# TEST REPORT

| | | |
|---|---|---|
| **Reference No.** ..... | : | WTS18S08121771-1W |
| **FCC ID** ..... | : | 2AQZO-LTS001 |
| **Applicant**..... | : | Seam Technic Ltd. |
| **Address**..... | : | 126 Ossington Ave., 2nd Floor Unit 1, Toronto, Ontario, Canada |
| **Manufacturer** ..... | : | Shenzhen Thinkrace Technology Co., Ltd. |
| **Address**..... | : | 2108, 1F, Building B, GuoRen Communication Building, Science and Technology Three Road, High Tech Park, Nanshan District, ShenZhen, China |
| **Product**..... | : | LOTUS BY SEAM |
| **Model(s)**. ..... | : | LTS-001 |
| **Brand Name**..... | : | SEAM |
| **Standards**..... | : | FCC CFR47 Part 15.247:2017 |
| **Date of Receipt sample** .... | : | 2018-08-22 |
| **Date of Test** ..... | : | 2018-08-23 to 2018-09-05 |
| **Date of Issue**..... | : | 2018-09-06 |
| **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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# 2 Laboratories Introduction

**Waltek Services (Shenzhen) Co., Ltd** is a professional third-party testing and certification laboratory with multi-year product testing and certification experience, established strictly in accordance with ISO/IEC 17025 requirements, and accredited by ILAC (International Laboratory Accreditation Cooperation) member. A2LA (American Association for Laboratory Accreditation) of USA, 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), CEC(California energy efficiency), IC(Industry Canada). It's the strategic partner and data recognition laboratory of international authoritative organizations, such as Intertek(ETL-SEMKO), TÜV Rheinland, TÜV SÜD, etc.

Waltek Services (Shenzhen) Co., Ltd is one of the largest and the most comprehensive third party testing laboratory in China. Our test capability covered four large fields: safety test. Electro Magnetic Compatibility (EMC), and energy performance, wireless radio. 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.

**Test Facility:**

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

| Country/Region | Accreditation Body | Scope | Note |
|---|---|---|---|
| USA | **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:

1. FCC Designation No.: CN1201. Test Firm Registration No.: 523476.
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 |

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# 4 Revision History

| Test report No. | Date of Receipt sample | Date of Test | Date of Issue | Purpose | Comment | Approved |
|---|---|---|---|---|---|---|
| WTS18S08121771-1W | 2018-08-22 | 2018-08-23 to 2018-09-05 | 2018-09-06 | original | - | Valid |
| | | | | | | |

# 5 General Information

## 5.1 General Description of E.U.T.

| | |
|---|---|
| Product: | LOTUS BY SEAM |
| Model(s): | LTS-001 |
| Model Description: | N/A |
| Bluetooth Version: | Bluetooth v4.1 |
| Hardware Version: | SB-127-01-301-033-V10LOTUS_BETA |
| Software Version: | Lotus_Wear_1_16 |
| Highest frequency (Exclude Radio): | 312MHz |
| Storage Location: | Internal Storage |
| Note: | N/A |

## 5.2 Details of E.U.T.

| | |
|---|---|
| Operation Frequency: | Bluetooth: 2402~2480MHz |
| Max. RF output power: | Bluetooth: 2.72dBm |
| Type of Modulation: | Bluetooth: GFSK, Pi/4 DQPSK, 8DPSK |
| Antenna installation: | Bluetooth: internal permanent antenna |
| Antenna Gain: | Bluetooth: 0.5dBi |
| Ratings: | Battery DC 3.7V 120mAh<br>DC 3.7V, charging from charging base |
| Charging base | Battery DC 3.7V 600mAh<br>DC 5V, charging from USB |

## 5.3 Channel List

Normal

| Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 0 | 2402 | 1 | 2403 | 2 | 2404 | 3 | 2405 |
| 4 | 2406 | 5 | 2407 | 6 | 2408 | 7 | 2409 |
| 8 | 2410 | 9 | 2411 | 10 | 2412 | 11 | 2413 |
| 12 | 2414 | 13 | 2415 | 14 | 2416 | 15 | 2417 |
| 16 | 2418 | 17 | 2419 | 18 | 2420 | 19 | 2421 |
| 20 | 2422 | 21 | 2423 | 22 | 2424 | 23 | 2425 |
| 24 | 2426 | 25 | 2427 | 26 | 2428 | 27 | 2429 |
| 28 | 2430 | 29 | 2431 | 30 | 2432 | 31 | 2433 |
| 32 | 2434 | 33 | 2435 | 34 | 2436 | 35 | 2437 |
| 36 | 2438 | 37 | 2439 | 38 | 2440 | 39 | 2441 |
| 40 | 2442 | 41 | 2443 | 42 | 2444 | 43 | 2445 |
| 44 | 2446 | 45 | 2447 | 46 | 2448 | 47 | 2449 |
| 48 | 2450 | 49 | 2451 | 50 | 2452 | 51 | 2453 |
| 52 | 2454 | 53 | 2455 | 54 | 2456 | 55 | 2457 |
| 56 | 2458 | 57 | 2459 | 58 | 2460 | 59 | 2461 |
| 60 | 2462 | 61 | 2463 | 62 | 2464 | 63 | 2465 |
| 64 | 2466 | 65 | 2467 | 66 | 2468 | 67 | 2469 |
| 68 | 2470 | 69 | 2471 | 70 | 2472 | 71 | 2473 |
| 72 | 2474 | 73 | 2475 | 74 | 2476 | 75 | 2477 |
| 76 | 2478 | 77 | 2479 | 78 | 2480 | - | - |

## 5.4 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 |

# 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 |
| Conducted Emission | 15.207 | PASS |
| 20dB 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 | Complies |
| Maximum Permissible Exposure<br>(Exposure of Humans to RF Fields) | 1.1307(b)(1) | PASS |

# 7 Equipment Used during Test

## 7.1 Equipments List

| Conducted Emissions Test Site 1# | | | | | | |
|---|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMI Test Receiver | R&S | ESCI | 100947 | 2017-09-12 | 2018-09-11 |
| 2. | LISN | R&S | ENV216 | 101215 | 2017-09-12 | 2018-09-11 |
| 3. | Cable | Top | TYPE16(3.5M) | - | 2017-09-12 | 2018-09-11 |
| **Conducted Emissions Test Site 2#** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMI Test Receiver | R&S | ESCI | 101155 | 2017-09-12 | 2018-09-11 |
| 2. | LISN | SCHWARZBECK | NSLK 8128 | 8128-289 | 2017-09-12 | 2018-09-11 |
| 3. | Limiter | York | MTS-IMP-136 | 261115-001-0024 | 2017-09-12 | 2018-09-11 |
| 4. | Cable | LARGE | RF300 | - | 2017-09-12 | 2018-09-11 |
| **3m Semi-anechoic Chamber for Radiation Emissions Test site 1#** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1 | Spectrum Analyzer | R&S | FSP | 100091 | 2018-04-29 | 2019-04-28 |
| 2 | Active Loop Antenna | Beijing Dazhi | ZN30900A | - | 2018-04-09 | 2019-04-08 |
| 3 | Trilog Broadband Antenna | SCHWARZBECK | VULB9163 | 336 | 2018-04-09 | 2019-04-08 |
| 4 | Coaxial Cable (below 1GHz) | Top | TYPE16(13M) | - | 2018-09-12 | 2019-09-11 |
| 5 | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9120 D | 667 | 2018-04-09 | 2019-04-08 |
| 6 | Broad-band Horn Antenna | SCHWARZBECK | BBHA 9170 | 335 | 2018-04-09 | 2019-04-08 |
| 7 | Broadband Preamplifier | COMPLIANCE DIRECTION | PAP-1G18 | 2004 | 2018-04-13 | 2019-04-12 |
| 8 | Coaxial Cable (above 1GHz) | Top | 1GHz-25GHz | EW02014-7 | 2018-04-13 | 2019-04-12 |
| **3m Semi-anechoic Chamber for Radiation Emissions Test site 2#** | | | | | | |
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No** | **Last Calibration Date** | **Calibration Due Date** |
| 1 | Test Receiver | R&S | ESCI | 101296 | 2018-04-13 | 2019-04-12 |
| 2 | Trilog Broadband Antenna | SCHWARZBECK | VULB9160 | 9160-3325 | 2018-04-09 | 2019-04-08 |
| 3 | Amplifier | Compliance pirection systems inc | PAP-0203 | 22024 | 2018-04-13 | 2019-04-12 |
| 4 | Cable | HUBER+SUHNER | CBL2 | 525178 | 2018-04-13 | 2019-04-12 |

| RF Conducted Testing | | | | | | |
|---|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model No.** | **Serial No.** | **Last Calibration Date** | **Calibration Due Date** |
| 1. | EMC Analyzer (9k~26.5GHz) | Agilent | E7405A | MY45114943 | 2017-09-12 | 2018-09-11 |
| 2. | Spectrum Analyzer (9k-6GHz) | R&S | FSL6 | 100959 | 2017-09-12 | 2018-09-11 |
| 3. | Signal Analyzer (9k~26.5GHz) | Agilent | N9010A | MY50520207 | 2017-09-12 | 2018-09-11 |

## 7.2 Description of Support Units

| Equipment | Manufacturer | Model No. | Series No. |
|---|---|---|---|
| / | / | / | / |

## 7.3 Measurement Uncertainty

| Parameter | Uncertainty |
|---|---|
| Conducted Emission | ± 3.64 dB(AC mains 150KHz~30MHz) |
| Radiated Spurious Emissions | ± 5.08 dB (Bilog antenna 30M~1000MHz) |
| | ± 4.99 dB (Horn antenna 1000M~25000MHz) |
| Radio Frequency | ± 1 x $10^{-7}$Hz |
| RF Power | ± 0.42 dB |
| Dwell time | 1.0% |
| Conducted Spurious Emissions | ± 2.76 dB (9kHz~26500MHz) |
| Confidence interval：95%. Confidence factor:k=2 | |

## 7.4 Test Equipment Calibration

All the test equipments used are valid and calibrated by CEPREI Certification Body that address is No.110 Dongguan Zhuang RD. Guangzhou, P.R.China.

# 8 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) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.5 | 66 to 56* | 56 to 46* |
| 0.5 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

## 8.1 E.U.T. Operation

Operating Environment :

Temperature: 22.8 °C

Humidity: 52.6 % RH

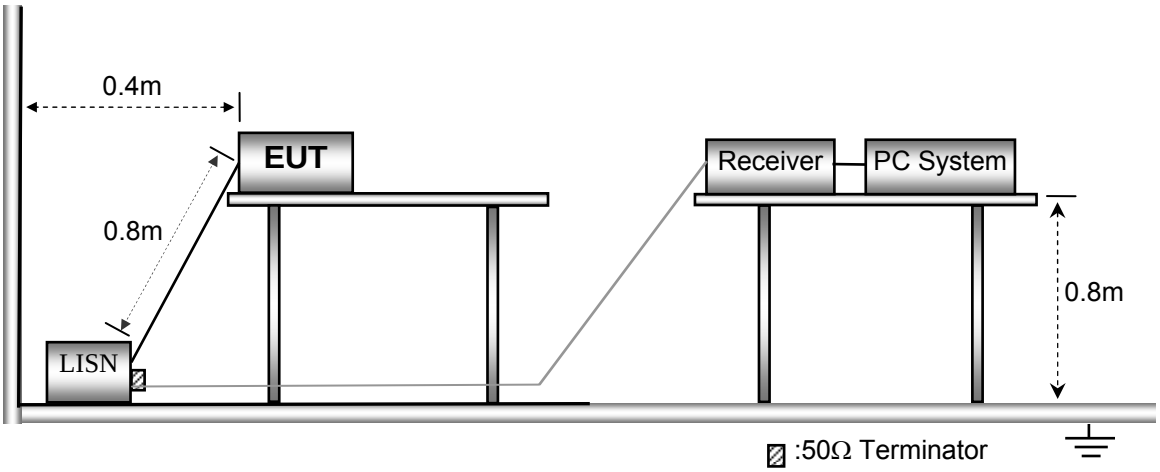
Atmospheric Pressure: 101.2kPa

EUT Operation :

The test was performed in TX Transmitting mode, the test data were shown in the report.

## 8.2 EUT Setup

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



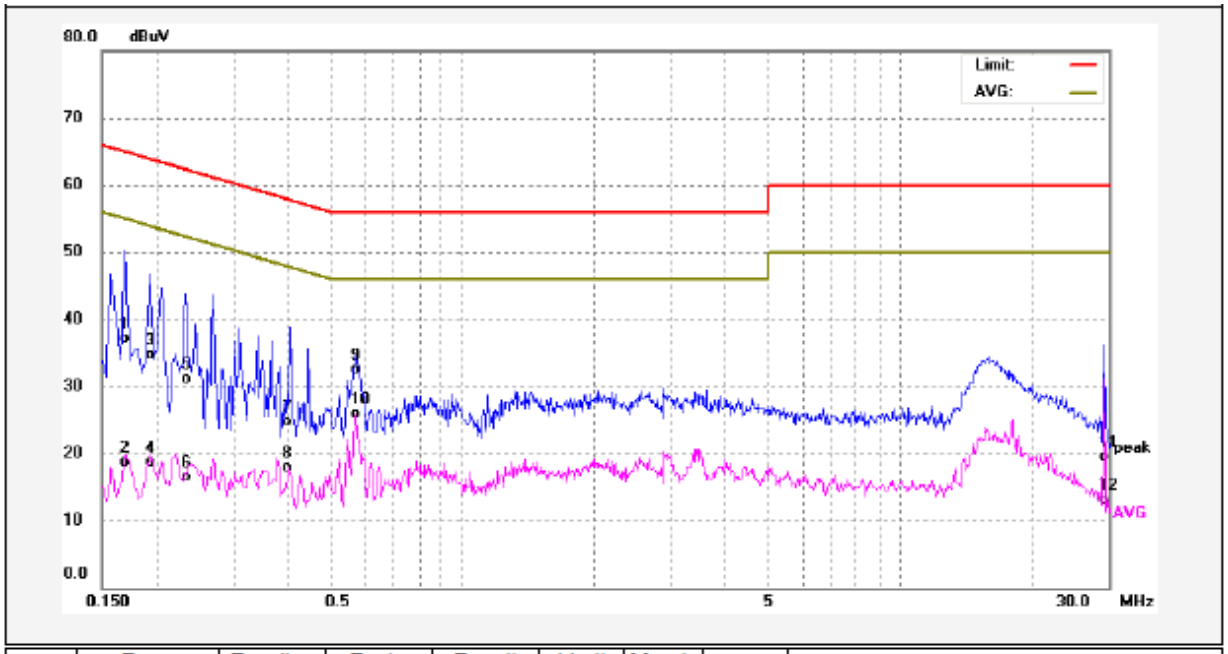

## 8.3 Measurement Description

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.

