

# FCC PART 15.247 TEST REPORT

For

## TP-Link Technologies Co., Ltd.

Building 24 (floors 1,3,4,5) and 28 (floors1-4),Central Science and Technology  
Park,Nanshan,Shenzhen,China

**FCC ID: TE7X20PROV1**

|                                                                                                                                                                                                                                                                                                                             |                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| <b>Report Type:</b><br>Original Report                                                                                                                                                                                                                                                                                      | <b>Product Type:</b><br>X20 Pro FDD-LTE Smartphone |
| <b>Report Number:</b> RSZ190626009-00B                                                                                                                                                                                                                                                                                      |                                                    |
| <b>Report Date:</b> 2019-07-17                                                                                                                                                                                                                                                                                              |                                                    |
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## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

|                                    |                                                                                   |
|------------------------------------|-----------------------------------------------------------------------------------|
| Product                            | X20 Pro FDD-LTE Smartphone                                                        |
| Tested Model                       | TP9131C                                                                           |
| Multiple Model <sup>#</sup>        | TP9131CXYZZ                                                                       |
| Voltage Range                      | DC 3.85V from battery or DC 5.0V from adapter                                     |
| Frequency Range                    | Bluetooth: 2402~2480MHz                                                           |
| Transmit Power<br>(Peak Conducted) | Bluetooth: 11.89dBm                                                               |
| Modulation Technique               | Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK                                            |
| Antenna Specification              | FPC Antenna: 1.2dBi                                                               |
| Date of Test                       | 2019-06-27 to 2019-07-02                                                          |
| Sample serial number               | DE9131C931200001                                                                  |
| Received date                      | 2019-06-26                                                                        |
| Sample/EUT Status                  | Good condition                                                                    |
| Adapter information                | Model: A8A-050200U-US1<br>Input: AC 100-240V, 50/60Hz, 0.35A<br>Output: DC 5V, 2A |

Notes: This series products model: TP9131CXYZZ and TP9131C are identical schematics, Model TP9131C was selected for fully testing, the detailed information can be referred to the declaration which was stated and guaranteed by the applicant.

### Objective

This test report is prepared on behalf of *TP-Link Technologies Co., Ltd.* 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)

FCC Part 15.247 DTS, Part 15.407 NII, Part 22H /24E / 27 PCE and Part 15B JBP submissions with FCC ID: TE7X20PROV1.

### 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.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

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   |            | ±0.73dB     |
| RF conducted test with spectrum    |            | ±1.6dB      |
| AC Power Lines Conducted Emissions |            | ±1.95dB     |
| Emissions,<br>Radiated             | Below 1GHz | ±4.75dB     |
|                                    | Above 1GHz | ±4.88dB     |
| Temperature                        |            | ±1 °C       |
| Humidity                           |            | ±6%         |
| Supply voltages                    |            | ±0.4%       |

*Note: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.*

**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 | 1.0        | 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  |

Note: \* Please refer to SAR report released by BACL, report number: RSZ190626009-20.

**TEST EQUIPMENT LIST**

| Manufacturer                    | Description                  | Model                   | Serial Number          | Calibration Date | Calibration Due Date |
|---------------------------------|------------------------------|-------------------------|------------------------|------------------|----------------------|
| <b>Conducted Emissions Test</b> |                              |                         |                        |                  |                      |
| Rohde & Schwarz                 | EMI Test Receiver            | ESCS30                  | 100176                 | 2018-07-11       | 2019-07-11           |
| Rohde & Schwarz                 | LISN                         | ENV216                  | 3560.6650.12-101613-Yb | 2019-01-25       | 2020-01-25           |
| Rohde & Schwarz                 | Transient Limiter            | ESH3Z2                  | DE25985                | 2019-03-02       | 2020-03-02           |
| Rohde & Schwarz                 | CE Test software             | EMC 32                  | V8.53.0                | NCR              | NCR                  |
| Un-known                        | Conducted Emission Cable     | 78652                   | UF A210B-1-0720-504504 | 2018-11-12       | 2019-11-12           |
| <b>Radiated Emission Test</b>   |                              |                         |                        |                  |                      |
| A.H. System                     | Horn Antenna                 | SAS-200/571             | 135                    | 2018-09-01       | 2021-08-31           |
| Rohde & Schwarz                 | Signal and Spectrum Analyzer | FSV40-N                 | 102259                 | 2019-06-22       | 2020-06-22           |
| Sunol Sciences                  | Broadband Antenna            | JB1                     | A040904-1              | 2017-12-22       | 2020-12-21           |
| COM-POWER                       | Pre-amplifier                | PA-122                  | 181919                 | 2018-11-12       | 2019-11-12           |
| Sonoma Instrument               | Amplifier                    | 310N                    | 186238                 | 2018-11-12       | 2019-11-12           |
| Rohde & Schwarz                 | EMI Test Receiver            | ESR                     | 1316.3003K03-101746-zn | 2018-07-11       | 2019-07-11           |
| Ducommun technologies           | RF Cable                     | UFA147A-2362-100100     | MFR64639 231029-003    | 2018-11-12       | 2019-11-12           |
| Ducommun technologies           | RF Cable                     | 104PEA                  | 218124002              | 2018-11-12       | 2019-11-12           |
| Ducommun technologies           | RF Cable                     | RG-214                  | 1                      | 2019-05-21       | 2019-11-19           |
| Ducommun technologies           | RF Cable                     | RG-214                  | 2                      | 2018-11-12       | 2019-11-12           |
| the electro-Mechanics Co.       | Horn Antenna                 | 3116                    | 9510-2270              | 2016-10-14       | 2019-10-14           |
| Heatsink Required               | Amplifier                    | QLW-18405536-J0         | 15964001002            | 2018-11-12       | 2019-11-12           |
| Sinoscite                       | Notch Filter                 | BSF2402-2480MN-0898-001 | 99632                  | 2018-11-12       | 2019-11-12           |
| Rohde & Schwarz                 | Auto test software           | EMC 32                  | V9.10                  | NCR              | NCR                  |

| Manufacturer             | Description              | Model   | Serial Number | Calibration Date | Calibration Due Date |
|--------------------------|--------------------------|---------|---------------|------------------|----------------------|
| <b>RF Conducted Test</b> |                          |         |               |                  |                      |
| Agilent                  | USB wideband power meter | U2021XA | MY54250003    | 2019-06-23       | 2020-06-23           |
| WEINSCHTEL               | 3 dB Attenuator          | N/A     | N/A           | Each Time        |                      |
| Rohde & Schwarz          | Spectrum Analyzer        | FSU26   | 200120        | 2019-03-02       | 2020-03-01           |
| 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).

