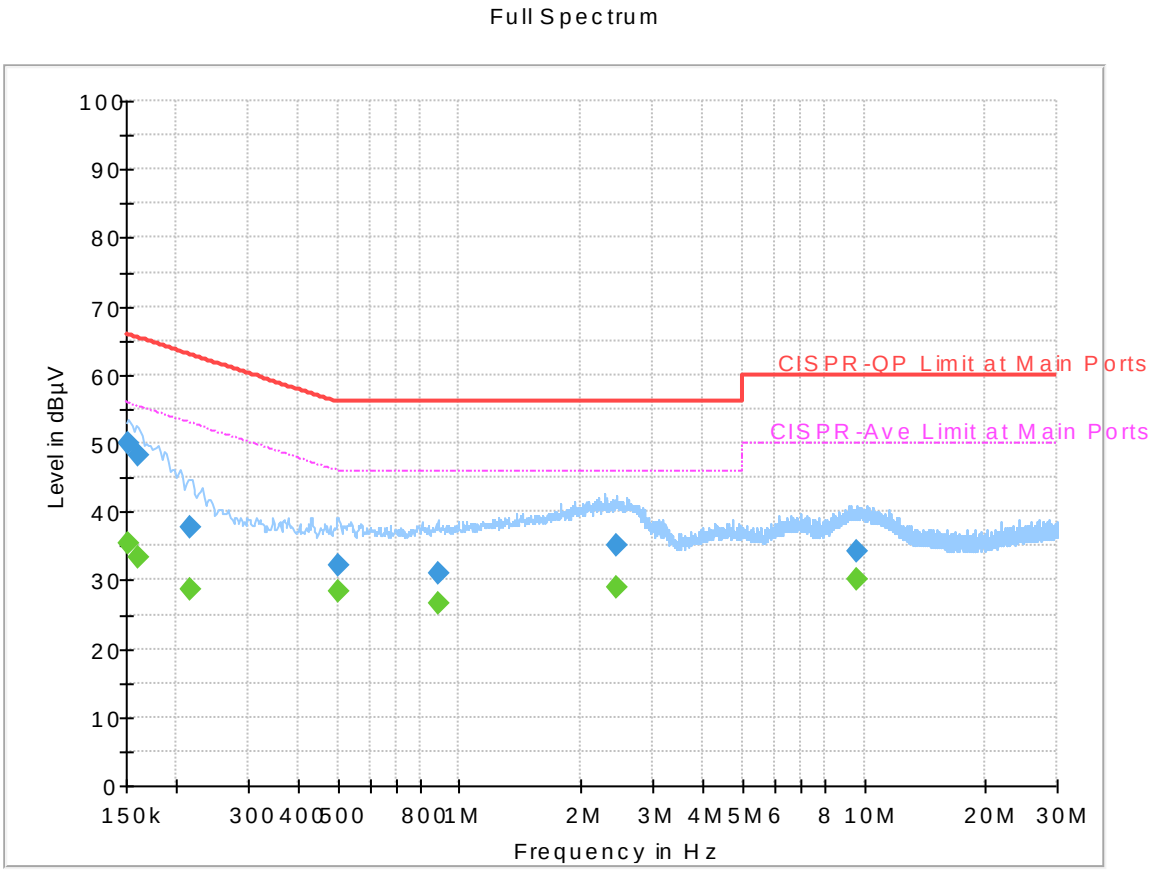
Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 20dBc limit.

# Appendix B. AC Conducted Emission Test Results

| | | | |
|---|---|---|---|
| **Test Engineer :** | Shareef Yu | **Temperature :** | 21~25℃ |
| | | **Relative Humidity :** | 51~55% |

## EUT Information

| | |
|---|---|
| Report NO : | 7D0544-01 |
| Test Mode : | Mode 1 |
| Test Voltage : | 120Vac/60Hz |
| Phase : | Line |

