# TEST REPORT

| | | |
|---|---|---|
| **Reference No.** | : | WTS17S0989659E |
| **FCC ID** | : | 2ALZL-TS220 |
| **Applicant** | : | Goldwood Sound, Inc. |
| **Address** | : | 9333 Oso Ave. Chatsworth, CA 91311, United States |
| **Manufacturer** | : | Flyball Electronic (Shenzhen) Co., Ltd. |
| **Address** | : | 5-6 Building, Zhiji Industrial Park, Jinye Road, Kuichong Street, LongGang District, Shenzhen, China. |
| **Product** | : | 2.1 CH MULTIMEDIA SPEAKER SYSTEM |
| **Model(s)** | : | TS220 |
| **Brand Name** | : | Theater Solutions |
| **Standards** | : | FCC CFR47 Part 15.247:2016 |
| **Date of Receipt sample** | : | 2017-09-08 |
| **Date of Test** | : | 2017-09-12 to 2017-09-16 |
| **Date of Issue** | : | 2017-09-18 |
| **Test Result** | : | **Pass** |

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.


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# 1 Laboratories Introduction

**Waltek Services Test Group Ltd.** is one of the largest and the most comprehensive third party testing organizations in China, our headquarter located in Shenzhen (CNAS Registration No. L3110, A2LA Certificate Number: 4243.01) and have branches in Foshan (CNAS Registration No. L6478), Dongguan (CNAS Registration No. L9950), Zhongshan, Suzhou (CNAS Registration No. L7754), Ningbo and Hong Kong, Our test capability covered four large fields: safety test. Electronic Magnetic Compatibility(EMC), reliability and energy performance, Chemical test. Meanwhile, Waltek has got recognition as registration and accreditation laboratory from EMSD (Electrical and Mechanical Services Department), and American Energy star, FCC(The Federal Communications Commission), CPSC(Consumer Product Safety Commission), CEC(California energy efficiency), IC(Industry Canada) and ELI(Efficient Lighting Initiative). It's the strategic partner and data recognition laboratory of international authoritative organizations, such as UL, Intertek(ETL-SEMKO), CSA, TÜV Rheinland, TÜV SÜD, etc. As a professional, comprehensive, justice international test organization, we still keep the scientific and rigorous work attitude to help each client satisfy the international standards and assist their product enter into globe market smoothly.

**Waltek Services (Shenzhen) Co., Ltd.**

**A. Accreditations for Conformity Assessment (International)**

| Country/Region | Accreditation Body | Scope | Note |
|---|---|---|---|
| USA | **CNAS (Registration No.: L3110) A2LA (Certificate No.: 4243.01)** | FCC ID \ DOC \ VOC | 1 |
| Canada | | IC ID \ VOC | 2 |
| Japan | | MIC-T \ MIC-R | - |
| Europe | | EMCD \ RED | - |
| Taiwan | | NCC | - |
| Hong Kong | | OFCA | - |
| Australia | | RCM | - |
| India | **International Services** | WPC | - |
| Thailand | | NTC | - |
| Singapore | | IDA | - |
| Note:<br>1. FCC Designation No.: CN1201. Test Firm Registration No.: 523476.<br>2. IC Canada Registration No.: 7760A | | | |

**B. TCBs and Notify Bodies Recognized Testing Laboratory.**

| Recognized Testing Laboratory of … | Notify body number |
|---|---|
| TUV Rheinland | Optional. |
| Intertek | |
| TUV SUD | |
| SGS | |
| Phoenix Testlab GmbH | 0700 |
| Element Materials Technology Warwick Ltd | 0891 |
| Timco Engineering, Inc. | 1177 |
| Eurofins Product Service GmbH | 0681 |

# 2 Contents

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# 3 Revision History

| Test report No. | Date of Receipt sample | Date of Test | Date of Issue | Purpose | Comment | Approved |
|---|---|---|---|---|---|---|
| WTS17S0989659E | 2017-09-08 | 2017-09-12 to 2017-09-16 | 2017-09-18 | original | - | Valid |

# 4 General Information

## 4.1 General Description of E.U.T

| | |
|---|---|
| Product Name | : 2.1 CH MULTIMEDIA SPEAKER SYSTEM |
| Model No. | : TS220 |
| Model Description | : N/A |
| Hardware Version | : A0 |
| Software Version | : A0 |

## 4.2 Details of E.U.T

| | |
|---|---|
| Operation Frequency | : 2402~2480MHz |
| Max. RF output power | : 0.98dBm |
| Type of Modulation | :GFSK, Pi/4 DQPSK,8DPSK |
| Antenna installation | : PCB Printed Antenna |
| Antenna Gain | : 0dBi |
| Ratings | : ~120V 60Hz |

## 4.3 Channel List

Bluetooth Classic mode

| Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 1 | 2402 | 2 | 2403 | 3 | 2404 | 4 | 2405 |
| 5 | 2406 | 6 | 2407 | 7 | 2408 | 8 | 2409 |
| 9 | 2410 | 10 | 2411 | 11 | 2412 | 12 | 2413 |
| 13 | 2414 | 14 | 2415 | 15 | 2416 | 16 | 2417 |
| 17 | 2418 | 18 | 2419 | 19 | 2420 | 20 | 2421 |
| 21 | 2422 | 22 | 2423 | 23 | 2424 | 24 | 2425 |
| 25 | 2426 | 26 | 2427 | 27 | 2428 | 28 | 2429 |
| 29 | 2430 | 30 | 2431 | 31 | 2432 | 32 | 2433 |
| 33 | 2434 | 34 | 2435 | 35 | 2436 | 36 | 2437 |
| 37 | 2438 | 38 | 2439 | 39 | 2440 | 40 | 2441 |
| 41 | 2442 | 42 | 2443 | 43 | 2444 | 44 | 2445 |
| 45 | 2446 | 46 | 2447 | 47 | 2448 | 48 | 2449 |
| 49 | 2450 | 50 | 2451 | 51 | 2452 | 52 | 2453 |
| 53 | 2454 | 54 | 2455 | 55 | 2456 | 56 | 2457 |
| 57 | 2458 | 58 | 2459 | 59 | 2460 | 60 | 2461 |
| 61 | 2462 | 62 | 2463 | 63 | 2464 | 64 | 2465 |
| 65 | 2466 | 66 | 2467 | 67 | 2468 | 68 | 2469 |
| 69 | 2470 | 70 | 2471 | 71 | 2472 | 72 | 2473 |
| 73 | 2474 | 74 | 2475 | 75 | 2476 | 76 | 2477 |
| 77 | 2478 | 78 | 2479 | 79 | 2480 | - | - |

## 4.4 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests; the worst data were recorded and reported.

| Test mode | Low channel | Middle channel | High channel |
|---|---|---|---|
| Transmitting | 2402MHz | 2441MHz | 2480MHz |

# 5 Equipment Used during Test

## 5.1 Equipments List

| Conducted Emissions | | | | | | |
|---|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMI Test Receiver | R&S | ESCI | 101155 | 2017-09-11 | 2018-09-12 |
| 2. | LISN | SCHWARZBECK | NSLK 8128 | 8128-289 | 2017-09-11 | 2018-09-12 |
| 3. | Limiter | York | MTS-IMP-136 | 261115-001-0024 | 2017-09-11 | 2018-09-12 |
| 4. | Cable | LARGE | RF300 | - | 2017-09-11 | 2018-09-12 |
| **3m Semi-anechoic Chamber for Radiation Emissions** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1 | Spectrum Analyzer | R&S | FSP | 100091 | 2017-04-29 | 2018-04-28 |
| 2 | Active Loop Antenna | Beijing Dazhi | ZN30900A | - | 2017-01-12 | 2018-01-11 |
| 3 | Trilog Broadband Antenna | SCHWARZBECK | VULB9163 | 336 | 2016-10-17 | 2017-10-16 |
| 4 | Coaxial Cable (below 1GHz) | Top | TYPE16(13M) | - | 2017-04-07 | 2018-04-06 |
| 5 | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9120 D | 667 | 2017-09-12 | 2018-09-11 |
| 6 | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9170 | 335 | 2017-04-07 | 2018-04-06 |
| 7 | Broadband Preamplifier | COMPLIANCE DIRECTION | PAP-1G18 | 2004 | 2017-04-07 | 2018-04-06 |
| 8 | Coaxial Cable (above 1GHz) | Top | 1GHz-25GHz | EW02014-7 | 2017-04-07 | 2018-04-06 |
| **3m Semi-anechoic Chamber for Radiation Emissions** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No** | **Last Calibration Date** | **Calibration Due Date** |
| 1 | Test Receiver | R&S | ESCI | 101296 | 2017-04-06 | 2018-04-05 |
| 2 | Trilog Broadband Antenna | SCHWARZBECK | VULB9160 | 9160-3325 | 2017-04-07 | 2018-04-06 |
| 3 | Amplifier | Compliance pirection systems inc | PAP-0203 | 22024 | 2017-04-07 | 2018-04-06 |
| 4 | Cable | HUBER+SUHNER | CBL2 | 525178 | 2017-04-07 | 2018-04-06 |
| **RF Conducted Testing** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 2. | Spectrum Analyzer (9k-6GHz) | R&S | FSL6 | 100959 | 2017-09-11 | 2018-09-12 |
| 3. | Signal Analyzer (9k~26.5GHz) | Agilent | N9010A | MY50520207 | 2017-09-11 | 2018-09-12 |

## 5.2 Measurement Uncertainty

| Parameter | Uncertainty |
|---|---|
| Radio Frequency | ± 1 x $10^{-6}$ |
| RF Power | ± 1.0 dB |
| RF Power Density | ± 2.2 dB |
| Radiated Spurious Emissions test | ± 5.03 dB (30M~1000MHz) |
| | ± 5.47 dB (1000M~25000MHz) |
| Conducted Spurious Emissions test | ± 3.64 dB (AC mains 150KHz~30MHz) |

## 5.3 Test Equipment Calibration

All the test equipments used are valid and calibrated by GUANG ZHOU GRG METROLOGY & TEST CO., LTD. address is No.163, Pingyun Rd. West of Huangpu Ave, Tianhe District, Guangzhou, Guangdong, China.

# 6 Test Summary

| Test Items | Test Requirement | Result |
|---|---|---|
| Radiated Spurious Emissions | 15.205(a)<br>15.209<br>15.247(d) | Pass |
| Conducted Spurious emissions | 15.247(d) | Pass |
| Band edge | 15.247(d)<br>15.205(a) | Pass |
| Conduct Emission | 15.207 | Pass |
| Bandwidth | 15.247(a)(1) | Pass |
| Maximum Peak Output Power | 15.247(b)(1) | Pass |
| Frequency Separation | 15.247(a)(1) | Pass |
| Number of Hopping Frequency | 15.247(a)(1)(iii) | Pass |
| Dwell time | 15.247(a)(1)(iii) | Pass |
| Antenna Requirement | 15.203 | Pass |
| Maximum Permissible Exposure<br>(Exposure of Humans to RF Fields) | 1.1307(b)(1) | Pass |
| Note: Pass=Compliance; Fail=Not Compliance; NT=Not Tested; N/A=Not Applicable. | | |

# 7 Conducted Emission

Test Requirement: FCC CFR 47 Part 15 Section 15.207

Test Method: ANSI C63.10:2013

Test Result: PASS

Frequency Range: 150kHz to 30MHz

Class/Severity: Class B

Limit:

| Frequency (MHz) | Limit (dBμV) | |
|---|---|---|
| | Qsi-peak | Average |
| 0.15 to 0.5 | 66 to 56* | 56 to 46* |
| 0.5 t 5 | 5 | 60 |
| 5 to 30 | 60 | 50 |

## 7.1 E.U.T. Operation

Operating Environment **:**

Temperature: 22.8 °C

Humidity: 52.6 % RH

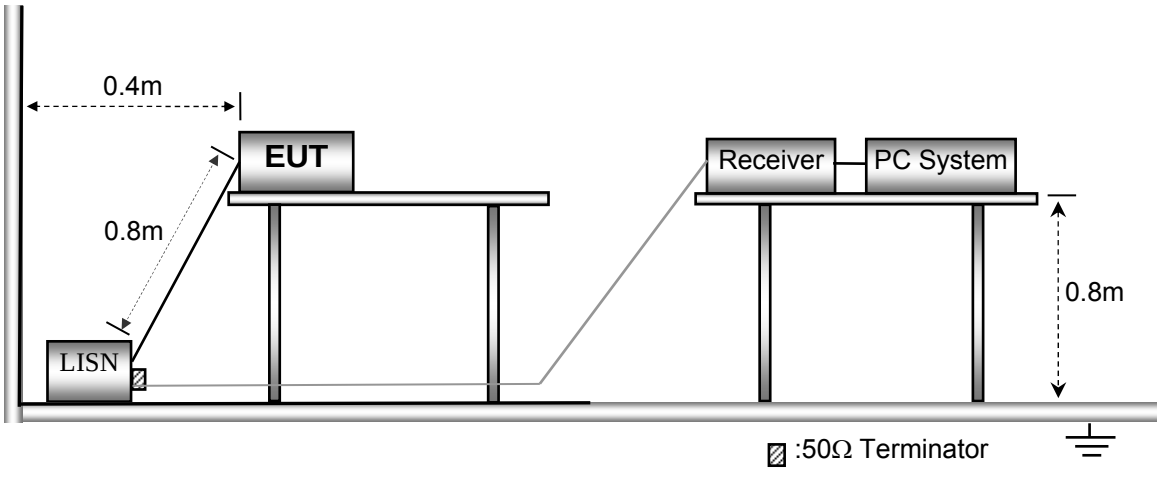
Atmospheric Pressure: 101.2kPa

EUT Operation **:**

The test was performed in Transmitting mode, the worst test data (GFSK modulation Low channel) were shown in the report.

## 7.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10:2013.



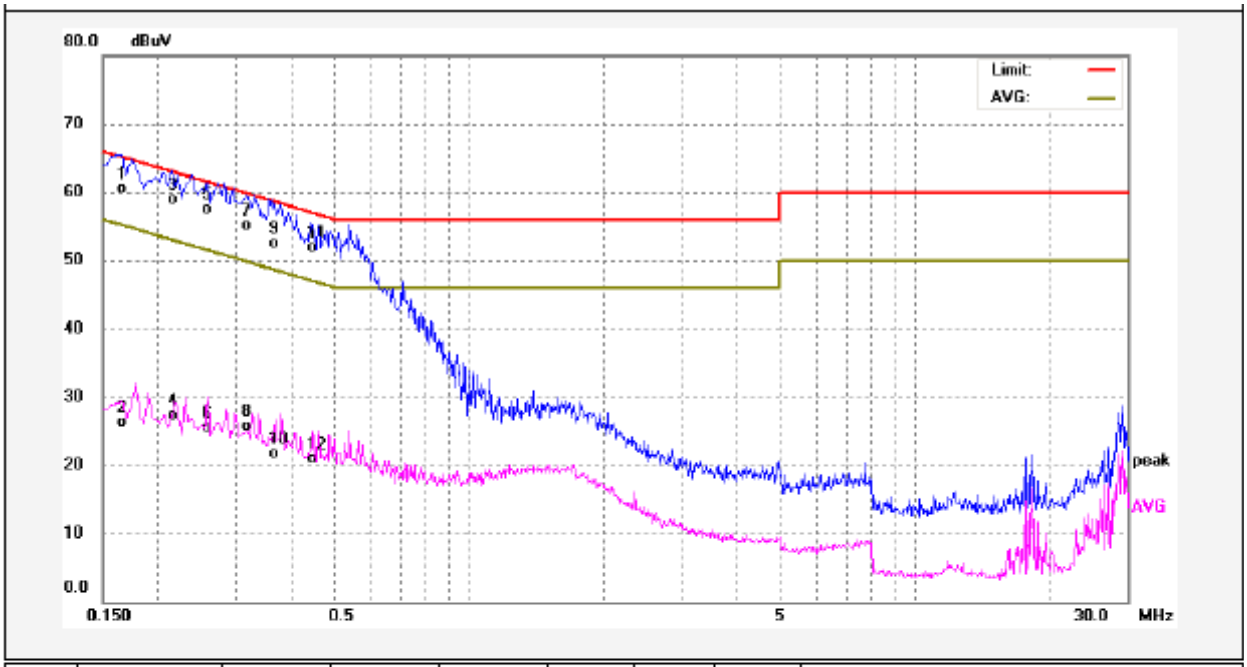

## 7.3 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

## 7.4 Conducted Emission Test Result

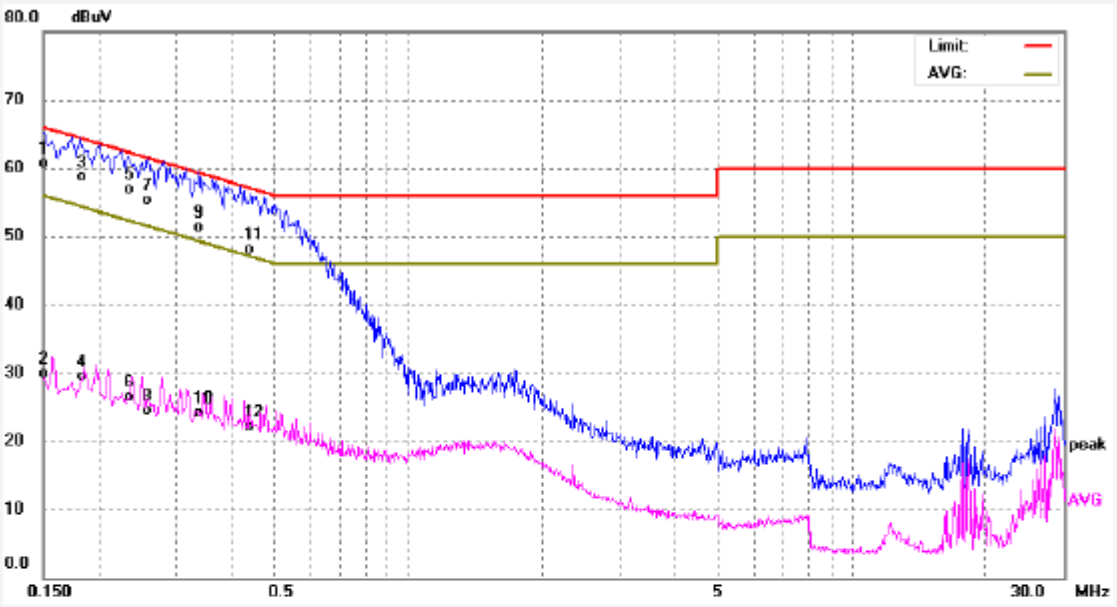
Remark: only the worst data (GFSK modulation Low channel mode) were reported

Live line:




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit dBuV | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1660 | 50.57 | 9.90 | 60.47 | 65.15 | -4.68 | QP | |
| 2 | 0.1660 | 16.32 | 9.90 | 26.22 | 55.15 | -28.93 | AVG | |
| 3 | 0.2140 | 48.92 | 9.94 | 58.86 | 63.04 | -4.18 | QP | |
| 4 | 0.2140 | 17.36 | 9.94 | 27.30 | 53.04 | -25.74 | AVG | |
| 5 | 0.2580 | 47.48 | 10.01 | 57.49 | 61.49 | -4.00 | QP | |
| 6 | 0.2580 | 15.49 | 10.01 | 25.50 | 51.49 | -25.99 | AVG | |
| 7 | 0.3180 | 45.03 | 10.01 | 55.04 | 59.76 | -4.72 | QP | |
| 8 | 0.3180 | 15.68 | 10.01 | 25.69 | 49.76 | -24.07 | AVG | |
| 9 | 0.3620 | 42.47 | 10.05 | 52.52 | 58.68 | -6.16 | QP | |
| 10 | 0.3620 | 11.64 | 10.05 | 21.69 | 48.68 | -26.99 | AVG | |
| 11 | 0.4420 | 41.92 | 10.05 | 51.97 | 57.02 | -5.05 | QP | |
| 12 | 0.4420 | 10.80 | 10.05 | 20.85 | 47.02 | -26.17 | AVG | |

Neutral line:




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit dBuV | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1500 | 50.63 | 10.06 | 60.69 | 65.99 | -5.30 | QP | |
| 2 | 0.1500 | 19.88 | 10.06 | 29.94 | 55.99 | -26.05 | AVG | |
| 3 | 0.1819 | 48.85 | 9.88 | 58.73 | 64.39 | -5.66 | QP | |
| 4 | 0.1819 | 19.72 | 9.88 | 29.60 | 54.39 | -24.79 | AVG | |
| 5 | 0.2340 | 46.95 | 9.98 | 56.93 | 62.30 | -5.37 | QP | |
| 6 | 0.2340 | 16.58 | 9.98 | 26.56 | 52.30 | -25.74 | AVG | |
| 7 | 0.2580 | 45.34 | 10.01 | 55.35 | 61.49 | -6.14 | QP | |
| 8 | 0.2580 | 14.55 | 10.01 | 24.56 | 51.49 | -26.93 | AVG | |
| 9 | 0.3379 | 41.33 | 10.04 | 51.37 | 59.25 | -7.88 | QP | |
| 10 | 0.3379 | 14.16 | 10.04 | 24.20 | 49.25 | -25.05 | AVG | |
| 11 | 0.4420 | 38.15 | 10.05 | 48.20 | 57.02 | -8.82 | QP | |
| 12 | 0.4420 | 12.09 | 10.05 | 22.14 | 47.02 | -24.88 | AVG | |

# 8 Radiated Spurious Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.209 & 15.247

Test Method: ANSI C63.10:2013

Test Result: PASS

Measurement Distance: 3m

Limit:

| Frequency (MHz) | Field Strength | | Field Strength Limit at 3m Measurement Dist | |
|---|---|---|---|---|
| | uV/m | Distance (m) | uV/m | dBuV/m |
| 0.009 ~ 0.490 | 2400/F(kHz) | 300 | 10000 * 2400/F(kHz) | $20\log^{(2400/F(kHz))} + 80$ |
| 0.490 ~ 1.705 | 24000/F(kHz) | 30 | 100 * 24000/F(kHz) | $20\log^{(24000/F(kHz))} + 40$ |
| 1.705 ~ 30 | 30 | 30 | 100 * 30 | $20\log^{(30)} + 40$ |
| 30 ~ 88 | 100 | 3 | 100 | $20\log^{(100)}$ |
| 88 ~ 216 | 150 | 3 | 150 | $20\log^{(150)}$ |
| 216 ~ 960 | 200 | 3 | 200 | $20\log^{(200)}$ |
| Above 960 | 500 | 3 | 500 | $20\log^{(500)}$ |

## 8.1 EUT Operation

Operating Environment **:**

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

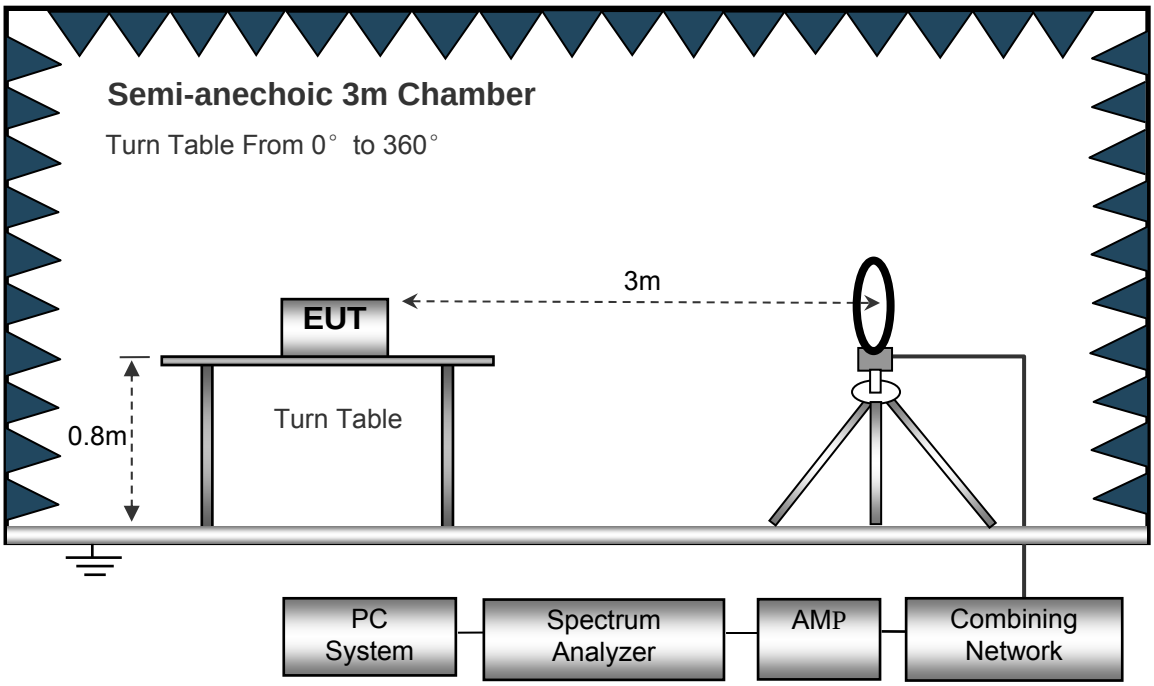
EUT Operation **:**

The test was performed in Transmitting mode, the worst test data (GFSK modulation) were shown in the report.