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

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### **Applicable Standard**

FCC§1.1310 and §2.1093.

### **Test Result**

Compliance, please refer to the SAR report: RSZ190626009-20.

**FCC §15.203 – ANTENNA REQUIREMENT**

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**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 1.2 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

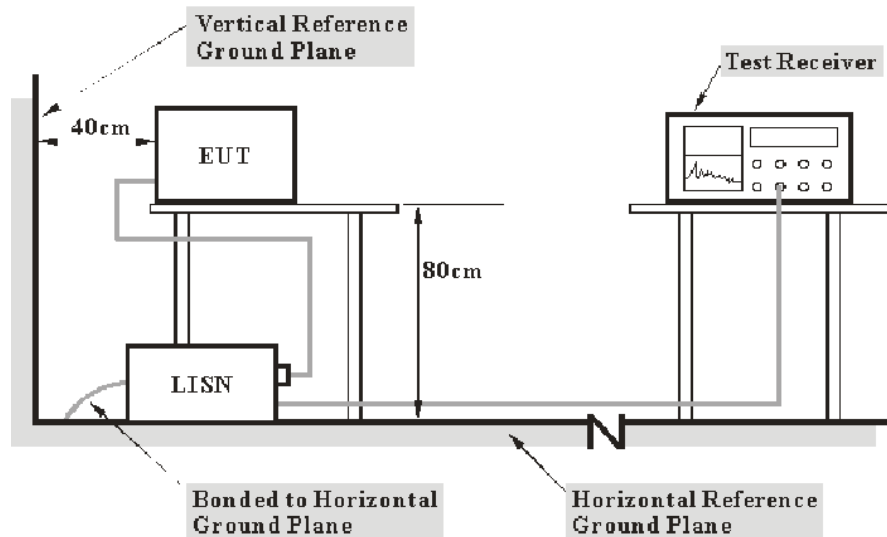
**Result:** Compliance.

## 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:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## 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

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

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

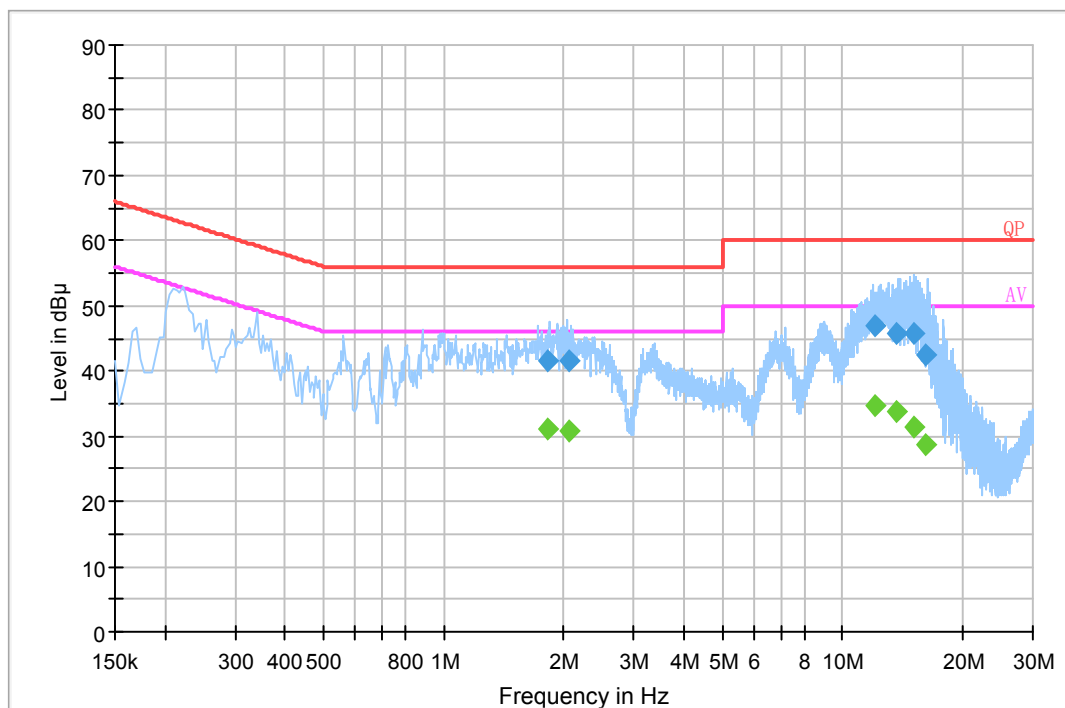
## Test Data

### Environmental Conditions

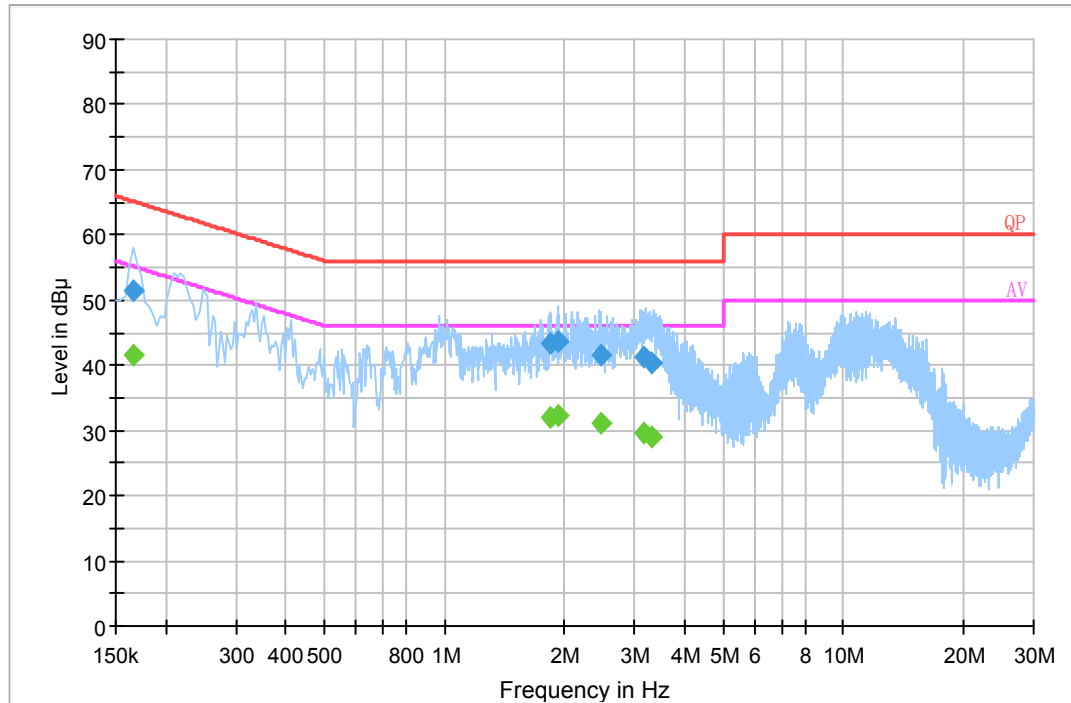
|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 50 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Haiguo Li on 2019-07-02.*

