TESTING LABORATORY
CERTIFICATE # 4821.01

# FCC PART 15.247
# TEST REPORT

For

# AVENIR TELECOM

208, Boulevard de Plombieres 13014 Marseille- France

**FCC ID: 2AM4J-E500S**

| **Report Type:** | **Product Type:** |
|---|---|
| Original Report | Mobile phone |

**Report Number:** RSZ180515005-00B

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# TABLE OF CONTENTS

**GENERAL INFORMATION** ..... **4**
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) ..... 4
OBJECTIVE ..... 4
RELATED SUBMITTAL(S)/GRANT(S) ..... 4
TEST METHODOLOGY ..... 4
MEASUREMENT UNCERTAINTY ..... 5
TEST FACILITY ..... 5
**SYSTEM TEST CONFIGURATION** ..... **6**
DESCRIPTION OF TEST CONFIGURATION ..... 6
EUT EXERCISE SOFTWARE ..... 6
SPECIAL ACCESSORIES ..... 6
EQUIPMENT MODIFICATIONS ..... 6
SUPPORT EQUIPMENT LIST AND DETAILS ..... 6
EXTERNAL I/O CABLE ..... 6
BLOCK DIAGRAM OF TEST SETUP ..... 7
**SUMMARY OF TEST RESULTS** ..... **8**
**TEST EQUIPMENT LIST** ..... **9**
**FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE** ..... **11**
APPLICABLE STANDARD ..... 11
**FCC §15.203 – ANTENNA REQUIREMENT** ..... **12**
APPLICABLE STANDARD ..... 12
ANTENNA CONNECTOR CONSTRUCTION ..... 12
**FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS** ..... **13**
APPLICABLE STANDARD ..... 13
EUT SETUP ..... 13
EMI TEST RECEIVER SETUP ..... 13
TEST PROCEDURE ..... 13
CORRECTED FACTOR & MARGIN CALCULATION ..... 14
TEST RESULTS SUMMARY ..... 14
TEST DATA ..... 14
**FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS** ..... **17**
APPLICABLE STANDARD ..... 17
EUT SETUP ..... 17
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP ..... 18
TEST PROCEDURE ..... 18
CORRECTED AMPLITUDE & MARGIN CALCULATION ..... 18
TEST RESULTS SUMMARY ..... 18
TEST DATA ..... 19
**FCC §15.247(a) (1)-CHANNEL SEPARATION TEST** ..... **26**
APPLICABLE STANDARD ..... 26
TEST PROCEDURE ..... 26
TEST DATA ..... 26
**FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH** ..... **33**

APPLICABLE STANDARD .....33
TEST PROCEDURE .....33
TEST DATA .....33

**FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST .....39**

APPLICABLE STANDARD .....39
TEST PROCEDURE .....39
TEST DATA .....39

**FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME) .....42**

APPLICABLE STANDARD .....42
TEST PROCEDURE .....42
TEST DATA .....42

**FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT .....58**

APPLICABLE STANDARD .....58
TEST PROCEDURE .....58
TEST DATA .....58

**FCC §15.247(d) - BAND EDGES TESTING .....59**

APPLICABLE STANDARD .....59
TEST PROCEDURE .....59
TEST DATA .....59

# GENERAL INFORMATION

## Product Description for Equipment under Test (EUT)

The *AVENIR TELECOM's* product, model number: *ENERGY E500S (FCC ID: 2AM4J-E500S)* or the "EUT" in this report was a *Mobile phone,* which was measured approximately: 14.0 cm (L) * 7.2 cm (W) * 1.0 cm (H), rated with input voltage: DC 3.8 V from rechargeable li-ion battery or DC 5.0V from adapter.

Adapter Information:
Model: YW1000M
Input: 100-240V, 50/60Hz, 0.2A
Output: 5.0V, 1 A

*Notes: This series products model: EM500SUS and ENERGY E500S are electrically identical, the difference between them is only model name due to marketing purpose. Model ENERGY E500S was selected for fully testing, the detailed information can be referred to the declaration letter which was stated and guaranteed by the applicant.*

**All measurement and test data in this report was gathered from production sample serial number: 180515005 (Assigned by BACL, Shenzhen). The EUT supplied by the applicant was received on 2018-05-15.*

## Objective

This test report is prepared on behalf of *AVENIR TELECOM* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

## Related Submittal(s)/Grant(s)

Part 15.247 DTS and Part 22H /24E /27 PCE submissions with FCC ID: 2AM4J-E500S.

## Test Methodology

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

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

## Measurement Uncertainty

| Parameter | | Uncertainty |
|---|---|---|
| Occupied Channel Bandwidth | | ±5% |
| RF Output Power with Power meter | | ±0.5dB |
| RF conducted test with spectrum | | ±1.5dB |
| AC Power Lines Conducted Emissions | | ±1.95dB |
| Emissions, Radiated | Below 1GHz | ±4.75dB |
| | Above 1GHz | ±4.88dB |
| Temperature | | ±3℃ |
| Humidity | | ±6% |
| Supply voltages | | ±0.4% |

## Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

# SYSTEM TEST CONFIGURATION

## Description of Test Configuration

The system was configured for testing in an engineering mode.

## EUT Exercise Software

No exercise software was made to the EUT tested.

## Special Accessories

No special accessory.

## Equipment Modifications

No modification was made to the EUT tested.

## Support Equipment List and Details

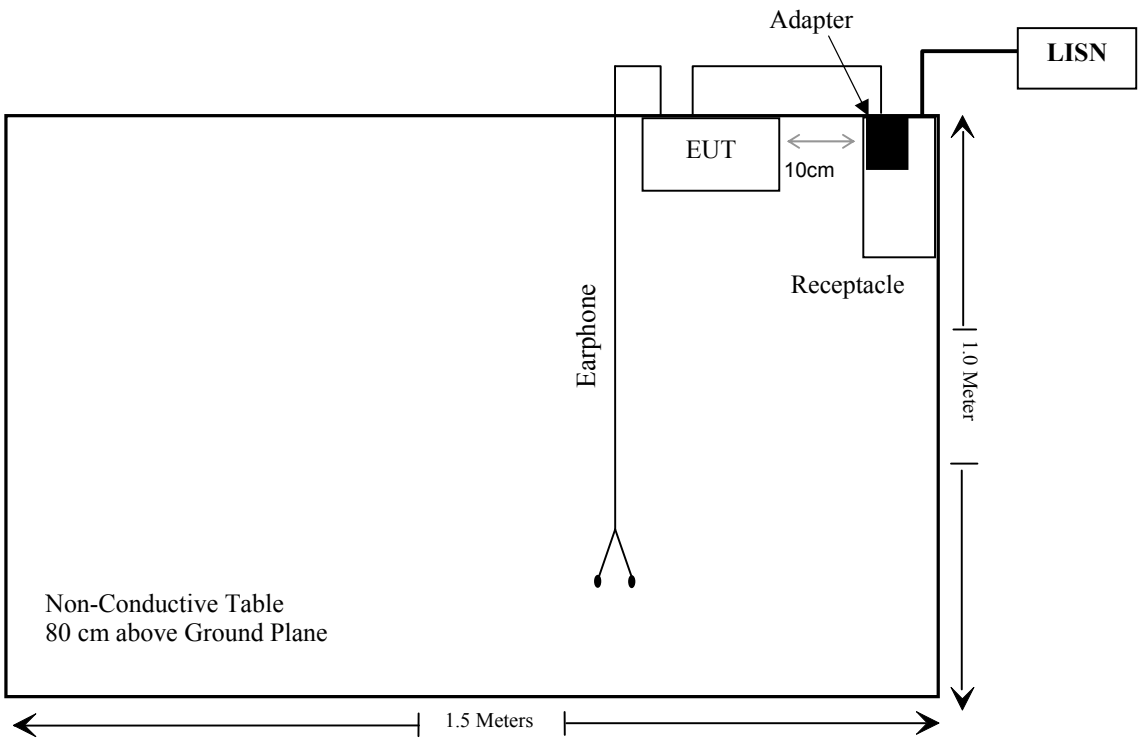
| Manufacturer | Description | Model | Serial Number |
|---|---|---|---|
| / | / | / | / |

## External I/O Cable

| Cable Description | Length (m) | From Port | To |
|---|---|---|---|
| Un-shielding Detachable USB Cable | 0.8 | EUT | Adapter |

## Block Diagram of Test Setup

For conducted emission:



# SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test | Result |
|---|---|---|
| §15.247 (i), §1.1307 (b) (1)& §2.1093 | RF Exposure | Compliance |
| §15.203 | Antenna Requirement | Compliance |
| §15.207(a) | AC Line Conducted Emissions | Compliance |
| §15.205, §15.209 & §15.247(d) | Radiated Emissions | Compliance |
| §15.247(a)(1) | 20 dB Emission Bandwidth | Compliance |
| §15.247(a)(1) | Channel Separation Test | Compliance |
| §15.247(a)(1)(iii) | Time of Occupancy (Dwell Time) | Compliance |
| §15.247(a)(1)(iii) | Quantity of hopping channel Test | Compliance |
| §15.247(b)(1) | Peak Output Power Measurement | Compliance |
| §15.247(d) | Band edges | Compliance |

# TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| **Conducted Emissions Test** | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESCS30 | 100176 | 2017-08-04 | 2018-08-04 |
| Rohde & Schwarz | LISN | ENV216 | 3560.6650.12-101613-Yb | 2017-12-21 | 2018-12-21 |
| Rohde & Schwarz | Transient Limiter | ESH3Z2 | DE25985 | 2018-05-21 | 2018-11-19 |
| Rohde & Schwarz | CE Test software | EMC 32 | V8.53.0 | NCR | NCR |
| N/A | Conducted Emission Cable | N/A | UF A210B-1-0720-504504 | 2018-05-12 | 2018-11-12 |
| **Radiated Emission Test** | | | | | |
| A.H.System | Horn Antenna | SAS-200/571 | 135 | 2015-08-18 | 2018-08-17 |
| Rohde & Schwarz | Signal Analyzer | FSEM | 845987/005 | 2018-04-24 | 2019-04-24 |
| Mini | Pre-amplifier | ZVA-183-S+ | 5969001149 | 2018-05-21 | 2019-05-21 |
| HP | Amplifier | HP8447E | 1937A01046 | 2018-05-21 | 2018-11-19 |
| Sunol Sciences | Broadband Antenna | JB1 | A040904-1 | 2017-12-22 | 2020-12-21 |
| Rohde & Schwarz | EMI Test Receiver | ESCI | 101120 | 2018-01-11 | 2019-01-11 |
| Ducommun technologies | RF Cable | UFA210A-1-4724-30050U | MFR64369 223410-001 | 2018-05-21 | 2018-11-19 |
| Ducommun technologies | RF Cable | 104PEA | 218124002 | 2018-05-17 | 2018-11-19 |
| Ducommun technologies | RF Cable | RG-214 | 1 | 2018-05-17 | 2018-11-19 |
| Ducommun technologies | RF Cable | RG-214 | 2 | 2018-05-22 | 2018-11-22 |
| Ducommun Technologies | Horn Antenna | ARH-4223-02 | 1007726-04 | 2017-12-29 | 2020-12-28 |
| Ducommun Technologies | Pre-amplifier | ALN-22093530-01 | 991373-01 | 2017-08-03 | 2018-08-03 |
| Sinoscite | Notch Filter | BSF2402-2480MN-0898-001 | N/A | 2018-05-21 | 2019-05-21 |
| Rohde & Schwarz | Auto test software | EMC 32 | V9.10 | NCR | NCR |

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| **RF Conducted Test** | | | | | |
| Agilent | Wideband Power Sensor | U2021XA | MY54250003 | 2018-03-21 | 2019-03-21 |
| WEINSCHEL | 3dB Attenuator | N/A | N/A | Each Time | |
| Rohde & Schwarz | SPECTRUM ANALYZER | FSU26 | 200120 | 2017-12-24 | 2018-12-24 |
| Ducommun technologies | RF Cable | RG-214 | 3 | Each Time | |

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

# FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE

## Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

**For worst case:**

| Frequency (MHz) | Maximum Tune-up power | | Calculated Distance (mm) | Calculated Value | Threshold (1-g SAR) | SAR Test Exclusion |
|---|---|---|---|---|---|---|
| | (dBm) | (mW) | | | | |
| 2480 | 6 | 3.98 | 5 | 1.25 | 3.0 | **Yes** |

**Result: No Standalone SAR test is required**

# FCC §15.203 – ANTENNA REQUIREMENT

## Applicable Standard

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

## Antenna Connector Construction

The EUT has one internal antenna arrangement, which was permanently attached and the antenna gain is 1.5 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

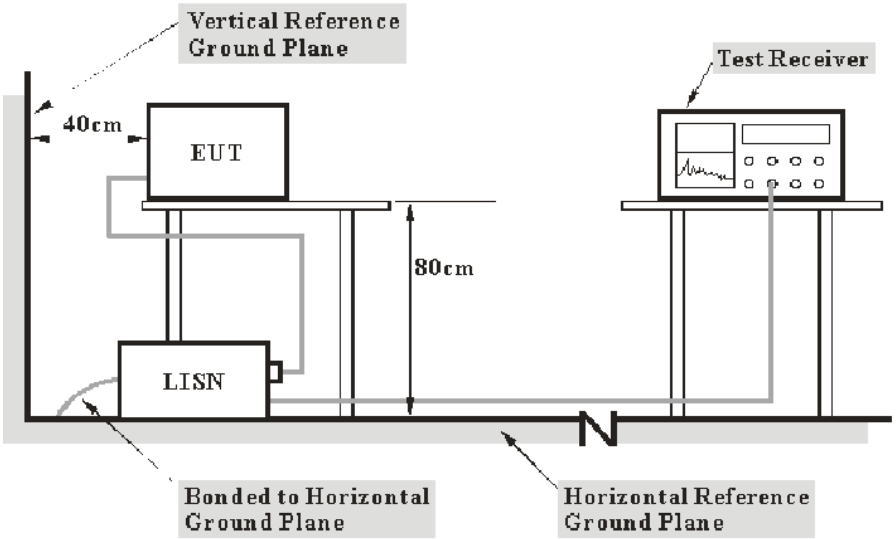
**Result:** Compliance.

# FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

## Applicable Standard

FCC §15.207(a)

## EUT Setup




Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

## EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

| Frequency Range | IF B/W |
|---|---|
| 150 kHz – 30 MHz | 9 kHz |

## Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

## Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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

Margin = Limit – Corrected Amplitude

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207,

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{lim} + U_{cispr}$$

In BACL, $U_{(Lm)}$ is less than $U_{cispr}$, if $L_m$ is less than $L_{lim}$, it implies that the EUT complies with the limit.

## Test Data

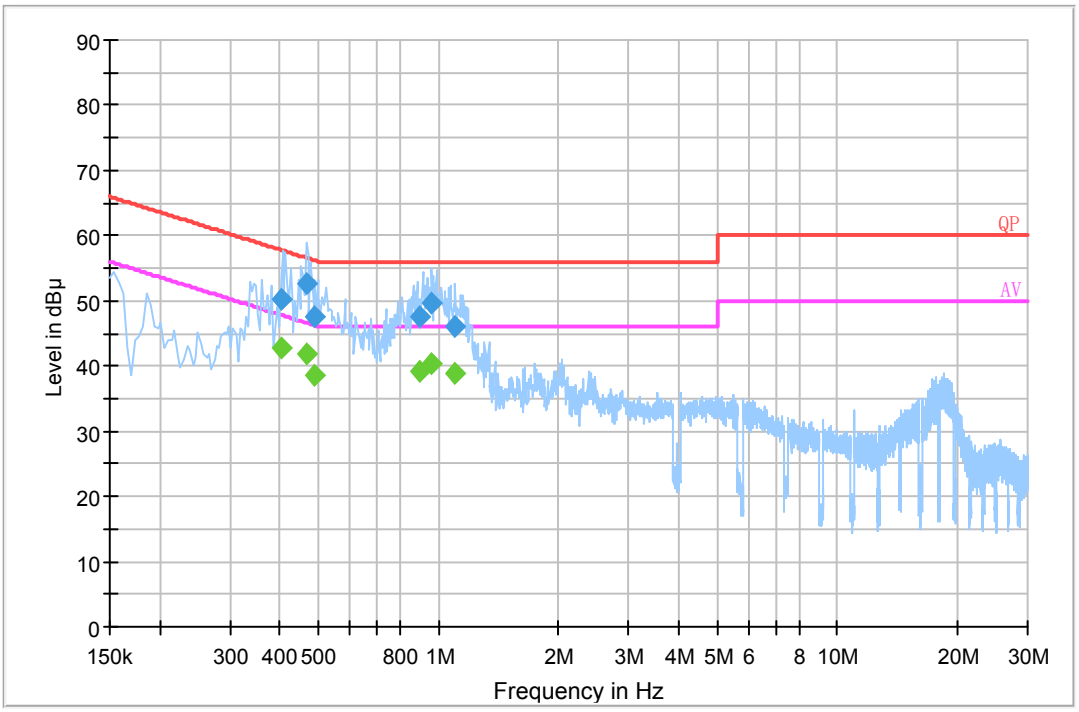
### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Hill He on 2018-06-19.*

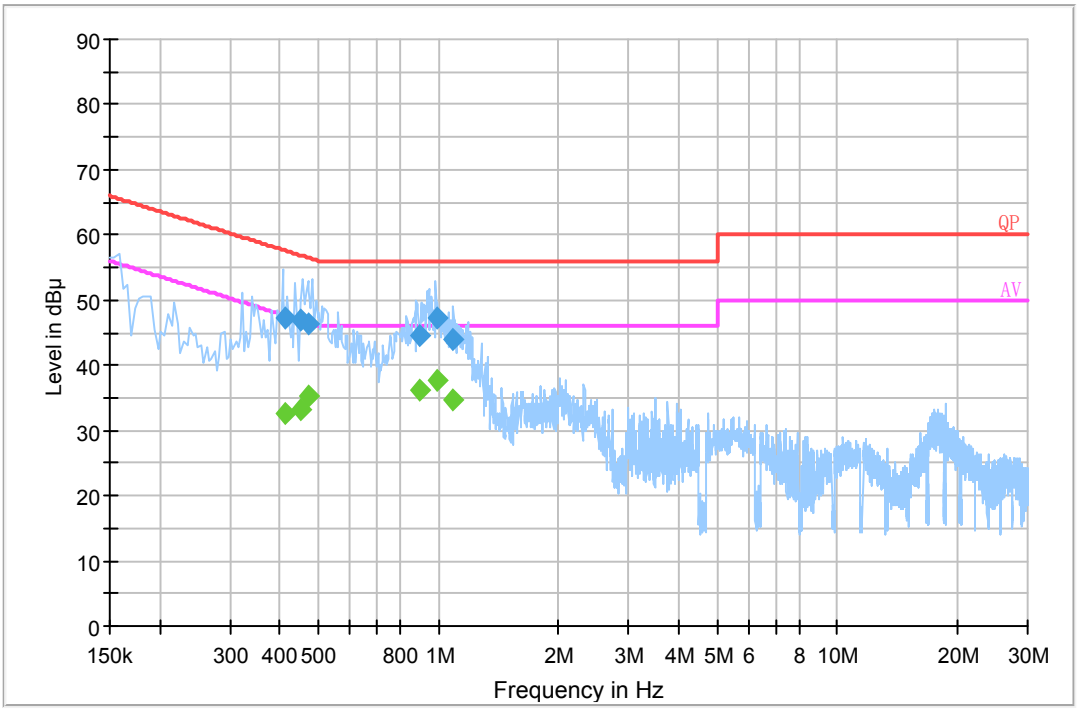
*EUT operation mode: Transmitting & charging (the worst case is GFSK Mode, Low channel)*