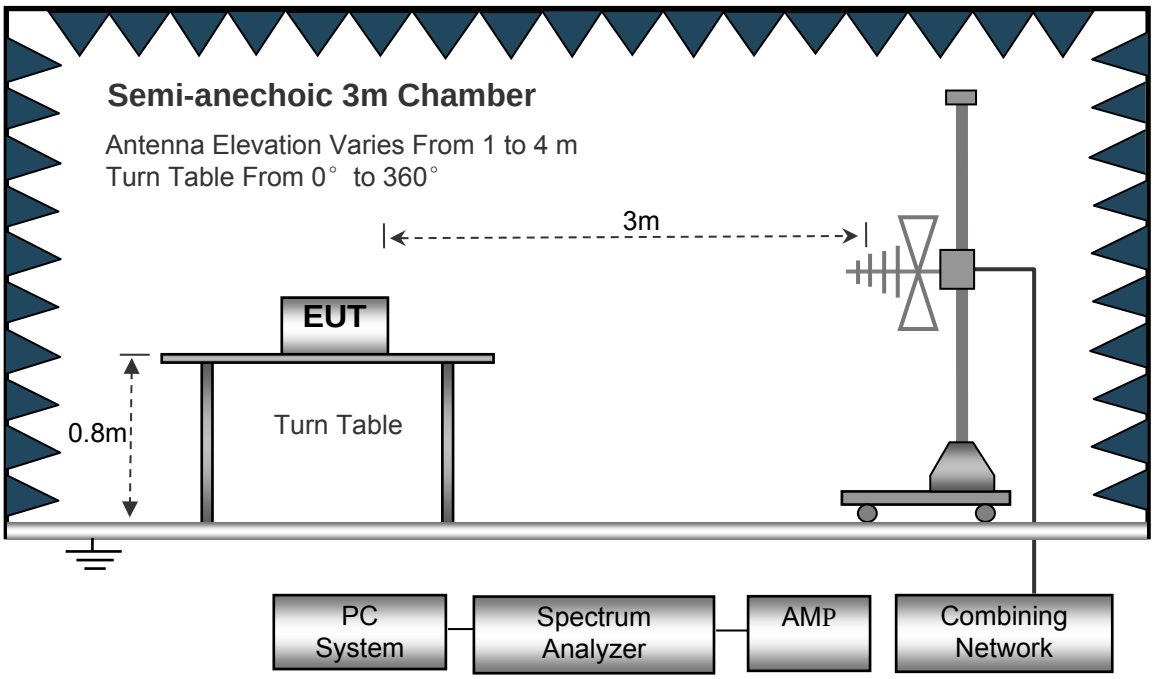
## 8.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10:2013.

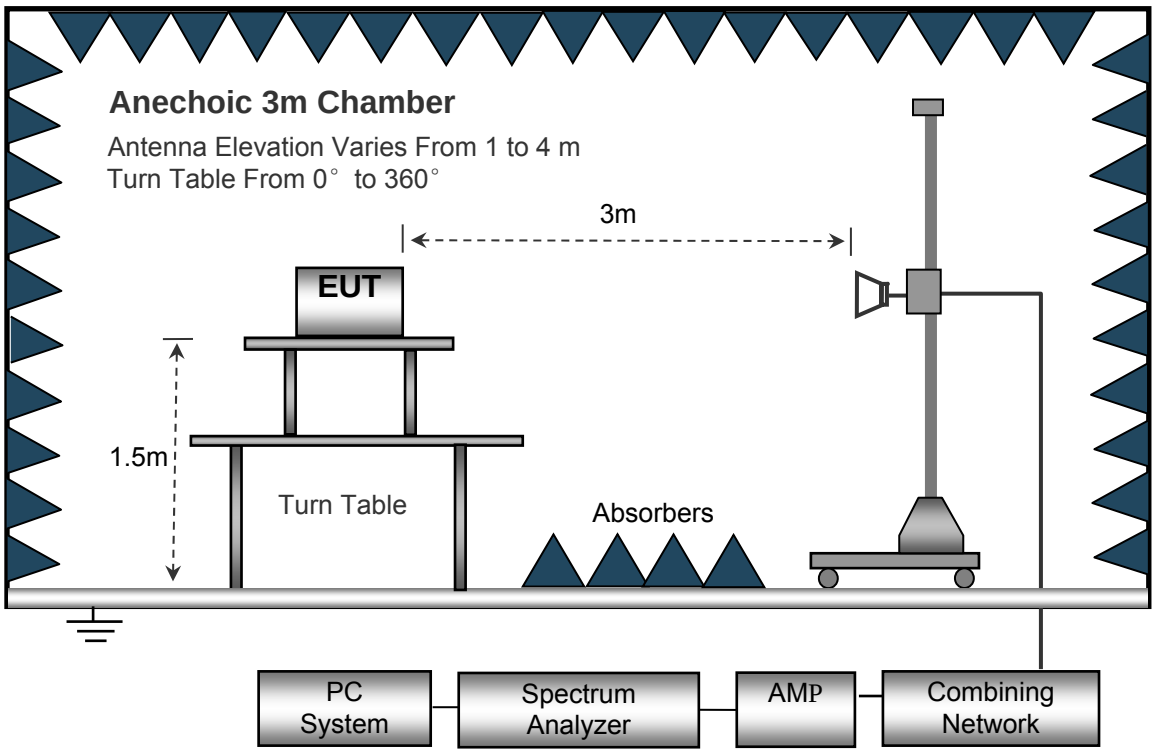
The test setup for emission measurement below 30MHz.




The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz.




## 8.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed ..... Auto
IF Bandwidth..... 10kHz
Video Bandwidth..... 10kHz

Resolution Bandwidth..... 10kHz

30MHz ~ 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 100kHz
Video Bandwidth..... 300kHz

Above 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 3MHz
Detector ..... Ave.
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 10Hz

## 8.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane for below 1GHz and 1.5m for above 1GHz.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the Z position. So the data shown was the Z position only.

## 8.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

## 8.6 Summary of Test Results

**Test Frequency: 9 KHz~30 MHz**

The measurements were more than 20 dB below the limit and not reported.

**Test Frequency: 30MHz ~ 18GHz**

Remark: only the worst data (GFSK modulation) were reported.

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | FCC Part 15.247/209/205 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | Limit | Margin |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| GFSK Low Channel 2402MHz | | | | | | | | | |
| 258.38 | 35.46 | QP | 359 | 1.4 | H | -13.35 | 22.11 | 46.00 | -23.89 |
| 258.38 | 40.29 | QP | 116 | 1.5 | V | -13.35 | 26.94 | 46.00 | -19.06 |
| 4804.00 | 45.63 | PK | 71 | 1.5 | V | -1.06 | 44.57 | 74.00 | -29.43 |
| 4804.00 | 42.79 | Ave | 71 | 1.5 | V | -1.06 | 41.73 | 54.00 | -12.27 |
| 7206.00 | 41.99 | PK | 327 | 1.1 | H | 1.33 | 43.32 | 74.00 | -30.68 |
| 7206.00 | 36.54 | Ave | 327 | 1.1 | H | 1.33 | 37.87 | 54.00 | -16.13 |
| 2344.88 | 45.82 | PK | 64 | 1.7 | V | -13.19 | 32.63 | 74.00 | -41.37 |
| 2344.88 | 38.23 | Ave | 64 | 1.7 | V | -13.19 | 25.04 | 54.00 | -28.96 |
| 2389.60 | 44.74 | PK | 128 | 1.9 | H | -13.14 | 31.60 | 74.00 | -42.40 |
| 2389.60 | 37.14 | Ave | 128 | 1.9 | H | -13.14 | 24.00 | 54.00 | -30.00 |
| 2495.50 | 43.30 | PK | 202 | 1.6 | V | -13.08 | 30.22 | 74.00 | -43.78 |
| 2495.50 | 37.54 | Ave | 202 | 1.6 | V | -13.08 | 24.46 | 54.00 | -29.54 |

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | FCC Part 15.247/209/205 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | Limit | Margin |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| GFSK Middle Channel 2441MHz | | | | | | | | | |
| 258.38 | 35.91 | QP | 275 | 1.0 | H | -13.35 | 22.56 | 46.00 | -23.44 |
| 258.38 | 41.55 | QP | 73 | 1.2 | V | -13.35 | 28.20 | 46.00 | -17.80 |
| 4882.00 | 46.21 | PK | 80 | 1.9 | V | -0.62 | 45.59 | 74.00 | -28.41 |
| 4882.00 | 42.44 | Ave | 80 | 1.9 | V | -0.62 | 41.82 | 54.00 | -12.18 |
| 7323.00 | 43.34 | PK | 188 | 1.7 | H | 2.21 | 45.55 | 74.00 | -28.45 |
| 7323.00 | 35.48 | Ave | 188 | 1.7 | H | 2.21 | 37.69 | 54.00 | -16.31 |
| 2345.39 | 45.98 | PK | 145 | 1.4 | V | -13.19 | 32.79 | 74.00 | -41.21 |
| 2345.39 | 39.93 | Ave | 145 | 1.4 | V | -13.19 | 26.74 | 54.00 | -27.26 |
| 2357.48 | 42.79 | PK | 207 | 1.0 | H | -13.14 | 29.65 | 74.00 | -44.35 |
| 2357.48 | 37.06 | Ave | 207 | 1.0 | H | -13.14 | 23.92 | 54.00 | -30.08 |
| 2494.90 | 44.47 | PK | 108 | 1.0 | V | -13.08 | 31.39 | 74.00 | -42.61 |
| 2494.90 | 37.11 | Ave | 108 | 1.0 | V | -13.08 | 24.03 | 54.00 | -29.97 |

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | FCC Part 15.247/209/205 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | Limit | Margin |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| GFSK High Channel 2480MHz | | | | | | | | | |
| 258.38 | 34.85 | QP | 350 | 1.4 | H | -13.35 | 21.50 | 46.00 | -24.50 |
| 258.38 | 42.92 | QP | 184 | 1.1 | V | -13.35 | 29.57 | 46.00 | -16.43 |
| 4960.00 | 47.06 | PK | 235 | 1.7 | V | -0.24 | 46.82 | 74.00 | -27.18 |
| 4960.00 | 43.14 | Ave | 235 | 1.7 | V | -0.24 | 42.90 | 54.00 | -11.10 |
| 7440.00 | 42.73 | PK | 224 | 1.4 | H | 2.84 | 45.57 | 74.00 | -28.43 |
| 7440.00 | 35.28 | Ave | 224 | 1.4 | H | 2.84 | 38.12 | 54.00 | -15.88 |
| 2322.15 | 45.70 | PK | 1 | 1.8 | V | -13.19 | 32.51 | 74.00 | -41.49 |
| 2322.15 | 39.64 | Ave | 1 | 1.8 | V | -13.19 | 26.45 | 54.00 | -27.55 |
| 2387.56 | 44.95 | PK | 254 | 1.6 | H | -13.14 | 31.81 | 74.00 | -42.19 |
| 2387.56 | 38.54 | Ave | 254 | 1.6 | H | -13.14 | 25.40 | 54.00 | -28.60 |
| 2483.68 | 42.55 | PK | 231 | 1.3 | V | -13.08 | 29.47 | 74.00 | -44.53 |
| 2483.68 | 38.86 | Ave | 231 | 1.3 | V | -13.08 | 25.78 | 54.00 | -28.22 |

**Test Frequency: 18GHz~25GHz**

The measurements were more than 20 dB below the limit and not recorded

# 9 Conducted Spurious Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: ANSI C63.10:2013

Test Result: PASS

Limit:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

## 9.1 Test Procedure

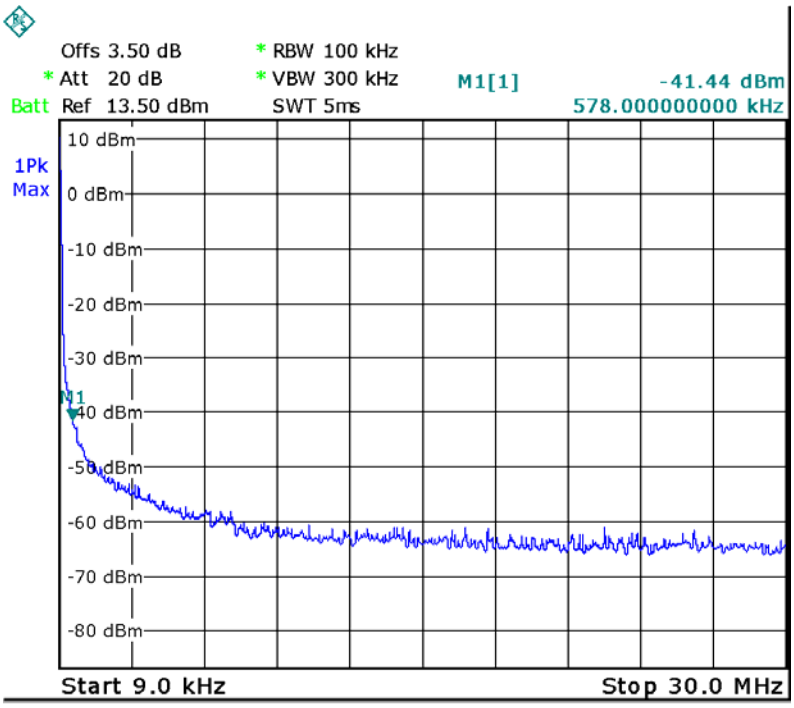
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:
   RBW = 100kHz, VBW = 300kHz, Sweep = auto
   Detector function = peak, Trace = max hold