*EUT operation mode: Transmitting & charging (the worst case is 8DPSK Mode, Middle channel)*

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

| Frequency (MHz) | Corrected Amplitude (dBμV) | Correction Factor (dB) | Limit (dBμV) | Margin (dB) | Detector (PK/Ave./QP) |
|-----------------|----------------------------|------------------------|--------------|-------------|-----------------------|
| 1.822370        | 41.6                       | 19.9                   | 56.0         | 14.4        | QP                    |
| 2.063430        | 41.5                       | 19.9                   | 56.0         | 14.5        | QP                    |
| 12.104890       | 46.9                       | 20.0                   | 60.0         | 13.1        | QP                    |
| 13.646490       | 45.8                       | 20.0                   | 60.0         | 14.2        | QP                    |
| 15.143530       | 45.9                       | 20.0                   | 60.0         | 14.1        | QP                    |
| 16.121410       | 42.5                       | 20.1                   | 60.0         | 17.5        | QP                    |
| 1.822370        | 31.1                       | 19.9                   | 46.0         | 14.9        | Ave.                  |
| 2.063430        | 30.9                       | 19.9                   | 46.0         | 15.1        | Ave.                  |
| 12.104890       | 34.7                       | 20.0                   | 50.0         | 15.3        | Ave.                  |
| 13.646490       | 33.8                       | 20.0                   | 50.0         | 16.2        | Ave.                  |
| 15.143530       | 31.3                       | 20.0                   | 50.0         | 18.7        | Ave.                  |
| 16.121410       | 28.8                       | 20.1                   | 50.0         | 21.2        | Ave.                  |

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

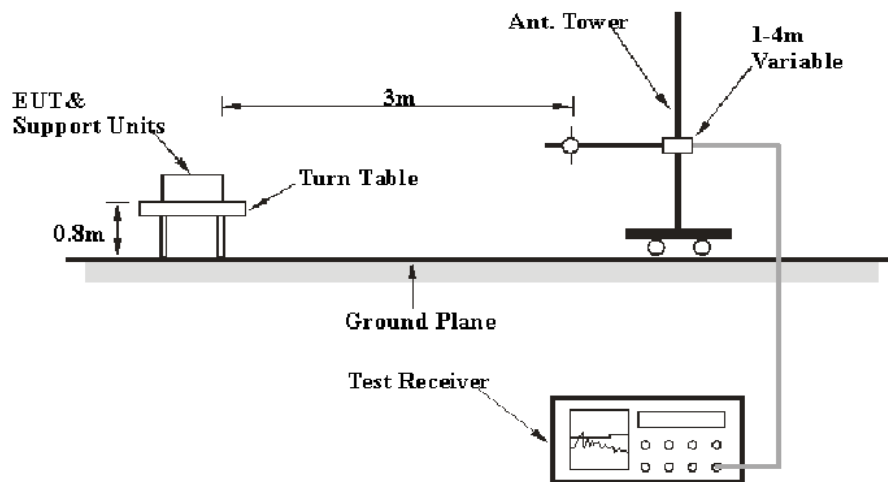
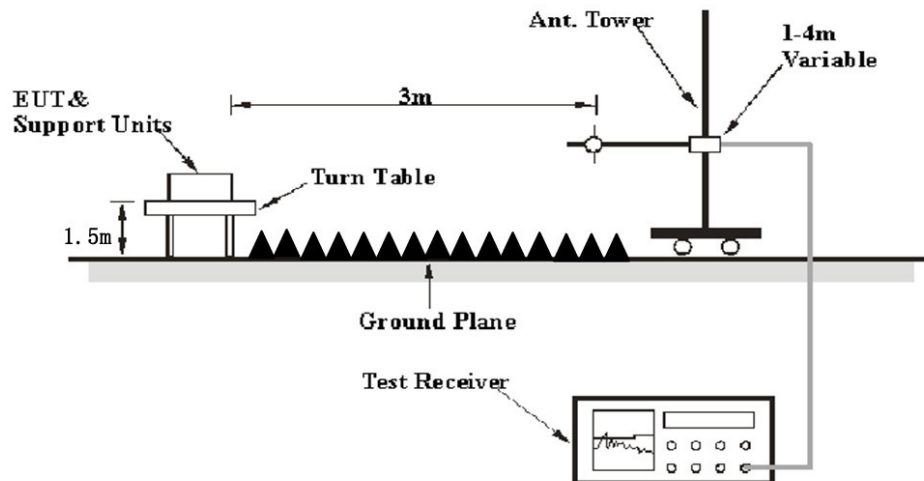
| Frequency (MHz) | Corrected Amplitude (dBμV) | Correction Factor (dB) | Limit (dBμV) | Margin (dB) | Detector (PK/Ave./QP) |
|-----------------|----------------------------|------------------------|--------------|-------------|-----------------------|
| 0.165500        | 51.5                       | 19.8                   | 65.2         | 13.7        | QP                    |
| 1.838490        | 43.4                       | 19.8                   | 56.0         | 12.6        | QP                    |
| 1.929230        | 43.8                       | 19.9                   | 56.0         | 12.2        | QP                    |
| 2.461190        | 41.5                       | 19.8                   | 56.0         | 14.5        | QP                    |
| 3.161970        | 41.3                       | 19.9                   | 56.0         | 14.7        | QP                    |
| 3.323750        | 40.3                       | 19.9                   | 56.0         | 15.7        | QP                    |
| 0.165500        | 41.4                       | 19.8                   | 55.2         | 13.7        | Ave.                  |
| 1.838490        | 32.0                       | 19.8                   | 46.0         | 14.0        | Ave.                  |
| 1.929230        | 32.4                       | 19.9                   | 46.0         | 13.6        | Ave.                  |
| 2.461190        | 31.1                       | 19.8                   | 46.0         | 14.9        | Ave.                  |
| 3.161970        | 29.6                       | 19.9                   | 46.0         | 16.4        | Ave.                  |
| 3.323750        | 28.9                       | 19.9                   | 46.0         | 17.1        | 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, According to the DA 00-705 Released March 30, 2000, 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:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## 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.

