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ee.shanghai@sgs.com



# 1 Cover Page

# *RF TEST REPORT*

| | |
|---|---|
| **Application No.:** | SHEM1502000363RF |
| **Applicant:** | Hansong (Nanjing) Technology Ltd. |
| **FCC ID:** | XCO-EDWIN |
| **IC:** | 7756A-EDWIN |
| **Equipment Under Test (EUT):**<br>**NOTE:** The following sample(s) was/were submitted and identified by the client as | |
| **Product Name:** | Edwin the Duck |
| **Model No.(EUT):** | EDW-001 |
| **Standards:** | FCC PART 15 Subpart C: 2014<br>RSS-247 Issue 1 (May 2015)<br>RSS-Gen Issue 4 (November 2014) |
| **Date of Receipt:** | February 06, 2015 |
| **Date of Test:** | March 24, 2015 to March 30, 2015 |
| **Date of Issue:** | May 27, 2015 |
| **Test Result:** | **Pass*** |

* In the configuration tested, the EUT (Equipment under test) complied with the standards specified above.

**Parlam Zhan**
**E&E Section Manager**
**SGS-CSTC (Shanghai) Co., Ltd.**

**The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards.**

**The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government. All test results in this report can be traceable to National or International Standards.**

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# 2 Version

| Revision Record | | | | |
|---|---|---|---|---|
| **Version** | **Chapter** | **Date** | **Modifier** | **Remark** |
| 00 | / | May 27, 2015 | / | Original |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| **Authorized for issue by:** | | | | |
|---|---|---|---|---|
| **Engineer** | | Eddy Zong<br>**Print Name** | | Eddy Zong |
| **Clerk** | | Susie Liu<br>**Print Name** | | Susie Liu |
| **Reviewer** | | Keny Xu<br>**Print Name** | | Keny.xu |

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# 3 Test Summary

| Test Item | FCC Test Requirement | IC Test Requirement | Test method | Result |
|---|---|---|---|---|
| Antenna Requirement | FCC Part 15, Subpart C Section 15.203/15.247 (c) | RSS-Gen Section 8.1.3 | --- | PASS |
| AC Power Line Conducted Emission | FCC Part 15, Subpart C Section 15.207 | RSS-Gen Section 8.8 | ANSI C63.10 (2013) Section 6.2 | N/A |
| 20dB Occupied Bandwidth | FCC Part 15, Subpart C Section 15.247 (a)(1) | RSS-247 Issue 1 Clause 5.1(1) | ANSI C63.10 (2013) Section 6.9.2 | PASS |
| Conducted Peak Output Power | FCC Part 15, Subpart C Section 15.247 (b)(1) | RSS-247 Issue 1 Clause 5.4(2) | ANSI C63.10 (2013) Section 7.8.5 | PASS |
| Carrier Frequencies Separation | FCC Part 15, Subpart C Section 15.247 (a)(1) | RSS-247 Issue 1 Clause 5.1(2)) | ANSI C63.10 (2013) Section 7.8.2 | PASS |
| Hopping Channel Number | FCC Part 15, Subpart C Section 15.247 (b) | RSS-247 Issue 1 Clause 5.1(3) | ANSI C63.10 (2013) Section 7.8.3 | PASS |
| Dwell Time | FCC Part 15, Subpart C Section 15.247 (a)(1) | RSS-247 Issue 1 Clause 5.1(4) | ANSI C63.10 (2013) Section 7.8.4 | PASS |
| RF Conducted Spurious Emissions and Band-edge | FCC Part 15, Subpart C Section 15.247(d) | RSS-247 Issue 1 Clause 5.5 | ANSI C63.10 (2013) Section 7.8.6&7.8.8 | PASS |
| Radiated Spurious Emissions and Band-edge | FCC Part 15, Subpart C Section 15.209&15.205 | RSS-247 Issue 1 Clause 5.5 | ANSI C63.10 (2013) Section 6.4&6.5&6.6&6.10 | PASS |
| 99% Occupied Bandwidth | --- | RSS-Gen Section 6.6 | RSS-Gen section 6.6 | PASS |

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# 5 General Information

## 5.1 Client Information

| | |
|---|---|
| Applicant: | Hansong (Nanjing) Technology Ltd. |
| Address of Applicant: | 8th Kangping Road, Jiangning Economy and Technology Development Zone, Nanjing, 211106, China |
| Manufacturer: | pi lab, LLC |
| Address of Manufacturer: | 252 West Main Street, Carmel, IN 46032, USA |
| Factory: | Hansong (Nanjing) Technology Ltd. |
| Address of Factory: | 8th Kangping Road, Jiangning Economy and Technology Development Zone, Nanjing, 211106, China |

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

| | | | |
|---|---|---|---|
| Product Description: | Portable product | | |
| Brand Name: | pi lab | | |
| Adapter: | Model No.: | ASUC32a-050100 | |
| | Rated Input: | AC 100V-240V 50/60Hz 0.3A | |
| | Rated Output: | DC 5.0V 1.0A | |
| | Cable length: | AC port: | 2 wires |
| | | DC port: | 200 cm |
| Rechargeable Batteries: | DC 3.7V Li-on Rechargeable Battery<br>Supply the EUT with fully charged battery during the testing. | | |

## 5.3 Technical Specifications

| | |
|---|---|
| Operation Frequency: | 2402MHz~2480MHz |
| Bluetooth Version: | 3.0+HS |
| Modulation Technique: | FHSS(GFSK, π/4DQPSK, 8DPSK) |
| Number of Channel: | 79 |
| Antenna Type | Integral |
| Antenna Gain | 2 dBi |

## 5.4 Description of Support Units

The EUT has been tested independently, or The EUT has been tested with associated equipment below.

| Description | Manufacturer | Model No. | Supplied by |
|---|---|---|---|
| Laptop | Lenovo | ThinkPad X100e | SGS |
| BT test board | / | / | SGS |

| Software name | Manufacturer | Version | Supplied By |
|---|---|---|---|
| Blue Test3 (For CSR) | / | 2.5.0 | SGS |

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## 5.5 Test Mode

| Test Mode | Description of Test Mode |
|---|---|
| Hopping disabled mode | Using test software to control EUT working in continuous transmitting, and select channel and modulation type. |
| Hopping enabled mode | Using test software to control EUT working in continuous transmitting, and hopping on status. |

The packet type used for the final test:

| Test Item | Packet Type | | | | | | | | | Hopping Status | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DH1 | DH3 | DH5 | 2DH1 | 2DH3 | 2DH5 | 3DH1 | 3DH3 | 3DH5 | Disabled | Enabled |
| CE | - | - | √ | - | - | √ | - | - | √ | √ | √ |
| 20dB OBW | - | - | √ | - | - | √ | - | - | √ | √ | - |
| Peak Power | - | - | √ | - | - | √ | - | - | √ | √ | - |
| CFS | - | - | √ | - | - | √ | - | - | √ | - | √ |
| HCN | - | - | √ | - | - | √ | - | - | √ | - | √ |
| Dwell Time | √ | √ | √ | √ | √ | √ | √ | √ | √ | - | √ |
| CSE | - | - | √ | - | - | √ | - | - | √ | √ | - |
| Conducted Band-edge | - | - | √ | - | - | √ | - | - | √ | √ | √ |
| RSE & Band-edge | - | - | √ | - | - | √ | - | - | √ | √ | - |
| 99% OBW | - | - | √ | - | - | √ | - | - | √ | √ | - |

## 5.6 Test Channel

Using test software was control EUT work in continuous transmitter mode. And select test channel as below:

| Channel | Frequency (MHz) |
|---|---|
| Low Channel | 2402 |
| Middle Channel | 2441 |
| High Channel | 2480 |

## 5.7 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd.
No.588 West Jindu Road, Songjiang District, Shanghai, China.201612.
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Fax: +86 21 6191 5678

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## 5.8 Test Facility

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

- **CNAS (No. CNAS L0599)**
  CNAS has accredited SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing. Date of expiry: 2017-07-14.

- **FCC – Registration No.: 402683**
  SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered and fully described in a report filed with the Federal Communications Commission (FCC). The acceptance letter from the FCC is maintained in our files. Registration No.: 402683, Expiry Date: 2017-09-16.

- **Industry Canada (IC) – IC Assigned Code: 8617A**
  The 3m Semi-anechoic chamber of SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 8617A-1. Expiry Date: 2017-06-18.

- **VCCI (Member No.: 3061)**
  The 3m Semi-anechoic chamber and Shielded Room of SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd. has been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: R-3868 and C-4336 respectively. Date of Registration: 2012-05-29. Date of Expiry: 2015-05-28.

## 5.9 Measurement Uncertainty

| No. | Parameter | Measurement Uncertainty |
|---|---|---|
| 1 | Radio Frequency | < ±1 x $10^{-5}$ |
| 2 | Total RF power, conducted | < ±1.5 dB |
| 3 | RF power density, conducted | < ±3 dB |
| 4 | Spurious emissions, conducted | < ±3 dB |
| 5 | All emissions, radiated | < ±6 dB (30MHz – 1GHz)<br>< ±6 dB (above 1GHz) |
| 6 | Temperature | < ±1°C |
| 7 | Humidity | < ±5 % |
| 8 | DC and low frequency voltages | < ±3 % |

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# 6 Equipments Used during Test

| Item | Test Equipment | Manufacturer | Model No. | Serial No. | Cal. Date | Cal. Due date |
|---|---|---|---|---|---|---|
| 1 | EMI test receiver | Rohde & Schwarz | ESCS30 | 100086 | 2015-01-22 | 2016-01-21 |
| 2 | Line impedance stabilization network | SCHWARZBECK | NSLK8127 | 8127490 | 2015-01-22 | 2016-01-21 |
| 3 | Line impedance stabilization network | ETS | 3816/2 | 00034161 | 2015-01-22 | 2016-01-21 |
| 4 | Spectrum Analyzer | Rohde & Schwarz | FSP-30 | 2705121009 | 2015-01-22 | 2016-01-21 |
| 5 | EMI test receiver | Rohde & Schwarz | ESU40 | 100109 | 2015-02-13 | 2016-02-12 |
| 6 | Active Loop Antenna (9kHz to 30MHz) | Schwarzbeck - Mess-Elektronik | FMZB 1519 | 1519-034 | 2015-02-07 | 2016-02-06 |
| 7 | Broadband UHF-VHF ANTENNA (25MHz to 2GHz) | SCHWARZBECK | VULB9168 | 9168-313 | 2015-02-07 | 2016-02-06 |
| 8 | Ultra broadband antenna (25MHz to3GHz) | Rohde & Schwarz | HL562 | 100227 | 2014-08-30 | 2015-08-29 |
| 9 | Horn Antenna (1GHz to 18GHz) | Rohde & Schwarz | HF906 | 100284 | 2015-02-07 | 2016-02-06 |
| 10 | Horn Antenna (1GHz to 18GHz) | SCHWARZBECK | BBHA9120D | 9120D-679 | 2015-02-07 | 2016-02-06 |
| 11 | Horn Antenna (14GHz to 40GHz) | SCHWARZBECK | BBHA 9170 | BBHA9170373 | 2015-02-13 | 2016-02-12 |
| 12 | Pre-amplifier (9KHz – 2GHz) | LNA6900 | TESEQ | 71033 | 2014-12-27 | 2015-12-27 |
| 13 | Pre-amplifier (1GHz – 26.5GHz) | Rohde & Schwarz | SCU-F0118-G40-BZ4-CSS(F) | 10001 | 2015-01-22 | 2016-01-21 |
| 14 | Pre-amplifier (14GHz – 40GHz) | Rohde & Schwarz | SCU-F1840-G35-BZ3-CSS(F) | 10001 | 2015-01-22 | 2016-01-21 |
| 15 | Tunable Notch Filter | Wainwright instruments Gmbh | WRCT800.0/880.0-0.2/40-5SSK | 9170397 | / | / |
| 16 | High pass Filter | FSCW | HP 12/2800-5AA2 | 19A45-02 | / | / |
| 17 | High-low temperature cabinet | Suzhou Zhihe | TL-40 | 50110050 | 2014-09-11 | 2015-09-10 |
| 18 | AC power stabilizer | WOCEN | 6100 | 51122 | 2015-01-02 | 2016-01-01 |
| 19 | DC power | QJE | QJ30003SII | 611145 | 2015-01-02 | 2016-01-01 |
| 20 | Signal Generator (Interferer) | Agilent | SMR40 | 100555 | 2014-08-10 | 2015-08-09 |
| 21 | Signal Generator (Blocker) | Rohde & Schwarz | SMJ100A | 02.20.360.142 | 2015-01-22 | 2016-01-21 |
| 22 | Splitter | Anritsu | MA1612A | M12265 | / | / |
| 23 | Coupler | e-meca | 803-S-1 | 900-M01 | / | / |

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# 7 Test Results

## 7.1 E.U.T. test conditions

**Test Power:** AC 120V, 60Hz

**Requirements:** 15.31(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

**Operating Environment:**

| | |
|---|---|
| Temperature: | 20.0 -25.0 °C |
| Humidity: | 35-75 % RH |
| Atmospheric Pressure: | 99.2 -102 kPa |

**Test frequencies:** According to the 15.31(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and. if required. reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

| Frequency range over which device operates | Number of frequencies | Location in the range of operation |
|---|---|---|
| 1 MHz or less | 1 | Middle |
| 1 to 10 MHz | 2 | 1 near top and 1 near bottom |
| More than 10 MHz | 3 | 1 near top. 1 near middle and 1 near bottom |

Pursuant to Part 15.31(c) For swept frequency equipment, measurements shall be made with the frequency sweep stopped at those frequencies chosen for the measurements to be reported.

Test frequency is the lowest channel: 0 channel (2402MHz), middle channel: 39 channel (2441MHz) and highest channel: 78 channel (2480MHz) with fixed at channel.

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## 7.2 Frequency Hopping System Requirement

**Test Requirement: Section 15.247 (a)(1), (g), (h) requirement:**

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

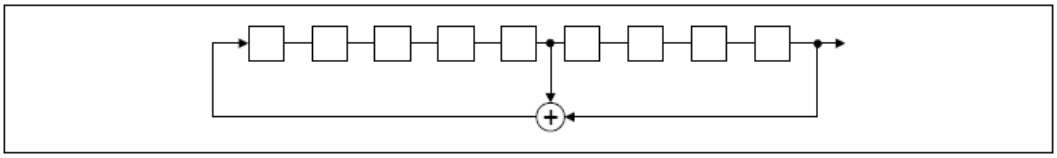
Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

**Compliance for section 15.247(a)(1)**

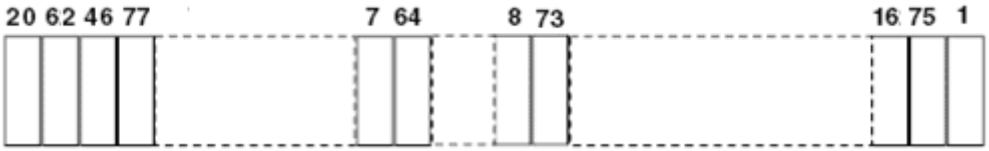
According to Bluetooth Core Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9$ -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)



*Linear Feedback Shift Register for Generation of the PRBS sequence*

An example of Pseudorandom Frequency Hopping Sequence as follow:




Each frequency used equally on the average by each transmitter.

According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.

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**Compliance for section 15.247(g)**

According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

**Compliance for section 15.247(h)**

According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.

According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinate with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

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## 7.3 Antenna Requirement

**Standard requirement:**

15.203 requirement:

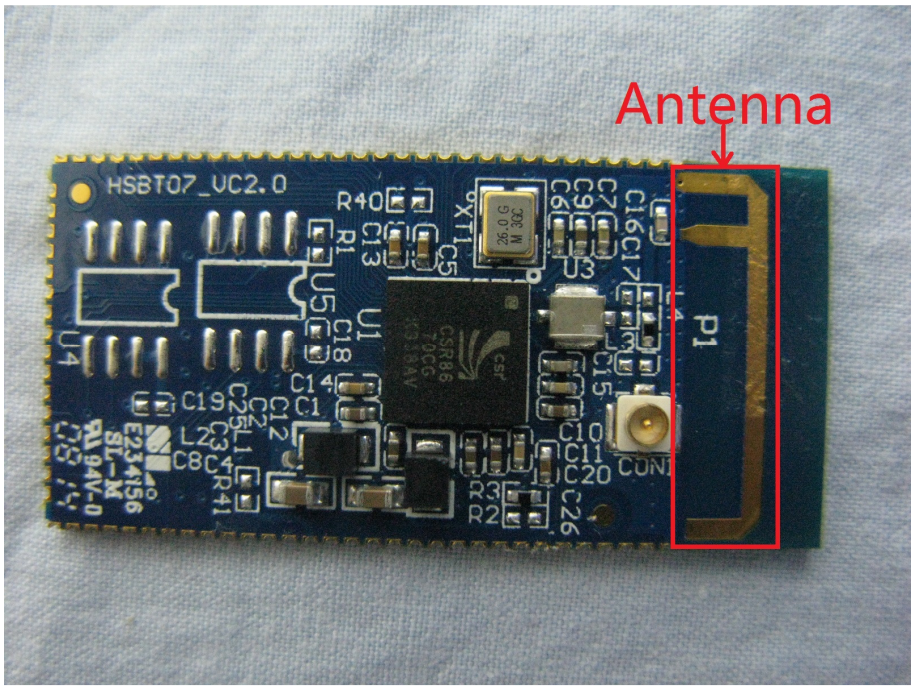
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**EUT Antenna:**

The BT antenna is Plug-in antenna. The gain of the antenna is less than 2.0 dBi.

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## 7.4 Conducted Emissions on Mains Terminals

**Frequency Range:** 150 KHz to 30 MHz

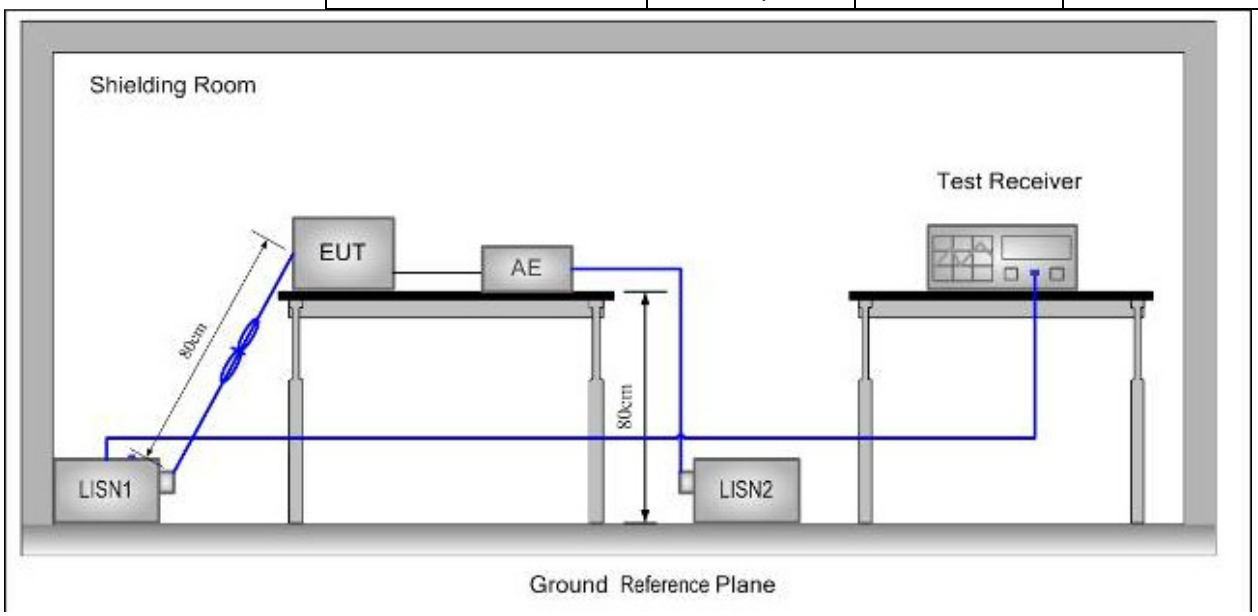
**Class/Severity:** Class B

**Limit:**

| Frequency range MHz | Class B Limits: dB (μV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |
| Note1: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50MHz.<br>Note2: The lower limit is applicable at the transition frequency. | | |

**Test site/setup:** Test instrumentation set-up:

| Frequency Range | Detector | RBW | VBW |
|---|---|---|---|
| 9KHz to 150Hz | Quasi-peak | 200Hz | 500Hz |
| 150KHz to 30MHz | Quasi-peak | 9kHz | 30kHz |




**Test Procedure:**

1. The mains terminal disturbance voltage was measured with the EUT in a shielded room.
2. The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN, which was bonded to the ground reference plane in the same way as the LISN for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded
3. The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference

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plane, but separated from metallic contact with the ground reference plane by 0.1m of insulation.

4. The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISN mounted on top of the ground reference plane. This distance was between the closest points of the LISN and the EUT. The mains lead of EUT excess 0.8m was folded back and forth parallel to the lead so as to form a horizontal bundle with a length between 0.3m and 0.4m. All other units of the EUT and associated equipment were at least 0.8 m from the LISN.

**Test Result:** N/A

**Test Data:**

This EUT in working mode is powered by battery only; therefore the AC Conducted Emission test is not applicable.

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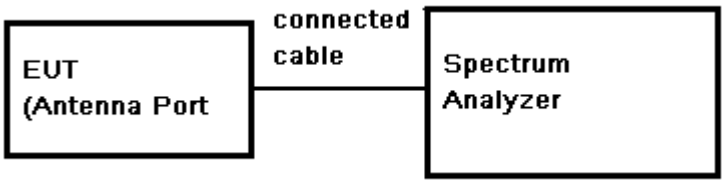
## 7.5 20dB Occupied Bandwidth

**Test Configuration:**




**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: Span = approximately 2 to 3 times the 20dB bandwidth, centred on the hopping channel;
3. Set the spectrum analyzer: RBW >= 1% of the 20dB bandwidth (set 30 kHz). VBW >= RBW. Sweep = auto; Detector Function = Peak. Trace = Max Hold.
4. Mark the peak frequency and -20dB points.

**Test Result:** PASS

**Test date:**

| Test Channel | Channel Frequency(MHz) | Modulation | Bandwidth(MHz) |
|---|---|---|---|
| Low | 2402 | GFSK | 1.044 |
| Middle | 2441 | GFSK | 1.041 |
| High | 2480 | GFSK | 1.044 |
| Low | 2402 | π/4DQPSK | 1.176 |
| Middle | 2441 | π/4DQPSK | 1.119 |
| High | 2480 | π/4DQPSK | 1.119 |
| Low | 2402 | 8DPSK | 1.188 |
| Middle | 2441 | 8DPSK | 1.179 |
| High | 2480 | 8DPSK | 1.179 |

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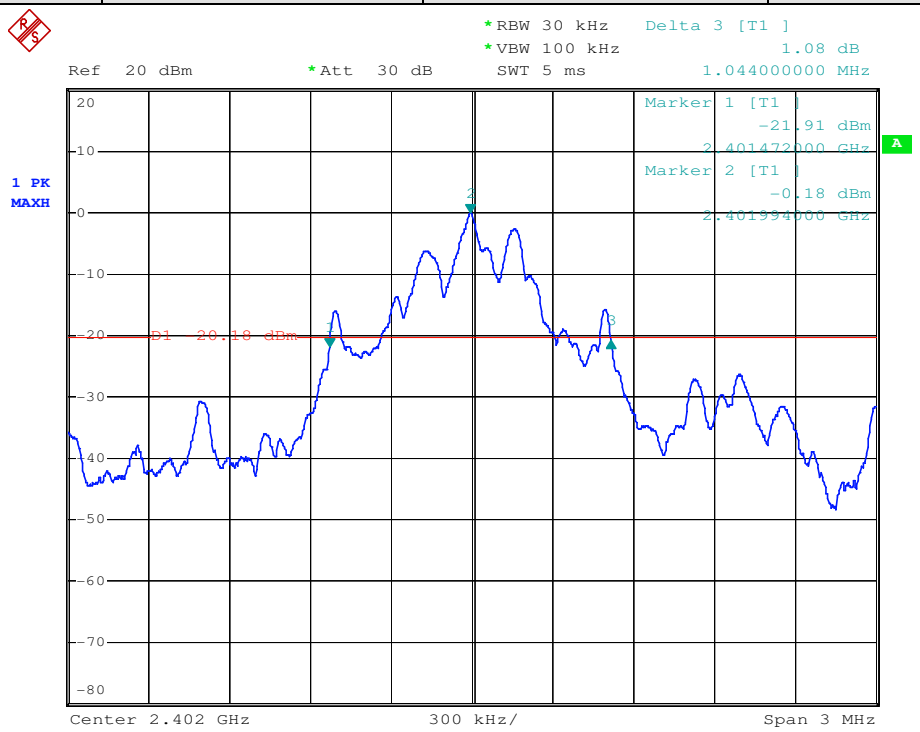
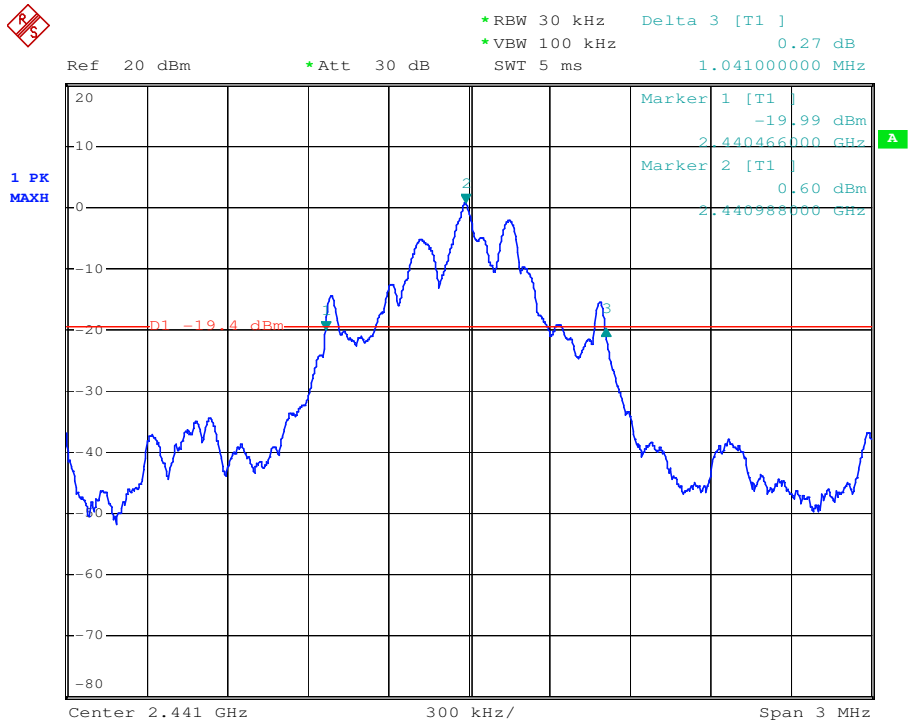
**Test plot as follows:**

| Test mode: | GFSK | Test channel: | Lowest |
|---|---|---|---|




| Test mode: | GFSK | Test channel: | Middle |
|---|---|---|---|

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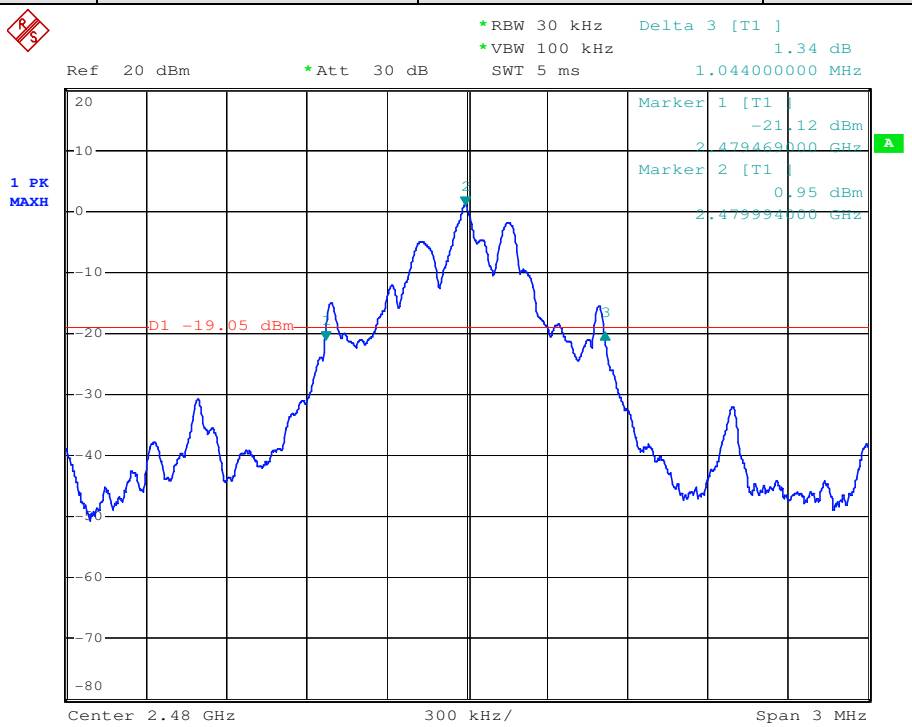
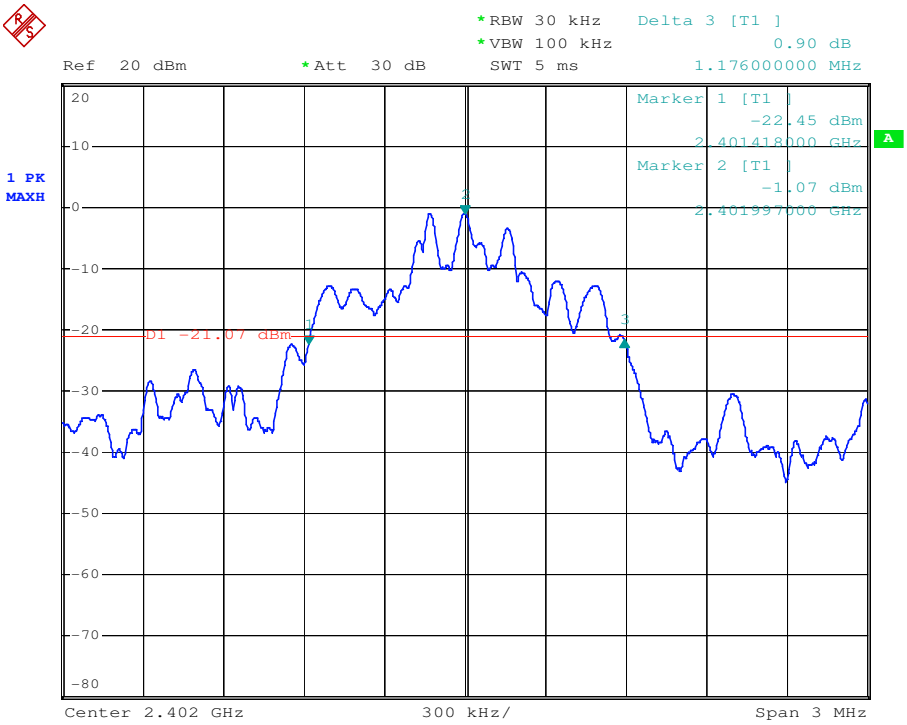
| Test mode: | GFSK | Test channel: | Highest |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Lowest |
|---|---|---|---|

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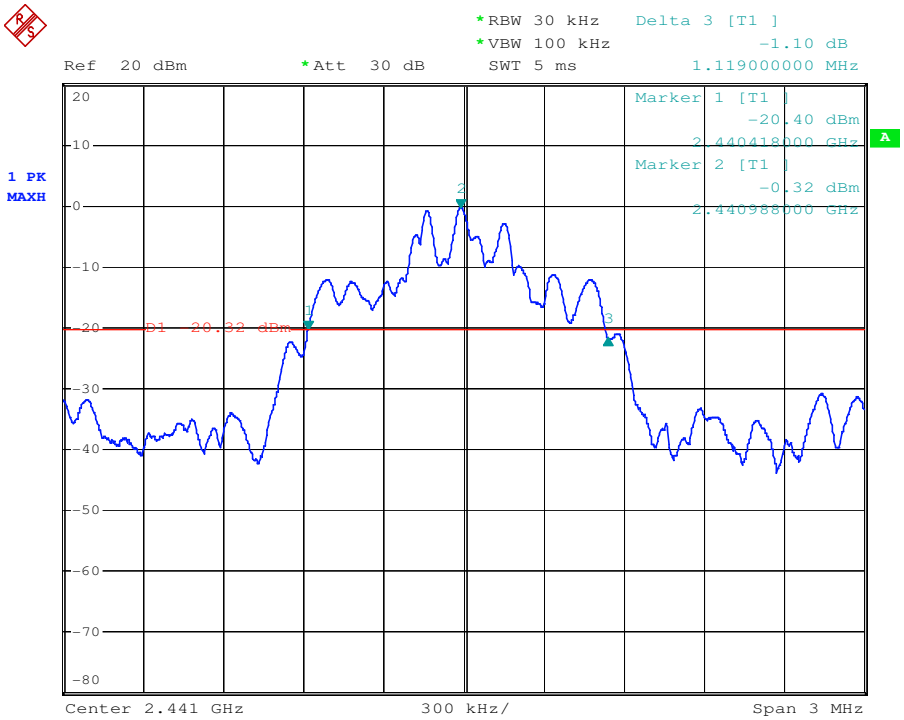
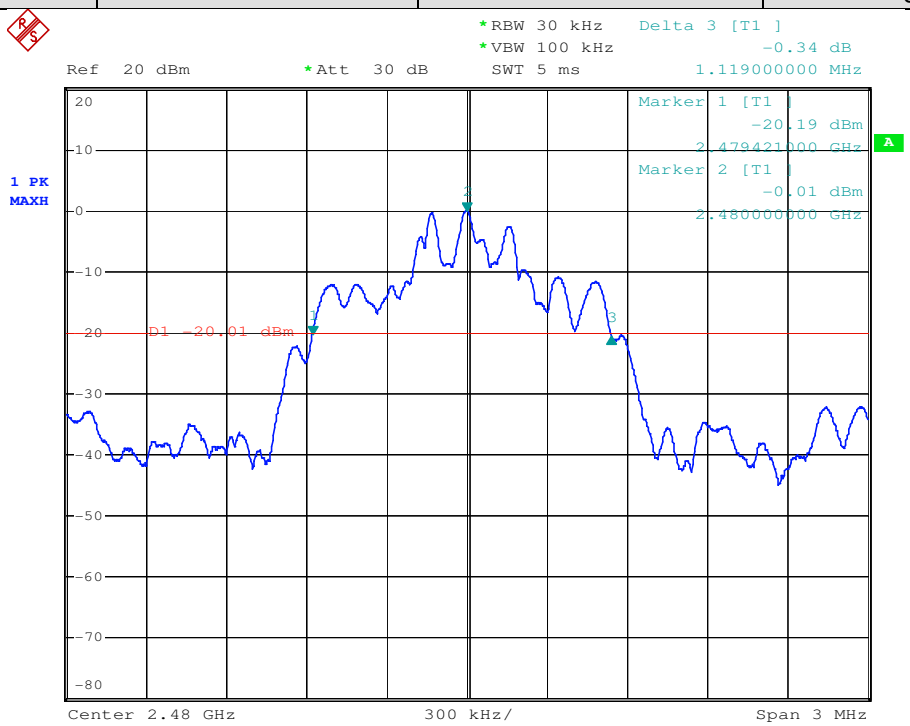
| Test mode: | π/4DQPSK | Test channel: | Middle |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Highest |
|---|---|---|---|