## 9.2 Test Result

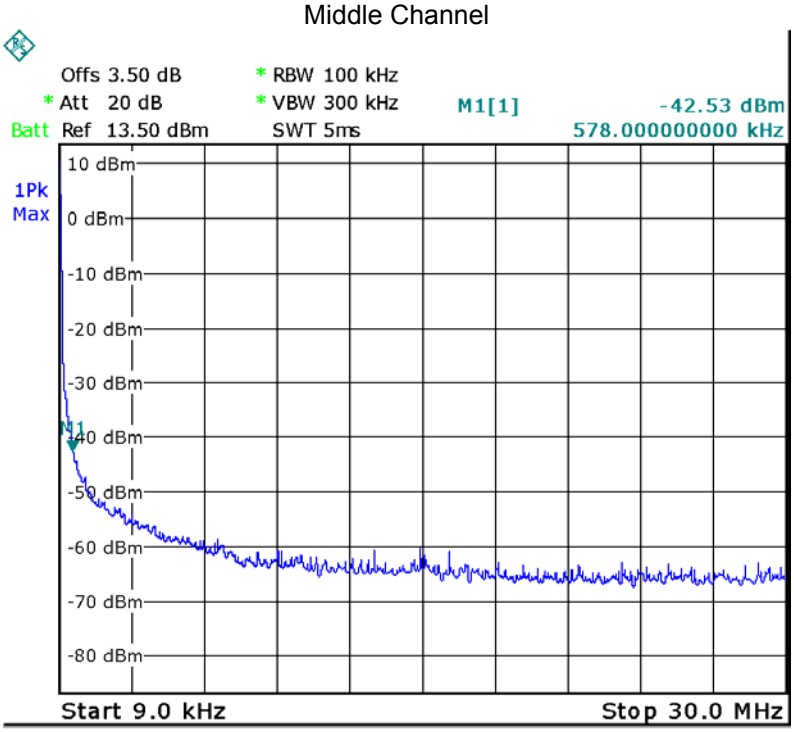
**9 KHz - 30MHz**

**GFSK**

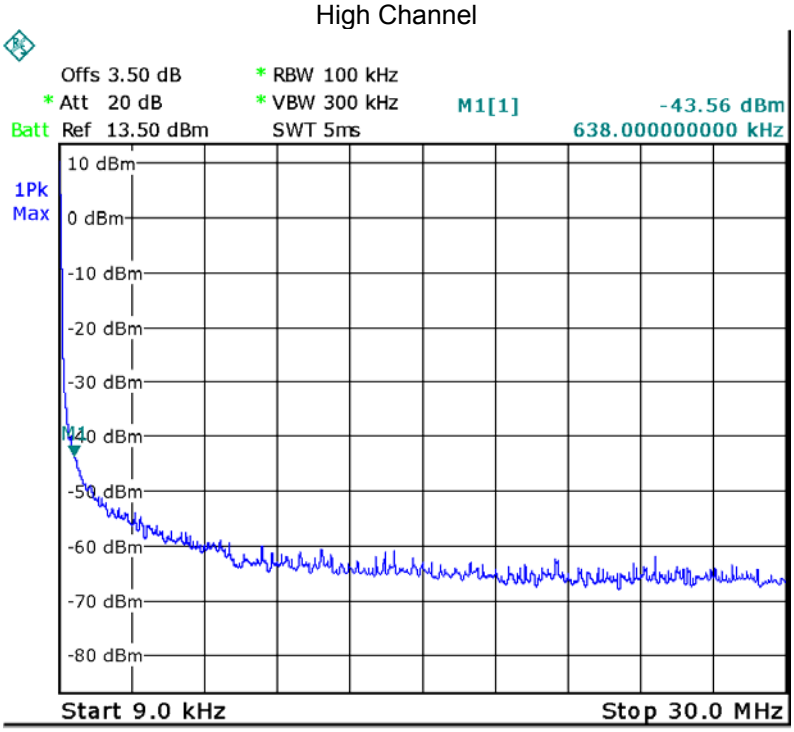
Low Channel




Middle Channel

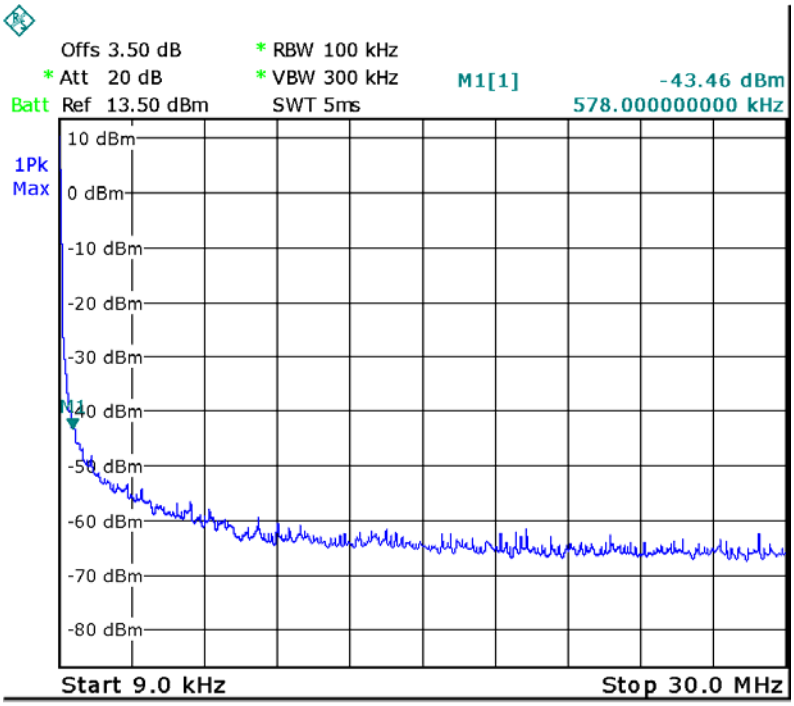


High Channel

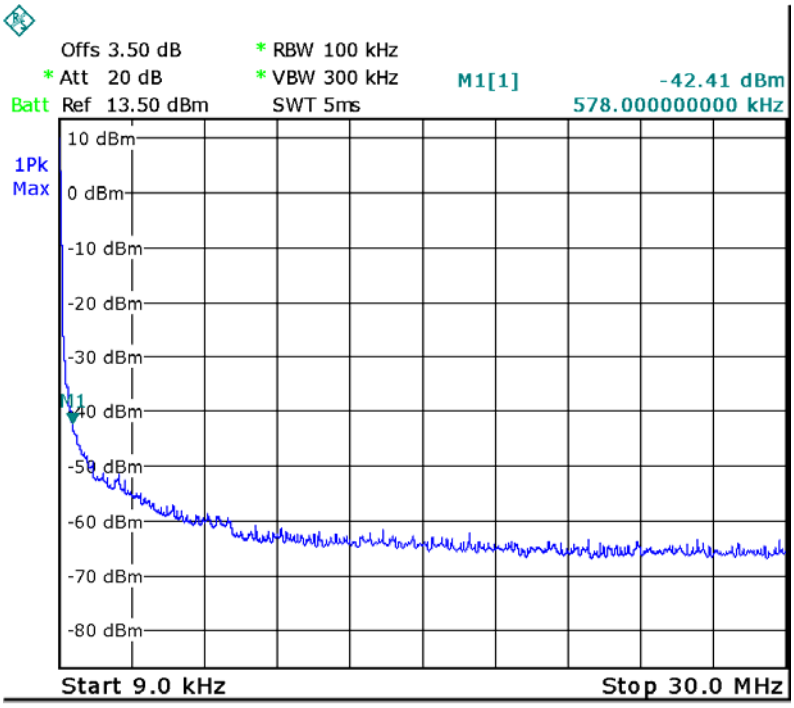



**Pi/4DQPSK**

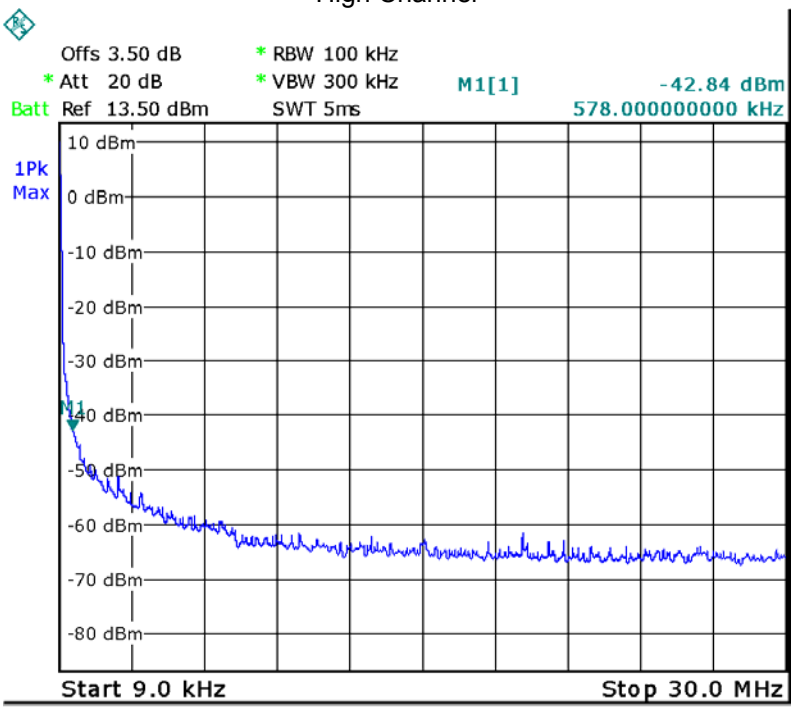
Low Channel



Middle Channel

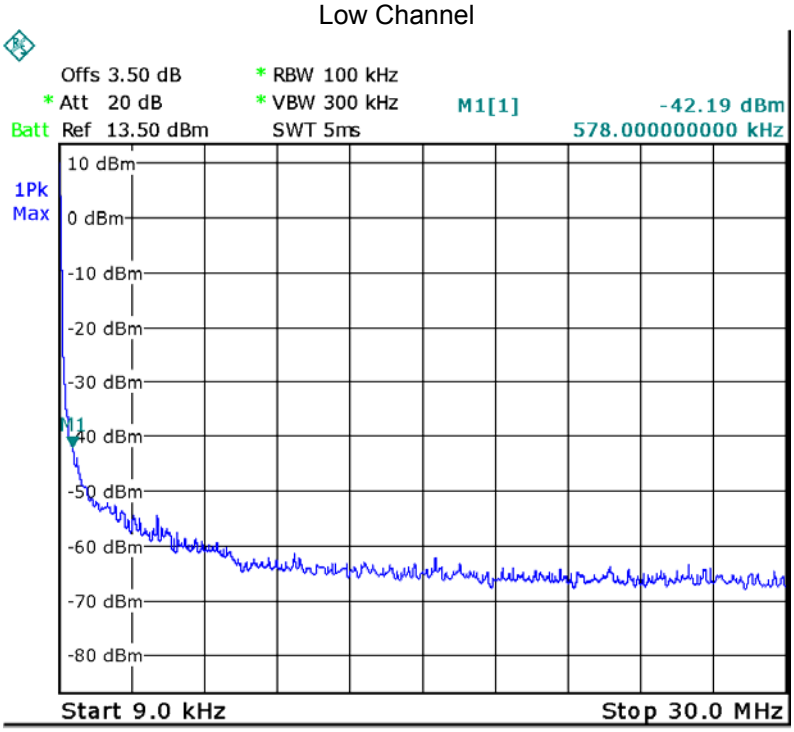



High Channel

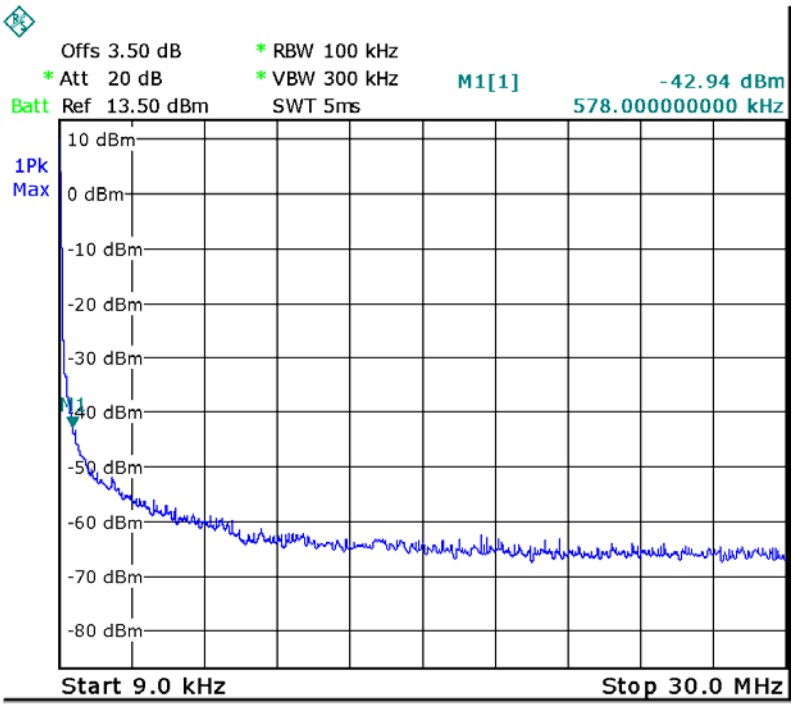


**8DPSK**

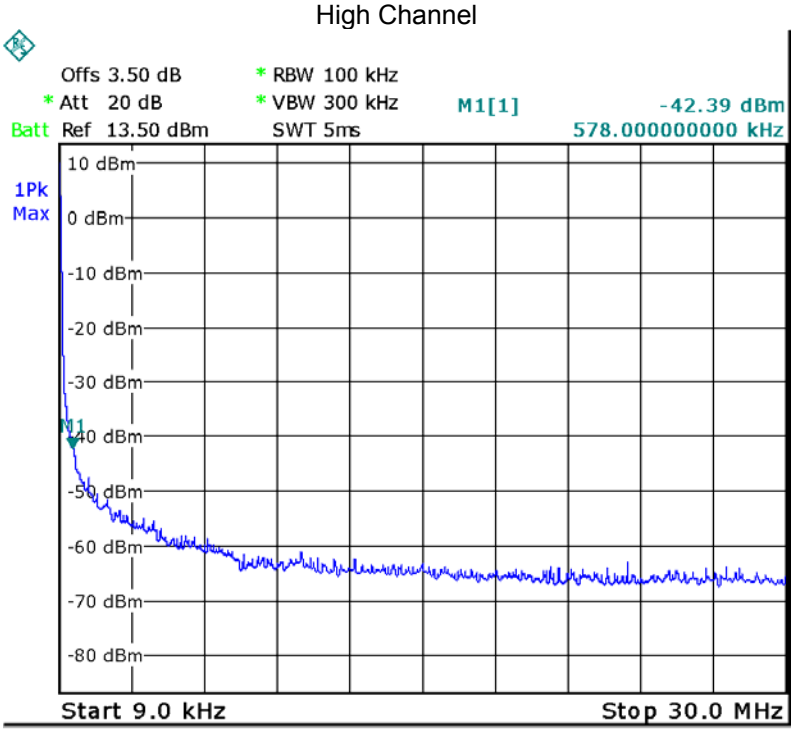
Low Channel




Middle Channel

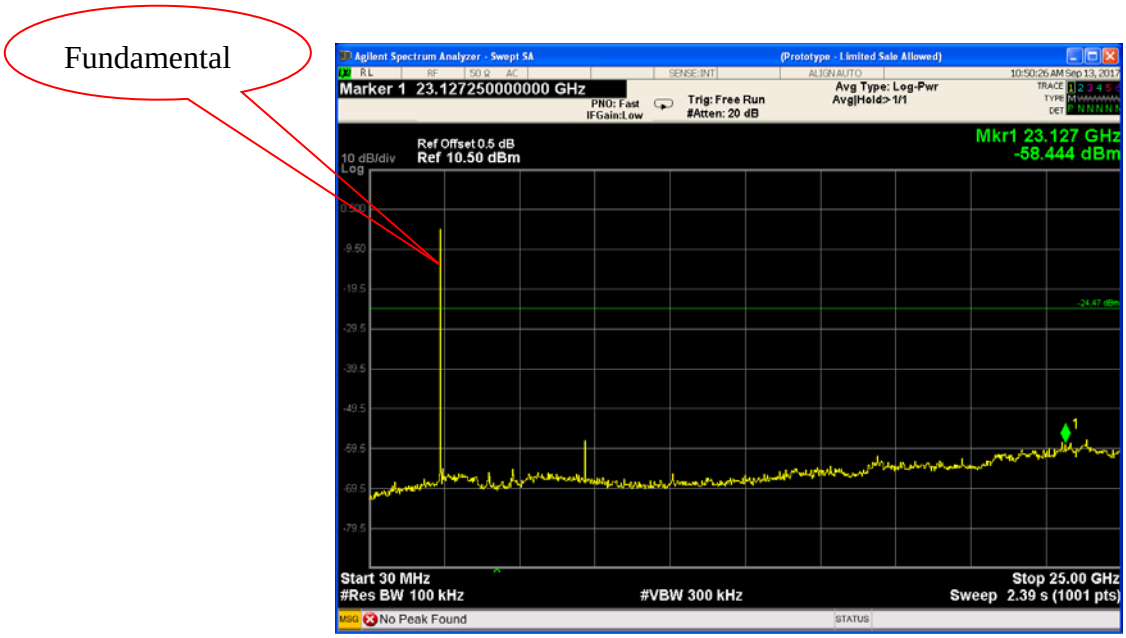


High Channel

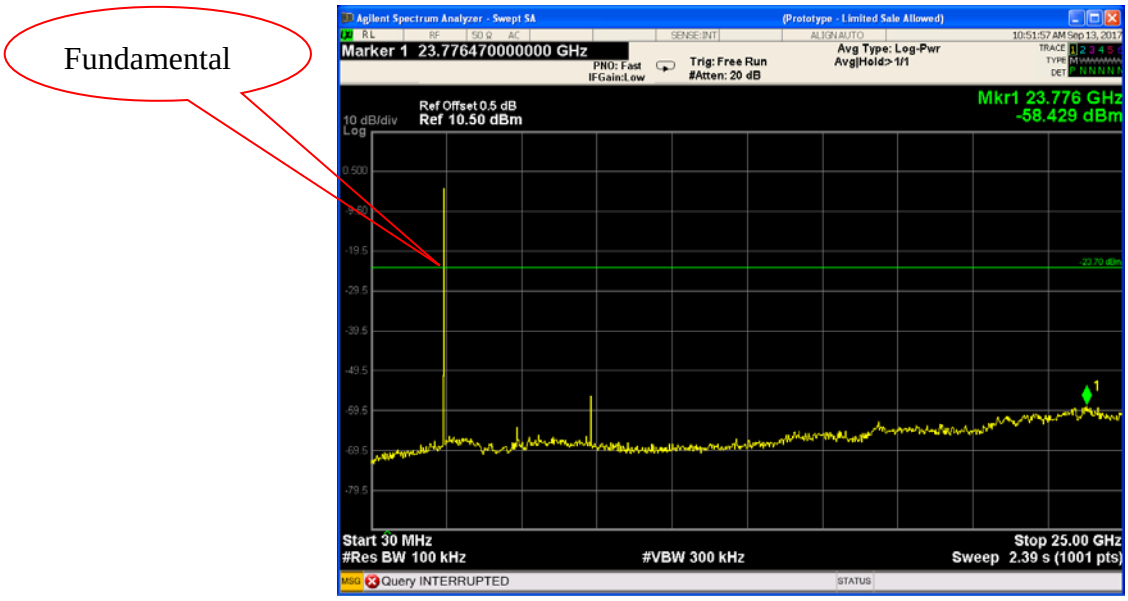



**30MHz – 25GHz**

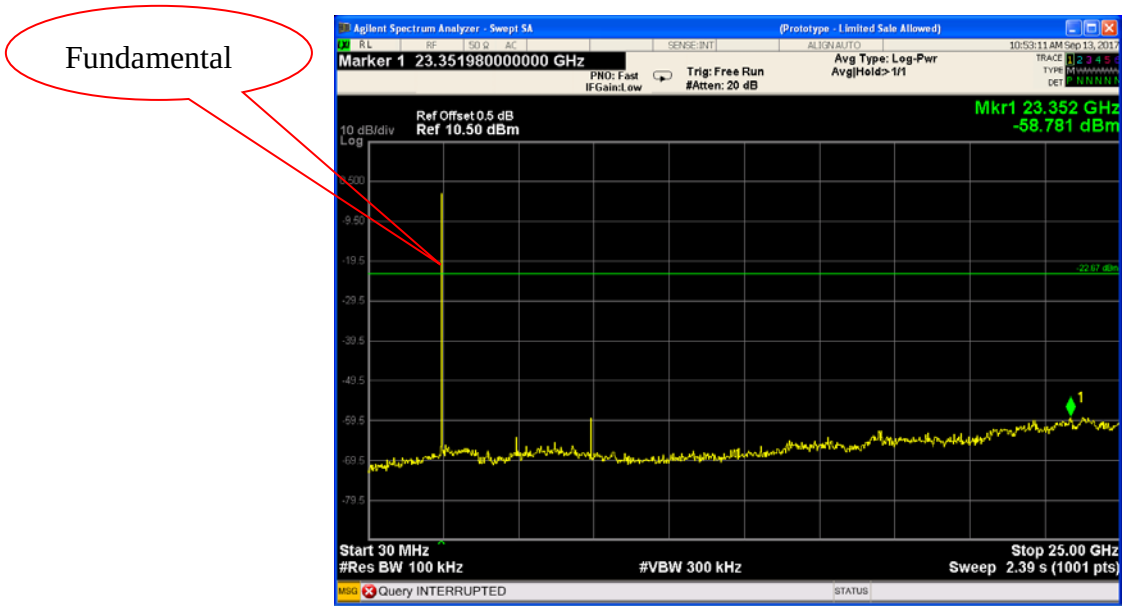
GFSK Low Channel



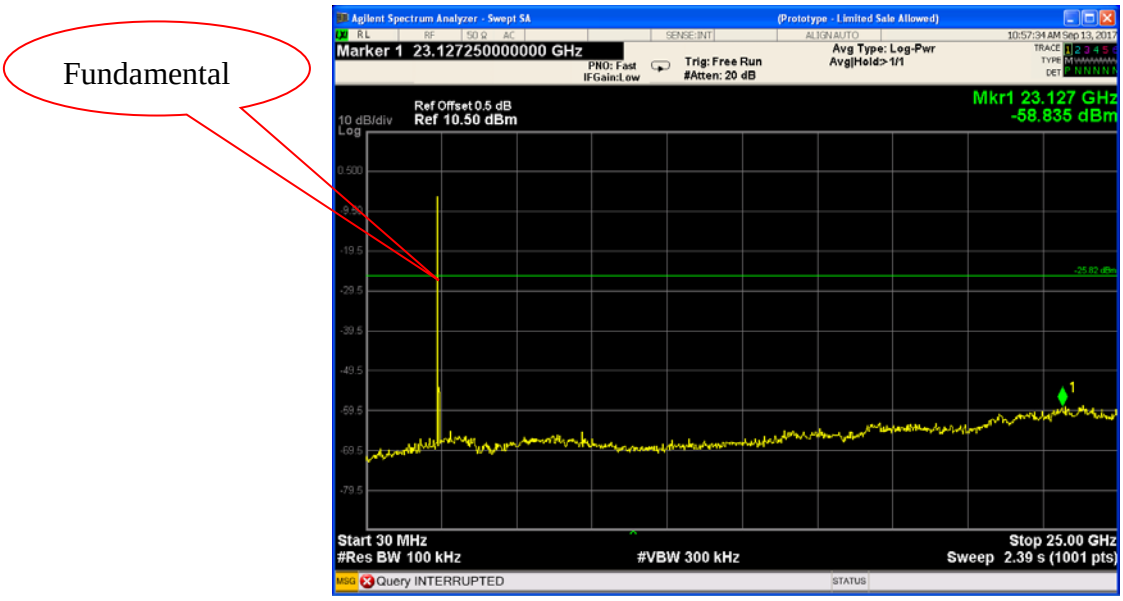
GFSK Middle Channel



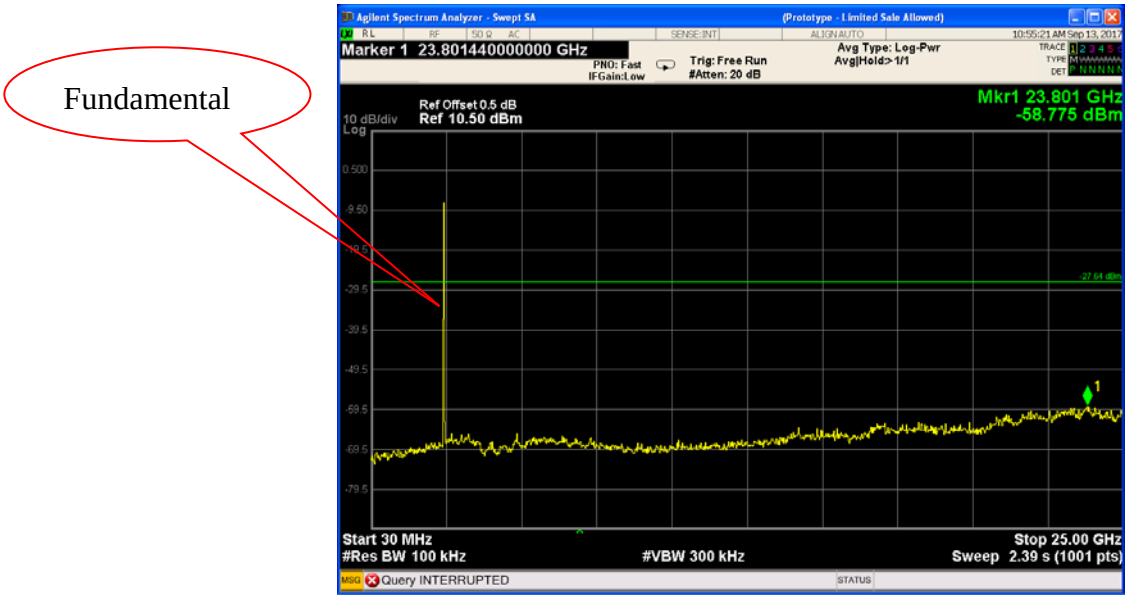

GFSK High Channel



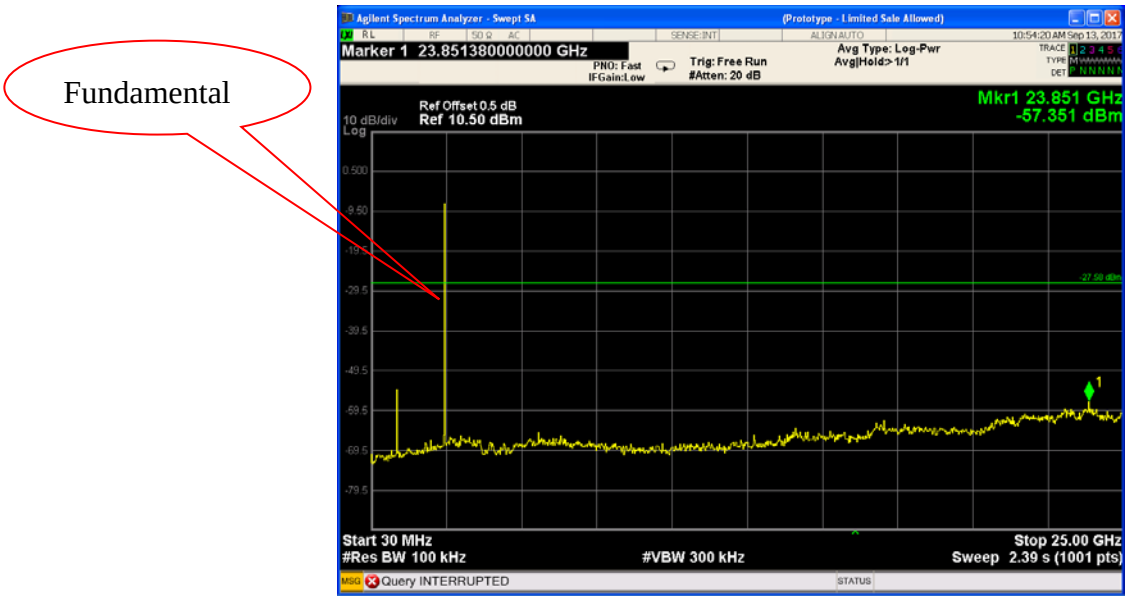
Pi/4 DQPSK Low Channel



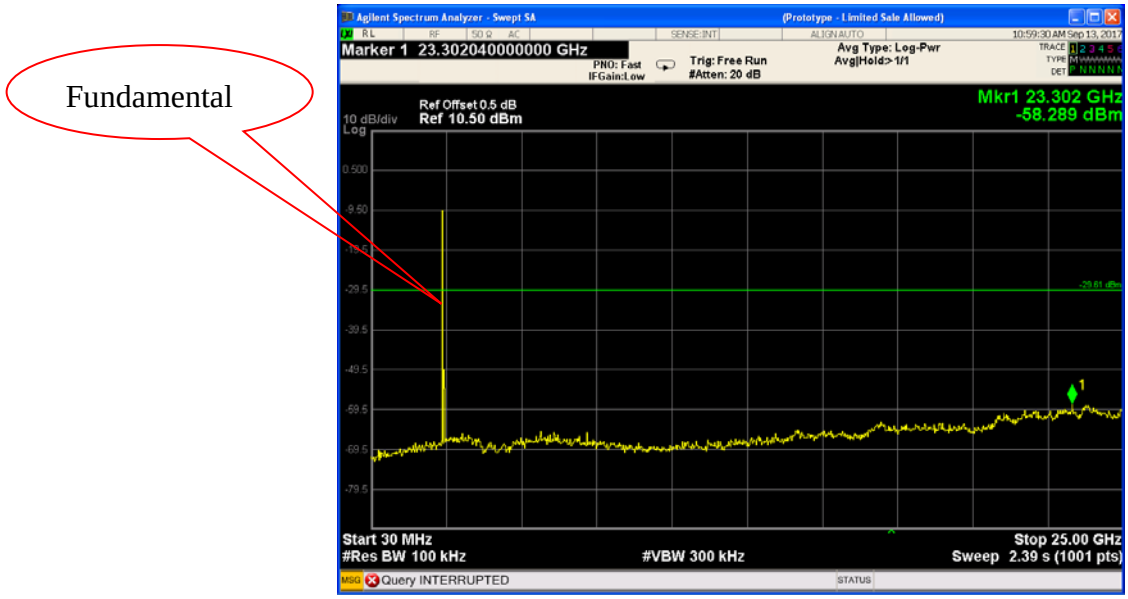

Pi/4 DQPSK Middle Channel



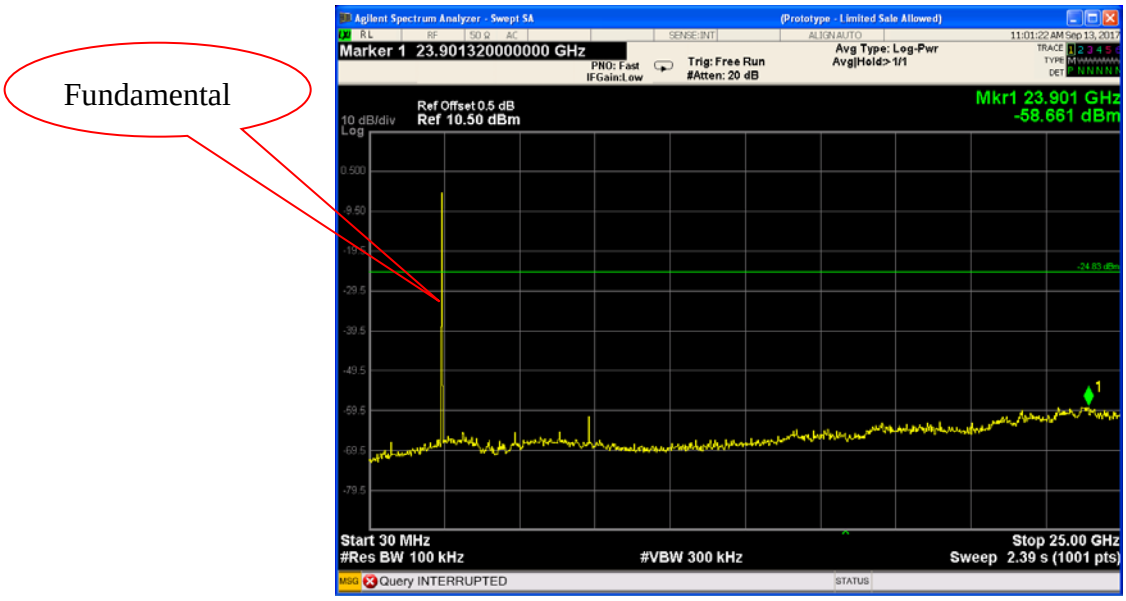
Pi/4 DQPSK High Channel



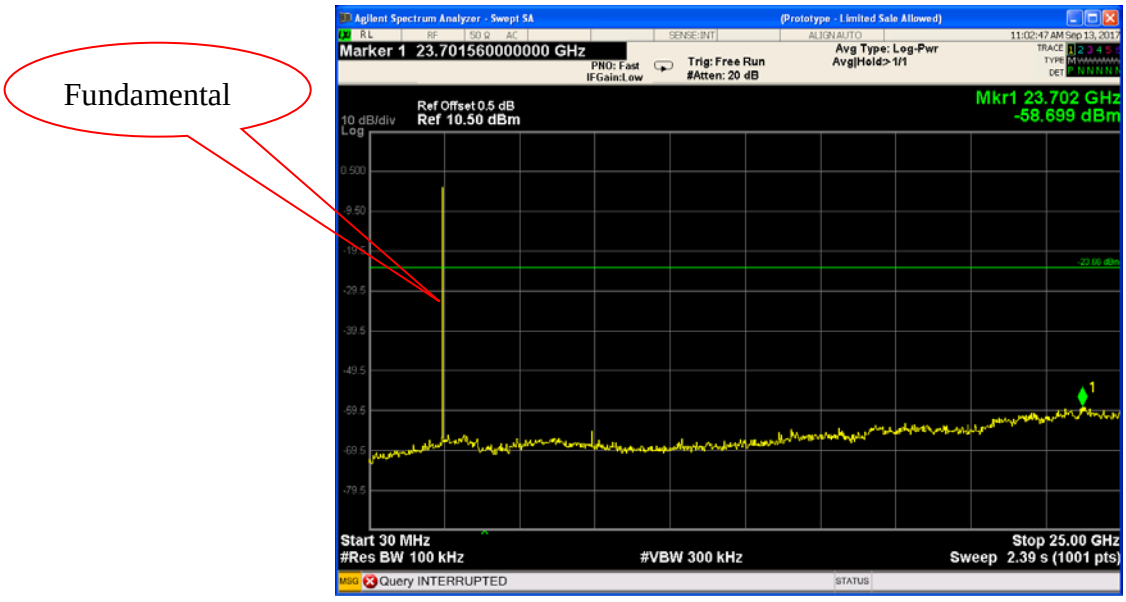

8DPSK Low Channel



8DPSK Middle Channel




8DPSK High Channel



# 10 Band Edge Measurement

| | |
|---|---|
| Test Requirement: | Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)). |
| Test Method: | ANSI C63.10:2013 |
| Test Limit: | Regulation 15.247 (d),In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)). |
| Test Mode: | Transmitting |

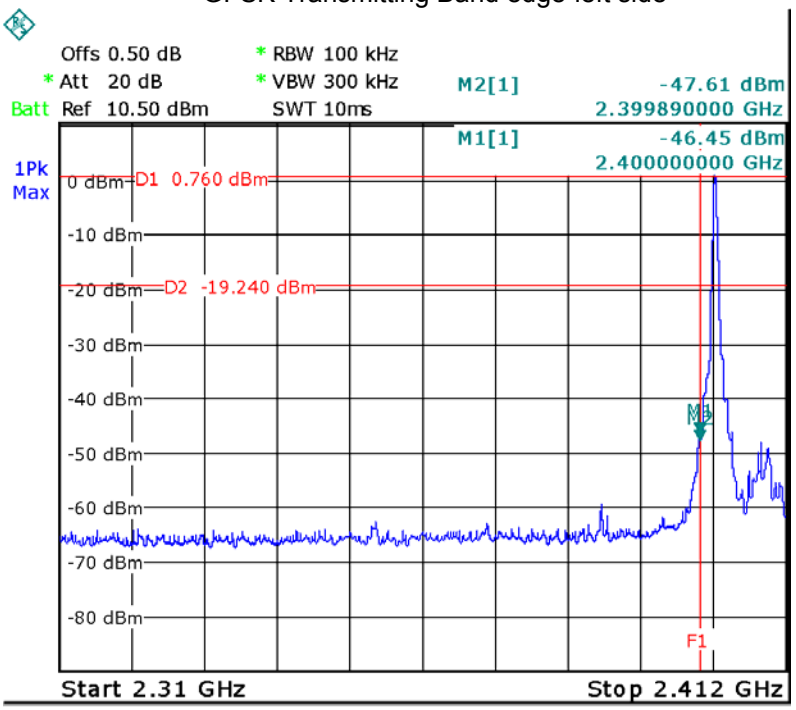
## 10.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz, Sweep = auto
   Detector function = peak, Trace = max hold