## 8.4 Conducted Emission Test Result

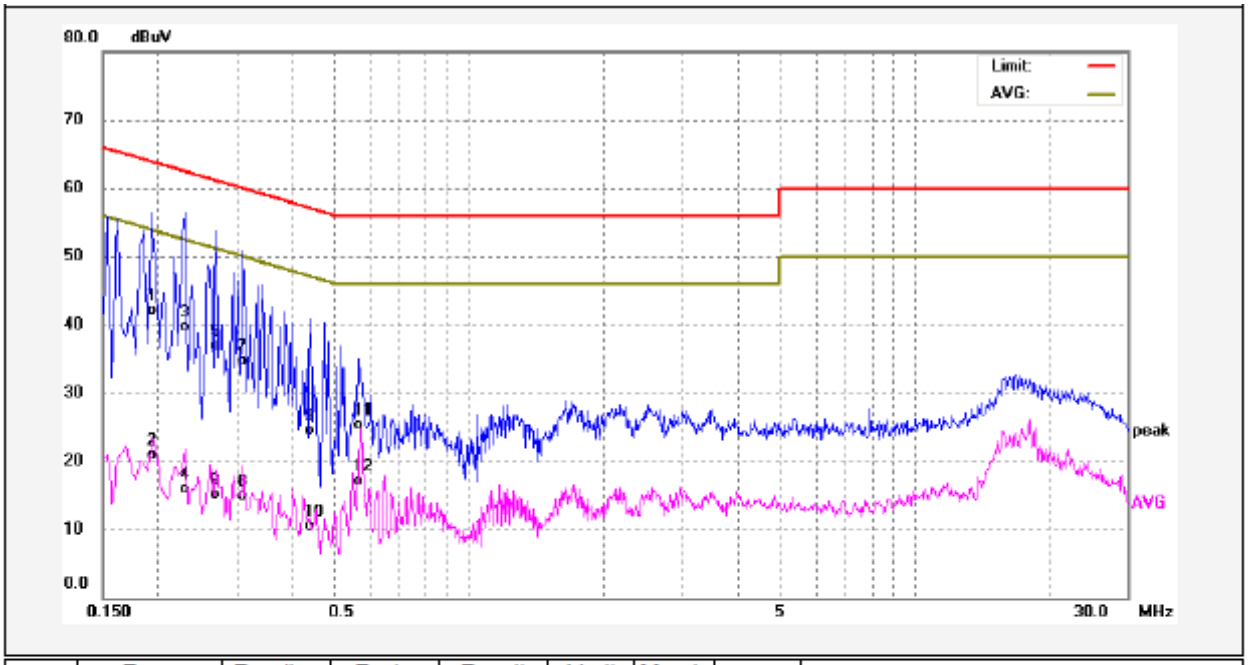
Remark: only the worst data (GFSK modulation Low channel mode) were reported

Live line:




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit dBuV | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1700 | 37.14 | 0.00 | 37.14 | 64.96 | -27.82 | QP | |
| 2 | 0.1700 | 18.78 | 0.00 | 18.78 | 54.96 | -36.18 | AVG | |
| 3 | 0.1940 | 34.73 | 0.00 | 34.73 | 63.86 | -29.13 | QP | |
| 4 | 0.1940 | 18.71 | 0.00 | 18.71 | 53.86 | -35.15 | AVG | |
| 5 | 0.2340 | 31.18 | 0.00 | 31.18 | 62.30 | -31.12 | QP | |
| 6 | 0.2340 | 16.47 | 0.00 | 16.47 | 52.30 | -35.83 | AVG | |
| 7 | 0.4060 | 24.71 | 0.00 | 24.71 | 57.73 | -33.02 | QP | |
| 8 | 0.4060 | 17.88 | 0.00 | 17.88 | 47.73 | -29.85 | AVG | |
| 9 | 0.5740 | 32.49 | 0.00 | 32.49 | 56.00 | -23.51 | QP | |
| 10 | 0.5740 | 25.91 | 0.00 | 25.91 | 46.00 | -20.09 | AVG | |
| 11 | 29.2180 | 19.45 | 0.00 | 19.45 | 60.00 | -40.55 | QP | |
| 12 | 29.2180 | 13.06 | 0.00 | 13.06 | 50.00 | -36.94 | AVG | |

Neutral line:




| No. | Freq. (MHz) | Reading (dBuV) | Factor (dB) | Result (dBuV) | Limit dBuV | Margin (dB) | Detector | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.1940 | 42.02 | 0.00 | 42.02 | 63.86 | -21.84 | QP | |
| 2 | 0.1940 | 20.95 | 0.00 | 20.95 | 53.86 | -32.91 | AVG | |
| 3 | 0.2300 | 39.66 | 0.00 | 39.66 | 62.45 | -22.79 | QP | |
| 4 | 0.2300 | 15.88 | 0.00 | 15.88 | 52.45 | -36.57 | AVG | |
| 5 | 0.2700 | 36.86 | 0.00 | 36.86 | 61.12 | -24.26 | QP | |
| 6 | 0.2700 | 15.12 | 0.00 | 15.12 | 51.12 | -36.00 | AVG | |
| 7 | 0.3100 | 34.71 | 0.00 | 34.71 | 59.97 | -25.26 | QP | |
| 8 | 0.3100 | 14.92 | 0.00 | 14.92 | 49.97 | -35.05 | AVG | |
| 9 | 0.4380 | 24.58 | 0.00 | 24.58 | 57.10 | -32.52 | QP | |
| 10 | 0.4380 | 10.42 | 0.00 | 10.42 | 47.10 | -36.68 | AVG | |
| 11 | 0.5660 | 25.29 | 0.00 | 25.29 | 56.00 | -30.71 | QP | |
| 12 | 0.5660 | 17.06 | 0.00 | 17.06 | 46.00 | -28.94 | AVG | |

# 9 Radiated Spurious Emissions

Test Requirement: FCC CFR47 Part 15 Section 15.205 &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 | $20\log^{(500)}$ |

## 9.1 EUT Operation

Operating Environment :

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

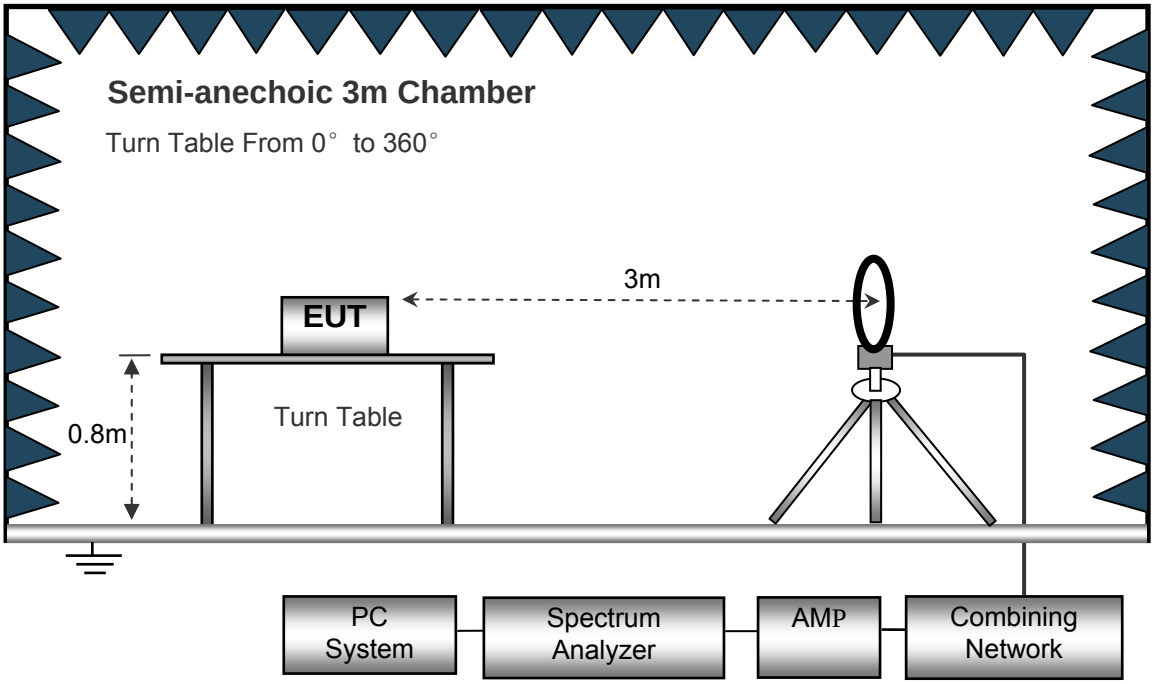
EUT Operation :

The test was performed in TX Transmitting mode, the test data were shown in the report.

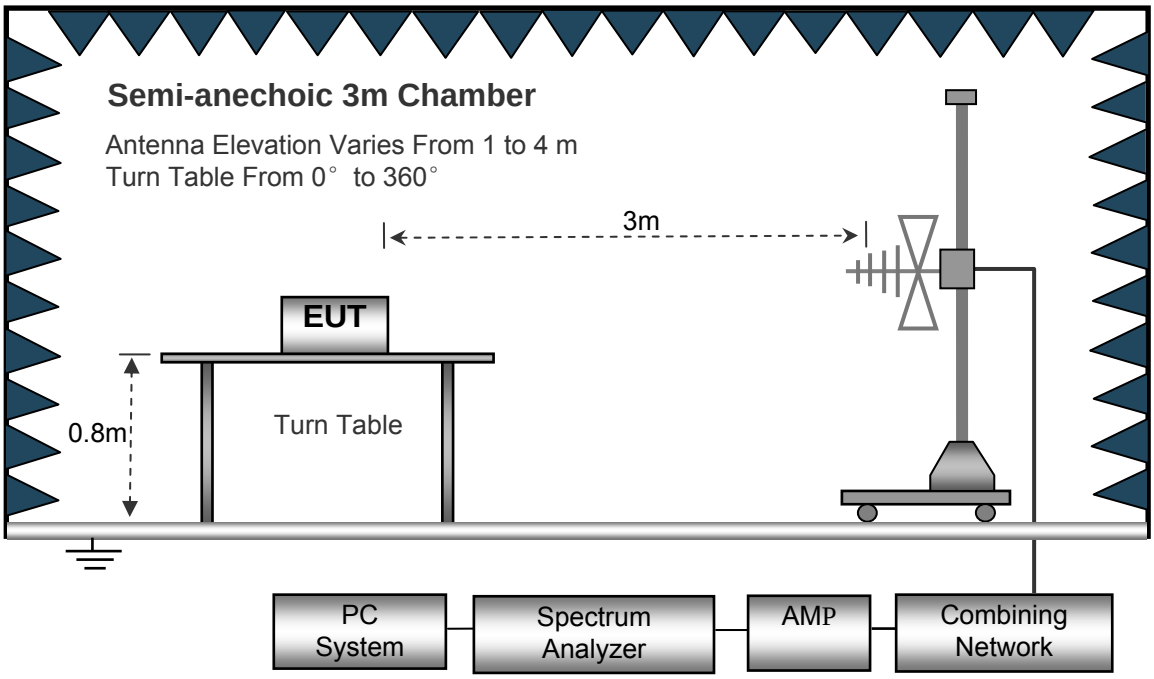
## 9.2 Test Setup

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

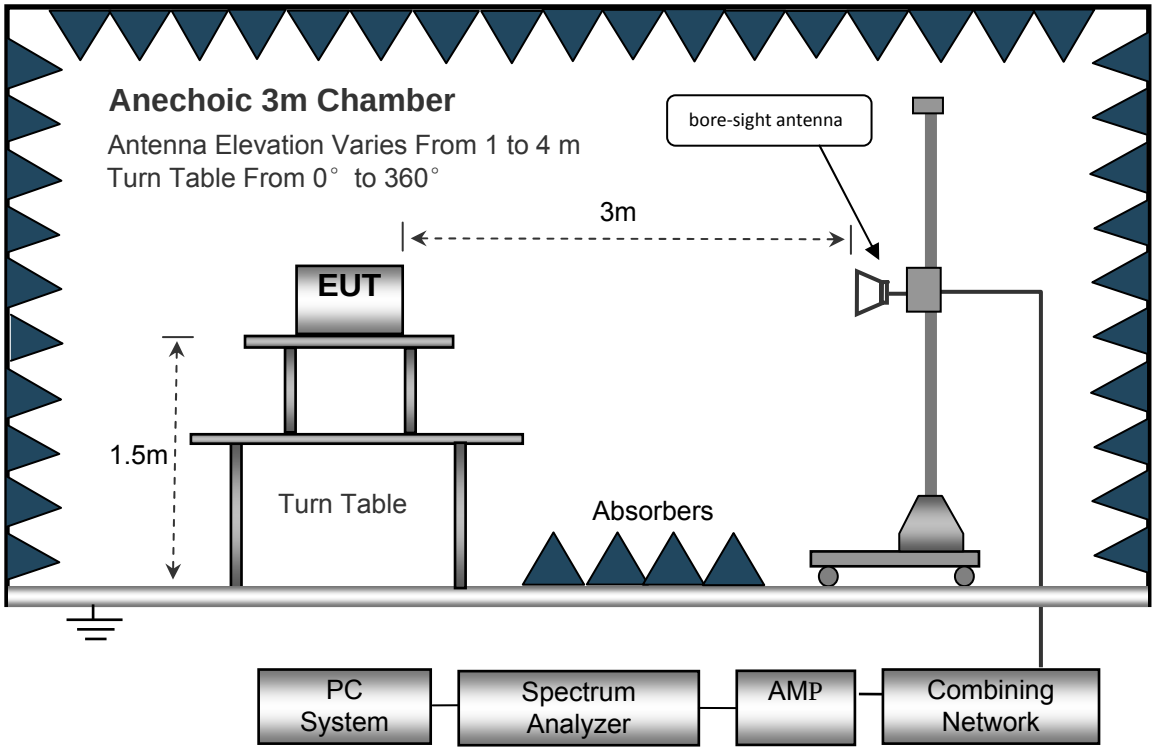
The test setup for emission measurement below 30MHz.




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



The test setup for emission measurement above 1 GHz.




## 9.3 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

## 9.4 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.

## 9.5 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

## 9.6 Summary of Test Results

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

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

| Frequency | Measurement results dBμV @3m | Detector PK/QP | Correct factor dB/m | Extrapolation factor dB | Measurement results (calculated) dBμV/m @30m | Limits dBμV/m @30m | Margin dB |
|---|---|---|---|---|---|---|---|
| (MHz) | Measurement results | Detector | Correct factor | Extrapolation factor | Measurement results (calculated) | Limits | Margin |
| 6.021 | 25.32 | QP | 21.84 | 40.00 | 7.16 | 29.54 | -22.38 |
| 15.730 | 25.26 | QP | 21.35 | 40.00 | 6.61 | 29.54 | -22.93 |
| 25.680 | 25.14 | QP | 20.67 | 40.00 | 5.81 | 29.54 | -23.73 |

.

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

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

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | | |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| GFSK Low Channel | | | | | | | | | |
| 268.32 | 37.26 | QP | 153 | 1.9 | H | -13.35 | 23.91 | 46.00 | -22.09 |
| 268.32 | 40.96 | QP | 135 | 1.5 | V | -13.35 | 27.61 | 46.00 | -18.39 |
| 4804.00 | 46.73 | PK | 287 | 1.2 | V | -1.06 | 45.67 | 74.00 | -28.33 |
| 4804.00 | 44.34 | Ave | 287 | 1.2 | V | -1.06 | 43.28 | 54.00 | -10.72 |
| 7206.00 | 41.41 | PK | 224 | 1.2 | H | 1.33 | 42.74 | 74.00 | -31.26 |
| 7206.00 | 34.42 | Ave | 224 | 1.2 | H | 1.33 | 35.75 | 54.00 | -18.25 |
| 2319.71 | 45.31 | PK | 41 | 1.2 | V | -13.19 | 32.12 | 74.00 | -41.88 |
| 2319.71 | 38.39 | Ave | 41 | 1.2 | V | -13.19 | 25.20 | 54.00 | -28.80 |
| 2376.31 | 44.82 | PK | 169 | 1.9 | H | -13.14 | 31.68 | 74.00 | -42.32 |
| 2376.31 | 36.48 | Ave | 169 | 1.9 | H | -13.14 | 23.34 | 54.00 | -30.66 |
| 2485.17 | 44.18 | PK | 121 | 1.5 | V | -13.08 | 31.10 | 74.00 | -42.90 |
| 2485.17 | 36.57 | Ave | 121 | 1.5 | V | -13.08 | 23.49 | 54.00 | -30.51 |

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | | |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| GFSK Middle Channel | | | | | | | | | |
| 268.32 | 34.10 | QP | 66 | 1.5 | H | -13.35 | 20.75 | 46.00 | -25.25 |
| 268.32 | 34.10 | QP | 180 | 1.3 | V | -13.35 | 20.75 | 46.00 | -25.25 |
| 4882.00 | 34.10 | PK | 286 | 1.8 | V | -0.62 | 33.48 | 74.00 | -40.52 |
| 4882.00 | 34.10 | Ave | 286 | 1.8 | V | -0.62 | 33.48 | 54.00 | -20.52 |
| 7323.00 | 34.10 | PK | 117 | 1.0 | H | 2.21 | 36.31 | 74.00 | -37.69 |
| 7323.00 | 34.10 | Ave | 117 | 1.0 | H | 2.21 | 36.31 | 54.00 | -17.69 |
| 2311.79 | 45.43 | PK | 191 | 1.5 | V | -13.19 | 32.24 | 74.00 | -41.76 |
| 2311.79 | 37.02 | Ave | 191 | 1.5 | V | -13.19 | 23.83 | 54.00 | -30.17 |
| 2385.37 | 44.66 | PK | 316 | 1.7 | H | -13.14 | 31.52 | 74.00 | -42.48 |
| 2385.37 | 36.75 | Ave | 316 | 1.7 | H | -13.14 | 23.61 | 54.00 | -30.39 |
| 2490.12 | 43.29 | PK | 344 | 1.2 | V | -13.08 | 30.21 | 74.00 | -43.79 |
| 2490.12 | 38.77 | Ave | 344 | 1.2 | V | -13.08 | 25.69 | 54.00 | -28.31 |

| Frequency | Receiver Reading | Detector | Turn table Angle | RX Antenna | | Corrected Factor | Corrected Amplitude | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Height | Polar | | | | |
| (MHz) | (dBμV) | (PK/QP/Ave) | Degree | (m) | (H/V) | (dB) | (dBμV/m) | (dBμV/m) | (dB) |
| GFSK High Channel | | | | | | | | | |
| 268.32 | 37.38 | QP | 321 | 1.8 | H | -13.35 | 24.03 | 46.00 | -21.97 |
| 268.32 | 41.17 | QP | 54 | 1.9 | V | -13.35 | 27.82 | 46.00 | -18.18 |
| 4960.00 | 47.12 | PK | 282 | 1.5 | V | -0.24 | 46.88 | 74.00 | -27.12 |
| 4960.00 | 43.58 | Ave | 282 | 1.5 | V | -0.24 | 43.34 | 54.00 | -10.66 |
| 7440.00 | 41.56 | PK | 232 | 1.0 | H | 2.84 | 44.40 | 74.00 | -29.60 |
| 7440.00 | 34.47 | Ave | 232 | 1.0 | H | 2.84 | 37.31 | 54.00 | -16.69 |
| 2334.14 | 46.83 | PK | 253 | 1.5 | V | -13.19 | 33.64 | 74.00 | -40.36 |
| 2334.14 | 38.29 | Ave | 253 | 1.5 | V | -13.19 | 25.10 | 54.00 | -28.90 |
| 2366.31 | 44.73 | PK | 154 | 1.7 | H | -13.14 | 31.59 | 74.00 | -42.41 |
| 2366.31 | 36.78 | Ave | 154 | 1.7 | H | -13.14 | 23.64 | 54.00 | -30.36 |
| 2496.56 | 44.63 | PK | 306 | 2.0 | V | -13.08 | 31.55 | 74.00 | -42.45 |
| 2496.56 | 37.08 | Ave | 306 | 2.0 | V | -13.08 | 24.00 | 54.00 | -30.00 |