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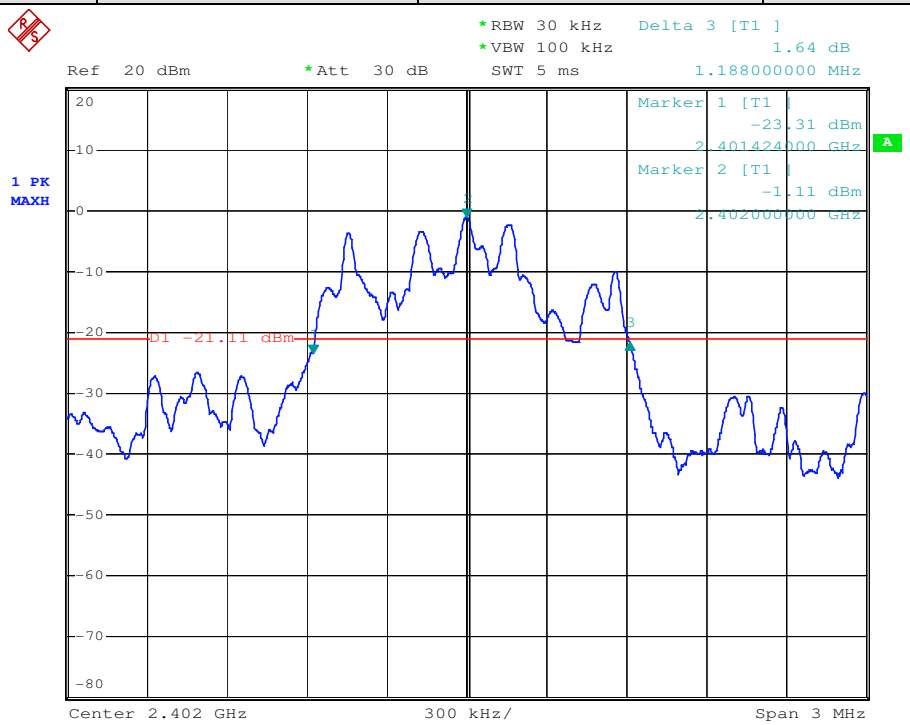
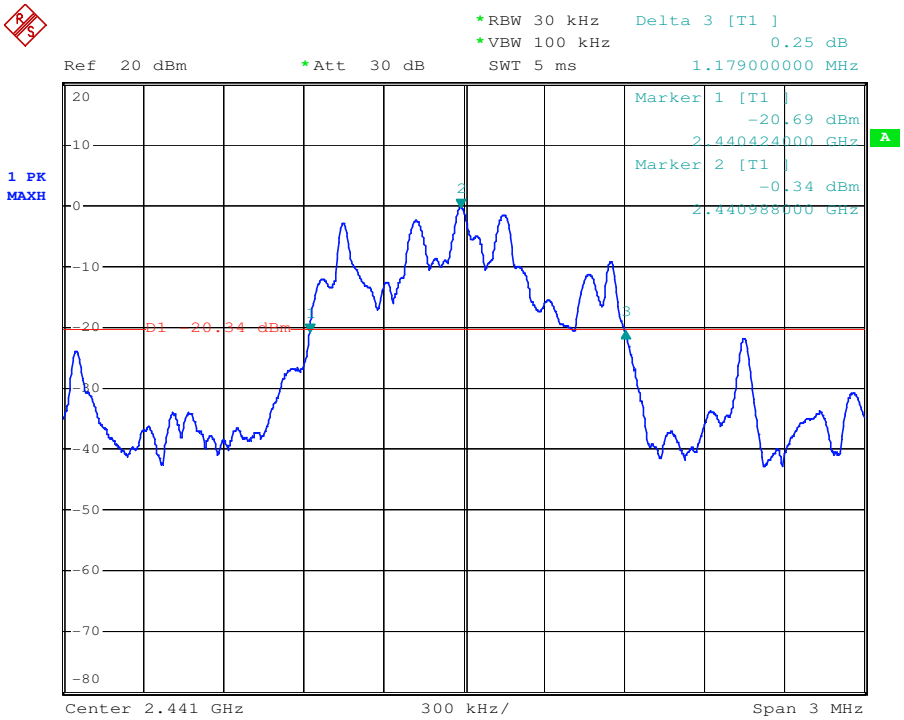
| Test mode: | 8DPSK | Test channel: | Lowest |
|---|---|---|---|




| Test mode: | 8DPSK | Test channel: | Middle |
|---|---|---|---|

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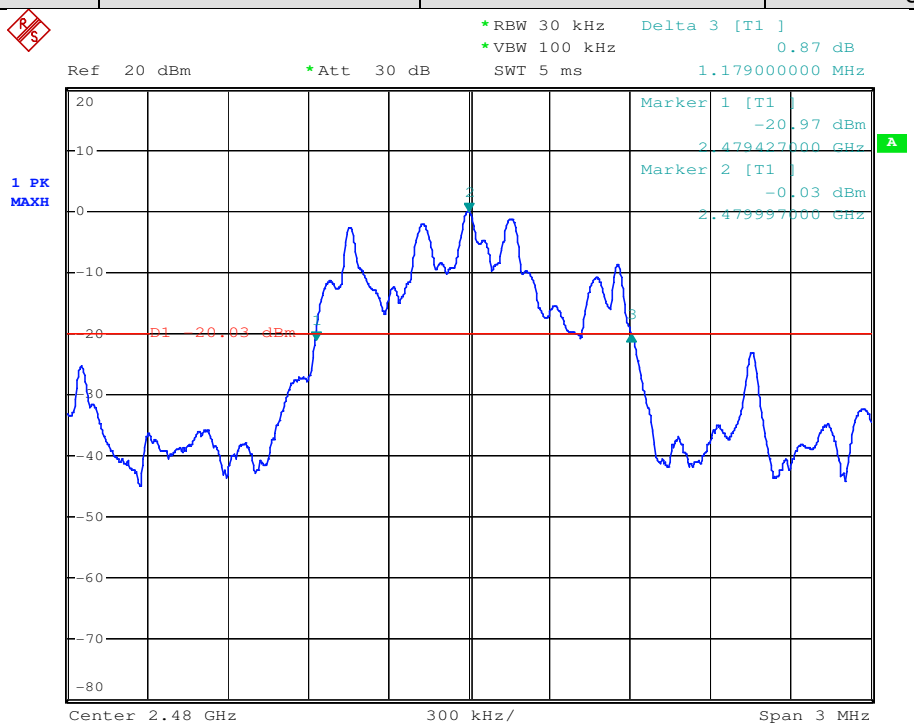
| Test mode: | 8DPSK | Test channel: | Highest |
|---|---|---|---|

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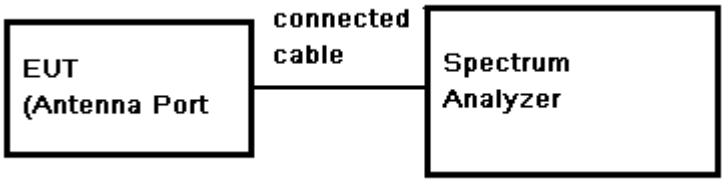
## 7.6 Conducted Peak Output Power

**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.

Refer to the result "Hopping channel number" of this document. The 1 watt (30.0dBm) limit applies.

**Test Configuration:**




**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 = 3 MHz, VBW = 3 MHz, Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

**Test Result:** Pass

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**Test Data:**

| Test Channel | Modulation | Fundamental Frequency (MHz) | Reading Power (dBm) | Cable Loss (dB) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| Lowest | GFSK | 2402 | 1.44 | 0.5 | 1.94 | 30 | 32.97 |
| Middle | GFSK | 2441 | 1.31 | 0.5 | 1.81 | 30 | 30.38 |
| Highest | GFSK | 2480 | -0.50 | 0.5 | 0.00 | 30 | 29.02 |
| Lowest | π/4DQPSK | 2402 | 2.12 | 0.5 | 2.62 | 30 | 32.49 |
| Middle | π/4DQPSK | 2441 | 1.52 | 0.5 | 2.02 | 30 | 29.98 |
| Highest | π/4DQPSK | 2480 | 1.06 | 0.5 | 1.56 | 30 | 28.78 |
| Lowest | 8DPSK | 2402 | 1.88 | 0.5 | 2.38 | 30 | 32.52 |
| Middle | 8DPSK | 2441 | 1.94 | 0.5 | 2.44 | 30 | 30.02 |
| Highest | 8DPSK | 2480 | 1.50 | 0.5 | 2.00 | 30 | 28.79 |

Remark: Output Power=Reading Power + Cable loss

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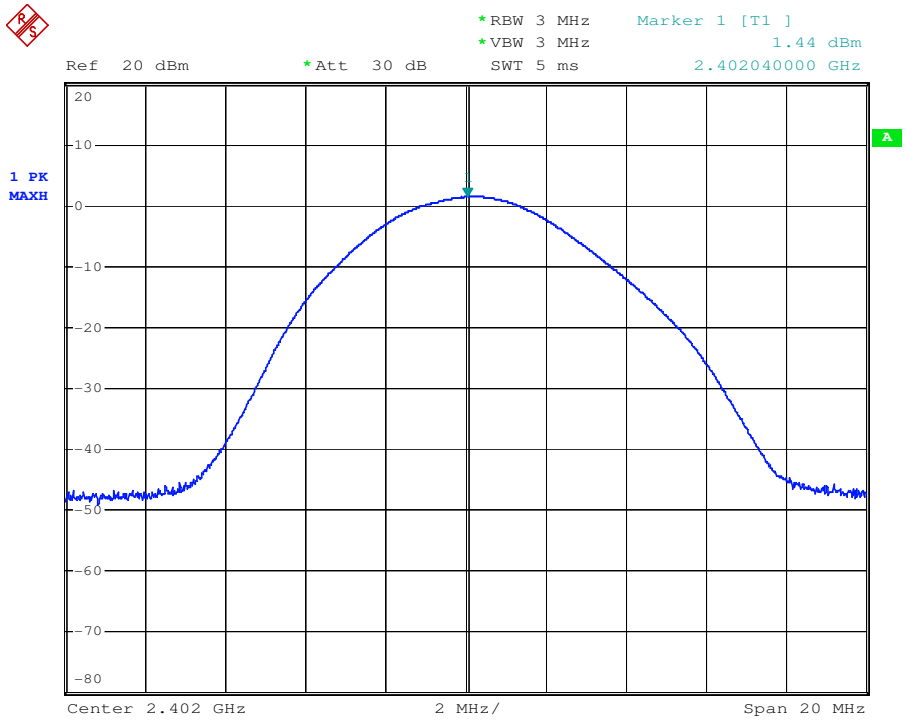
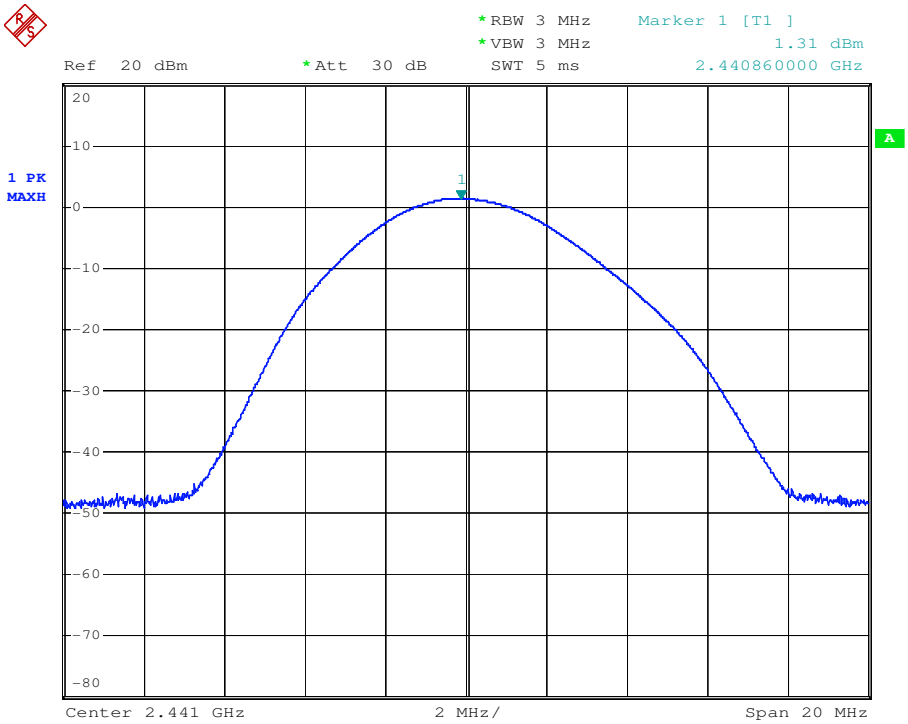
**Test result plot as follows:**

| Test mode: | GFSK | Test channel: | Lowest |
|---|---|---|---|




| Test mode: | GFSK | Test channel: | Middle |
|---|---|---|---|

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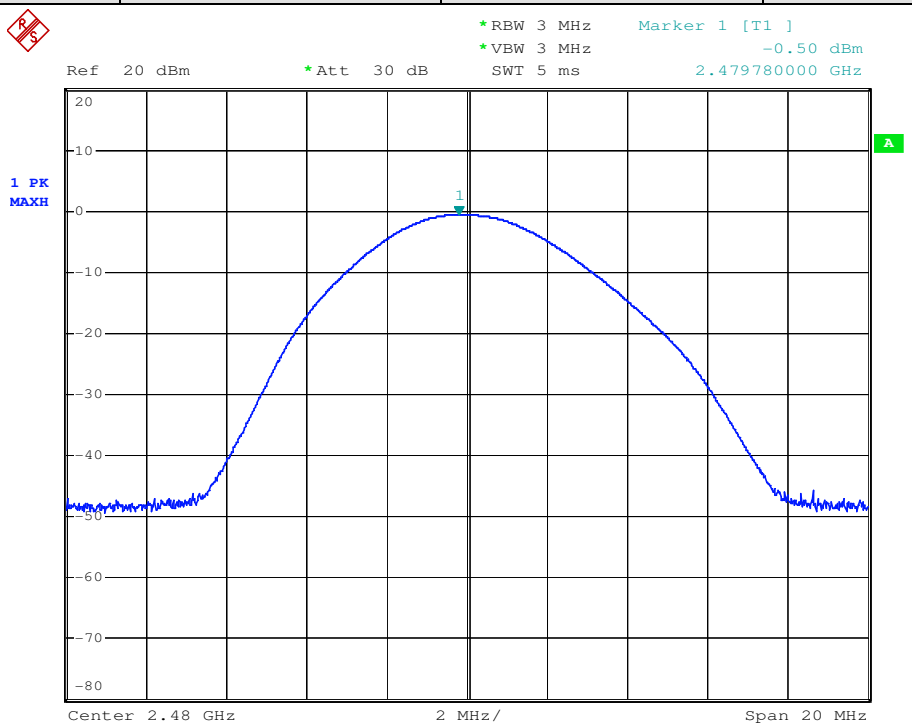
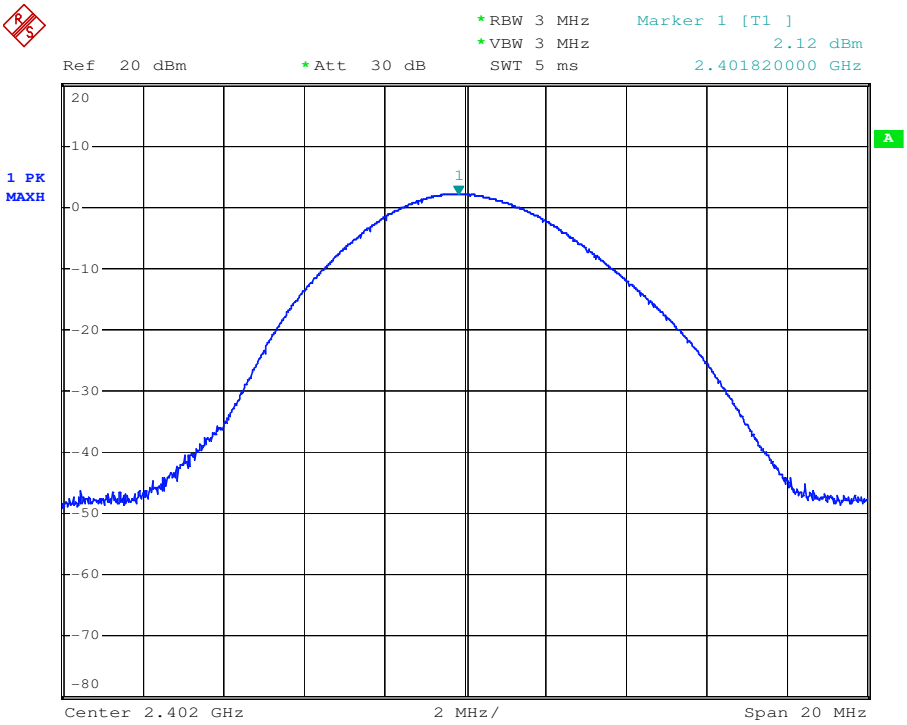
| Test mode: | GFSK | Test channel: | Highest |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Lowest |
|---|---|---|---|

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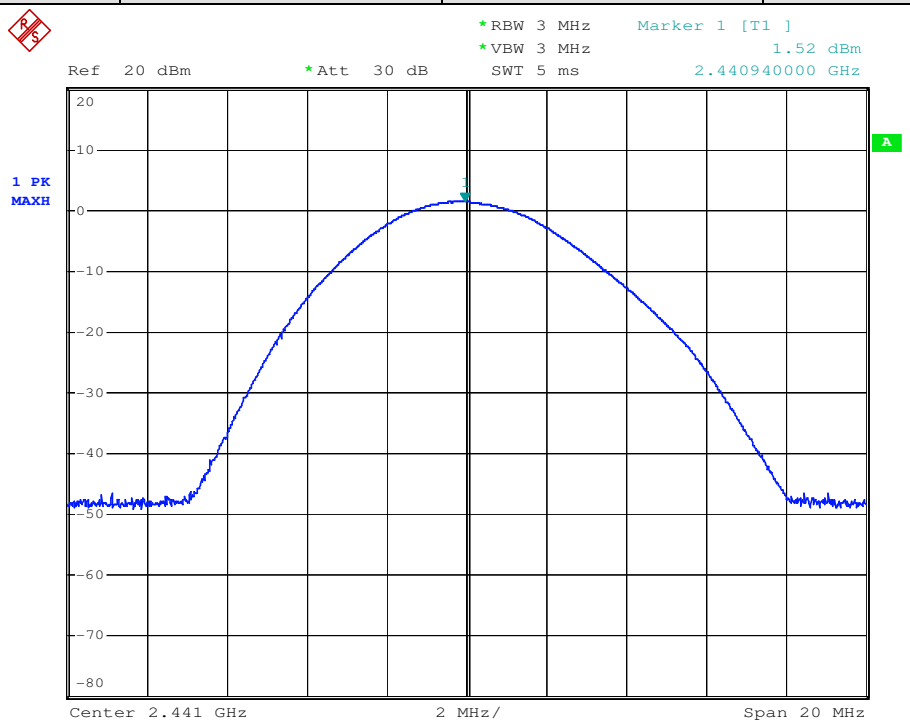
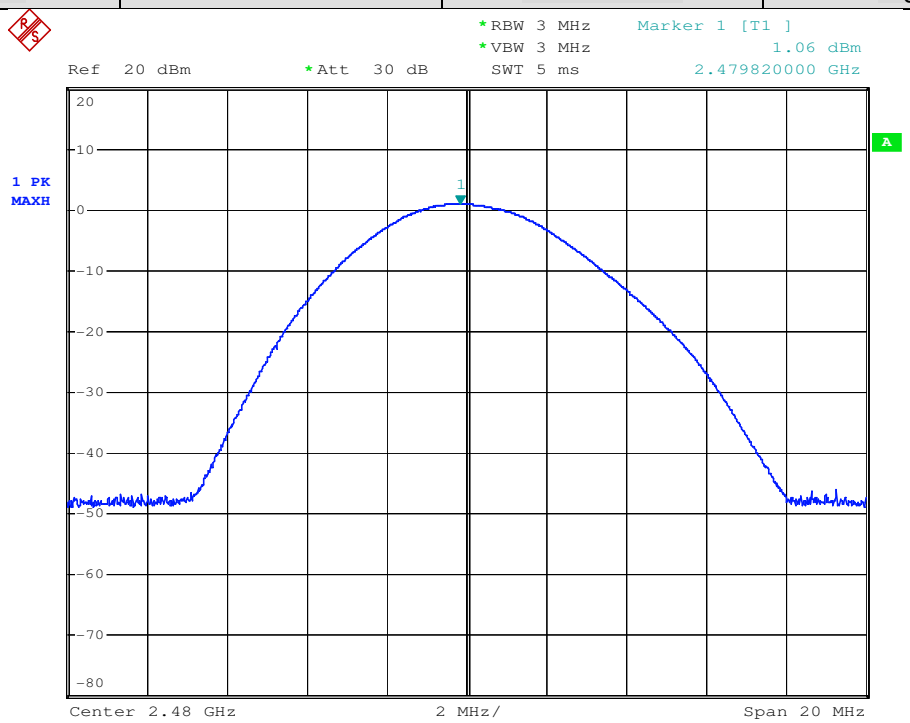
| Test mode: | π/4DQPSK | Test channel: | Middle |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Highest |
|---|---|---|---|

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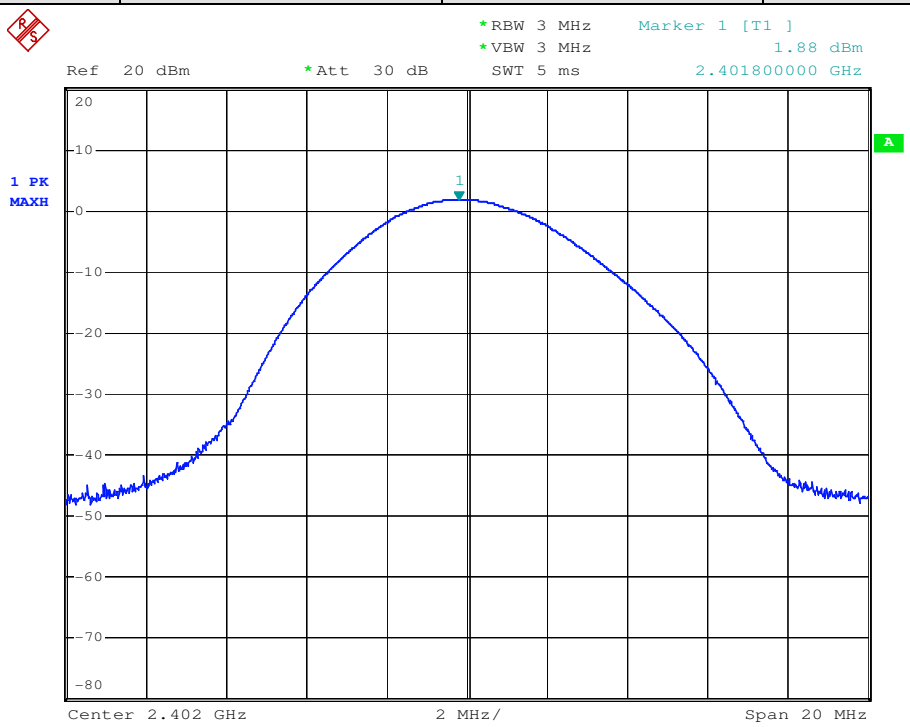
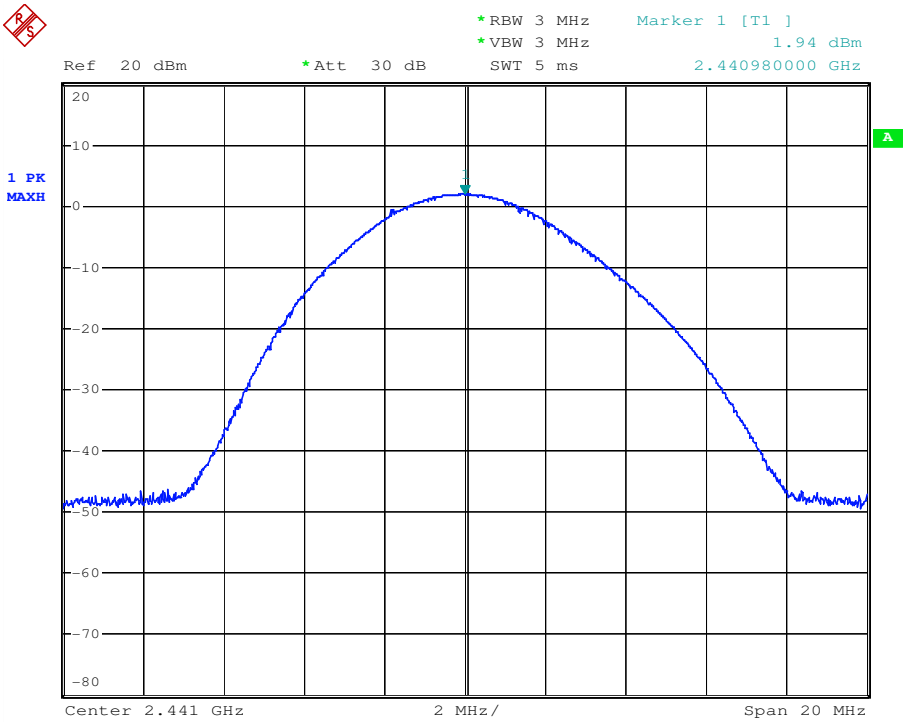
| Test mode: | 8DPSK | Test channel: | Lowest |
|---|---|---|---|




| Test mode: | 8DPSK | Test channel: | Middle |
|---|---|---|---|

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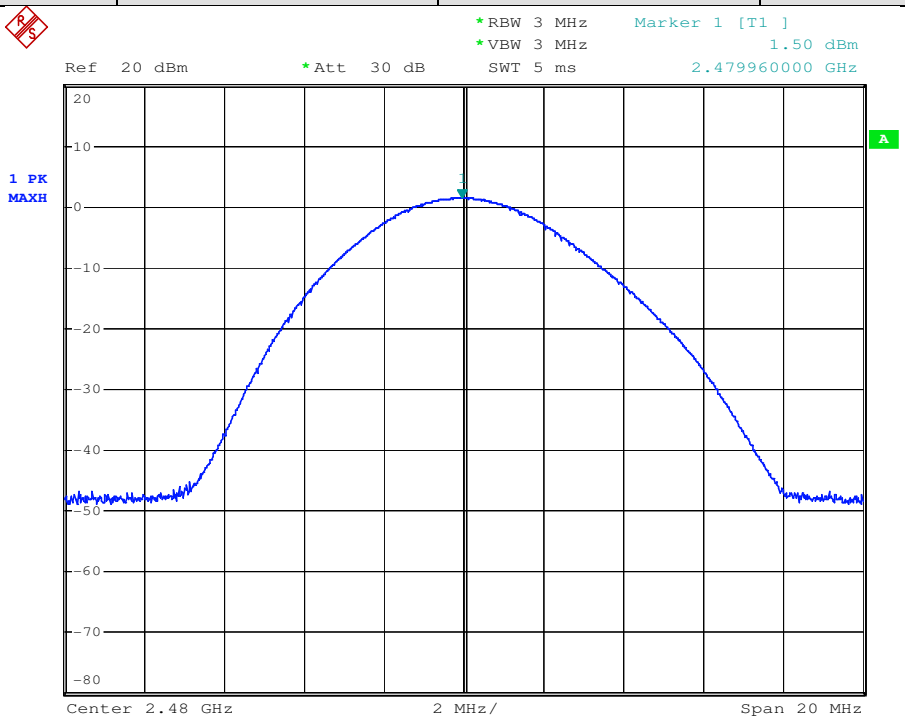
| Test mode: | 8DPSK | Test channel: | Highest |
|---|---|---|---|

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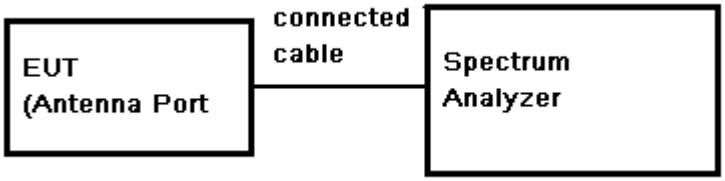
## 7.7 Carrier Frequencies Separated

**Limit:** 0.025MHz or 2/3 of the 20dB bandwidth (whichever is greater)

**Test Configuration:**




**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 >= 1% of the span (set 30 kHz). VBW >= RBW, Span = 3MHz. Sweep = auto; Detector Function = Peak. Trace = Maxhold.
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.

**Test result:** Pass

**Test data:**

| Test Channel | Modulation | Carrier Frequencies Separated (MHz) | Limit (25kHz or two-thirds of the 20 dB bandwidth) | Results |
|---|---|---|---|---|
| Middle Channels (channel 39 and channel 40) | GFSK | 0.996 | 25kHz/700kHz | PASS |
| Middle Channels (channel 39 and channel 40) | π/4DQPSK | 1.008 | 25kHz/780kHz | PASS |
| Middle Channels (channel 39 and channel 40) | 8DPSK | 1.002 | 25kHz/788kHz | PASS |

Remark: 1. According to the section 7.6, the conducted power measured is less than 125mW and 2/3 of 20dB bandwidth is used for limit.
2. 20dB bandwidth reference Section 7.5

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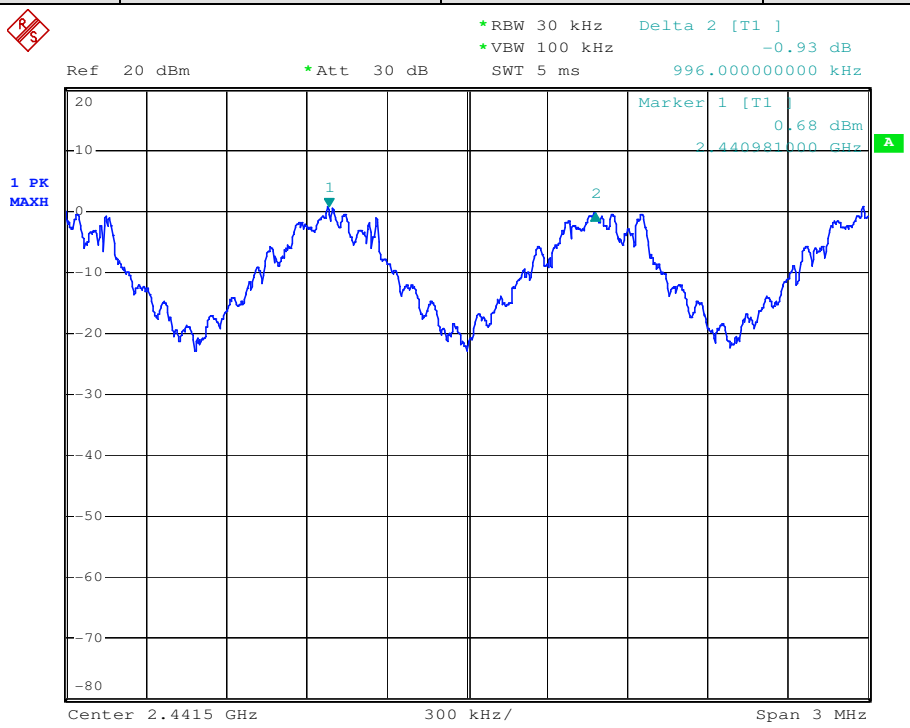
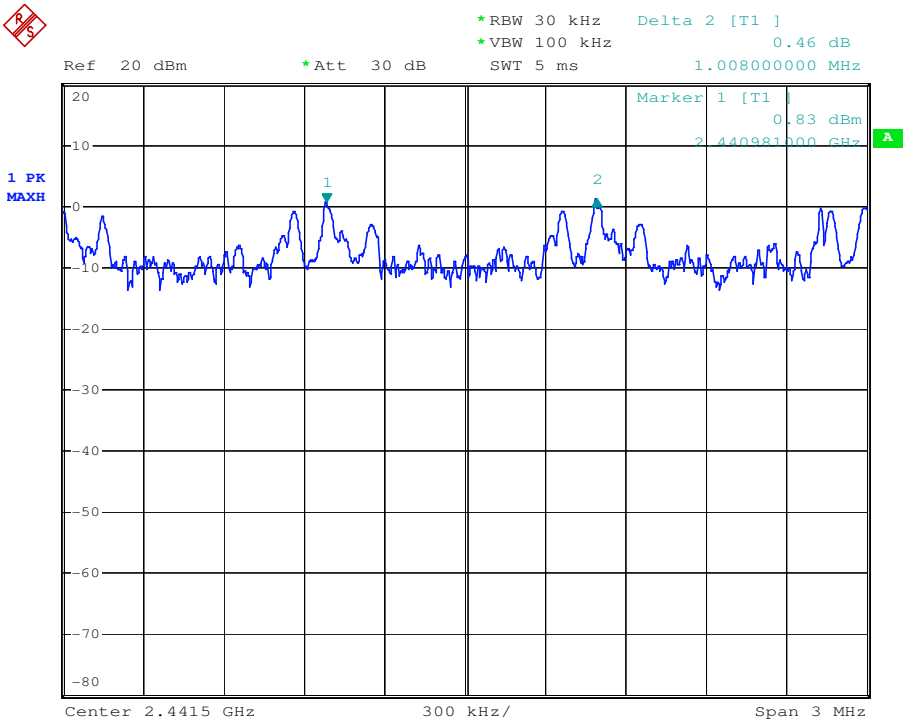
**Test plot as follows:**

| Test mode: | GFSK | Test channel: | Middle |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Middle |
|---|---|---|---|

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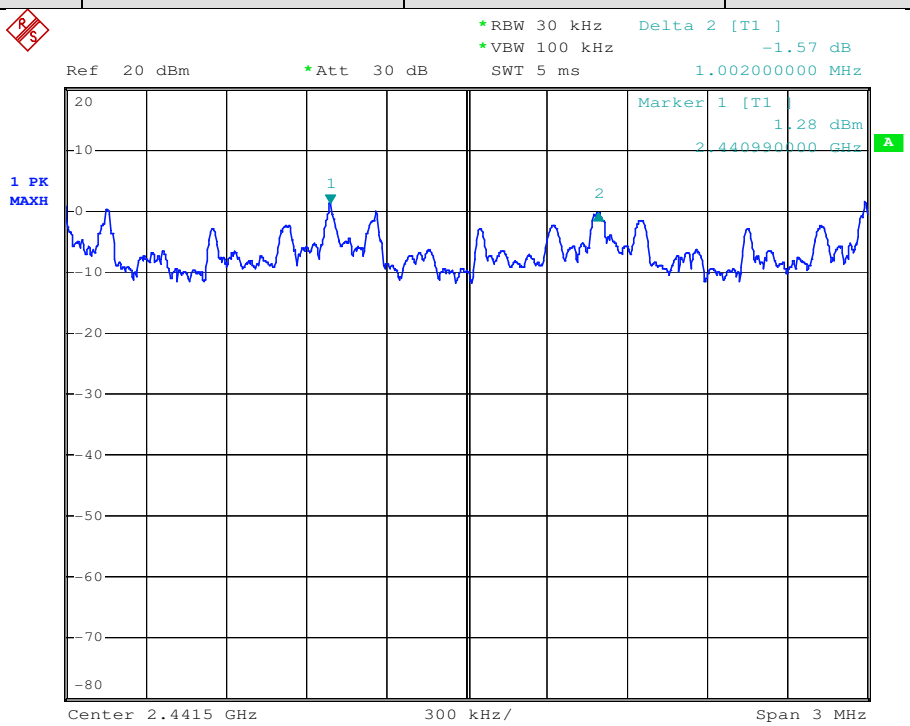
| Test mode: | 8DPSK | Test channel: | Middle |
|---|---|---|---|

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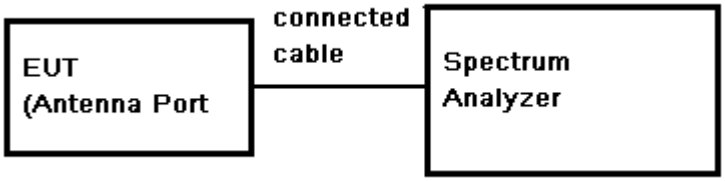
## 7.8 Hopping Channel Number

**Limit:** At least 15 channels

**Test Configuration:**




**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 = 100 kHz. VBW = 100 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 = 2400MHz. stop frequency = 2483.5MHz. Submit the test result graph.