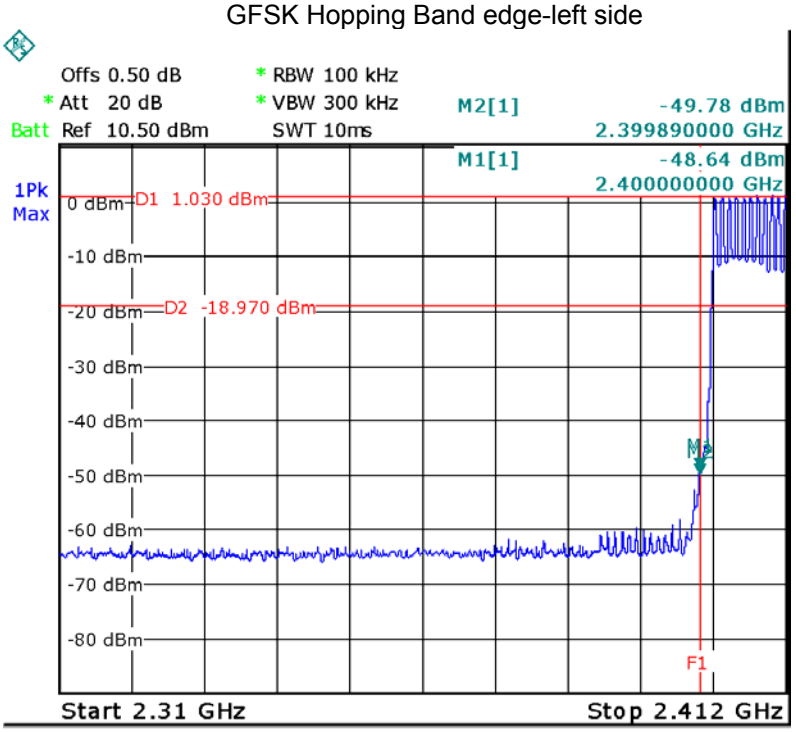
## 10.2 Test Result

Test plots

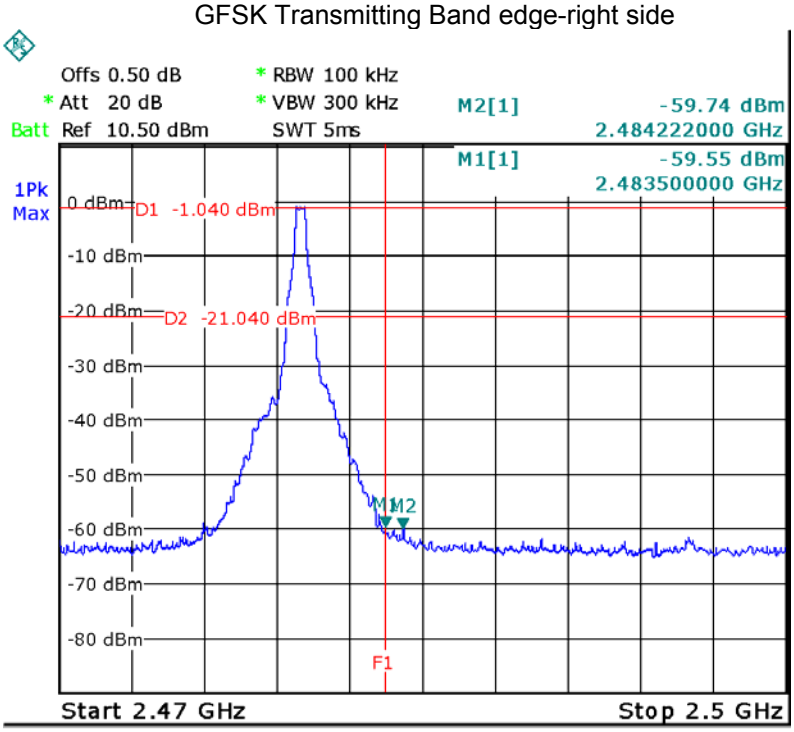
GFSK Transmitting Band edge-left side



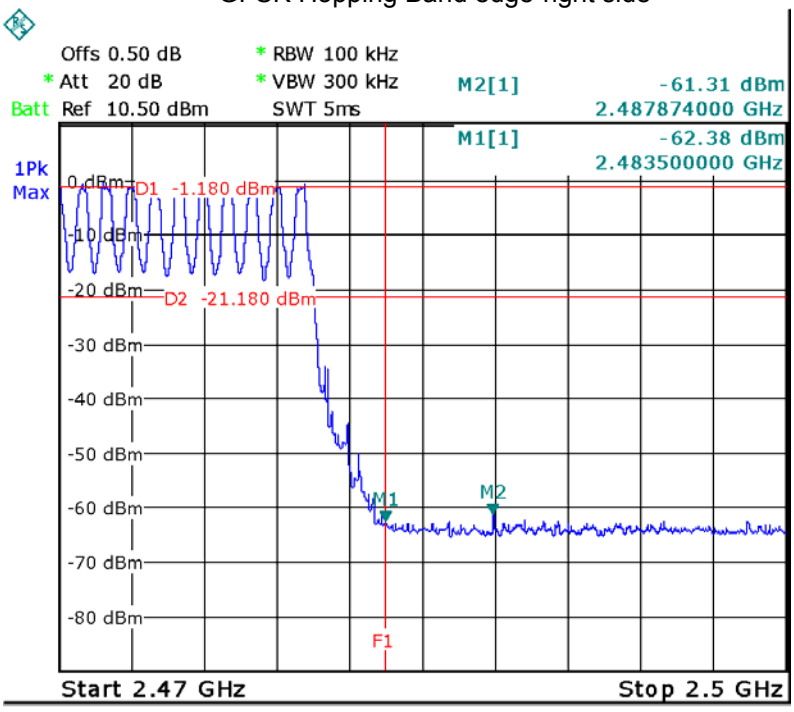

GFSK Hopping Band edge-left side



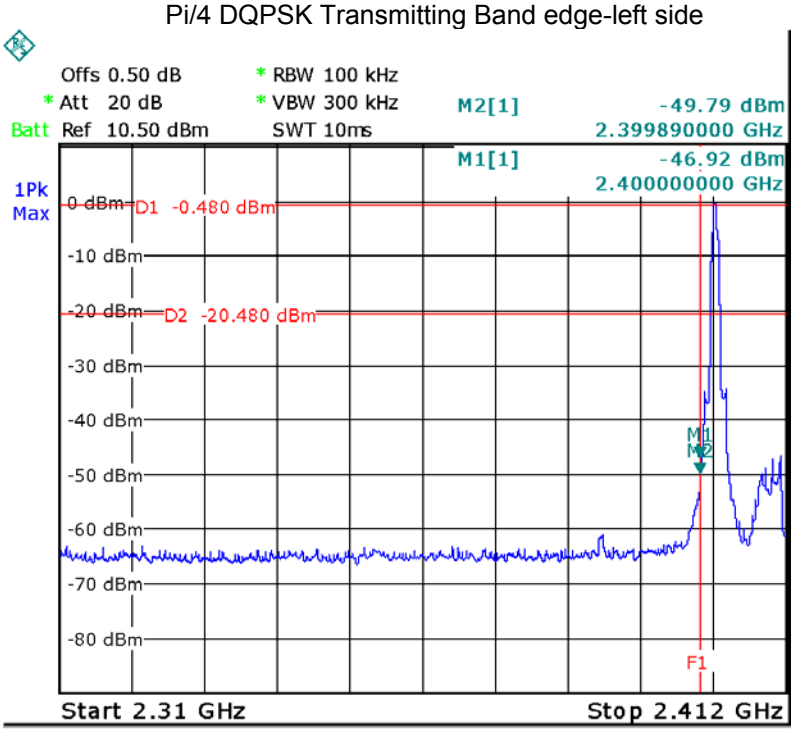
GFSK Transmitting Band edge-right side



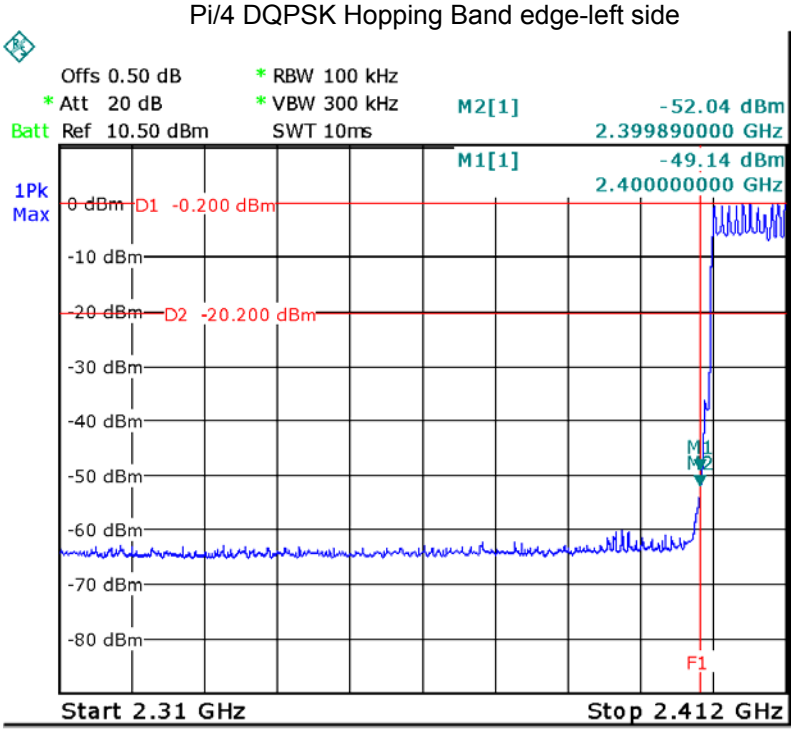

GFSK Hopping Band edge-right side



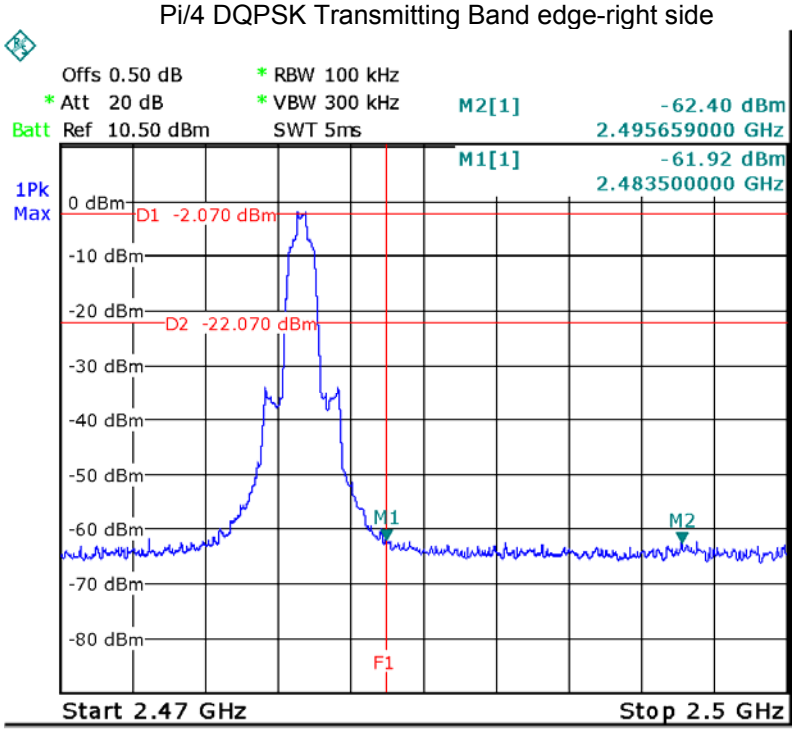
Pi/4 DQPSK Transmitting Band edge-left side



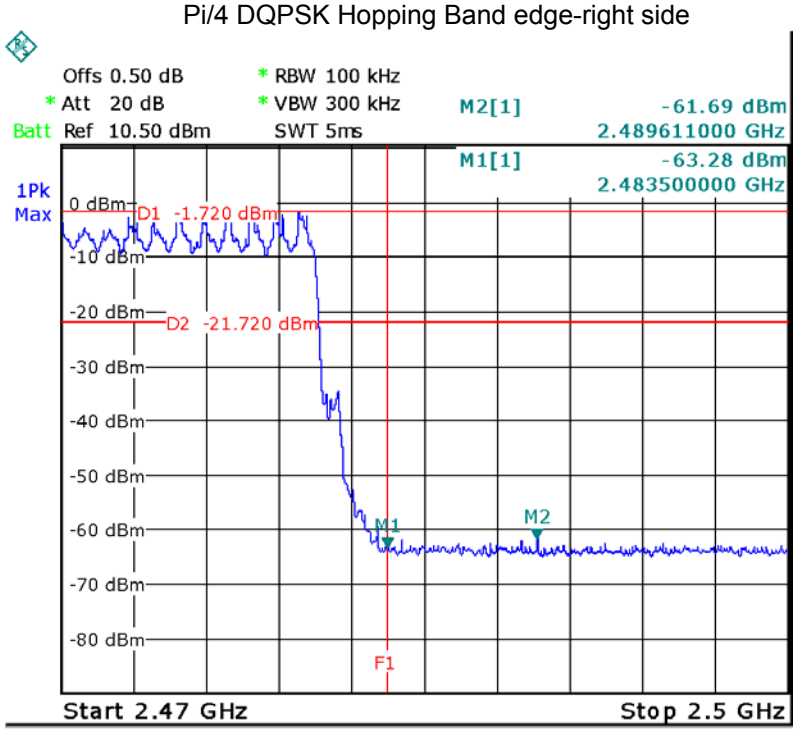

Pi/4 DQPSK Hopping Band edge-left side



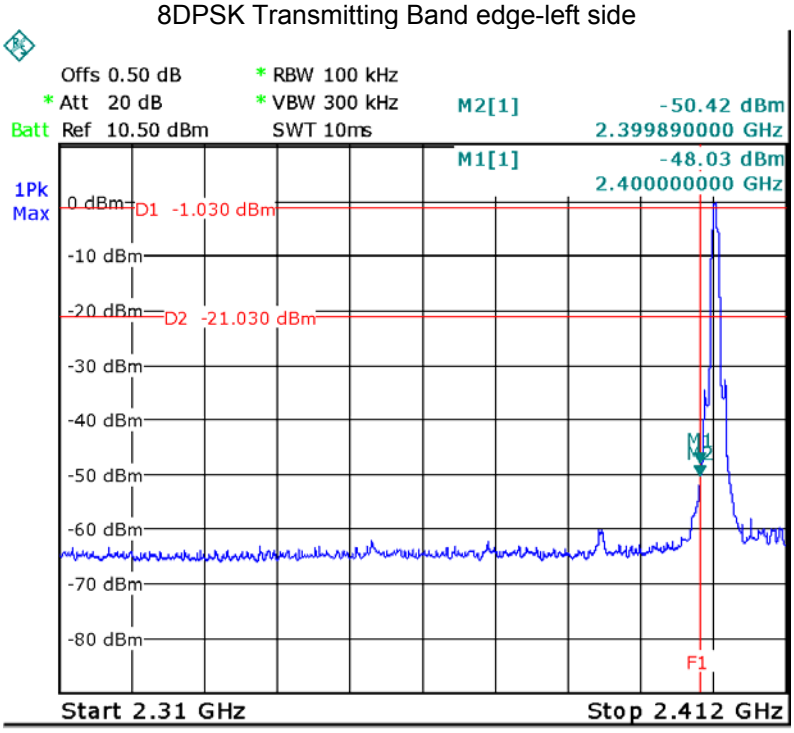
Pi/4 DQPSK Transmitting Band edge-right side



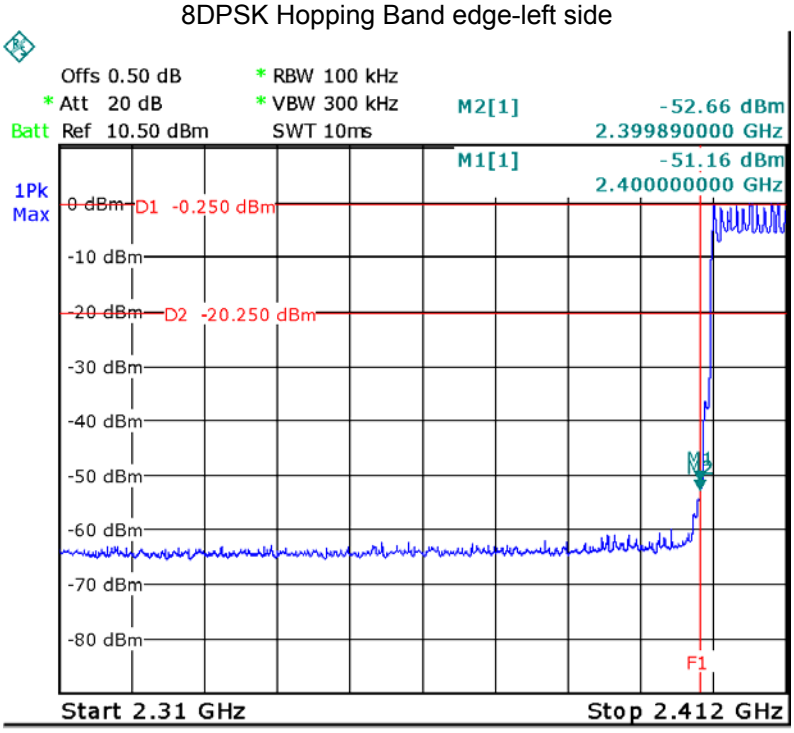

Pi/4 DQPSK Hopping Band edge-right side



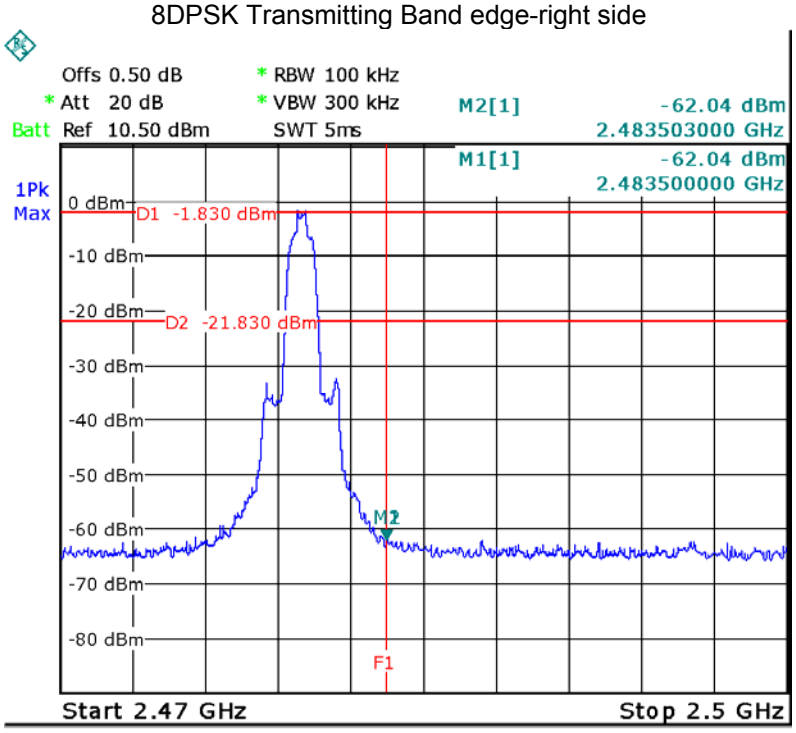
8DPSK Transmitting Band edge-left side



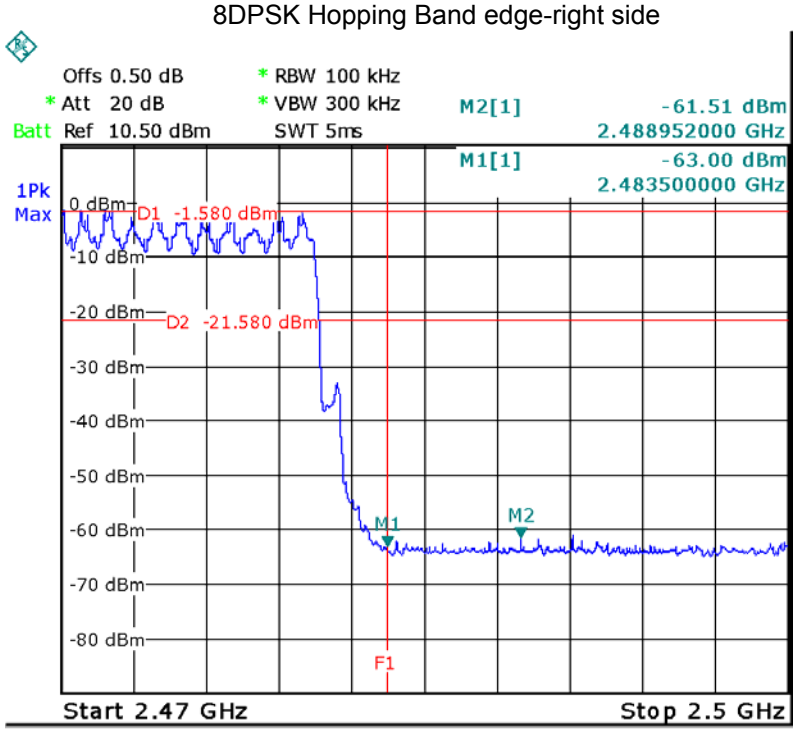

8DPSK Hopping Band edge-left side



8DPSK Transmitting Band edge-right side




8DPSK Hopping Band edge-right side



# 11 Bandwidth Measurement

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: ANSI C63.10:2013

Test Mode: Test in fixing operating frequency at low, Middle, high channel.

## 11.1 Test Procedure

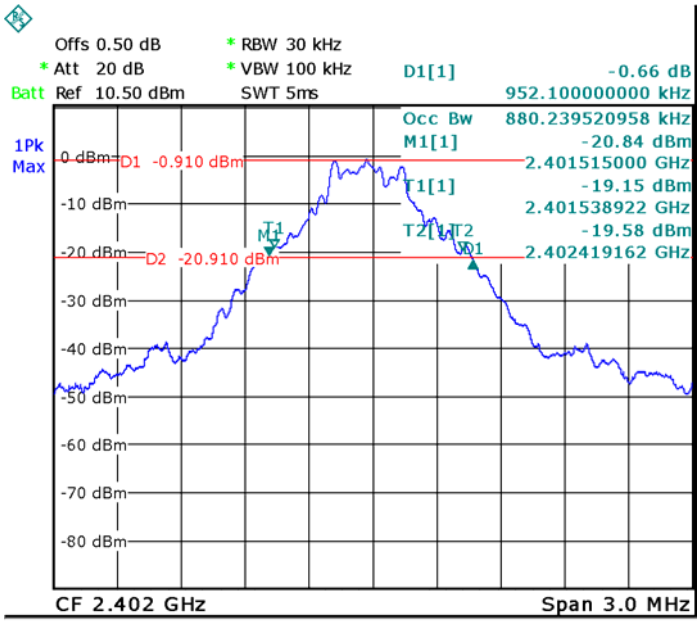
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 30kHz, VBW = 100kHz

## 11.2 Test Result

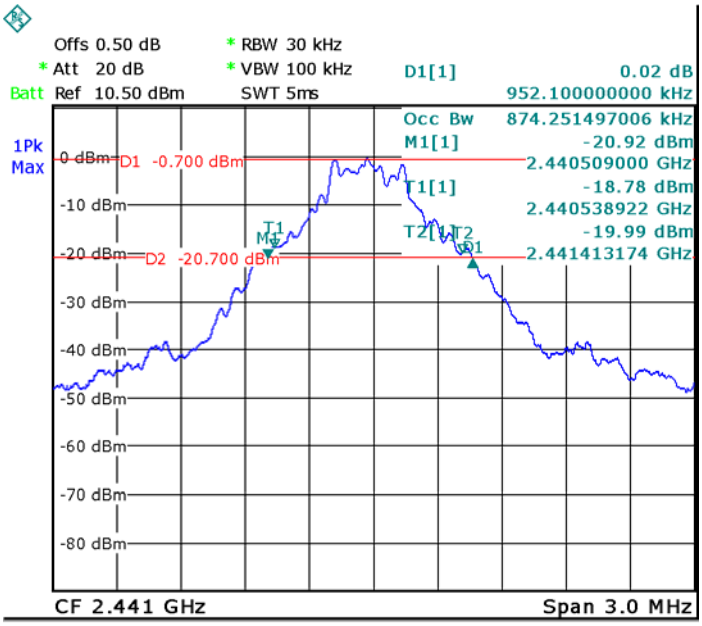
| Modulation | Test Channel | 99% Bandwidth(MHz) | 20dB Bandwidth(MHz) |
|---|---|---|---|
| GFSK | Low | 0.880 | 0.952 |
| GFSK | Middle | 0.874 | 0.952 |
| GFSK | High | 0.868 | 0.952 |
| Pi/4 DQPSK | Low | 1.150 | 1.258 |
| Pi/4 DQPSK | Middle | 1.557 | 1.258 |
| Pi/4 DQPSK | High | 1.162 | 1.258 |
| 8DPSK | Low | 1.162 | 1.264 |
| 8DPSK | Middle | 1.162 | 1.264 |
| 8DPSK | High | 1.174 | 1.264 |