**AC 120V/60 Hz, Line**




| Frequency (MHz) | Corrected Amplitude (dBµV) | Correction Factor (dB) | Limit (dBµV) | Margin (dB) | Detector (PK/Ave./QP) |
|---|---|---|---|---|---|
| 0.403910 | 50.2 | 20.1 | 57.8 | 7.6 | QP |
| 0.467010 | 52.5 | 20.1 | 56.6 | 4.1 | QP |
| 0.490530 | 47.6 | 20.1 | 56.2 | 8.6 | QP |
| 0.892710 | 47.6 | 20.0 | 56.0 | 8.4 | QP |
| 0.959570 | 49.6 | 20.0 | 56.0 | 6.4 | QP |
| 1.097470 | 45.9 | 20.0 | 56.0 | 10.1 | QP |
| 0.403910 | 42.7 | 20.1 | 47.8 | 5.1 | Ave. |
| 0.467010 | 41.7 | 20.1 | 46.6 | 4.9 | Ave. |
| 0.490530 | 38.4 | 20.1 | 46.2 | 7.8 | Ave. |
| 0.892710 | 39.1 | 20.0 | 46.0 | 6.9 | Ave. |
| 0.959570 | 40.3 | 20.0 | 46.0 | 5.7 | Ave. |
| 1.097470 | 38.9 | 20.0 | 46.0 | 7.1 | Ave. |

**AC 120V/60 Hz, Neutral**




| Frequency (MHz) | Corrected Amplitude (dBµV) | Correction Factor (dB) | Limit (dBµV) | Margin (dB) | Detector (PK/Ave./QP) |
|---|---|---|---|---|---|
| 0.412090 | 47.4 | 20.1 | 57.6 | 10.2 | QP |
| 0.451130 | 47.0 | 20.1 | 56.9 | 9.9 | QP |
| 0.474770 | 46.4 | 20.1 | 56.4 | 10.0 | QP |
| 0.895230 | 44.6 | 20.0 | 56.0 | 11.4 | QP |
| 0.987210 | 47.4 | 20.0 | 56.0 | 8.6 | QP |
| 1.085650 | 43.9 | 20.0 | 56.0 | 12.1 | QP |
| 0.412090 | 32.7 | 20.1 | 47.6 | 14.9 | Ave. |
| 0.451130 | 33.1 | 20.1 | 46.9 | 13.8 | Ave. |
| 0.474770 | 35.4 | 20.1 | 46.4 | 11.0 | Ave. |
| 0.895230 | 36.1 | 20.0 | 46.0 | 9.9 | Ave. |
| 0.987210 | 37.8 | 20.0 | 46.0 | 8.2 | Ave. |
| 1.085650 | 34.7 | 20.0 | 46.0 | 11.3 | Ave. |

**Note:**
1) Correction Factor =LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
2) Corrected Amplitude = Reading + Correction Factor
3) Margin = Limit – Corrected Amplitude

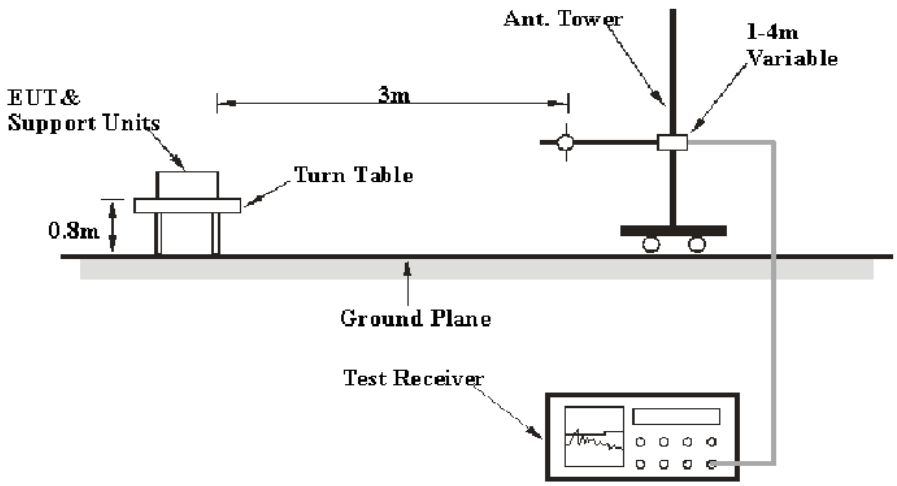
# FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

## Applicable Standard

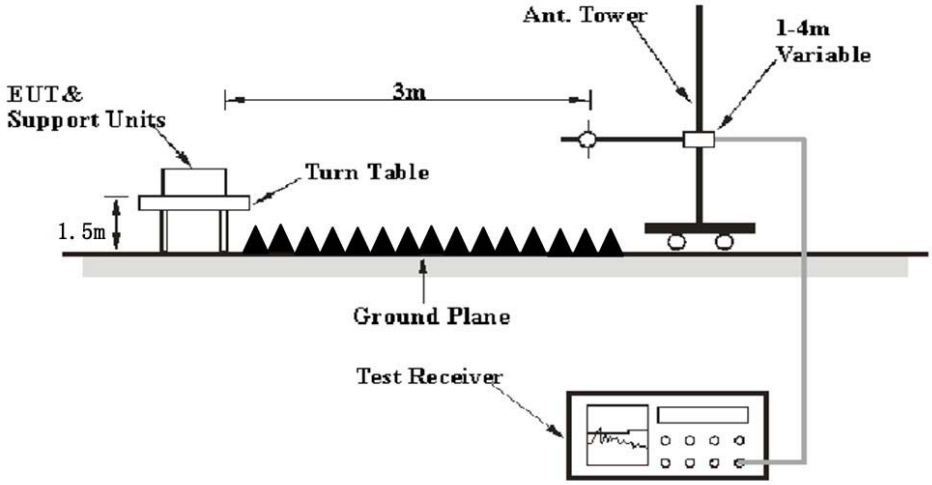
FCC §15.205; §15.209; §15.247(d)

## EUT Setup

**Below 1 GHz:**




**Above 1GHz:**




The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

## EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

| Frequency Range | RBW | Video B/W | IF B/W | Measurement |
|---|---|---|---|---|
| 30 MHz – 1000 MHz | 100 kHz | 300 kHz | 120 kHz | QP |
| Above 1 GHz | 1 MHz | 3 MHz | / | PK |
| | 1 MHz | 10 Hz | / | Average |

## Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

## Corrected Amplitude & Margin Calculation

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

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - 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 limit. The equation for margin calculation is as follows:

Margin = Limit – Corrected Amplitude

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{lim} + U_{cispr}$$

In BACL, $U_{(Lm)}$ is less than $U_{cispr}$, if $L_m$ is less than $L_{lim}$, it implies that the EUT complies with the limit.

## Test Data

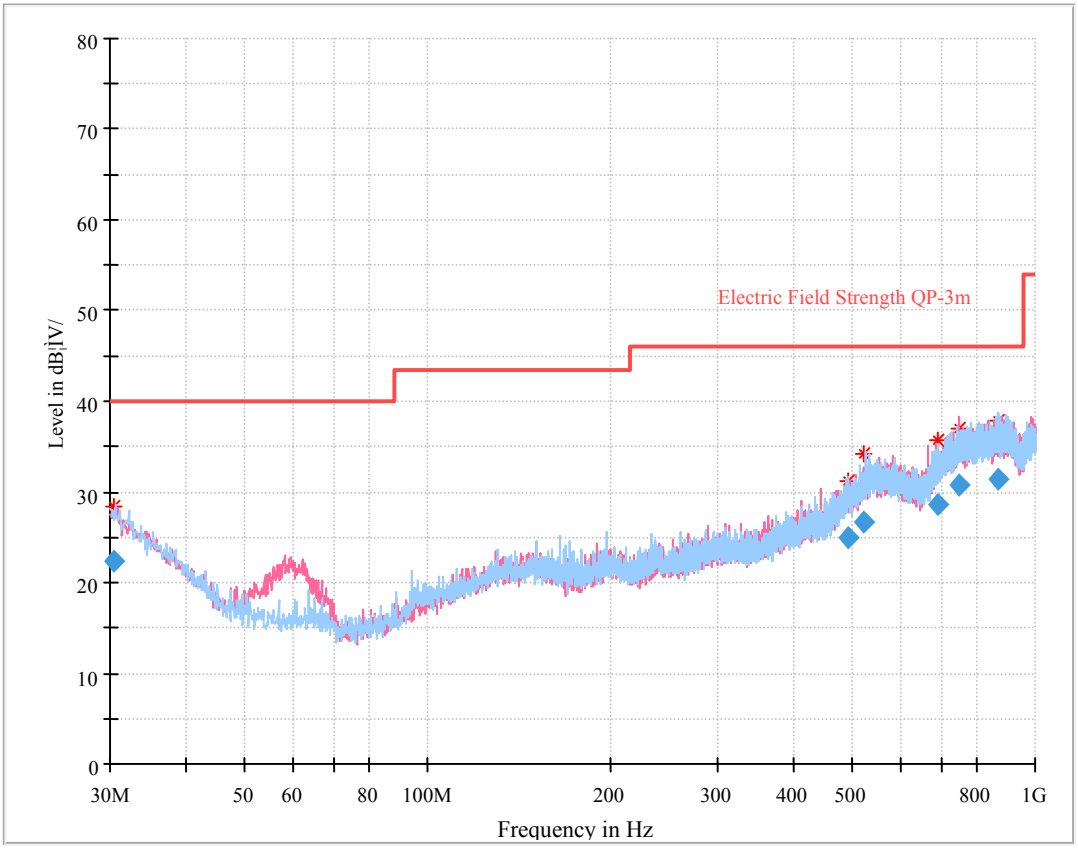
### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Hill He on 2018-06-18.*

*EUT operation mode: Transmitting* (*Scan with GFSK, π/4-DQPSK, 8-DPSK mode, the worst case is GFSK Mode*)

**30 MHz~1 GHz:** *(the worst case is GFSK Mode, Low channel)*



| Frequency (MHz) | Corrected Amplitude (dBµV/m) | Antenna height (cm) | Antenna Polarity | Turntable position (degree) | Correction Factor (dB/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 30.504625 | 22.47 | 198.0 | H | 107.0 | 0.4 | 40.00 | 17.53 |
| 493.228750 | 24.95 | 161.0 | H | 245.0 | 2.9 | 46.00 | 21.05 |
| 523.917500 | 26.59 | 202.0 | H | 255.0 | 4.3 | 46.00 | 19.41 |
| 689.657125 | 28.56 | 363.0 | H | 264.0 | 6.3 | 46.00 | 17.44 |
| 752.450000 | 30.74 | 120.0 | V | 217.0 | 8.7 | 46.00 | 15.26 |
| 870.898000 | 31.32 | 192.0 | H | 352.0 | 9.8 | 46.00 | 14.68 |

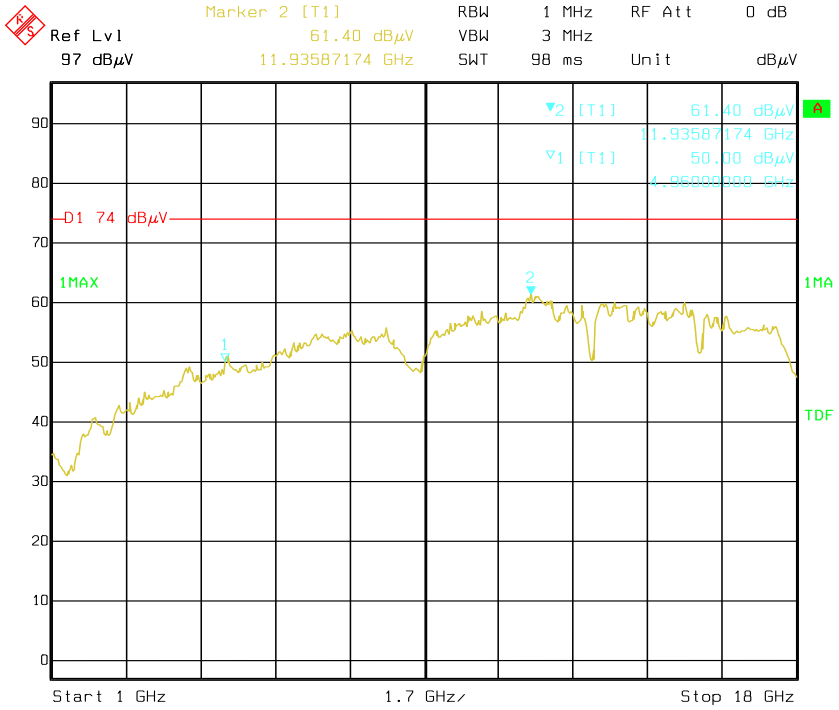
**1 GHz - 25 GHz:**

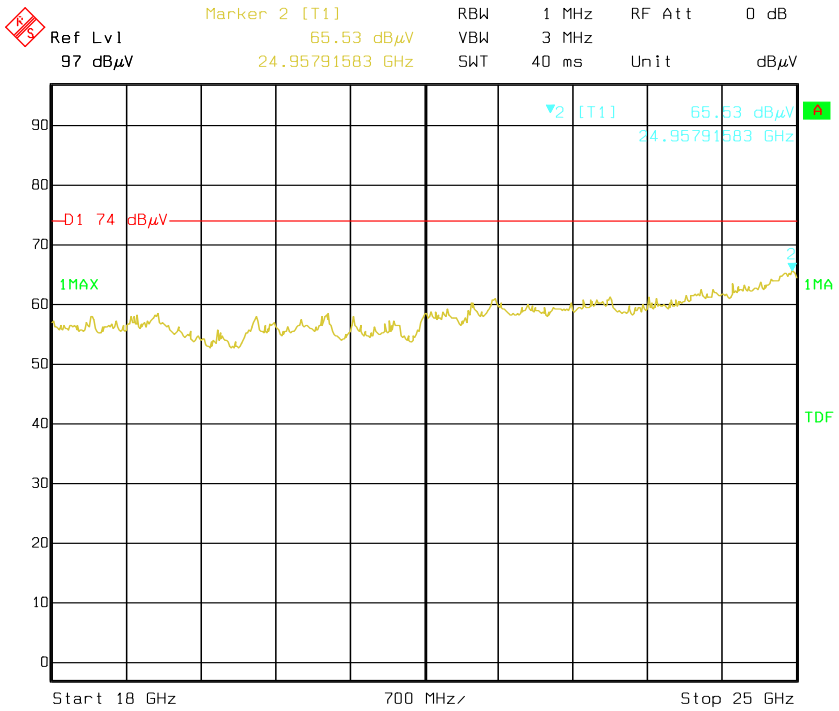
| Frequency (MHz) | Receiver | | Turntable Degree | Rx Antenna | | Corrected Factor (dB/m) | Corrected Amplitude (dBµV/m) | FCC Part 15.247/205/209 | |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBµV) | PK/QP/Ave. | | Height (m) | Polar (H/V) | | | Limit (dBµV/m) | Margin (dB) |
| **Low Channel (2402 MHz)** | | | | | | | | | |
| 2402.00 | 63.95 | PK | 88 | 2.1 | H | 33.92 | 97.87 | / | / |
| 2402.00 | 51.62 | Ave. | 88 | 2.1 | H | 33.92 | 85.54 | / | / |
| 2402.00 | 60.61 | PK | 140 | 1.2 | V | 33.92 | 94.53 | / | / |
| 2402.00 | 48.49 | Ave. | 140 | 1.2 | V | 33.92 | 82.41 | / | / |
| 2325.60 | 27.21 | PK | 308 | 2.5 | H | 33.83 | 61.04 | 74 | 12.96 |
| 2325.60 | 13.26 | Ave. | 308 | 2.5 | H | 33.83 | 47.09 | 54 | 6.91 |
| 2483.50 | 27.18 | PK | 78 | 1.9 | H | 34.08 | 61.26 | 74 | 12.74 |
| 2483.50 | 13.35 | Ave. | 78 | 1.9 | H | 34.08 | 47.43 | 54 | 6.57 |
| 4804.00 | 42.68 | PK | 149 | 1.3 | H | 5.84 | 48.52 | 74 | 25.48 |
| 4804.00 | 28.74 | Ave. | 149 | 1.3 | H | 5.84 | 34.58 | 54 | 19.42 |
| **Middle Channel (2441 MHz)** | | | | | | | | | |
| 2441.00 | 62.23 | PK | 242 | 2.1 | H | 33.92 | 96.15 | / | / |
| 2441.00 | 50.01 | Ave. | 242 | 2.1 | H | 33.92 | 83.93 | / | / |
| 2441.00 | 59.87 | PK | 93 | 1.9 | V | 33.92 | 93.79 | / | / |
| 2441.00 | 47.79 | Ave. | 93 | 1.9 | V | 33.92 | 81.71 | / | / |
| 4882.00 | 42.75 | PK | 182 | 1.3 | H | 6.21 | 48.96 | 74 | 25.04 |
| 4882.00 | 28.21 | Ave. | 182 | 1.3 | H | 6.21 | 34.42 | 54 | 19.58 |

| Frequency (MHz) | Receiver | | Turntable Degree | Rx Antenna | | Corrected Factor (dB/m) | Corrected Amplitude (dBμV/m) | FCC Part 15.247/205/209 | |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBμV) | PK/QP/Ave. | | Height (m) | Polar (H/V) | | | Limit (dBμV/m) | Margin (dB) |
| **High Channel (2480 MHz)** | | | | | | | | | |
| 2480.00 | 62.51 | PK | 123 | 1.6 | H | 34.08 | 96.59 | / | / |
| 2480.00 | 50.23 | Ave. | 123 | 1.6 | H | 34.08 | 84.31 | / | / |
| 2480.00 | 59.57 | PK | 279 | 1.0 | V | 34.08 | 93.65 | / | / |
| 2480.00 | 47.65 | Ave. | 279 | 1.0 | V | 34.08 | 81.73 | / | / |
| 2320.20 | 27.11 | PK | 227 | 2.4 | H | 33.83 | 60.94 | 74 | 13.06 |
| 2320.20 | 13.25 | Ave. | 227 | 2.4 | H | 33.83 | 47.08 | 54 | 6.92 |
| 2498.11 | 26.84 | PK | 56 | 1.1 | H | 34.08 | 60.92 | 74 | 13.08 |
| 2498.11 | 13.31 | Ave. | 56 | 1.1 | H | 34.08 | 47.39 | 54 | 6.61 |
| 4960.00 | 42.95 | PK | 220 | 2.1 | H | 7.82 | 50.77 | 74 | 23.23 |
| 4960.00 | 28.93 | Ave. | 298 | 2.2 | H | 7.82 | 36.75 | 54 | 17.25 |

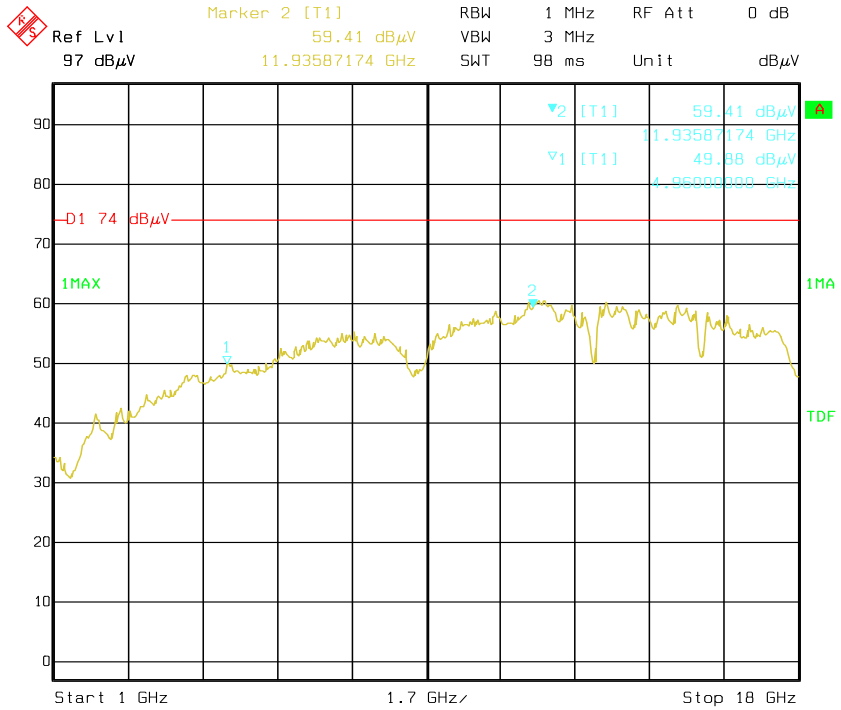
**Note:**
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB to the limit was not recorded.
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