**Test Result:** Pass

**Test Data:**

| Mode | Hopping channel numbers | Limit | Results |
|---|---|---|---|
| 8DPSK | 79 | ≥15 | Pass |
| GFSK | 79 | ≥15 | Pass |
| π/4DQPSK | 79 | ≥15 | Pass |

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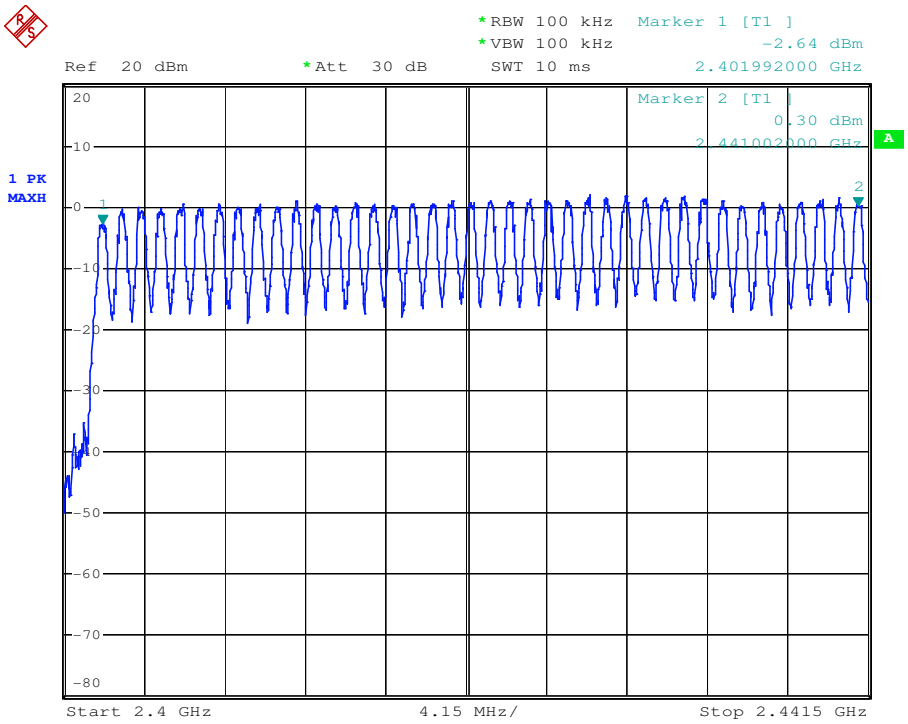
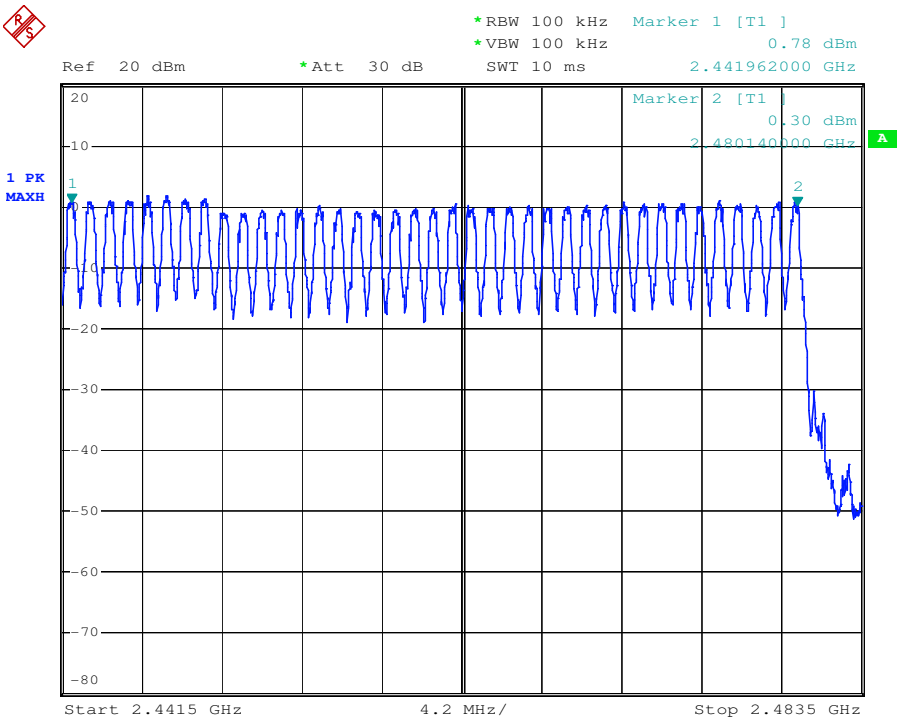
**Test plot as follows:**

| Test mode: | GFSK | Test channel: | Middle |
|---|---|---|---|

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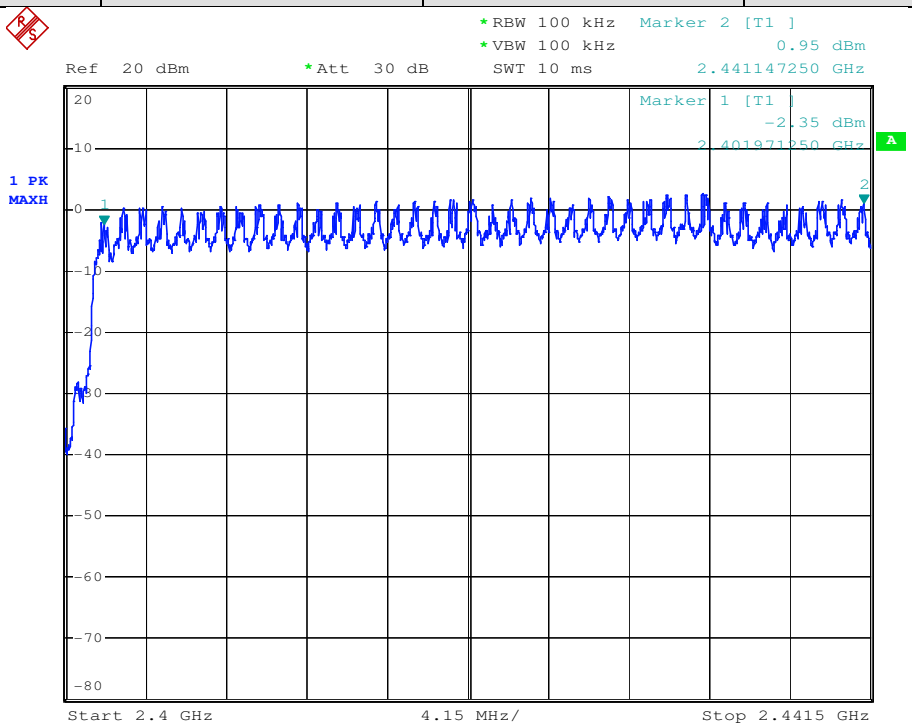
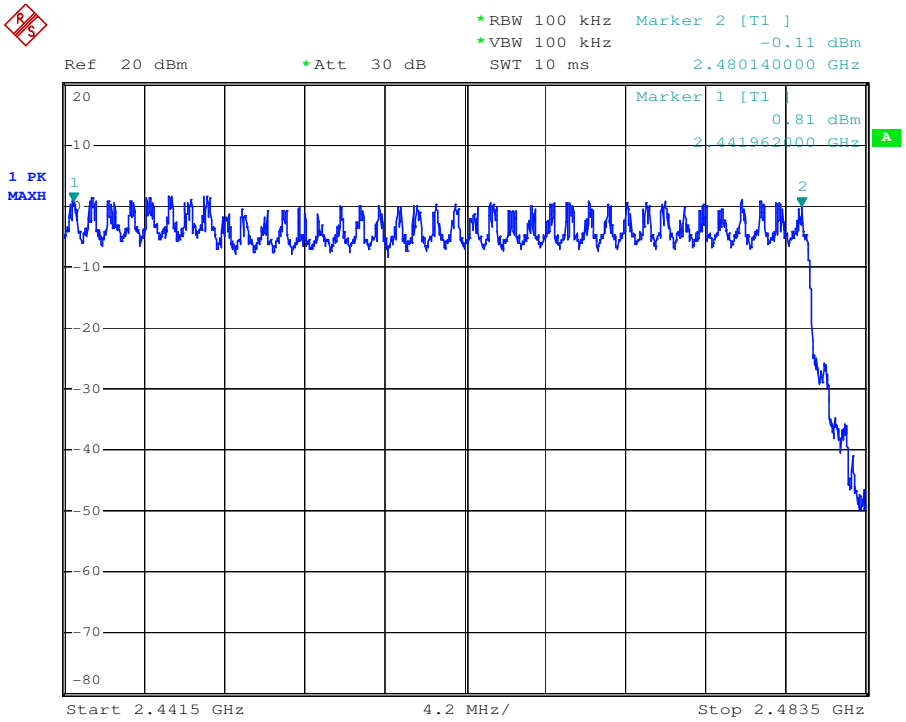
| Test mode: | π/4DQPSK | Test channel: | Middle |
|---|---|---|---|

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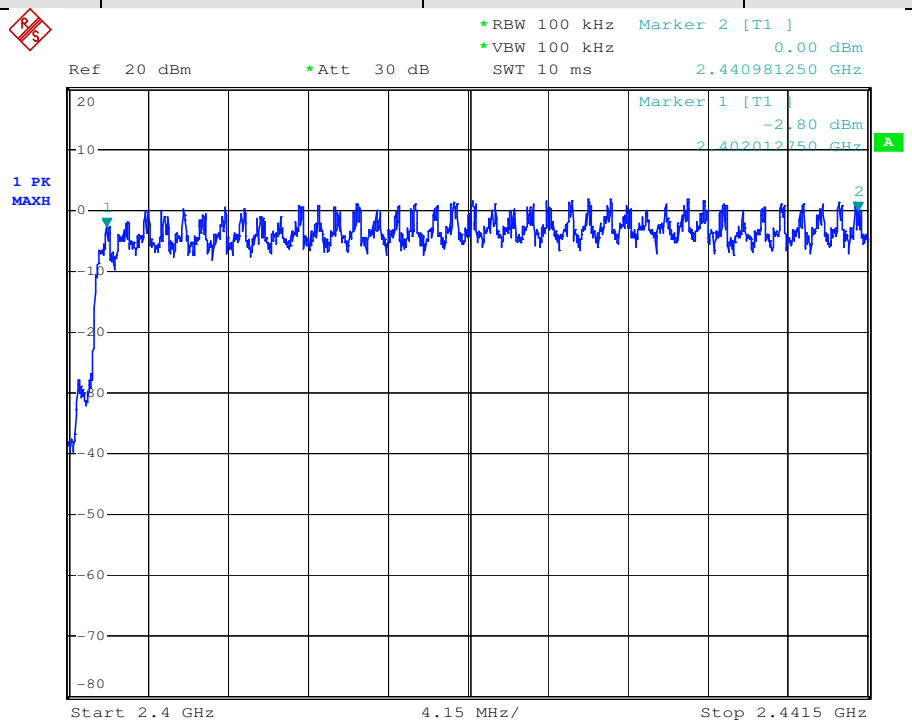
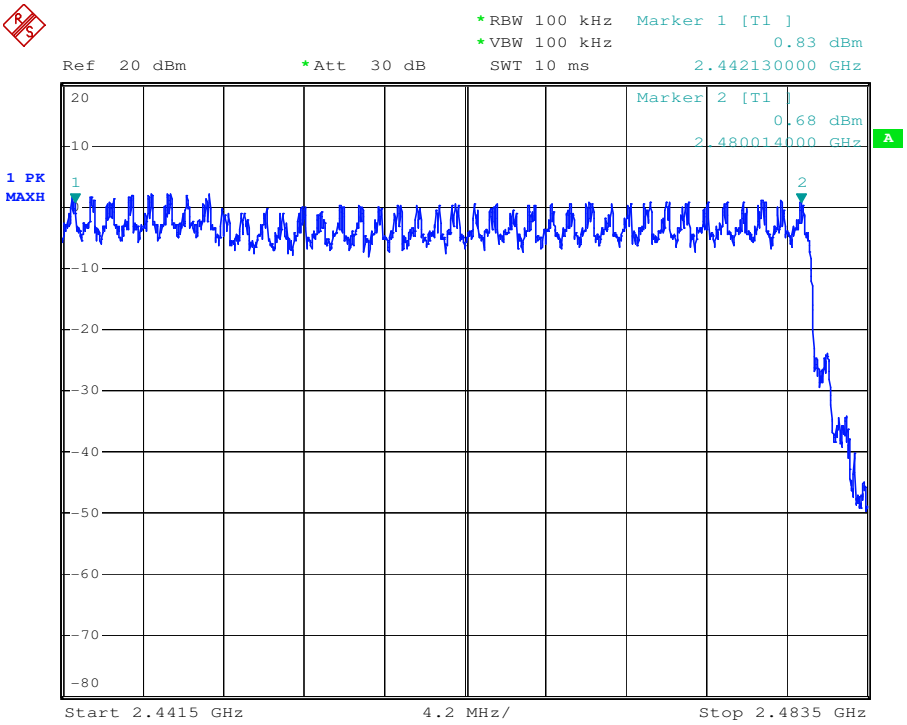
| Test mode: | 8DPSK | Test channel: | Middle |
|---|---|---|---|

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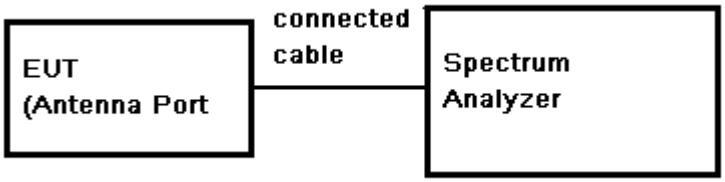
## 7.9 Dwell Time

**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 Configuration:**




**Test Procedure:**

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum. Keep EUT in Hopping transmitting with all kind of modulation.
2. Set spectrum analyzer span = 0. centered on a hopping channel;
3. Use Emission width * No. of Hopping Channels in 31.6s to determine the dwell time.

**Test Result:** Pass

**Test Data:**

| Frequency (MHz) | Modulation | Packet | Emission Width (ms) | Number of Hopping Channel in 31.6s | Average Time of Occupancy(s) | Limit(s) | Result |
|---|---|---|---|---|---|---|---|
| 2441 | GFSK | DH1 | 6.13 | 310 | 1.90 | 0.4 | Pass |
| | | DH3 | 5.91 | 150 | 0.89 | 0.4 | Pass |
| | | DH5 | 0.60 | 100 | 0.06 | 0.4 | Pass |
| | π/4DQPSK | DH1 | -0.98 | 310 | -0.30 | 0.4 | Pass |
| | | DH3 | 0.89 | 150 | 0.13 | 0.4 | Pass |
| | | DH5 | -0.40 | 150 | -0.06 | 0.4 | Pass |
| | 8DPSK | DH1 | 0.23 | 310 | 0.07 | 0.4 | Pass |
| | | DH3 | 1.09 | 150 | 0.16 | 0.4 | Pass |
| | | DH5 | 1.67 | 100 | 0.17 | 0.4 | Pass |

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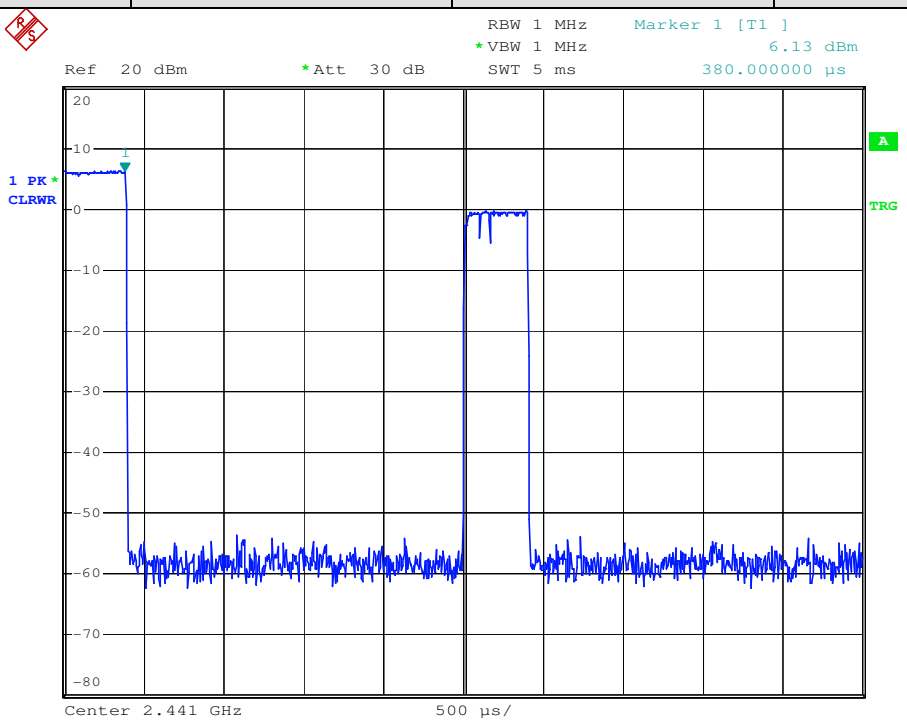
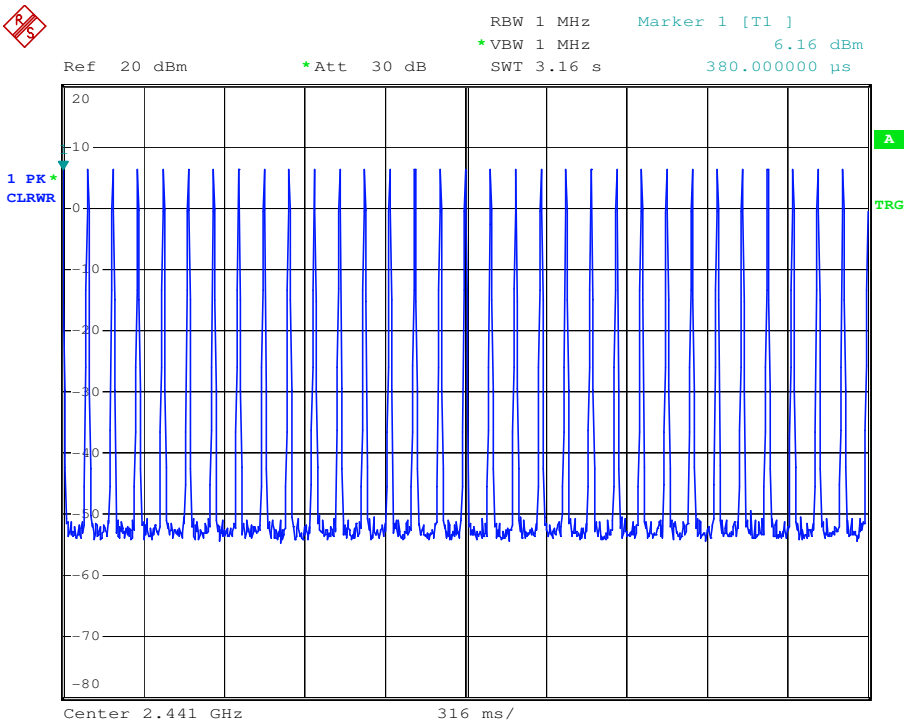
**Test plot as follows:**

| Test mode: | GFSK-DH1 | Test channel: | Middle |
|---|---|---|---|

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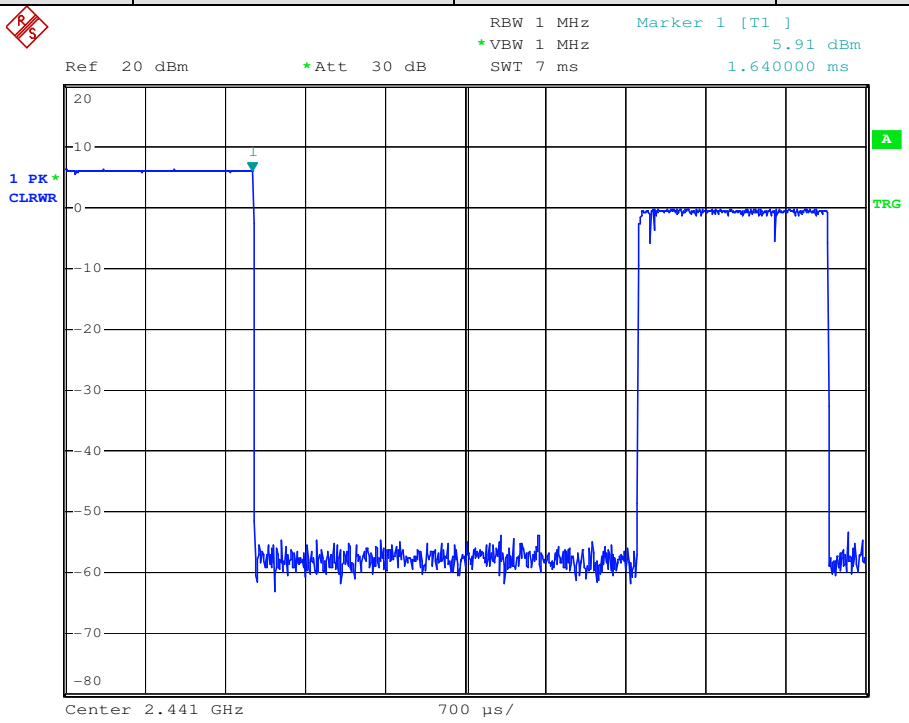
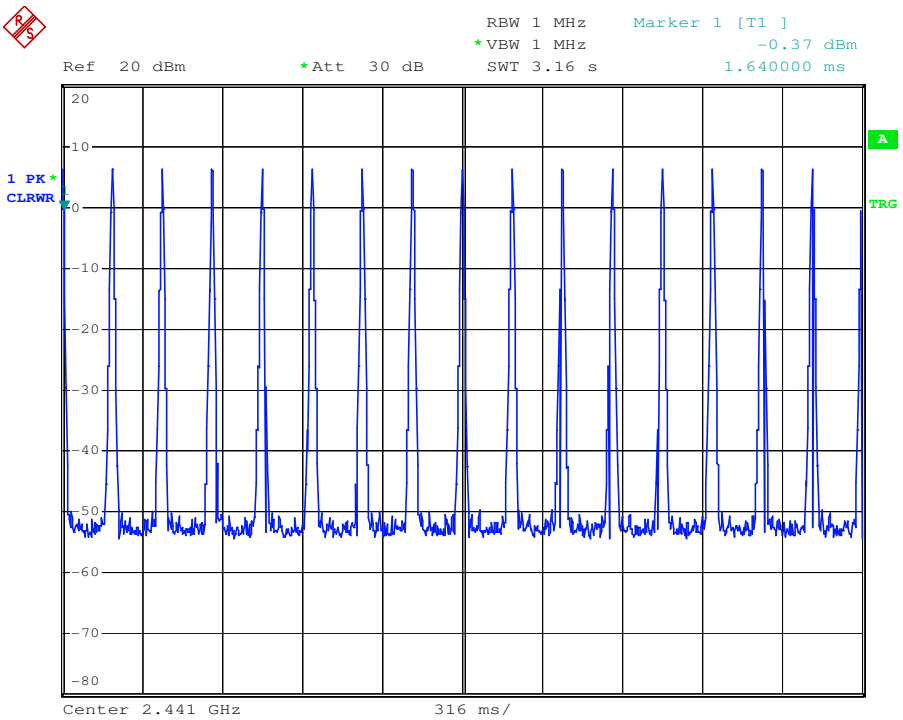
| Test mode: | GFSK-DH3 | Test channel: | Middle |
|---|---|---|---|

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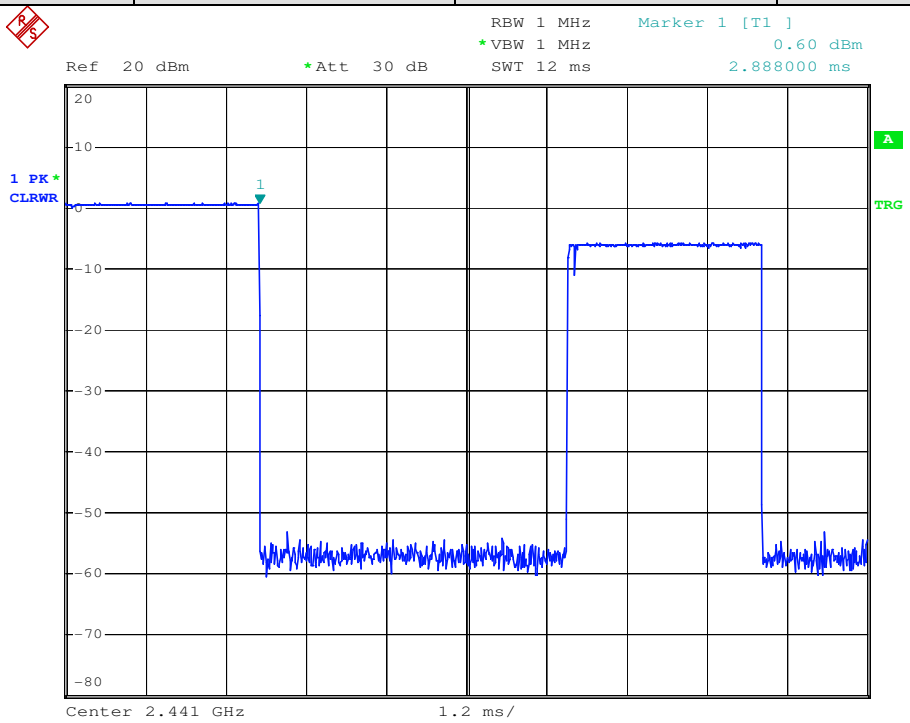
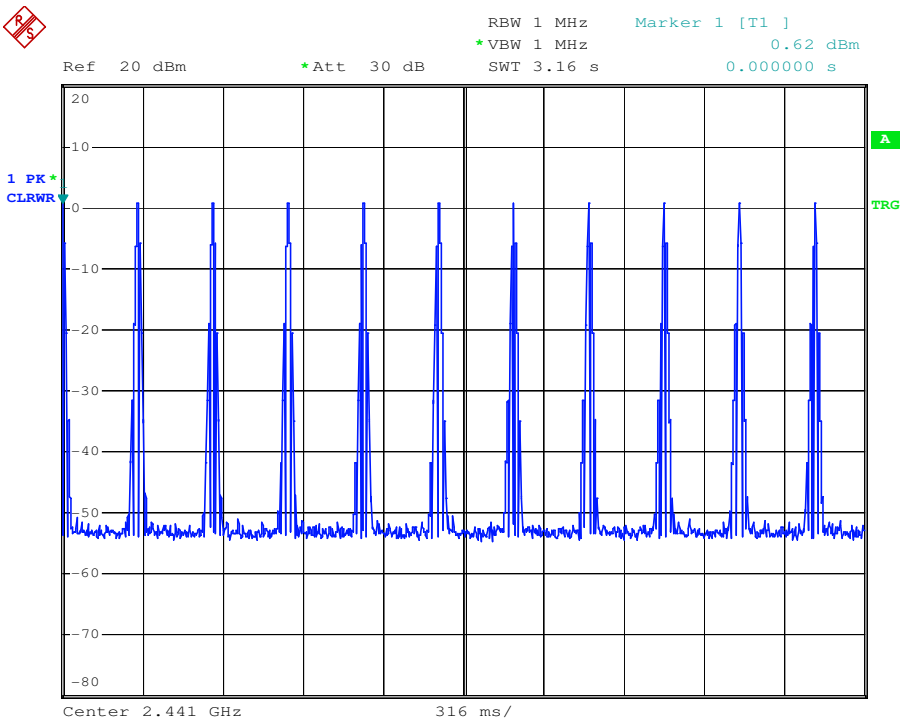
| Test mode: | GFSK-DH5 | Test channel: | Middle |
|---|---|---|---|

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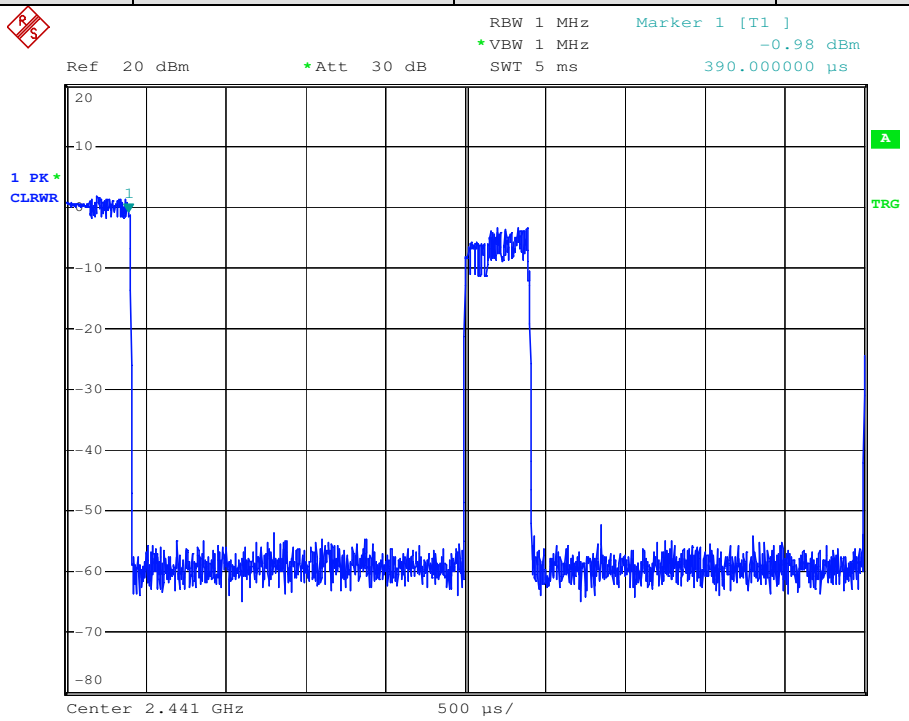
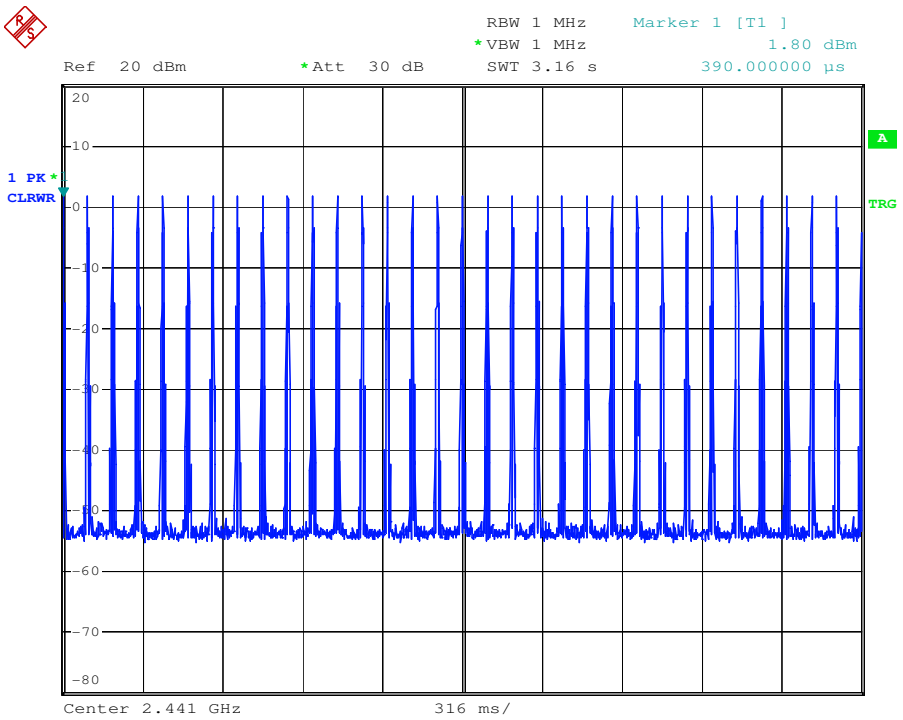
| Test mode: | π/4DQPSK -DH1 | Test channel: | Middle |
|---|---|---|---|