**Test plots**

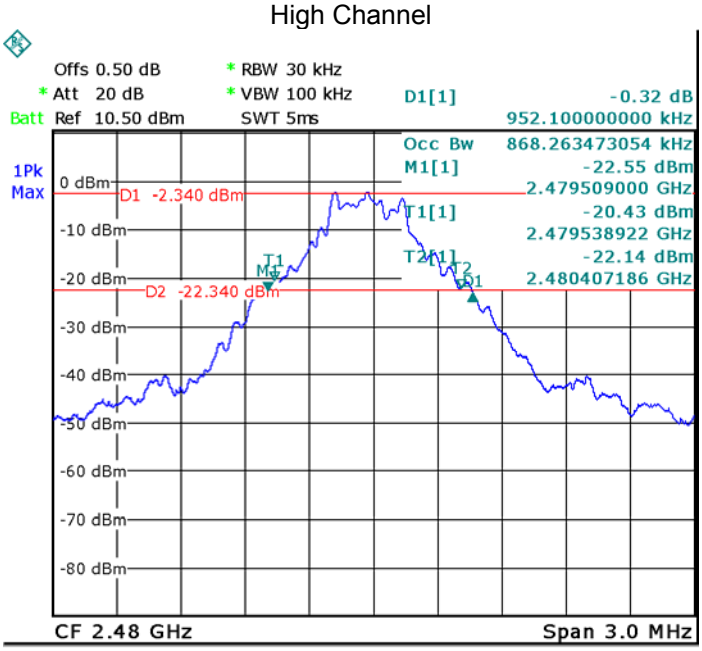
GFSK Low Channel



Middle Channel

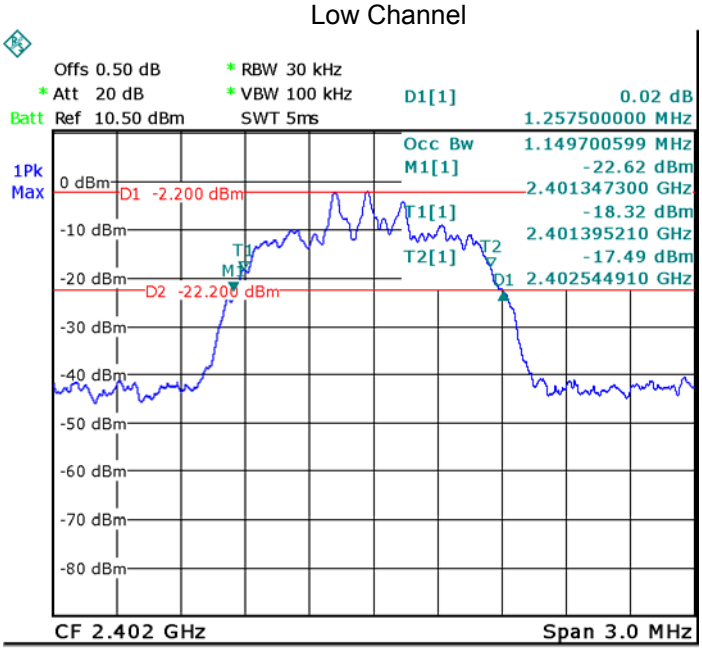



High Channel

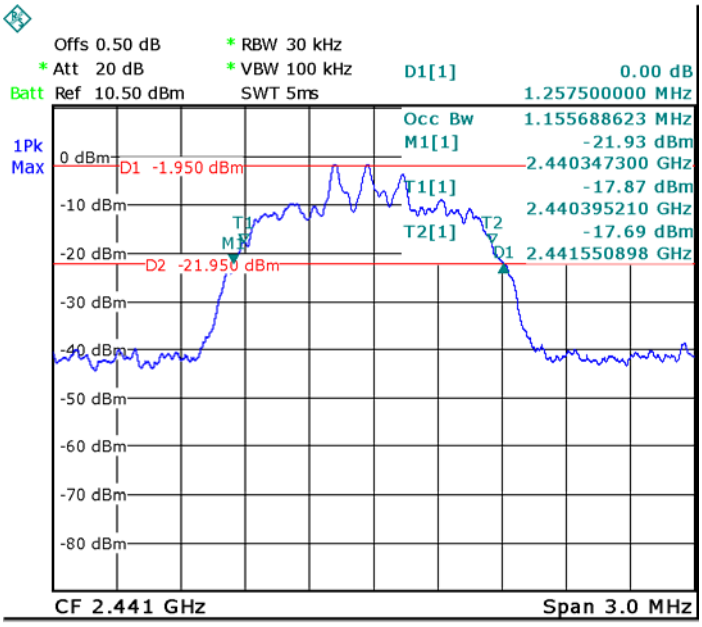


Modulation: Pi/4DQPSK

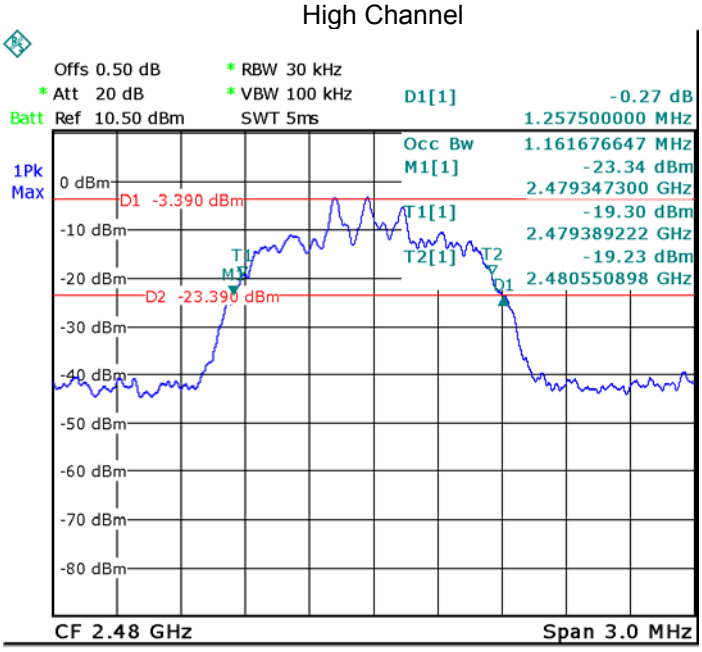
Low Channel




Middle Channel

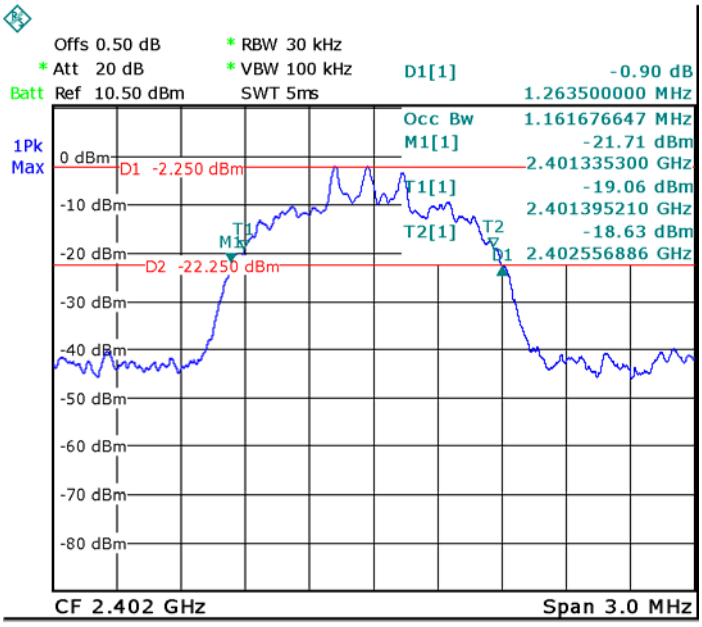


High Channel

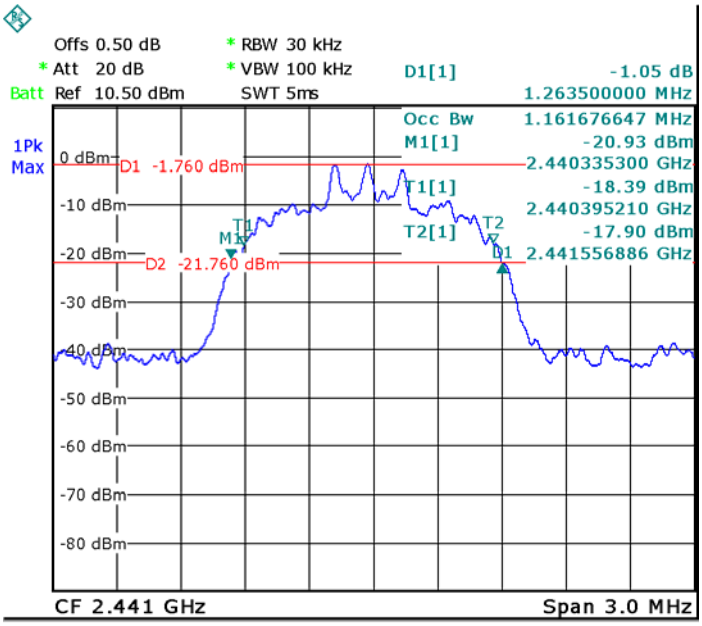



Modulation: 8DPSK

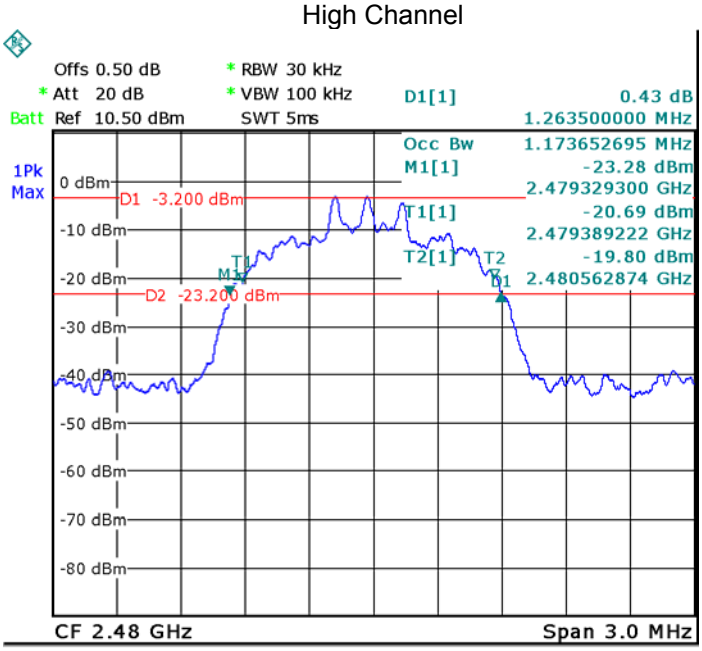
Low Channel



Middle Channel




High Channel



# 12 Maximum Peak Output Power

| | |
|---|---|
| Test Requirement: | FCC CFR47 Part 15 Section 15.247 |
| Test Method: | ANSI C63.10:2013 |
| Test Limit: | Regulation 15.247 (b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts. |
| Test mode: | Test in fixing frequency transmitting mode. |

## 12.1 Test Procedure

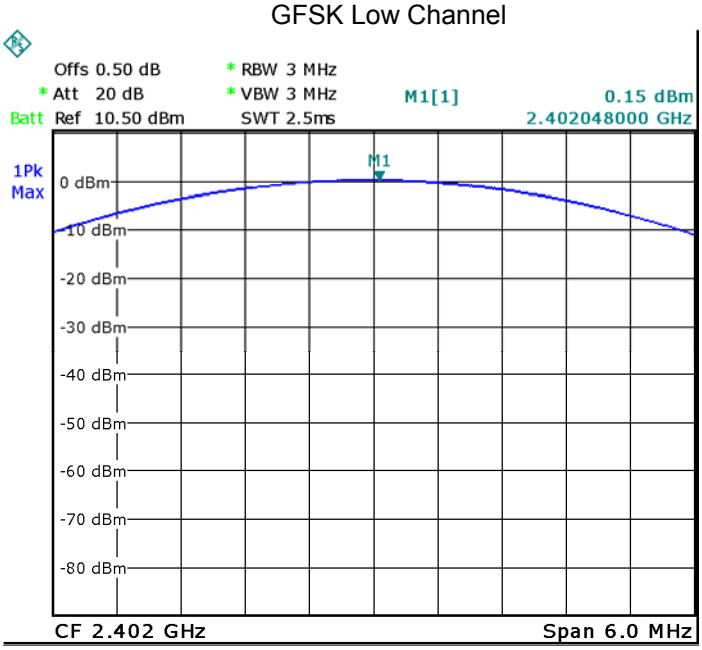
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

## 12.2 Test Result

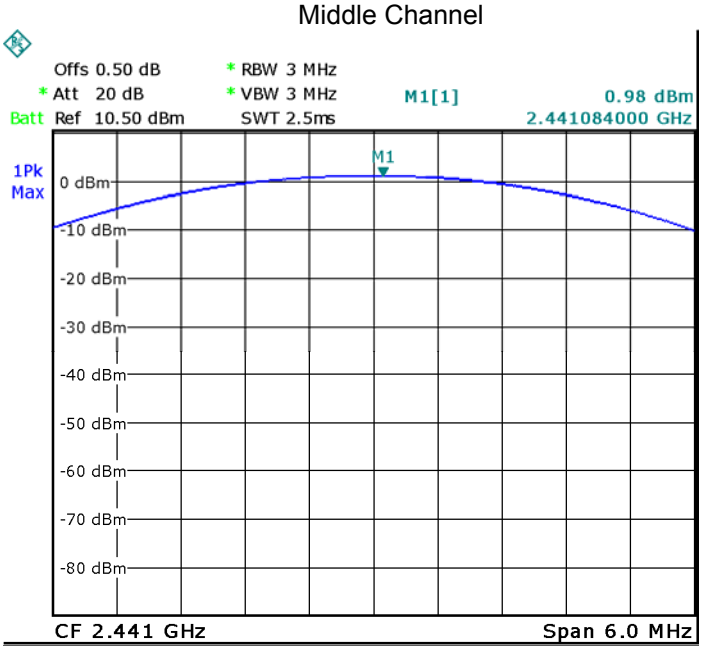
| Modulation | Test Channel | Output Power (dBm) | Limit (dBm) |
|---|---|---|---|
| GFSK | Low | 0.15 | 30 |
| GFSK | Middle | 0.98 | 30 |
| GFSK | High | -0.80 | 30 |
| Pi/4 DQPSK | Low | -0.12 | 21 |
| Pi/4 DQPSK | Middle | -0.11 | 21 |
| Pi/4 DQPSK | High | -1.68 | 21 |
| 8DPSK | Low | 0.15 | 21 |
| 8DPSK | Middle | 0.25 | 21 |
| 8DPSK | High | -1.48 | 21 |

**Test plots**

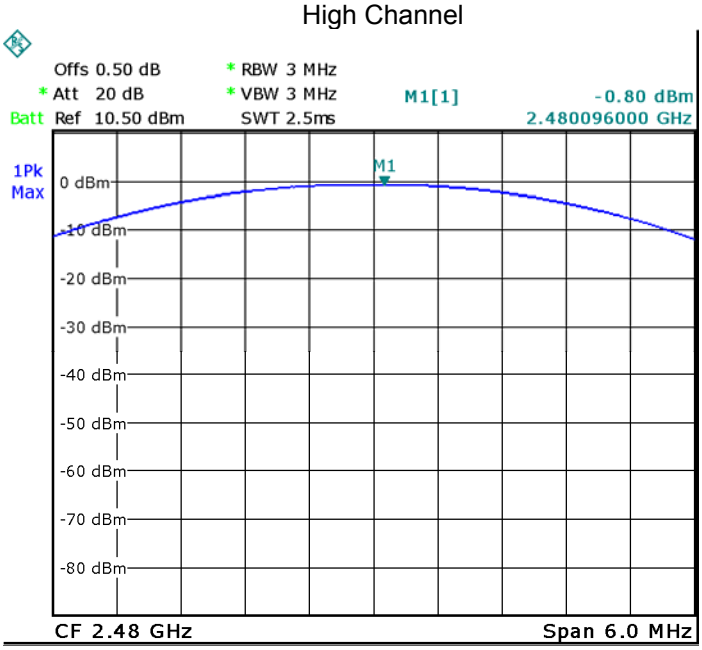
GFSK Low Channel




Middle Channel

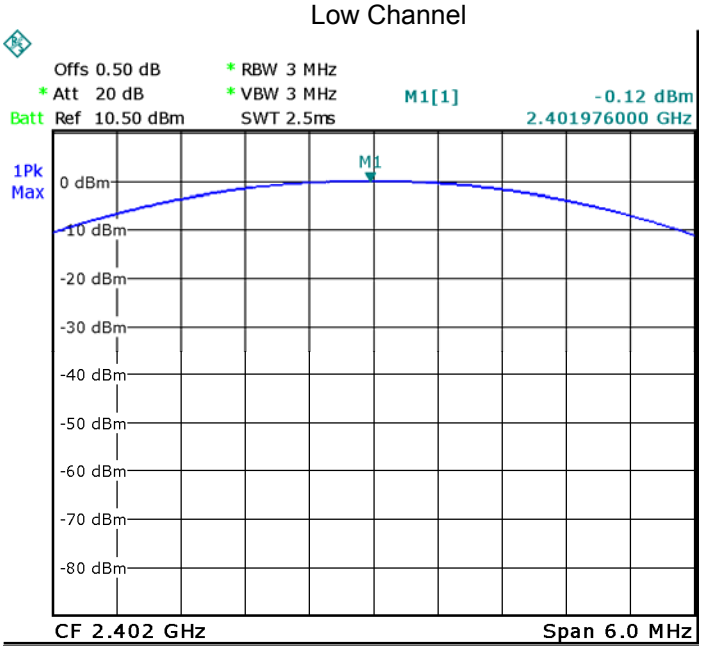


High Channel

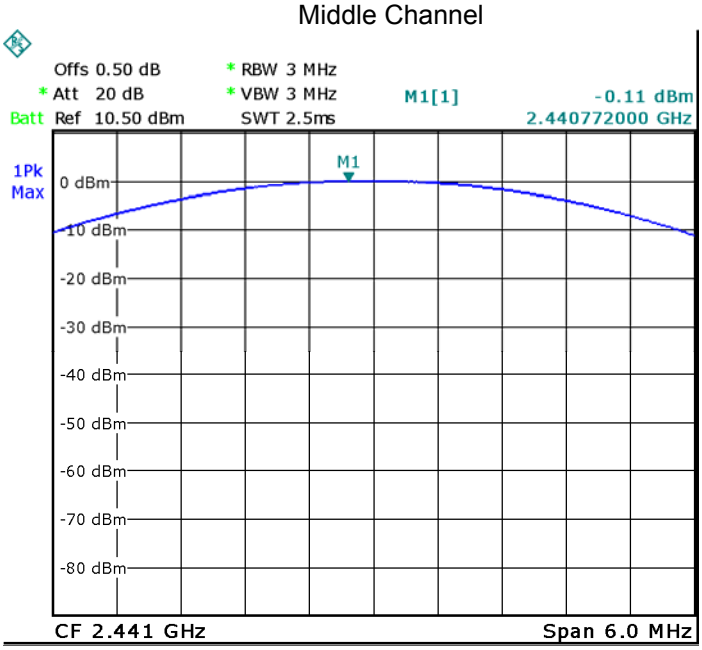



Modulation: Pi/4DQPSK

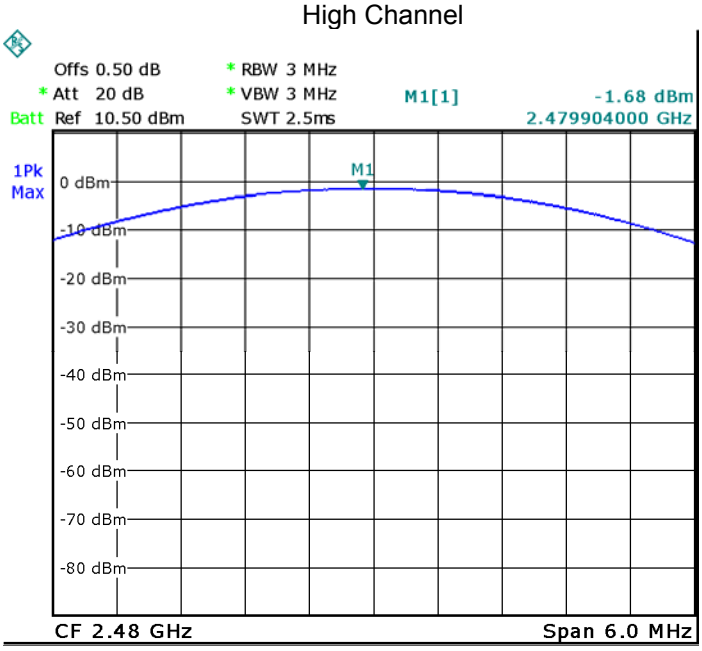
Low Channel



Middle Channel

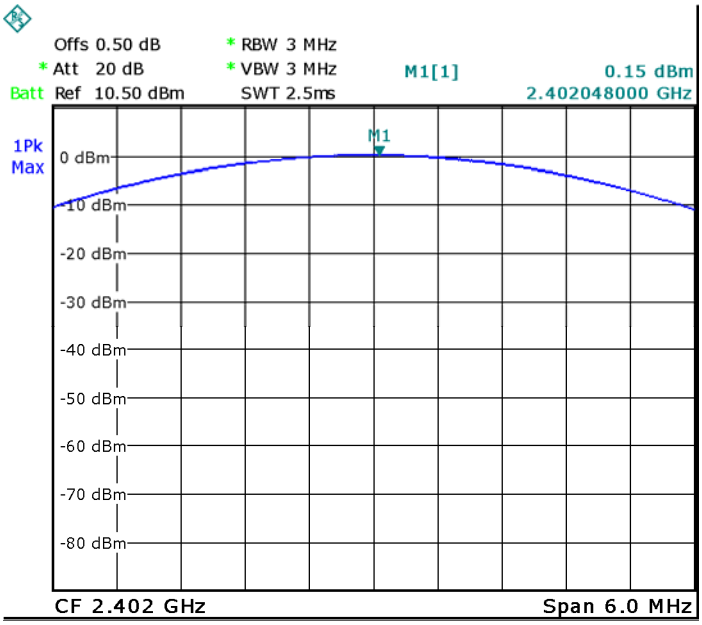



High Channel

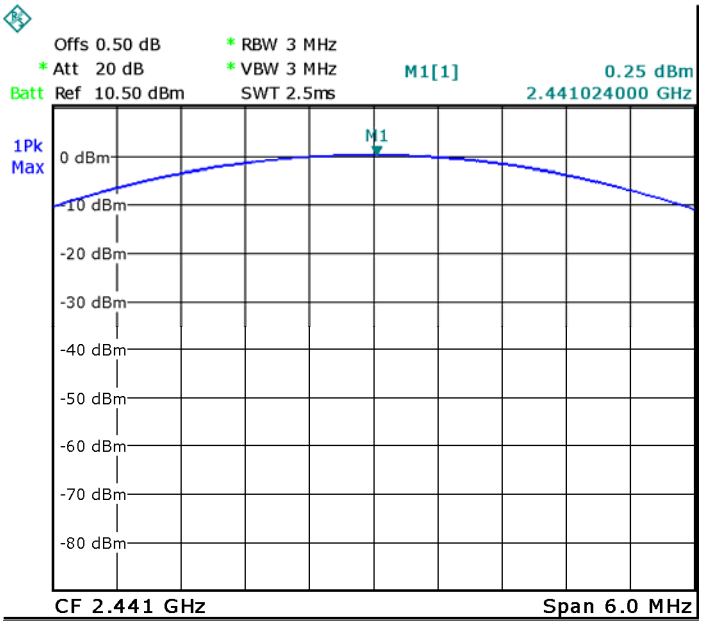


Modulation: 8DPSK

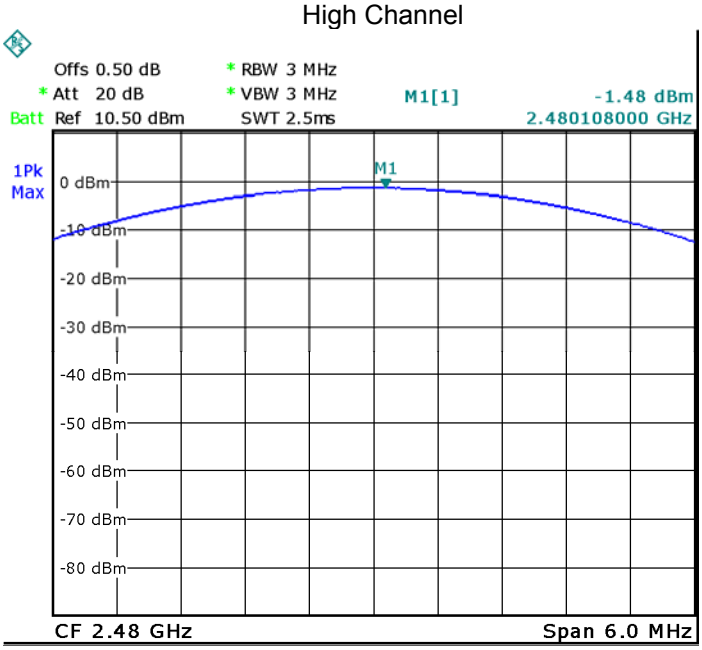
Low Channel




Middle Channel



High Channel



# 13 Hopping Channel Separation

| | |
|---|---|
| Test Requirement: | FCC CFR47 Part 15 Section 15.247 |
| Test Method: | ANSI C63.10:2013 |
| Test Limit: | Regulation 15.247(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125W. |
| Test Mode: | Test in hopping transmitting operating mode. |

## 13.1 Test Procedure

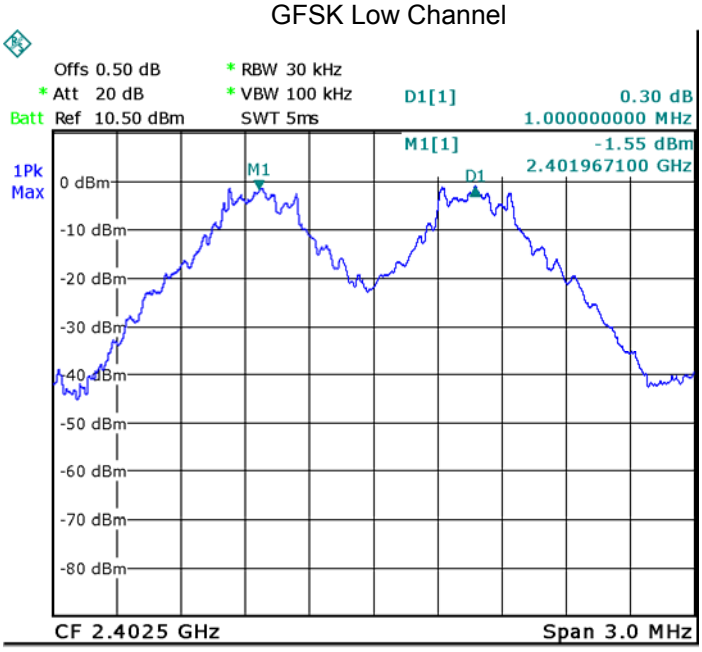
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 30kHz. VBW = 100kHz , Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