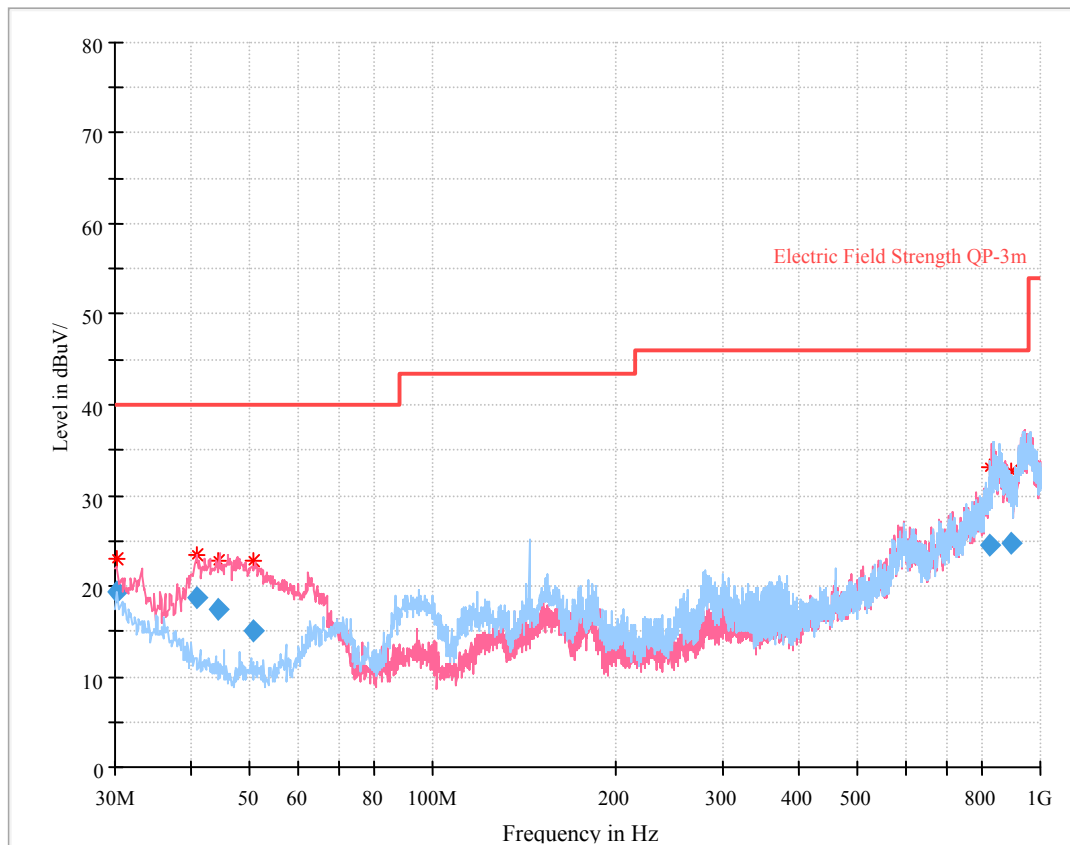
**Test Data****Environmental Conditions**

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 52 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

The testing was performed by Baston Chen on 2019-07-02 and Curry Xiang on 2019-06-27 and 2019-07-17.

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

**30 MHz~1 GHz:** (the worst case is 8DPSK Mode, Middle channel)



| Frequency (MHz) | Corrected Amplitude (dBμV/m) | Antenna height (cm) | Antenna Polarity | Turntable position (degree) | Correction Factor (dB/m) | Limit (dBμV/m) | Margin (dB) |
|-----------------|------------------------------|---------------------|------------------|-----------------------------|--------------------------|----------------|-------------|
| 30.111359       | 19.28                        | 100.0               | V                | 231.0                       | -7.7                     | 40.00          | 20.72       |
| 40.994750       | 18.65                        | 105.0               | V                | 227.0                       | -14.5                    | 40.00          | 21.35       |
| 44.255125       | 17.43                        | 107.0               | V                | 218.0                       | -16.8                    | 40.00          | 22.57       |
| 50.629000       | 14.98                        | 100.0               | V                | 231.0                       | -19.7                    | 40.00          | 25.02       |
| 826.782125      | 24.52                        | 278.0               | V                | 354.0                       | 4.6                      | 46.00          | 21.48       |
| 897.012875      | 24.76                        | 239.0               | H                | 78.0                        | 4.3                      | 46.00          | 21.24       |