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

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

# 10 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)).

## 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:

Blow 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

Detector function = peak, Trace = max hold

Above 30MHz:

RBW = 100kHz, VBW = 300kH, Sweep = auto

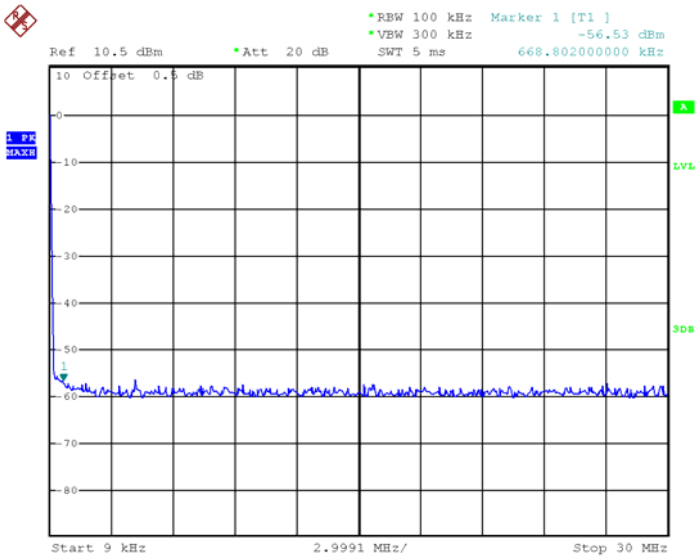
Detector function = peak, Trace = max hold