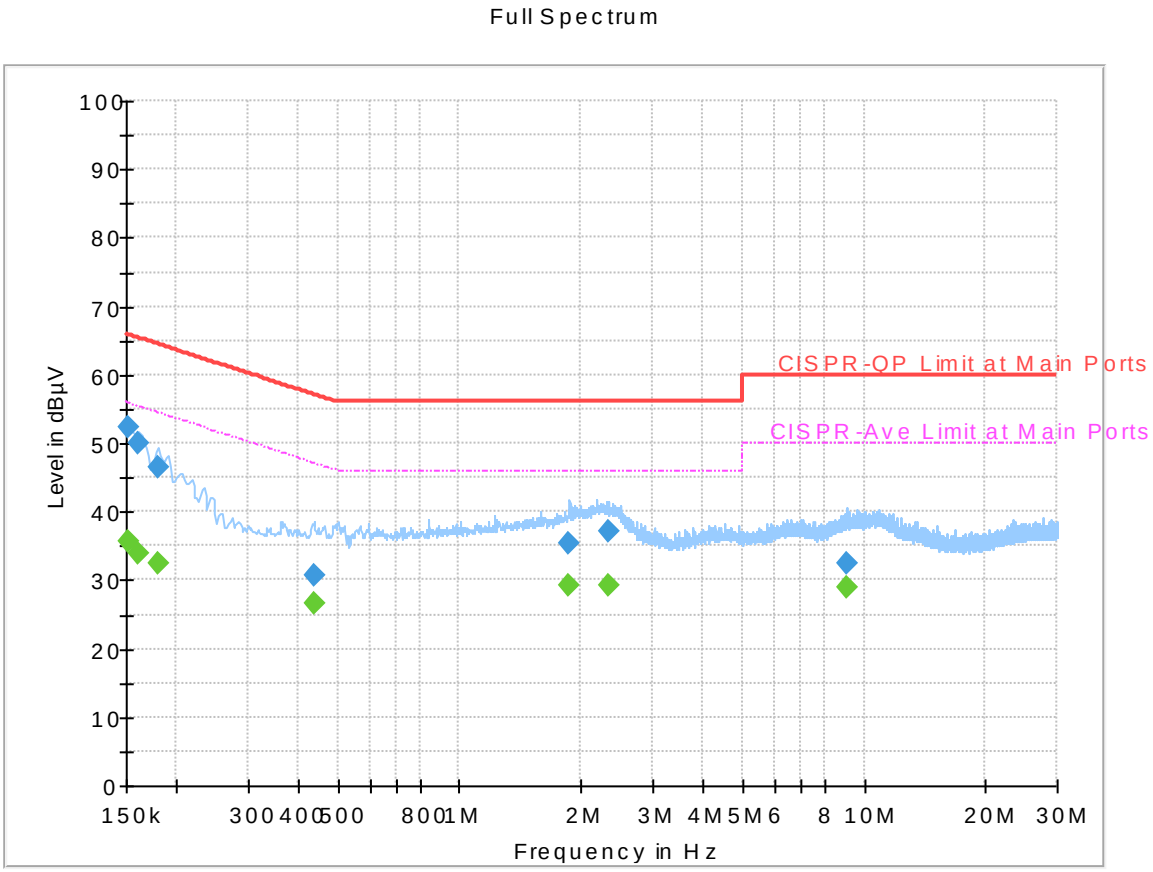



## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Line | Filter | Corr. (dB) |
|---|---|---|---|---|---|---|---|
| 0.152250 | --- | 35.32 | 55.88 | 20.56 | L1 | OFF | 19.5 |
| 0.152250 | 49.93 | --- | 65.88 | 15.95 | L1 | OFF | 19.5 |
| 0.161250 | --- | 33.28 | 55.40 | 22.12 | L1 | OFF | 19.5 |
| 0.161250 | 48.22 | --- | 65.40 | 17.18 | L1 | OFF | 19.5 |
| 0.215250 | --- | 28.64 | 53.00 | 24.36 | L1 | OFF | 19.5 |
| 0.215250 | 37.74 | --- | 63.00 | 25.26 | L1 | OFF | 19.5 |
| 0.501000 | --- | 28.25 | 46.00 | 17.75 | L1 | OFF | 19.5 |
| 0.501000 | 32.15 | --- | 56.00 | 23.85 | L1 | OFF | 19.5 |
| 0.883500 | --- | 26.70 | 46.00 | 19.30 | L1 | OFF | 19.5 |
| 0.883500 | 31.01 | --- | 56.00 | 24.99 | L1 | OFF | 19.5 |
| 2.445000 | --- | 28.84 | 46.00 | 17.16 | L1 | OFF | 19.5 |
| 2.445000 | 35.19 | --- | 56.00 | 20.81 | L1 | OFF | 19.5 |
| 9.609000 | --- | 30.06 | 50.00 | 19.94 | L1 | OFF | 19.7 |
| 9.609000 | 34.13 | --- | 60.00 | 25.87 | L1 | OFF | 19.7 |

## EUT Information

| | |
|---|---|
| Report NO : | 7D0544-01 |
| Test Mode : | Mode 1 |
| Test Voltage : | 120Vac/60Hz |
| Phase : | Neutral |

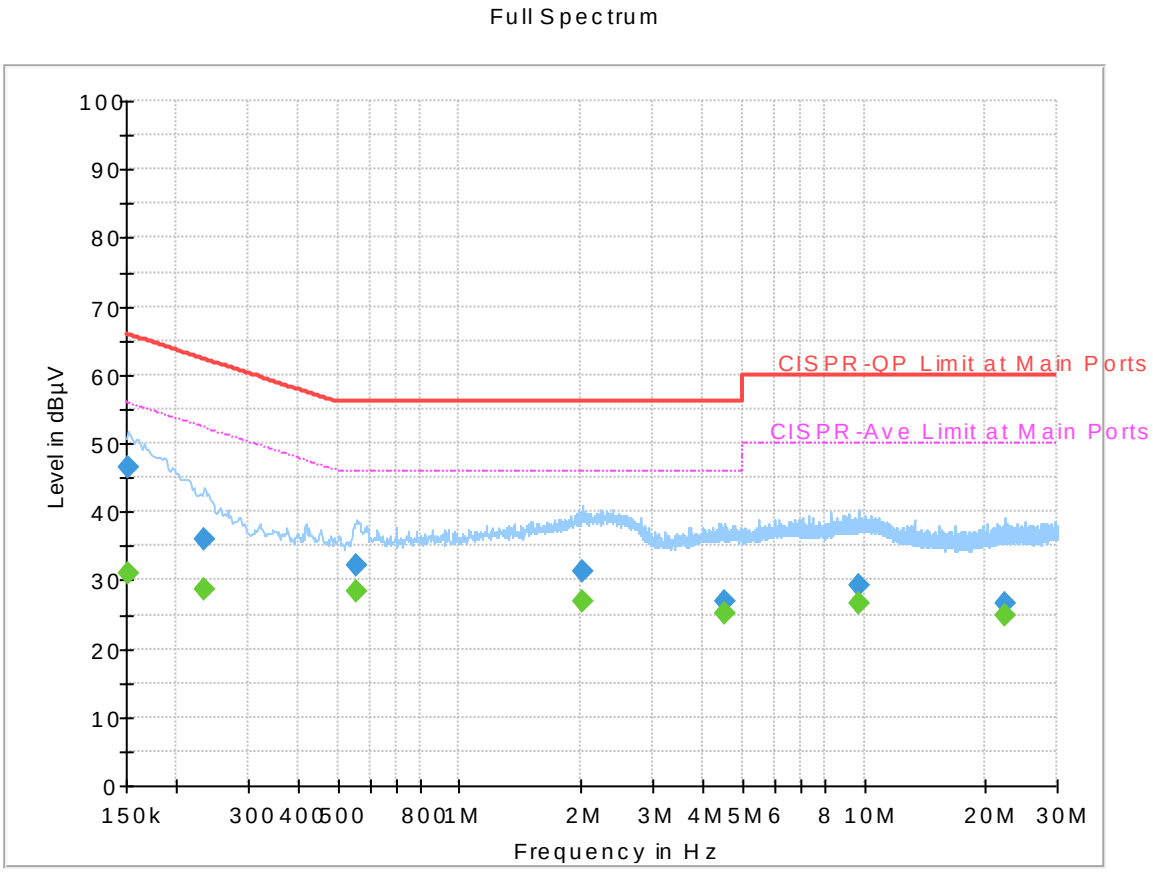



## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Line | Filter | Corr. (dB) |
|---|---|---|---|---|---|---|---|
| 0.152250 | --- | 35.59 | 55.88 | 20.29 | N | OFF | 19.5 |
| 0.152250 | 52.22 | --- | 65.88 | 13.66 | N | OFF | 19.5 |
| 0.161250 | --- | 33.88 | 55.40 | 21.52 | N | OFF | 19.5 |
| 0.161250 | 49.90 | --- | 65.40 | 15.50 | N | OFF | 19.5 |
| 0.179250 | --- | 32.34 | 54.52 | 22.18 | N | OFF | 19.5 |
| 0.179250 | 46.38 | --- | 64.52 | 18.14 | N | OFF | 19.5 |
| 0.438000 | --- | 26.73 | 47.10 | 20.37 | N | OFF | 19.5 |
| 0.438000 | 30.76 | --- | 57.10 | 26.34 | N | OFF | 19.5 |
| 1.871250 | --- | 29.31 | 46.00 | 16.69 | N | OFF | 19.6 |
| 1.871250 | 35.47 | --- | 56.00 | 20.53 | N | OFF | 19.6 |
| 2.339250 | --- | 29.26 | 46.00 | 16.74 | N | OFF | 19.5 |
| 2.339250 | 37.02 | --- | 56.00 | 18.98 | N | OFF | 19.5 |
| 9.051000 | --- | 28.82 | 50.00 | 21.18 | N | OFF | 19.7 |
| 9.051000 | 32.48 | --- | 60.00 | 27.52 | N | OFF | 19.7 |

## EUT Information

| | |
|---|---|
| Report NO : | 7D0544-01 |
| Test Mode : | Mode 2 |
| Test Voltage : | 120Vac/60Hz |
| Phase : | Line |