**1 GHz - 25 GHz:**

| Frequency<br>(MHz)        | Receiver          |            | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB/m) | Corrected<br>Amplitude<br>(dBμV/m) | Limit<br>(dBμV/m) | Margin<br>(dB) |
|---------------------------|-------------------|------------|---------------------|---------------|----------------|-------------------------------|------------------------------------|-------------------|----------------|
|                           | Reading<br>(dBμV) | PK/QP/Ave. |                     | Height<br>(m) | Polar<br>(H/V) |                               |                                    |                   |                |
| Low Channel (2402 MHz)    |                   |            |                     |               |                |                               |                                    |                   |                |
| 2373.52                   | 28.04             | PK         | 331                 | 1.7           | H              | 31.87                         | 59.91                              | 74                | 14.09          |
| 2373.52                   | 14.16             | Ave.       | 331                 | 1.7           | H              | 31.87                         | 46.03                              | 54                | 7.97           |
| 2496.93                   | 28.51             | PK         | 285                 | 1.3           | H              | 32.13                         | 60.64                              | 74                | 13.36          |
| 2496.93                   | 14.71             | Ave.       | 285                 | 1.3           | H              | 32.13                         | 46.84                              | 54                | 7.16           |
| 4804.00                   | 47.81             | PK         | 44                  | 1.5           | H              | 6.28                          | 54.09                              | 74                | 19.91          |
| 4804.00                   | 37.41             | Ave.       | 356                 | 2.2           | H              | 6.28                          | 43.69                              | 54                | 10.31          |
| Middle Channel (2441 MHz) |                   |            |                     |               |                |                               |                                    |                   |                |
| 4882.00                   | 44.56             | PK         | 94                  | 2.2           | H              | 6.76                          | 51.32                              | 74                | 22.68          |
| 4882.00                   | 33.13             | Ave.       | 94                  | 2.2           | H              | 6.76                          | 39.89                              | 54                | 14.11          |
| High Channel (2480 MHz)   |                   |            |                     |               |                |                               |                                    |                   |                |
| 2311.45                   | 27.79             | PK         | 18                  | 2.0           | H              | 31.64                         | 59.43                              | 74                | 14.57          |
| 2311.45                   | 13.89             | Ave.       | 18                  | 2.0           | H              | 31.64                         | 45.53                              | 54                | 8.47           |
| 2487.01                   | 28.14             | PK         | 330                 | 1.7           | H              | 32.13                         | 60.27                              | 74                | 13.73          |
| 2487.01                   | 14.29             | Ave.       | 330                 | 1.7           | H              | 32.13                         | 46.42                              | 54                | 7.58           |
| 4960.00                   | 44.95             | PK         | 28                  | 1.8           | H              | 6.80                          | 51.75                              | 74                | 22.25          |
| 4960.00                   | 33.71             | Ave.       | 28                  | 1.8           | H              | 6.80                          | 40.51                              | 54                | 13.49          |

Note:

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

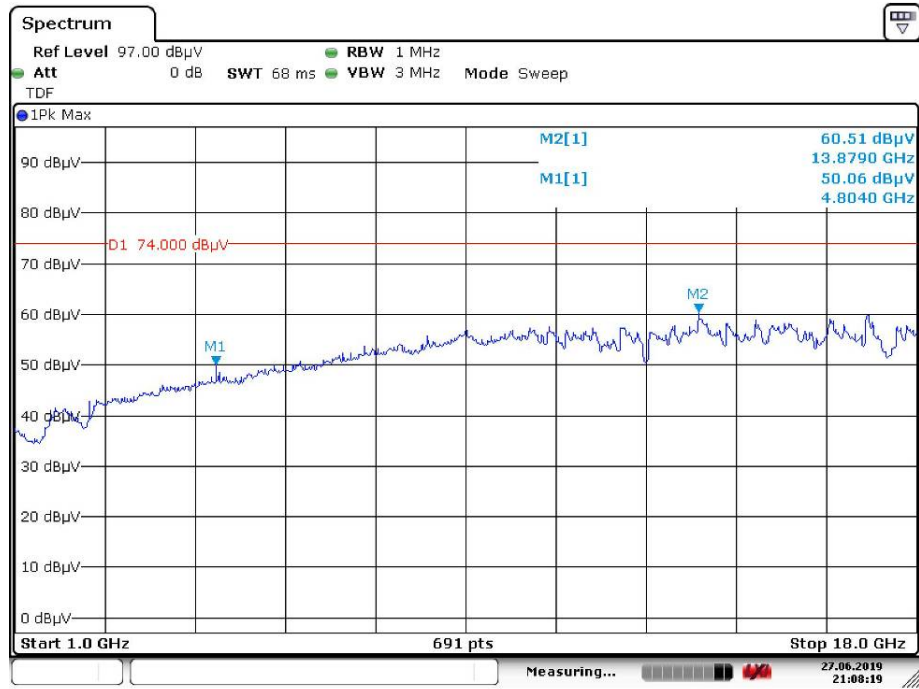
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

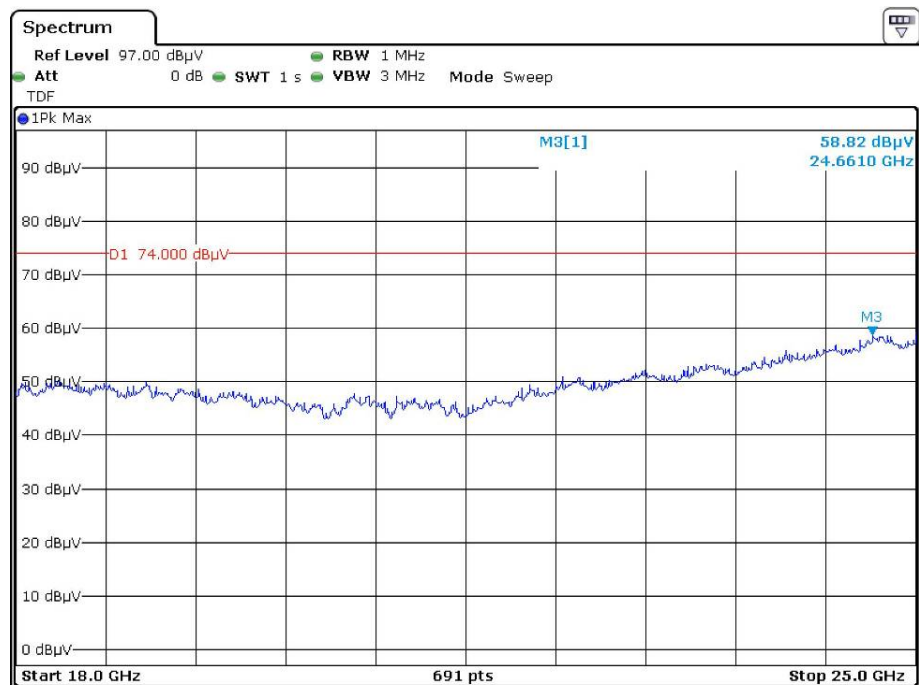
The other spurious emission which is 20dB to the limit was not recorded.

And for the pre-scan is performed with the 2400-2483.5MHz band filter.