## 13.2 Test Result

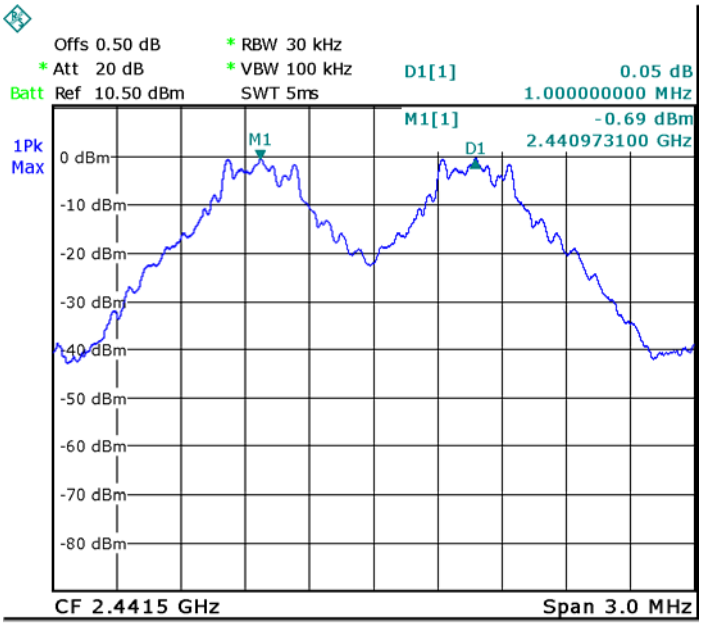
| Modulation | Test Channel | Separation (MHz) | Result |
|---|---|---|---|
| GFSK | Low | 1.000 | PASS |
| GFSK | Middle | 1.000 | PASS |
| GFSK | High | 1.000 | PASS |
| Pi/4 DQPSK | Low | 1.000 | PASS |
| Pi/4 DQPSK | Middle | 1.000 | PASS |
| Pi/4 DQPSK | High | 1.000 | PASS |
| 8DPSK | Low | 1.000 | PASS |
| 8DPSK | Middle | 1.000 | PASS |
| 8DPSK | High | 1.000 | PASS |

**Test plots**

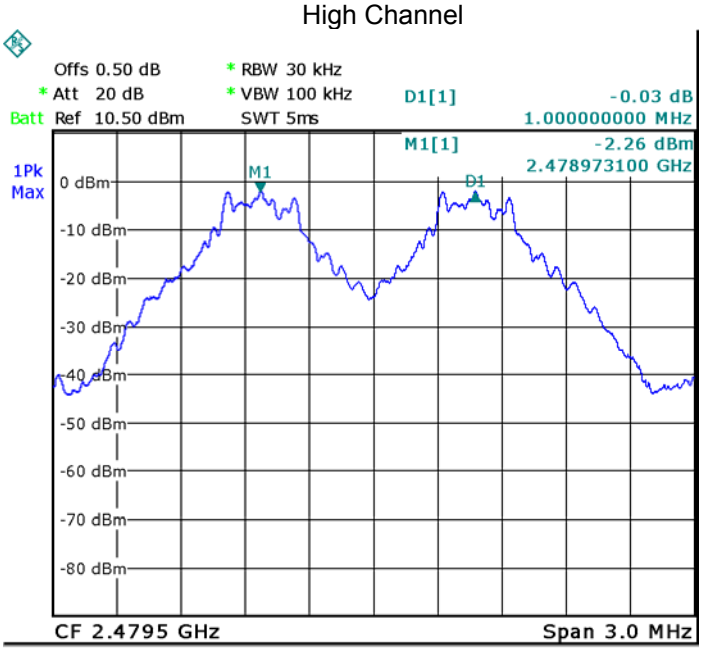
GFSK Low Channel




Middle Channel

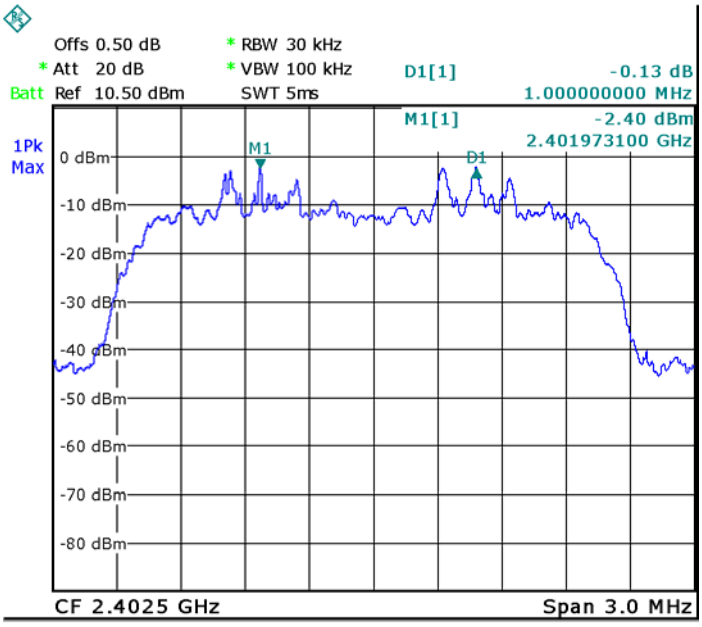


High Channel

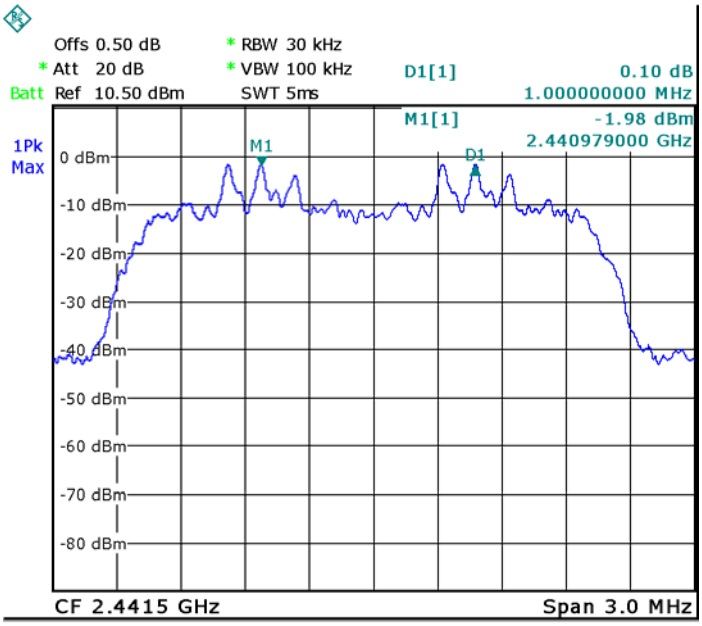



Modulation: Pi/4DQPSK

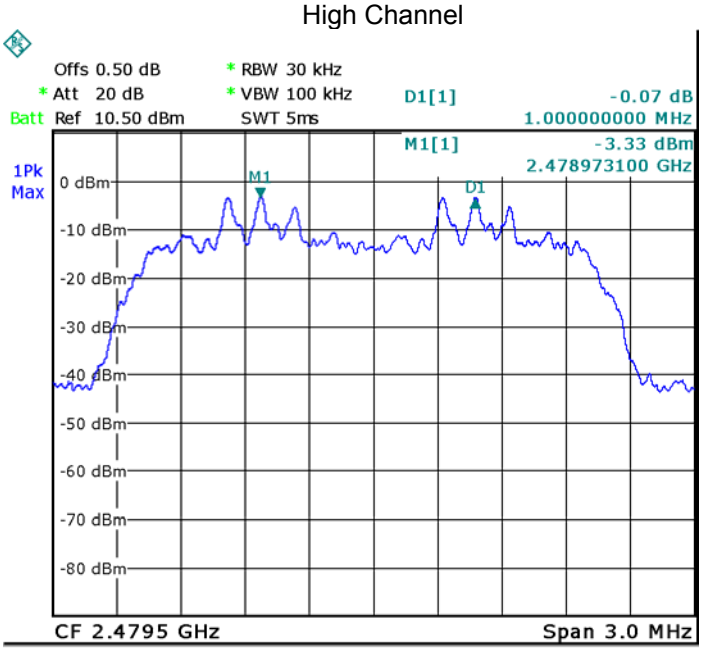
Low Channel



Middle Channel

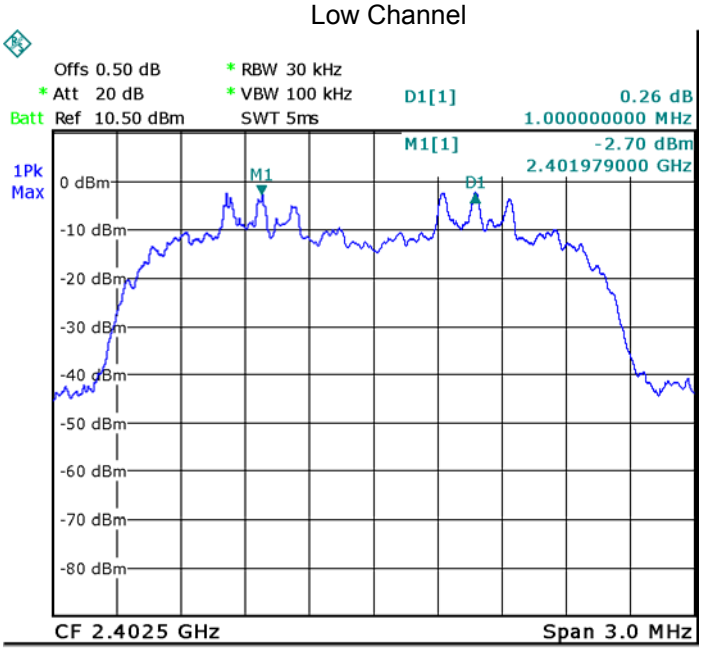



High Channel

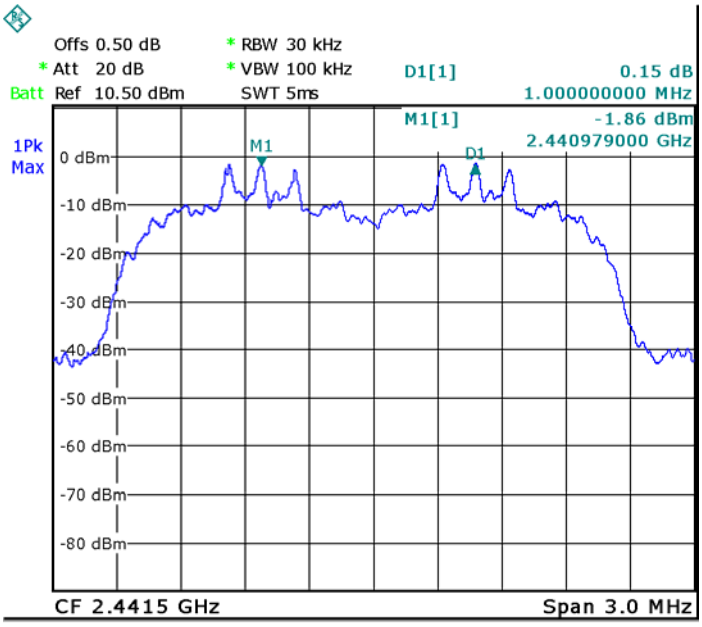


Modulation: 8DPSK

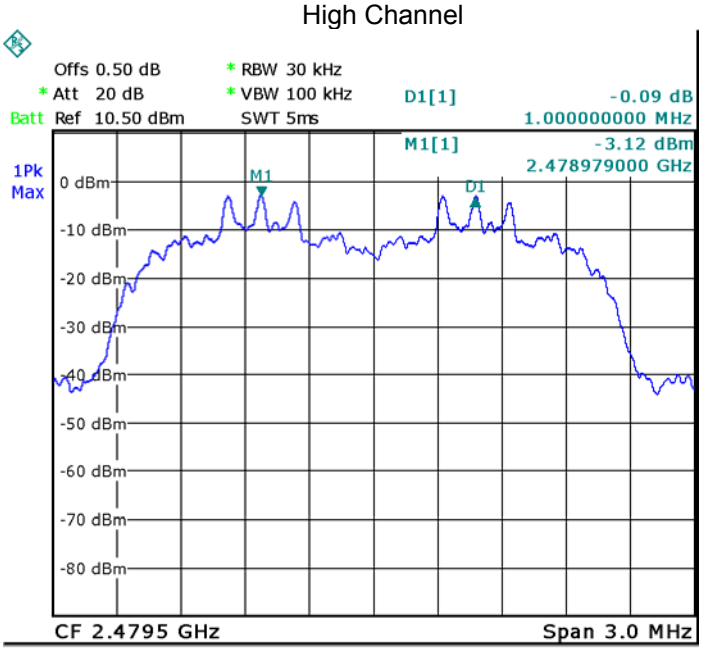
Low Channel




Middle Channel



High Channel



# 14 Number of Hopping Frequency

| | |
|---|---|
| Test Requirement: | FCC CFR47 Part 15 Section 15.247 |
| Test Method: | ANSI C63.10:2013 |
| Test Limit: | Regulation 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. |
| Test Mode: | Test in hopping transmitting operating mode. |

## 14.1 Test Procedure

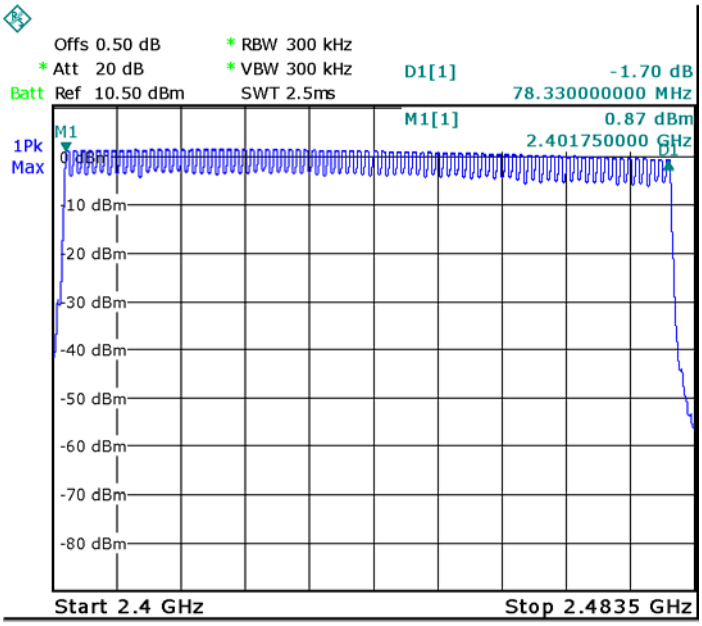
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 300 KHz. VBW = 300 KHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.483GHz. Sweep=auto;

## 14.2 Test Result

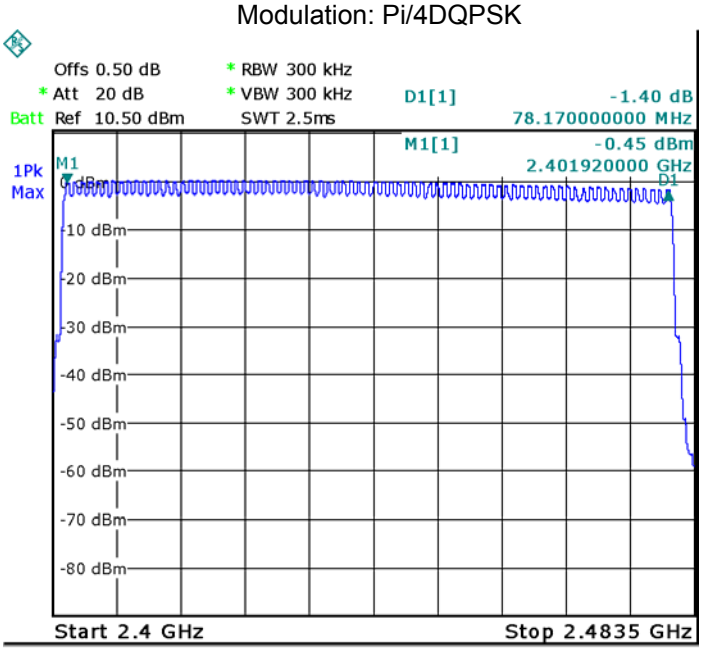
**Test Plots:**

79 Channels in total

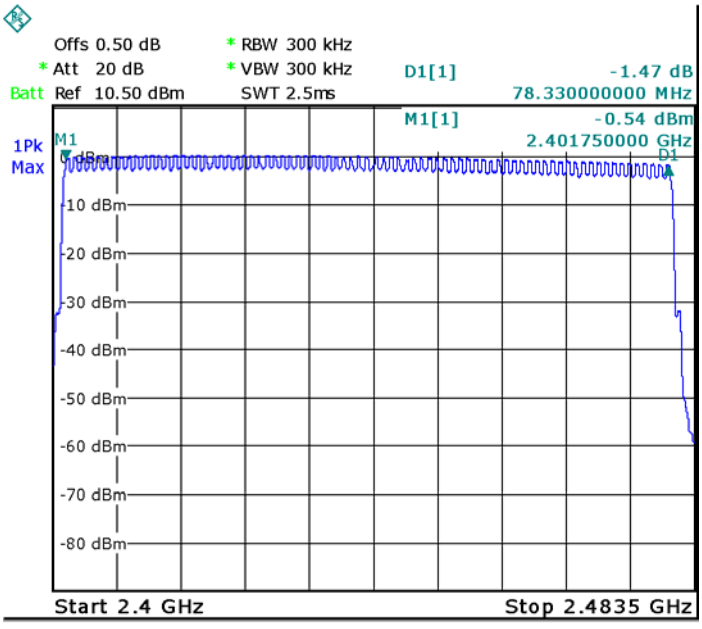
GFSK



Modulation: Pi/4DQPSK




Modulation: 8DPSK



# 15 Dwell Time

| | |
|---|---|
| Test Requirement: | FCC CFR47 Part 15 Section 15.247 |
| Test Method: | ANSI C63.10:2013 |
| Test Limit: | Regulation 15.247(a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used. |
| Test Mode: | Test in hopping transmitting operating mode. |

## 15.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz.Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. 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).

## 15.2 Test Result

DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

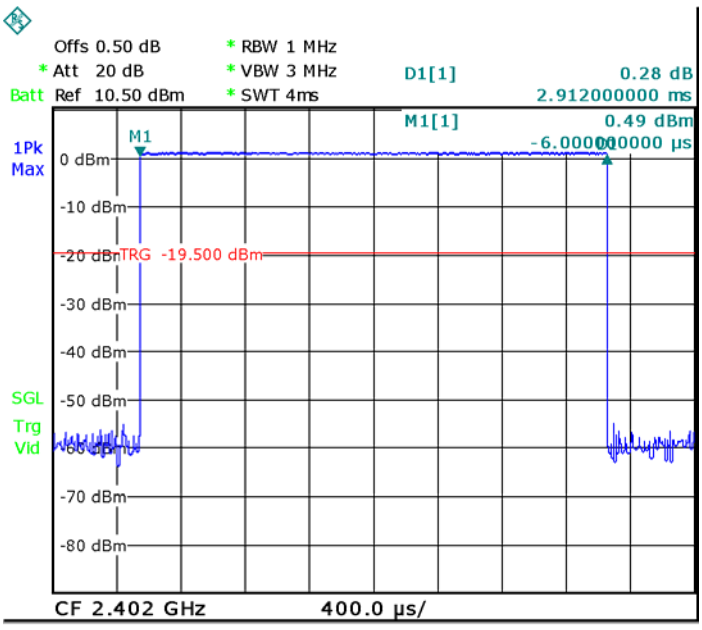
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

| Data Packet | Dwell Time(s) |
|---|---|
| DH5 | 1600/79/6*0.4*79*(MkrDelta)/1000 |
| DH3 | 1600/79/4*0.4*79*(MkrDelta)/1000 |
| DH1 | 1600/79/2*0.4*79*(MkrDelta)/1000 |
| Remark: Mkr Delta is once pulse time. | |

| Modulation | Data Packet | Channel | pulse time(ms) | Dwell Time(s) | Limits(s) |
|---|---|---|---|---|---|
| GFSK | DH5 | Low | 2.912 | 0.311 | 0.4 |
| | | middle | 2.912 | 0.311 | 0.4 |
| | | High | 2.912 | 0.311 | 0.4 |
| Pi/4DQPSK | DH5 | Low | 2.912 | 0.311 | 0.4 |
| | | middle | 2.912 | 0.311 | 0.4 |
| | | High | 2.912 | 0.311 | 0.4 |
| 8DPSK | DH5 | Low | 2.912 | 0.311 | 0.4 |
| | | middle | 2.912 | 0.311 | 0.4 |
| | | High | 2.912 | 0.311 | 0.4 |

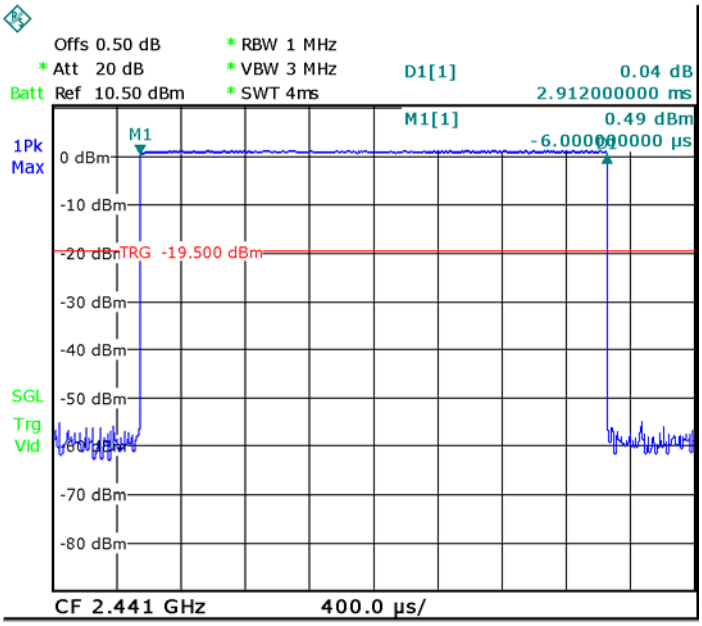
Remark: Only the worst-case is recorded.