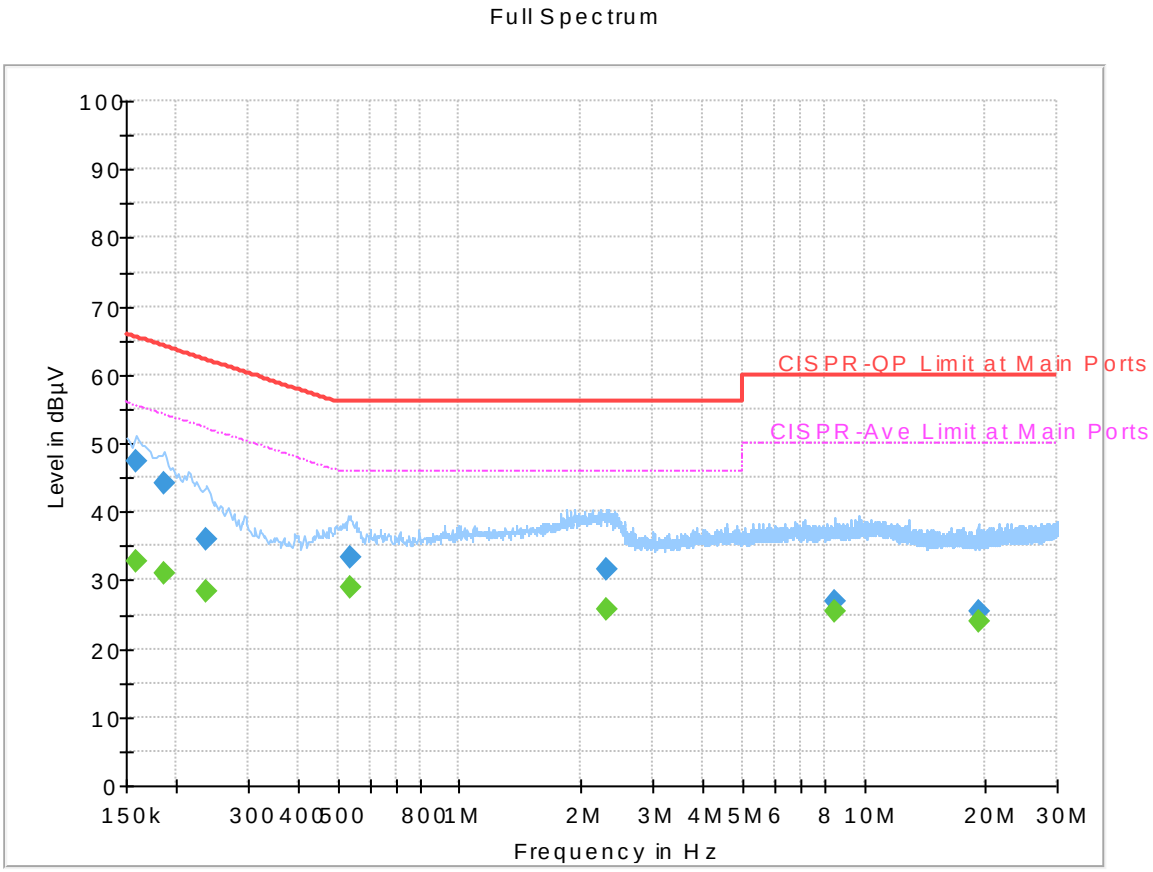



## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Line | Filter | Corr. (dB) |
|---|---|---|---|---|---|---|---|
| 0.152250 | --- | 31.12 | 55.88 | 24.76 | L1 | OFF | 19.5 |
| 0.152250 | 46.45 | --- | 65.88 | 19.43 | L1 | OFF | 19.5 |
| 0.233250 | --- | 28.67 | 52.33 | 23.66 | L1 | OFF | 19.5 |
| 0.233250 | 35.92 | --- | 62.33 | 26.41 | L1 | OFF | 19.5 |
| 0.557250 | --- | 28.24 | 46.00 | 17.76 | L1 | OFF | 19.5 |
| 0.557250 | 32.19 | --- | 56.00 | 23.81 | L1 | OFF | 19.5 |
| 2.010750 | --- | 26.77 | 46.00 | 19.23 | L1 | OFF | 19.6 |
| 2.010750 | 31.24 | --- | 56.00 | 24.76 | L1 | OFF | 19.6 |
| 4.512750 | --- | 25.15 | 46.00 | 20.85 | L1 | OFF | 19.6 |
| 4.512750 | 26.86 | --- | 56.00 | 29.14 | L1 | OFF | 19.6 |
| 9.676500 | --- | 26.61 | 50.00 | 23.39 | L1 | OFF | 19.7 |
| 9.676500 | 29.18 | --- | 60.00 | 30.82 | L1 | OFF | 19.7 |
| 22.416000 | --- | 24.97 | 50.00 | 25.03 | L1 | OFF | 19.8 |
| 22.416000 | 26.51 | --- | 60.00 | 33.49 | L1 | OFF | 19.8 |

## EUT Information

| | |
|---|---|
| Report NO : | 7D0544-01 |
| Test Mode : | Mode 2 |
| Test Voltage : | 120Vac/60Hz |
| Phase : | Neutral |




## Final_Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Line | Filter | Corr. (dB) |
|---|---|---|---|---|---|---|---|
| 0.159000 | --- | 32.86 | 55.52 | 22.66 | N | OFF | 19.5 |
| 0.159000 | 47.42 | --- | 65.52 | 18.10 | N | OFF | 19.5 |
| 0.186000 | --- | 30.99 | 54.21 | 23.22 | N | OFF | 19.5 |
| 0.186000 | 44.14 | --- | 64.21 | 20.07 | N | OFF | 19.5 |
| 0.237750 | --- | 28.31 | 52.17 | 23.86 | N | OFF | 19.5 |
| 0.237750 | 36.05 | --- | 62.17 | 26.12 | N | OFF | 19.5 |
| 0.537000 | --- | 28.88 | 46.00 | 17.12 | N | OFF | 19.5 |
| 0.537000 | 33.38 | --- | 56.00 | 22.62 | N | OFF | 19.5 |
| 2.314500 | --- | 25.62 | 46.00 | 20.38 | N | OFF | 19.5 |
| 2.314500 | 31.60 | --- | 56.00 | 24.40 | N | OFF | 19.5 |
| 8.488500 | --- | 25.37 | 50.00 | 24.63 | N | OFF | 19.7 |
| 8.488500 | 27.03 | --- | 60.00 | 32.97 | N | OFF | 19.7 |
| 19.128750 | --- | 24.12 | 50.00 | 25.88 | N | OFF | 19.9 |
| 19.128750 | 25.52 | --- | 60.00 | 34.48 | N | OFF | 19.9 |

# Appendix C. Radiated Spurious Emission

| Test Engineer : | Hao Hsu, Chuan Zhu, and Ken Wu | Temperature : | 22~25°C |
|---|---|---|---|
| | | Relative Humidity : | 52~57% |