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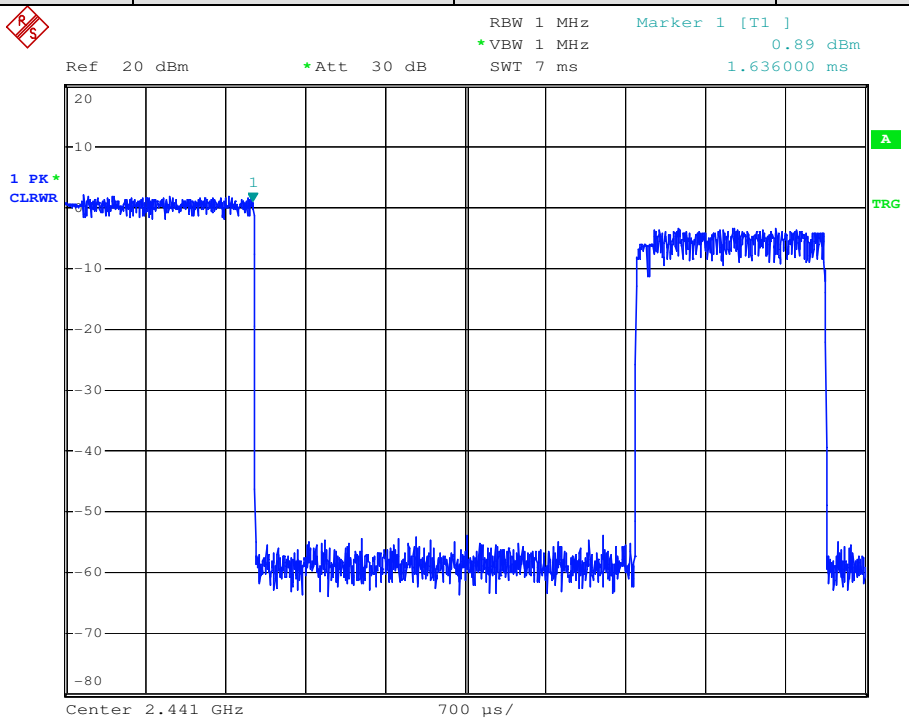
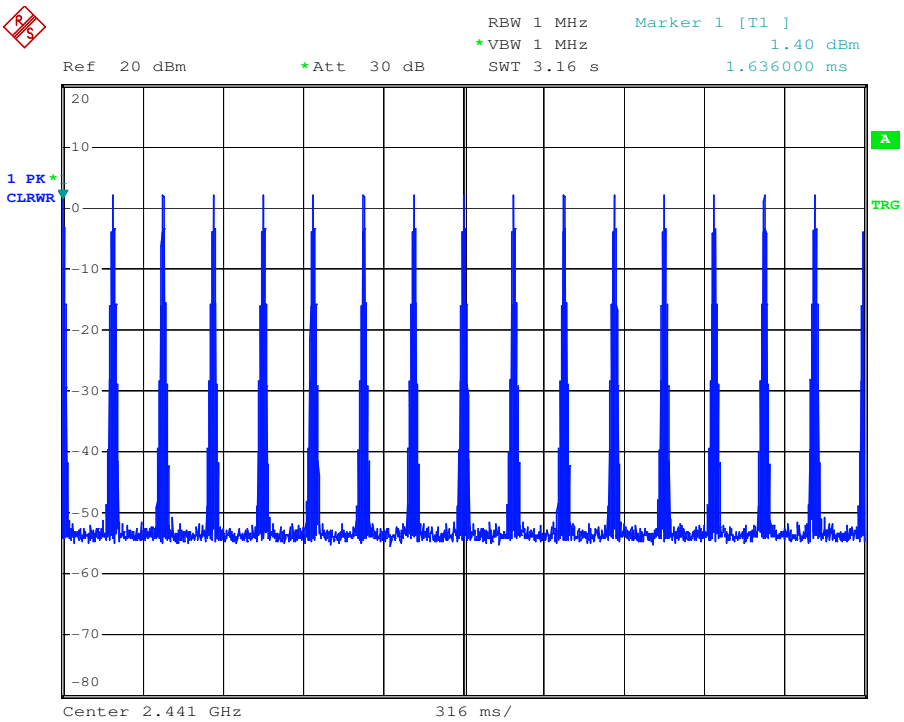
| Test mode: | π/4DQPSK –DH3 | Test channel: | Middle |
|---|---|---|---|

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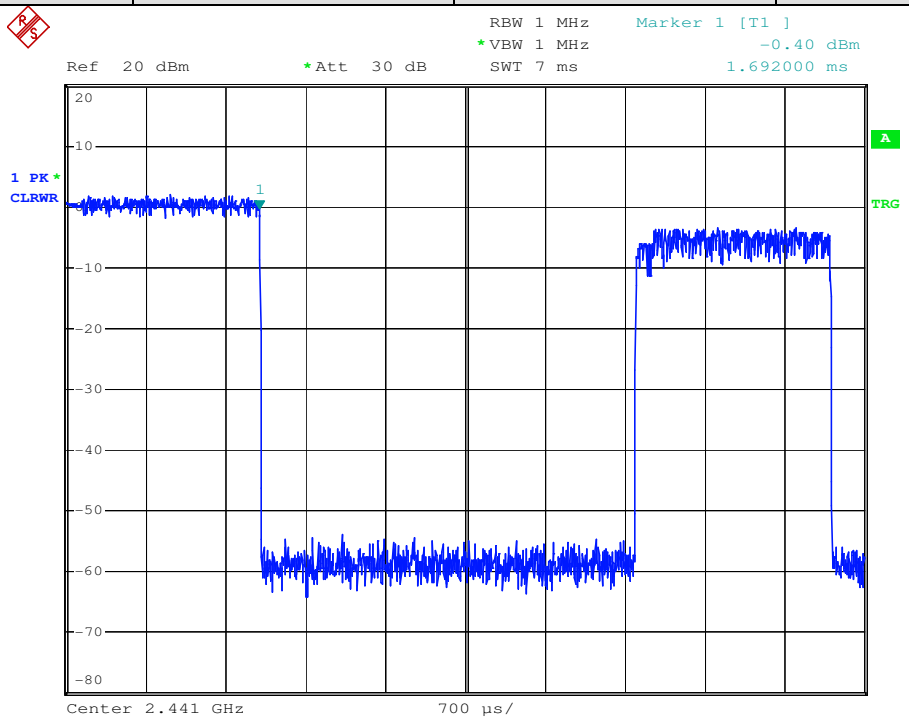
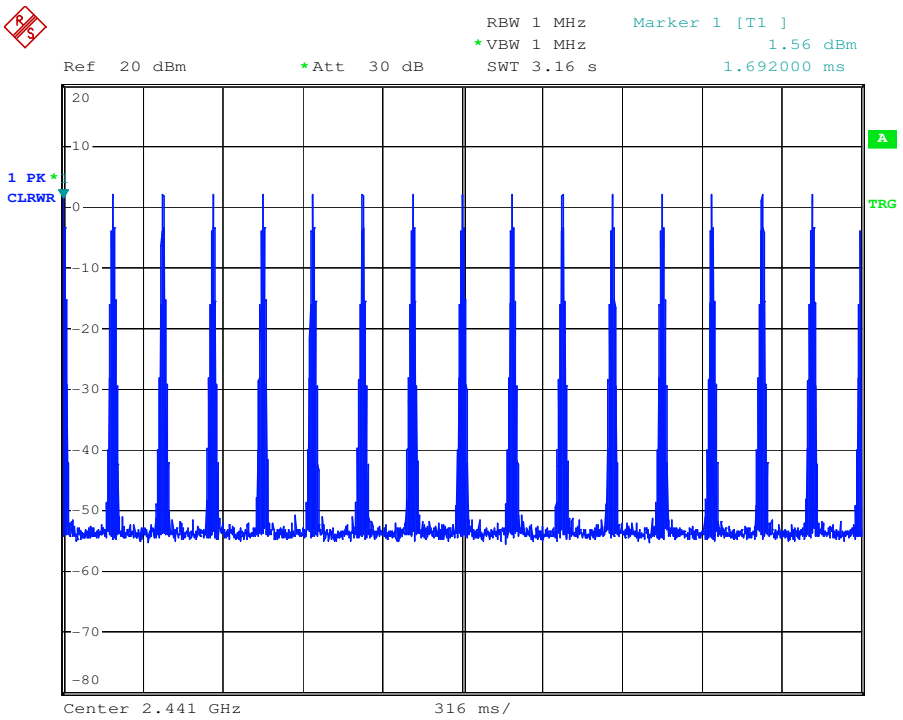
| Test mode: | π/4DQPSK –DH5 | Test channel: | Middle |
|---|---|---|---|

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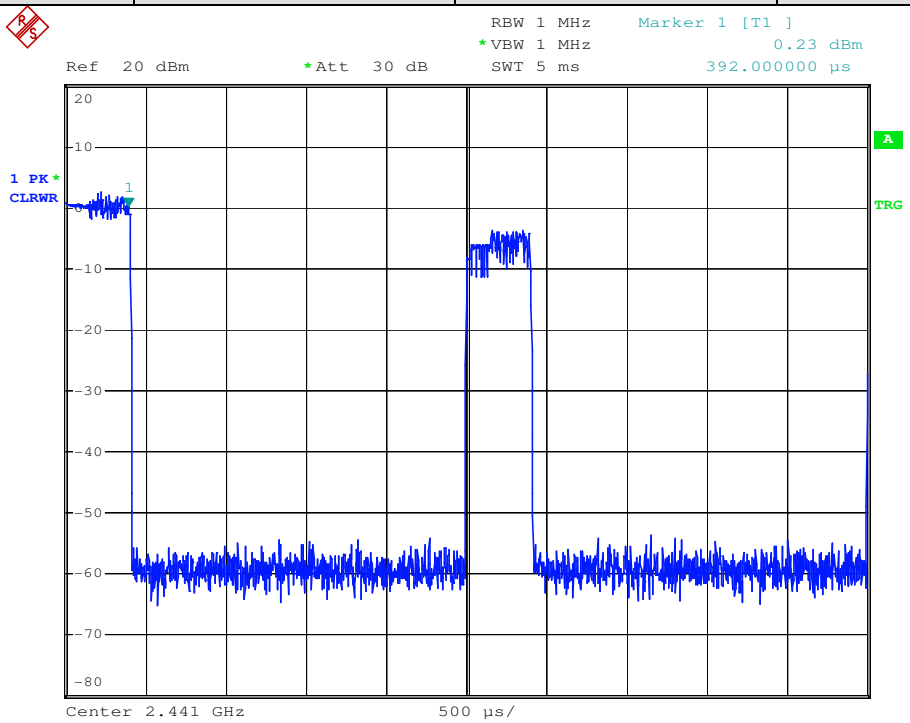
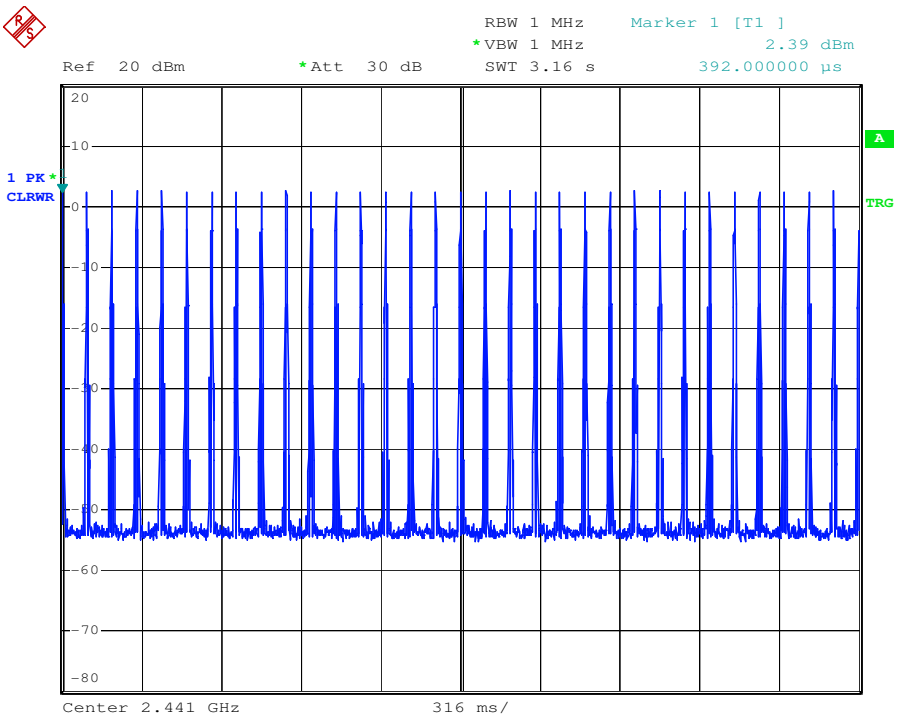
| Test mode: | 8DPSK -DH1 | Test channel: | Middle |
|---|---|---|---|

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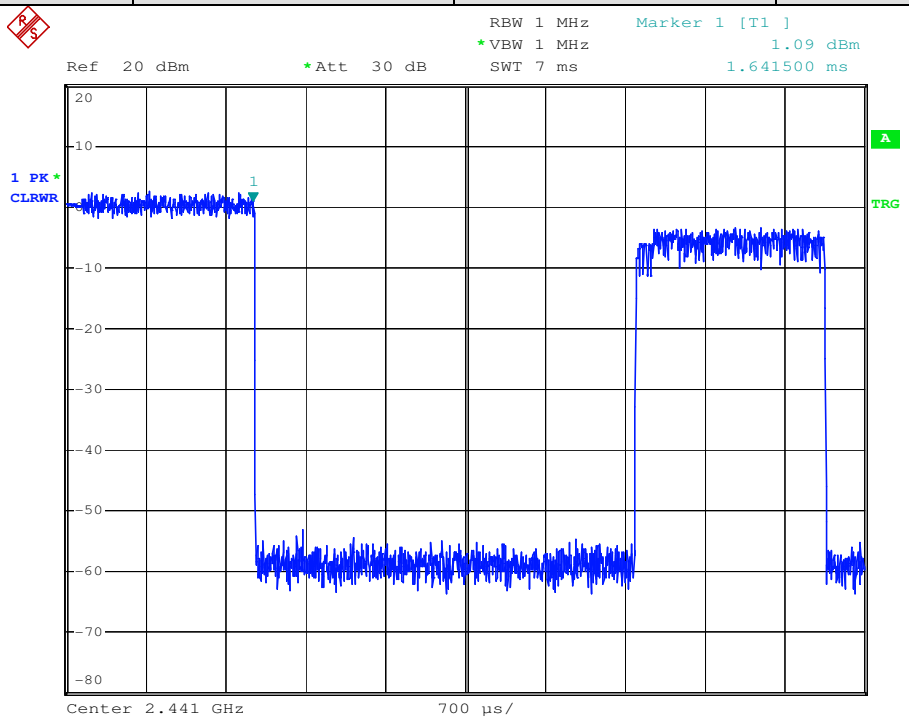
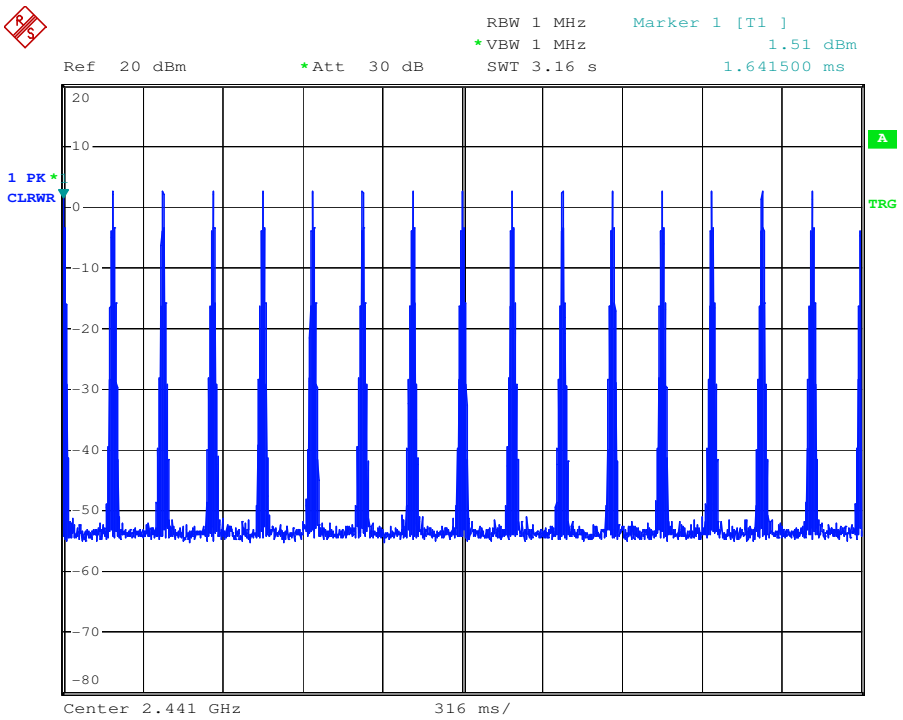
| Test mode: | 8DPSK –DH3 | Test channel: | Middle |
|---|---|---|---|

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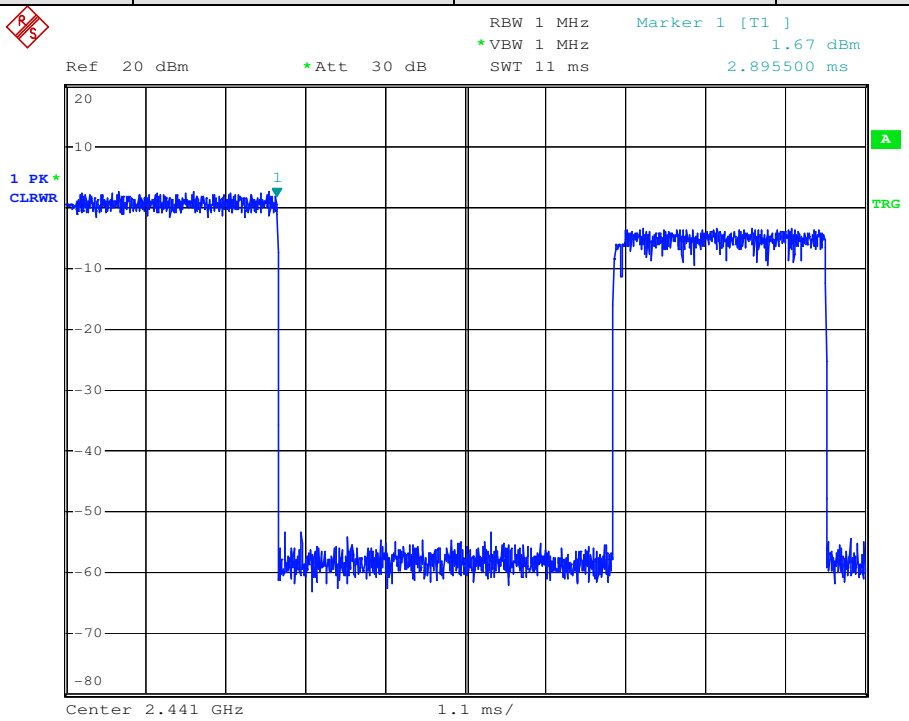
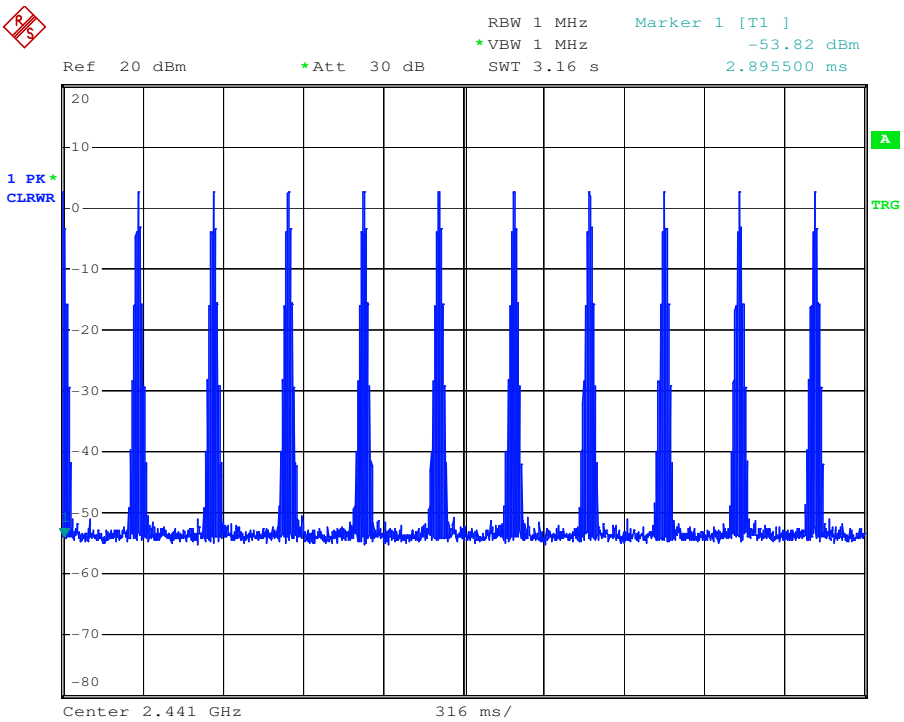
| Test mode: | 8DPSK –DH5 | Test channel: | Middle |
|---|---|---|---|

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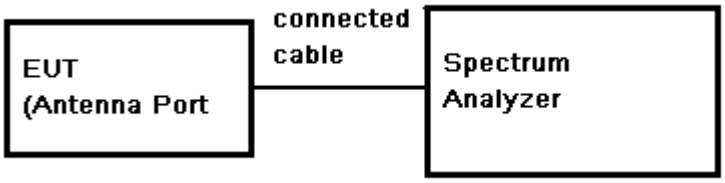
## 7.10 Conducted Spurious Emissions and Band-edge

**Limit:**

(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.

**Test Configuration:**




**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 >= RBW. Sweep = auto; Detector Function = Peak (Max. hold).

**Test Result:** Pass

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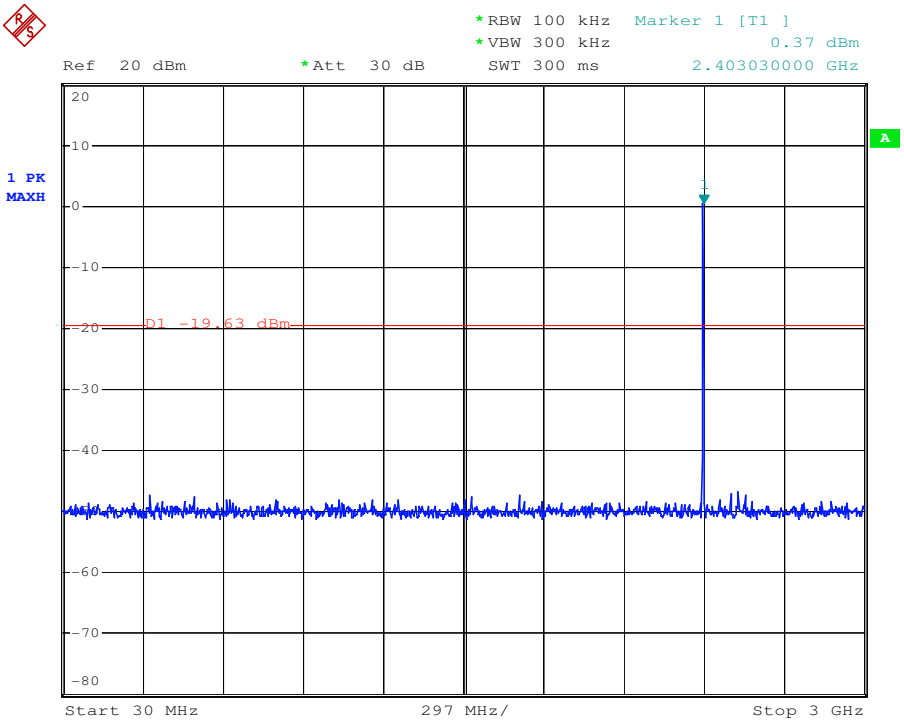
### 7.10.1 Conducted spurious emission

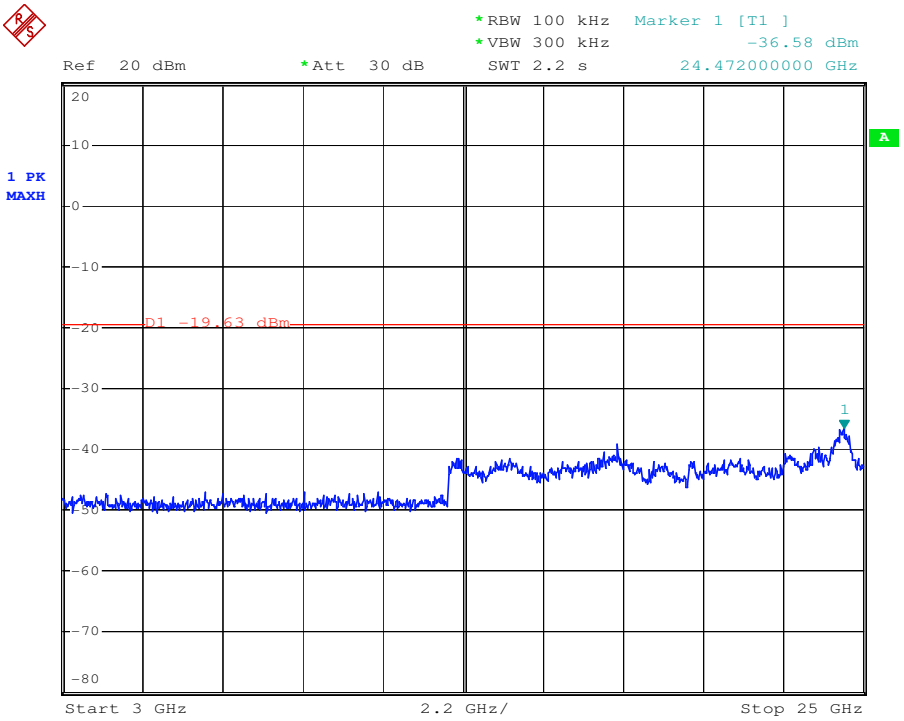
Test plot as follows:

| Test mode: | GFSK | Test channel: | Lowest |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz:

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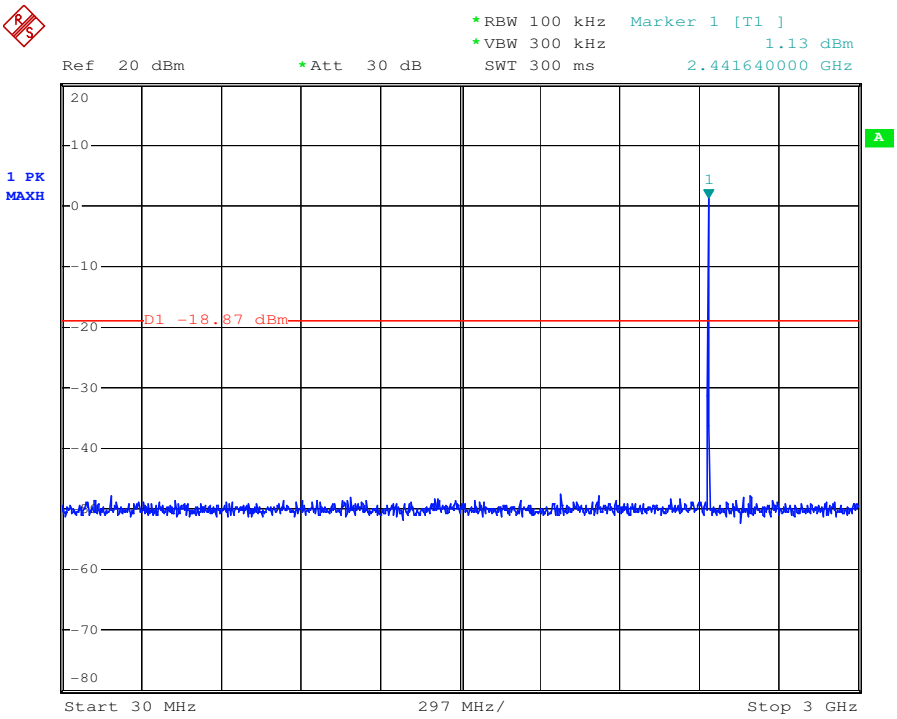
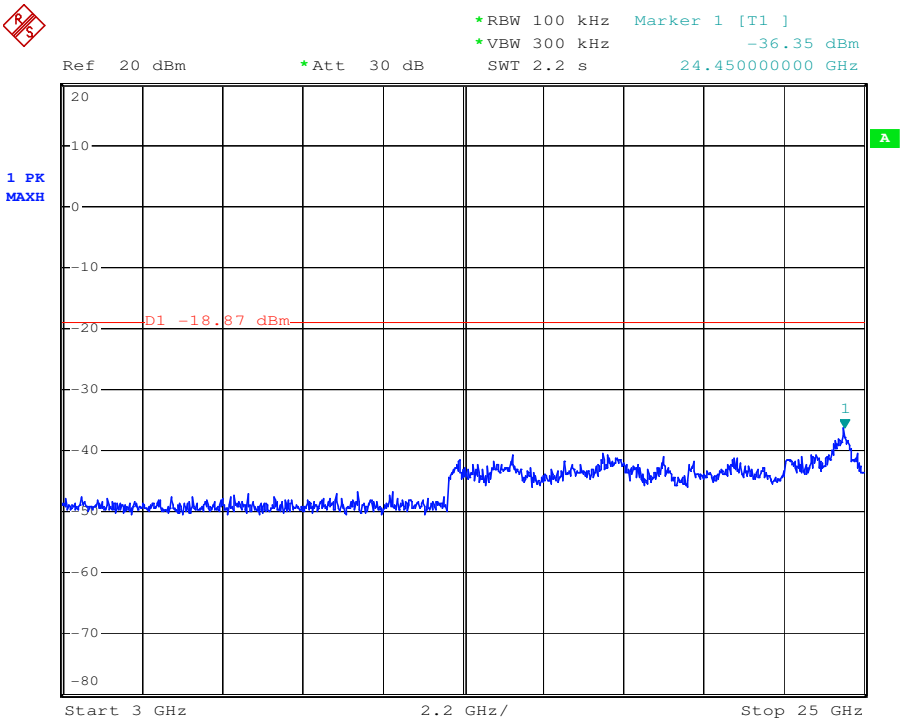
| Test mode: | GFSK | Test channel: | Middle |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz::

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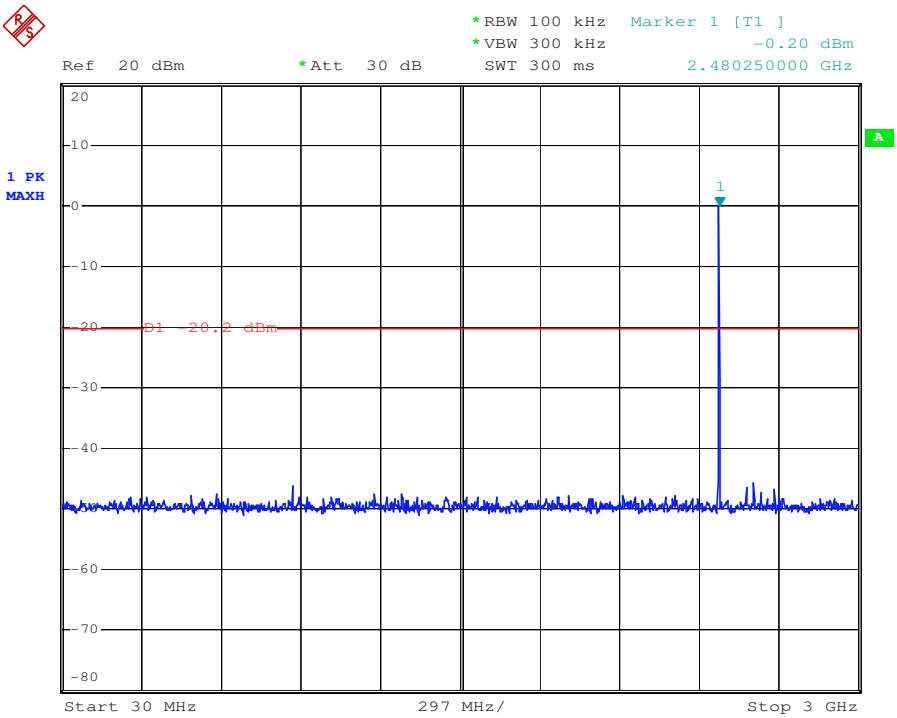
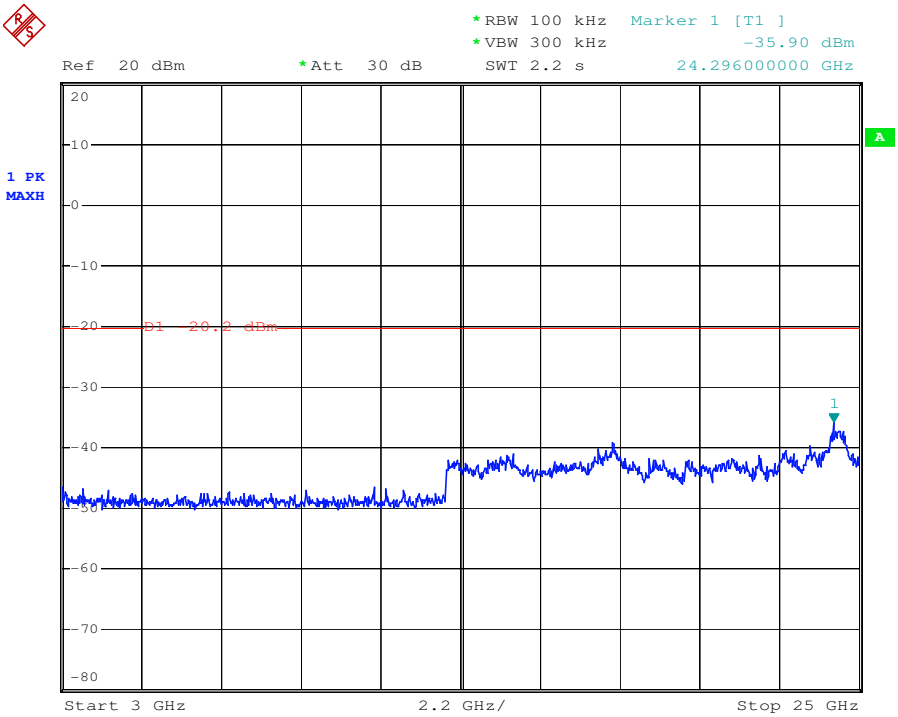
| Test mode: | GFSK | Test channel: | Highest |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz::