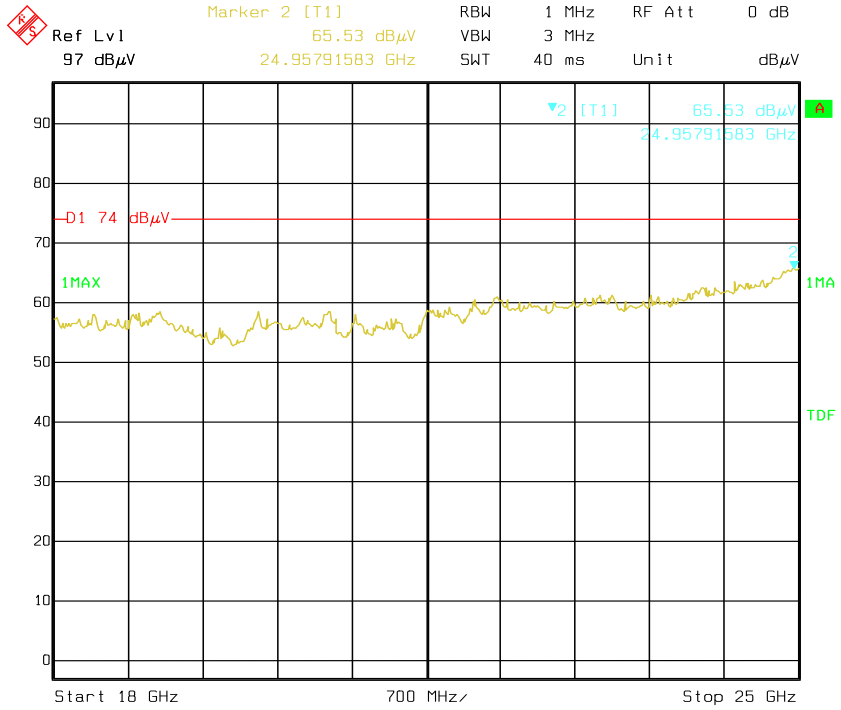
**Pre-scan with High channel Peak**
**Horizontal**



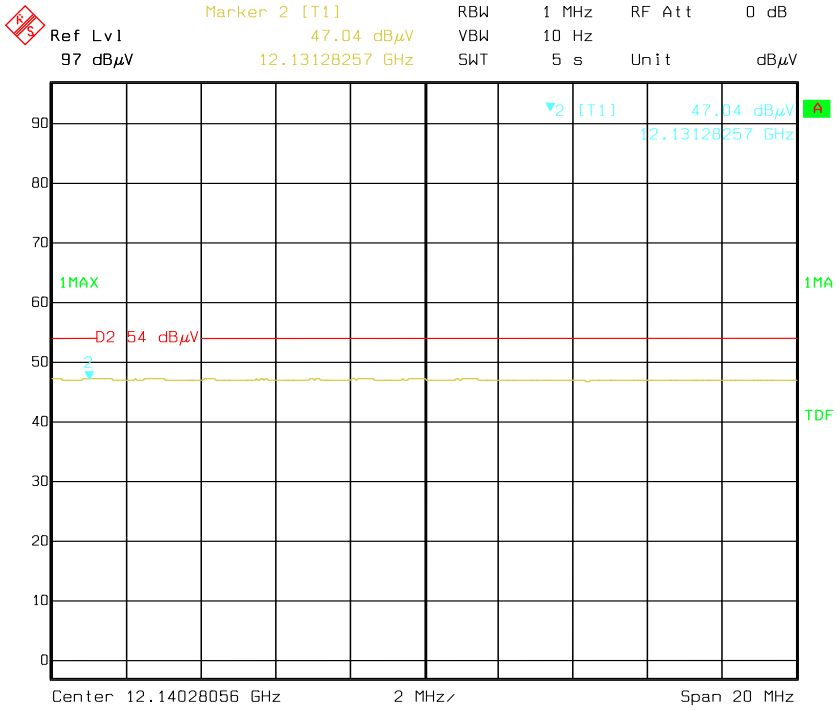



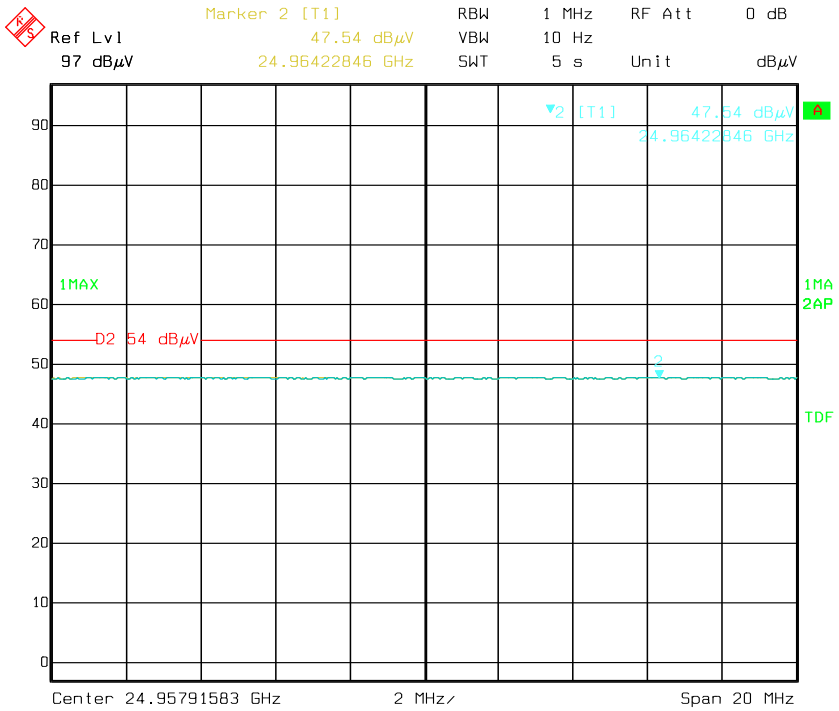
## Vertical


Marker 2 [T1]
59.41 dBµV
11.93587174 GHz
RBW 1 MHz
VBW 3 MHz
SWT 98 ms
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
▼2 [T1] 59.41 dBµV
11.93587174 GHz
▽1 [T1] 49.98 dBµV
4.95000000 GHz
D1 74 dBµV
1MAX
1MA
TDF
Start 1 GHz
1.7 GHz/
Stop 18 GHz
Date: 18.JUN.2018 13:58:09

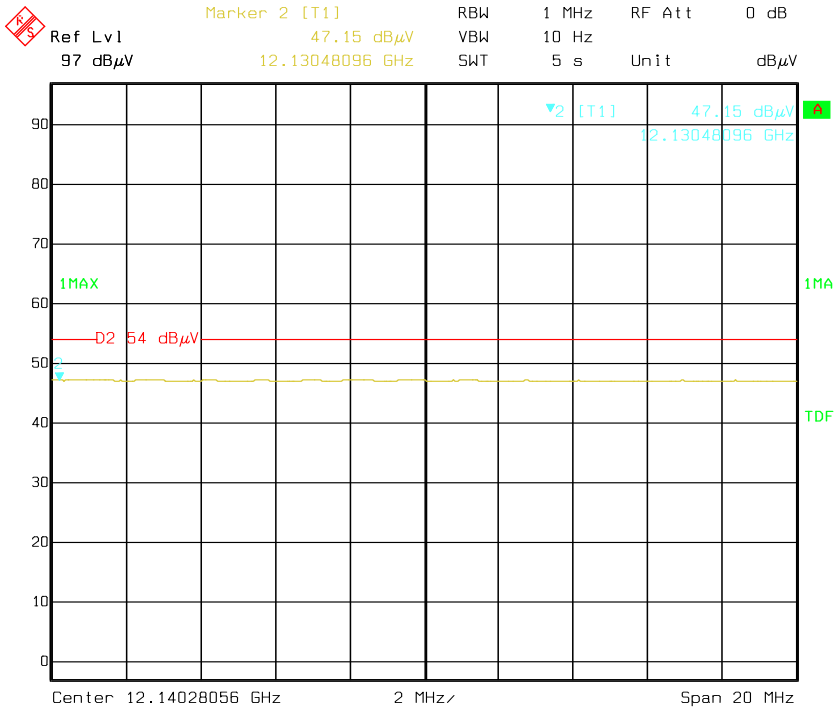

Marker 2 [T1]
65.53 dBµV
24.95791583 GHz
RBW 1 MHz
VBW 3 MHz
SWT 40 ms
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
▼2 [T1] 65.53 dBµV
24.95791583 GHz
D1 74 dBµV
1MAX
1MA
TDF
Start 18 GHz
700 MHz/
Stop 25 GHz
Date: 18.JUN.2018 14:53:09

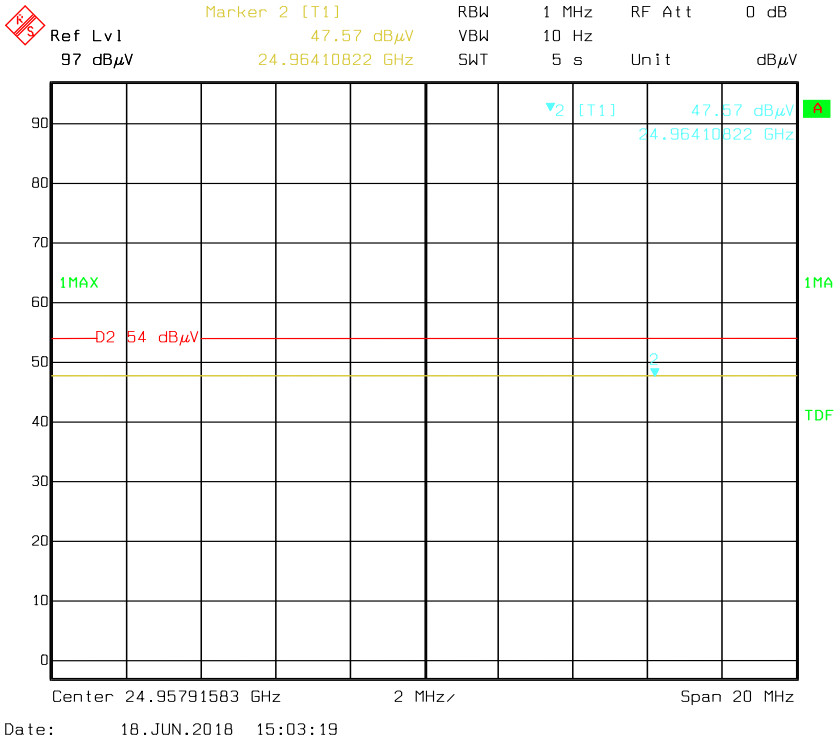
**Pre-scan for Average**
**Horizontal**



**Vertical**


Marker 2 [T1]
47.15 dBμV
12.13048096 GHz
RBW 1 MHz
VBW 10 Hz
SWT 5 s
RF Att 0 dB
Unit dBμV
Ref Lvl
97 dBμV
▼2 [T1] 47.15 dBμV
12.13048096 GHz
1MAX
1MA
D2 54 dBμV
TDF
Center 12.14028056 GHz
2 MHz/
Span 20 MHz
Date: 18.JUN.2018 14:05:23


Marker 2 [T1]
47.57 dBμV
24.96410822 GHz
RBW 1 MHz
VBW 10 Hz
SWT 5 s
RF Att 0 dB
Unit dBμV
Ref Lvl
97 dBμV
▼2 [T1] 47.57 dBμV
24.96410822 GHz
1MAX
1MA
D2 54 dBμV
TDF
Center 24.95791583 GHz
2 MHz/
Span 20 MHz
Date: 18.JUN.2018 15:03:19

# FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

## Applicable Standard

Frequency hopping systems shall have hoping 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 125 mW.

## Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Hill He on 2018-06-19 and 2018-06-20.*

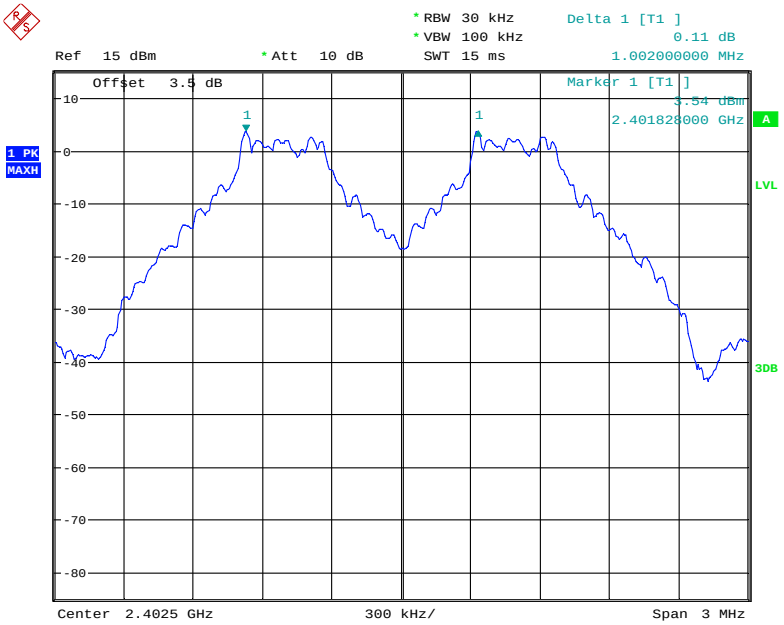
*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table and plots.*

| Mode | Channel | Frequency (MHz) | Channel Separation (MHz) | ≥Limit (MHz) | Result |
|---|---|---|---|---|---|
| **BDR (GFSK)** | Low | 2402 | 1.002 | 0.625 | Pass |
| | Adjacent | 2403 | | | |
| | Middle | 2441 | 1.002 | 0.622 | Pass |
| | Adjacent | 2442 | | | |
| | High | 2480 | 1.002 | 0.628 | Pass |
| | Adjacent | 2479 | | | |
| **EDR (π/4-DQPSK)** | Low | 2402 | 1.002 | 0.837 | Pass |
| | Adjacent | 2403 | | | |
| | Middle | 2441 | 1.014 | 0.845 | Pass |
| | Adjacent | 2442 | | | |
| | High | 2480 | 1.002 | 0.840 | Pass |
| | Adjacent | 2479 | | | |
| **EDR (8DPSK)** | Low | 2402 | 1.002 | 0.847 | Pass |
| | Adjacent | 2403 | | | |
| | Middle | 2441 | 1.008 | 0.840 | Pass |
| | Adjacent | 2442 | | | |
| | High | 2480 | 1.001 | 0.853 | Pass |
| | Adjacent | 2479 | | | |