**2.4GHz 2400~2483.5MHz**

**ZIGBEE (Band Edge @ 3m)**

| ZIGBEE | Note | Frequency | Level | Over Limit | Limit Line | Read Level | Antenna Factor | Cable Loss | Preamp Factor | Ant Pos | Table Pos | Peak Avg. | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ( MHz ) | ( dBµV/m ) | ( dB ) | ( dBµV/m ) | ( dBµV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| ZIGBEE CH 11 2405MHz | | 2367.435 | 52.51 | -21.49 | 74 | 42.85 | 27.04 | 16.22 | 33.6 | 257 | 74 | P | H |
| | | 2367.225 | 44.1 | -9.9 | 54 | 34.44 | 27.04 | 16.22 | 33.6 | 257 | 74 | A | H |
| | * | 2405 | 115.12 | - | - | 105.24 | 27.18 | 16.29 | 33.59 | 257 | 74 | P | H |
| | * | 2405 | 112.99 | - | - | 103.11 | 27.18 | 16.29 | 33.59 | 257 | 74 | A | H |
| | | 2382.135 | 52.91 | -21.09 | 74 | 43.13 | 27.09 | 16.29 | 33.6 | 206 | 105 | P | V |
| | | 2367.33 | 42.51 | -11.49 | 54 | 32.85 | 27.04 | 16.22 | 33.6 | 206 | 105 | A | V |
| | * | 2405 | 112.51 | - | - | 102.63 | 27.18 | 16.29 | 33.59 | 206 | 105 | P | V |
| | * | 2405 | 110.34 | - | - | 100.46 | 27.18 | 16.29 | 33.59 | 206 | 105 | A | V |
| ZIGBEE CH 17 2435MHz | | 2376.88 | 51.66 | -22.34 | 74 | 41.95 | 27.09 | 16.22 | 33.6 | 270 | 71 | P | H |
| | | 2389.84 | 41.21 | -12.79 | 54 | 31.38 | 27.13 | 16.29 | 33.59 | 270 | 71 | A | H |
| | * | 2435 | 115.98 | - | - | 106.04 | 27.22 | 16.31 | 33.59 | 270 | 71 | P | H |
| | * | 2435 | 113.86 | - | - | 103.92 | 27.22 | 16.31 | 33.59 | 270 | 71 | A | H |
| | | 2485.68 | 52.11 | -21.89 | 74 | 42.01 | 27.36 | 16.32 | 33.58 | 270 | 71 | P | H |
| | | 2490.32 | 41.59 | -12.41 | 54 | 31.45 | 27.4 | 16.32 | 33.58 | 270 | 71 | A | H |
| | | 2385.84 | 52.89 | -21.11 | 74 | 43.07 | 27.13 | 16.29 | 33.6 | 159 | 104 | P | V |
| | | 2385.36 | 41.1 | -12.9 | 54 | 31.32 | 27.09 | 16.29 | 33.6 | 159 | 104 | A | V |
| | * | 2435 | 113.08 | - | - | 103.14 | 27.22 | 16.31 | 33.59 | 159 | 104 | P | V |
| | * | 2435 | 110.93 | - | - | 100.99 | 27.22 | 16.31 | 33.59 | 159 | 104 | A | V |
| | | 2490.48 | 52.81 | -21.19 | 74 | 42.67 | 27.4 | 16.32 | 33.58 | 159 | 104 | P | V |
| | | 2483.92 | 41.46 | -12.54 | 54 | 31.37 | 27.36 | 16.31 | 33.58 | 159 | 104 | A | V |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ZIGBEE CH 25 2475MHz | * | 2475 | 116.88 | - | - | 106.79 | 27.36 | 16.31 | 33.58 | 271 | 70 | P | H |
| | * | 2475 | 114.74 | - | - | 104.65 | 27.36 | 16.31 | 33.58 | 271 | 70 | A | H |
| | | 2483.88 | 61.23 | -12.77 | 74 | 51.14 | 27.36 | 16.31 | 33.58 | 271 | 70 | P | H |
| | | 2483.52 | 51.52 | -2.48 | 54 | 41.43 | 27.36 | 16.31 | 33.58 | 271 | 70 | A | H |
| | * | 2475 | 114.53 | - | - | 104.44 | 27.36 | 16.31 | 33.58 | 218 | 101 | P | V |
| | * | 2475 | 112.39 | - | - | 102.3 | 27.36 | 16.31 | 33.58 | 218 | 101 | A | V |
| | | 2483.92 | 57.78 | -16.22 | 74 | 47.69 | 27.36 | 16.31 | 33.58 | 218 | 101 | P | V |
| | | 2483.52 | 49.11 | -4.89 | 54 | 39.02 | 27.36 | 16.31 | 33.58 | 218 | 101 | A | V |
| ZIGBEE CH 26 2480MHz | * | 2480 | 105.59 | - | - | 95.5 | 27.36 | 16.31 | 33.58 | 271 | 70 | P | H |
| | * | 2480 | 103.45 | - | - | 93.36 | 27.36 | 16.31 | 33.58 | 271 | 70 | A | H |
| | | 2483.6 | 61.24 | -12.76 | 74 | 51.15 | 27.36 | 16.31 | 33.58 | 271 | 70 | P | H |
| | | 2483.52 | 52.69 | -1.31 | 54 | 42.6 | 27.36 | 16.31 | 33.58 | 271 | 70 | A | H |
| | * | 2480 | 104.38 | - | - | 94.29 | 27.36 | 16.31 | 33.58 | 218 | 101 | P | V |
| | * | 2480 | 102.31 | - | - | 92.22 | 27.36 | 16.31 | 33.58 | 218 | 101 | A | V |
| | | 2483.52 | 60.25 | -13.75 | 74 | 50.16 | 27.36 | 16.31 | 33.58 | 218 | 101 | P | V |
| | | 2483.52 | 51.31 | -2.69 | 54 | 41.22 | 27.36 | 16.31 | 33.58 | 218 | 101 | A | V |
| **Remark** | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. | | | | | | | | | | | | |