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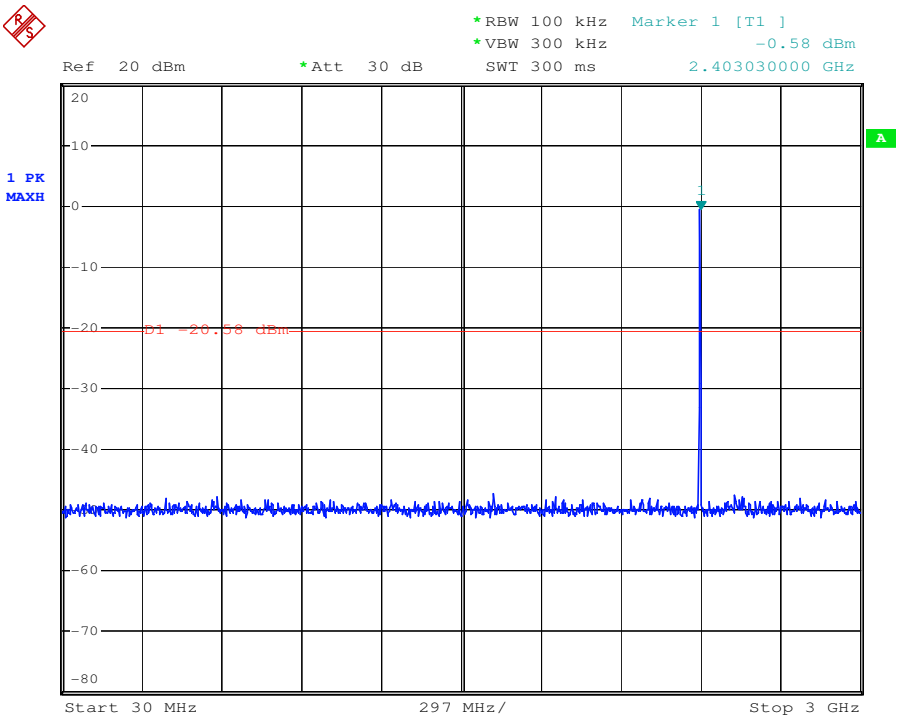
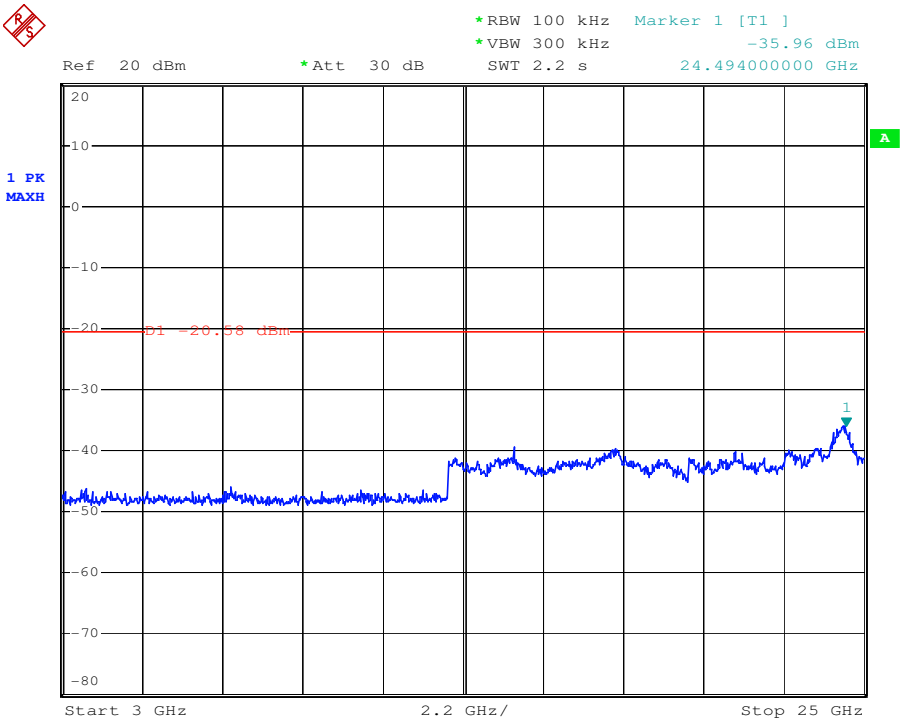
| Test mode: | π/4DQPSK | Test channel: | Lowest |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz::

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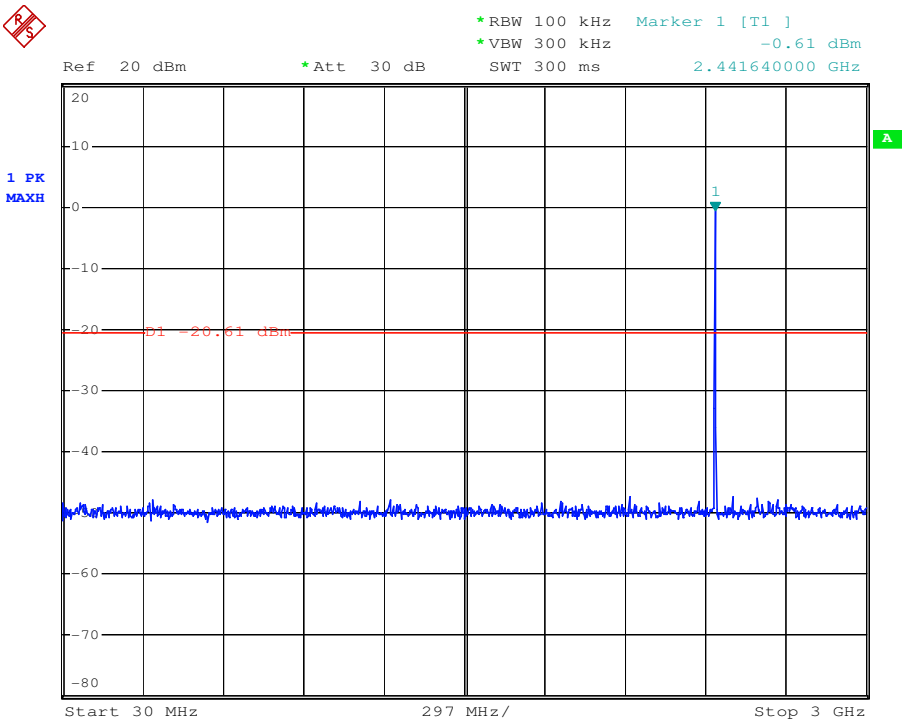
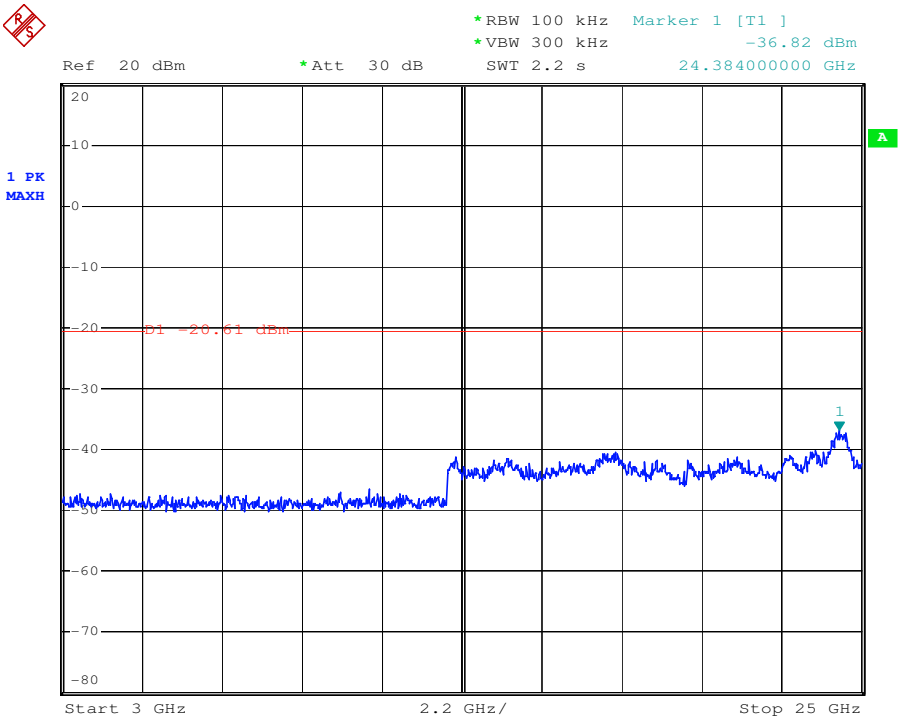
| Test mode: | π/4DQPSK | Test channel: | Middle |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz::

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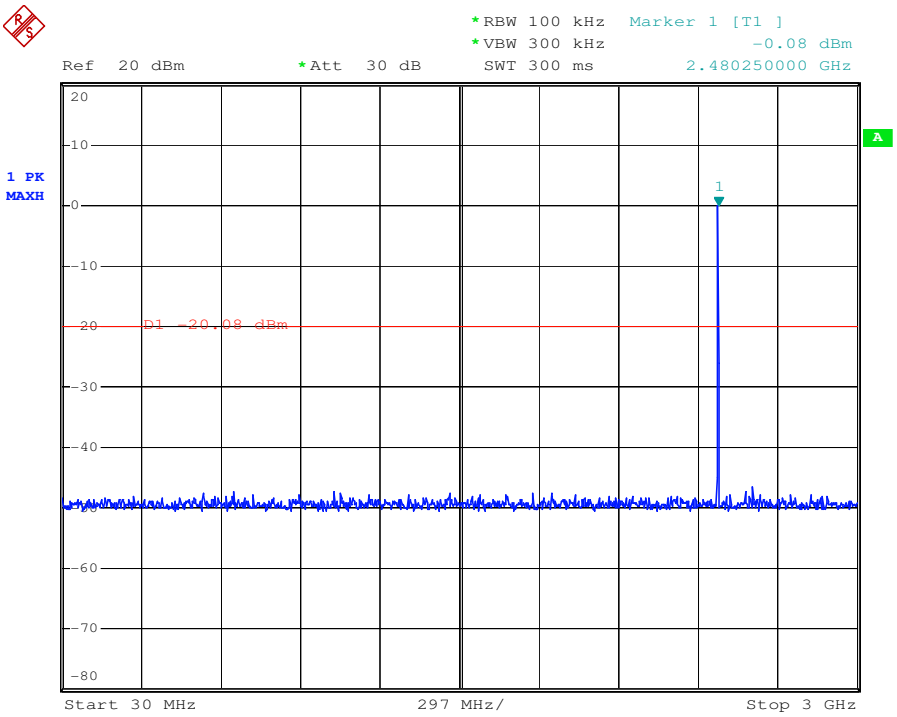
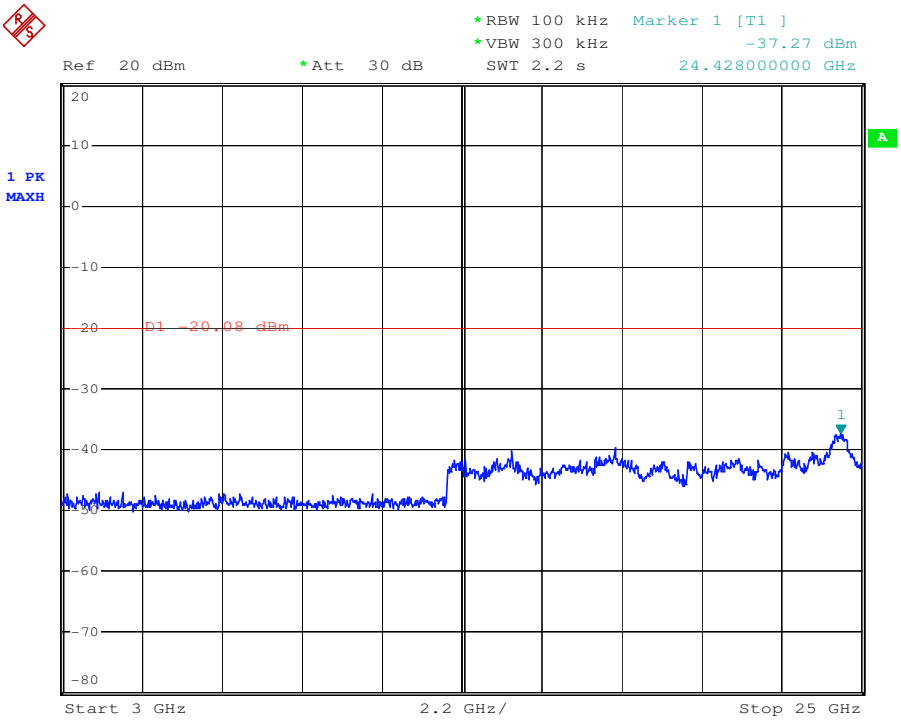
| Test mode: | π/4DQPSK | Test channel: | Highest |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz::

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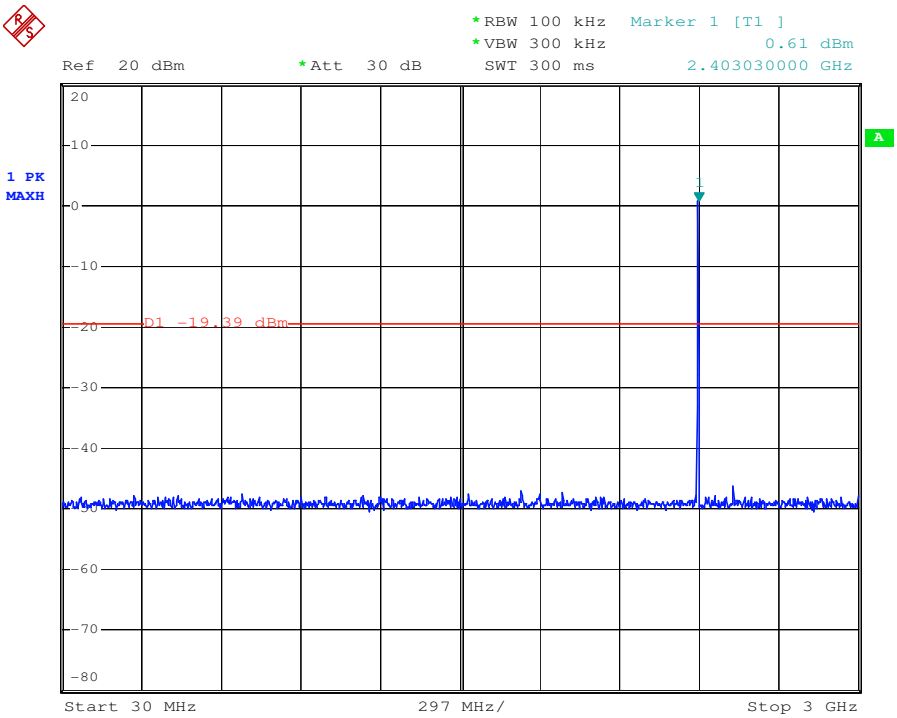
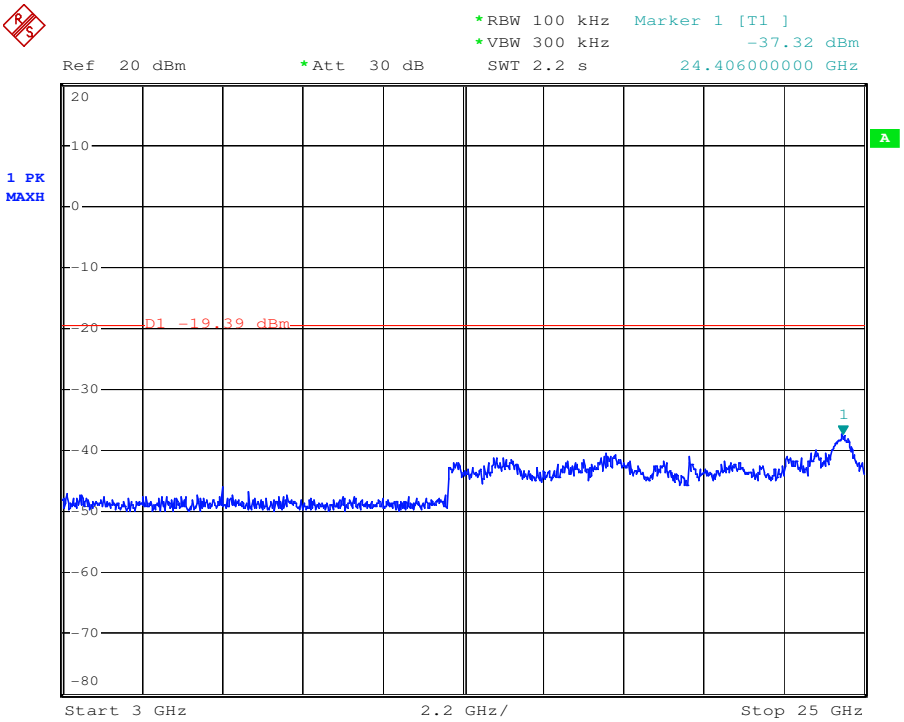
| Test mode: | 8DPSK | Test channel: | Lowest |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz::

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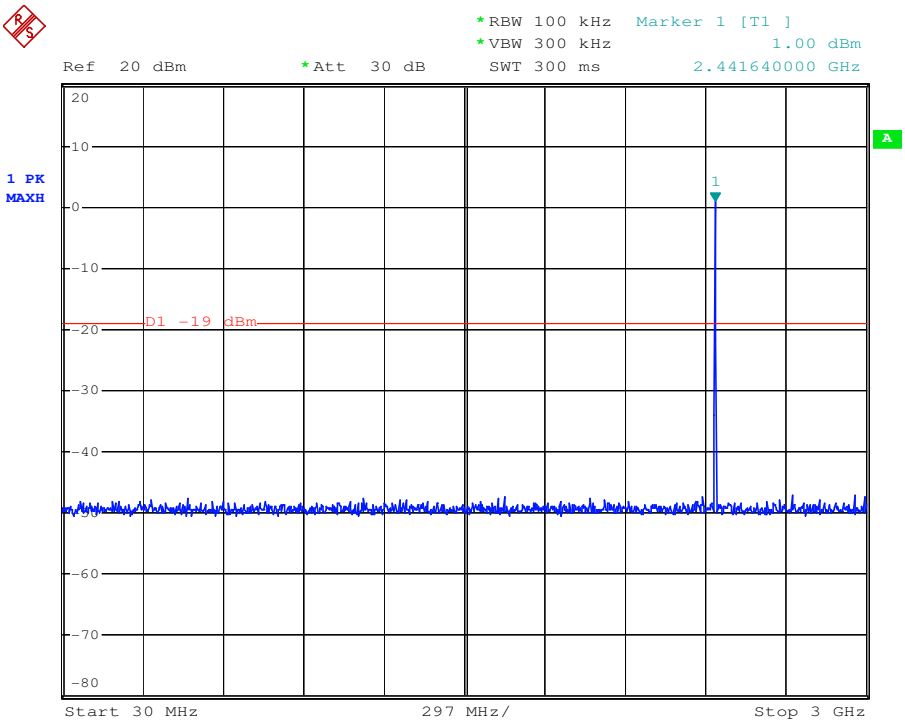
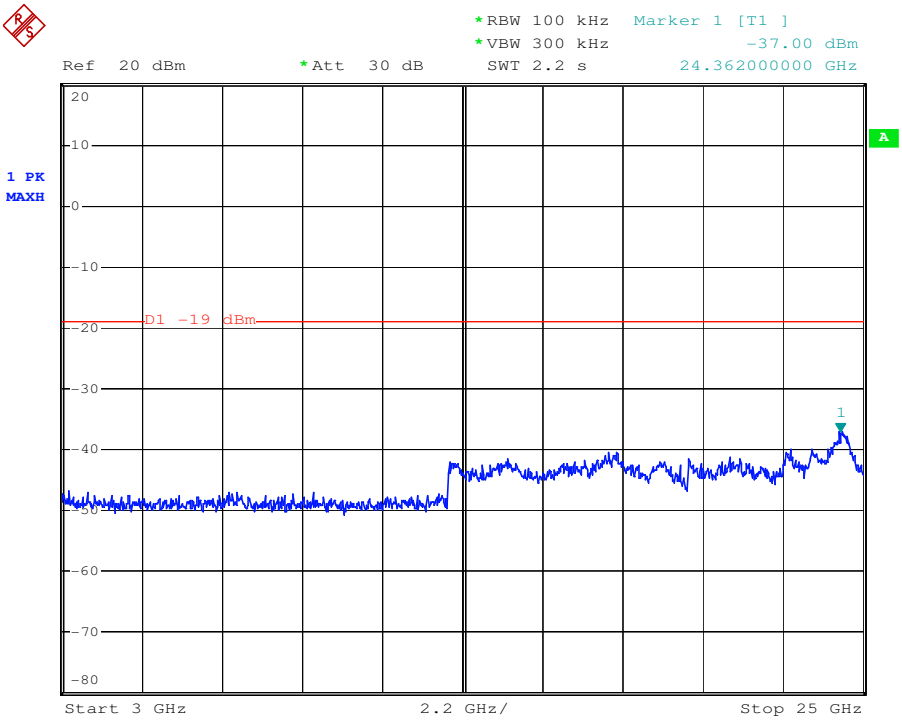
| Test mode: | 8DPSK | Test channel: | Middle |
|---|---|---|---|

30MHz-3GHz:




3GHz-13.6GHz:

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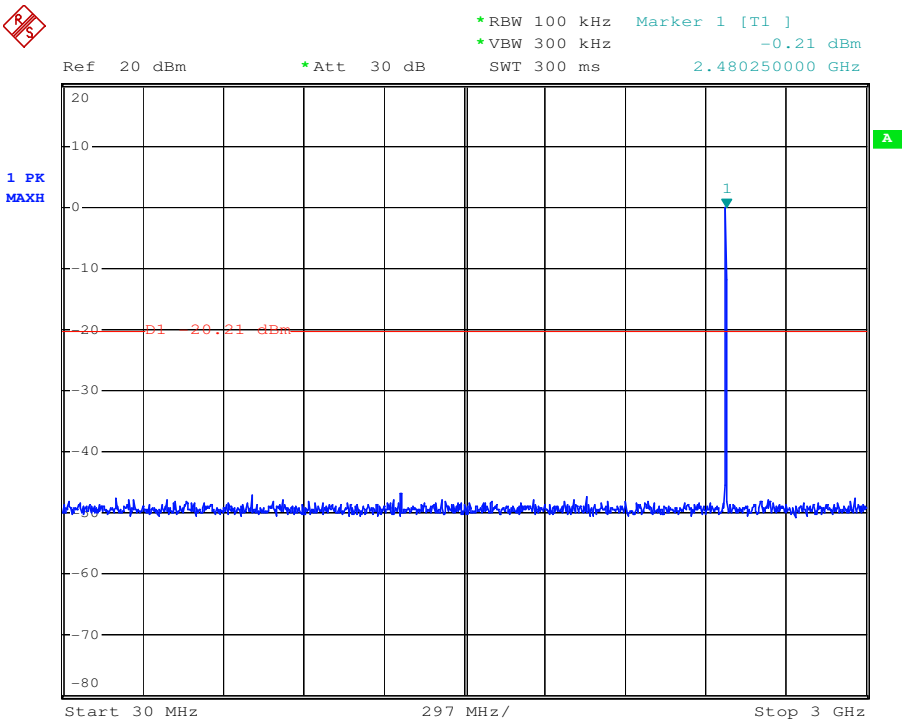
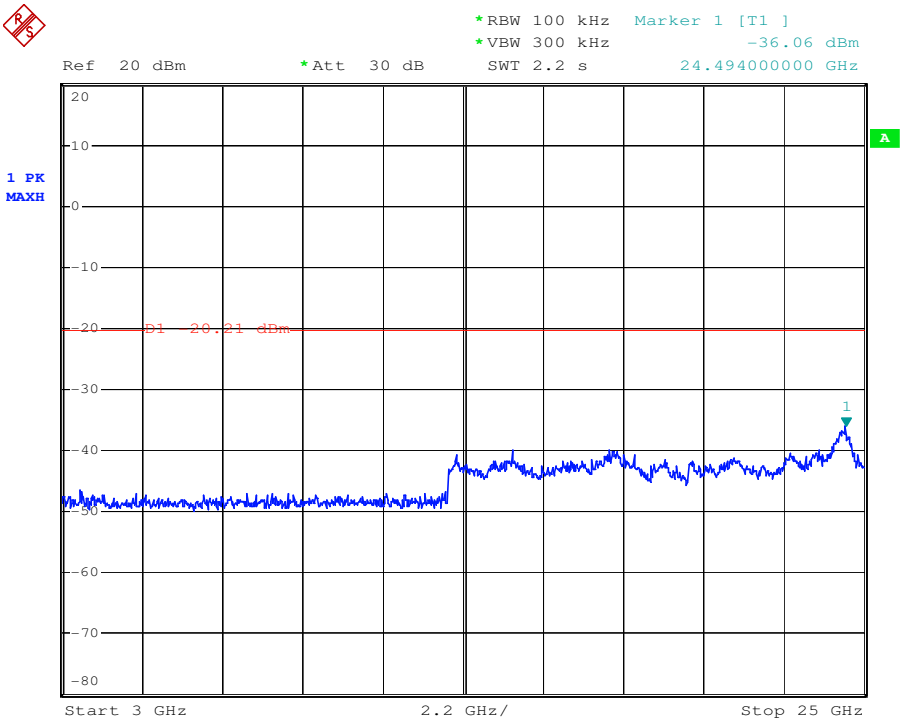
| Test mode: | 8DPSK | Test channel: | Highest |
|---|---|---|---|

30MHz-3GHz:




3GHz-25GHz::

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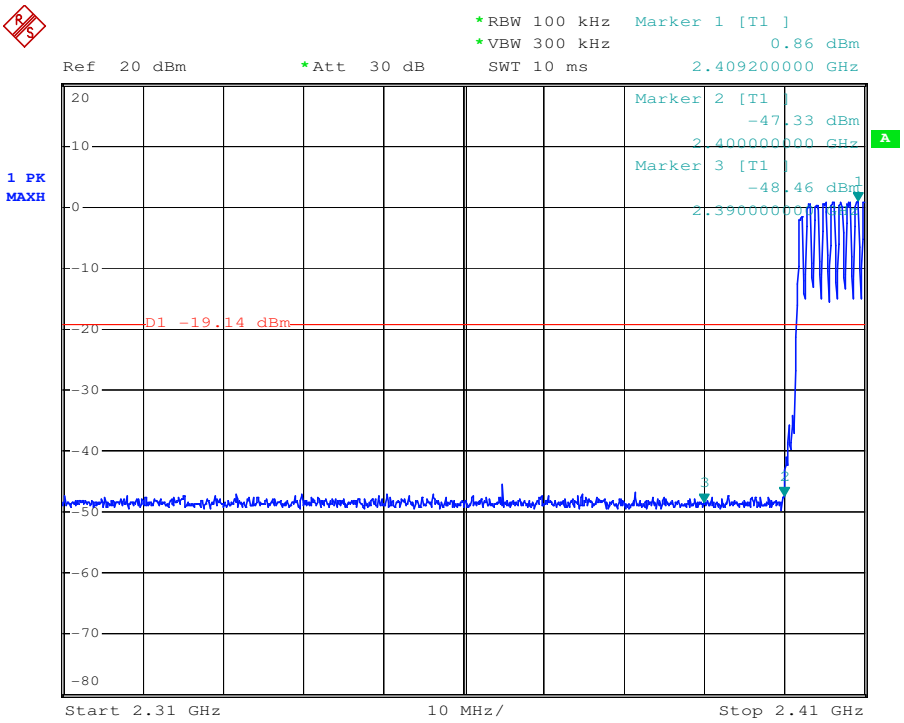
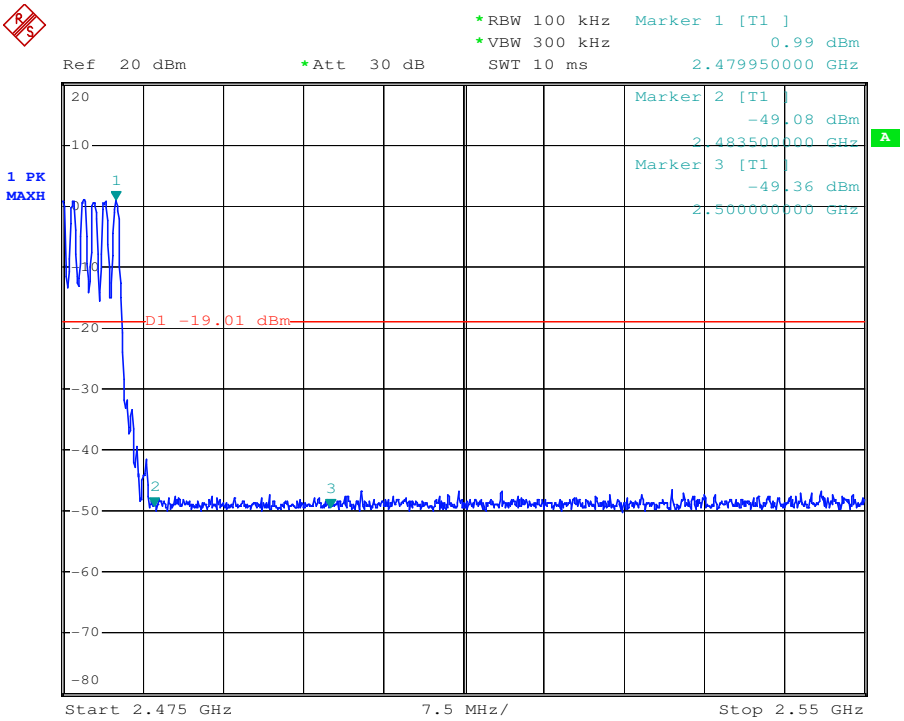
### 7.10.2 Conducted Band-edge

Test plot as follows:

| Test mode: | GFSK | Test channel: | Hopping enabled |
|---|---|---|---|

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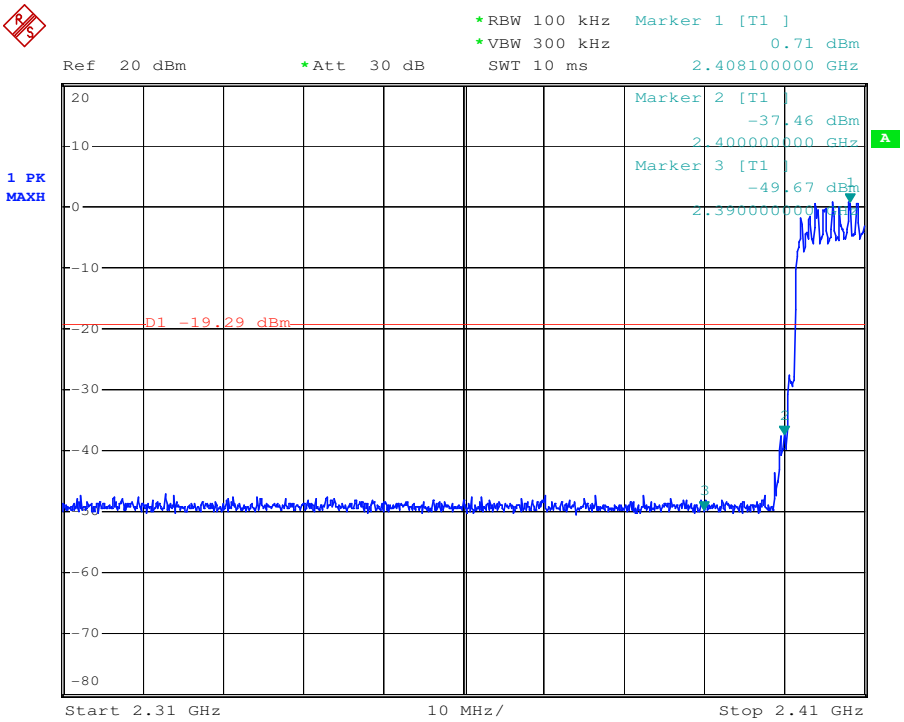
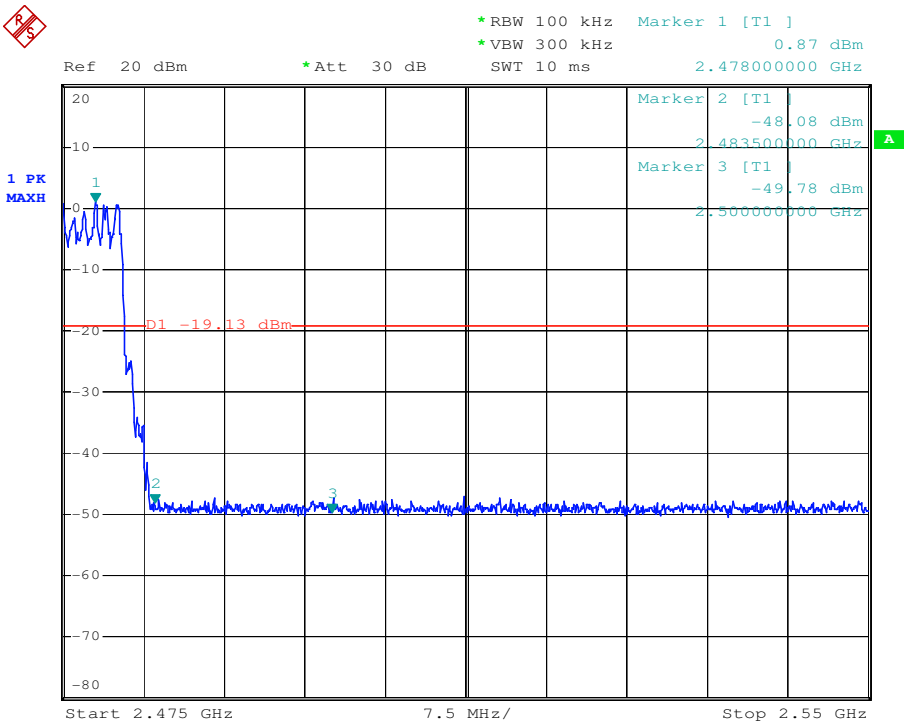
| Test mode: | π/4DQPSK | Test channel: | Hopping enabled |
|---|---|---|---|