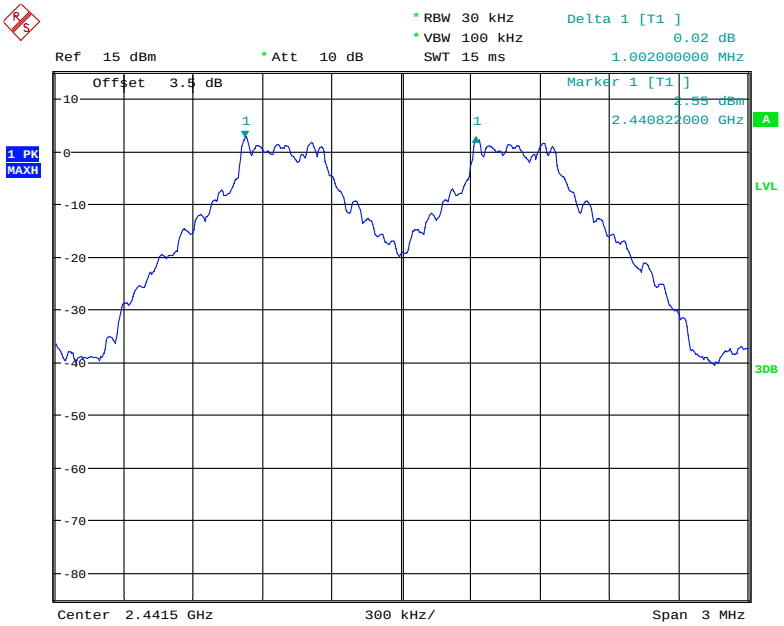
Note: Limit = 20 dB bandwidth *2/3

## BDR (GFSK): Low Channel



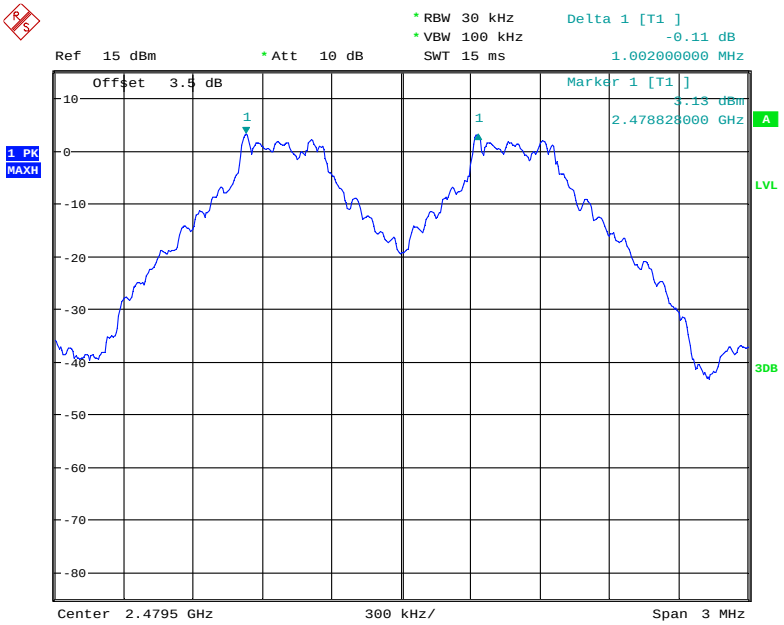

Date: 20.JUN.2018 00:02:28

## BDR (GFSK): Middle Channel



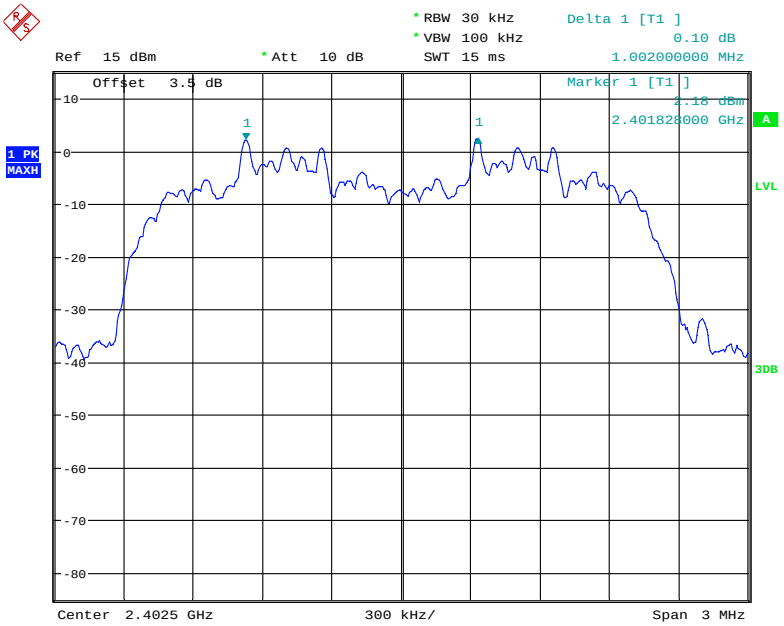

Date: 20.JUN.2018 00:03:16

## BDR (GFSK): High Channel



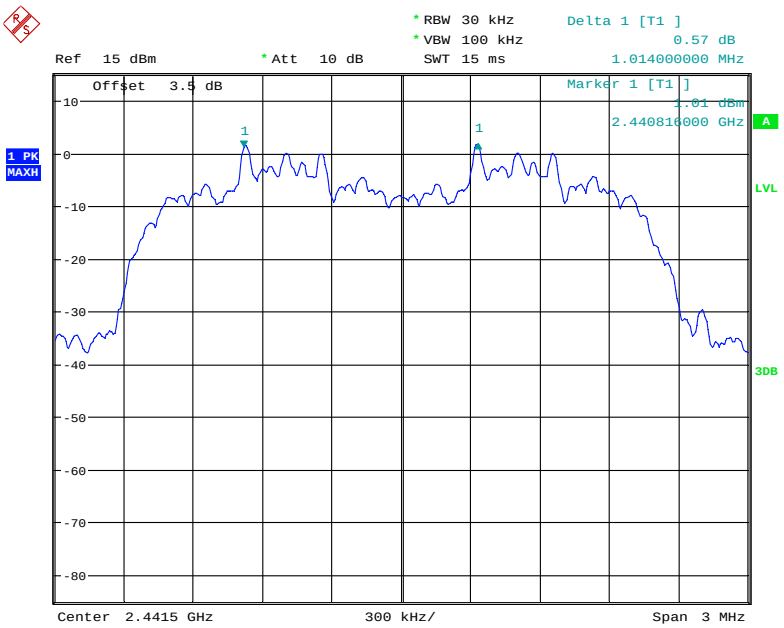

Date: 20.JUN.2018 00:04:01

## EDR (π/4-DQPSK): Low Channel



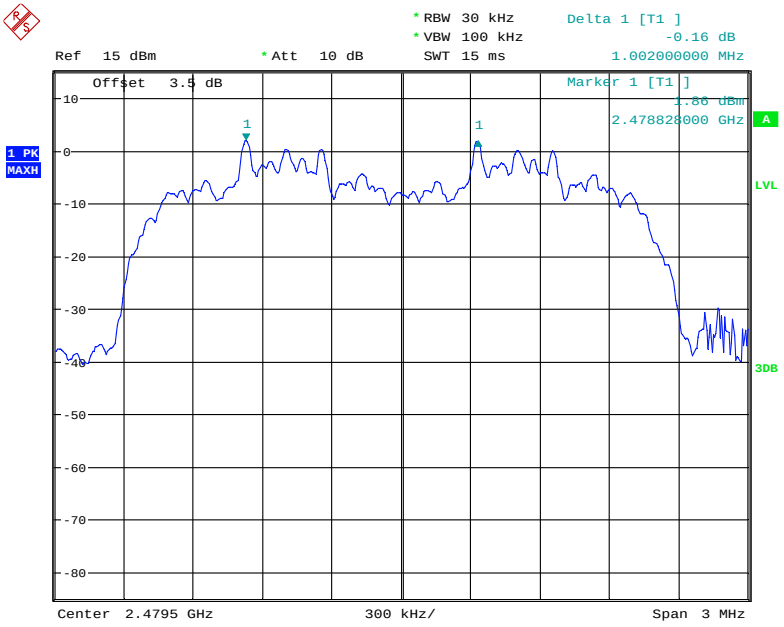

Date: 20.JUN.2018 00:01:13

## EDR (π/4-DQPSK): Middle Channel



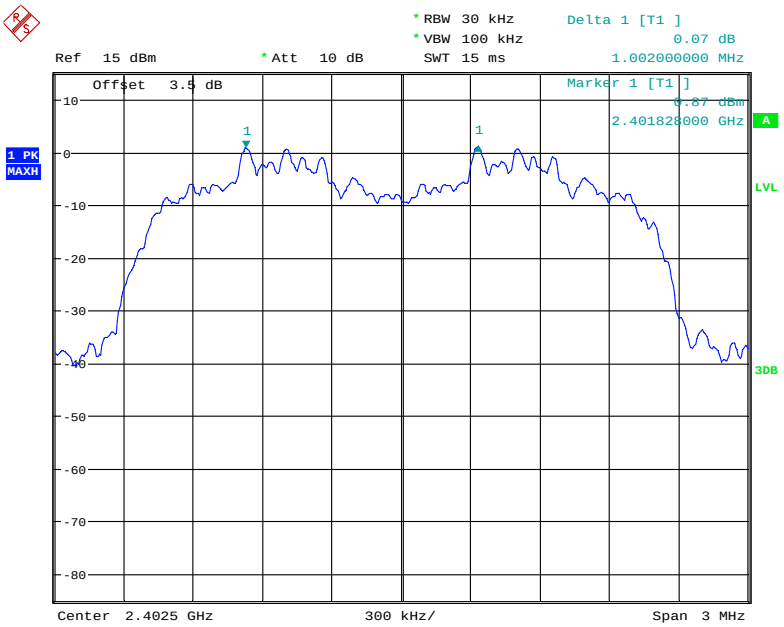

Date: 20.JUN.2018 00:00:13

## EDR (π/4-DQPSK): High Channel



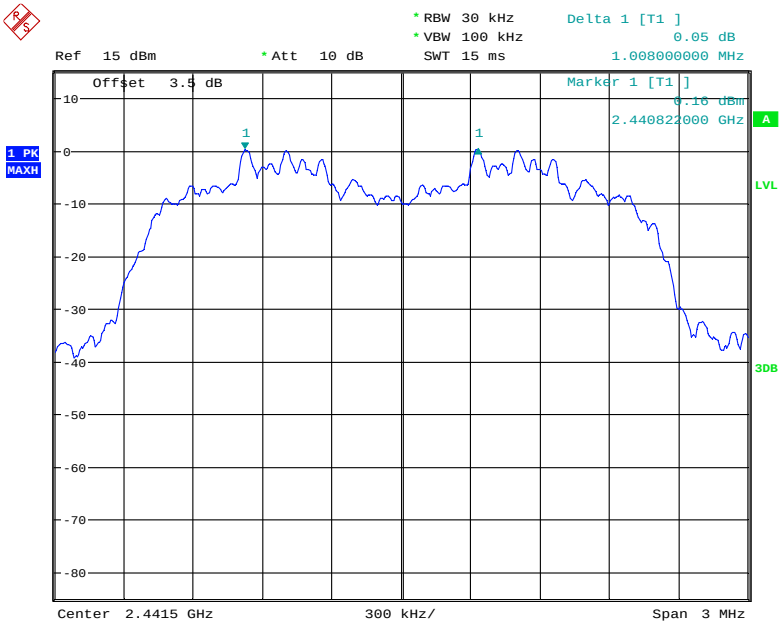

Date: 19.JUN.2018 23:59:09

## EDR (8DPSK): Low Channel



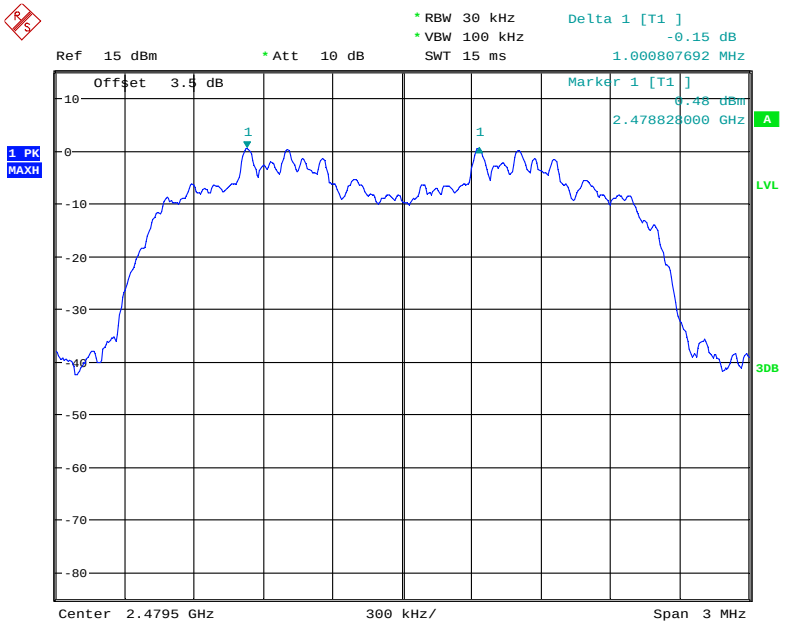

Date: 19.JUN.2018 23:54:22

## EDR (8DPSK): Middle Channel




Date: 19.JUN.2018 23:56:13

## EDR (8DPSK): High Channel




Date: 19.JUN.2018 23:57:16

# FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH

## Applicable Standard

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 125 mW.

## Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

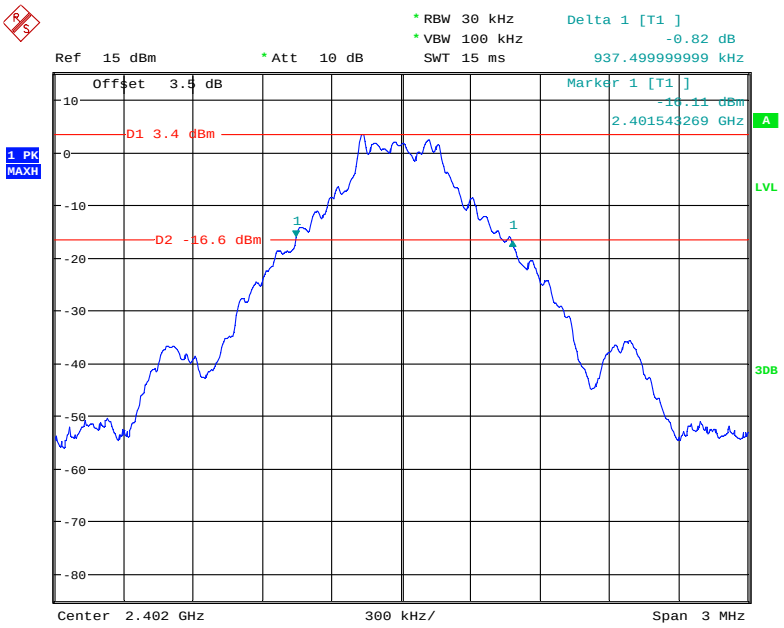
*The testing was performed by Hill He on 2018-06-20.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table and plots.*

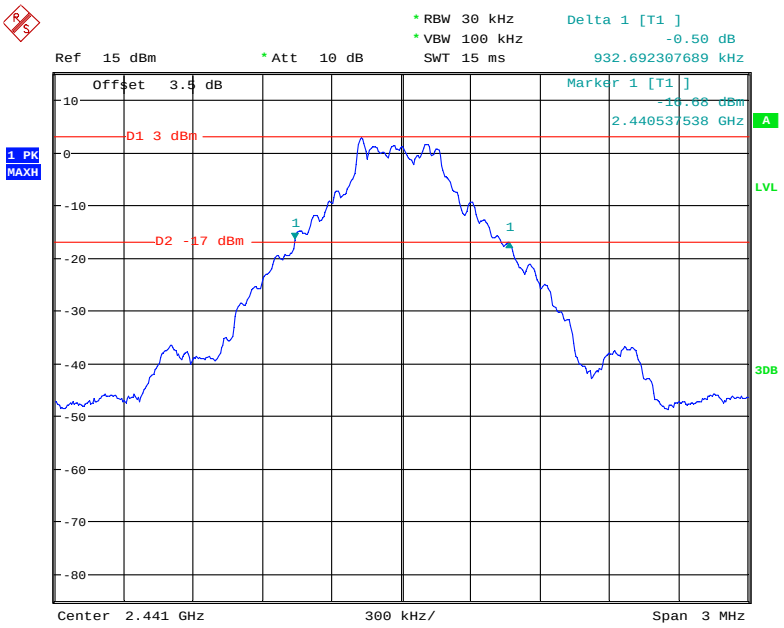
| Mode | Channel | Frequency (MHz) | 20 dB Emission Bandwidth (MHz) |
|---|---|---|---|
| BDR (GFSK) | Low | 2402 | 0.937 |
| | Middle | 2441 | 0.933 |
| | High | 2480 | 0.942 |
| EDR (π/4-DQPSK) | Low | 2402 | 1.255 |
| | Middle | 2441 | 1.268 |
| | High | 2480 | 1.260 |
| EDR (8DPSK) | Low | 2402 | 1.270 |
| | Middle | 2441 | 1.260 |
| | High | 2480 | 1.279 |