## 10.2 Test Result

**9KHz - 30MHz**

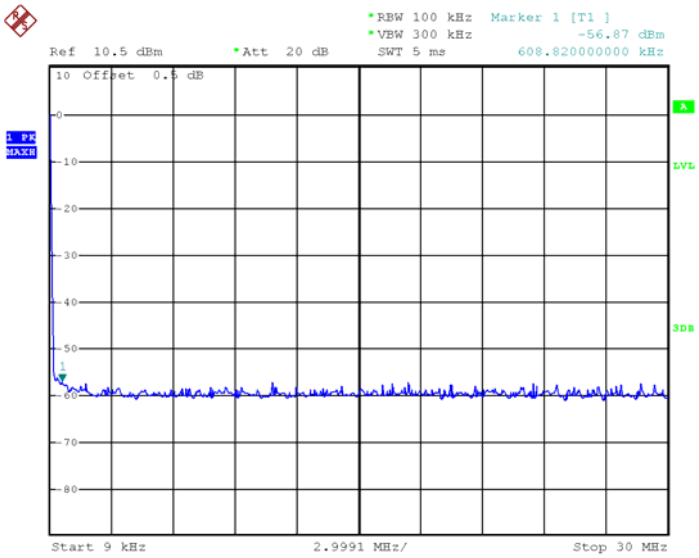
**GFSK**

Low Channel



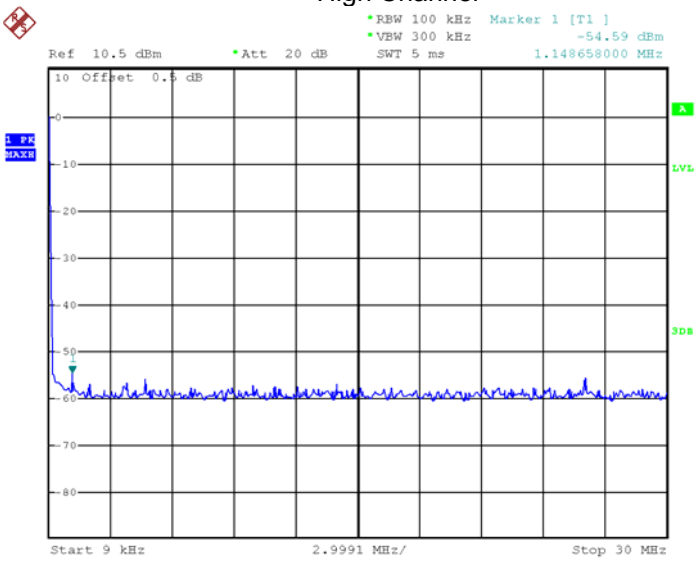

Date: 4.SEP.2018 02:11:01

Middle Channel




Date: 4.SEP.2018 02:11:37

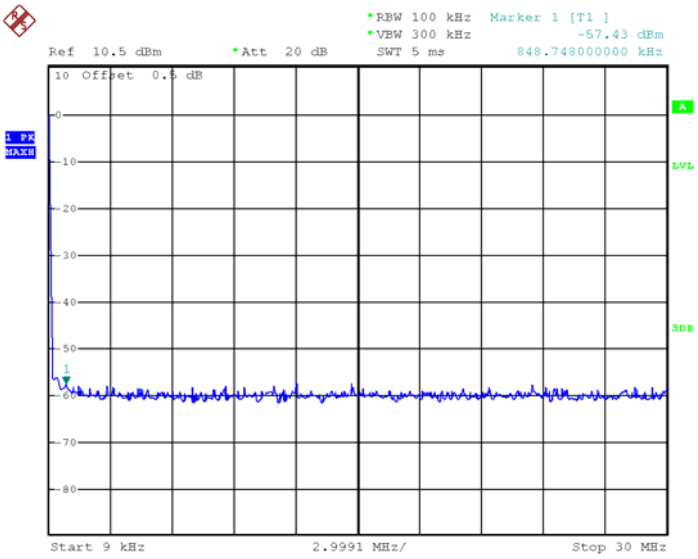
High Channel




Date: 4.SEP.2018 02:15:57

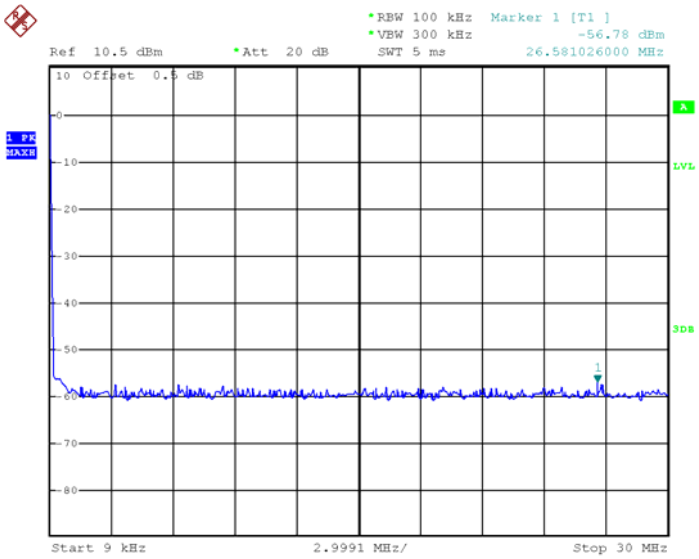
**Pi/4DQPSK**

Low Channel



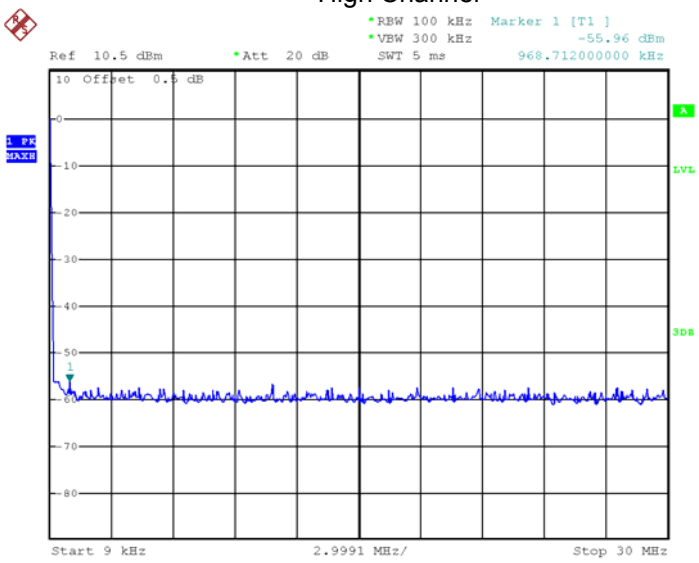

Date: 4.SEP.2018 02:16:34

Middle Channel




Date: 4.SEP.2018 02:16:57

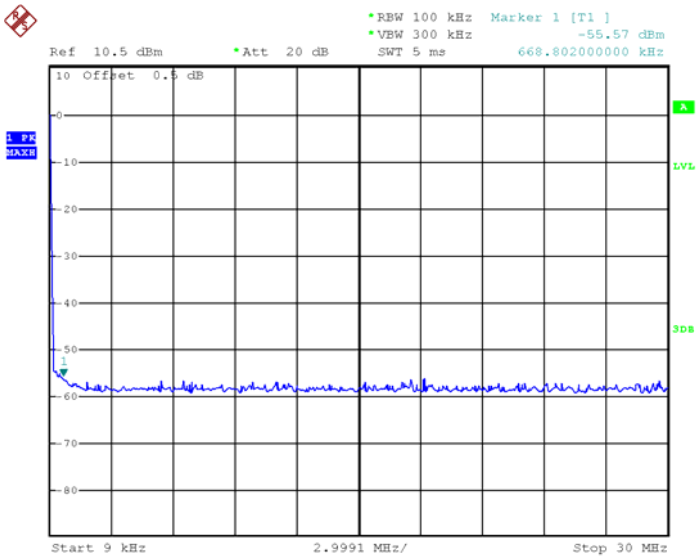
High Channel




Date: 4.SEP.2018 02:16:20

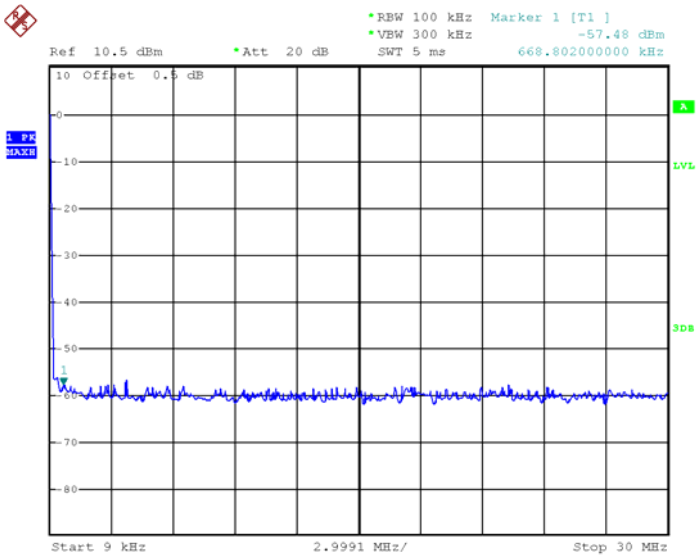
**8DPSK**

Low Channel



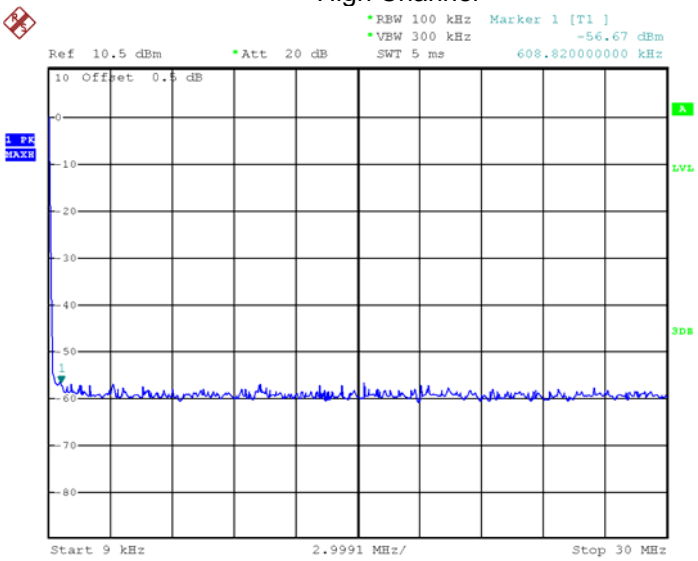

Date: 4.SEP.2018 02:14:46

Middle Channel




Date: 4.SEP.2018 02:11:14

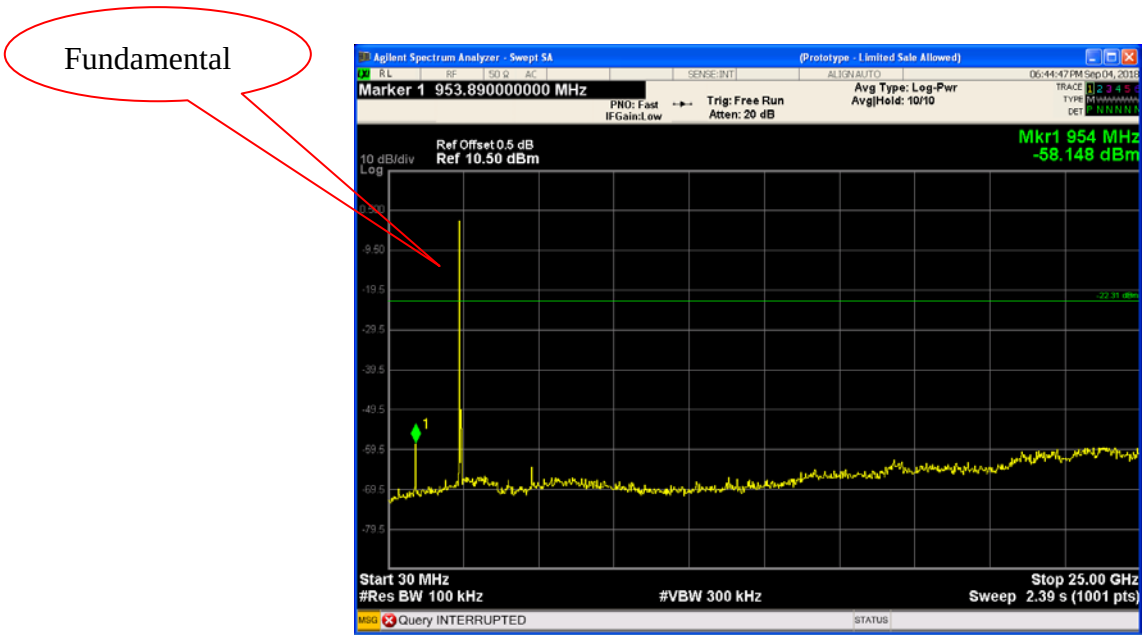
High Channel



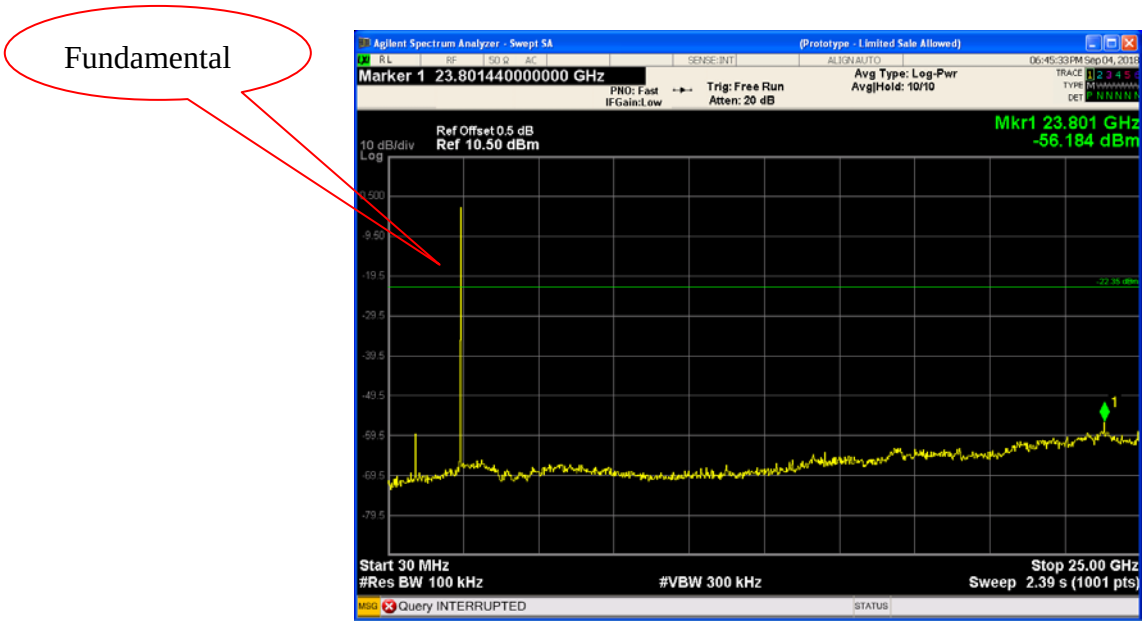

Date: 4.SEP.2018 02:15:20

**30MHz – 25GHz**

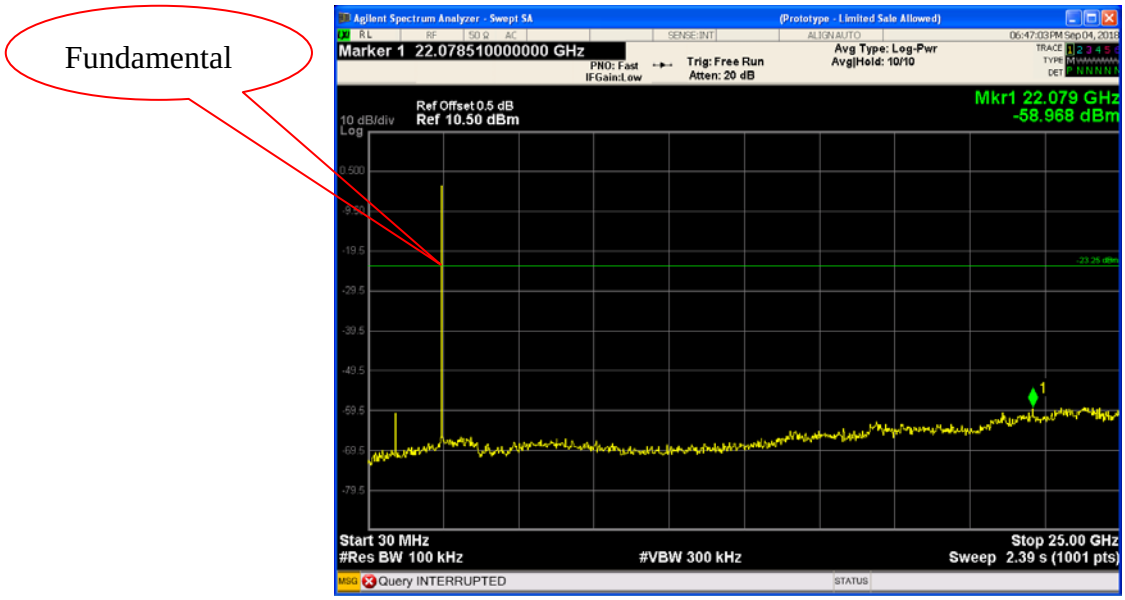
GFSK Low Channel



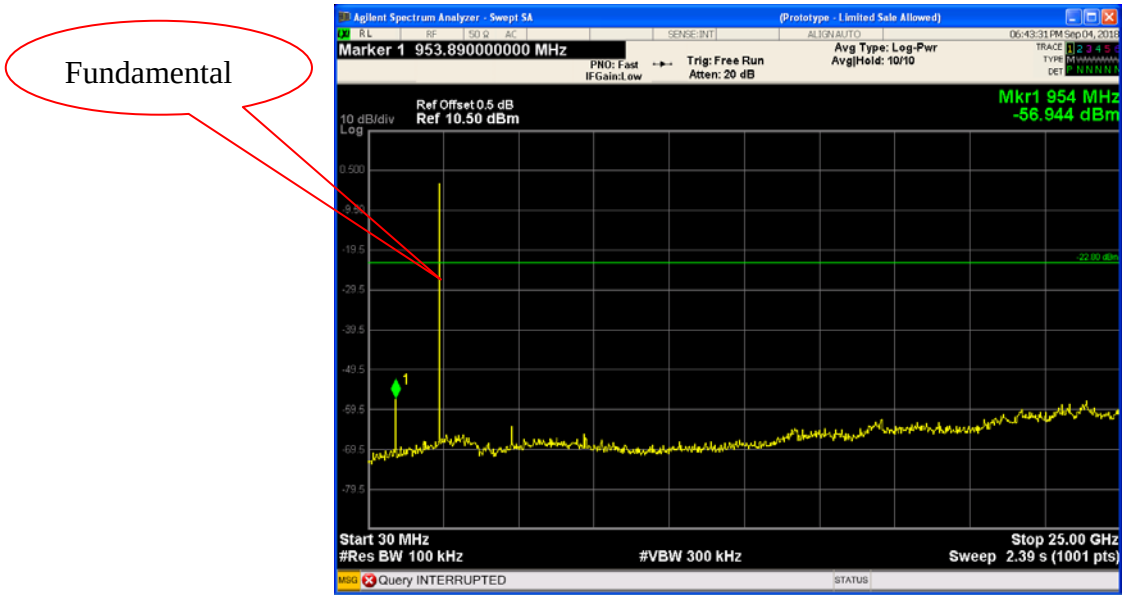

GFSK Middle Channel



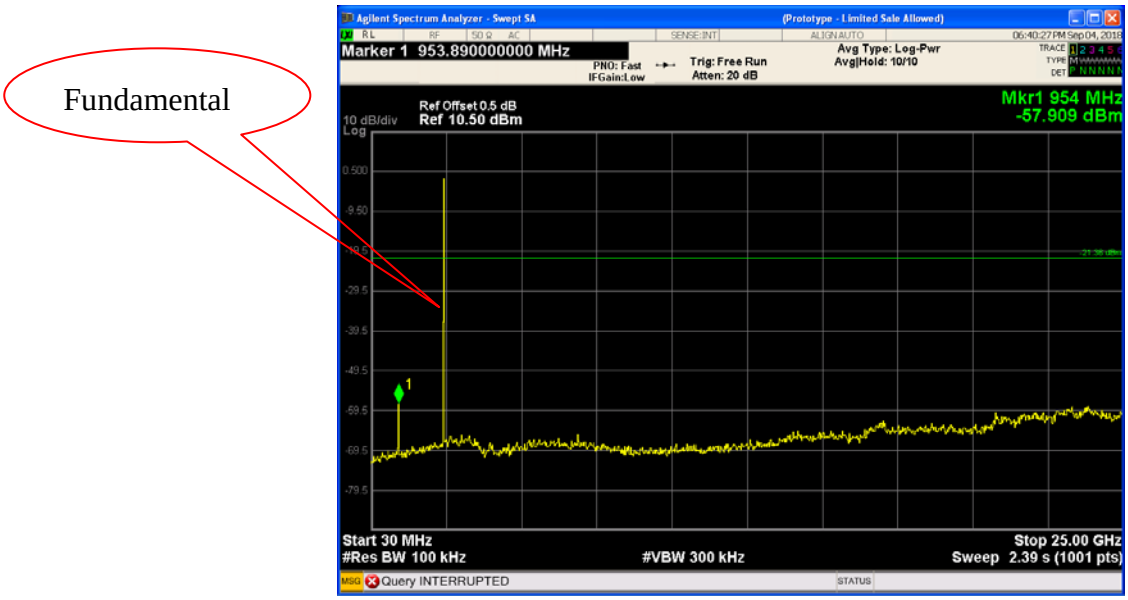
GFSK High Channel



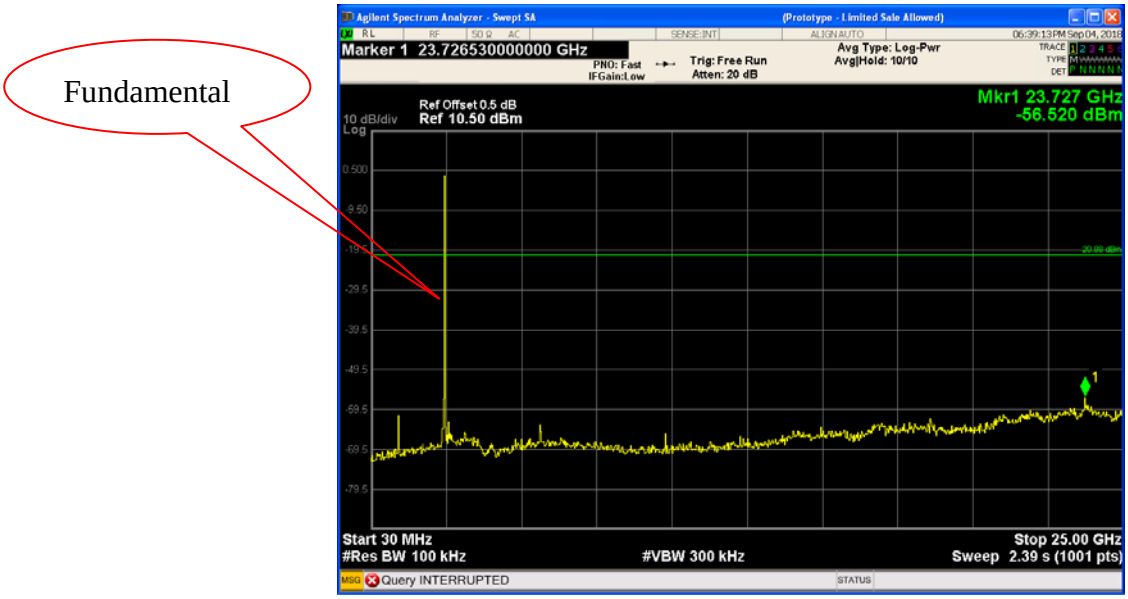

Pi/4 DQPSK Low Channel



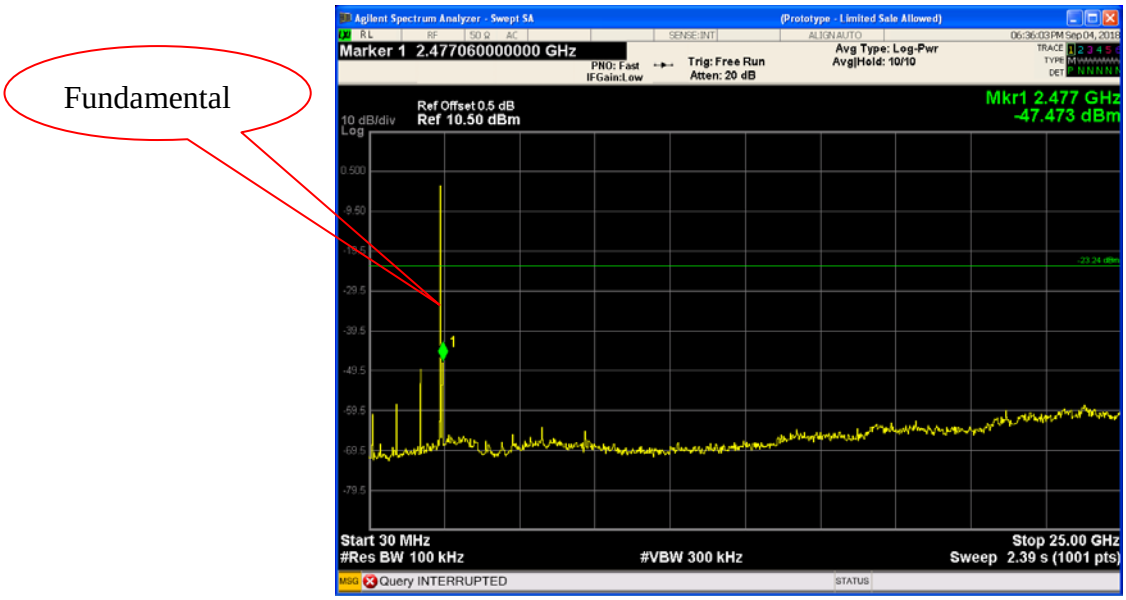
Pi/4 DQPSK Middle Channel



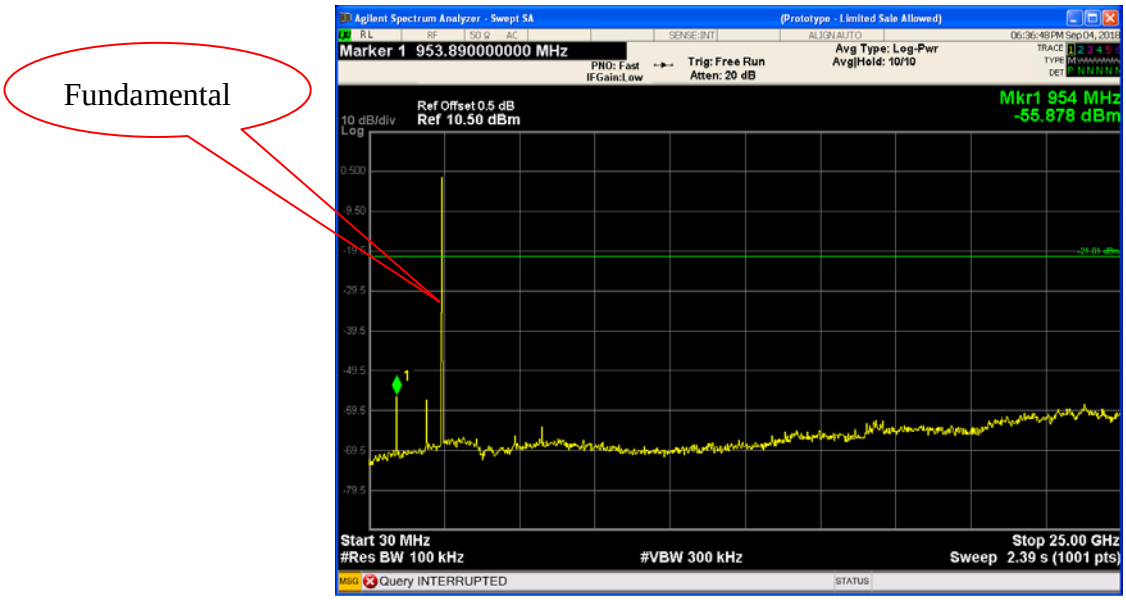

Pi/4 DQPSK High Channel



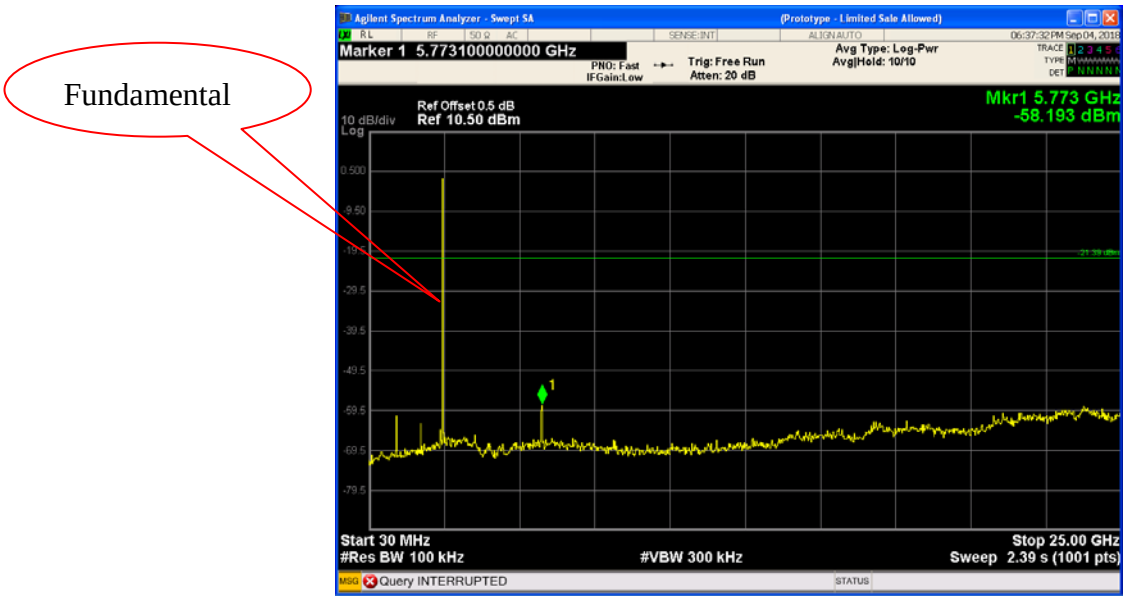
8DPSK Low Channel




8DPSK Middle Channel



8DPSK High Channel



# 11 Band Edge Measurement

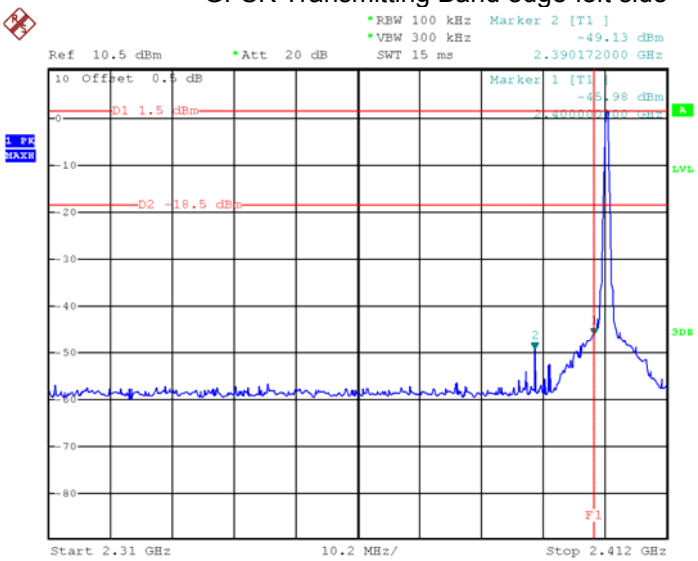
| | |
|---|---|
| Test Requirement: | Section 15.247(d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)). |
| Test Method: | ANSI C63.10: 2013 |
| 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 |

## 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 = 100kHz, VBW = 300kHz, Sweep = auto
   Detector function = peak, Trace = max hold