Test Plots
GFSK DH5 Low Channel



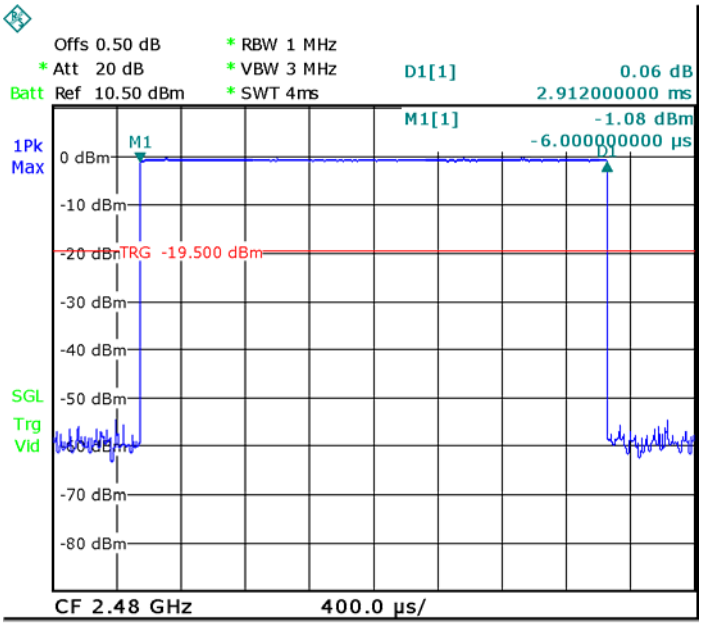
Data Packet:

DH5.Middle channel




Data Packet:

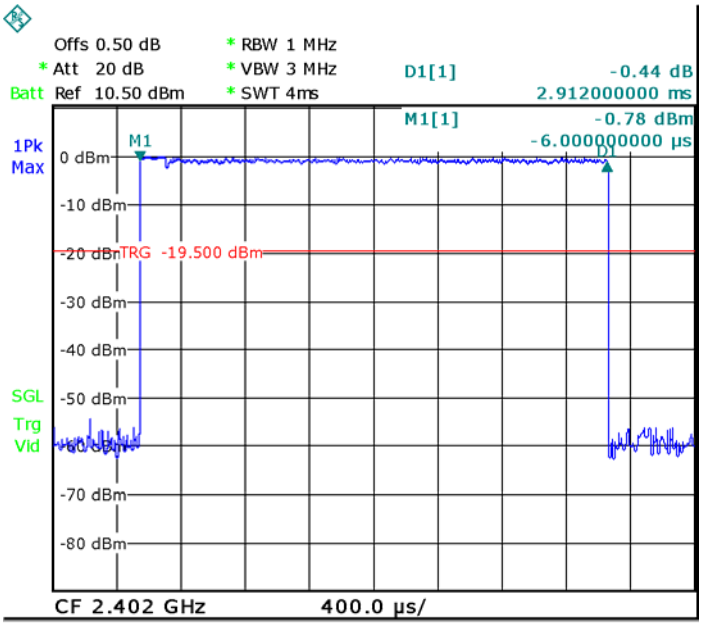
DH5, High channel



Pi/4DQPSK

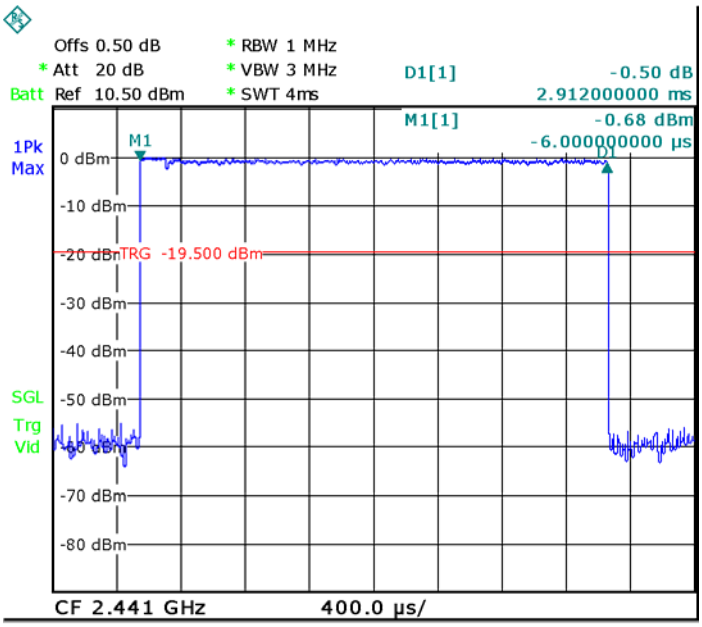
Data Packet:

DH5, Low channel



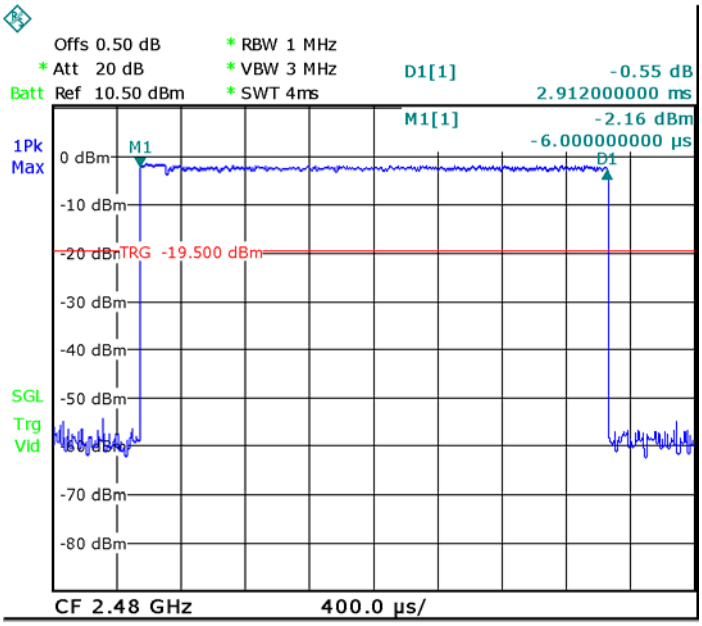

Data Packet:

DH5, Middle channel



Data Packet:

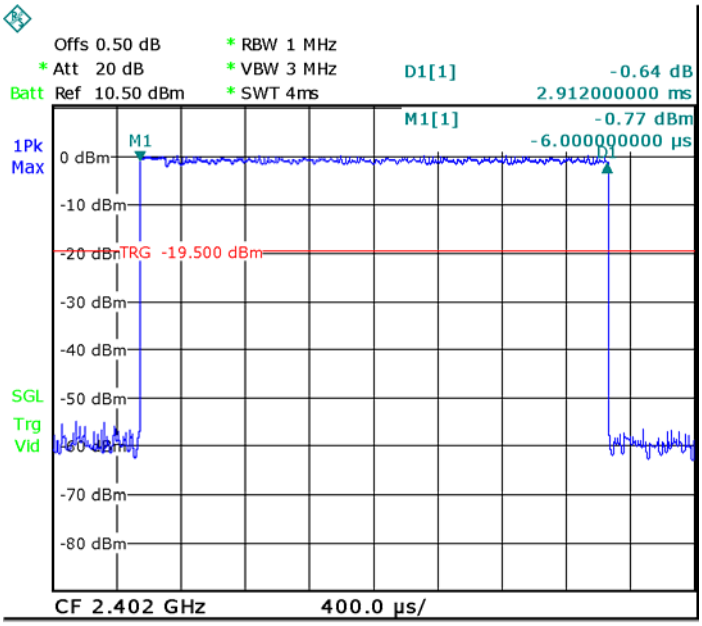
DH5, High channel




8DPSK

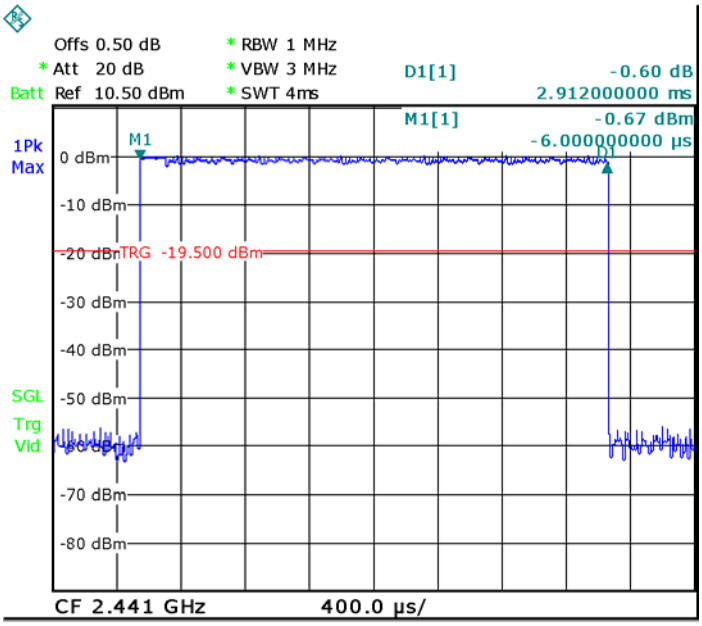
Data Packet:

DH5, Low channel



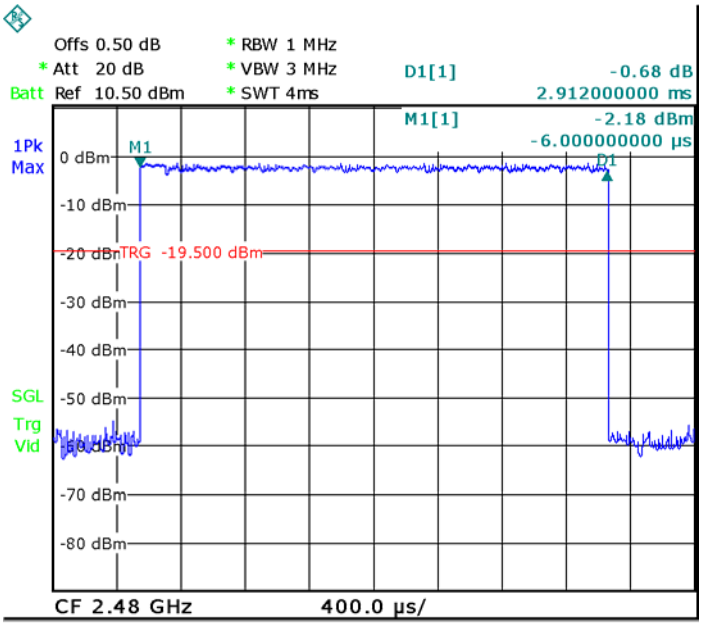
Data Packet:

DH5, Middle channel




Data Packet:

DH5, High channel



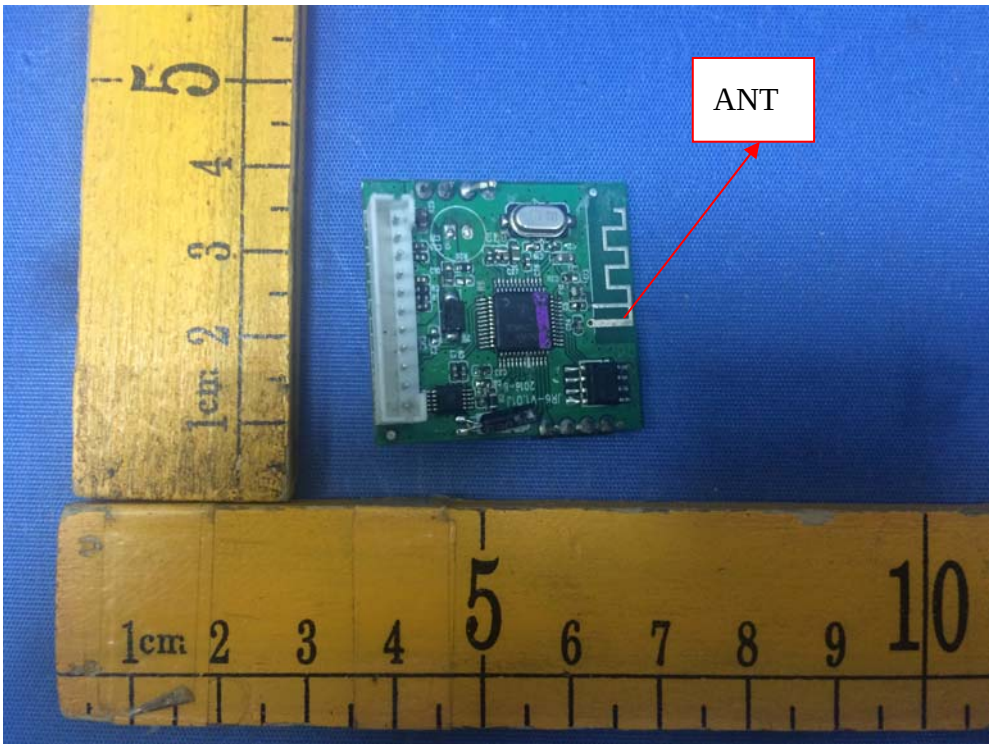
# 16 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Result:

The EUT has one PCB Printed Antenna, the gain is 0dBi. meets the requirements of FCC 15.203.



# 17 FCC ID: 2ALZL-TS220 RF Exposure

Test Requirement: FCC Part 1.1307

Evaluation Method: FCC Part 2.1091 & KDB 447498 D01 General RF Exposure Guidance v06

## 17.1 Requirements

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby a distance of 0.2 m normally can be maintained between the user and the device.

## 17.2 The procedures / limit

(A) Limits for Occupational / Controlled Exposure

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/ $cm^2$) | Averaging Time $\|E\|^2$,$\|H\|^2$or S (minutes) |
|---|---|---|---|---|
| 0.3-3.0 | 614 | 1.63 | (100)* | 6 |
| 3.0-30 | 1842 / f | 4.89 / f | (900 / f)* | 6 |
| 30-300 | 61.4 | 0.163 | 1.0 | 6 |
| 300-1500 | | | F/300 | 6 |
| 1500-100,000 | | | 5 | 6 |

(B) Limits for General Population / Uncontrolled Exposure

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/ $cm^2$) | Averaging Time $\|E\|^2$,$\|H\|^2$ or S (minutes) |
|---|---|---|---|---|
| 0.3-1.34 | 614 | 1.63 | (100)* | 30 |
| 1.34-30 | 824/f | 2.19/f | (180/f)* | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | | | F/1500 | 30 |
| 1500-100,000 | | | 1.0 | 30 |

Note: f = frequency in MHz ; *Plane-wave equivalent power density

## 17.3 MPE Calculation Method

$$S = \frac{P \times G}{4 \times \pi \times R^2}$$

S = power density (in appropriate units, e.g. mW/cm$^2$)
P = output power to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

From the peak EUT RF output power, the minimum mobile separation distance, R=20cm, as well as the gain of the used antenna, the RF power density can be obtained

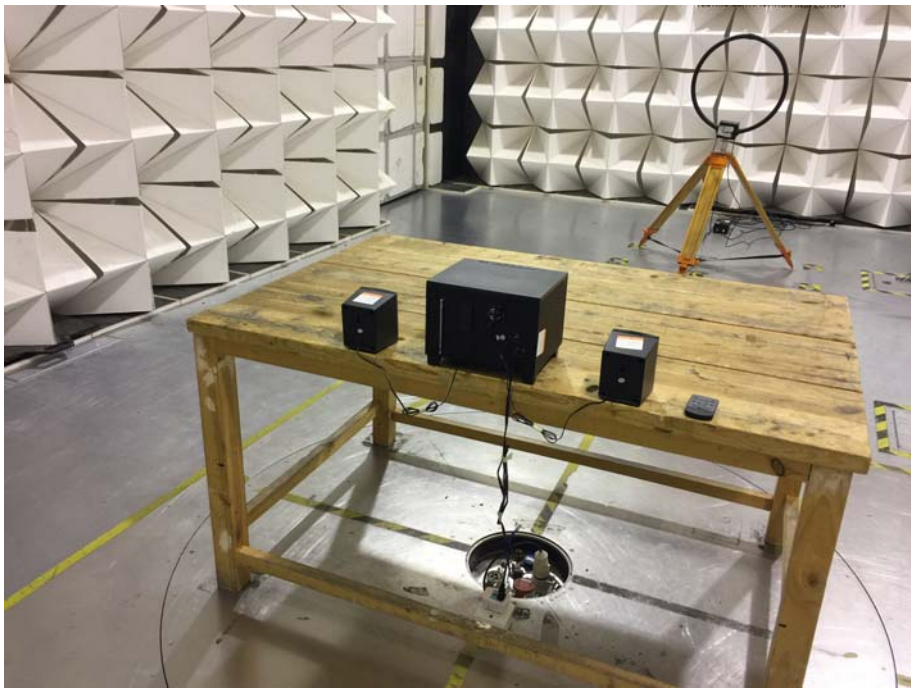
| Antenna Gain (dBi) | Antenna Gain (numeric) | Maximum Peak Output Power (dBm) | Maximum Peak Output Power (mW) | Power Density (mW/cm2) | Limit of Power Density (mW/cm2) | Result |
|---|---|---|---|---|---|---|
| 0 | 1.0 | 0.98 | 1.253 | 0.000249 | 1 | Compliance |

# 18 Photographs-Model TS220 Test Setup

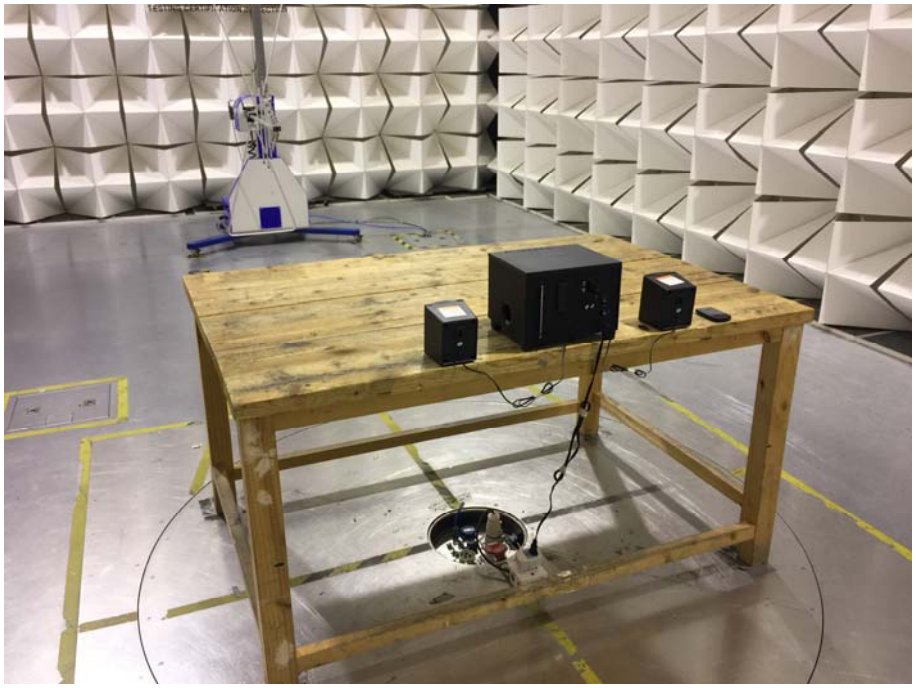
## 18.1 Photograph – Conducted Emission Test Setup