**BDR (GFSK): Low Channel**



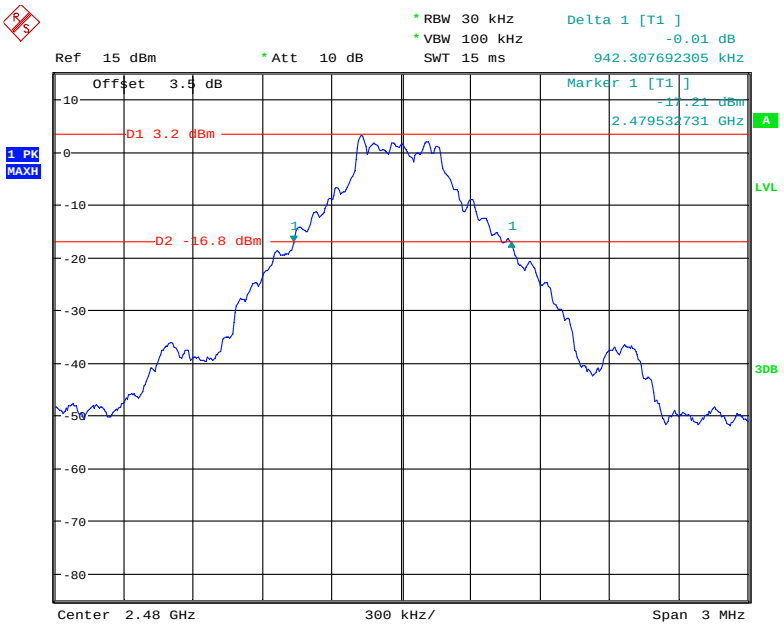

Date: 20.JUN.2018 21:57:55

## BDR (GFSK): Middle Channel



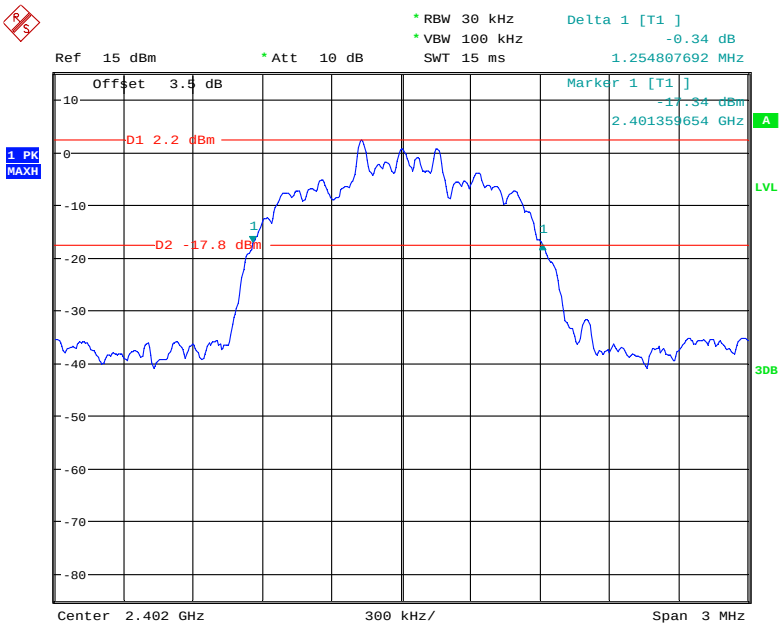

Date: 20.JUN.2018 00:08:45

## BDR (GFSK): High Channel



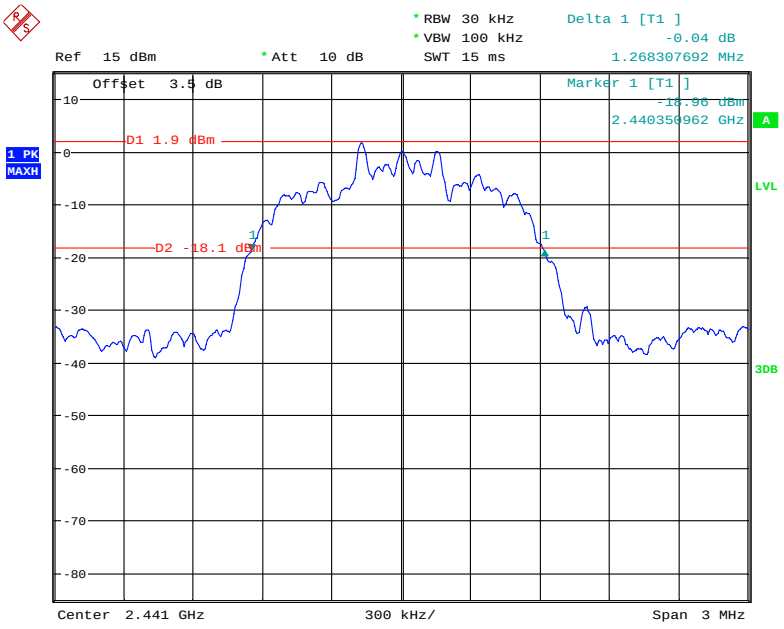

Date: 20.JUN.2018 00:06:41

## EDR (π/4-DQPSK): Low Channel



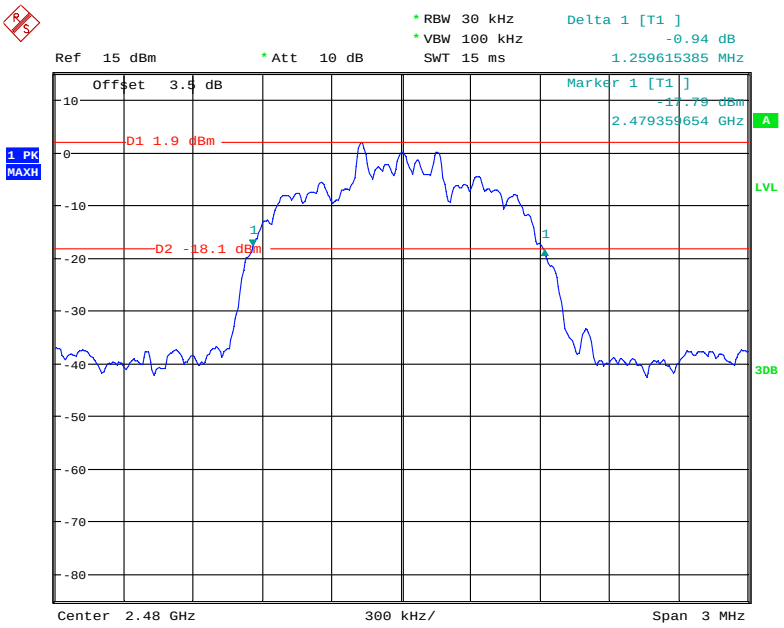

Date: 20.JUN.2018 00:14:50

## EDR (π/4-DQPSK): Middle Channel



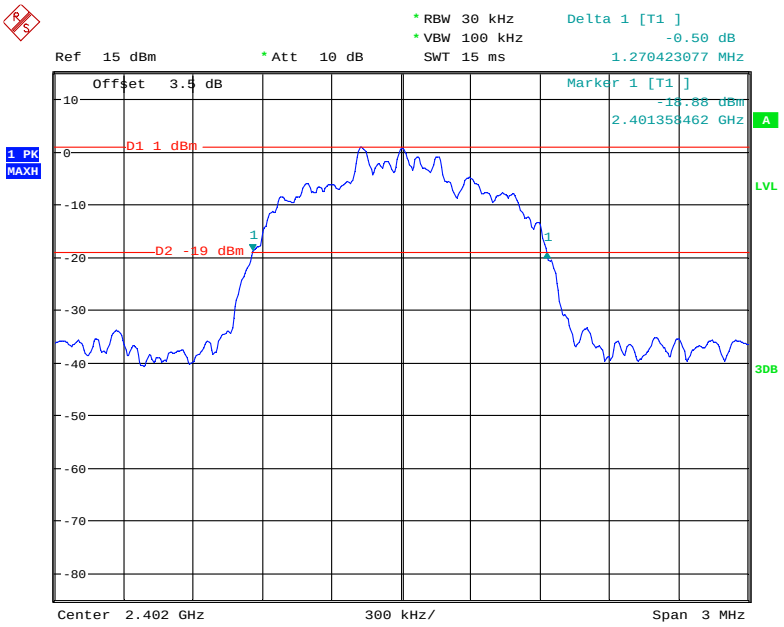

Date: 20.JUN.2018 00:13:38

## EDR (π/4-DQPSK): High Channel



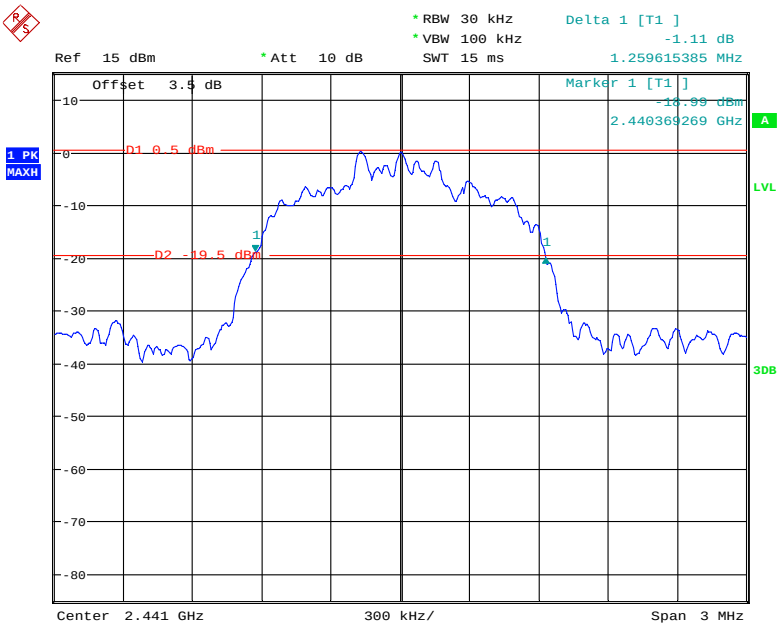

Date: 20.JUN.2018 00:12:16

## EDR (8DPSK): Low Channel



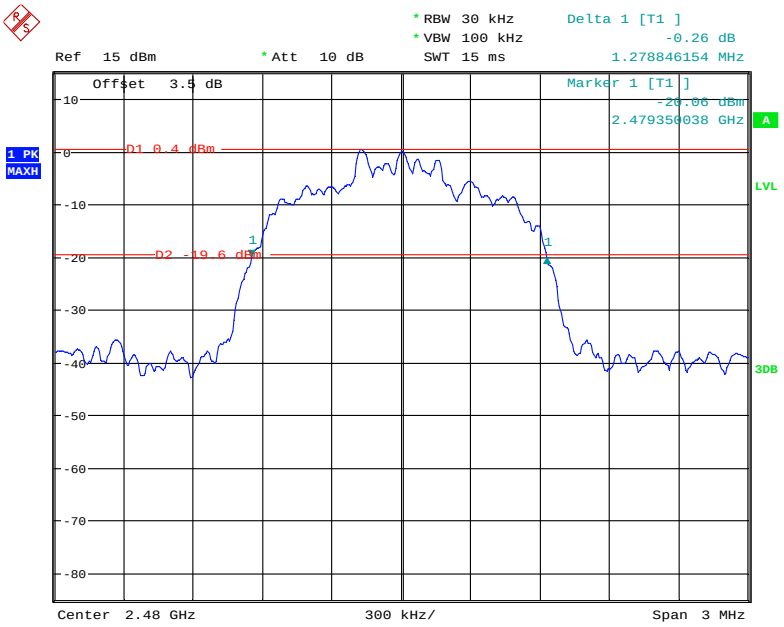

Date: 20.JUN.2018 00:17:02

## EDR (8DPSK): Middle Channel




Date: 20.JUN.2018 00:19:55

## EDR (8DPSK): High Channel




Date: 20.JUN.2018 00:21:17

# FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

## Applicable Standard

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 Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

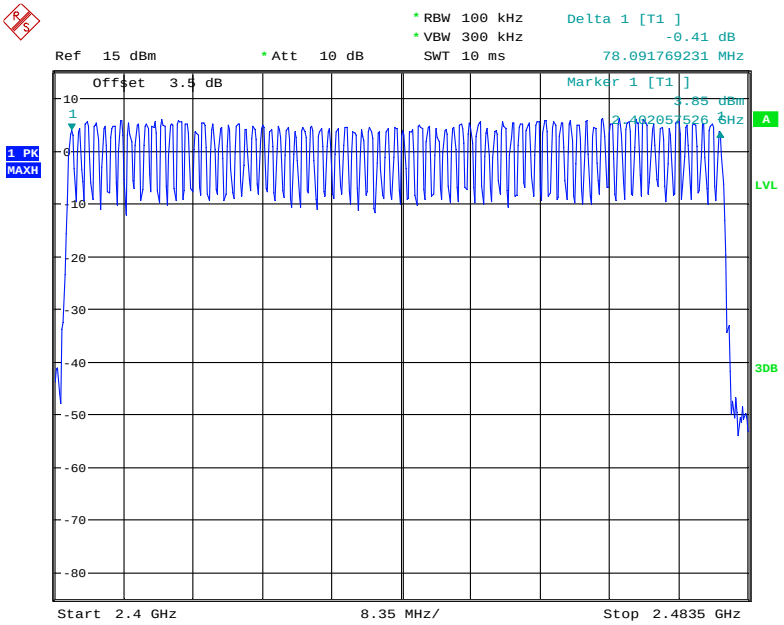
*The testing was performed by Hill He on 2018-06-19.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table and plots.*

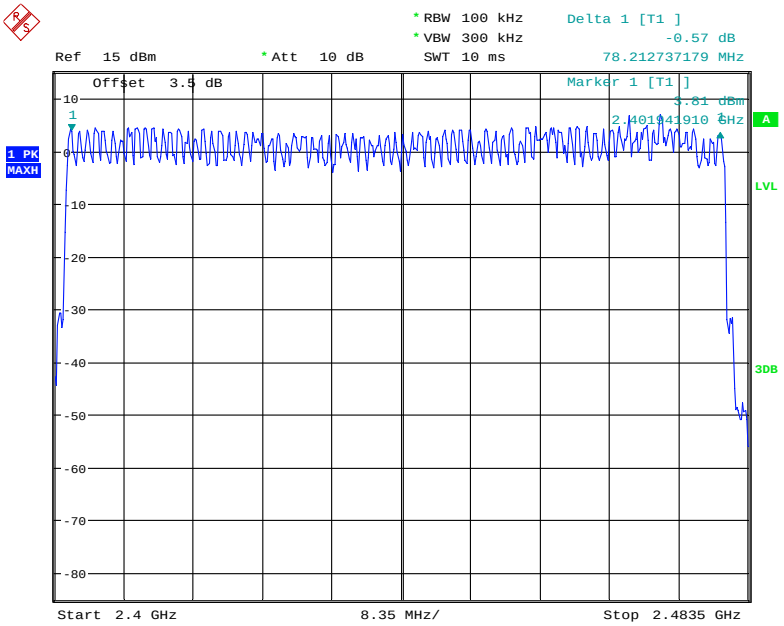
| Mode | Frequency Range (MHz) | Number of Hopping Channel (CH) | Limit (CH) |
|---|---|---|---|
| BDR (GFSK) | 2400-2483.5 | 79 | ⩾15 |
| EDR (π/4-DQPSK) | 2400-2483.5 | 79 | ⩾15 |
| EDR (8DPSK) | 2400-2483.5 | 79 | ⩾15 |

## BDR (GFSK): Number of Hopping Channels



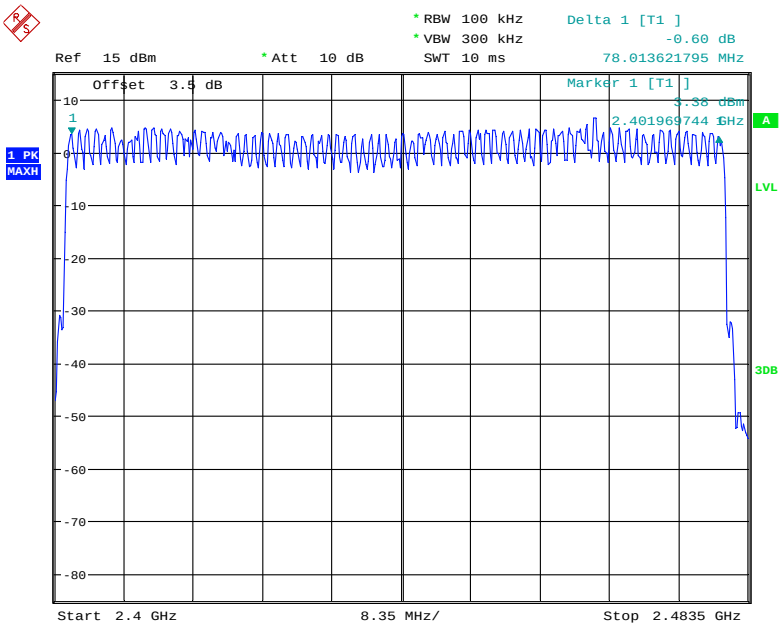

Date: 19.JUN.2018 23:46:15

## EDR (π/4-DQPSK): Number of Hopping Channels




Date: 19.JUN.2018 23:40:48

## EDR (8DPSK): Number of Hopping Channels




Date: 19.JUN.2018 23:51:55

# FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

## Applicable Standard

Frequency hopping systems in the 2400-2483.5 MHz 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 Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Hill He on 2018-06-20.*

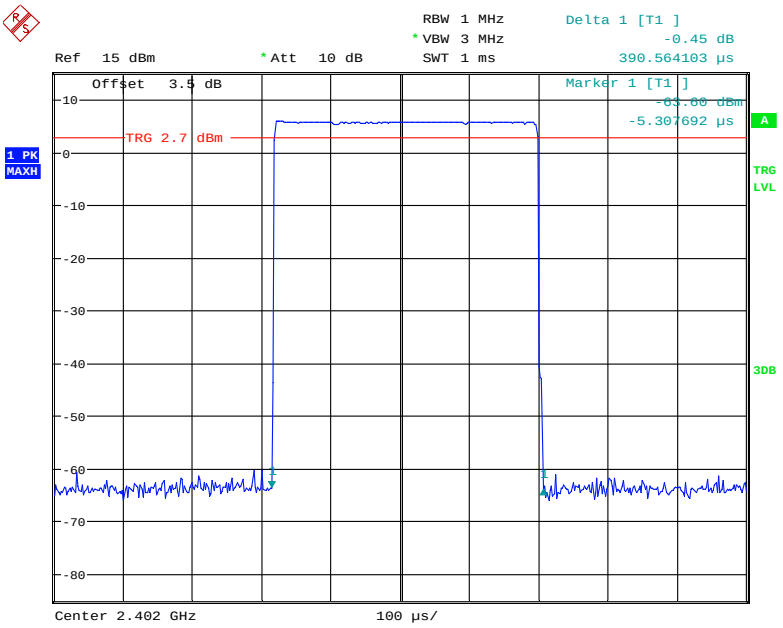
*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table and plots*

| Mode | | Channel | Pulse Width (ms) | Dwell Time (S) | Limit (S) | Result |
|---|---|---|---|---|---|---|
| BDR (GFSK) | DH 1 | Low | 0.391 | 0.125 | 0.4 | Pass |
| | | Middle | 0.391 | 0.125 | 0.4 | Pass |
| | | High | 0.391 | 0.125 | 0.4 | Pass |
| | | Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S | | | | |
| | DH 3 | Low | 1.668 | 0.267 | 0.4 | Pass |
| | | Middle | 1.668 | 0.267 | 0.4 | Pass |
| | | High | 1.668 | 0.267 | 0.4 | Pass |
| | | Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S | | | | |
| | DH 5 | Low | 2.918 | 0.311 | 0.4 | Pass |
| | | Middle | 2.918 | 0.311 | 0.4 | Pass |
| | | High | 2.918 | 0.311 | 0.4 | Pass |
| | | Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S | | | | |
| EDR (π/4-DQPSK) | 2DH 1 | Low | 0.397 | 0.127 | 0.4 | Pass |
| | | Middle | 0.397 | 0.127 | 0.4 | Pass |
| | | High | 0.397 | 0.127 | 0.4 | Pass |
| | | Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S | | | | |
| | 2DH 3 | Low | 1.668 | 0.267 | 0.4 | Pass |
| | | Middle | 1.668 | 0.267 | 0.4 | Pass |
| | | High | 1.668 | 0.267 | 0.4 | Pass |
| | | Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S | | | | |
| | 2DH 5 | Low | 2.918 | 0.311 | 0.4 | Pass |
| | | Middle | 2.918 | 0.311 | 0.4 | Pass |
| | | High | 2.918 | 0.311 | 0.4 | Pass |
| | | Note:2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S | | | | |
| EDR (8DPSK) | 3DH 1 | Low | 0.399 | 0.128 | 0.4 | Pass |
| | | Middle | 0.399 | 0.128 | 0.4 | Pass |
| | | High | 0.399 | 0.128 | 0.4 | Pass |
| | | Note: 3DH1:Dwell time = Pulse time*(1600/2/79)*31.6S | | | | |
| | 3DH 3 | Low | 1.668 | 0.267 | 0.4 | Pass |
| | | Middle | 1.668 | 0.267 | 0.4 | Pass |
| | | High | 1.668 | 0.267 | 0.4 | Pass |
| | | Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S | | | | |
| | 3DH 5 | Low | 2.926 | 0.312 | 0.4 | Pass |
| | | Middle | 2.918 | 0.311 | 0.4 | Pass |
| | | High | 2.942 | 0.314 | 0.4 | Pass |
| | | Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S | | | | |

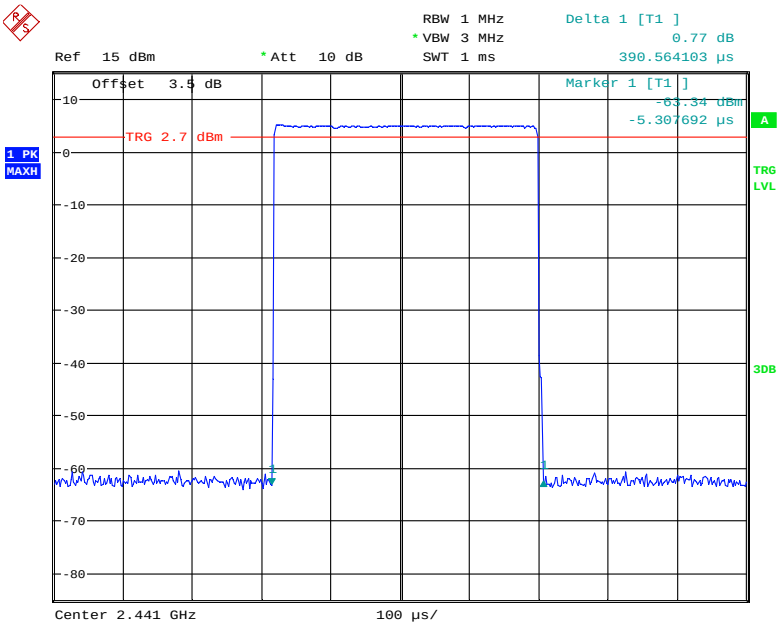
## BDR (GFSK):