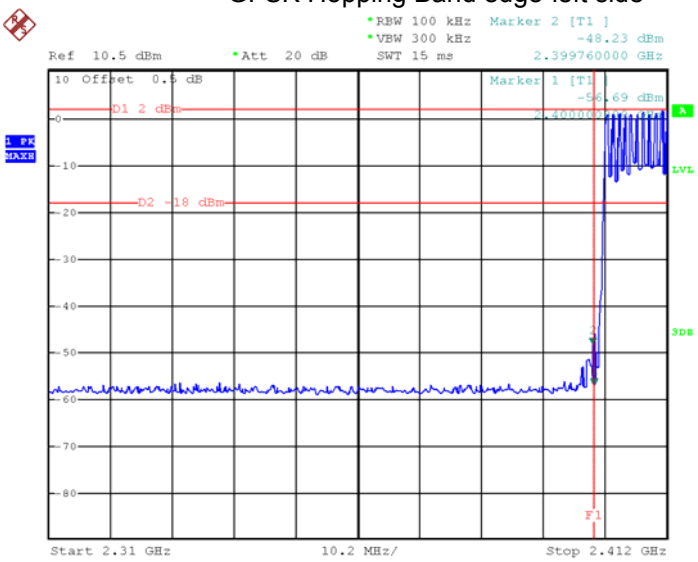
## 11.2 Test Result

GFSK Transmitting Band edge-left side



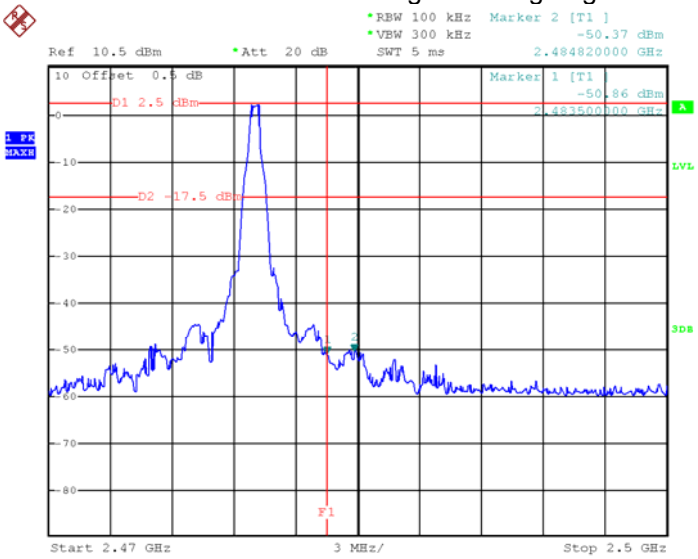

Date: 3.SEP.2018 22:11:12

GFSK Hopping Band edge-left side



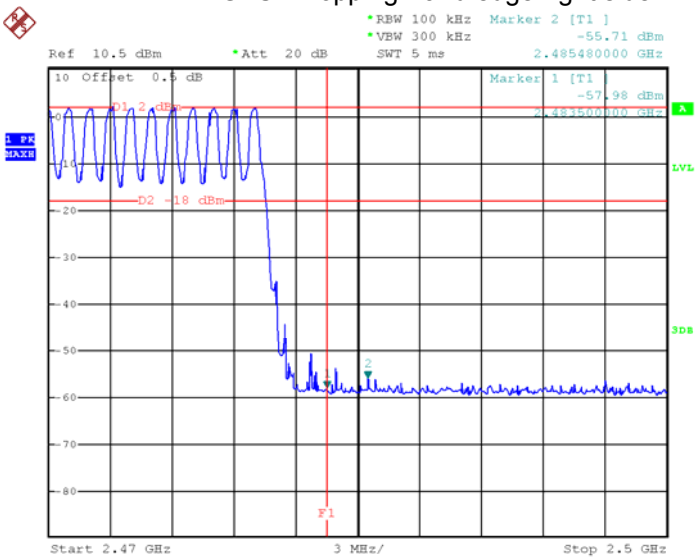

Date: 3.SEP.2018 22:13:31

GFSK Transmitting Band edge-right side



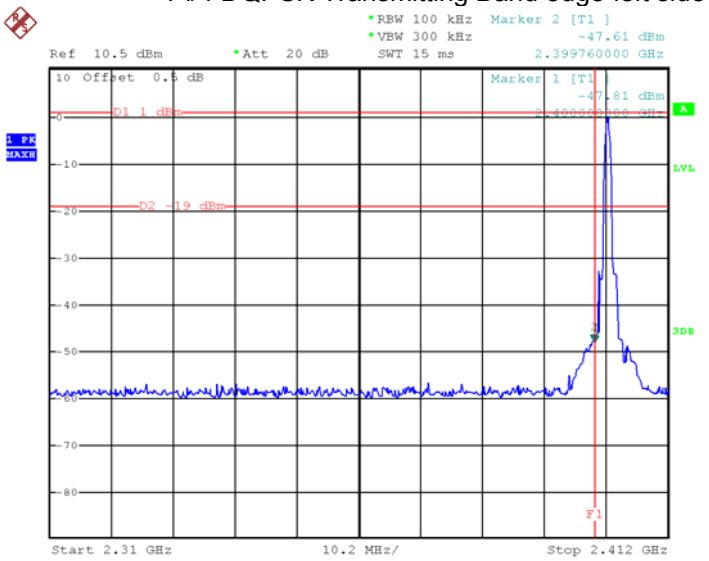

Date: 3.SEP.2018 22:16:41

GFSK Hopping Band edge-right side



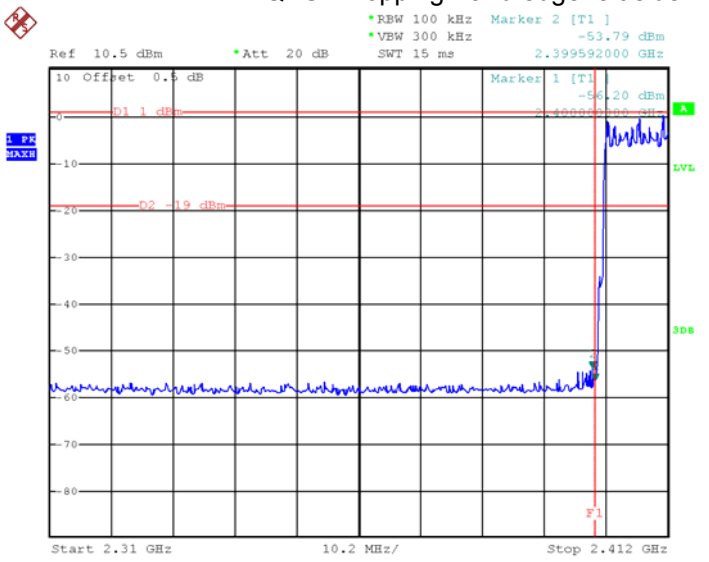

Date: 3.SEP.2018 22:14:57

Pi/4 DQPSK Transmitting Band edge-left side



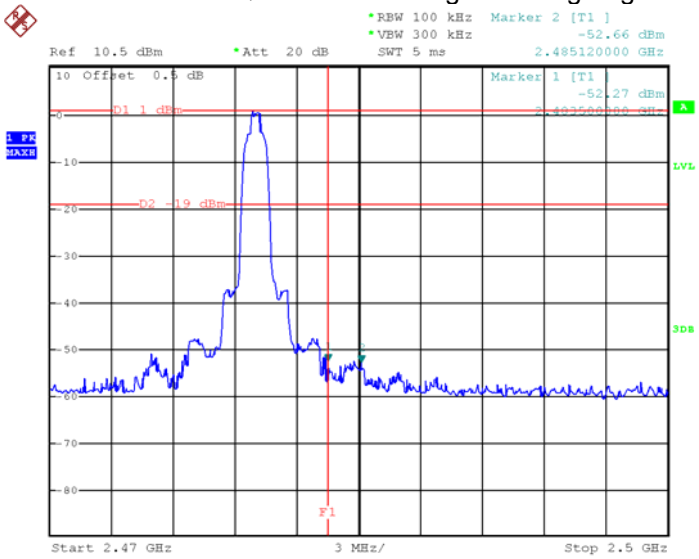

Date: 3.SEP.2018 22:09:39

Pi/4 DQPSK Hopping Band edge-left side



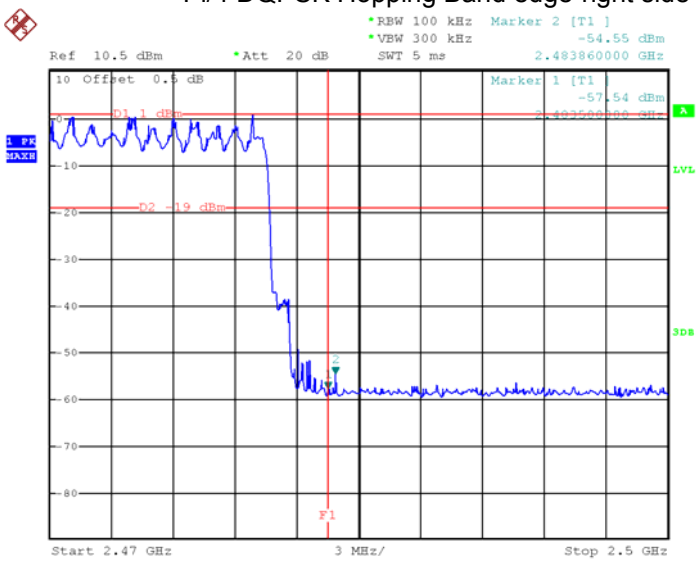

Date: 3.SEP.2018 22:08:57

Pi/4 DQPSK Transmitting Band edge-right side



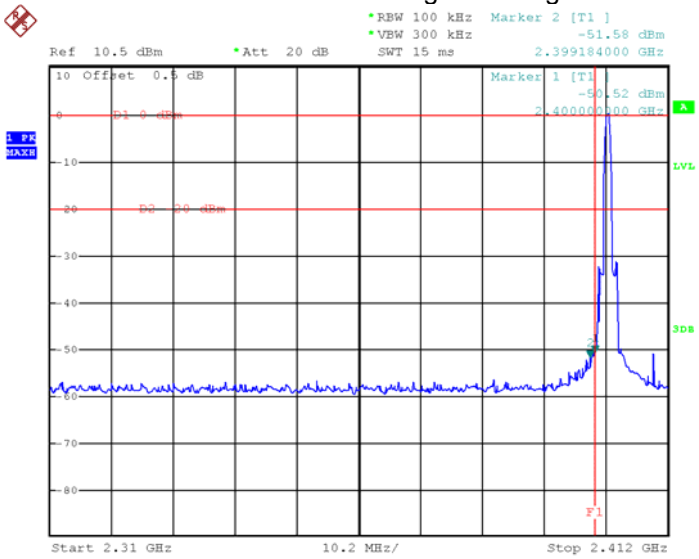

Date: 3.SEP.2018 22:05:23

Pi/4 DQPSK Hopping Band edge-right side



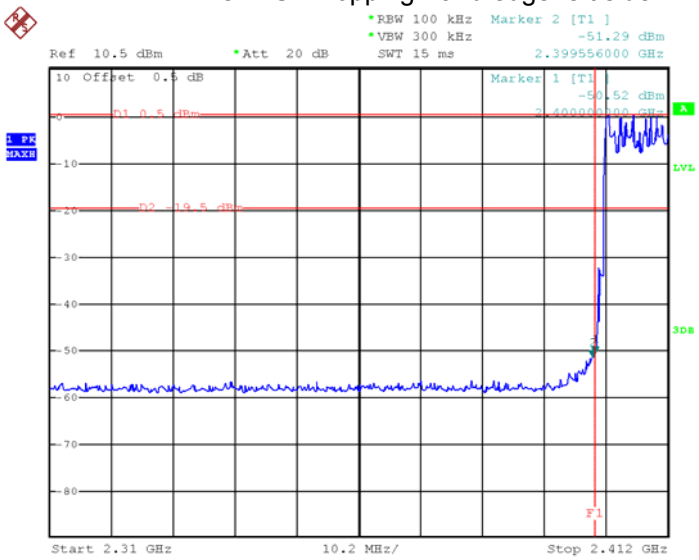

Date: 3.SEP.2018 22:07:11

8DPSK Transmitting Band edge-left side



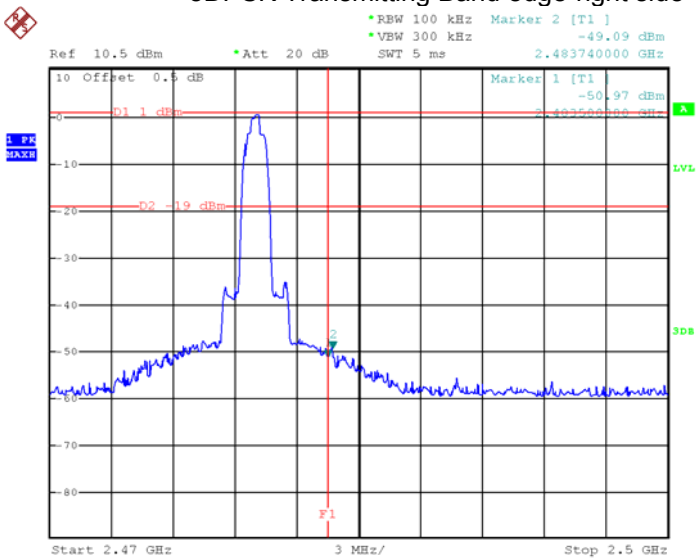

Date: 3.SEP.2018 21:59:48

8DPSK Hopping Band edge-left side



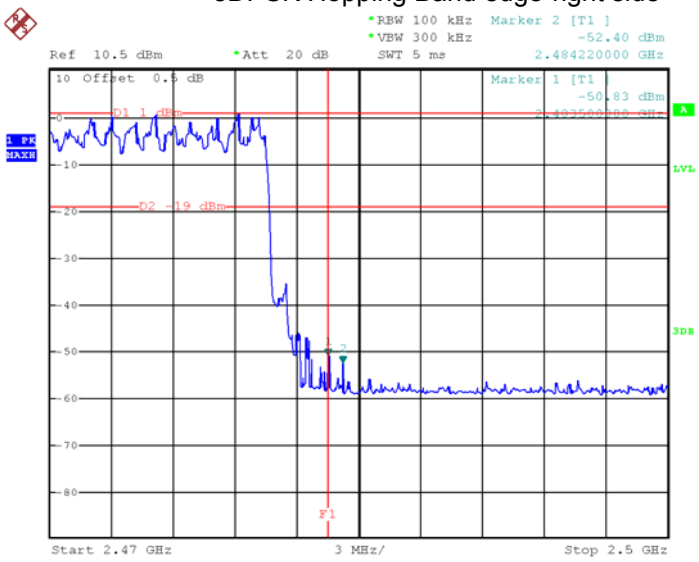

Date: 3.SEP.2018 22:00:57

8DPSK Transmitting Band edge-right side




Date: 3.SEP.2018 22:04:02

8DPSK Hopping Band edge-right side




Date: 3.SEP.2018 22:03:18

# 12 20 dB 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.

## 12.1 Test Procedure

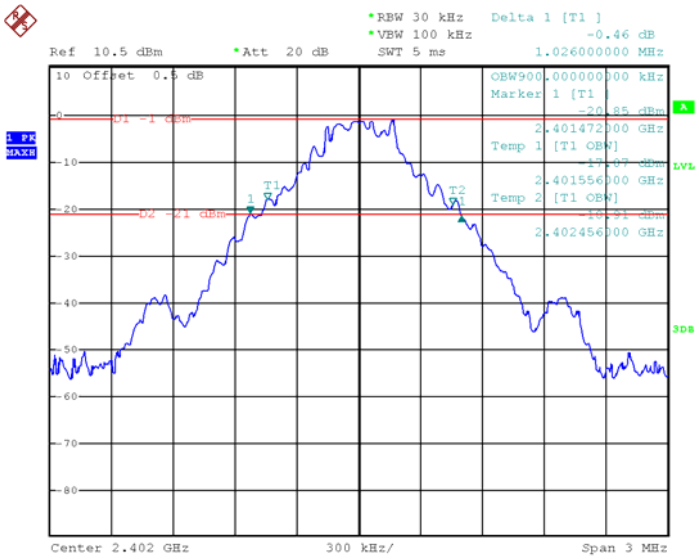
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 30kHz, VBW = 100kHz

## 12.2 Test Result

| Modulation | Test Channel | Bandwidth(MHz) |
|---|---|---|
| GFSK | Low | 1.026 |
| GFSK | Middle | 1.026 |
| GFSK | High | 1.026 |
| Pi/4 DQPSK | Low | 1.296 |
| Pi/4 DQPSK | Middle | 1.296 |
| Pi/4 DQPSK | High | 1.296 |
| 8DPSK | Low | 1.290 |
| 8DPSK | Middle | 1.290 |
| 8DPSK | High | 1.290 |