# Pre-scan with Low channel Peak Horizontal

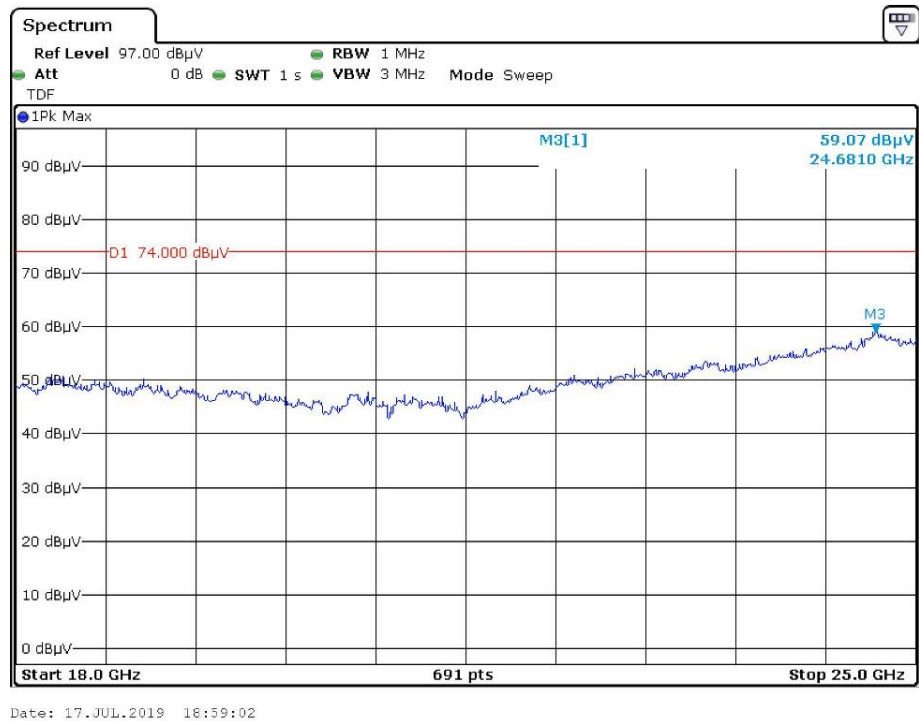
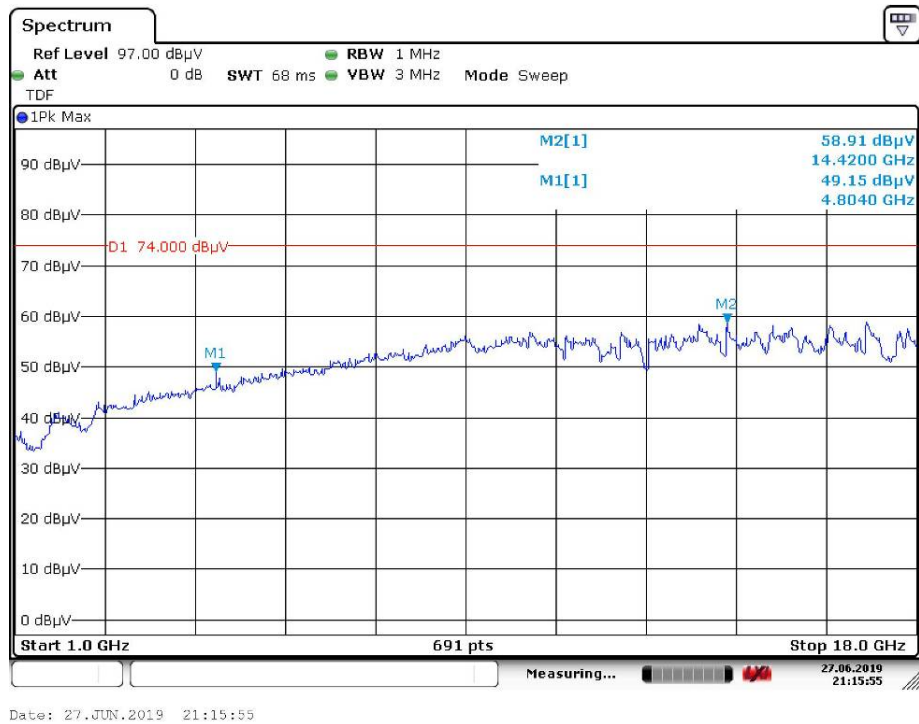