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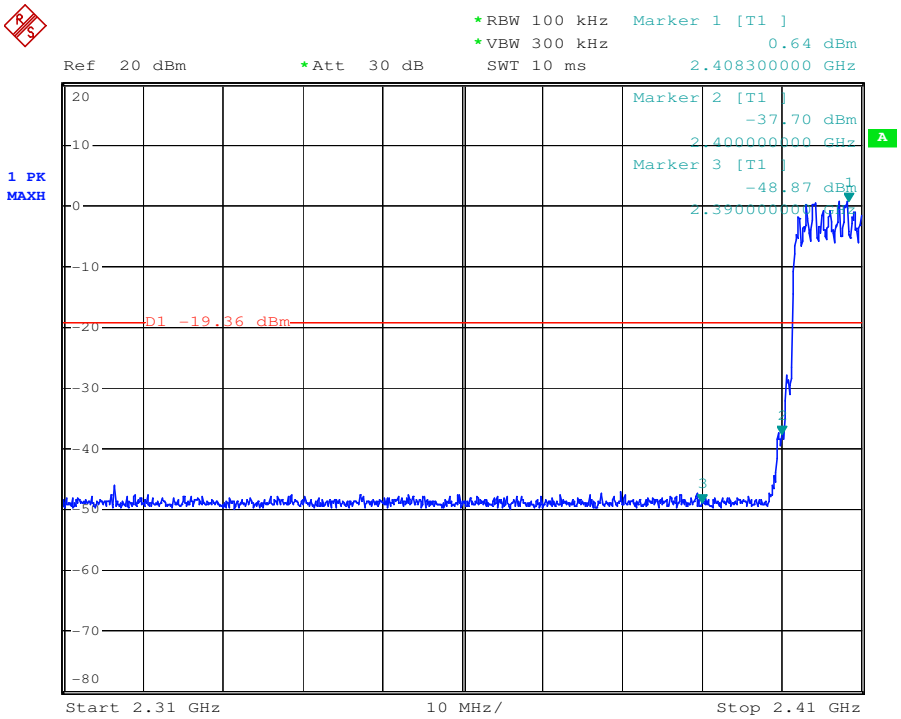
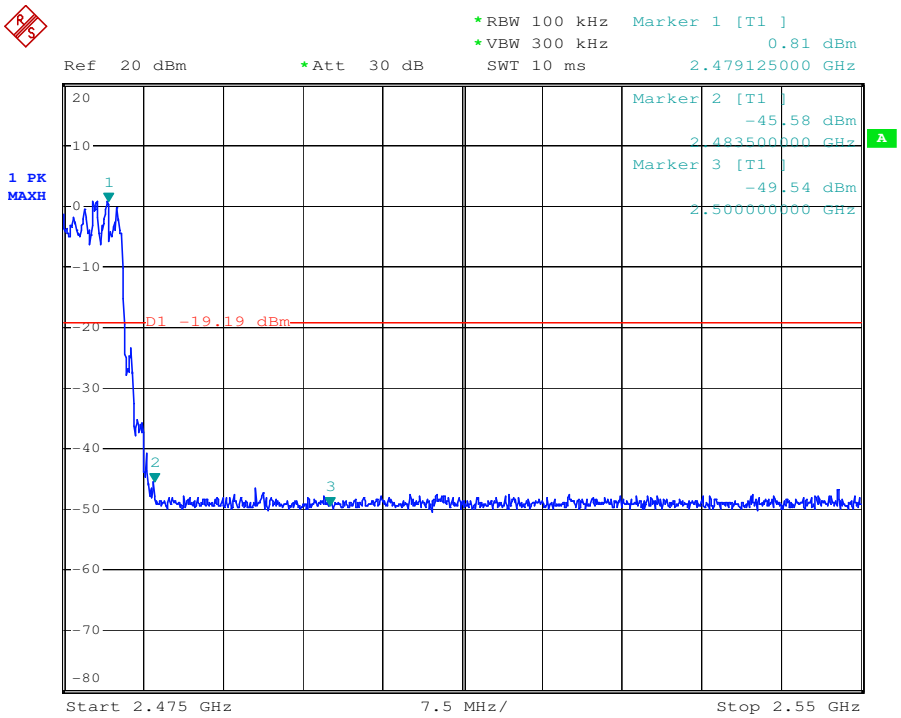
| Test mode: | 8DPSK | Test channel: | Hopping enabled |
|---|---|---|---|

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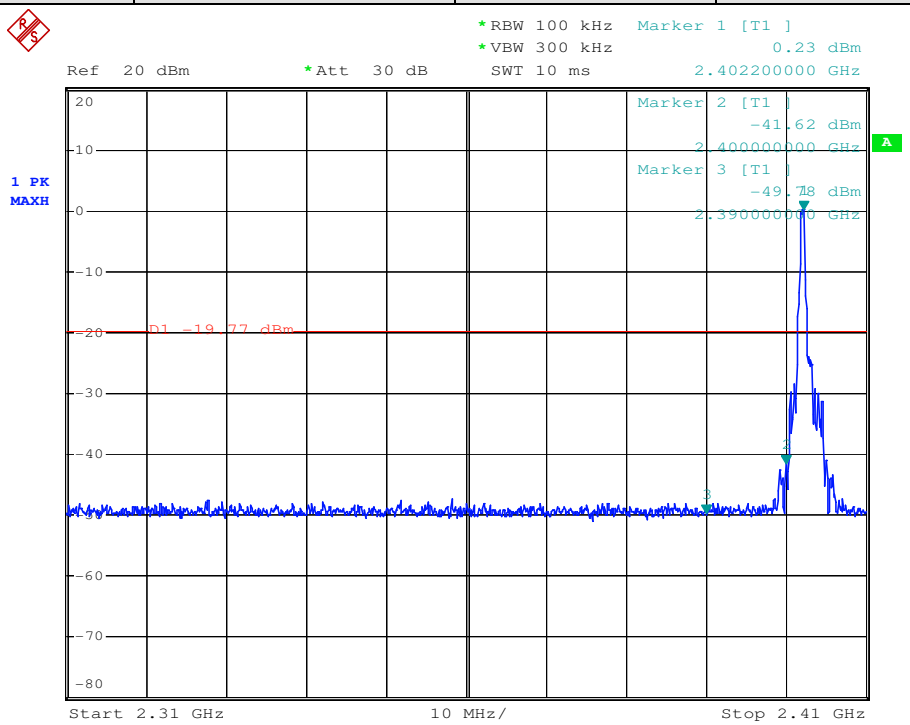
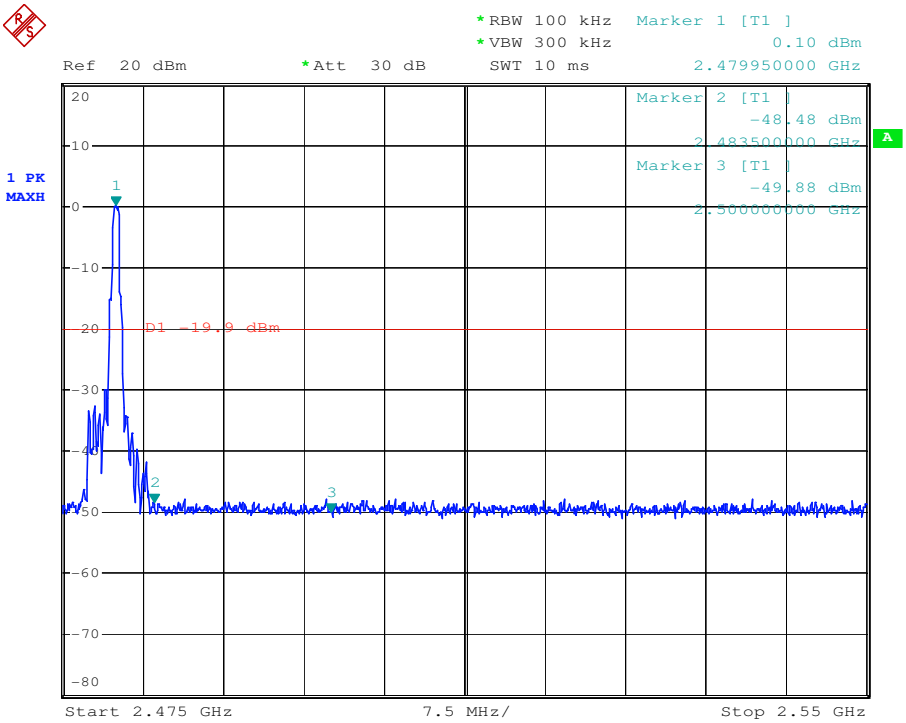
| Test mode: | GFSK | Test channel: | Hopping disabled- Lowest |
|---|---|---|---|




| Test mode: | GFSK | Test channel: | Hopping disabled- Highest |
|---|---|---|---|

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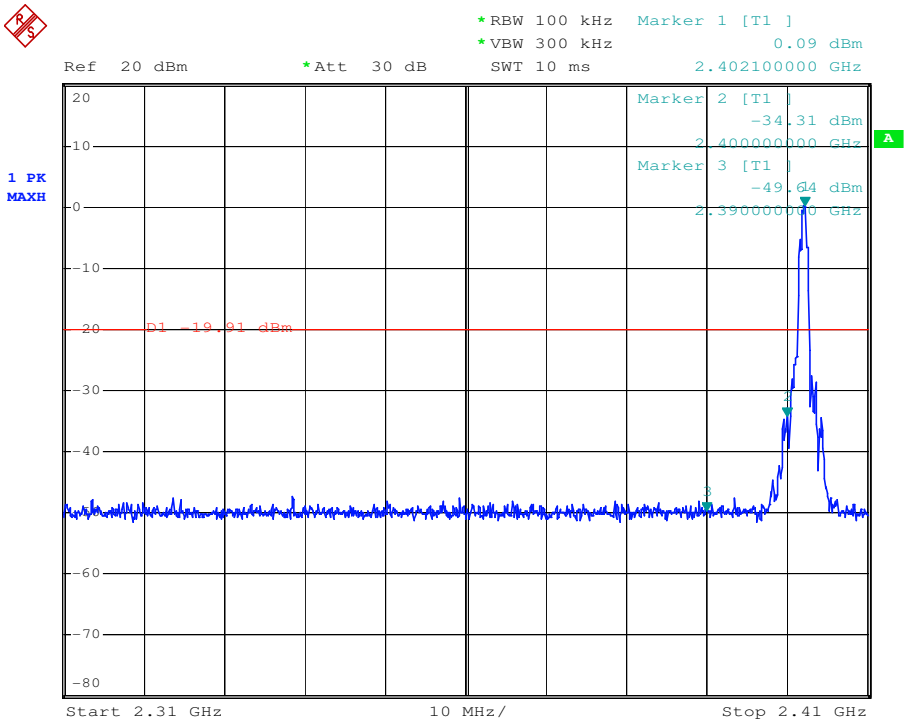
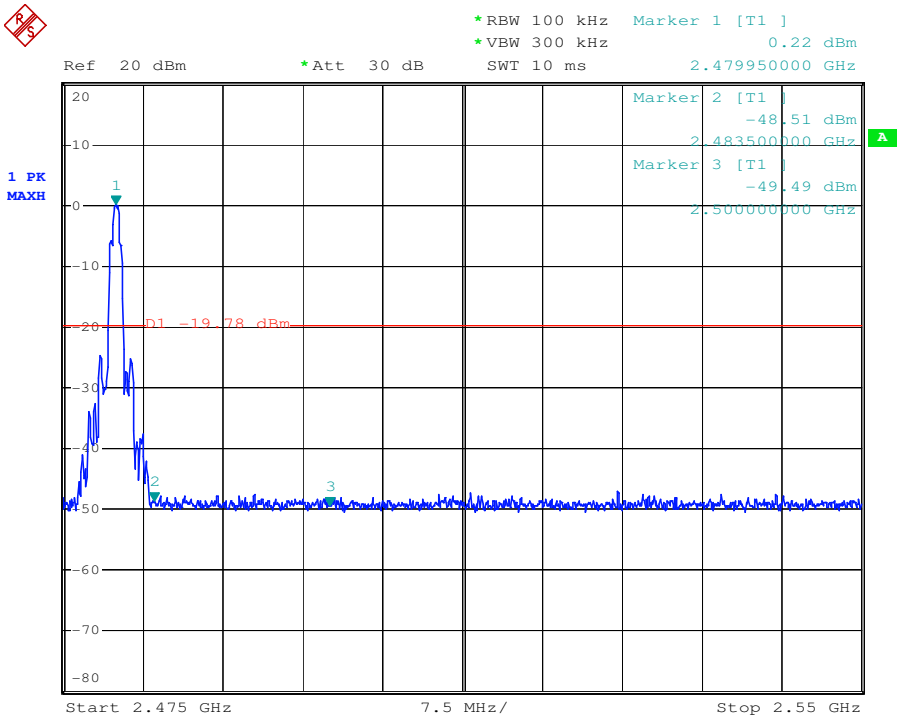
| Test mode: | π/4DQPSK | Test channel: | Hopping disabled- Lowest |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Hopping disabled- Highest |
|---|---|---|---|

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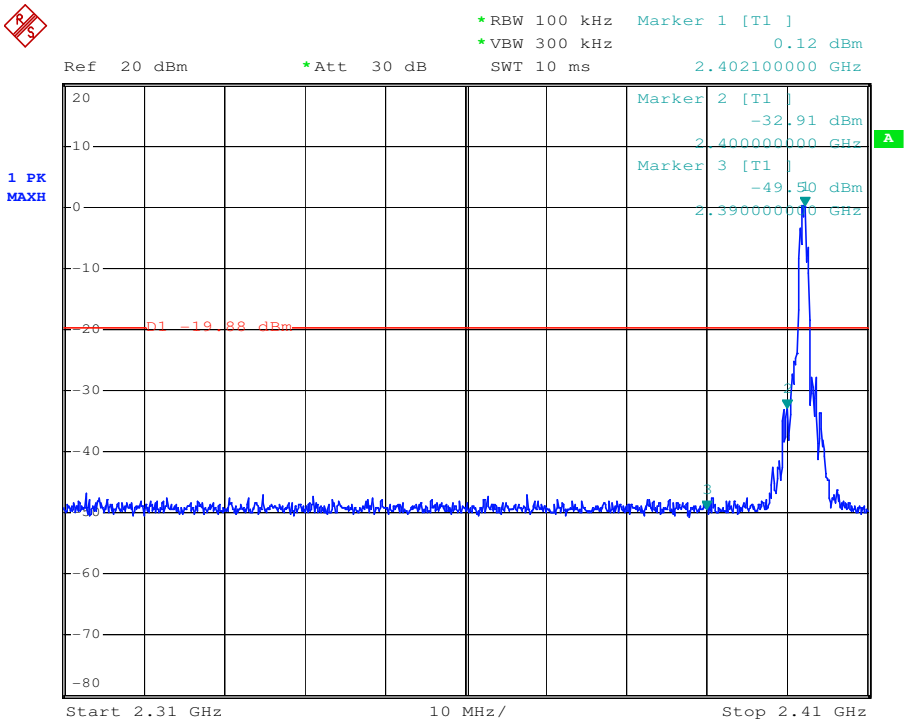
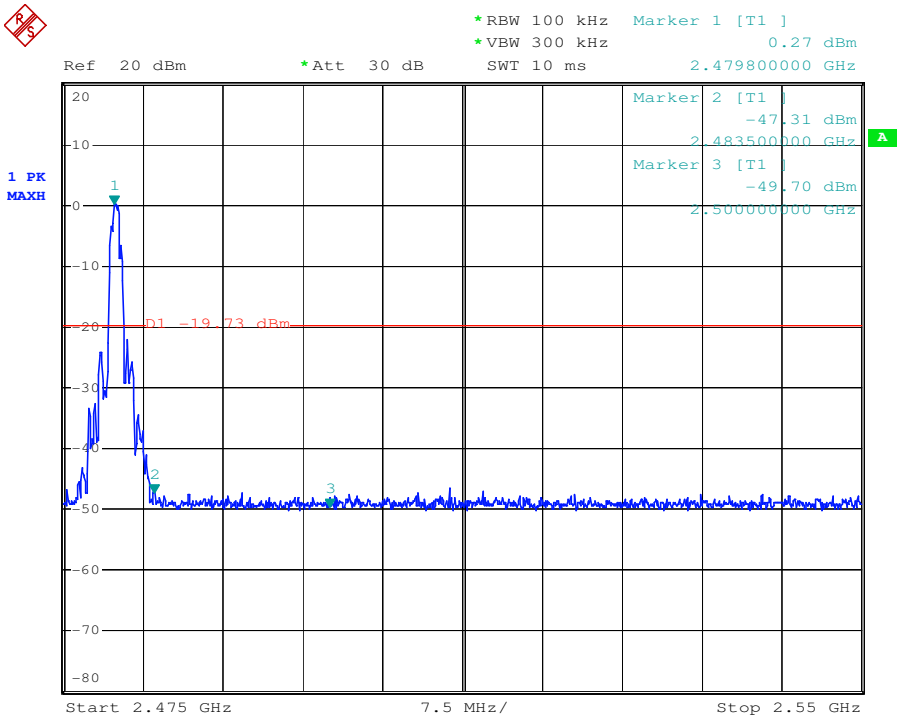
| Test mode: | 8DPSK | Test channel: | Hopping disabled- Lowest |
|---|---|---|---|




| Test mode: | 8DPSK | Test channel: | Hopping disabled- Highest |
|---|---|---|---|

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## 7.11 Radiated Spurious Emissions and Band-edge

**Frequency Range:** 9KHz to 25GHz

**Test site/setup:**

Measurement Distance: 3m (Semi-Anechoic Chamber)
Test instrumentation set-up:

| Frequency Range | Detector | RBW | VBW |
|---|---|---|---|
| 0.009MHz-0.090MHz | Peak | 10kHz | 30kHz |
| 0.009MHz-0.090MHz | Average | 10kHz | 30kHz |
| 0.090MHz-0.110MHz | Quasi-peak | 10kHz | 30kHz |
| 0.110MHz-0.490MHz | Peak | 10kHz | 30kHz |
| 0.110MHz-0.490MHz | Average | 10kHz | 30kHz |
| 0.490MHz -30MHz | Quasi-peak | 10kHz | 30kHz |
| 30MHz-1GHz | Quasi-peak | 100kHz | 300kHz |
| Above 1GHz | Peak | RBW=1MHz | VBW≥RBW |
| | Average | | VBW=10Hz |

Sweep=Auto

**15.209 Limit:**

| Frequency | Limit (dBuV/m) |
|---|---|
| 0.009MHz-0.490MHz | 128.5 ~ 93.8 |
| 0.490MHz-1.705MHz | 73.8 ~63.0 |
| 1.705MHz-30MHz | 69.5 |
| 30MHz-88MHz | 40.0 |
| 88MHz-216MHz | 43.5 |
| 216MHz-960MHz | 46.0 |
| 960MHz-1GHz | 54.0 |
| Above 1GHz | 54.0 |

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

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**Test Configuration:** Receive antenna scan height 1 m - 4 m. polarization Vertical / Horizontal

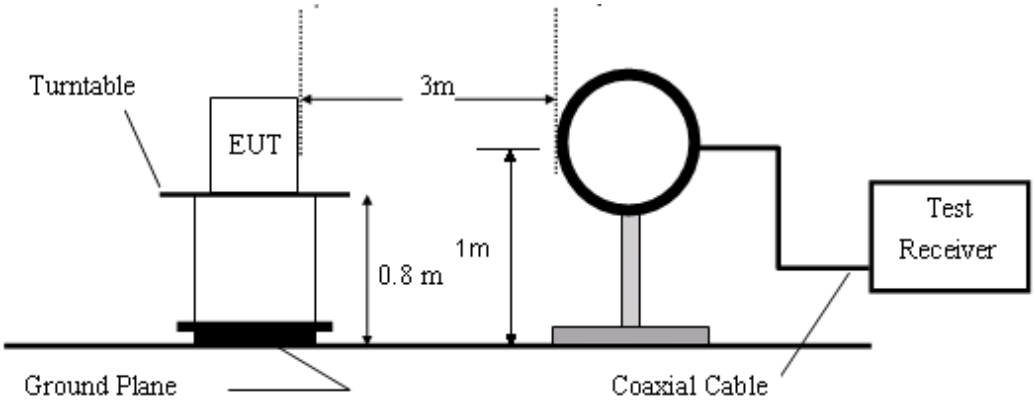


**Figure1. 30MHz to 1GHz radiated emissions test configuration**

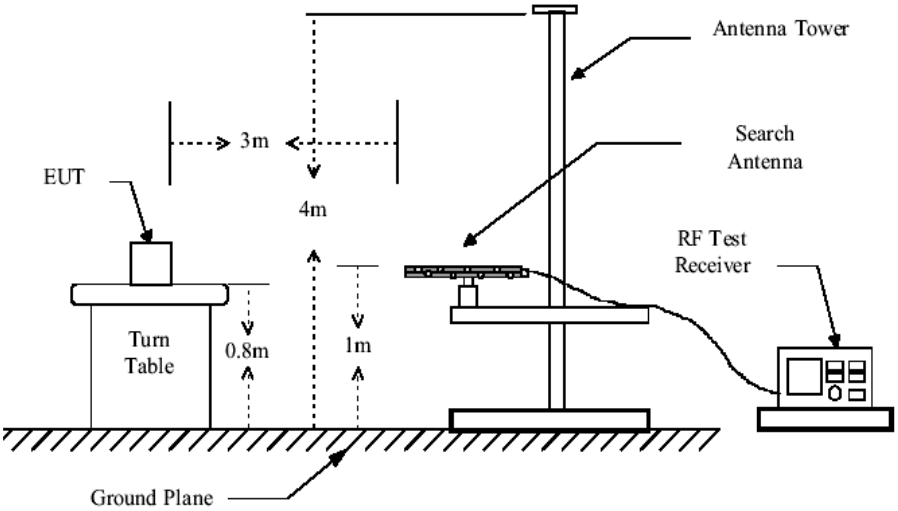


**Figure2. 30MHz to 1GHz radiated emissions test configuration**

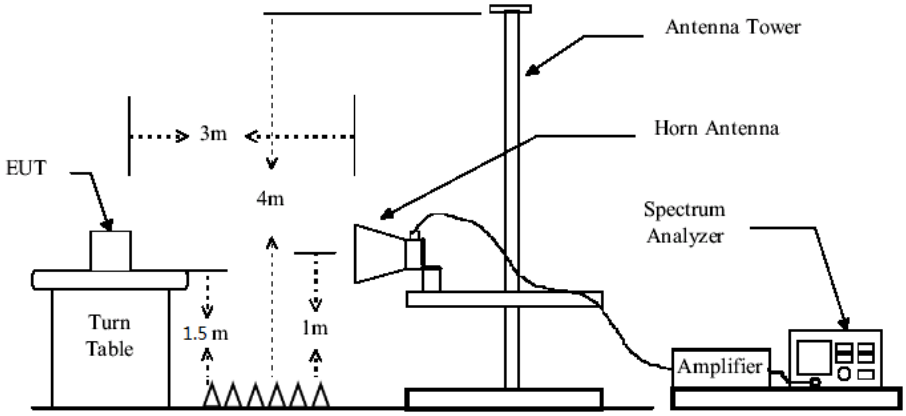


**Figure3. Above 1GHz radiated emissions test configuration**

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**Test Procedure:** The procedure used was ANSI Standard C63.10:2009. The receiver was scanned from 9KHz to 25GHz.When an emission was found, the table was rotated to produce the maximum signal strength. An initial pre-scan was performed for in peak detection mode using the receiver. The EUT was measured for both the Horizontal and Vertical polarities and performed a pre-test three orthogonal planes. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. The worst case emissions were reported.

Low noise amplifier was used below 1GHz, High pass Filter was used above 3GHz.

Between 1G and 3GHz, we did not use any amplifier or filter.

Pre-test was performed on all modes, Compliance test was performed on worse case (8DPSK mode).

Test were performed for their spatial orthogonal(X, Y, Z), the worst test data (X orthogonal) was submitted.

1) For this intentional radiator operates below 25 GHz. the spectrum shall be investigated to the tenth harmonic of the highest fundamental frequency. And above the third harmonic of this intentional radiator, the disturbance is very low. So the test result only displays to 5rd harmonic.
2) As shown in Section, for frequencies above 1000MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

The test only perform the EUT in transmitting status since the test frequencies were over 1GHz only required transmitting status.

**Test Result:** Pass

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### 7.11.1 Radiated Spurious Emissions

30MHz-1GHz:

**lowest Channel**

| Item | Freq. | Read Level | Antenna Factor | Preamp Factor | Cable Loss | Result Level | Limit Line | Over Limit | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|---|---|
| (Mark) | (MHz) | (dBµV) | (dB/m) | (dB) | (dB) | (dBµV/m) | (dBµV/m) | (dB) | | |
| 1 | 31.949 | 23.72 | 12.54 | 23.71 | 0.13 | 12.68 | 40.00 | -27.32 | QP | Horizontal |
| 2 | 38.722 | 23.89 | 12.98 | 23.71 | 0.25 | 13.41 | 40.00 | -26.59 | QP | Horizontal |
| 3 | 224.736 | 26.24 | 9.14 | 23.63 | 1.47 | 13.22 | 46.00 | -32.78 | QP | Horizontal |
| 4 | 782.905 | 21.31 | 22.11 | 23.92 | 3.18 | 22.68 | 46.00 | -23.32 | QP | Horizontal |
| 5 | 955.549 | 22.11 | 23.77 | 23.94 | 3.58 | 25.52 | 46.00 | -20.48 | QP | Horizontal |
| 6 | 993.011 | 21.37 | 24.37 | 23.94 | 3.68 | 25.48 | 54.00 | -28.52 | QP | Horizontal |
| 1 | 32.957 | 28.37 | 12.56 | 23.71 | 0.15 | 17.37 | 40.00 | -22.63 | QP | Vertical |
| 2 | 38.664 | 28.77 | 12.96 | 23.71 | 0.25 | 18.27 | 40.00 | -21.73 | QP | Vertical |
| 3 | 41.157 | 27.15 | 13.10 | 23.70 | 0.29 | 16.84 | 40.00 | -23.16 | QP | Vertical |
| 4 | 43.811 | 27.42 | 13.10 | 23.70 | 0.31 | 17.13 | 40.00 | -22.87 | QP | Vertical |
| 5 | 46.152 | 26.54 | 13.00 | 23.70 | 0.34 | 16.18 | 40.00 | -23.82 | QP | Vertical |
| 6 | 939.392 | 23.01 | 23.44 | 23.94 | 3.56 | 26.07 | 46.00 | -19.93 | QP | Vertical |

**Middle Channel**

| Item | Freq. | Read Level | Antenna Factor | Preamp Factor | Cable Loss | Result Level | Limit Line | Over Limit | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|---|---|
| (Mark) | (MHz) | (dBµV) | (dB/m) | (dB) | (dB) | (dBµV/m) | (dBµV/m) | (dB) | | |
| 1 | 30.211 | 24.89 | 12.51 | 23.72 | 0.55 | 14.23 | 40.00 | -25.77 | QP | Horizontal |
| 2 | 653.568 | 22.86 | 19.71 | 23.84 | 2.85 | 21.58 | 46.00 | -24.42 | QP | Horizontal |
| 3 | 740.944 | 22.16 | 21.10 | 23.89 | 3.06 | 22.43 | 46.00 | -23.57 | QP | Horizontal |
| 4 | 805.593 | 21.62 | 21.81 | 23.93 | 3.23 | 22.73 | 46.00 | -23.27 | QP | Horizontal |
| 5 | 857.755 | 21.24 | 22.23 | 23.93 | 3.33 | 22.87 | 46.00 | -23.13 | QP | Horizontal |
| 6 | 955.629 | 21.86 | 23.77 | 23.94 | 3.58 | 25.27 | 46.00 | -20.73 | QP | Horizontal |
| 1 | 30.000 | 39.17 | 12.50 | 23.72 | 0.55 | 28.50 | 40.00 | -11.50 | QP | Vertical |
| 2 | 38.481 | 31.43 | 12.94 | 23.71 | 0.25 | 20.91 | 40.00 | -19.09 | QP | Vertical |
| 3 | 43.966 | 29.08 | 13.10 | 23.70 | 0.31 | 18.79 | 40.00 | -21.21 | QP | Vertical |
| 4 | 105.272 | 34.26 | 9.91 | 23.66 | 0.96 | 21.47 | 43.50 | -22.03 | QP | Vertical |
| 5 | 151.067 | 31.71 | 12.30 | 23.64 | 1.17 | 21.54 | 43.50 | -21.96 | QP | Vertical |
| 6 | 185.788 | 34.67 | 11.72 | 23.62 | 1.36 | 24.13 | 43.50 | -19.37 | QP | Vertical |

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**Highest Channel**

| Item | Freq. | Read Level | Antenna Factor | Preamp Factor | Cable Loss | Result Level | Limit Line | Over Limit | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|---|---|
| (Mark) | (MHz) | (dBµV) | (dB/m) | (dB) | (dB) | (dBµV/m) | (dBµV/m) | (dB) | | |
| 1 | 49.707 | 39.25 | 12.73 | 23.69 | 0.41 | 28.70 | 40.00 | -11.30 | QP | Horizontal |
| 2 | 61.995 | 39.05 | 11.85 | 23.68 | 0.54 | 27.76 | 40.00 | -12.24 | QP | Horizontal |
| 3 | 98.487 | 44.25 | 9.05 | 23.66 | 0.90 | 30.54 | 43.50 | -12.96 | QP | Horizontal |
| 4 | 150.011 | 43.82 | 12.30 | 23.64 | 1.17 | 33.65 | 43.50 | -9.85 | QP | Horizontal |
| 5 | 184.490 | 43.23 | 11.78 | 23.62 | 1.35 | 32.74 | 43.50 | -10.76 | QP | Horizontal |
| 6 | 332.519 | 44.03 | 13.13 | 23.68 | 1.92 | 35.40 | 46.00 | -10.60 | QP | Horizontal |
| 1 | 123.698 | 40.67 | 11.16 | 23.65 | 1.05 | 29.23 | 43.50 | -14.27 | QP | Vertical |
| 2 | 150.011 | 38.43 | 12.30 | 23.64 | 1.17 | 28.26 | 43.50 | -15.24 | QP | Vertical |
| 3 | 233.349 | 47.26 | 9.54 | 23.64 | 1.51 | 34.67 | 46.00 | -11.33 | QP | Vertical |
| 4 | 282.985 | 47.03 | 11.28 | 23.66 | 1.78 | 36.43 | 46.00 | -9.57 | QP | Vertical |
| 5 | 332.519 | 45.45 | 13.13 | 23.68 | 1.92 | 36.82 | 46.00 | -9.18 | QP | Vertical |
| 6 | 492.469 | 41.26 | 16.20 | 23.73 | 2.42 | 36.15 | 46.00 | -9.85 | QP | Vertical |

Result Level = Read Level + Antenna Factor + Cable loss - Preamp Factor

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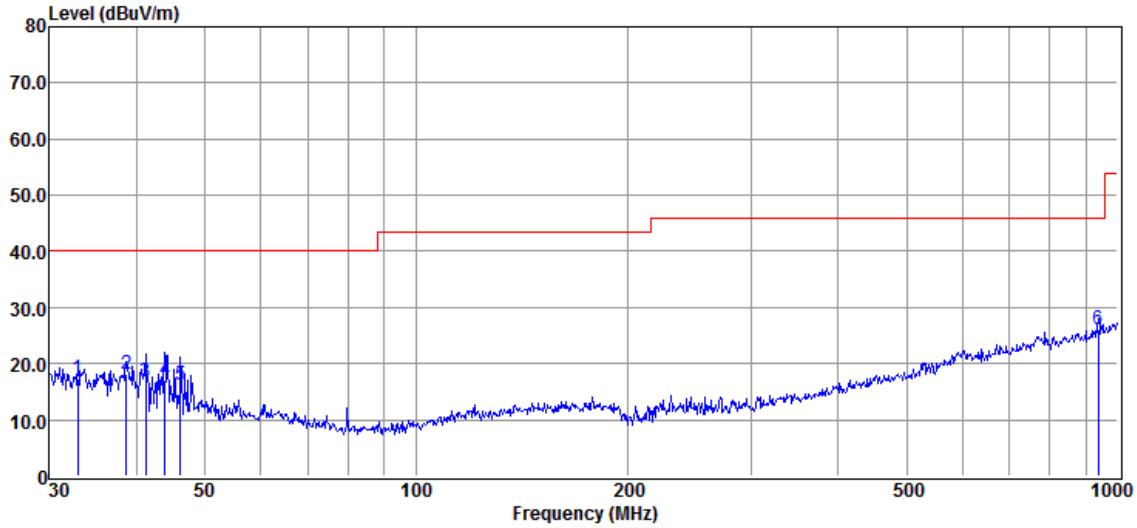
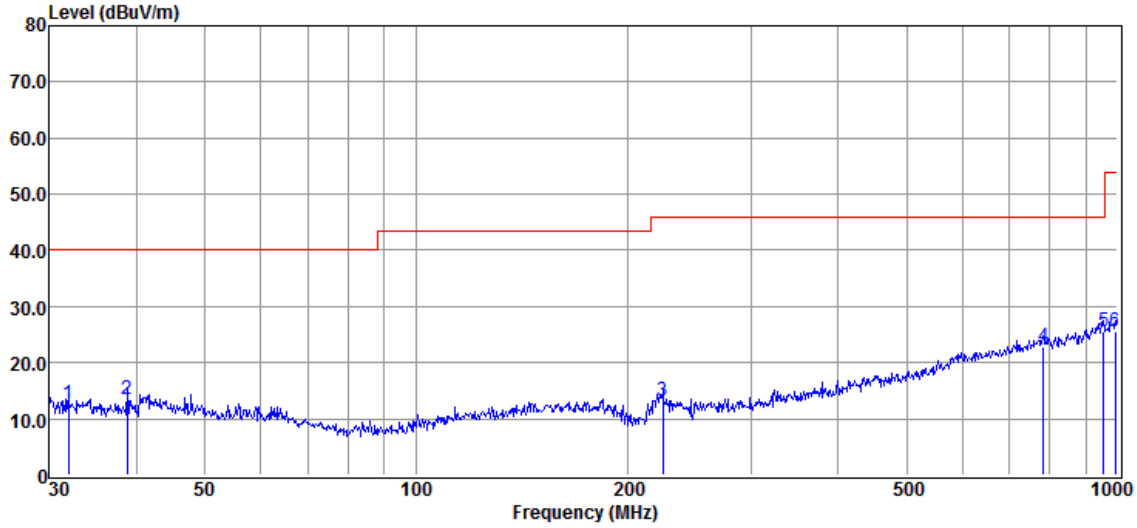
Below is the plot of worst case on lowest channel:
Vertical:




Horizontal:

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Above 1GHz:

**Lowest Channel(2402MHz)**

| Mark | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Emission (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 4804 | 36.25 | 6.18 | 42.43 | 54 | -11.57 | peak | Horizontal |
| 2 | 7206 | 35.96 | 10.63 | 46.59 | 54 | -7.41 | peak | Horizontal |
| 3 | 9608 | 33.31 | 14.38 | 47.69 | 54 | -6.31 | peak | Horizontal |
| 4 | 4804 | 33.20 | 6.18 | 39.38 | 54 | -14.62 | peak | Vertical |
| 5 | 7206 | 33.20 | 10.63 | 43.83 | 54 | -10.17 | peak | Vertical |
| 6 | 9608 | 32.09 | 14.38 | 46.47 | 54 | -7.53 | peak | Vertical |

**Middle Channel(2441MHz)**

| Mark | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Emission (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 4882 | 35.52 | 7.00 | 42.52 | 54 | -11.48 | peak | Horizontal |
| 2 | 7323 | 36.55 | 11.13 | 47.68 | 54 | -6.32 | peak | Horizontal |
| 3 | 9764 | 34.13 | 14.36 | 48.49 | 54 | -5.51 | peak | Horizontal |
| 4 | 4882 | 32.17 | 7.00 | 39.17 | 54 | -14.83 | peak | Vertical |
| 5 | 7323 | 33.61 | 11.13 | 44.74 | 54 | -9.26 | peak | Vertical |
| 6 | 9764 | 31.48 | 14.36 | 45.84 | 54 | -8.16 | peak | Vertical |

**Highest Channel(2480MHz)**

| Mark | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Emission (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 4960 | 37.59 | 7.49 | 45.08 | 54 | -8.92 | peak | Horizontal |
| 2 | 7440 | 37.61 | 11.65 | 49.26 | 54 | -4.74 | peak | Horizontal |
| 3 | 9920 | 34.05 | 14.40 | 48.45 | 54 | -5.55 | peak | Horizontal |
| 4 | 4960 | 34.32 | 7.49 | 41.81 | 54 | -12.19 | peak | Vertical |
| 5 | 7440 | 33.56 | 11.65 | 45.21 | 54 | -8.79 | peak | Vertical |
| 6 | 9920 | 32.40 | 14.40 | 46.80 | 54 | -7.20 | peak | Vertical |

Remark: 1. Test Level =Receiver Reading + Antenna Factor + Cable Loss –Preamplifier Factor.