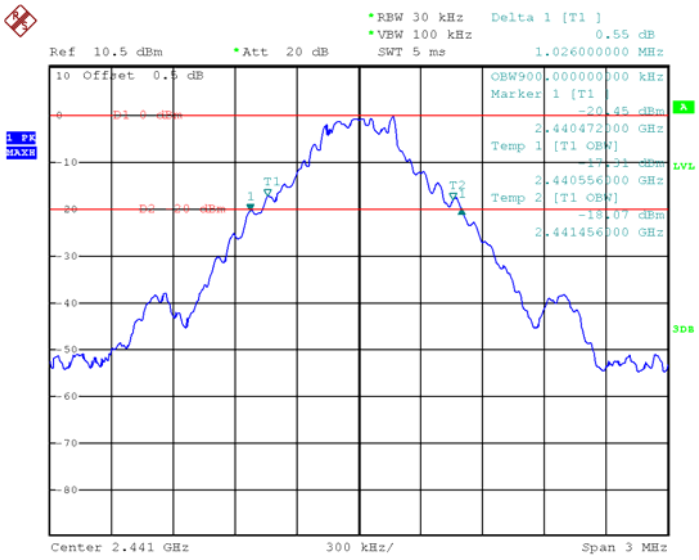
**Test plots**

GFSK Low Channel



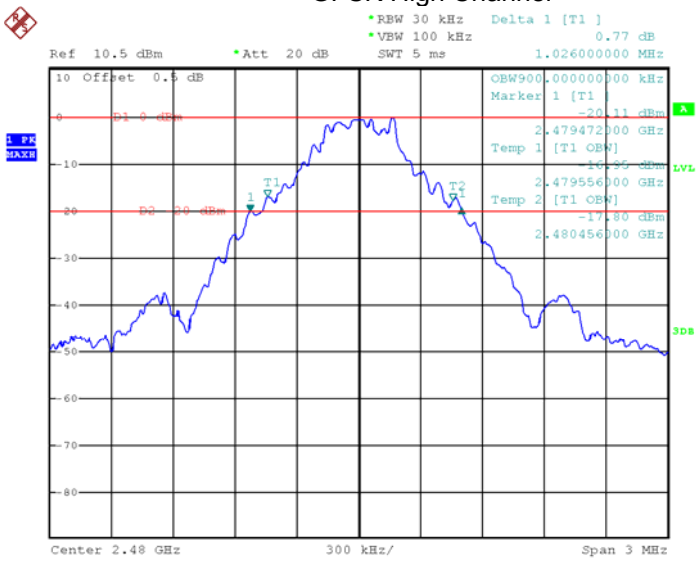

Date: 3.SEP.2018 21:38:25

GFSK Middle Channel



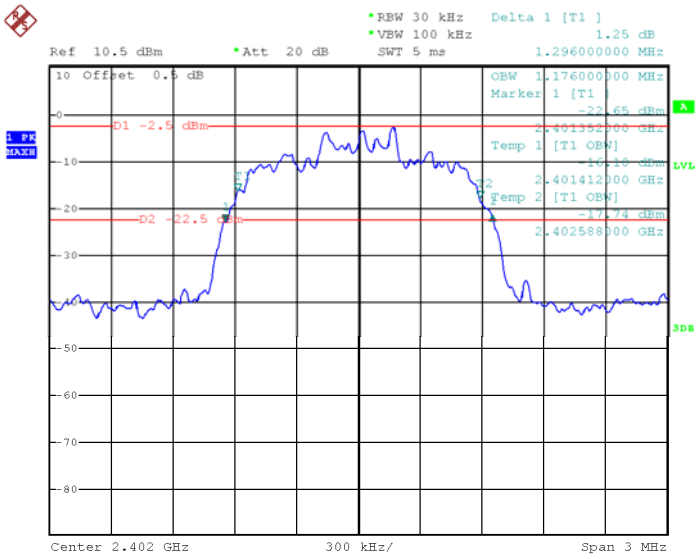

Date: 3.SEP.2018 21:36:53

GFSK High Channel



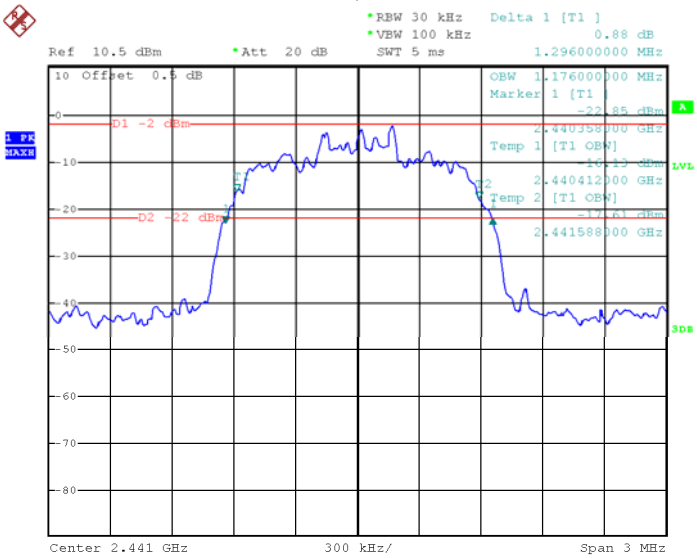

Date: 3.SEP.2018 21:35:33

Pi/4 DQPSK Low Channel



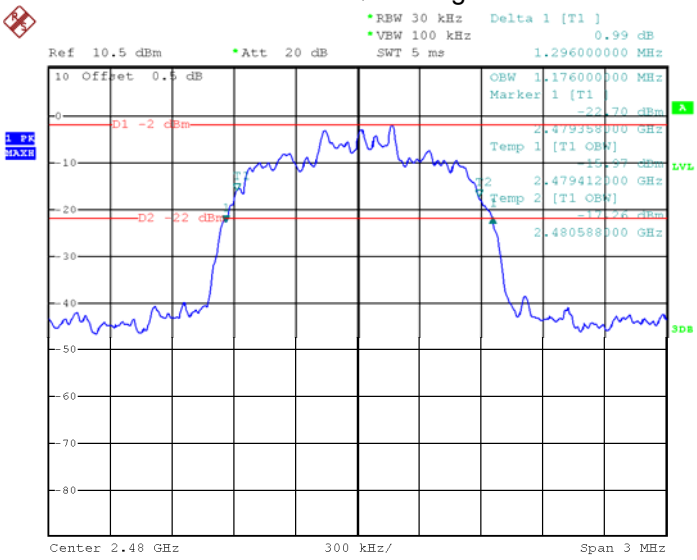

Date: 3.SEP.2018 21:32:15

Pi/4 DQPSK Middle Channel



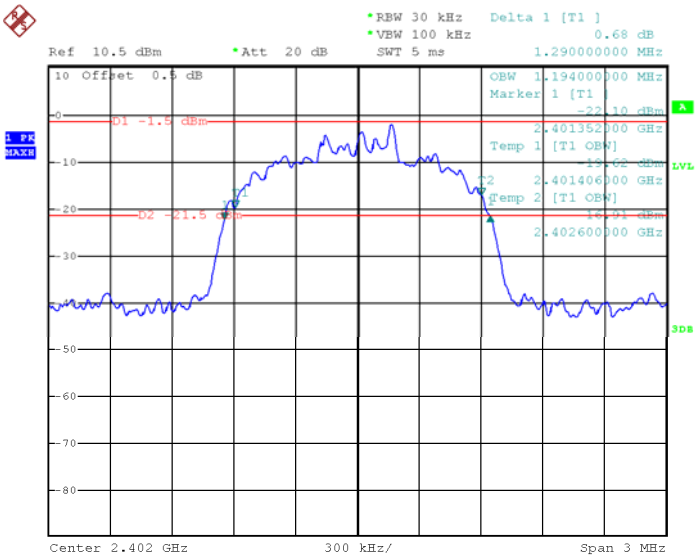

Date: 3.SEP.2018 21:33:28

Pi/4 DQPSK High Channel



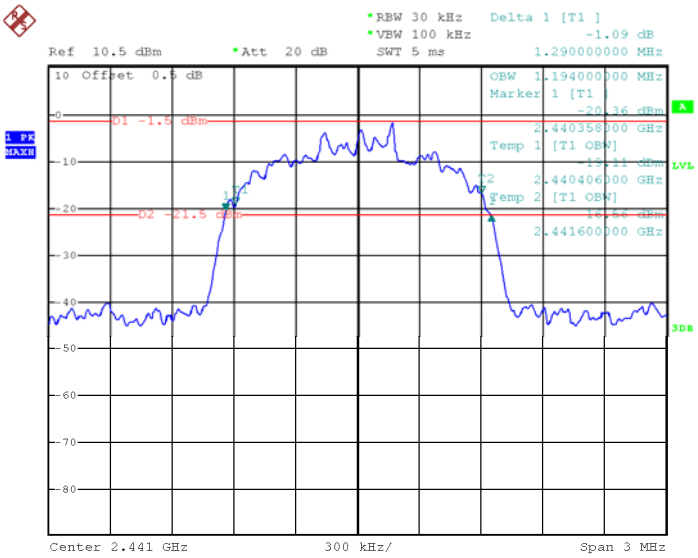

Date: 3.SEP.2018 21:34:19

8DPSK Low Channel



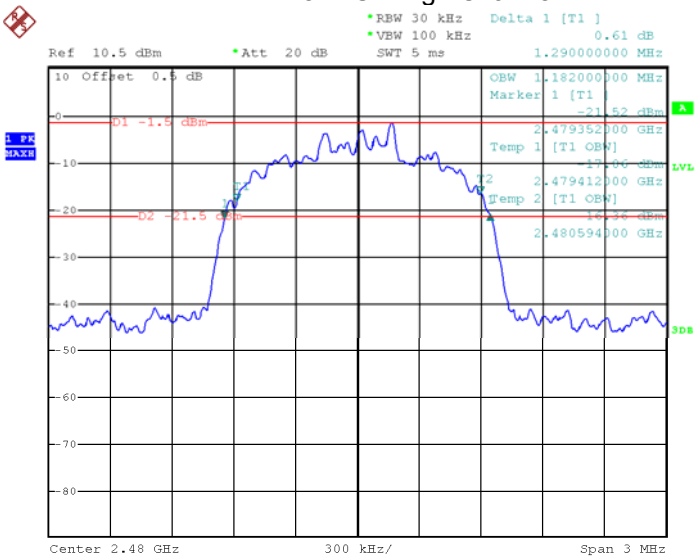

Date: 3.SEP.2018 21:30:23

8DPSK Middle Channel




Date: 3.SEP.2018 21:28:24

8DPSK High Channel




Date: 3.SEP.2018 21:29:24

# 13 Maximum Peak Output Power

Test Requirement: FCC CFR47 Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247 (a)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater: 0.125 watts..

Test mode: Test in fixing frequency transmitting mode.

## 13.1 Test Procedure

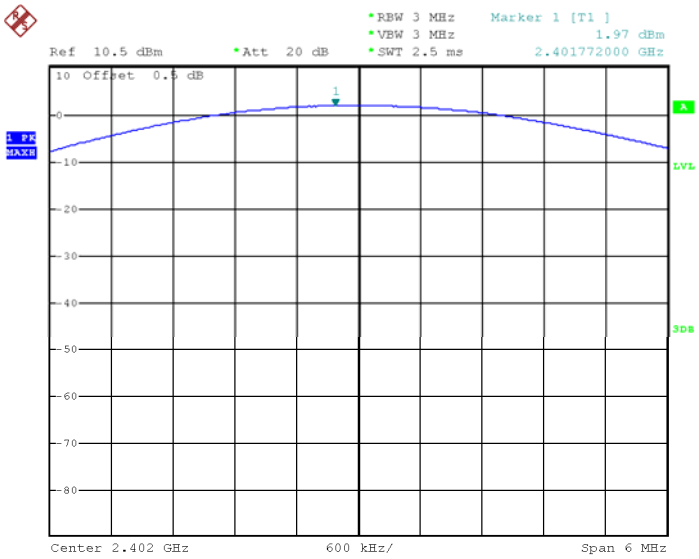
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.///

## 13.2 Test Result

| Modulation | Test Channel | Output Power (dBm) | Limit (dBm) |
|---|---|---|---|
| GFSK | Low | 1.97 | 21 |
| GFSK | Middle | 2.37 | 21 |
| GFSK | High | 2.72 | 21 |
| Pi/4 DQPSK | Low | 1.20 | 21 |
| Pi/4 DQPSK | Middle | 1.59 | 21 |
| Pi/4 DQPSK | High | 1.89 | 21 |
| 8DPSK | Low | 1.28 | 21 |
| 8DPSK | Middle | 1.73 | 21 |
| 8DPSK | High | 2.07 | 21 |