## 18.2 Photograph - Spurious Emissions Radiated Test Setup

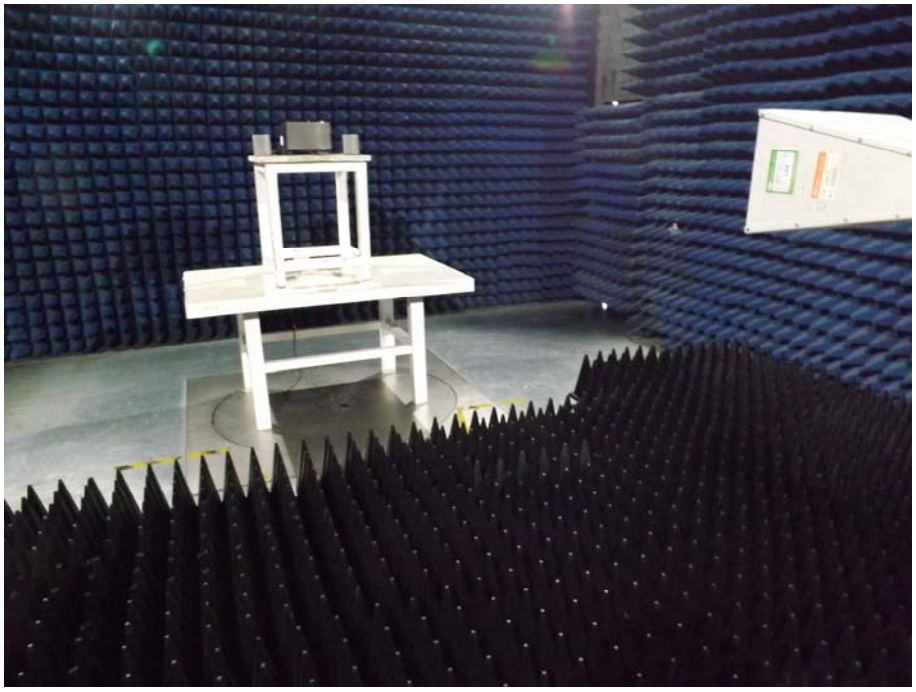
For 9KHz to 30MHz



For 30MHz-1000MHz

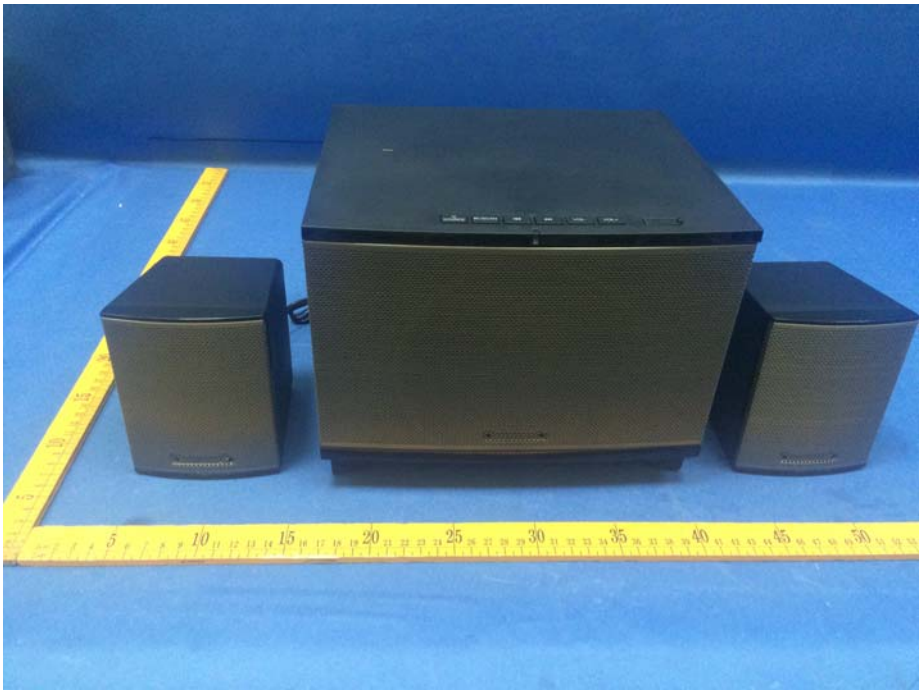


For Above 1GHz



# 19 Photographs - Constructional Details

## 19.1 Model TS220 –External Photos

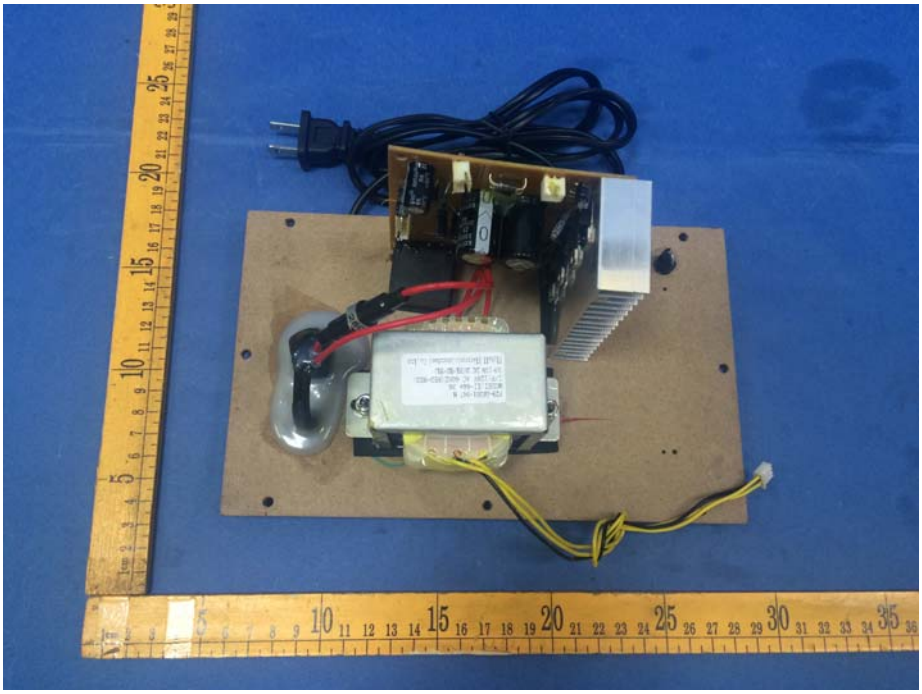


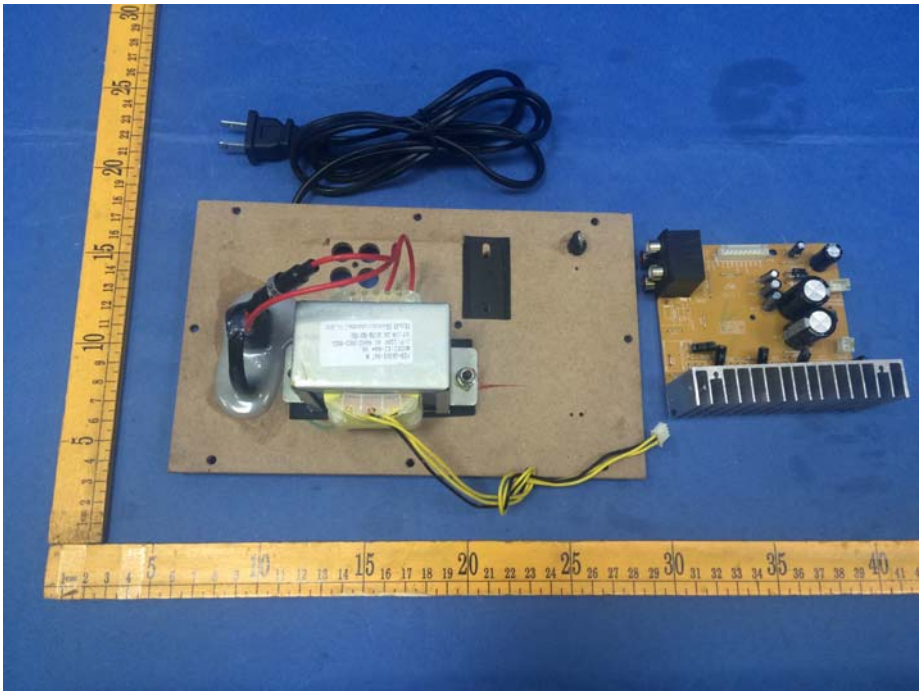

SOURCE
VOL-
VOL+

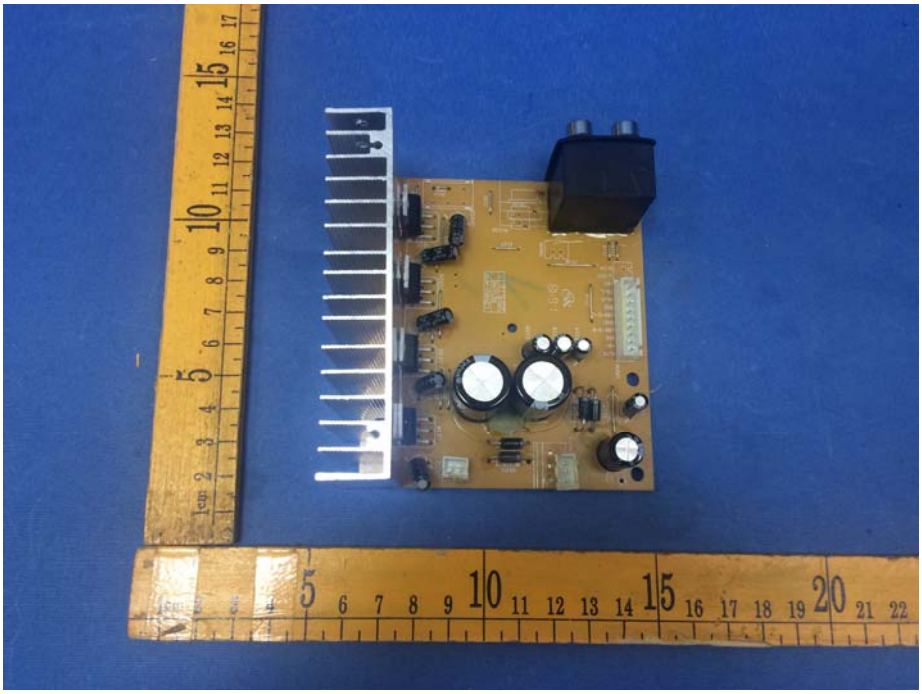

SOURCE
VOL-
VOL+

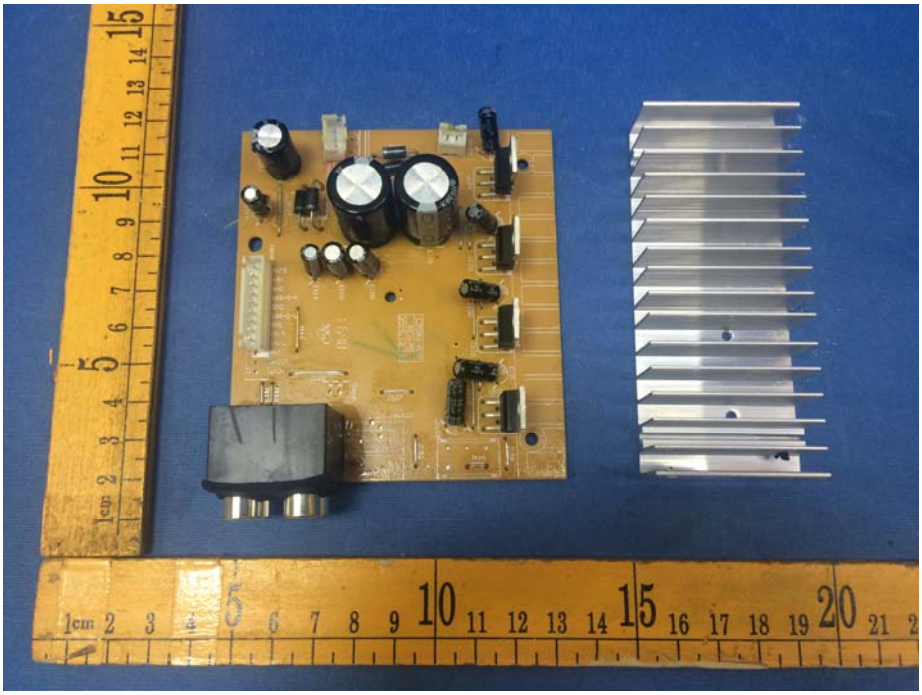

CAUTION
INPUT
OUTPUT
R
R
L
L
ON
OFF
POWER
120V

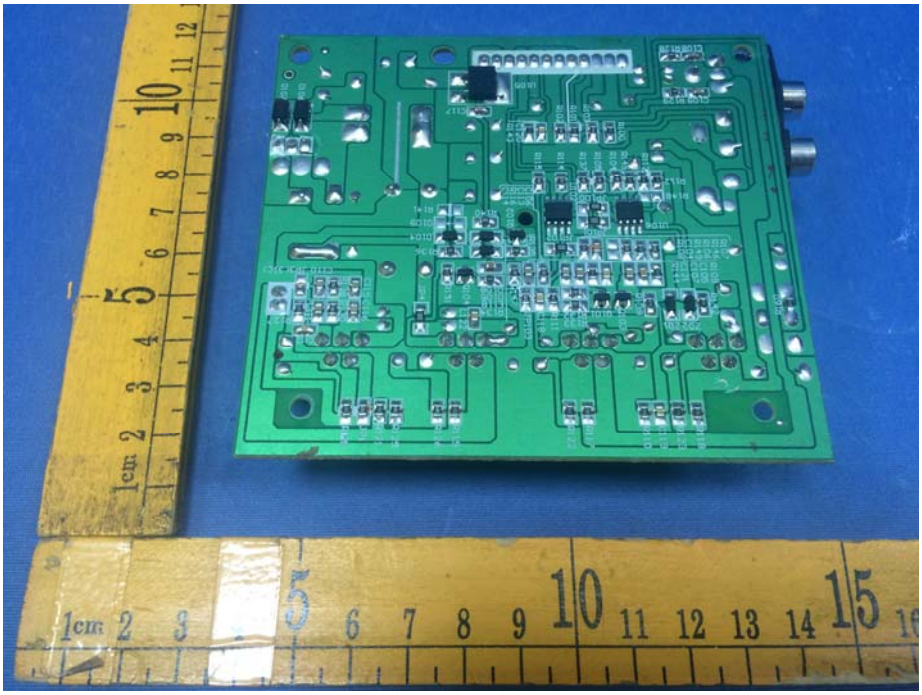
## 19.2 Model TS220 – Internal Photos

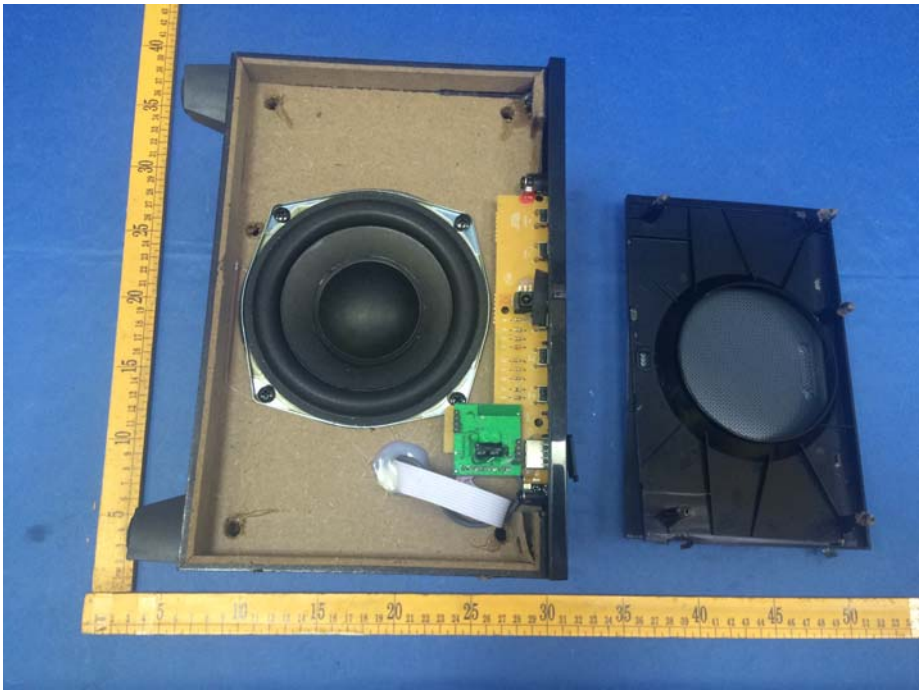


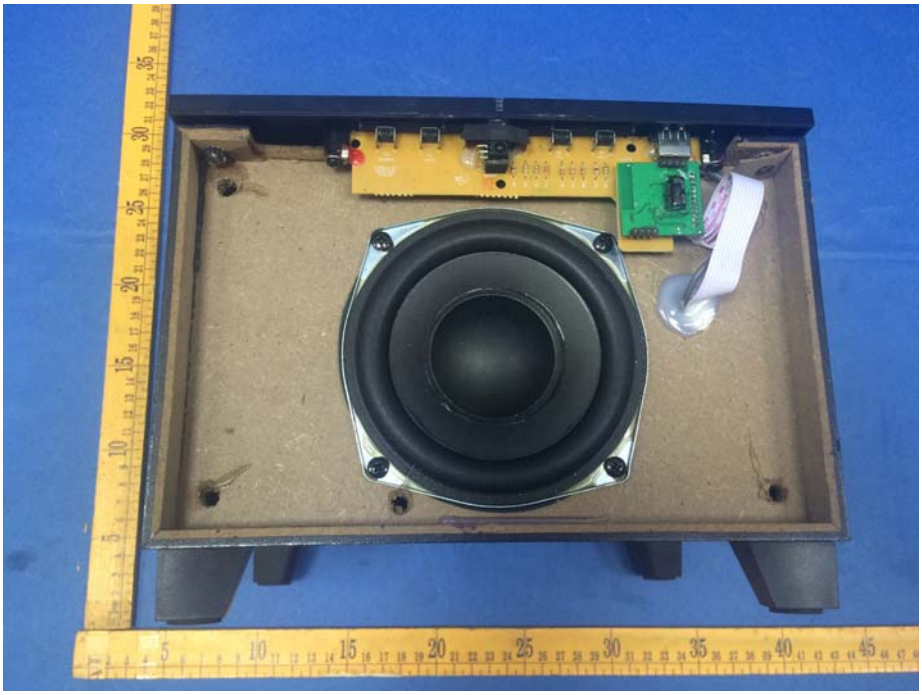


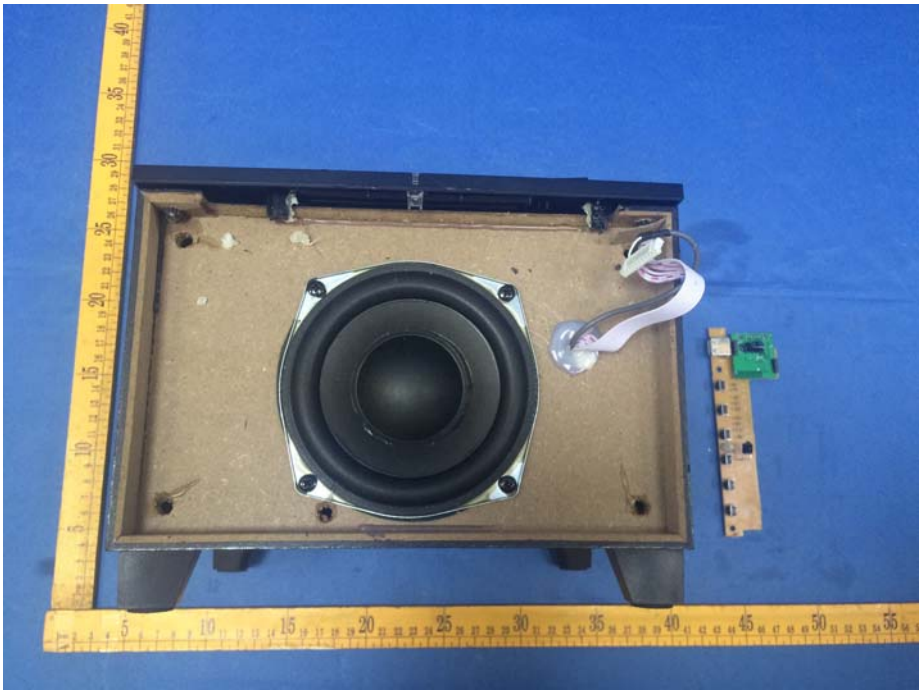


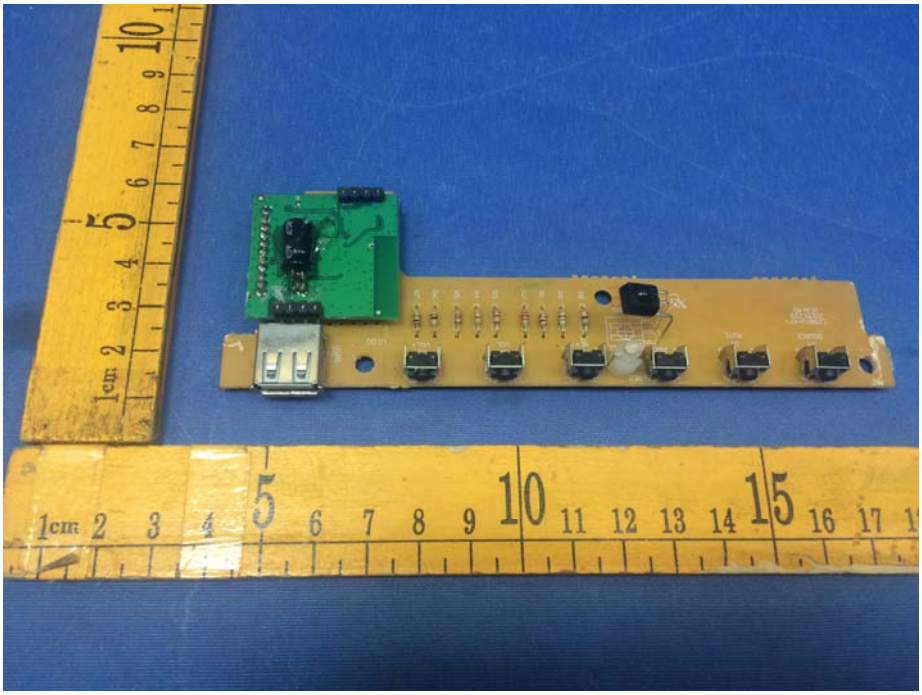


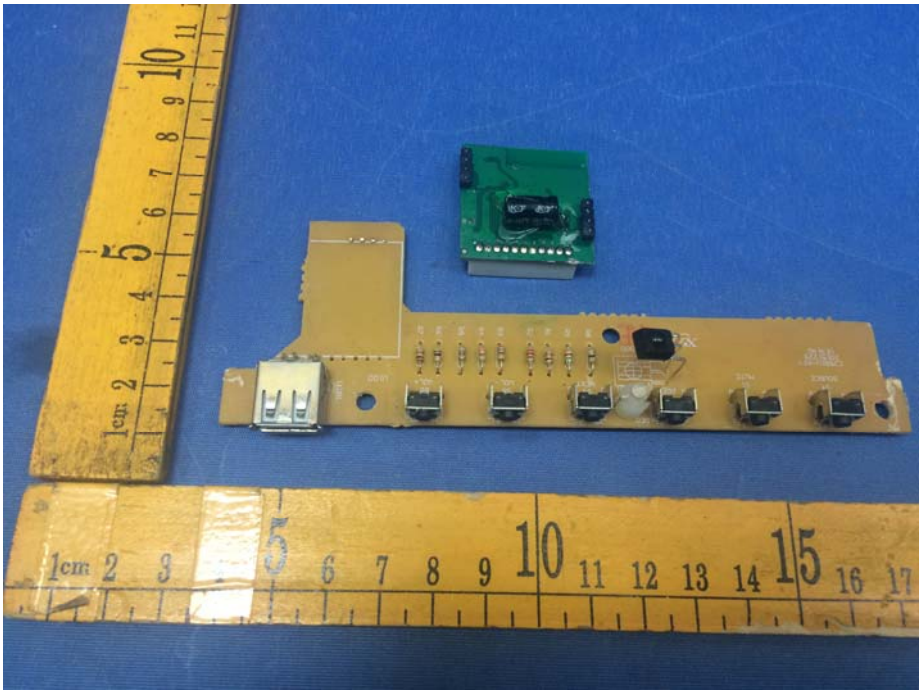


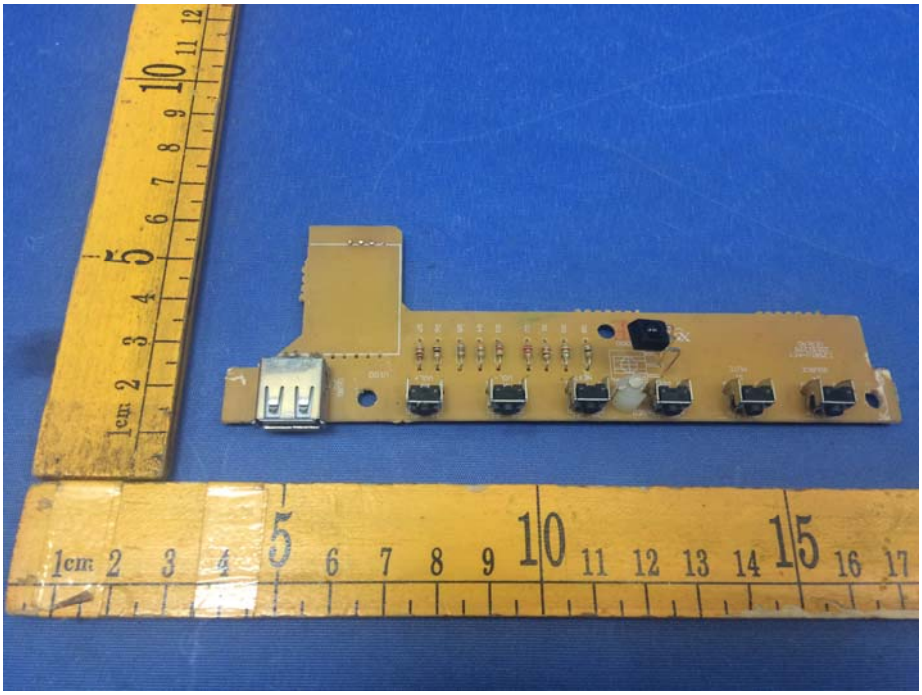


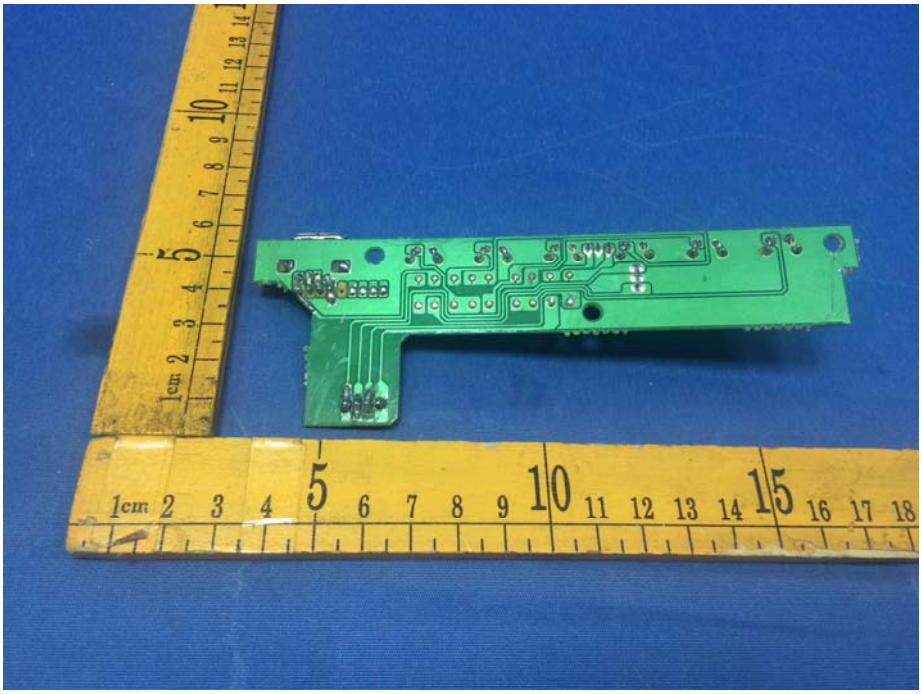








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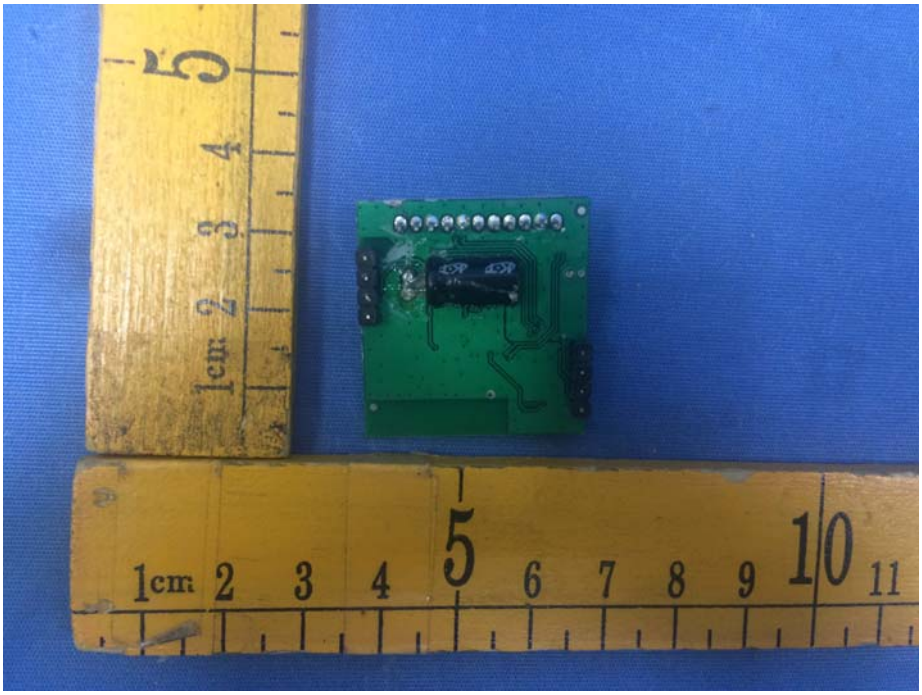
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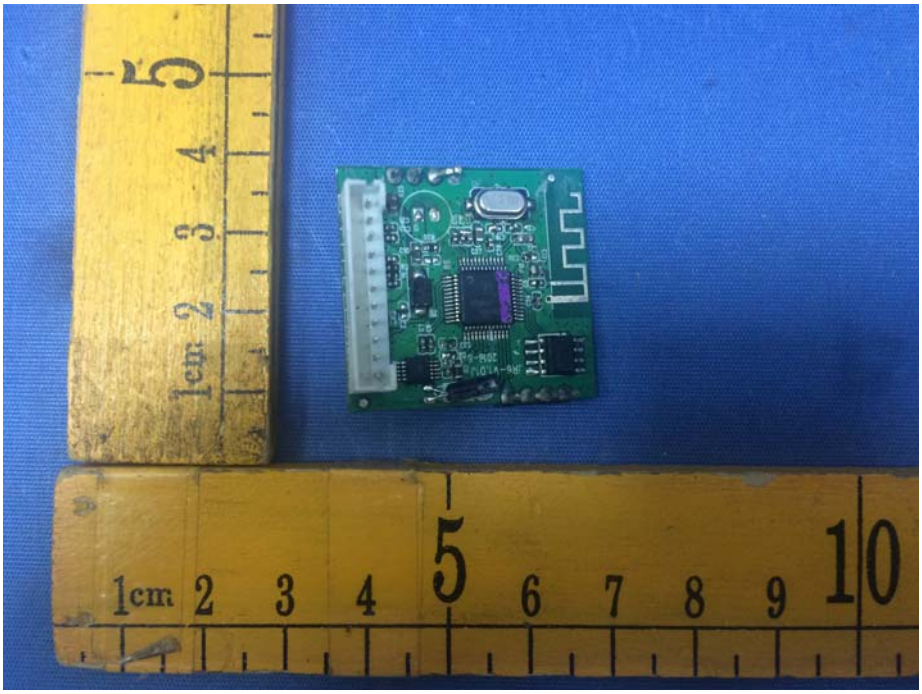

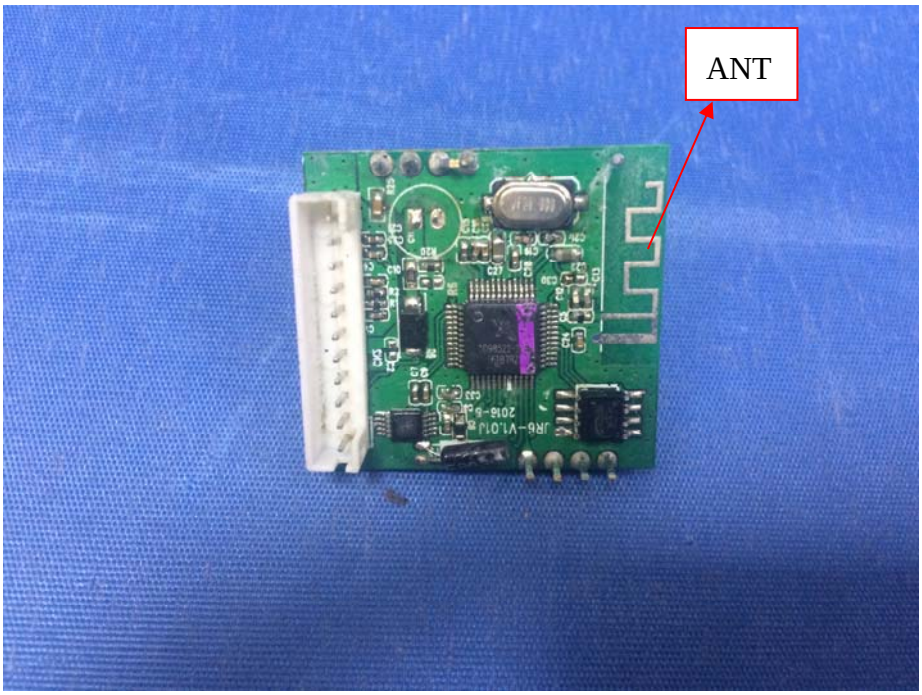


======End of Report======