## 2.4GHz 2400~2483.5MHz

## ZIGBEE (Harmonic @ 3m)

| ZIGBEE | Note | Frequency ( MHz ) | Level ( dBμV/m ) | Over Limit ( dB ) | Limit Line ( dBμV/m ) | Read Level ( dBμV ) | Antenna Factor ( dB/m ) | Cable Loss ( dB ) | Preamp Factor ( dB ) | Ant Pos ( cm ) | Table Pos ( deg ) | Peak Avg. (P/A) | Pol. (H/V) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ZIGBEE CH 11 2405MHz | | 4810 | 54.18 | -19.82 | 74 | 70.16 | 31.26 | 10.03 | 57.27 | 215 | 267 | P | H |
| | | 4810 | 49.17 | -4.83 | 54 | 65.15 | 31.26 | 10.03 | 57.27 | 215 | 267 | A | H |
| | | 4810 | 54.12 | -19.88 | 74 | 70.1 | 31.26 | 10.03 | 57.27 | 100 | 280 | P | V |
| | | 4810 | 48.89 | -5.11 | 54 | 64.87 | 31.26 | 10.03 | 57.27 | 100 | 280 | A | V |
| ZIGBEE CH 17 2435MHz | | 4870 | 54.6 | -19.4 | 74 | 70.39 | 31.38 | 10 | 57.17 | 104 | 21 | P | H |
| | | 4870 | 49.28 | -4.72 | 54 | 65.07 | 31.38 | 10 | 57.17 | 104 | 21 | A | H |
| | | 7305 | 42.03 | -31.97 | 74 | 51.24 | 36.28 | 11.78 | 57.27 | 100 | 0 | P | H |
| | | 4870 | 58.65 | -15.35 | 74 | 74.44 | 31.38 | 10 | 57.17 | 185 | 275 | P | V |
| | | 4870 | 50.92 | -3.08 | 54 | 66.71 | 31.38 | 10 | 57.17 | 185 | 275 | A | V |
| | | 7305 | 42.7 | -31.3 | 74 | 51.91 | 36.28 | 11.78 | 57.27 | 100 | 0 | P | V |
| ZIGBEE CH 25 2475MHz | | 4950 | 53.43 | -20.57 | 74 | 69.02 | 31.51 | 9.97 | 57.07 | 108 | 19 | P | H |
| | | 4950 | 48.53 | -5.47 | 54 | 64.12 | 31.51 | 9.97 | 57.07 | 108 | 19 | A | H |
| | | 7425 | 41.83 | -32.17 | 74 | 50.99 | 36.55 | 11.71 | 57.42 | 100 | 0 | P | H |
| | | 4950 | 54.61 | -19.39 | 74 | 70.2 | 31.51 | 9.97 | 57.07 | 184 | 271 | P | V |
| | | 4950 | 49.81 | -4.19 | 54 | 65.4 | 31.51 | 9.97 | 57.07 | 184 | 271 | A | V |
| | | 7425 | 42.29 | -31.71 | 74 | 51.45 | 36.55 | 11.71 | 57.42 | 100 | 0 | P | V |
| ZIGBEE CH 26 2480MHz | | 4960 | 45.64 | -28.36 | 74 | 61.18 | 31.54 | 9.97 | 57.05 | 100 | 0 | P | H |
| | | 7440 | 42.55 | -31.45 | 74 | 51.68 | 36.59 | 11.72 | 57.44 | 100 | 0 | P | H |
| | | 4960 | 46.61 | -27.39 | 74 | 62.15 | 31.54 | 9.97 | 57.05 | 100 | 0 | P | V |
| | | 7440 | 43.14 | -30.86 | 74 | 52.27 | 36.59 | 11.72 | 57.44 | 100 | 0 | P | V |
| Remark | 1. No other spurious found.<br>2. All results are PASS against Peak and Average limit line. | | | | | | | | | | | | |

## Emission below 1GHz

## 2.4GHz ZIGBEE (LF)

| ZIGBEE | Note | Frequency | Level | Over | Limit | Read | Antenna | Cable | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Limit | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | (dBμV) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| 2.4GHz ZIGBEE LF | | 88.86 | 27.34 | -16.16 | 43.5 | 44.13 | 14.45 | 1.24 | 32.48 | - | - | P | H |
| | | 93.72 | 25.26 | -18.24 | 43.5 | 41.46 | 15.04 | 1.24 | 32.48 | - | - | P | H |
| | | 214.95 | 30.34 | -13.16 | 43.5 | 45.91 | 15.04 | 1.78 | 32.39 | - | - | P | H |
| | | 430.2 | 25.34 | -20.66 | 46 | 32.35 | 22.66 | 2.68 | 32.35 | - | - | P | H |
| | | 766.9 | 30.26 | -15.74 | 46 | 31.02 | 27.94 | 3.58 | 32.28 | - | - | P | H |
| | | 947.5 | 33.84 | -12.16 | 46 | 30.62 | 30.46 | 3.99 | 31.23 | 100 | 0 | P | H |
| | | 40.8 | 33.08 | -6.92 | 40 | 46.06 | 18.68 | 0.83 | 32.49 | - | - | P | V |
| | | 45.93 | 34.25 | -5.75 | 40 | 49.58 | 16.14 | 1.02 | 32.49 | 100 | 281 | P | V |
| | | 63.48 | 29.22 | -10.78 | 40 | 48.99 | 11.69 | 1.03 | 32.49 | - | - | P | V |
| | | 429.5 | 24.72 | -21.28 | 46 | 31.74 | 22.64 | 2.68 | 32.34 | - | - | P | V |
| | | 573.7 | 29.69 | -16.31 | 46 | 33.38 | 25.63 | 3.12 | 32.44 | - | - | P | V |
| | | 958.7 | 33.87 | -12.13 | 46 | 29.89 | 31.02 | 4.08 | 31.12 | - | - | P | V |
| Remark | 1. No other spurious found.<br>2. All results are PASS against limit line. | | | | | | | | | | | | |

## Note symbol

| | |
|---|---|
| * | **Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency. |
| ! | Test result is **over limit** line. |
| P/A | **P**eak or **A**verage |
| H/V | **H**orizontal or **V**ertical |

## A calculation example for radiated spurious emission is shown as below:

| WIFI | Note | Frequency | Level | Over | Limit | Read | Antenna | Cable | Preamp | Ant | Table | Peak | Pol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ant. | | | | Limit | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | |
| 1+2 | | ( MHz ) | ( dBμV/m ) | ( dB ) | ( dBμV/m ) | ( dBμV ) | ( dB/m ) | ( dB ) | ( dB ) | ( cm ) | ( deg ) | (P/A) | (H/V) |
| 802.11b CH 01 2412MHz | | 2390 | 55.45 | -18.55 | 74 | 54.51 | 32.22 | 4.58 | 35.86 | 103 | 308 | P | H |
| | | 2390 | 43.54 | -10.46 | 54 | 42.6 | 32.22 | 4.58 | 35.86 | 103 | 308 | A | H |

1. Level(dBμV/m) =

Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

**For Peak Limit @ 2390MHz:**

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

**For Average Limit @ 2390MHz:**

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

**Both peak and average measured complies with the limit line, so test result is “PASS”.**

# Appendix D. Radiated Spurious Emission Plots

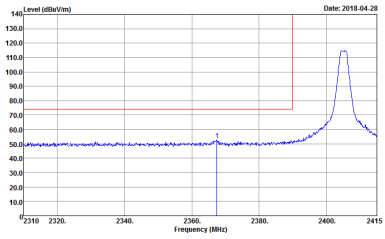
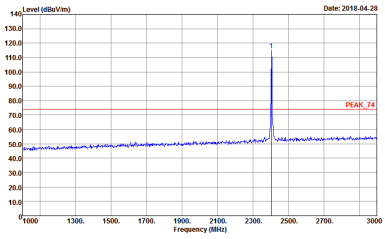
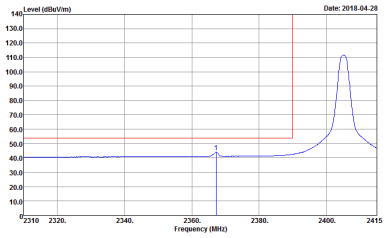
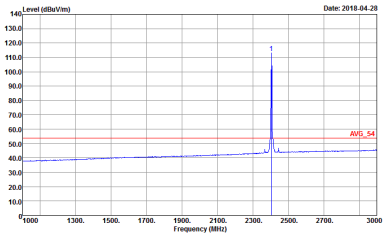
| | | | |
|---|---|---|---|
| **Test Engineer :** | Hao Hsu, Chuan Zhu, and Ken Wu | **Temperature :** | 22~25°C |
| | | **Relative Humidity :** | 52~57% |