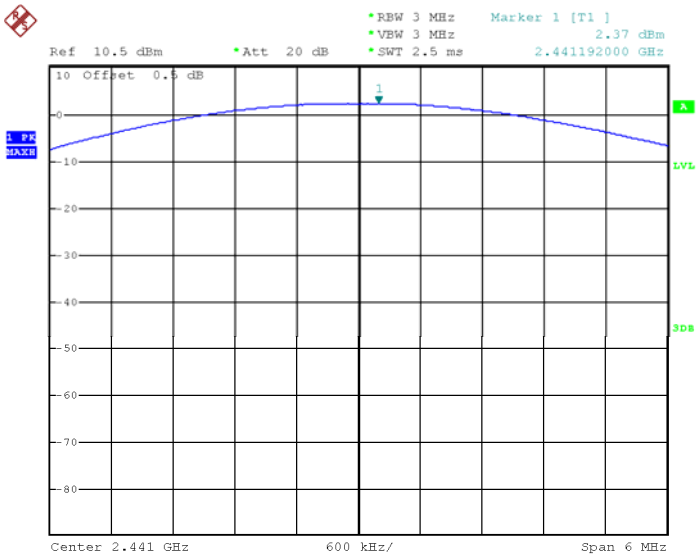
## Test plots

GFSK Low Channel



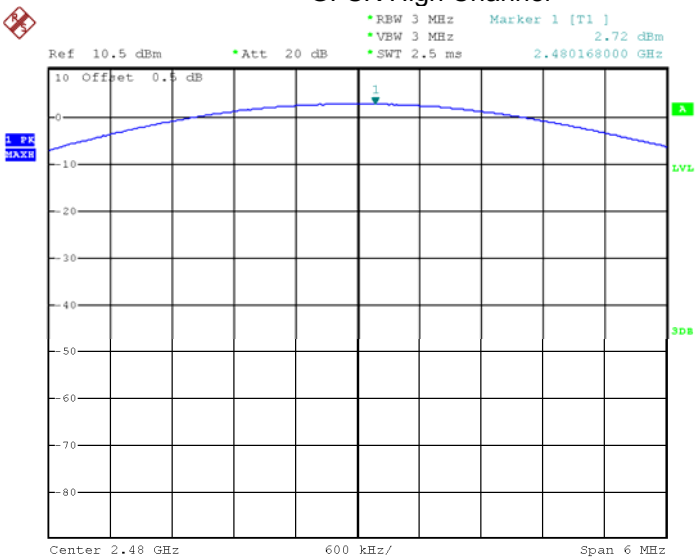

Date: 3.SEP.2018 21:19:58

GFSK Middle Channel



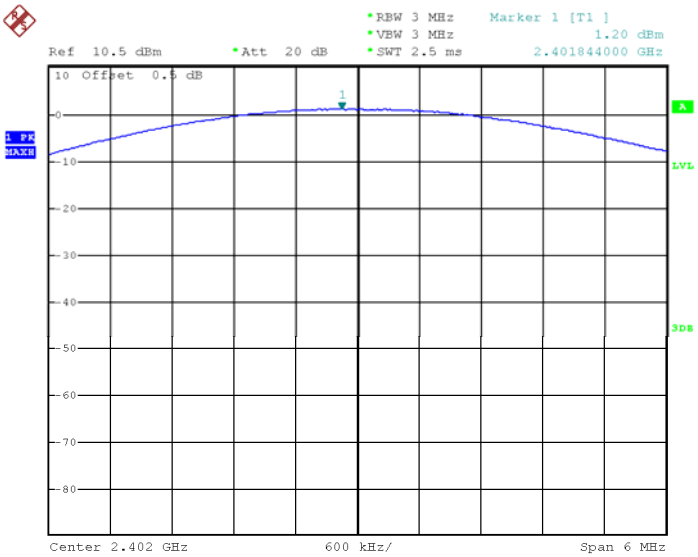

Date: 3.SEP.2018 21:22:47

GFSK High Channel



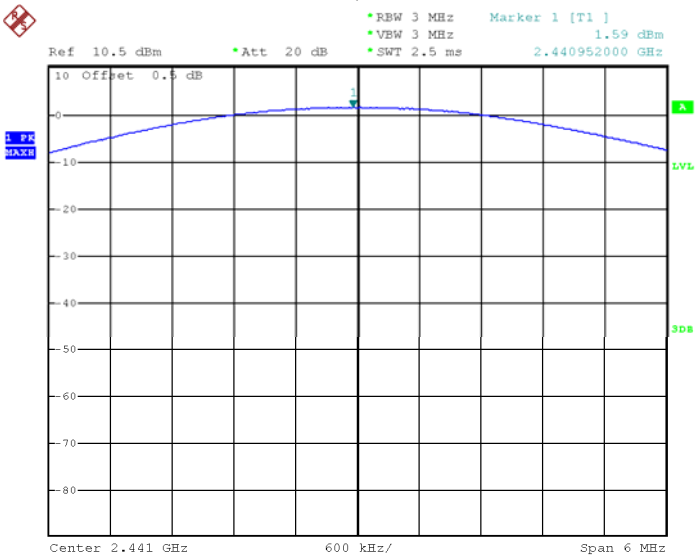

Date: 3.SEP.2018 21:23:20

Pi/4 DQPSK Low Channel



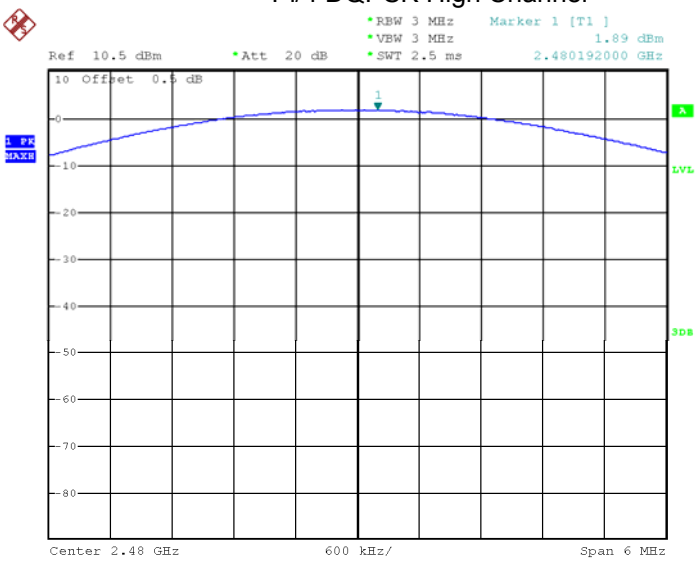

Date: 3.SEP.2018 21:20:53

Pi/4 DQPSK Middle Channel



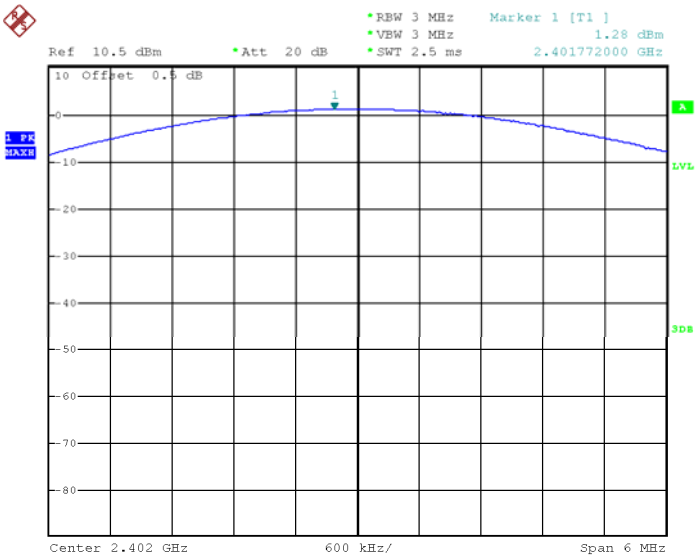

Date: 3.SEP.2018 21:22:16

Pi/4 DQPSK High Channel



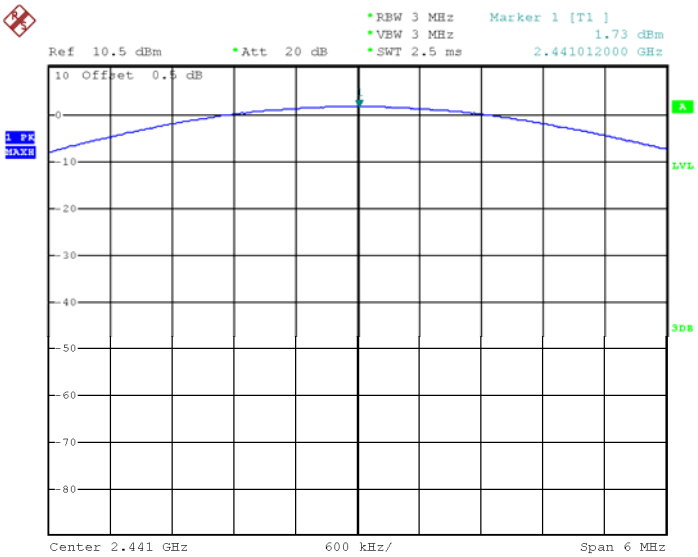

Date: 3.SEP.2018 21:23:54

8DPSK Low Channel



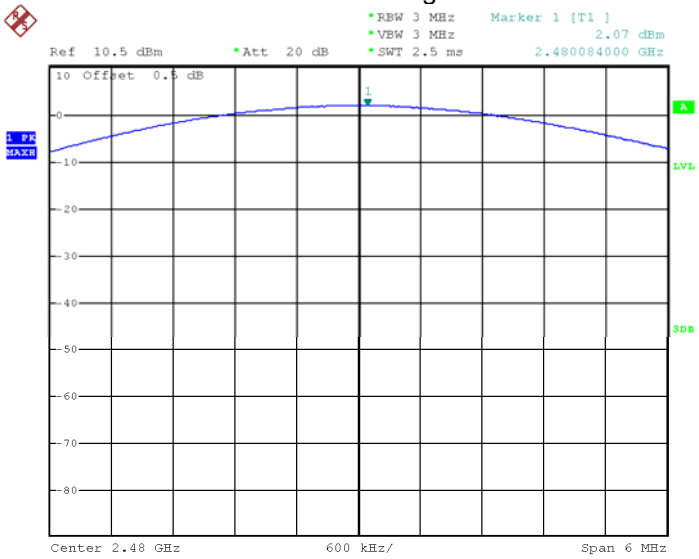

Date: 3.SEP.2018 21:21:18

8DPSK Middle Channel




Date: 3.SEP.2018 21:21:46

8DPSK High Channel




Date: 3.SEP.2018 21:24:11

# 14 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.

## 14.1 Test Procedure

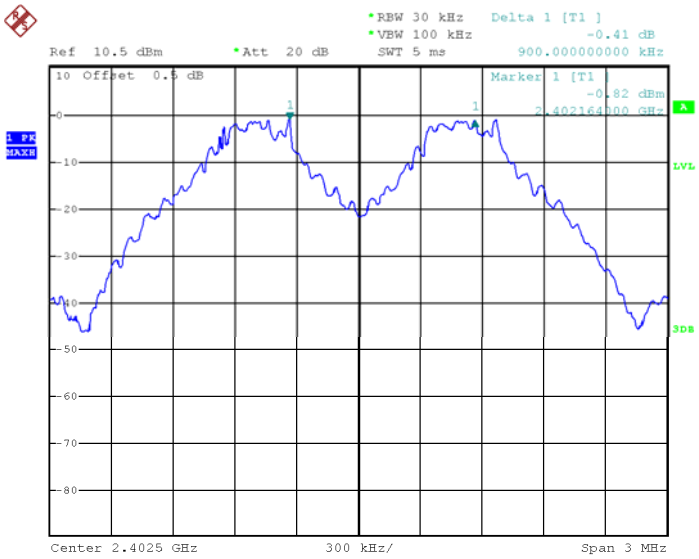
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 30kHz. VBW = 100kHz , Span = 3.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to 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.

## 14.2 Test Result

| Modulation | Test Channel | Separation (MHz) | Limit(MHz) | Result |
|---|---|---|---|---|
| GFSK | Low | 0.900 | 0.684 | PASS |
| GFSK | Middle | 0.900 | 0.684 | PASS |
| GFSK | High | 0.900 | 0.684 | PASS |
| Pi/4 DQPSK | Low | 1.002 | 0.864 | PASS |
| Pi/4 DQPSK | Middle | 1.002 | 0.864 | PASS |
| Pi/4 DQPSK | High | 1.002 | 0.864 | PASS |
| 8DPSK | Low | 1.002 | 0.860 | PASS |
| 8DPSK | Middle | 1.002 | 0.860 | PASS |
| 8DPSK | High | 1.002 | 0.860 | PASS |

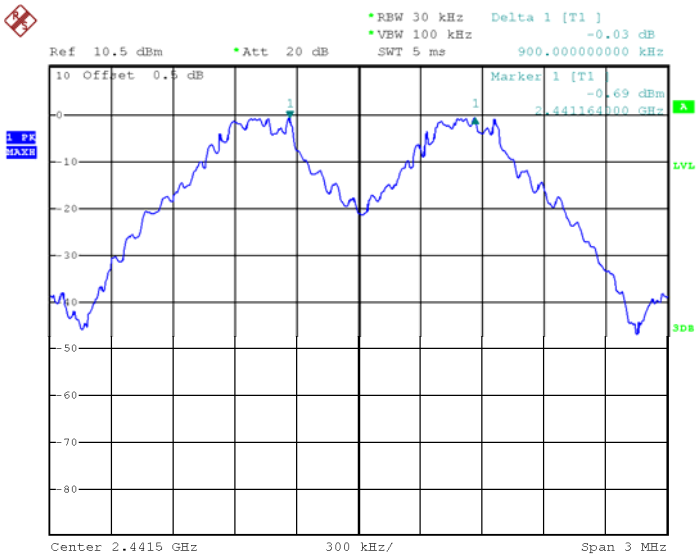
## Test plots

GFSK Low Channel



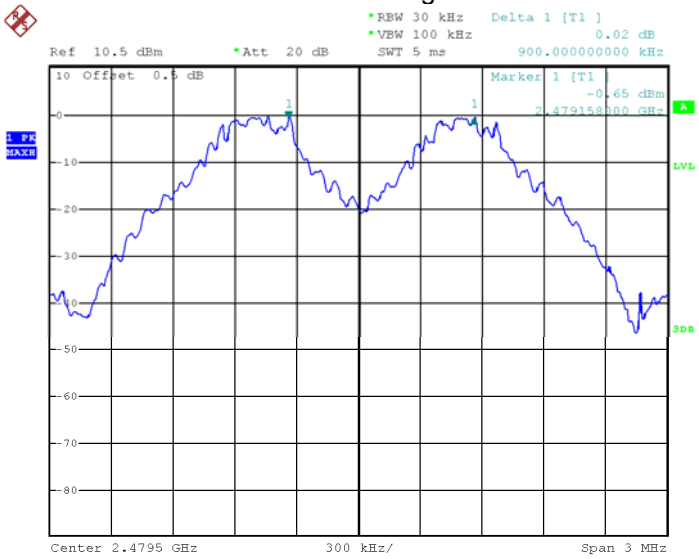

Date: 3.SEP.2018 21:39:44

GFSK Middle Channel



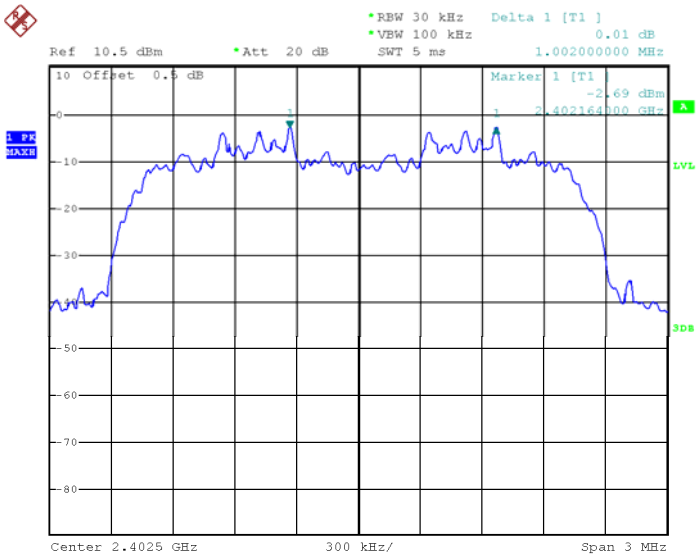

Date: 3.SEP.2018 21:41:18

GFSK High Channel



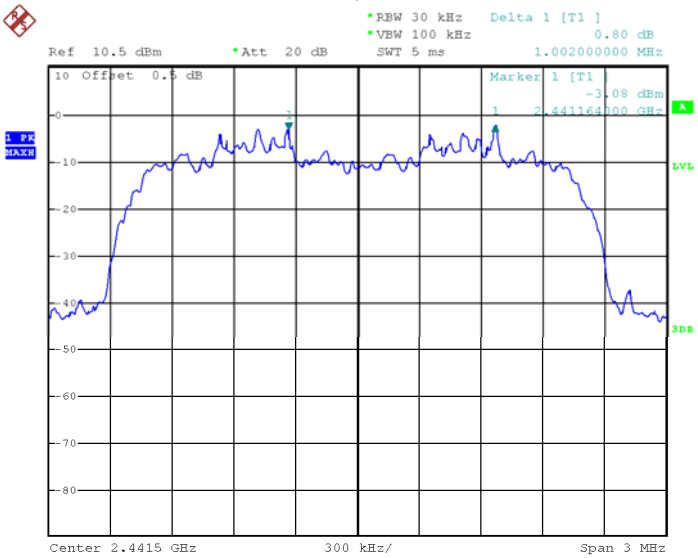

Date: 3.SEP.2018 21:42:26

Pi/4 DQPSK Low Channel



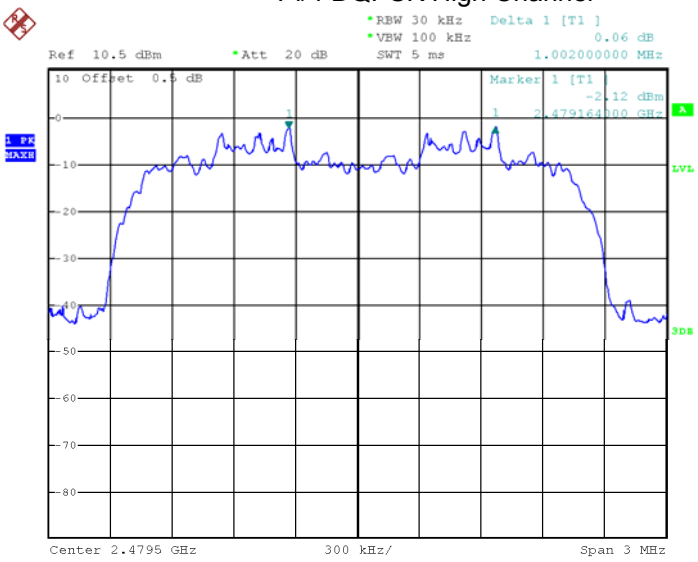

Date: 3.SEP.2018 21:46:12

Pi/4 DQPSK Middle Channel



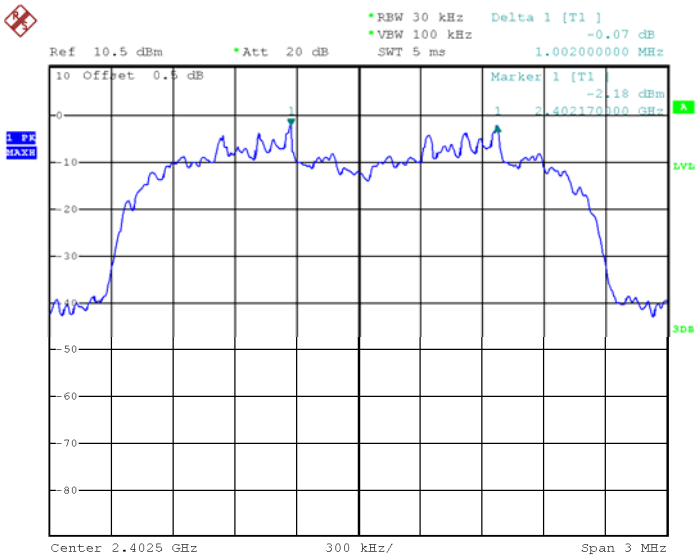

Date: 3.SEP.2018 21:45:05

Pi/4 DQPSK High Channel



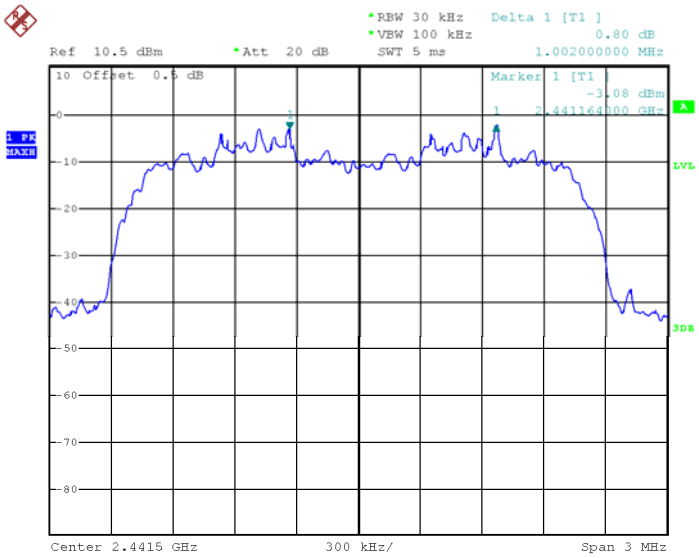

Date: 3.SEP.2018 21:43:16

8DPSK Low Channel



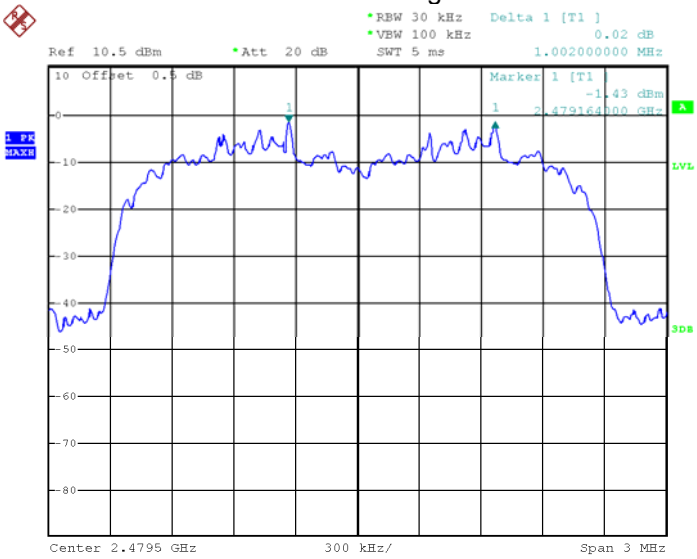

Date: 3.SEP.2018 21:47:24

8DPSK Middle Channel




Date: 3.SEP.2018 21:45:05

8DPSK High Channel




Date: 3.SEP.2018 21:48:49

# 15 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. |

## 15.1 Test Procedure

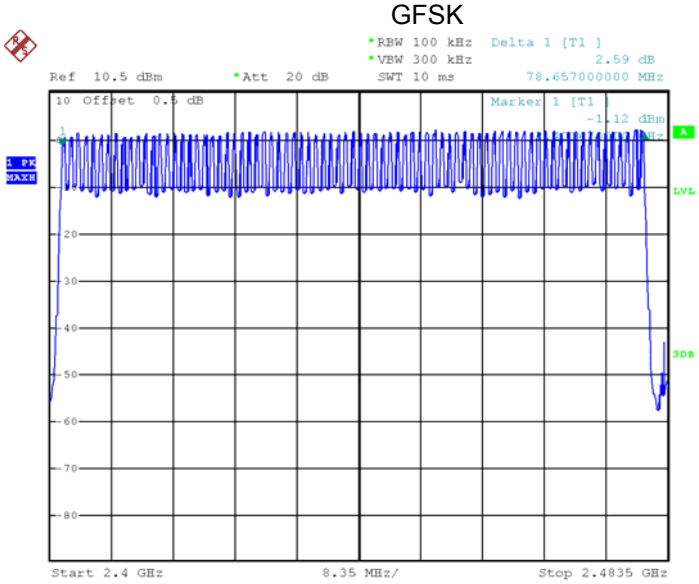
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to 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 = 2.4835GHz. Sweep=auto;