2. No any other emissions level which are attenuated less than 20dB below the limit. According to 15.31(o), the amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this Part. Hence there no other emissions have been reported.

3. If the Peak value below the AV Limit, the AV test doesn't perform for this submission.

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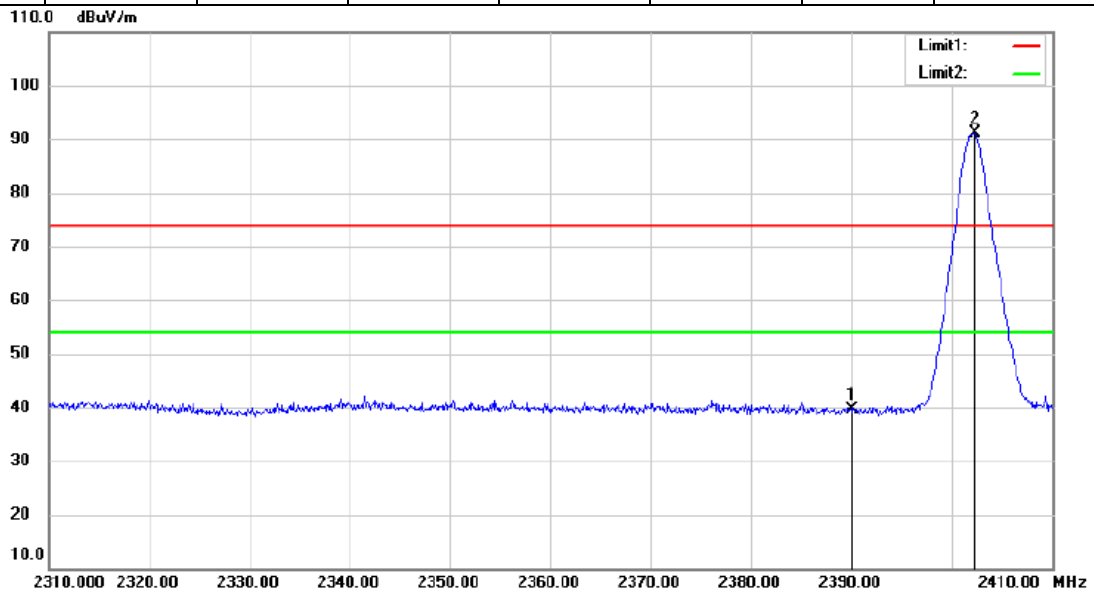
### 7.11.2 Radiated Band edge

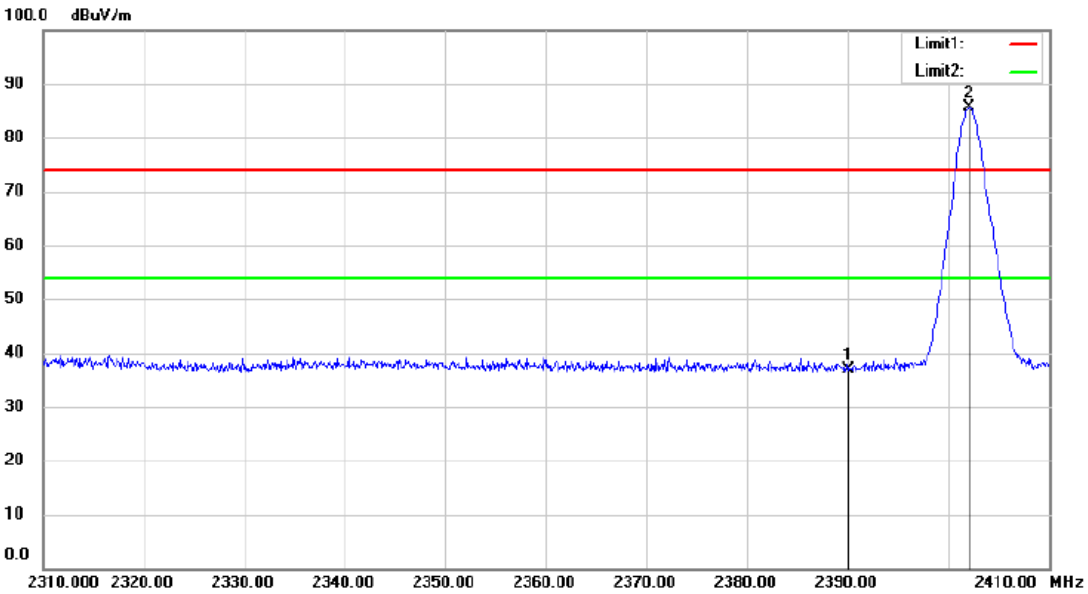
**Lowest Channel(2402MHz)** **Modulation: GFSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2390.0 | 43.40 | -3.89 | 39.51 | 54 | -14.49 | Peak | Horizontal |
| 2 | 2402.3 | 95.09 | -3.92 | 91.17 | 54 | 37.17 | Peak | Horizontal |
| 1 | 2390.0 | 40.70 | -3.89 | 36.81 | 54 | -17.19 | Peak | Vertical |
| 2 | 2402.1 | 89.43 | -3.92 | 85.51 | 54 | 31.51 | Peak | Vertical |

Horizontal:




Vertical:

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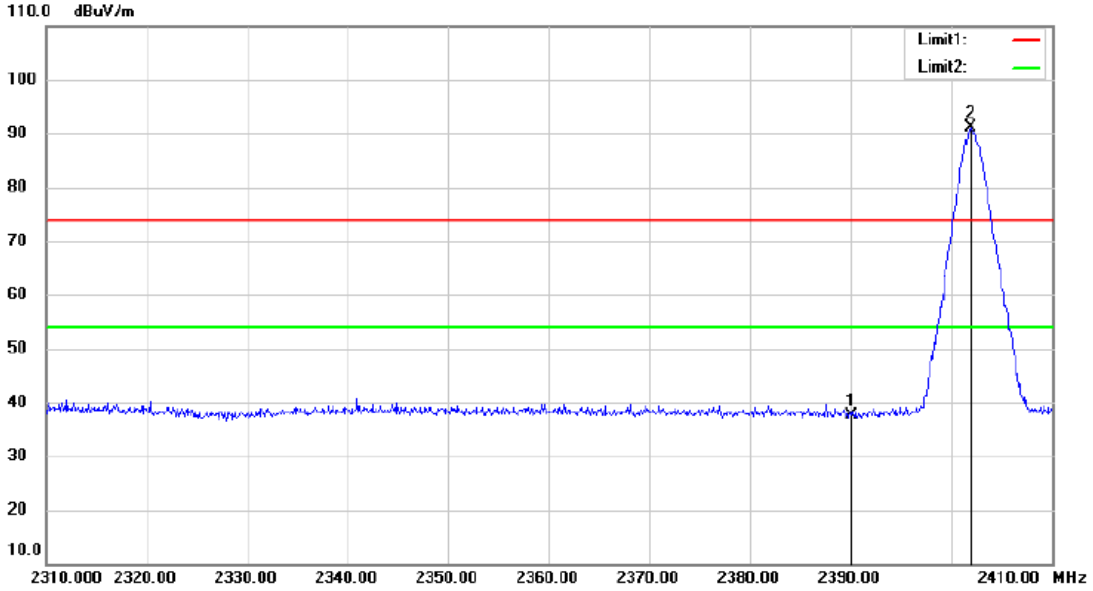
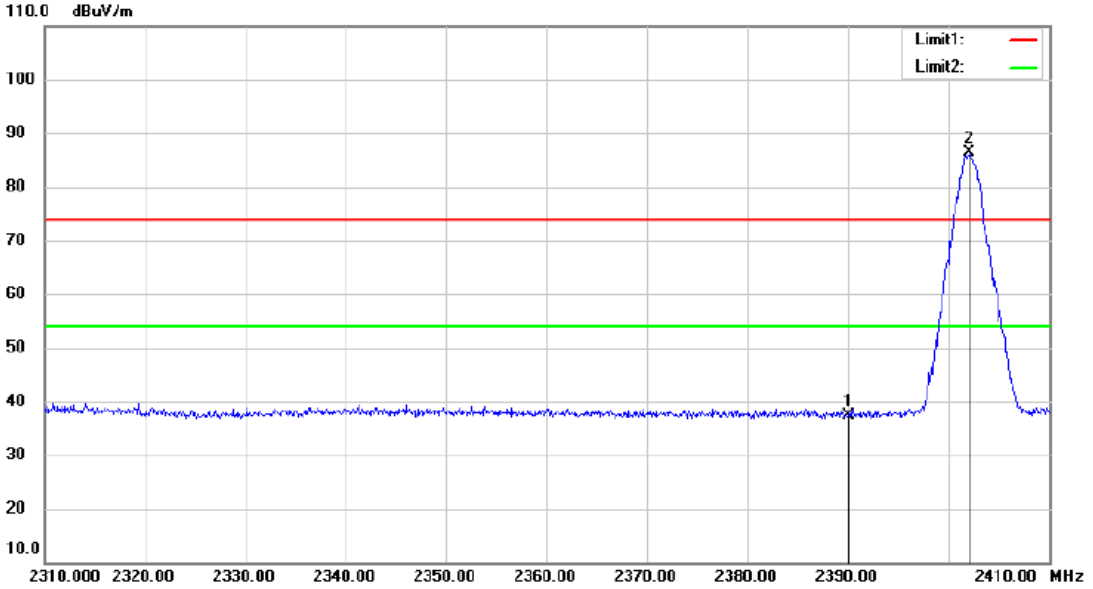
**Lowest Channel(2402MHz)** **Modulation: π/4DQPSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2390.0 | 41.40 | -3.89 | 37.51 | 54 | -16.49 | Peak | Horizontal |
| 2 | 2401.9 | 94.99 | -3.91 | 91.08 | 54 | 37.08 | Peak | Horizontal |
| 1 | 2390.0 | 41.17 | -3.89 | 37.28 | 54 | -16.72 | Peak | Vertical |
| 2 | 2402.1 | 90.33 | -3.92 | 86.41 | 54 | 32.41 | Peak | Vertical |

Horizontal:




Vertical:

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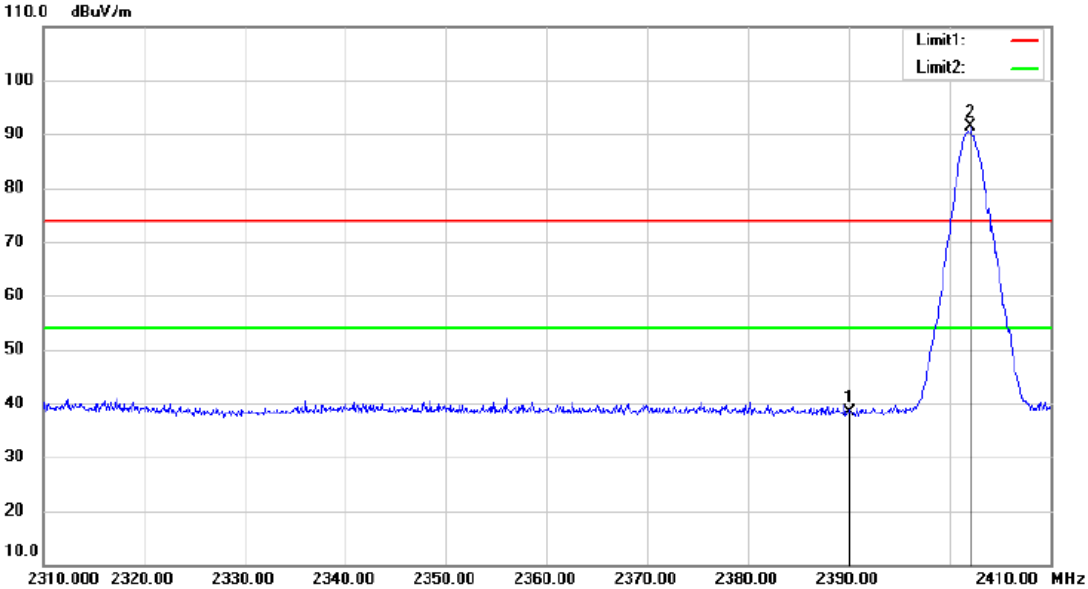
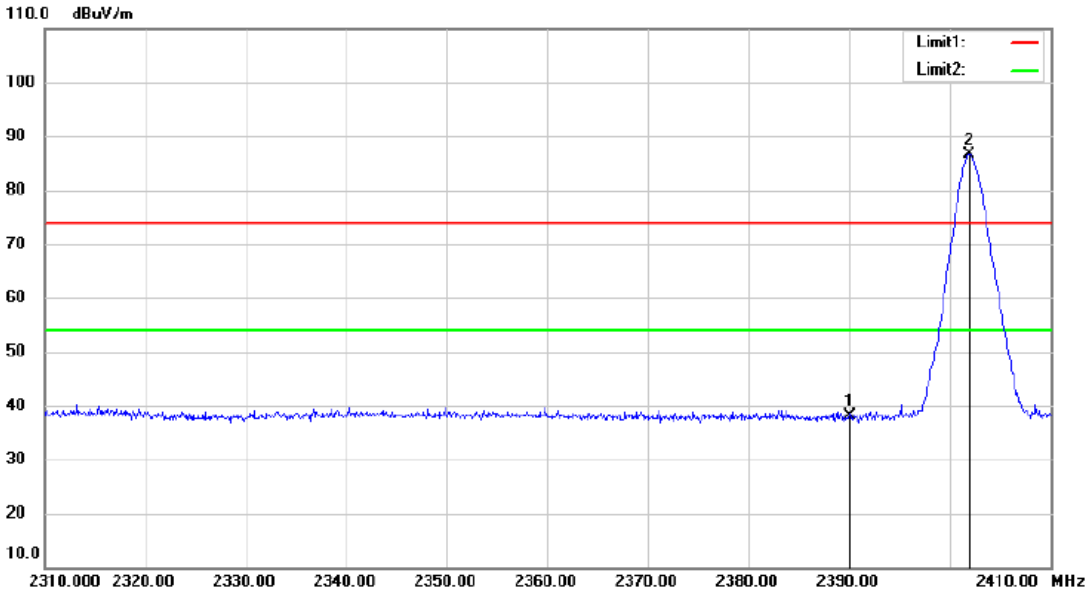
**Lowest Channel(2402MHz)** **Modulation: 8DPSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2390.0 | 42.21 | -3.89 | 38.32 | 54 | -15.68 | Peak | Horizontal |
| 2 | 2402.1 | 95.18 | -3.92 | 91.26 | 54 | 37.26 | Peak | Horizontal |
| 1 | 2390.0 | 42.14 | -3.89 | 38.25 | 54 | -15.75 | Peak | Vertical |
| 2 | 2401.9 | 90.64 | -3.91 | 86.73 | 54 | 32.73 | Peak | Vertical |

Horizontal:




Vertical:

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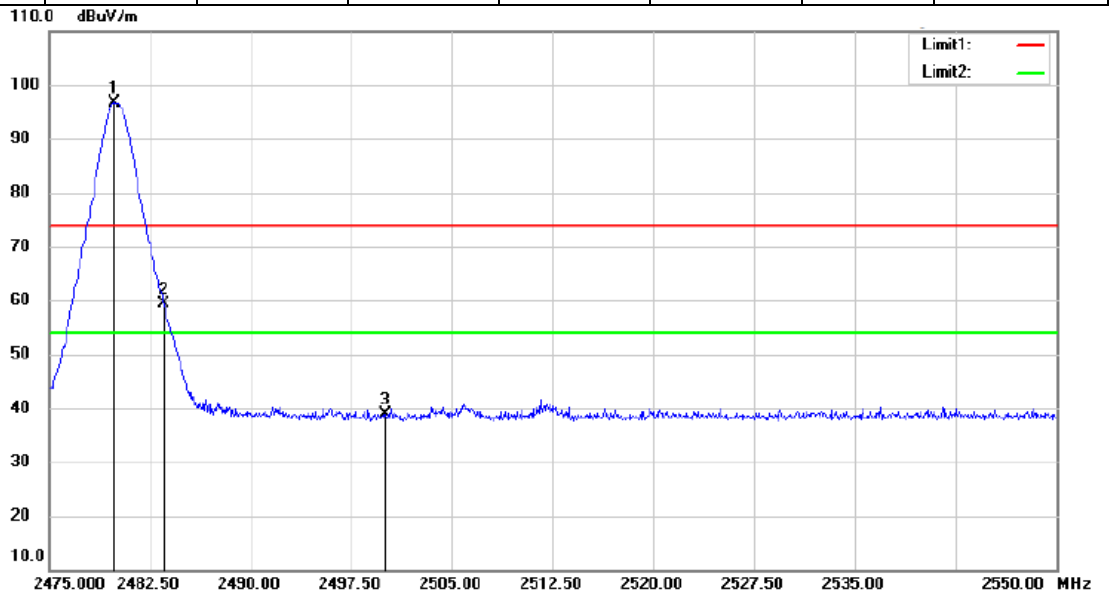
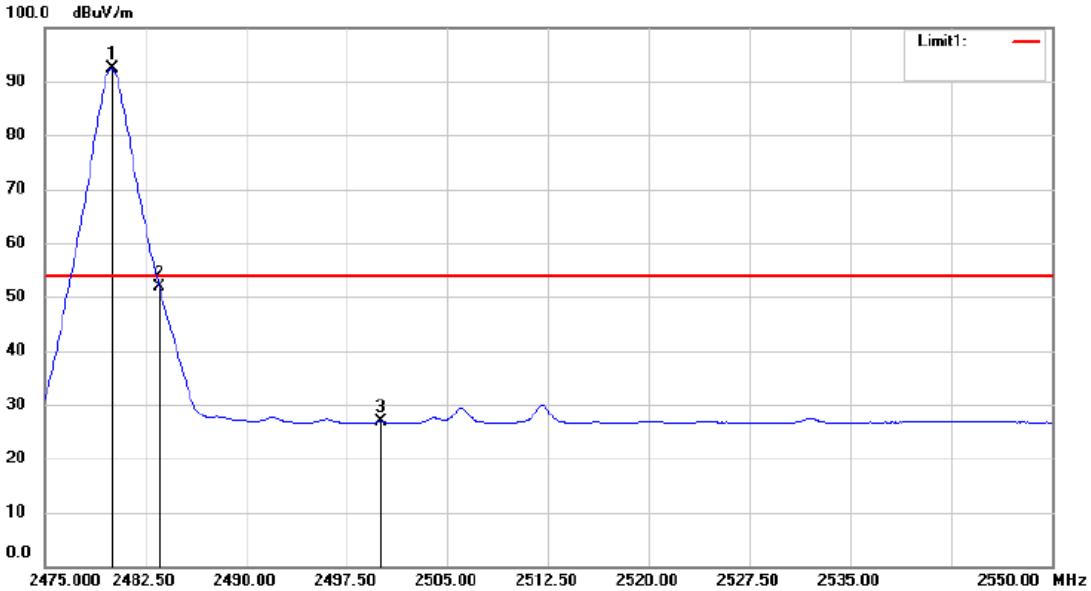
**CH Low 2480MHz** **Modulation: GFSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2479.875 | 100.75 | -4.00 | 96.75 | 74 | 22.75 | Peak | Horizontal |
| 2 | 2483.5 | 63.36 | -4.01 | 59.35 | 74 | -14.65 | Peak | Horizontal |
| 3 | 2500.0 | 43.02 | -4.03 | 38.99 | 74 | -35.01 | Peak | Horizontal |
| 1 | 2480.025 | 96.40 | -4.00 | 92.40 | 54 | 38.40 | Average | Horizontal |
| 2 | 2483.5 | 55.77 | -4.01 | 51.76 | 54 | -2.24 | Average | Horizontal |
| 3 | 2500.0 | 30.83 | -4.03 | 26.80 | 54 | -27.20 | Average | Horizontal |

Peak:




Average:

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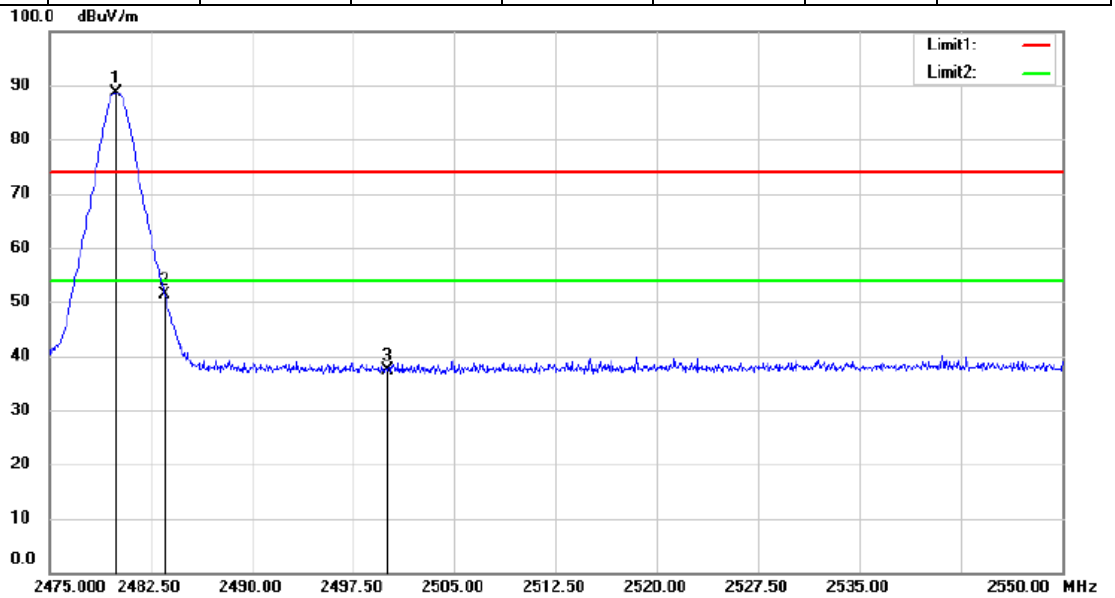
**CH Low 2480MHz** **Modulation: GFSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2479.95 | 92.61 | -4.00 | 88.61 | 54 | 34.61 | Peak | Vertical |
| 2 | 2483.5 | 55.36 | -4.01 | 51.35 | 54 | -2.65 | Peak | Vertical |
| 3 | 2500.0 | 41.51 | -4.03 | 37.48 | 54 | -16.52 | Peak | Vertical |

Peak:

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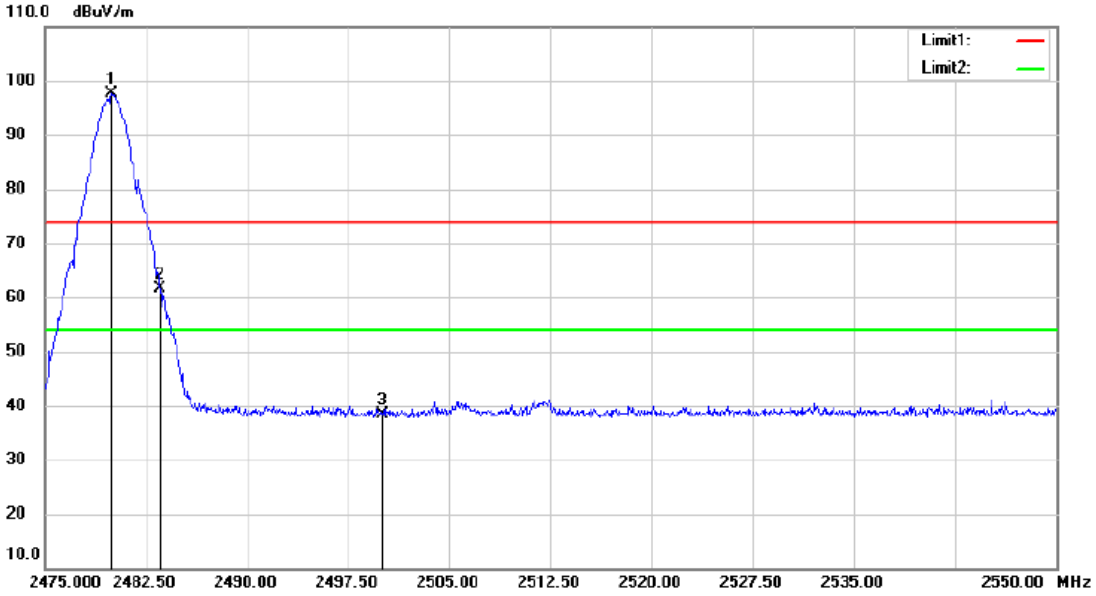
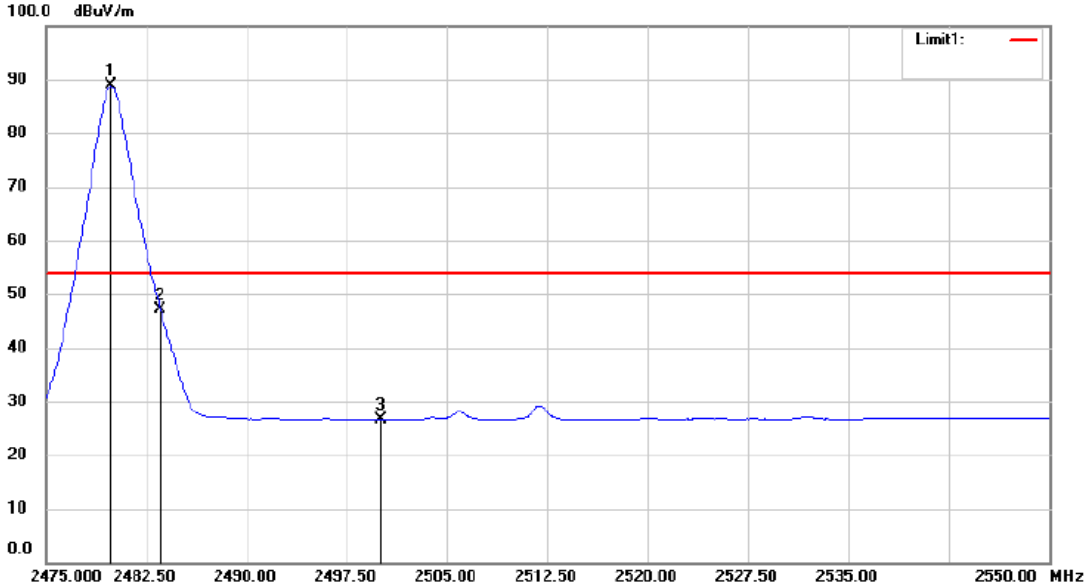
**CH Low 2480MHz** **Modulation: π/4DQPSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2479.95 | 101.66 | -4.00 | 97.66 | 74 | 23.66 | Peak | Horizontal |
| 2 | 2483.5 | 65.73 | -4.01 | 61.72 | 74 | -12.28 | Peak | Horizontal |
| 3 | 2500.0 | 42.39 | -4.03 | 38.36 | 74 | -35.64 | Peak | Horizontal |
| 1 | 2479.875 | 92.81 | -4.00 | 88.81 | 54 | 34.81 | Average | Horizontal |
| 2 | 2483.5 | 51.17 | -4.01 | 47.16 | 54 | -6.84 | Average | Horizontal |
| 3 | 2500.0 | 30.72 | -4.03 | 26.69 | 54 | -27.31 | Average | Horizontal |

Peak:




Average:

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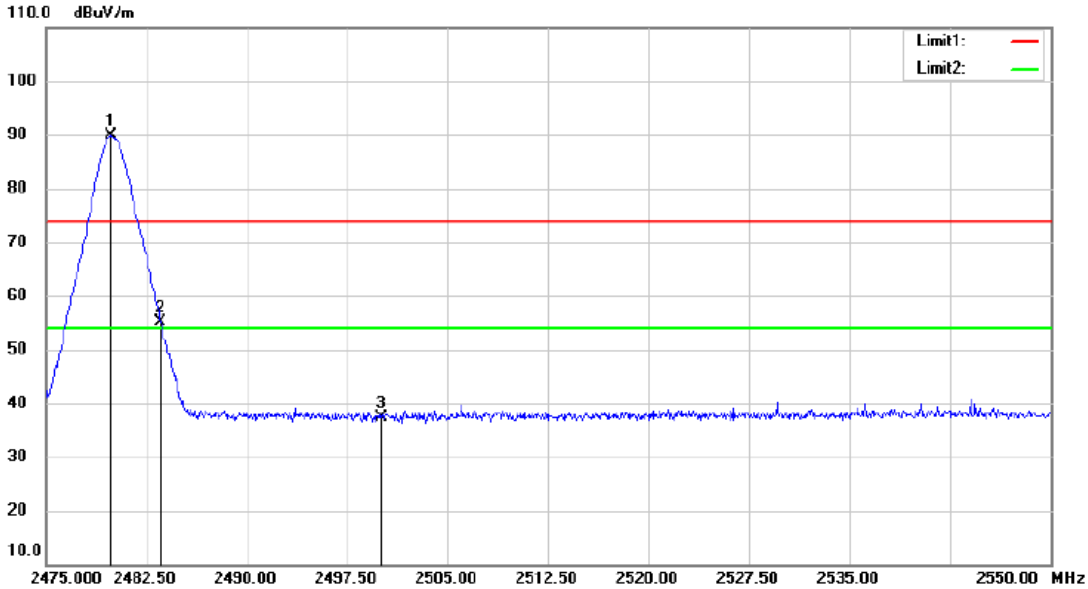
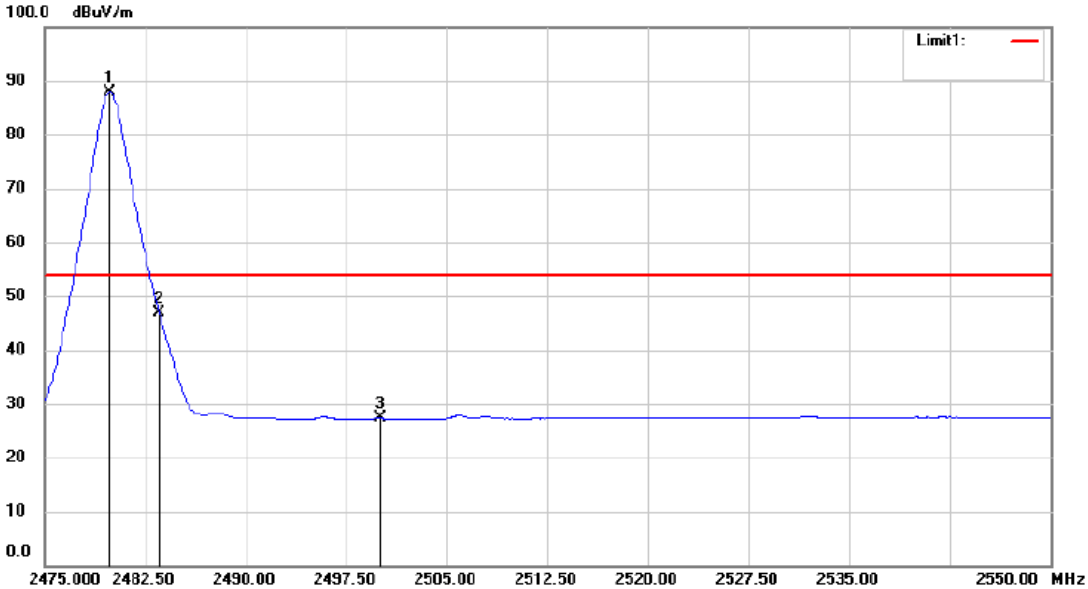
**CH Low 2480MHz** **Modulation: π/4DQPSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2479.875 | 93.86 | -4.00 | 89.86 | 74 | 15.86 | Peak | Vertical |
| 2 | 2483.5 | 59.16 | -4.01 | 55.15 | 74 | -18.85 | Peak | Vertical |
| 3 | 2500.0 | 41.45 | -4.03 | 37.42 | 74 | -36.58 | Peak | Vertical |
| 1 | 2479.875 | 91.96 | -4.00 | 87.96 | 54 | 33.96 | Average | Vertical |
| 2 | 2483.5 | 50.83 | -4.01 | 46.82 | 54 | -7.18 | Average | Vertical |
| 3 | 2500.0 | 31.29 | -4.03 | 27.26 | 54 | -26.74 | Average | Vertical |

Peak:




Average:

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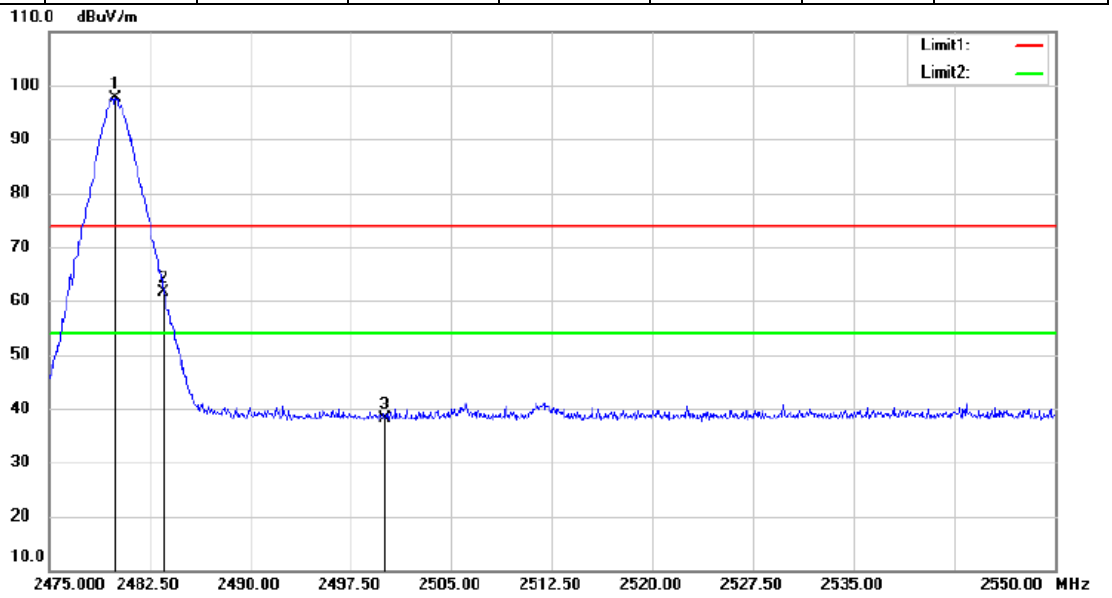
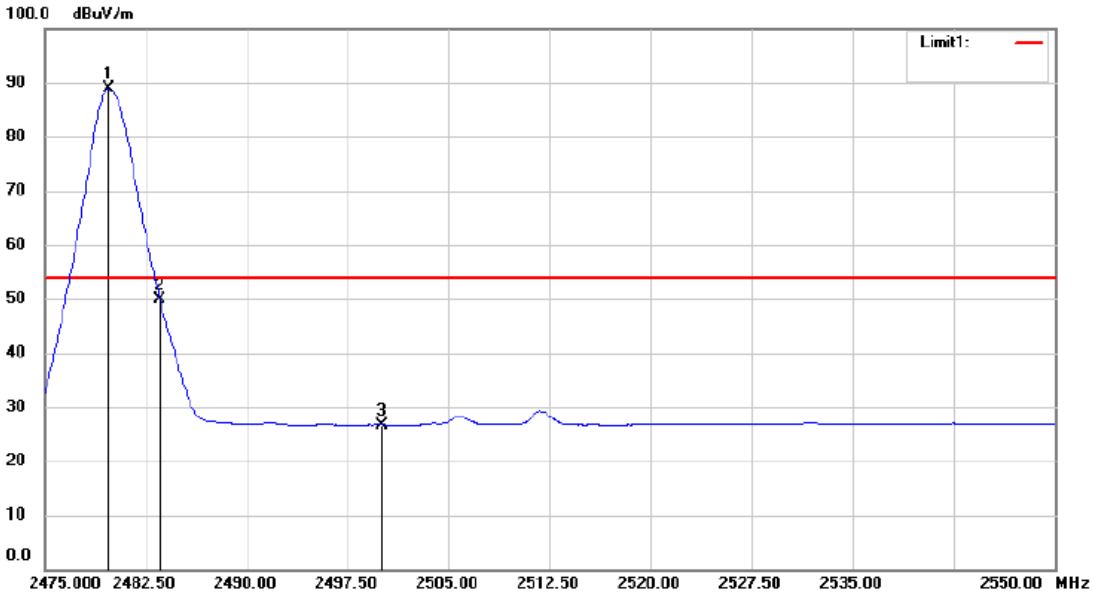
**CH Low 2480MHz** **Modulation: 8DPSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2479.95 | 101.51 | -4.00 | 97.51 | 74 | 23.51 | Peak | Horizontal |
| 2 | 2483.5 | 65.54 | -4.01 | 61.53 | 74 | -12.47 | Peak | Horizontal |
| 3 | 2500.0 | 42.06 | -4.03 | 38.03 | 74 | -35.97 | Peak | Horizontal |
| 1 | 2479.725 | 92.77 | -4.01 | 88.76 | 54 | 34.76 | Average | Horizontal |
| 2 | 2483.5 | 53.99 | -4.01 | 49.98 | 54 | -4.02 | Average | Horizontal |
| 3 | 2500.0 | 30.78 | -4.03 | 26.75 | 54 | -27.25 | Average | Horizontal |

Peak:




Average:

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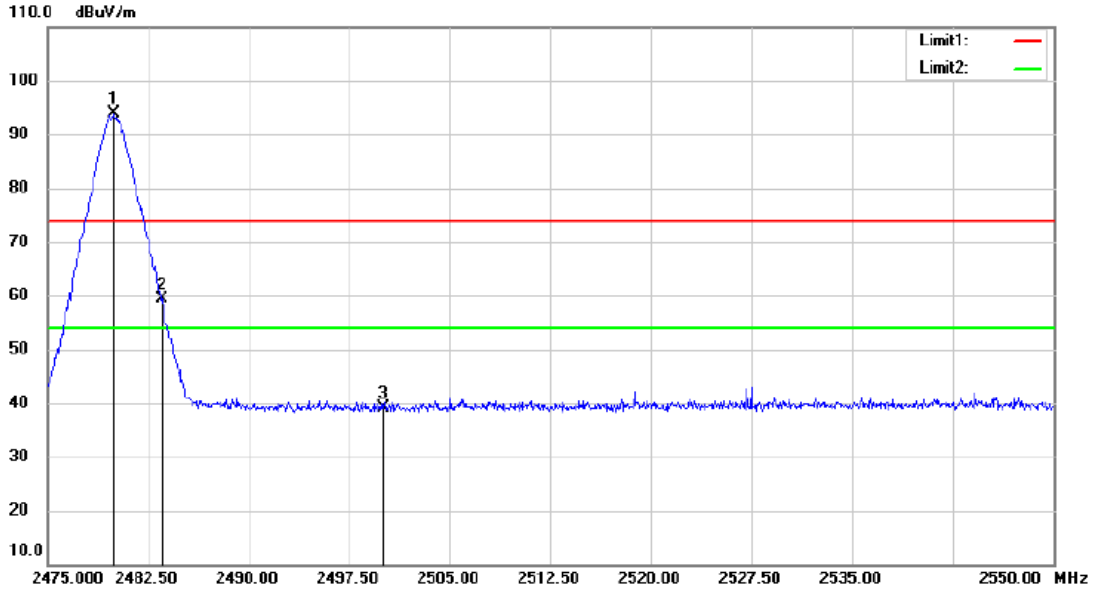
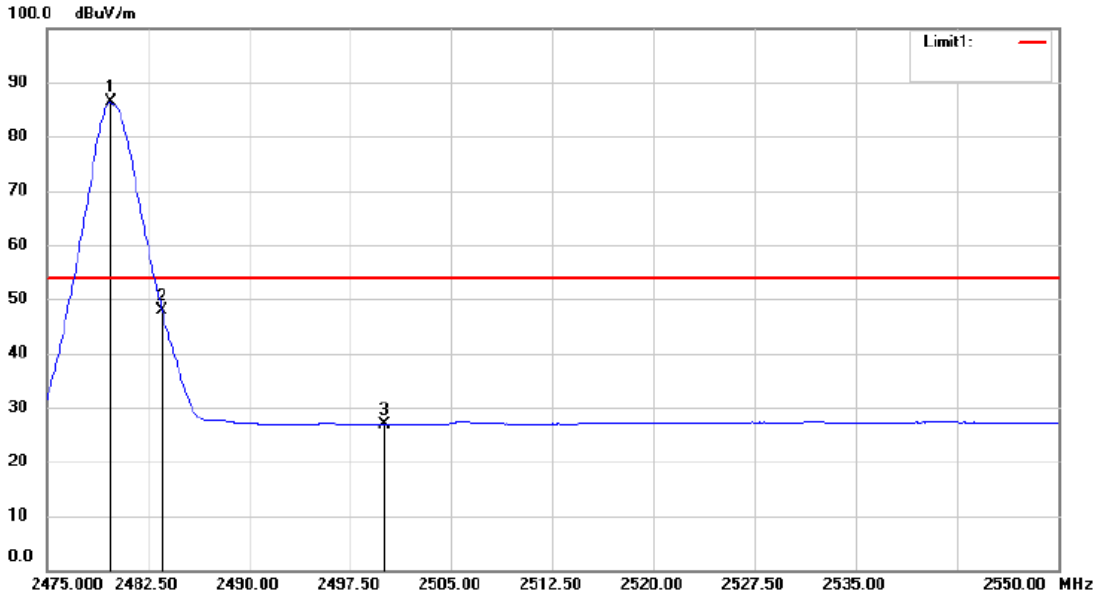
**CH Low 2480MHz** **Modulation: 8DPSK**

| MK. | Frequency (MHz) | Reading (dBuV/m) | Corrected factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|
| 1 | 2479.95 | 97.95 | -4.00 | 93.95 | 74 | 19.95 | Peak | Vertical |
| 2 | 2483.5 | 63.32 | -4.01 | 59.31 | 74 | -14.69 | Peak | Vertical |
| 3 | 2500.0 | 43.27 | -4.03 | 39.24 | 74 | -34.76 | Peak | Vertical |
| 1 | 2479.725 | 90.27 | -4.01 | 86.26 | 54 | 32.26 | Average | Vertical |
| 2 | 2483.5 | 51.91 | -4.01 | 47.9 | 54 | -6.10 | Average | Vertical |
| 3 | 2500.0 | 30.96 | -4.03 | 26.93 | 54 | -27.07 | Average | Vertical |

Peak:




Average:

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Remark: 1. Test Level =Receiver Reading + Antenna Factor + Cable Loss –Preamplifier Factor.

2. No any other emissions level which are attenuated less than 20dB below the limit. According to 15.31(o), the amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this Part. Hence there no other emissions have been reported.

3. If the Peak value below the AV Limit, the AV test doesn't perform for this submission.

All frequencies within the "Restricted bands" have been evaluated to compliance.
Except as shown in paragraph of this section, only spurious emissions are permitted in any of the frequency bands listed below:
1. FCC Part 15, Subpart C Section 15.205 Restricted bands of operation.

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090 - 0.110 | 16.42 - 16.423 | 399.9 - 410 | 4.5 - 5.15 |
| [1]0.495 - 0.505 | 16.69475 - 16.69525 | 608 - 614 | 5.35 - 5.46 |
| 2.1735 - 2.1905 | 16.80425 - 16.80475 | 960 - 1240 | 7.25 - 7.75 |
| 4.125 - 4.128 | 25.5 - 25.67 | 1300 - 1427 | 8.025 - 8.5 |
| 4.17725 - 4.17775 | 37.5 - 38.25 | 1435 - 1626.5 | 9.0 - 9.2 |
| 4.20725 - 4.20775 | 73 - 74.6 | 1645.5 - 1646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1660 - 1710 | 10.5 - 12.7 |
| 6.26775 - 6.26825 | 108 - 121.94 | 1718.8 - 1722.2 | 13.25 - 13.4 |
| 6.31175 - 6.31225 | 123 - 138 | 2200 - 2300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2310 - 2390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.52475 - 156.52525 | 2483.5 - 2500 | 17.7 - 21.4 |
| 8.37625 - 8.38675 | 156.7 - 156.9 | 2655 - 2900 | 22.01 - 23.12 |
| 8.41425 - 8.41475 | 162.0125 - 167.17 | 3260 - 3267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3332 - 3339 | 31.2 - 31.8 |
| 12.51975 - 12.52025 | 240 - 285 | 3345.8 - 3358 | 36.43 - 36.5 |
| 12.57675 - 12.57725 | 322 - 335.4 | 3600 - 4400 | |
| 13.36 - 13.41 | | | |

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2. RSS-Gen section 7.2.2 Restricted bands of operation

| MHz | MHz | GHz |
|---|---|---|
| 0.090-0.110 | 240-285 | 9.0-9.2 |
| 2.1735-2.1905 | 322-335.4 | 9.3-9.5 |
| 3.020-3.026 | 399.9-410 | 10.6-12.7 |
| 4.125-4.128 | 608-614 | 13.25-13.4 |
| 4.17725-4.17775 | 960-1427 | 14.47-14.5 |
| 4.20725-4.20775 | 1435-1626.5 | 15.35-16.2 |
| 5.677-5.683 | 1645.5-1646.5 | 17.7-21.4 |
| 6.215-6.218 | 1660-1710 | 22.01-23.12 |
| 6.26775-6.26825 | 1718.8-1722.2 | 23.6-24.0 |
| 6.31175-6.31225 | 2200-2300 | 31.2-31.8 |
| 8.291-8.294 | 2310-2390 | 36.43-36.5 |
| 8.362-8.366 | 2655-2900 | Above 38.6 |
| 8.37625-8.38675 | 3260-3267 | |
| 8.41425-8.41475 | 3332-3339 | |
| 12.29-12.293 | 3345.8-3358 | |
| 12.51975-12.52025 | 3500-4400 | |
| 12.57675-12.57725 | 4500-5150 | |
| 13.36-13.41 | 5350-5460 | |
| 16.42-16.423 | 7250-7750 | |
| 16.69475-16.69525 | 8025-8500 | |
| 16.80425-16.80475 | | |
| 25.5-25.67 | | |
| 37.5-38.25 | | |
| 73-74.6 | | |
| 74.8-75.2 | | |
| 108-138 | | |
| 156.52475-156.52525 | | |
| 156.7-156.9 | | |

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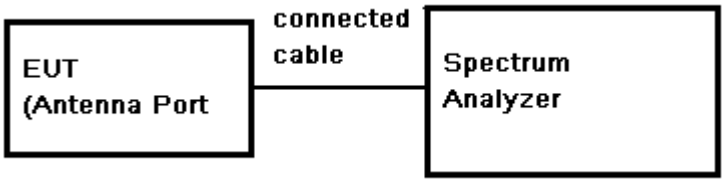
## 7.12 Occupied Bandwidth Test

**Test Configuration:**




**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: Span = approximately 2 to 3 times the 20dB bandwidth, centred on the hopping channel;
3. Set the spectrum analyzer: RBW >= 1% of the selected span (set 30 kHz). VBW >= RBW. Sweep = auto; Detector Function = Peak. Trace = Max Hold.
4. Mark the peak frequency and 99% bandwidth points.

**Test Result:** Pass

**Test Data:**

| Test Mode | Channel | Frequency (MHz) | Bandwidth (MHz) |
|---|---|---|---|
| GFSK | LOW | 2402 | 1.020 |
| | MID | 2441 | 0.999 |
| | HIGH | 2480 | 0.996 |
| π/4DQPSK | LOW | 2402 | 1.101 |
| | MID | 2441 | 1.092 |
| | HIGH | 2480 | 1.092 |
| 8DPSK | LOW | 2402 | 1.137 |
| | MID | 2441 | 1.128 |
| | HIGH | 2480 | 1.128 |

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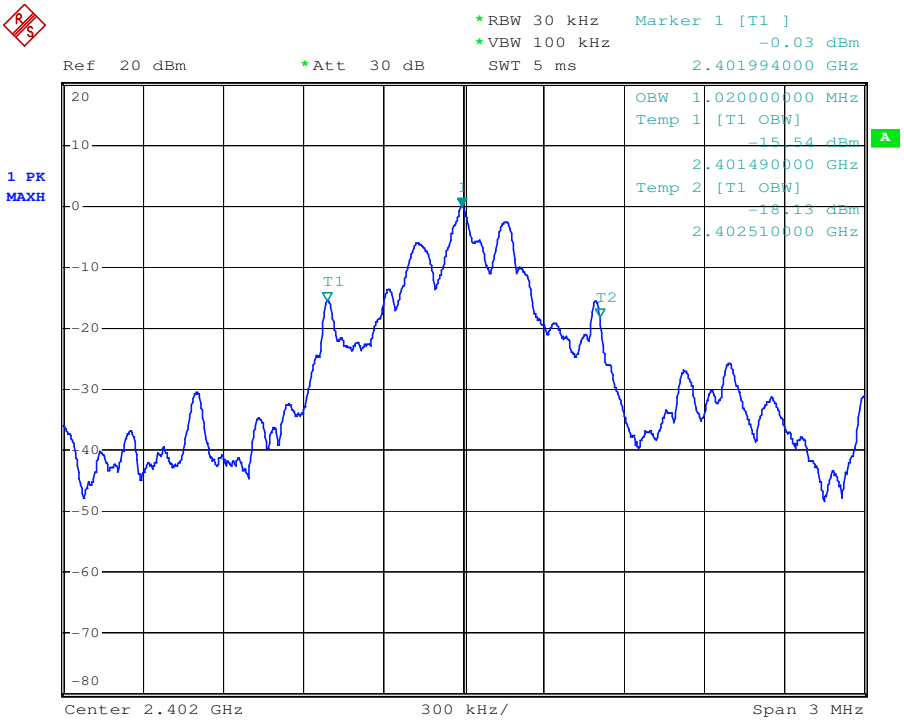
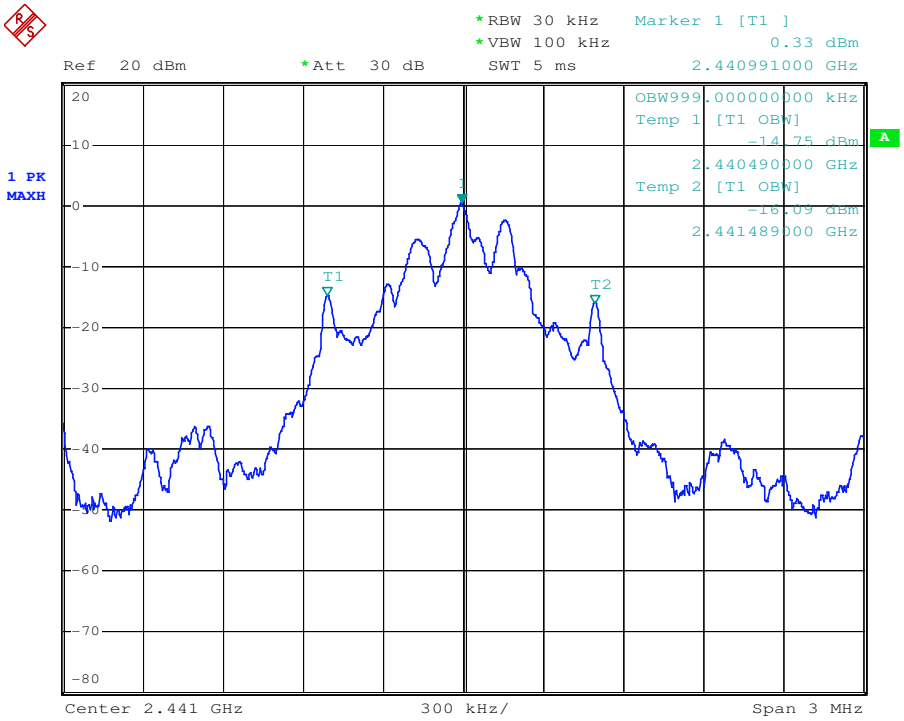
**Test plot as follows:**

| Test mode: | GFSK | Test channel: | Lowest |
|---|---|---|---|




| Test mode: | GFSK | Test channel: | Middle |
|---|---|---|---|

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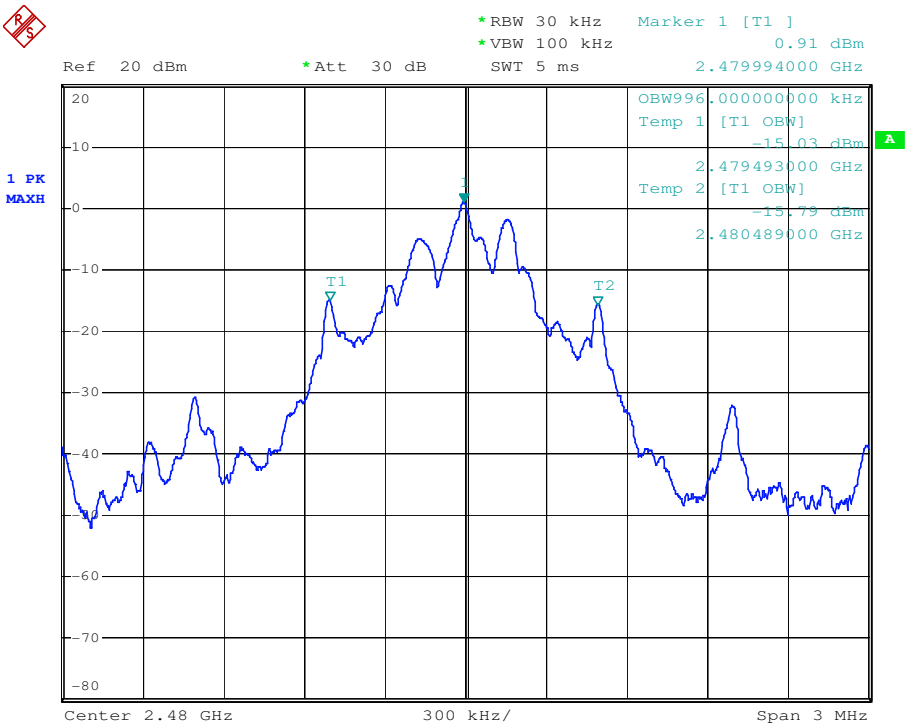
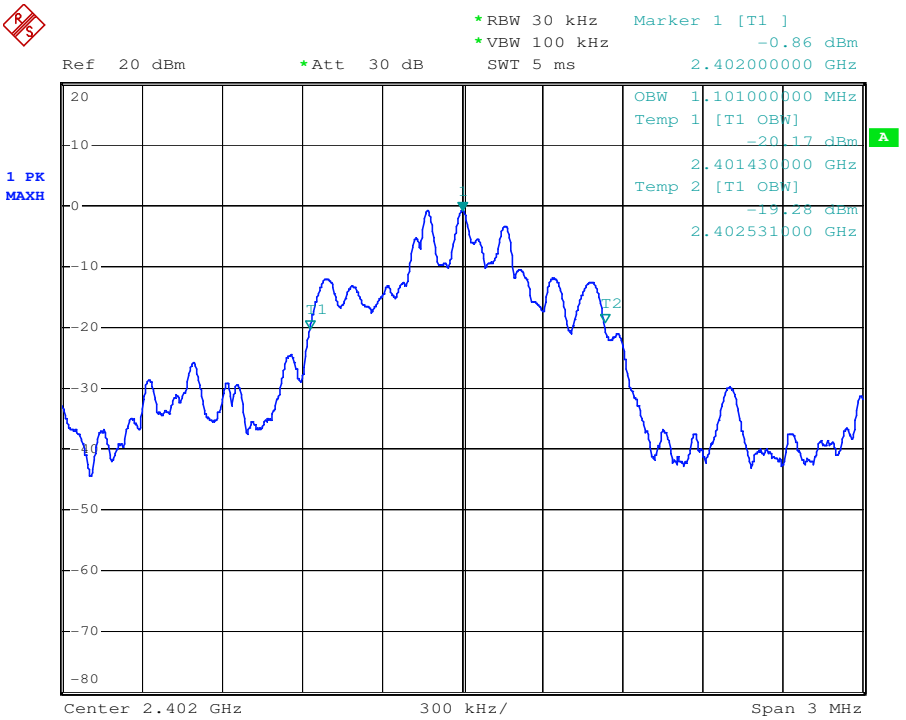
| Test mode: | GFSK | Test channel: | Highest |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Low |
|---|---|---|---|

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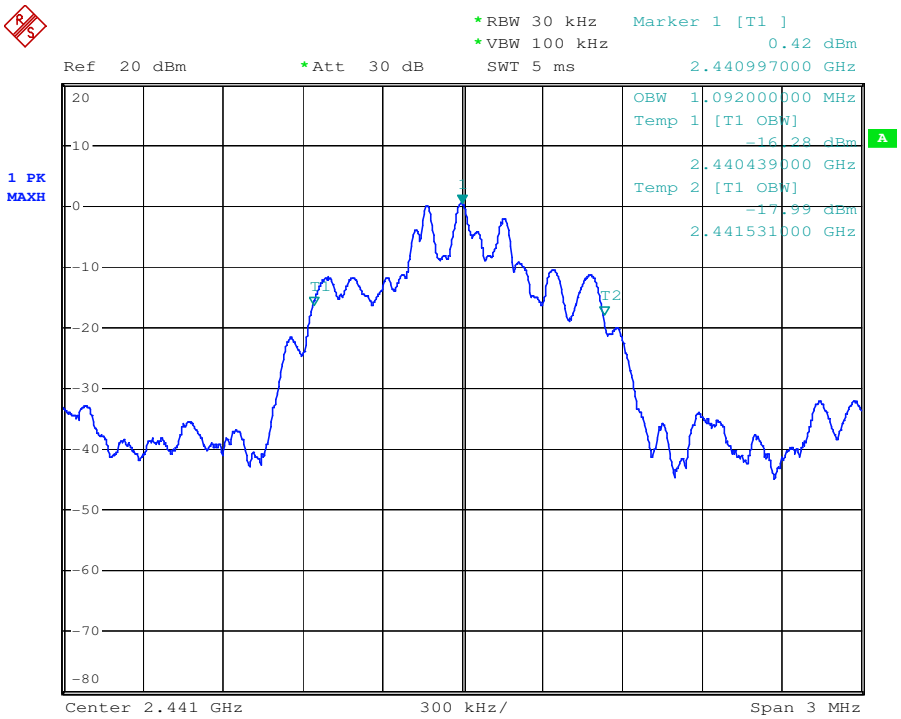
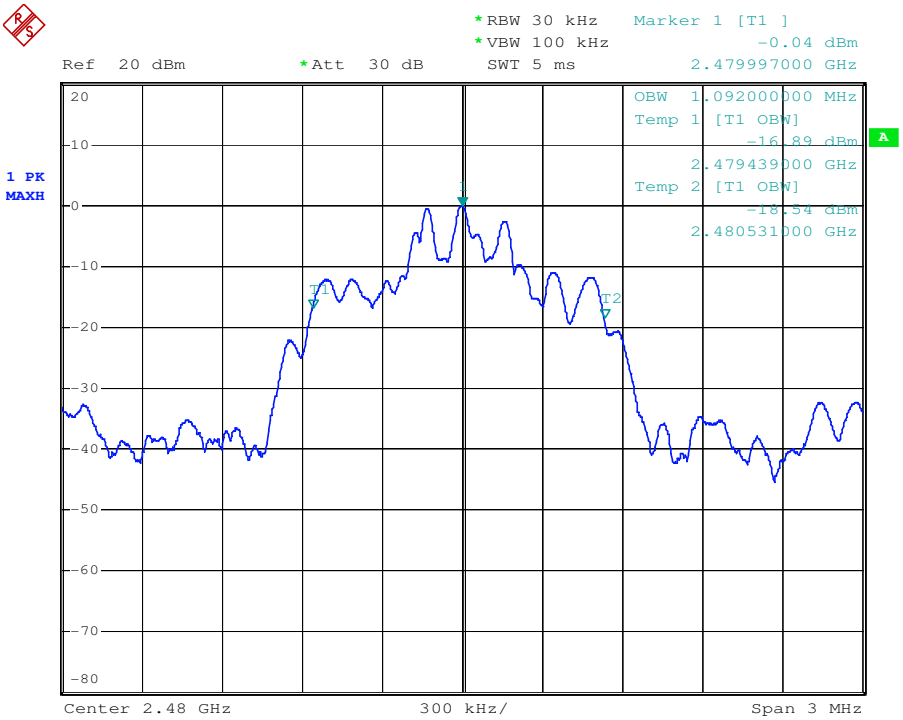
| Test mode: | π/4DQPSK | Test channel: | Middle |
|---|---|---|---|




| Test mode: | π/4DQPSK | Test channel: | Highest |
|---|---|---|---|

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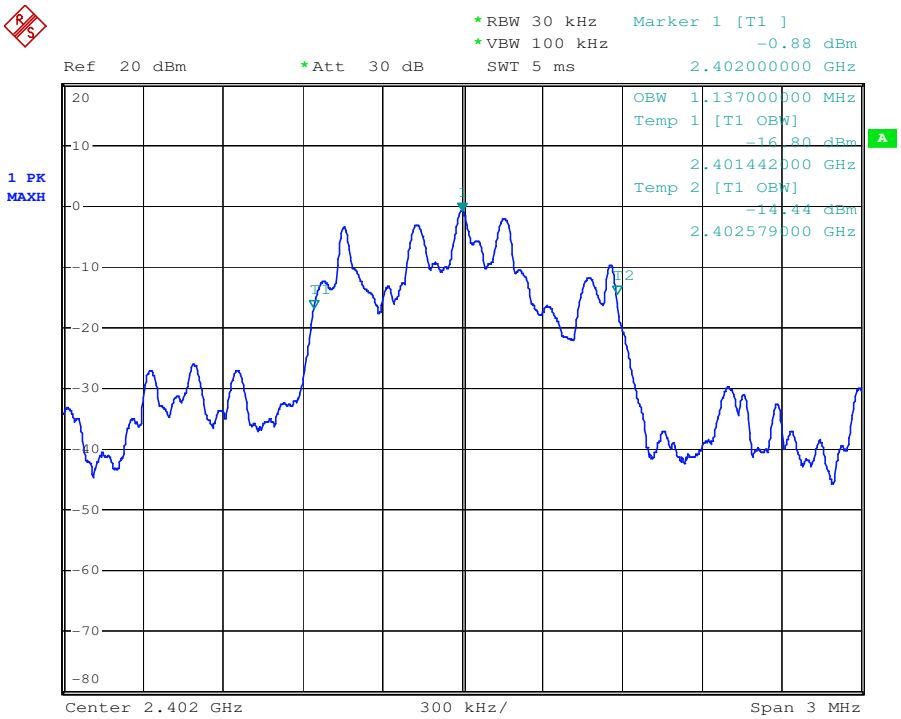
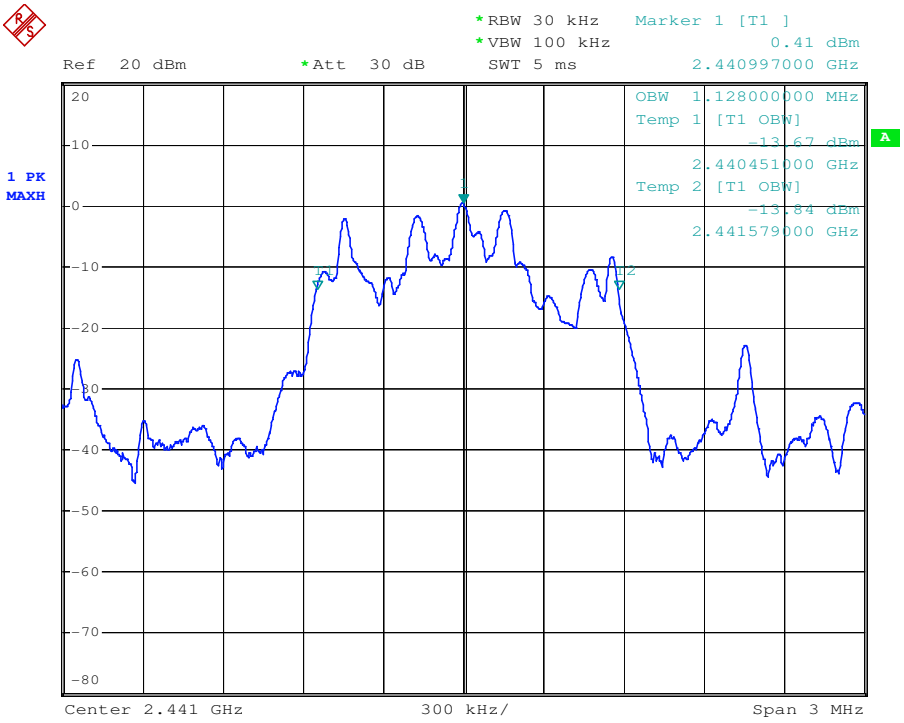
| Test mode: | 8DPSK | Test channel: | Low |
|---|---|---|---|




| Test mode: | 8DPSK | Test channel: | Middle |
|---|---|---|---|

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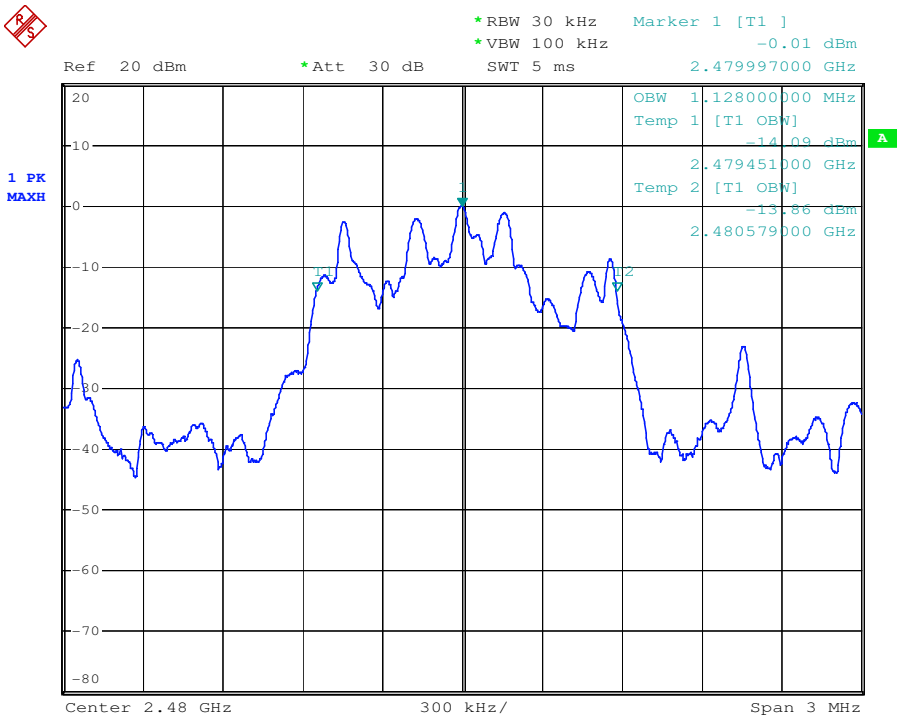
| Test mode: | 8DPSK | Test channel: | Highest |
|---|---|---|---|

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# 8 Test Setup Photographs

Refer to the < Edwin _Test Setup photos-FCC>.

# 9 EUT Constructional Details

Refer to the < Edwin _External Photos-FCC > & < Edwin _Internal Photos-FCC>.

**--End of the Report--**

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