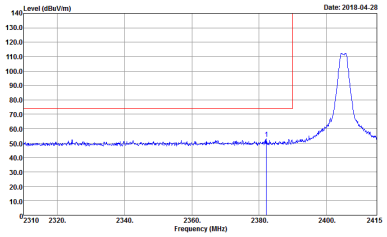
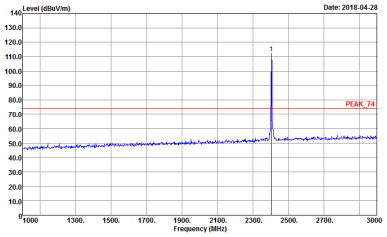
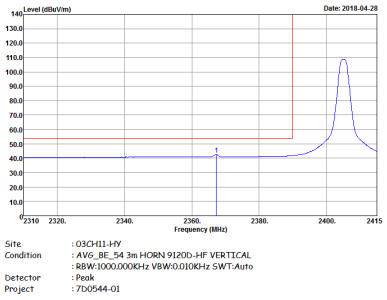
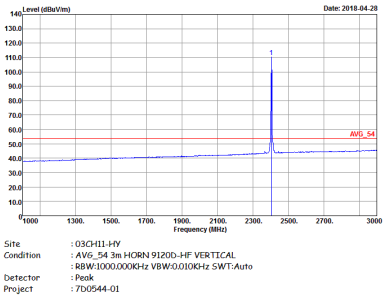
**Note symbol**

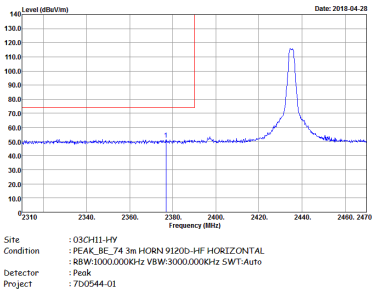
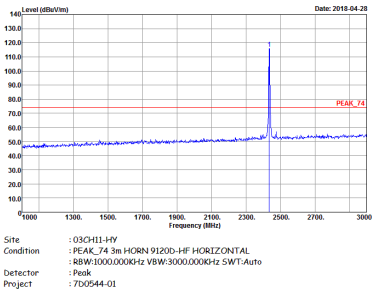
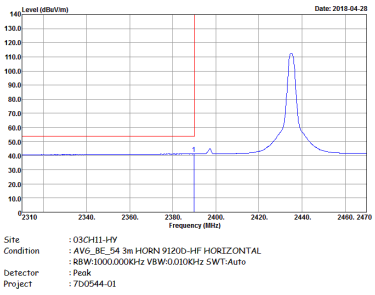
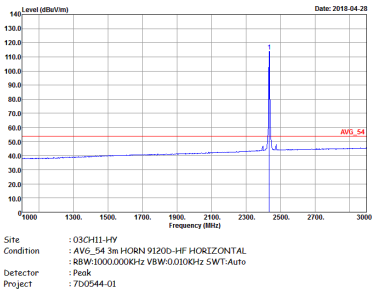
| | |
|---|---|
| -L | **Low channel location** |
| -R | **High channel location** |

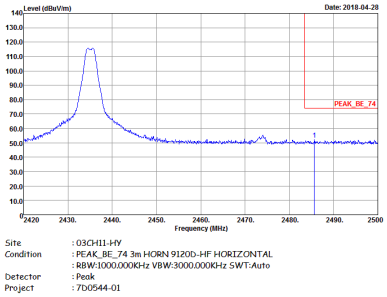
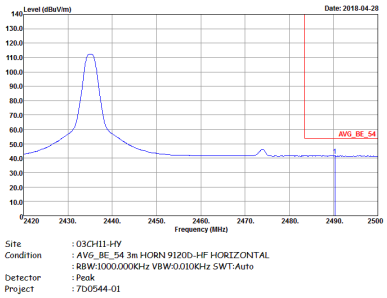
## 2.4GHz 2400~2483.5MHz

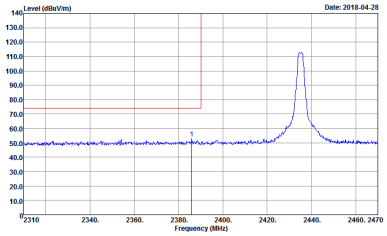
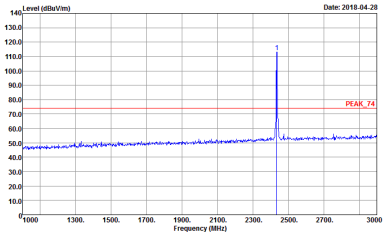
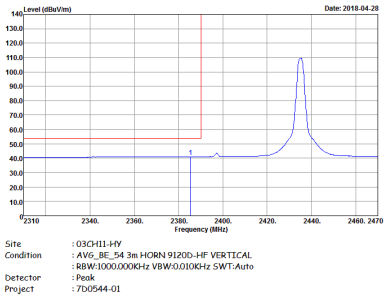
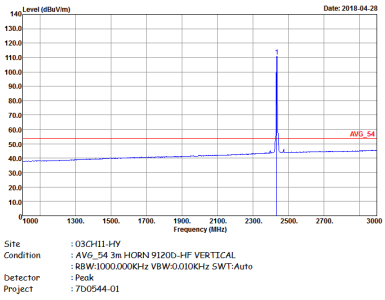
## Zigbee (Band Edge @ 3m)

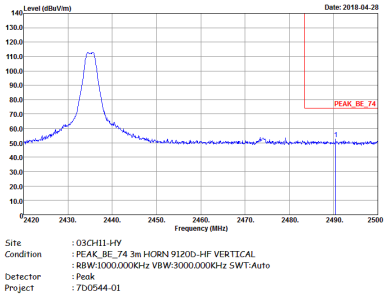
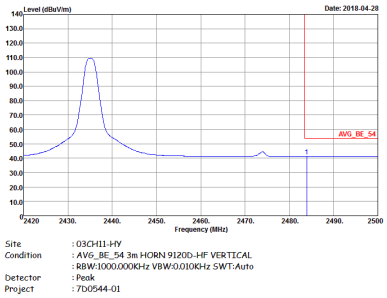
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH11 2405MHz | |
| 1 | Horizontal | Fundamental |
| Peak |  |  |
| Avg. |  |  |