### Pulse time, Low Channel, DH1



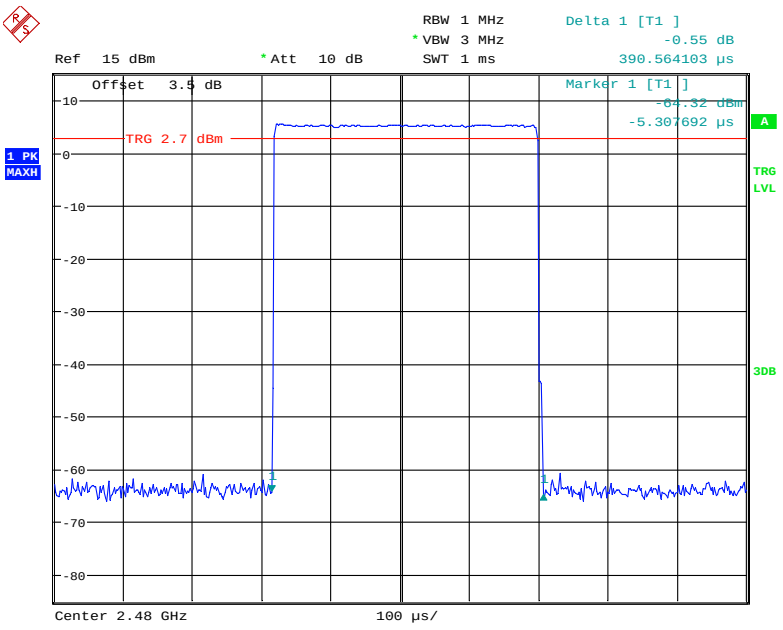

Date: 20.JUN.2018 01:17:12

### Pulse time, Middle Channel, DH1



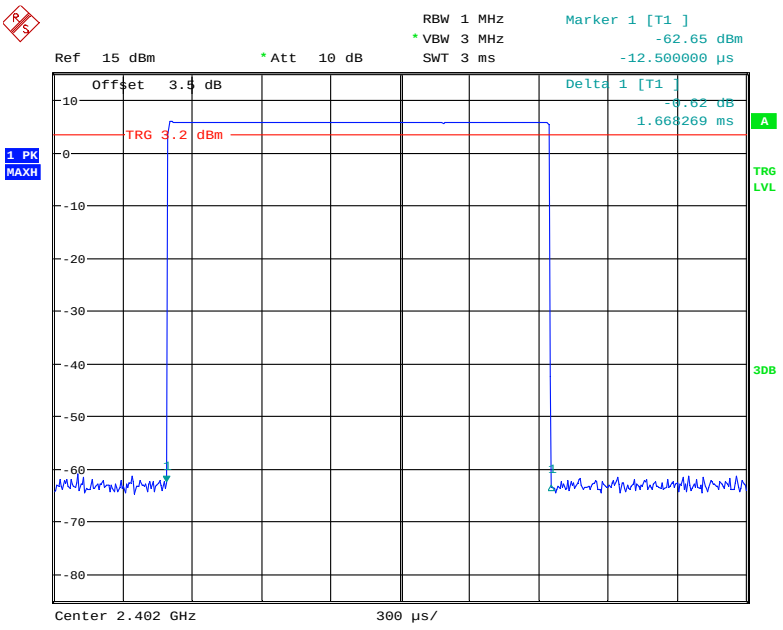

Date: 20.JUN.2018 01:16:39

## Pulse time, High Channel, DH1



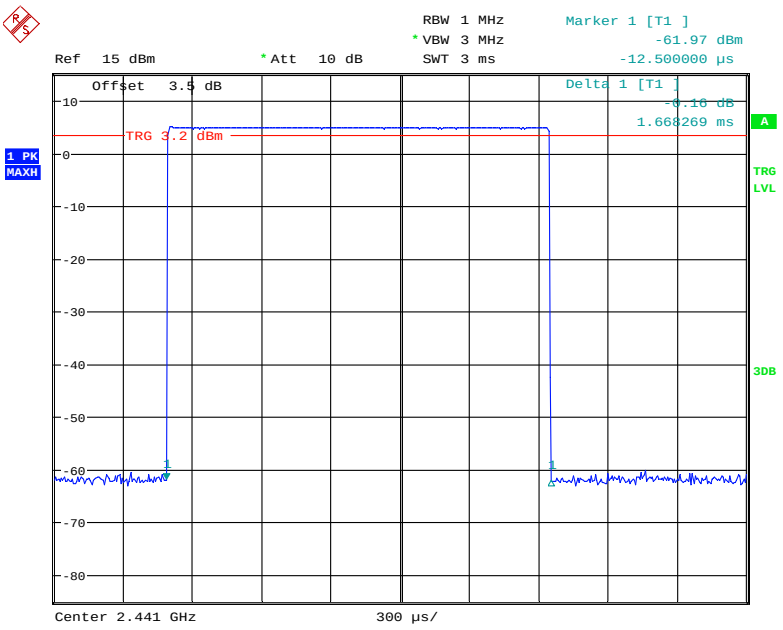

Date: 20.JUN.2018 01:17:25

## Pulse time, Low Channel, DH3



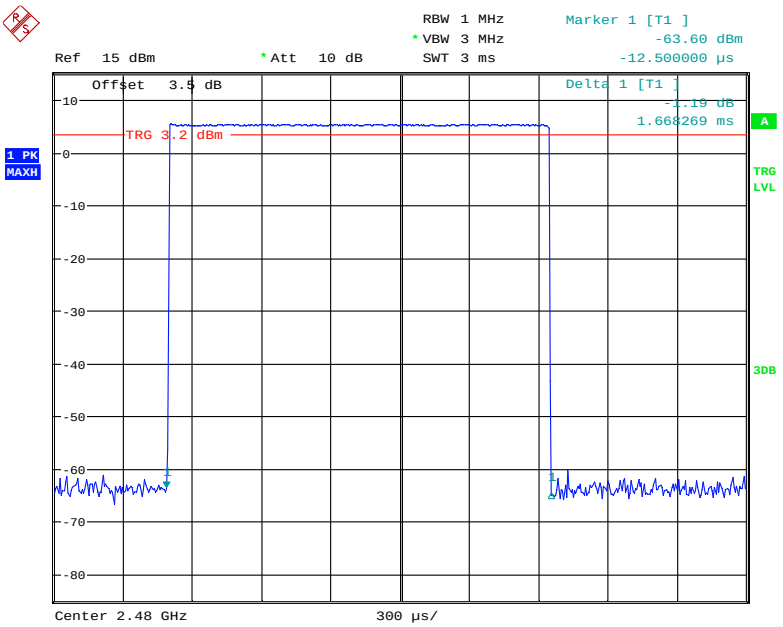

Date: 20.JUN.2018 01:01:24

## Pulse time, Middle Channel, DH3



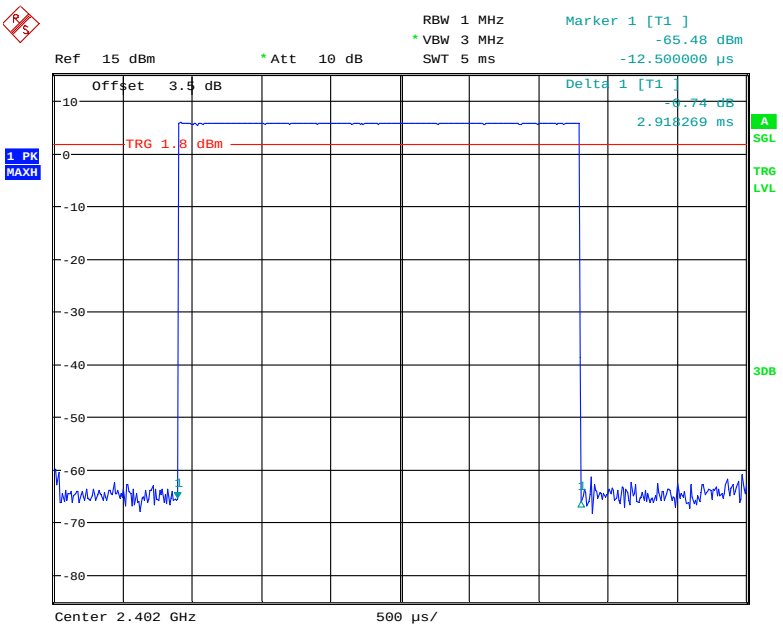

Date: 20.JUN.2018 01:00:51

## Pulse time, High Channel, DH3



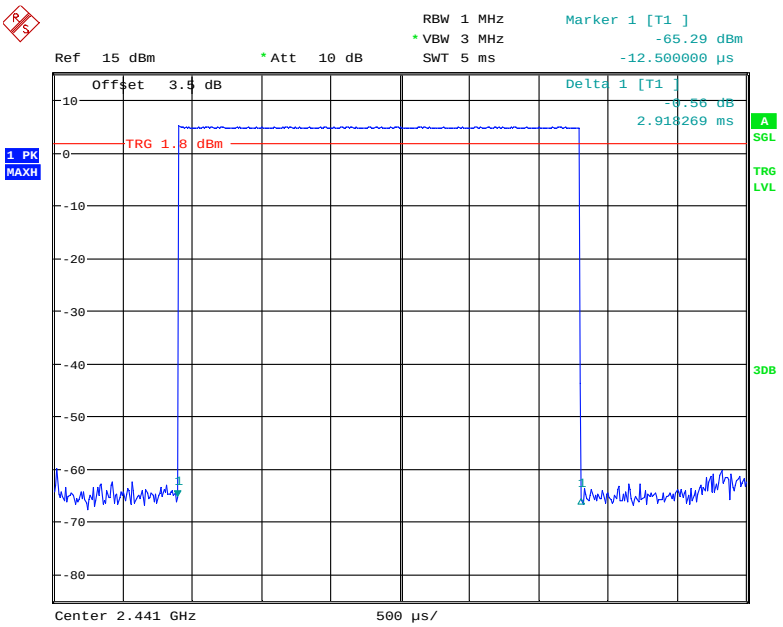

Date: 20.JUN.2018 01:01:34

## Pulse time, Low Channel, DH5



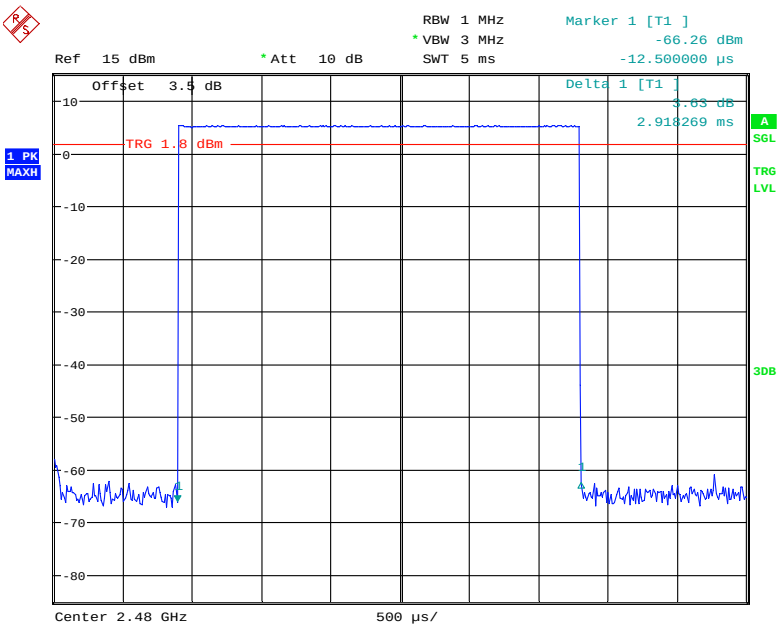

Date: 20.JUN.2018 01:13:23

## Pulse time, Middle Channel, DH5




Date: 20.JUN.2018 01:13:04

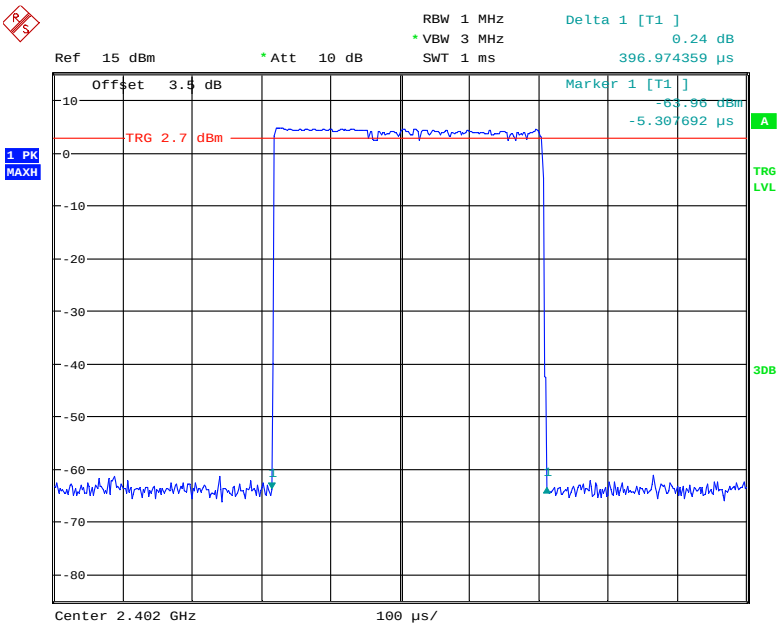
## Pulse time, High Channel, DH5




Date: 20.JUN.2018 01:12:33

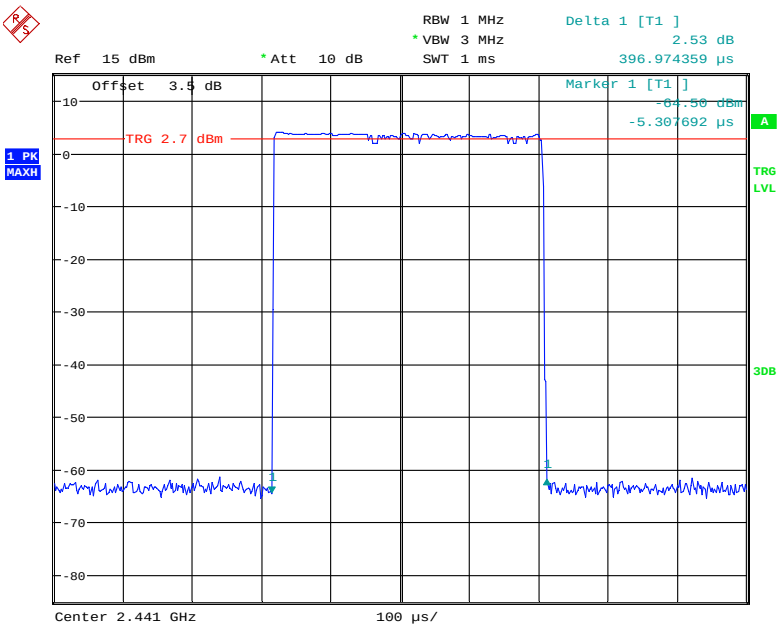
## EDR (π/4-DQPSK):