## 15.2 Test Result

**Test Plots:**

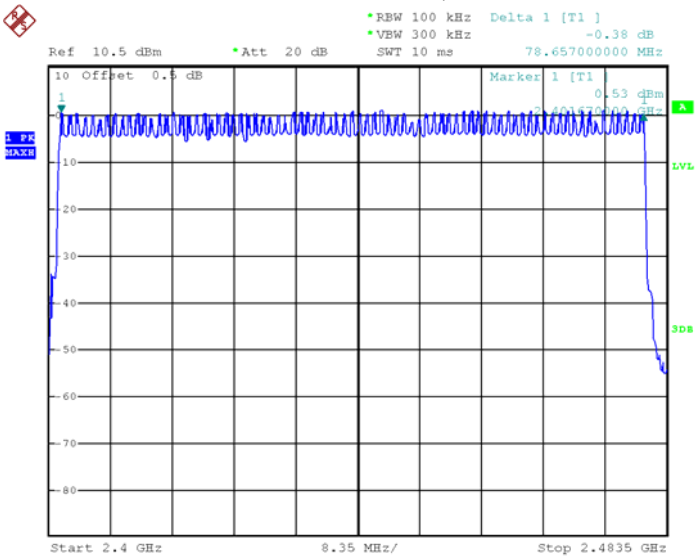
79 Channels in total

GFSK



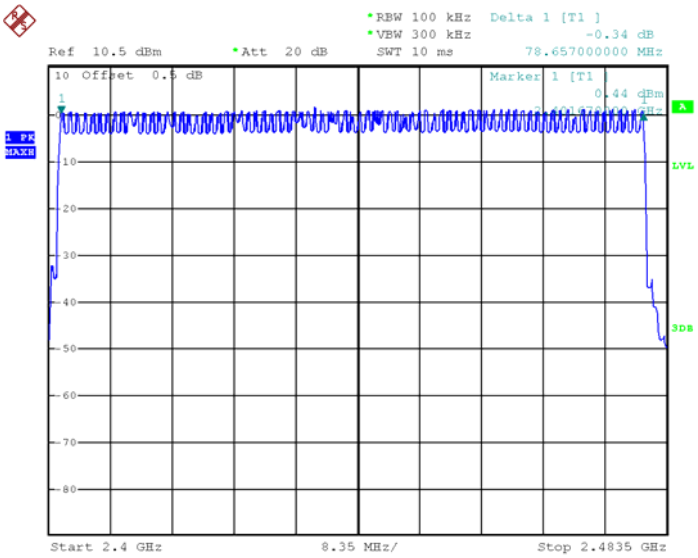

Date: 3.SEP.2018 22:18:49

Pi/4 DQPSK




Date: 3.SEP.2018 22:55:48

8DPSK




Date: 3.SEP.2018 23:30:46

# 16 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. |

## 16.1 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).

## 16.2 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).

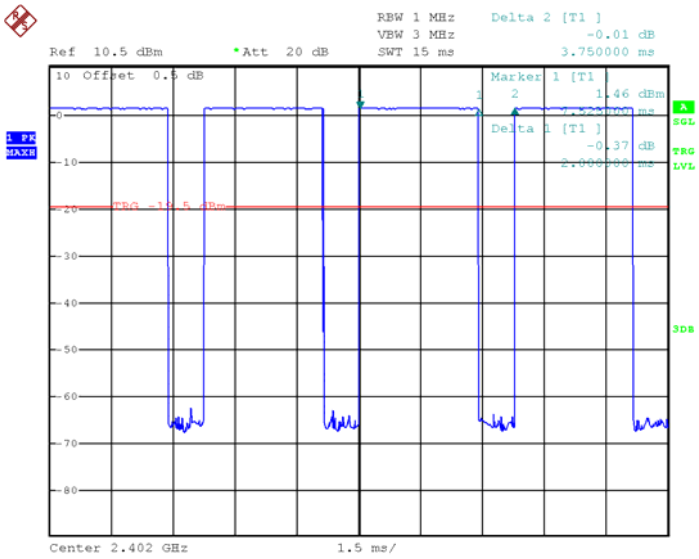
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

| 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 | 2.880 | 0.307 | 0.4 |
| | | middle | 2.880 | 0.307 | 0.4 |
| | | High | 2.880 | 0.307 | 0.4 |
| Pi/4DQPSK | DH5 | Low | 2.880 | 0.307 | 0.4 |
| | | middle | 2.880 | 0.307 | 0.4 |
| | | High | 2.880 | 0.307 | 0.4 |
| 8DPSK | DH5 | Low | 2.880 | 0.307 | 0.4 |
| | | middle | 2.880 | 0.307 | 0.4 |
| | | High | 2.880 | 0.307 | 0.4 |

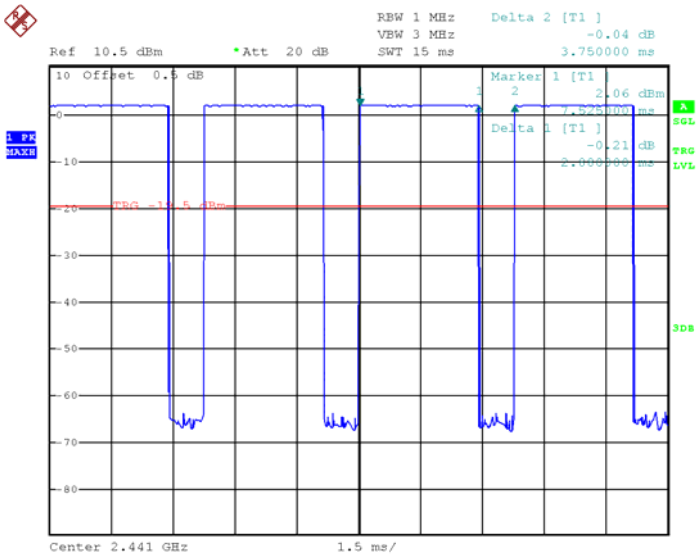
Remark: Only the worst-case mode DH5 is recorded.

Test Plots
GFSK DH5 Low Channel



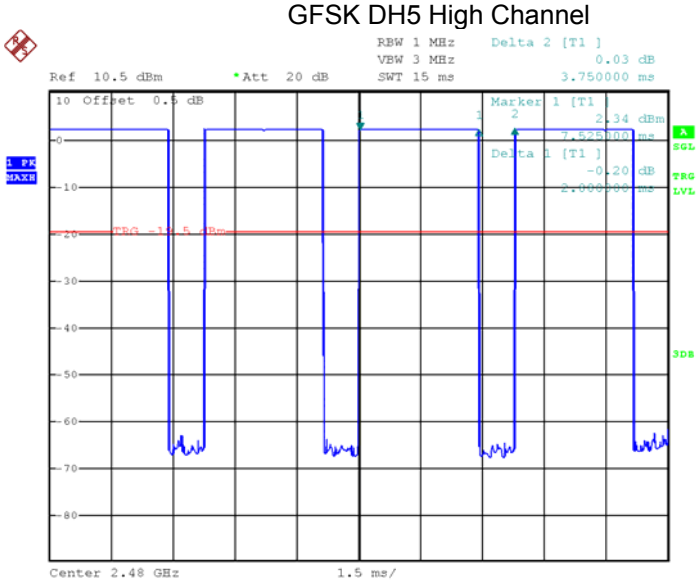

Date: 4.SEP.2018 01:57:15

GFSK DH5 Middle Channel



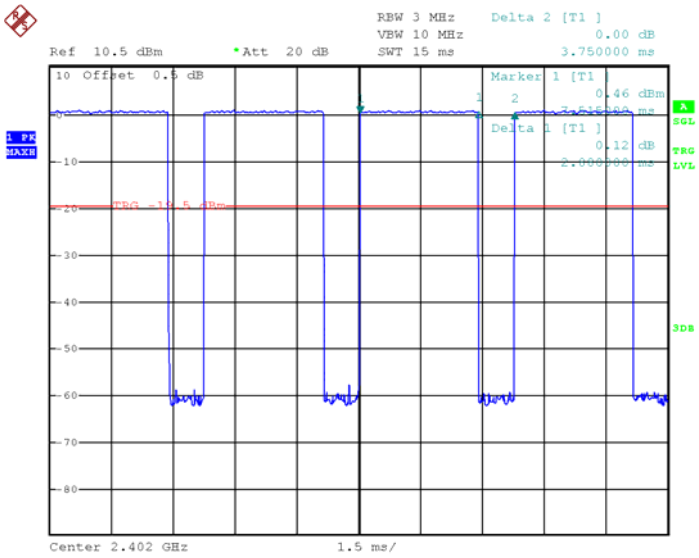

Date: 4.SEP.2018 01:57:03

GFSK DH5 High Channel



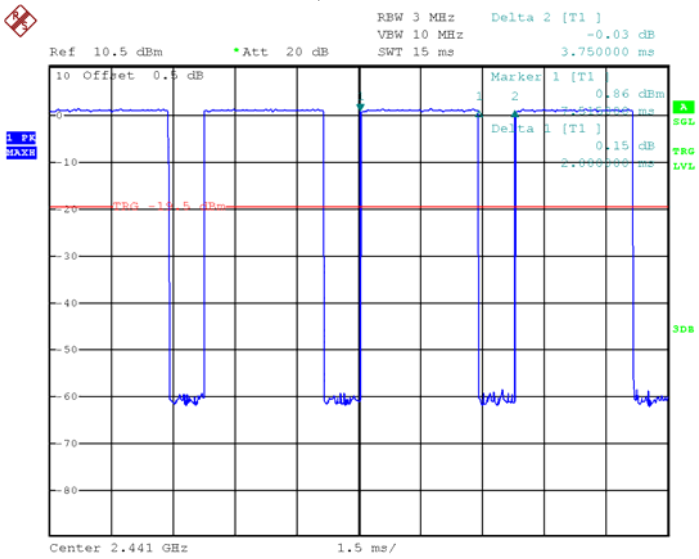

Date: 4.SEP.2018 01:56:46

Pi/4DQPSK DH5 Low Channel



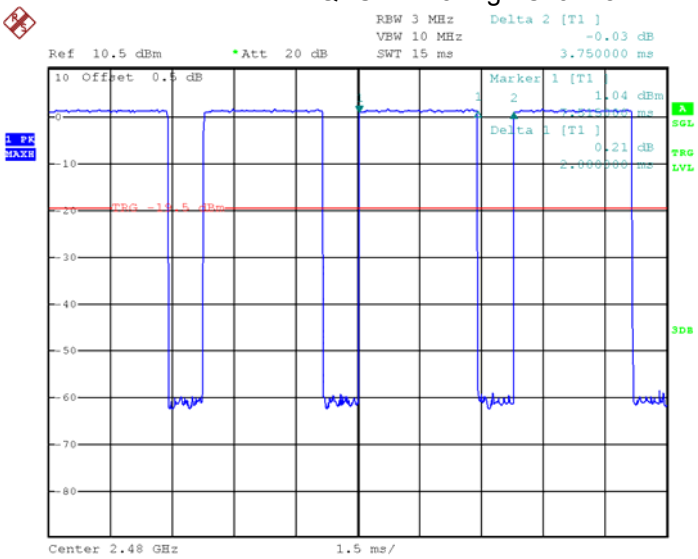

Date: 4.SEP.2018 01:49:16

Pi/4DQPSK DH5 Middle Channel



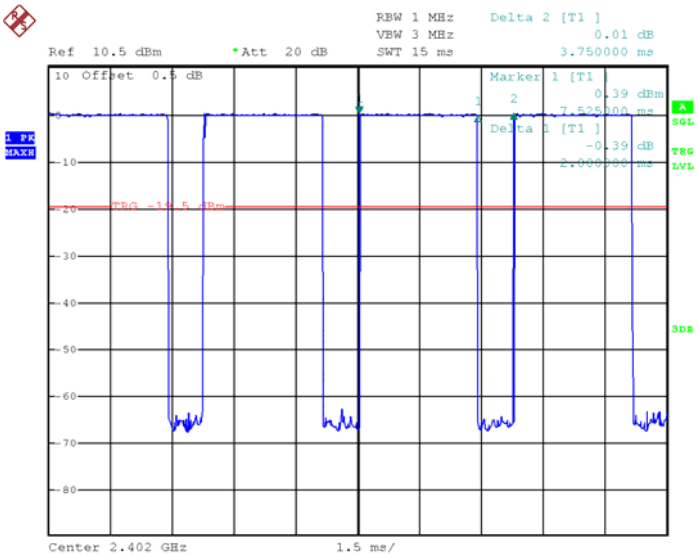

Date: 4.SEP.2018 01:49:02

Pi/4DQPSK DH5 High Channel



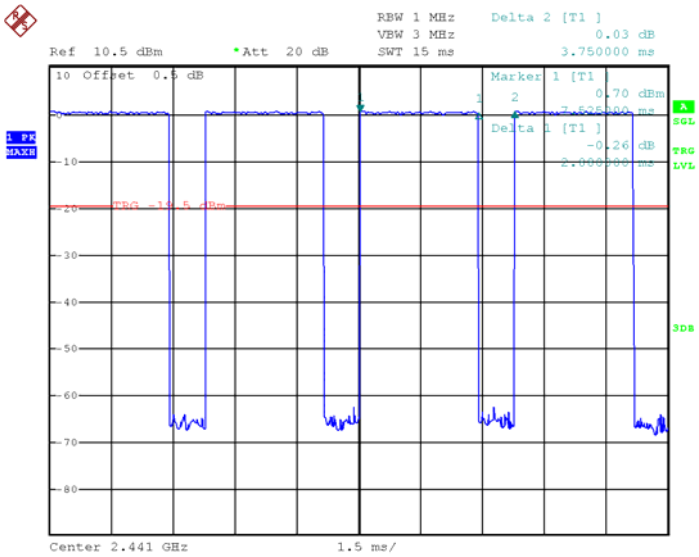

Date: 4.SEP.2018 01:48:46

8DPSK DH5 Low Channel



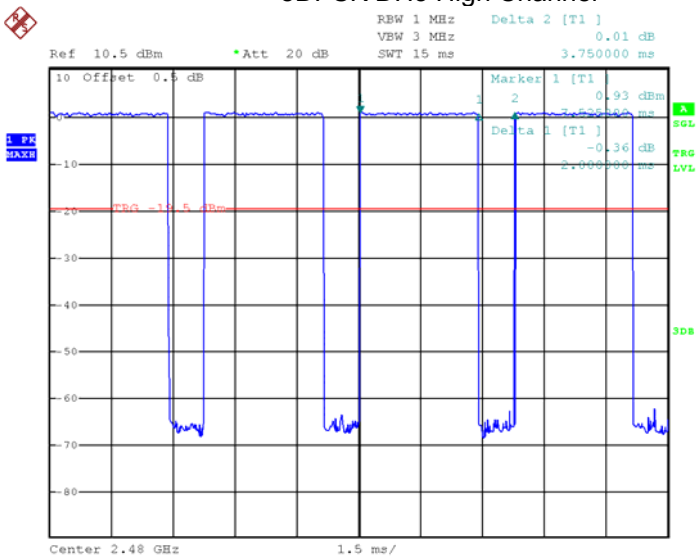

Date: 4.SEP.2018 01:55:45

8DPSK DH5 Middle Channel




Date: 4.SEP.2018 01:56:03

8DPSK DH5 High Channel




Date: 4.SEP.2018 01:56:18

# 17 Antenna Requirement

According to the FCC Part 15 Paragraph 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. This product has an integrated antenna, fulfil the requirement of this section.

# 18 RF Exposure

Remark: refer to MPE test report: WTS18S08121771-2W.

# 19 Photographs of test setup and EUT.

Note: Please refer to appendix: WTS18S08121771W-Photo.

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