Date: 27.JUN.2019 21:08:19

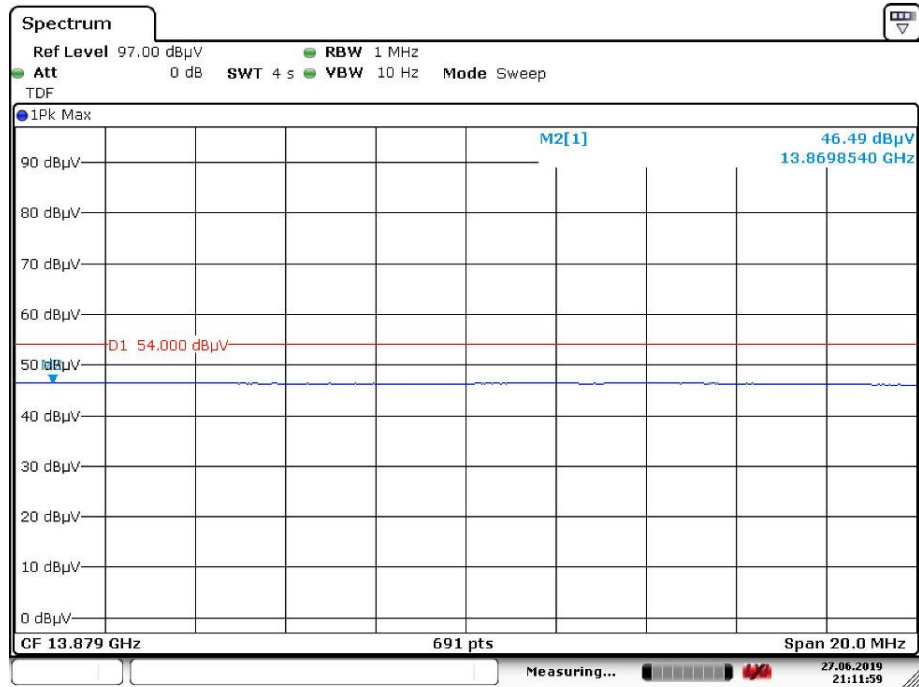


Date: 17.JUL.2019 18:51:45

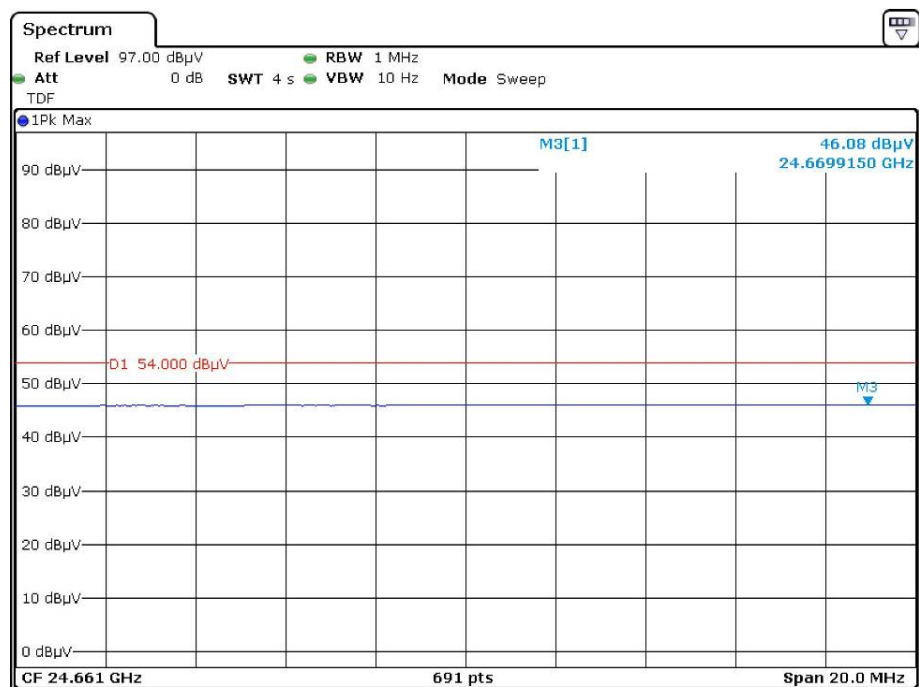
# Vertical



### Pre-scan for Average Horizontal

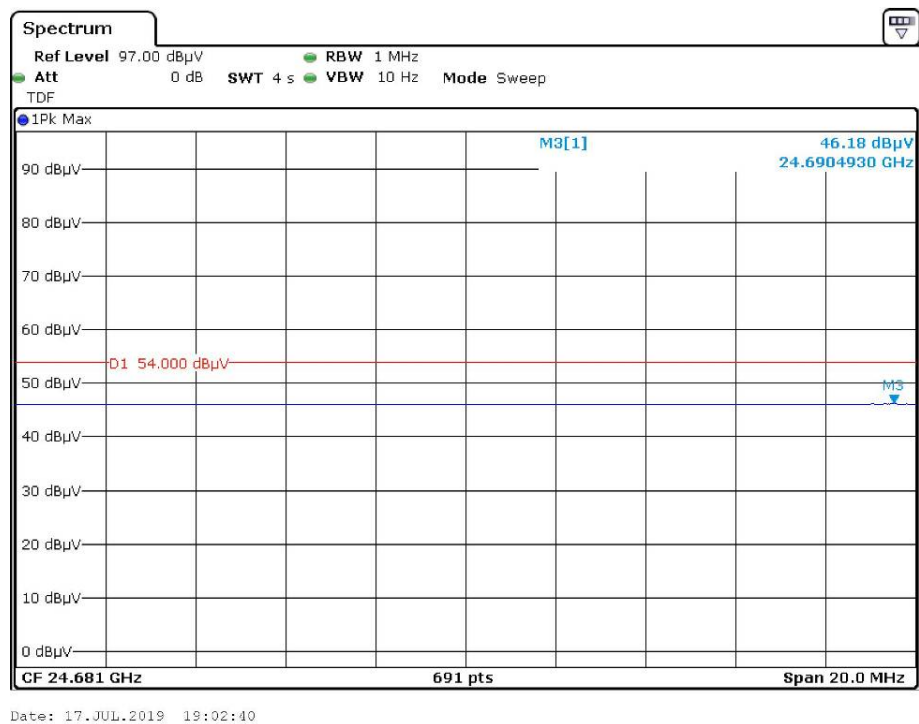
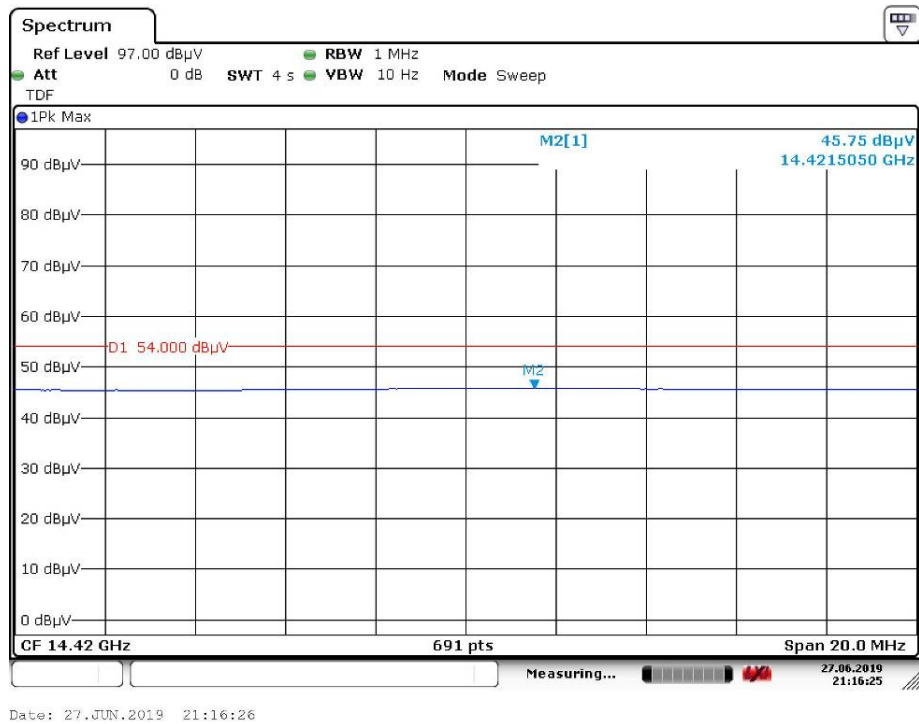


Date: 27.JUN.2019 21:11:59



Date: 17.JUL.2019 18:55:17

## Vertical



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

### **Applicable Standard**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly 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.