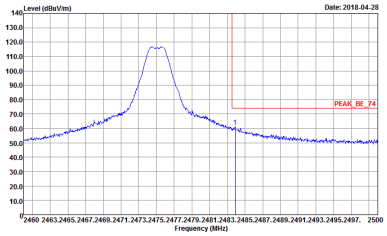
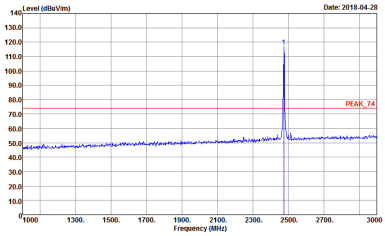
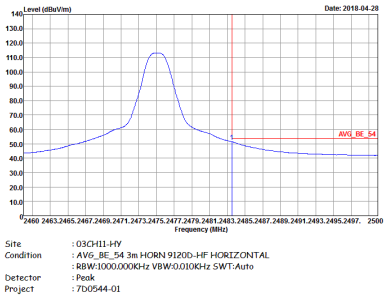
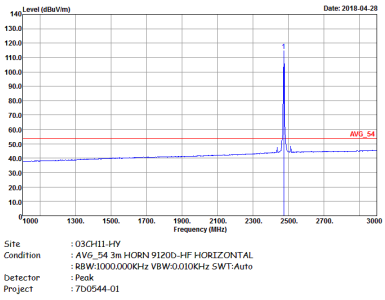
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH11 2405MHz | |
| 1 | Vertical | Fundamental |
| Peak |  |  |
| Avg |  |  |

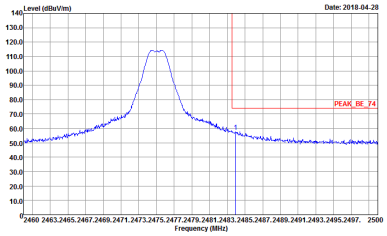
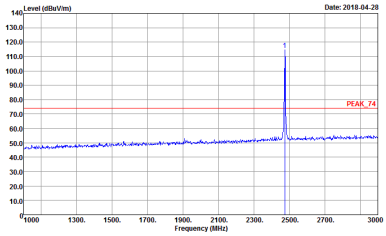
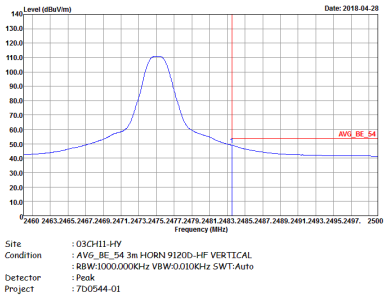
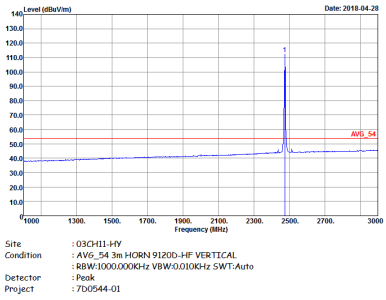
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH17 2435MHz - L | |
| 1 | Horizontal | Fundamental |
| Peak |  |  |
| Avg. |  |  |

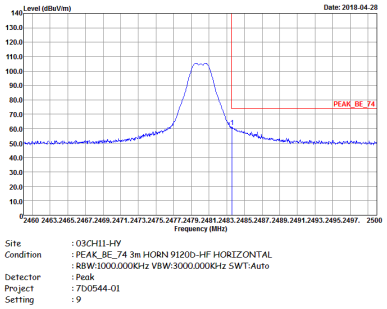
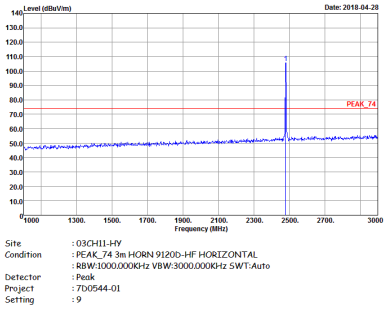
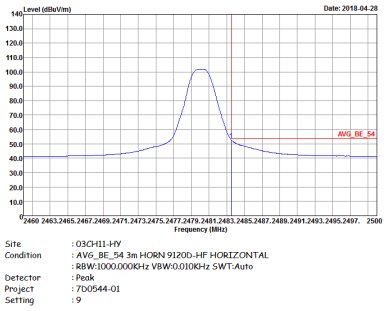
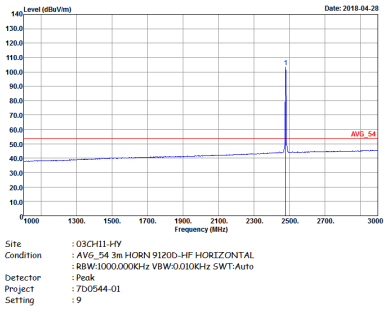
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH17 2435MHz - R | |
| 1 | Horizontal | Fundamental |
| Peak |  | Left blank |
| Avg. |  | Left blank |

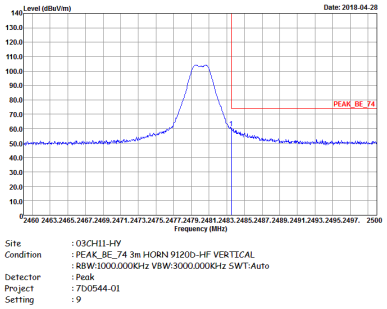
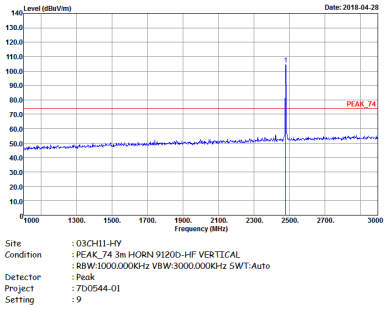
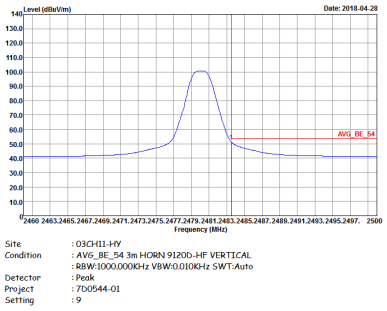
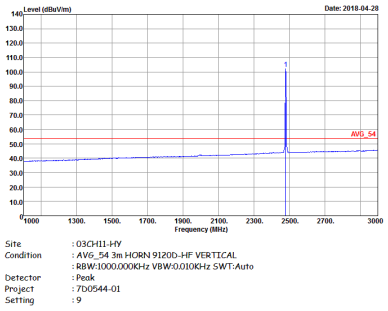
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH17 2435MHz - L | |
| 1 | Vertical | Fundamental |
| Peak |  |  |
| Avg. |  |  |

| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH17 2435MHz - R | |
| 1 | Vertical | Fundamental |
| Peak |  | Left blank |
| Avg. |  | Left blank |

| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH25 2475MHz | |
| 1 | Horizontal | Fundamental |
| Peak |  |  |
| Avg. |  |  |