## Pulse time, Low Channel, 2DH1



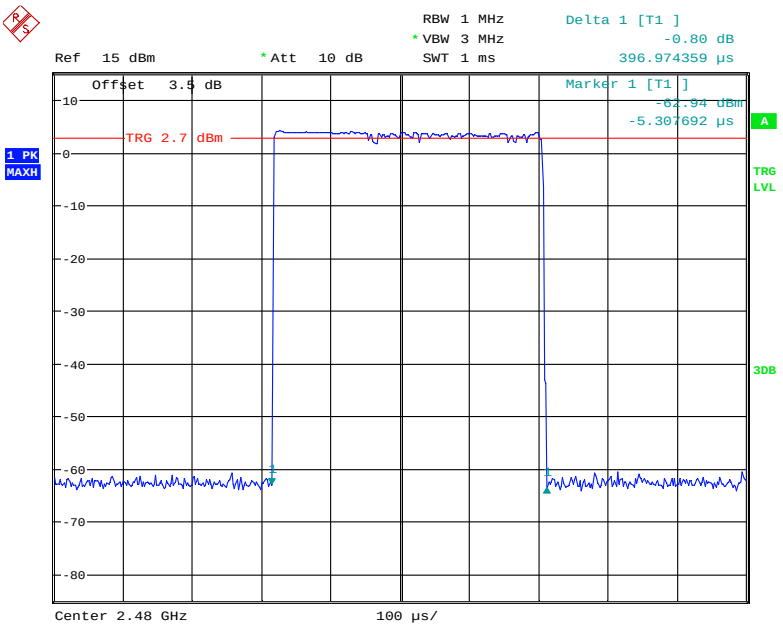

Date: 20.JUN.2018 01:18:33

## Pulse time, Middle Channel, 2DH1



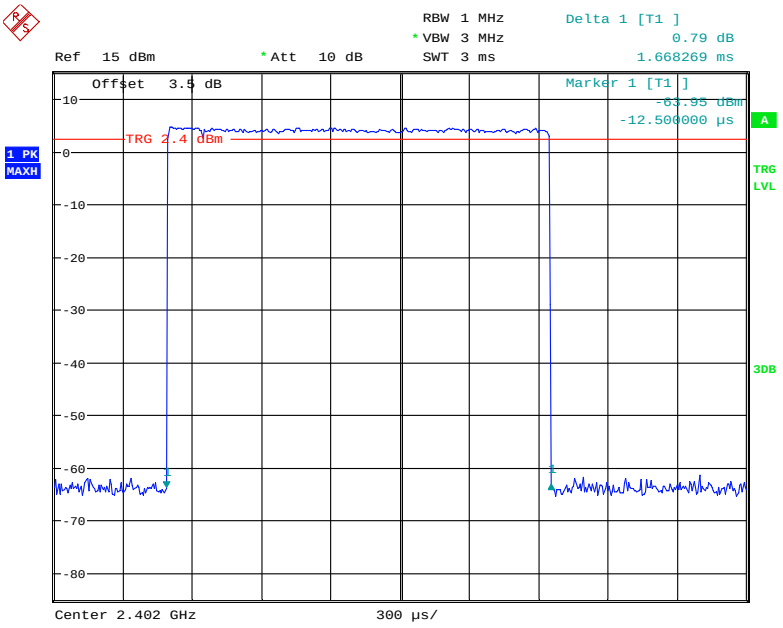

Date: 20.JUN.2018 01:18:20

## Pulse time, High Channel, 2DH1



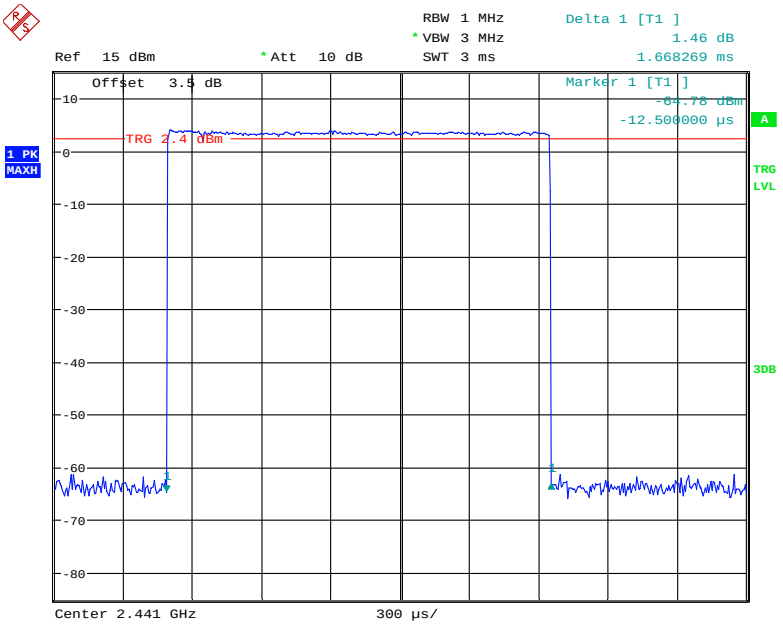

Date: 20.JUN.2018 01:18:01

## Pulse time, Low Channel, 2DH3



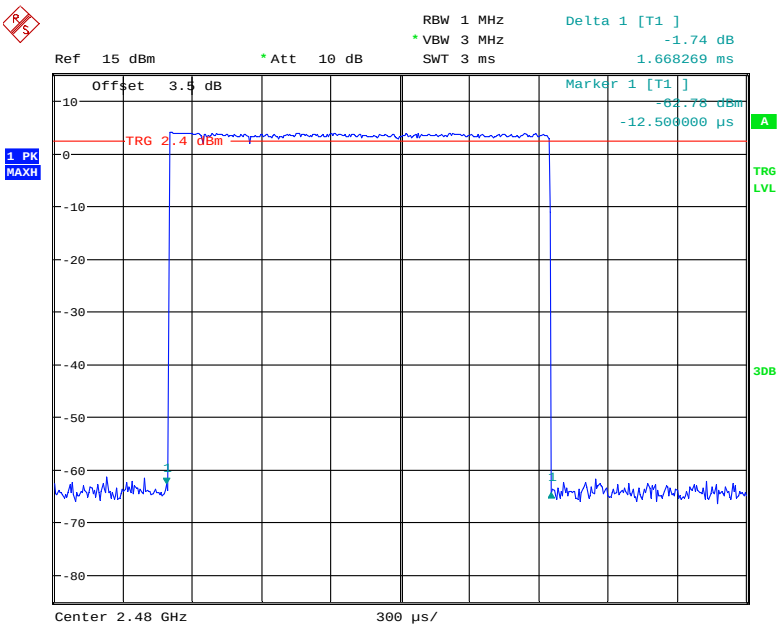

Date: 20.JUN.2018 01:04:01

## Pulse time, Middle Channel, 2DH3



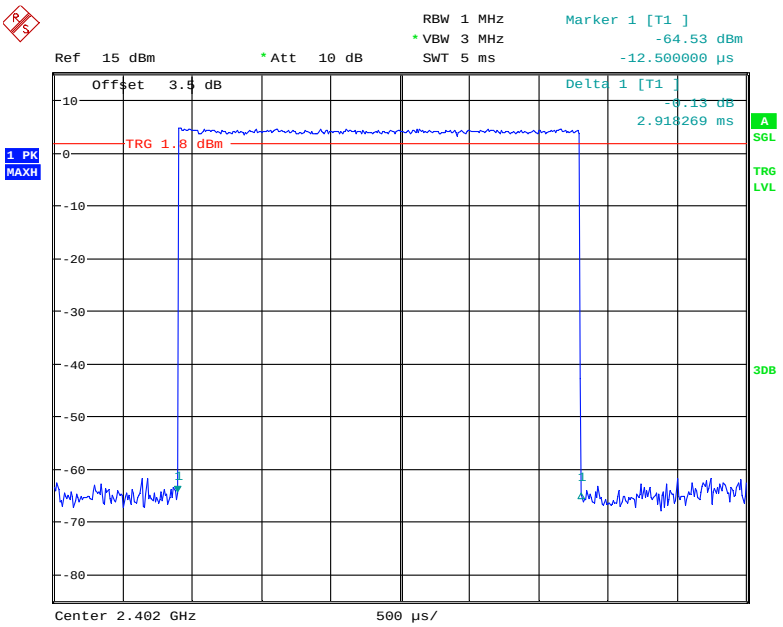

Date: 20.JUN.2018 01:03:49

## Pulse time, High Channel, 2DH3



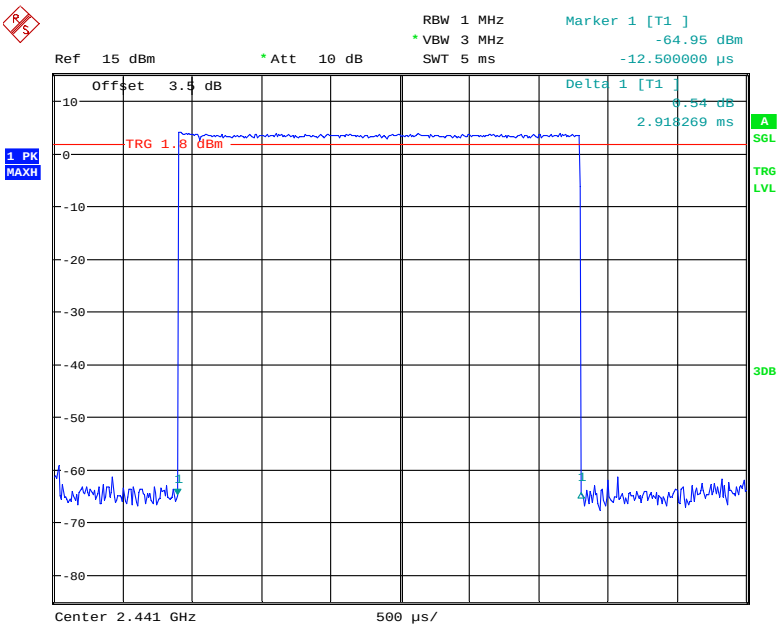

Date: 20.JUN.2018 01:03:17

## Pulse time, Low Channel, 2DH5



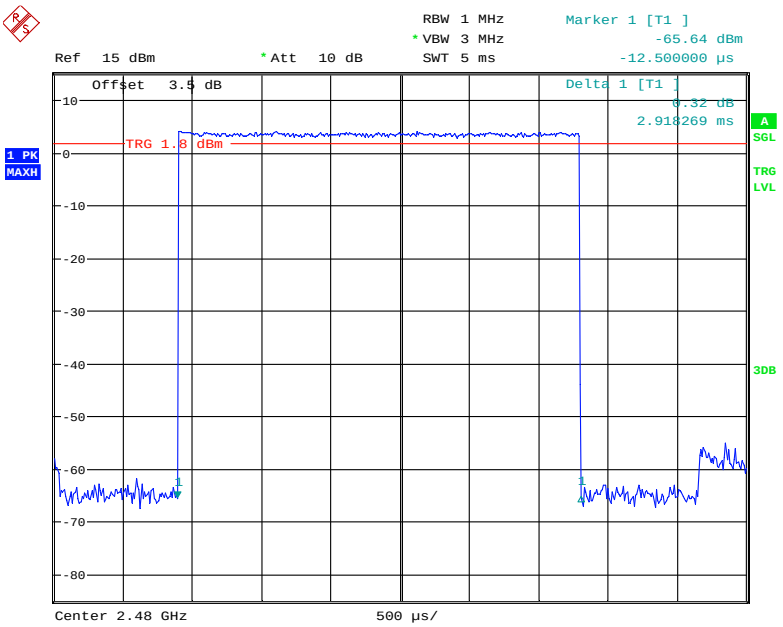

Date: 20.JUN.2018 01:10:59

## Pulse time, Middle Channel, 2DH5



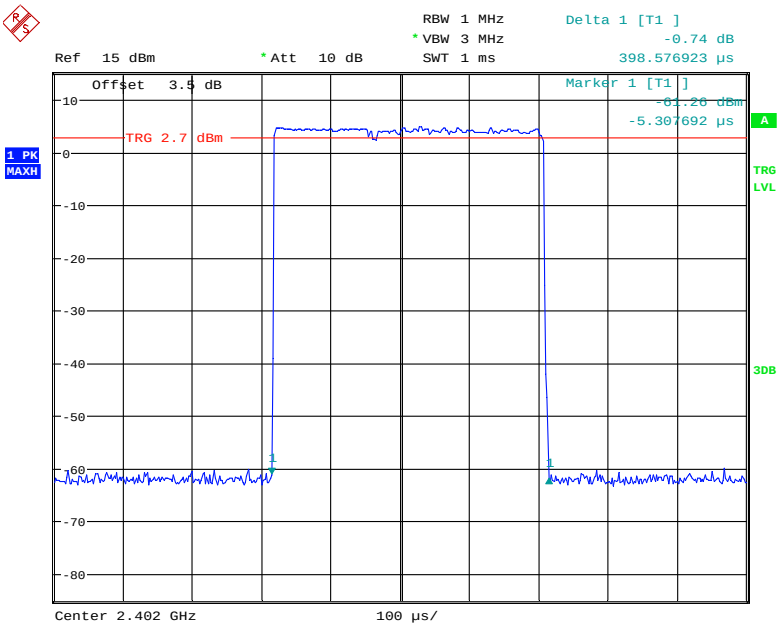

Date: 20.JUN.2018 01:10:38

## Pulse time, High Channel, 2DH5



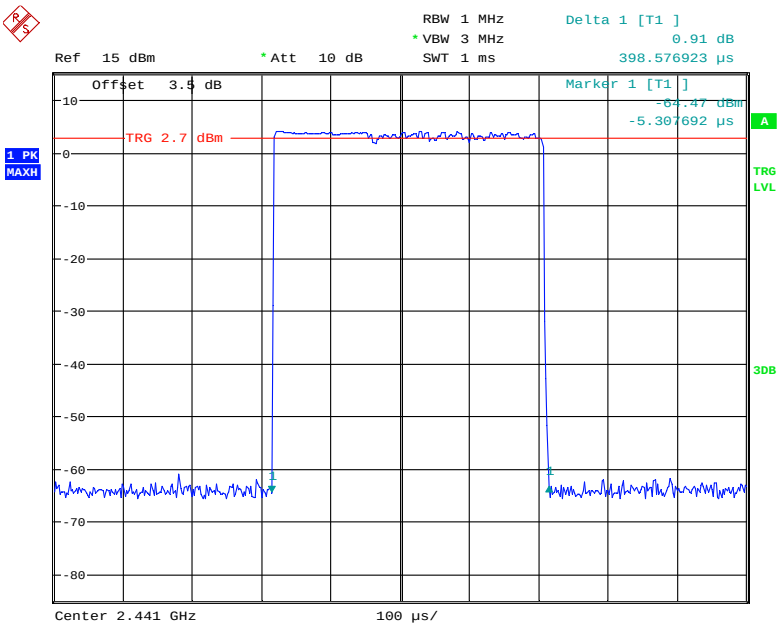

Date: 20.JUN.2018 01:11:34

## EDR (8DPSK):
## Pulse time, Low Channel, 3DH1



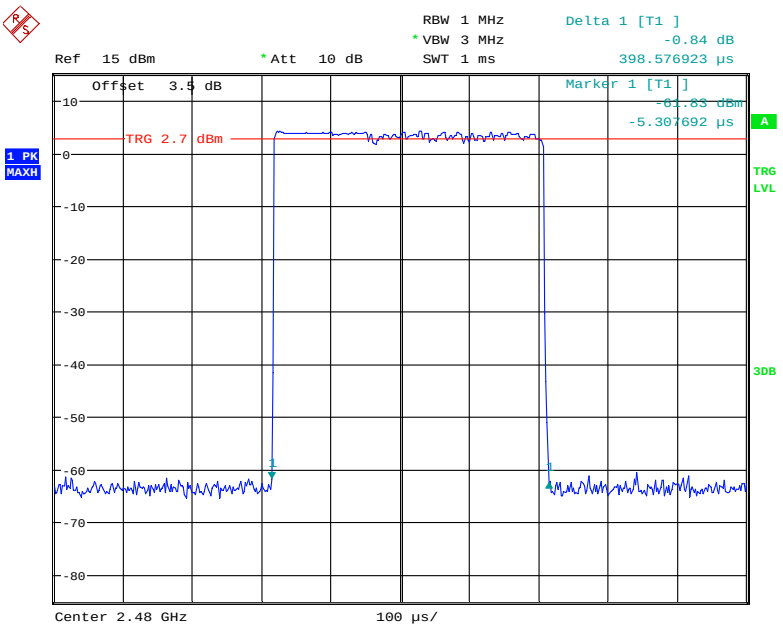

Date: 20.JUN.2018 01:19:18

## Pulse time, Middle Channel, 3DH1



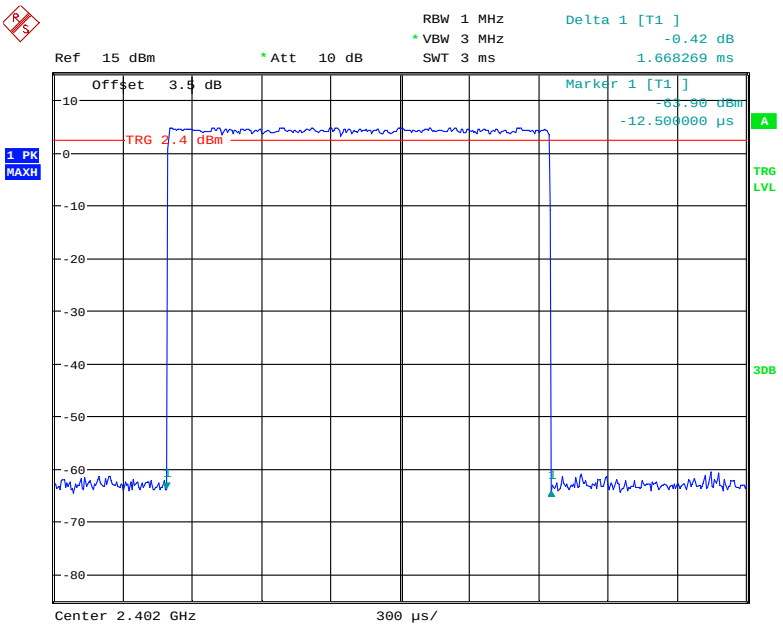

Date: 20.JUN.2018 01:19:34

## Pulse time, High Channel, 3DH1



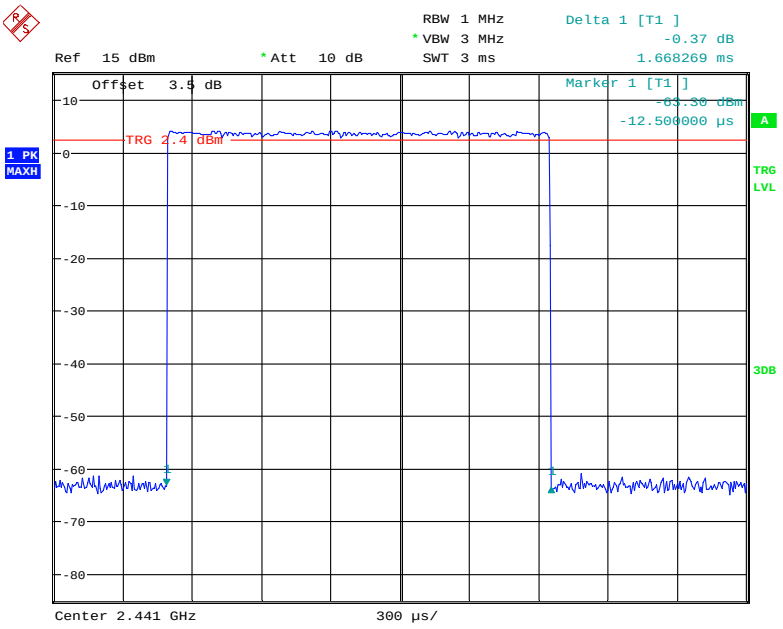

Date: 20.JUN.2018 01:19:48

## Pulse time, Low Channel, 3DH3



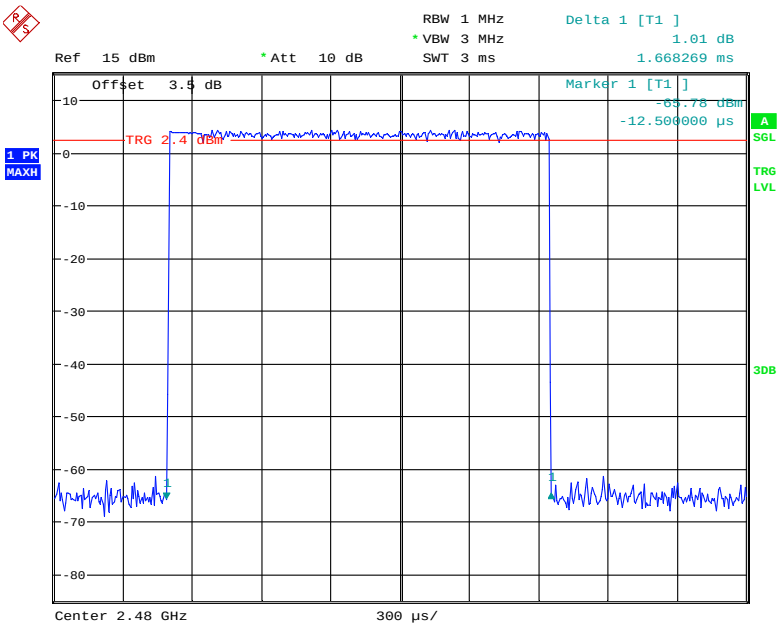

Date: 20.JUN.2018 01:04:40

## Pulse time, Middle Channel, 3DH3



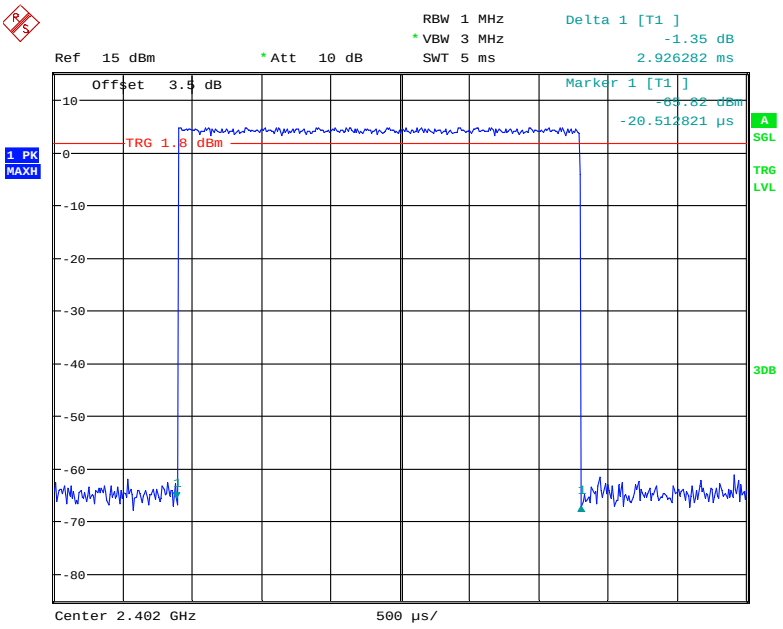

Date: 20.JUN.2018 01:05:06

## Pulse time, High Channel, 3DH3



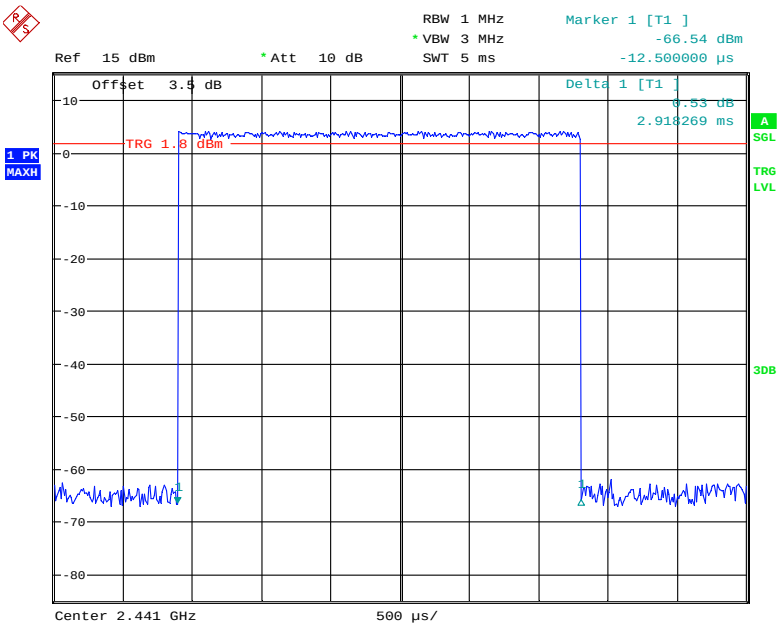

Date: 20.JUN.2018 01:05:22

## Pulse time, Low Channel, 3DH5



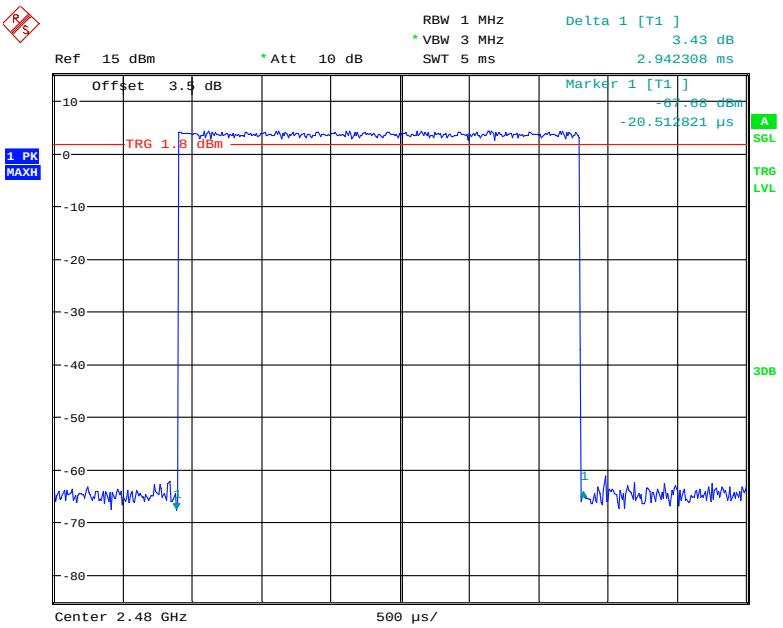

Date: 20.JUN.2018 01:08:33

## Pulse time, Middle Channel, 3DH5




Date: 20.JUN.2018 01:09:32

## Pulse time, High Channel, 3DH5




Date: 20.JUN.2018 01:07:12

# FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

## Applicable Standard

According to §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. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

## Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Hill He on 2018-06-19.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following table.*

| Mode | Channel | Frequency (MHz) | Peak Output Power | | Limit (mW) |
|---|---|---|---|---|---|
| | | | (dBm) | (mW) | |
| BDR (GFSK) | Low | 2402 | 5.87 | 3.86 | 125 |
| | Middle | 2441 | 4.84 | 3.05 | 125 |
| | High | 2480 | 5.38 | 3.45 | 125 |
| EDR (π/4-DQPSK) | Low | 2402 | 4.68 | 2.94 | 125 |
| | Middle | 2441 | 3.94 | 2.48 | 125 |
| | High | 2480 | 5.37 | 3.44 | 125 |
| EDR (8DPSK) | Low | 2402 | 4.99 | 3.16 | 125 |
| | Middle | 2441 | 4.18 | 2.62 | 125 |
| | High | 2480 | 4.59 | 2.88 | 125 |

# FCC §15.247(d) - BAND EDGES TESTING

## Applicable Standard

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 Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