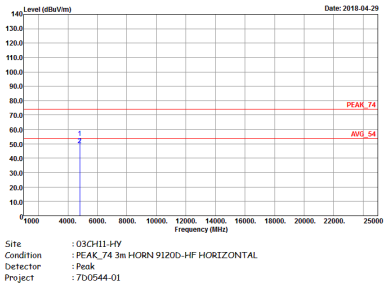
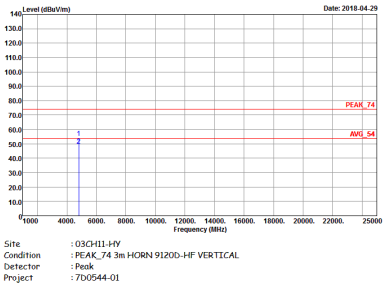
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH25 2475MHz | |
| 1 | Vertical | Fundamental |
| Peak |  |  |
| Avg. |  |  |

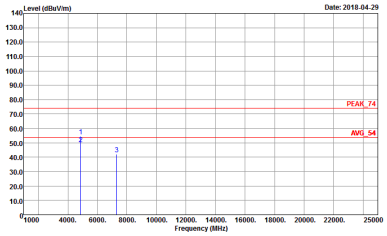
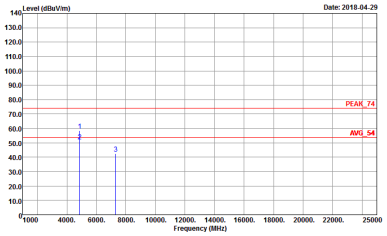
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH26 2480MHz | |
| 1 | Horizontal | Fundamental |
| Peak |  |  |
| Avg. |  |  |

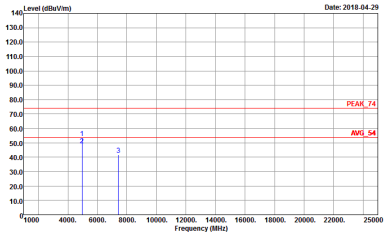
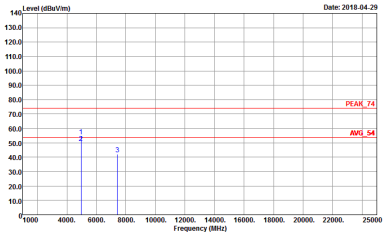
| Zigbee | 2.4GHz 2400~2483.5MHz Band Edge @ 3m | |
|---|---|---|
| ANT | Zigbee CH26 2480MHz | |
| 1 | Vertical | Fundamental |
| Peak |  |  |
| Avg. |  |  |

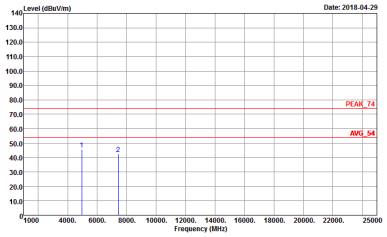
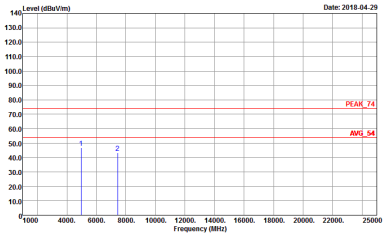
## 2.4GHz 2400~2483.5MHz

## BLE (Harmonic @ 3m)

| Zigbee | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| ANT | Zigbee CH11 2405MHz | |
| 1 | Horizontal | Vertical |
| Peak<br>Avg. |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF HORIZONTAL<br>Detector : Peak<br>Project : 7D0544-01 |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF VERTICAL<br>Detector : Peak<br>Project : 7D0544-01 |

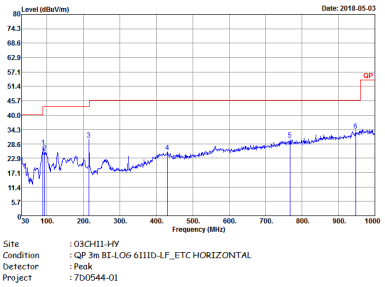
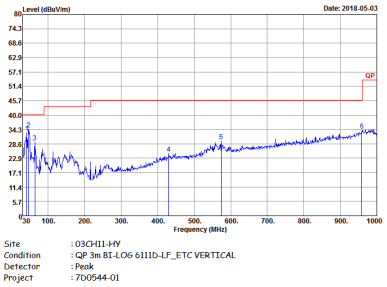
| Zigbee | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| ANT | Zigbee CH17 2435MHz | |
| 1 | Horizontal | Vertical |
| Peak<br>Avg. |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF HORIZONTAL<br>Detector : Peak<br>Project : 7D0544-01 |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF VERTICAL<br>Detector : Peak<br>Project : 7D0544-01 |

| Zigbee | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| ANT | Zigbee CH25 2475MHz | |
| 1 | Horizontal | Vertical |
| Peak |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF HORIZONTAL<br>Detector : Peak<br>Project : 7D0544-01 |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF VERTICAL<br>Detector : Peak<br>Project : 7D0544-01 |

| Zigbee | 2.4GHz 2400~2483.5MHz Harmonic @ 3m | |
|---|---|---|
| ANT | Zigbee CH26 2480MHz | |
| 1 | Horizontal | Vertical |
| Peak |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF HORIZONTAL<br>Detector : Peak<br>Project : 7D0544-01<br>Setting : 9 |  <br>Site : 03CH11-HY<br>Condition : PEAK_74 3m HORN 9120D-HF VERTICAL<br>Detector : Peak<br>Project : 7D0544-01<br>Setting : 9 |

## Emission below 1GHz

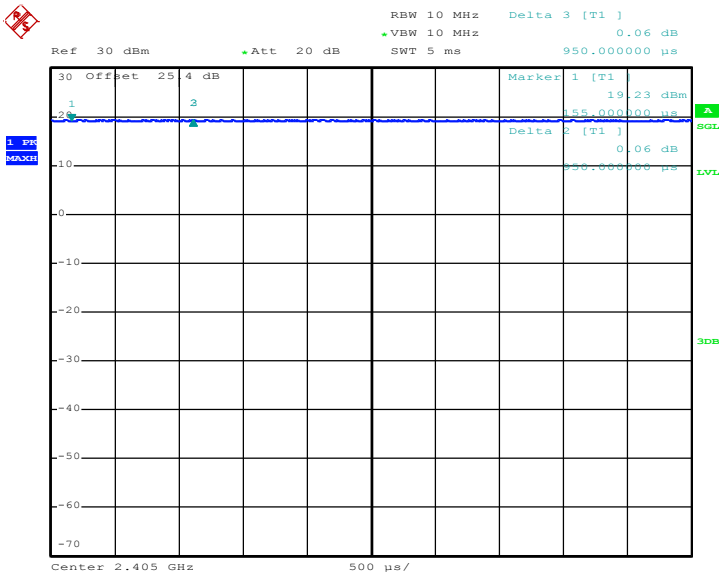
## 2.4GHz Zigbee (LF)

| Zigbee | 2.4GHz 2400~2483.5MHz | |
|---|---|---|
| ANT | Zigbee LF | |
| 1 | Horizontal | Vertical |
| QP / Peak |  |  |

# Appendix E. Duty Cycle Plots

| Band | Duty Cycle(%) | T(us) | 1/T(kHz) | VBW Setting | Duty Factor(dB) |
|---|---|---|---|---|---|
| Zigbee | 100.00 | - | - | 10Hz | 0.00 |

**Zigbee**




Date: 17.APR.2018 14:43:54