## Test Data

### Environmental Conditions

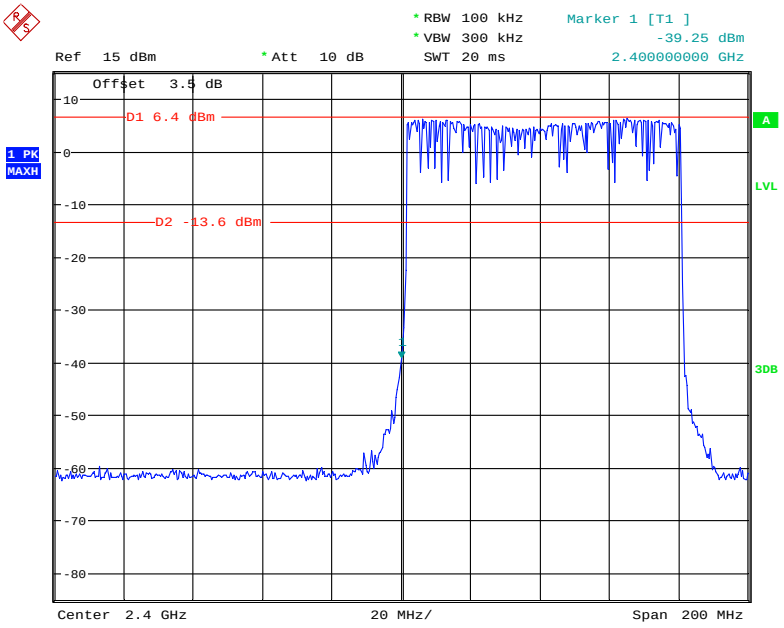
| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Hill He on 2018-06-19.*

*EUT operation mode: Transmitting*

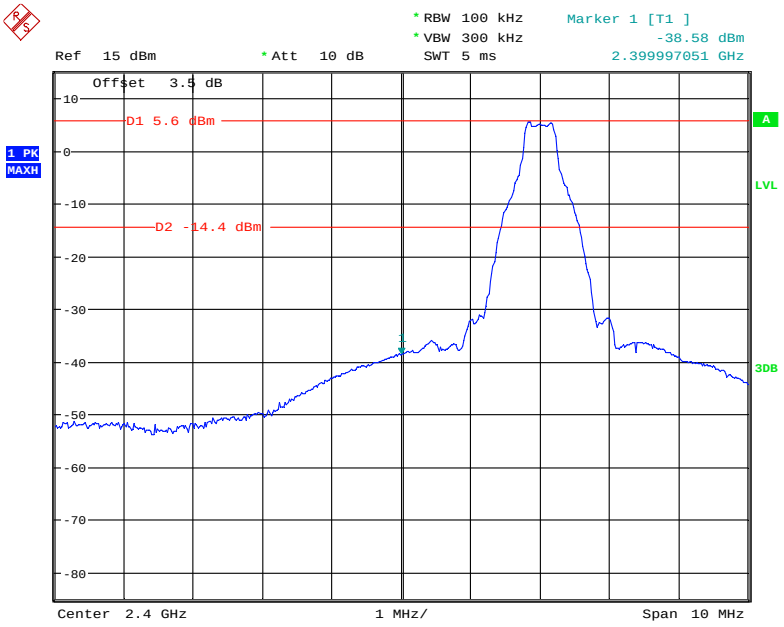
*Test Result: Compliance. Please refer to following plots.*

## BDR (GFSK): Band Edge-Left Side Hopping



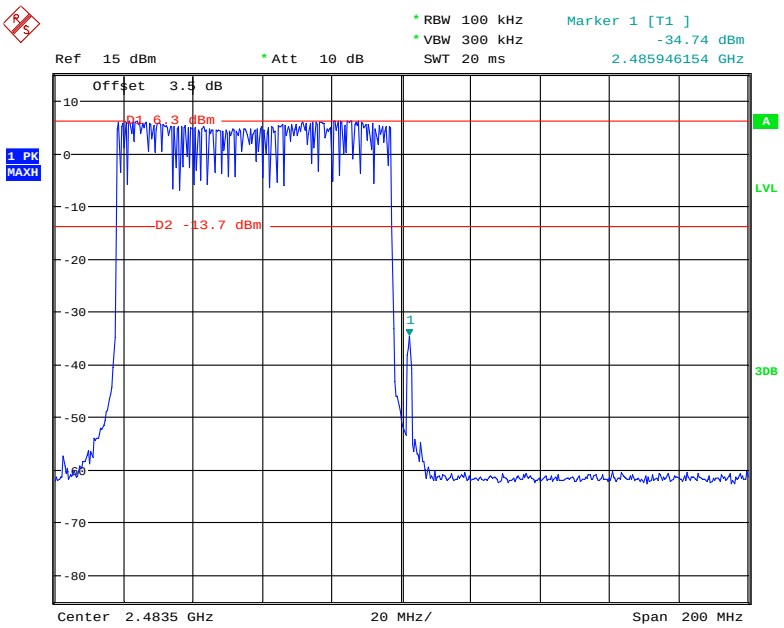

Date: 19.JUN.2018 23:13:32

## Single



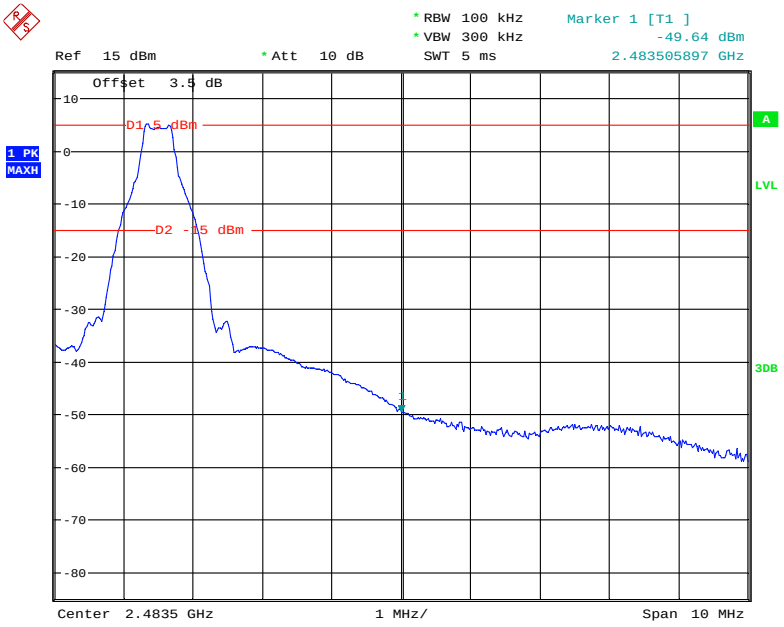

Date: 19.JUN.2018 23:06:13

## BDR (GFSK): Band Edge-Right Side Hopping



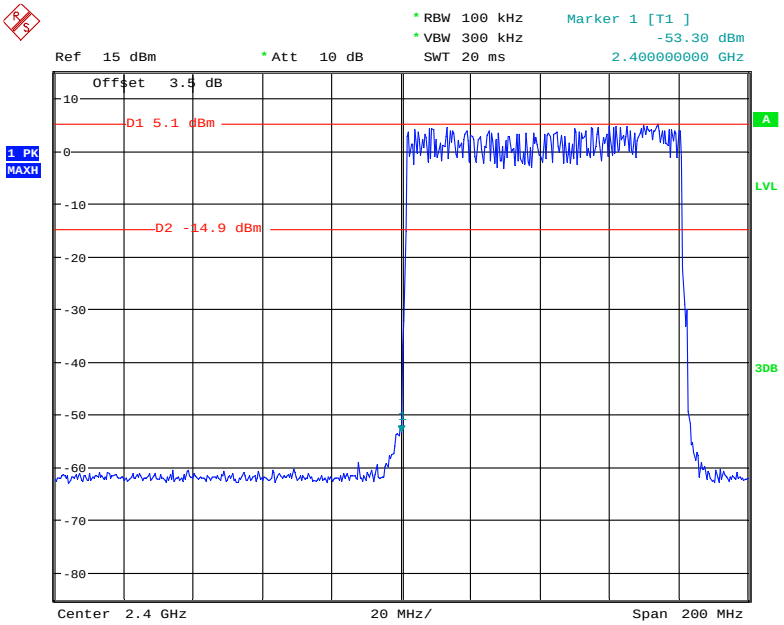

Date: 19.JUN.2018 23:17:55

## Single



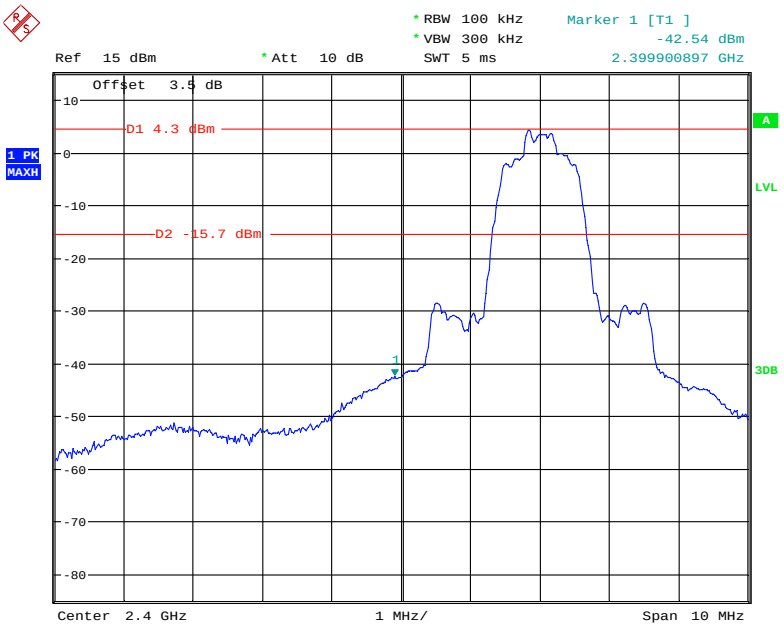

Date: 19.JUN.2018 23:04:59

## EDR (π/4-DQPSK): Band Edge-Left Side Hopping



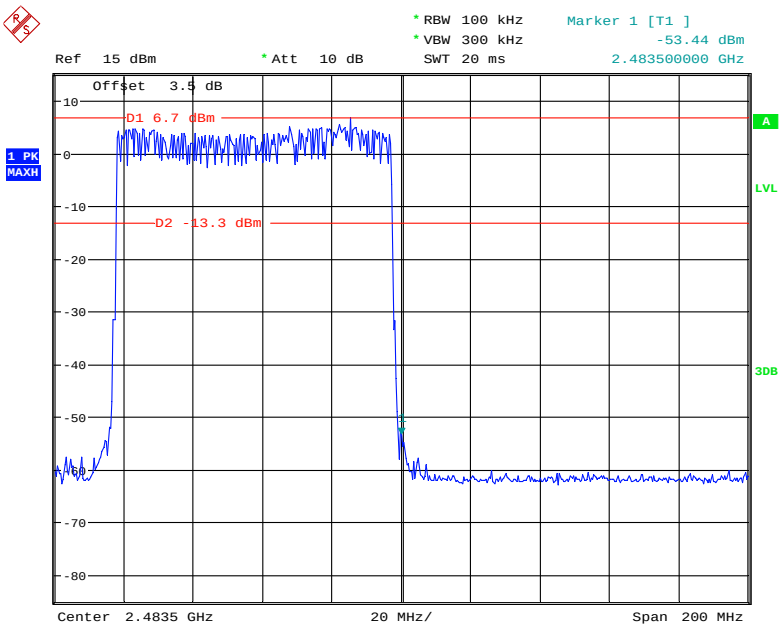

Date: 19.JUN.2018 23:22:54

## Single



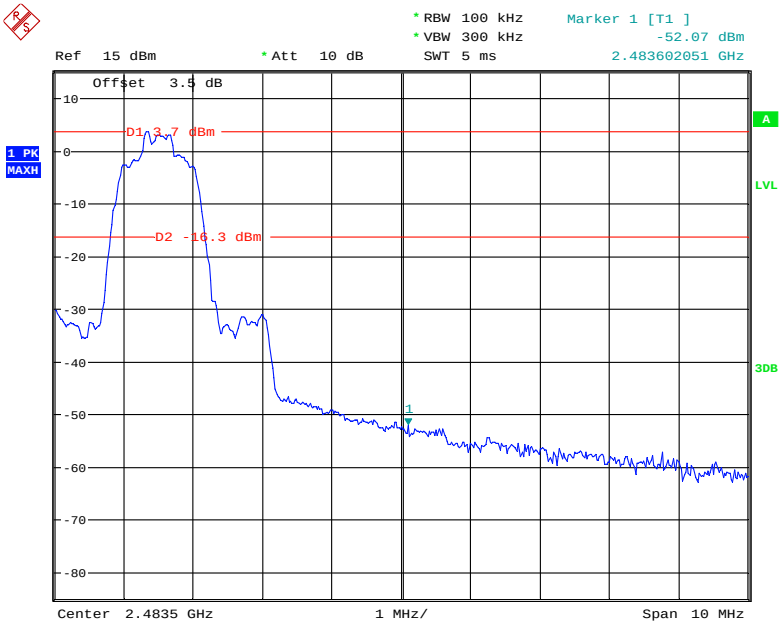

Date: 19.JUN.2018 23:02:03

## EDR (π/4-DQPSK): Band Edge-Right Side Hopping



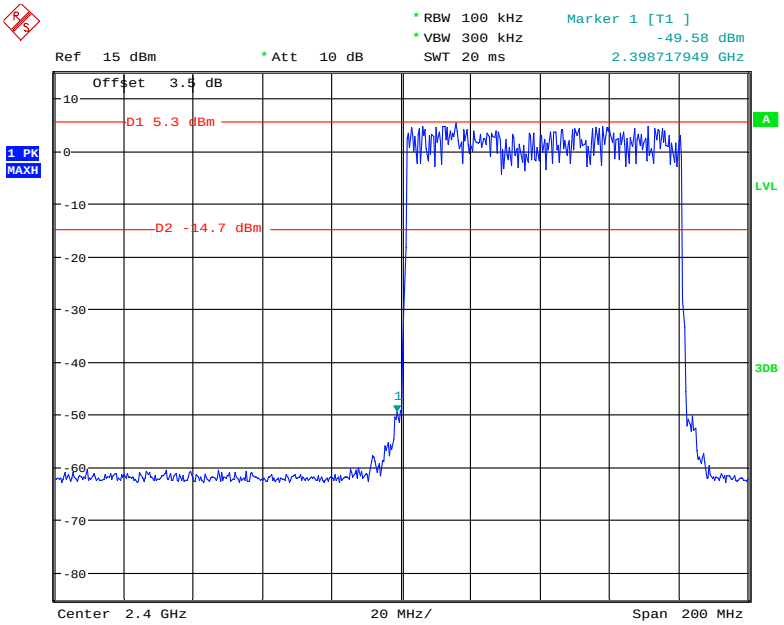

Date: 19.JUN.2018 23:21:01

## Single



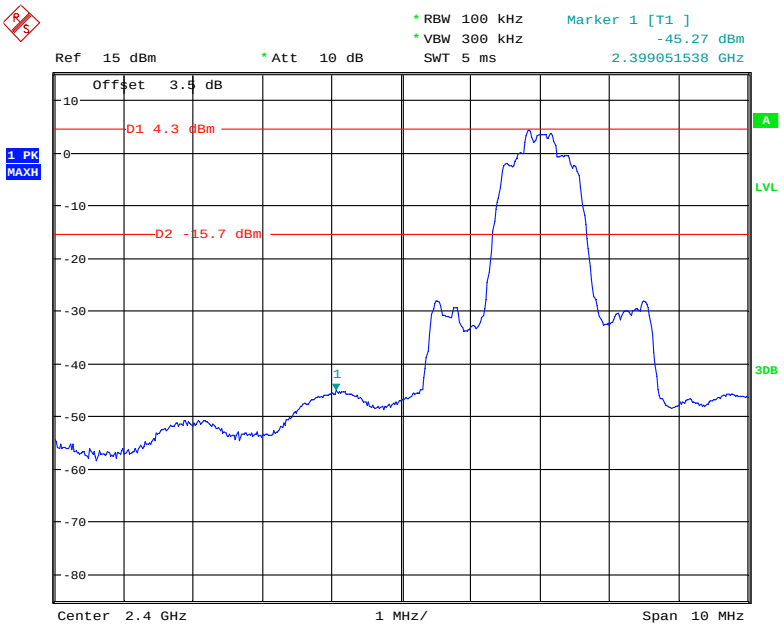

Date: 19.JUN.2018 23:03:39

## EDR (8DPSK): Band Edge-Left Side Hopping



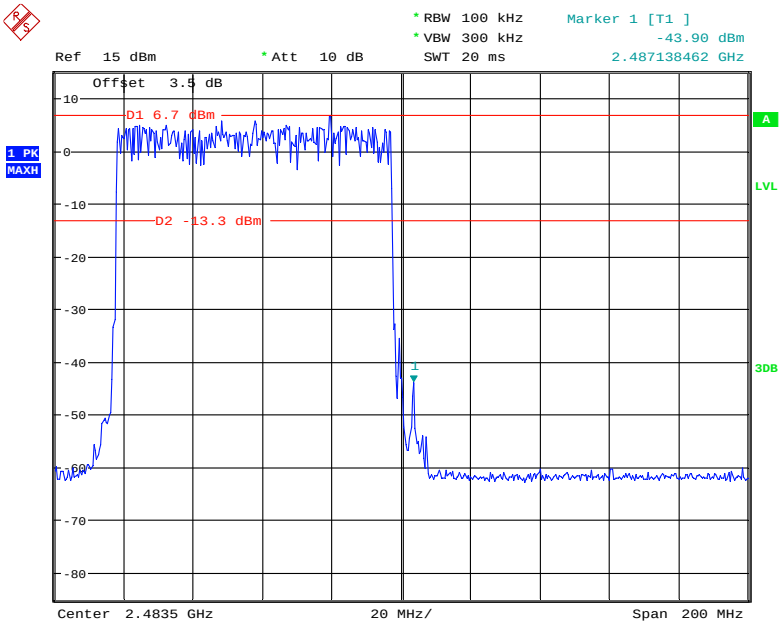

Date: 19.JUN.2018 23:28:47

## Single




Date: 19.JUN.2018 22:59:20

## EDR (8DPSK): Band Edge-Right Side Hopping

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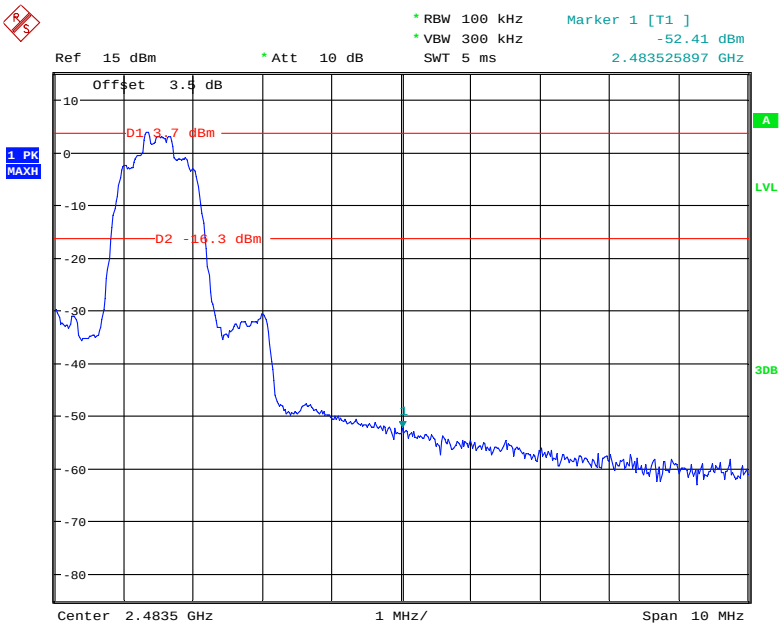
## Single

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