### **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**

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 55 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Leo Huang on 2019-06-28.*

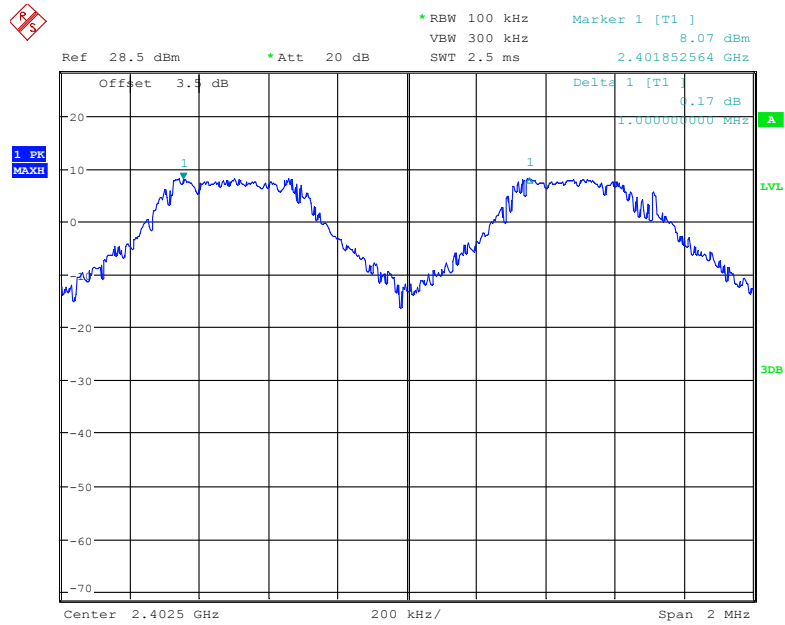
*EUT operation mode: Transmitting*

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

| Channel                              | Channel Separation (MHz) | 20 dBc BW (MHz) | Two-thirds of the 20 dB bandwidth (MHz) | Channel Separation Limit            | Result     |
|--------------------------------------|--------------------------|-----------------|-----------------------------------------|-------------------------------------|------------|
| <b>BDR(GFSK)</b>                     |                          |                 |                                         |                                     |            |
| Low                                  | 1.000                    | 0.836           | 0.557                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| Middle                               | 1.006                    | 0.842           | 0.561                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| High                                 | 1.006                    | 0.789           | 0.526                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| <b>EDR(<math>\pi/4</math>-DQPSK)</b> |                          |                 |                                         |                                     |            |
| Low                                  | 0.997                    | 1.248           | 0.832                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| Middle                               | 1.000                    | 1.243           | 0.829                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| High                                 | 1.006                    | 1.252           | 0.835                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| <b>EDR(8DPSK)</b>                    |                          |                 |                                         |                                     |            |
| Low                                  | 0.997                    | 1.258           | 0.839                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| Middle                               | 1.003                    | 1.258           | 0.839                                   | > two-thirds of the 20 dB bandwidth | Compliance |
| High                                 | 1.013                    | 1.271           | 0.847                                   | > two-thirds of the 20 dB bandwidth | Compliance |

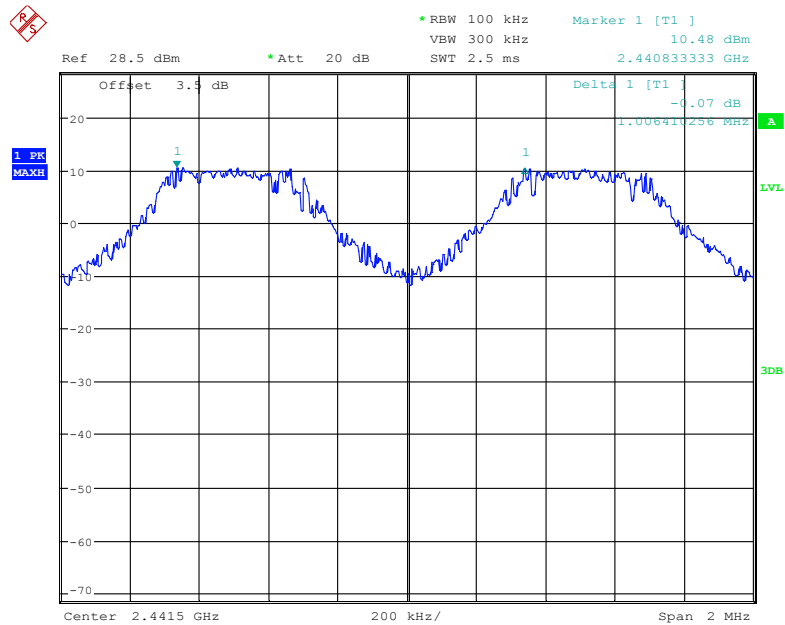
Please refer to the following plots.

### BDR (GFSK): Low Channel



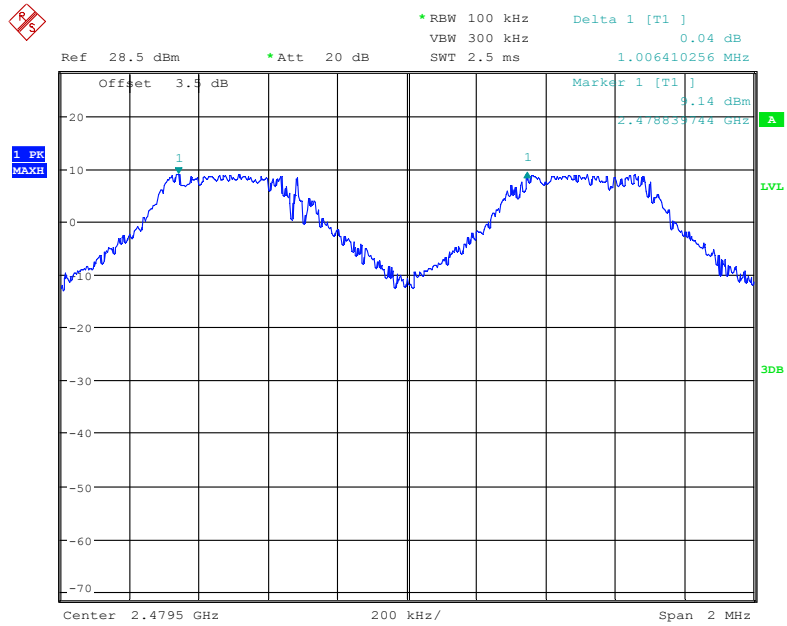
Date: 28.JUN.2019 18:32:26

### BDR (GFSK): Middle Channel



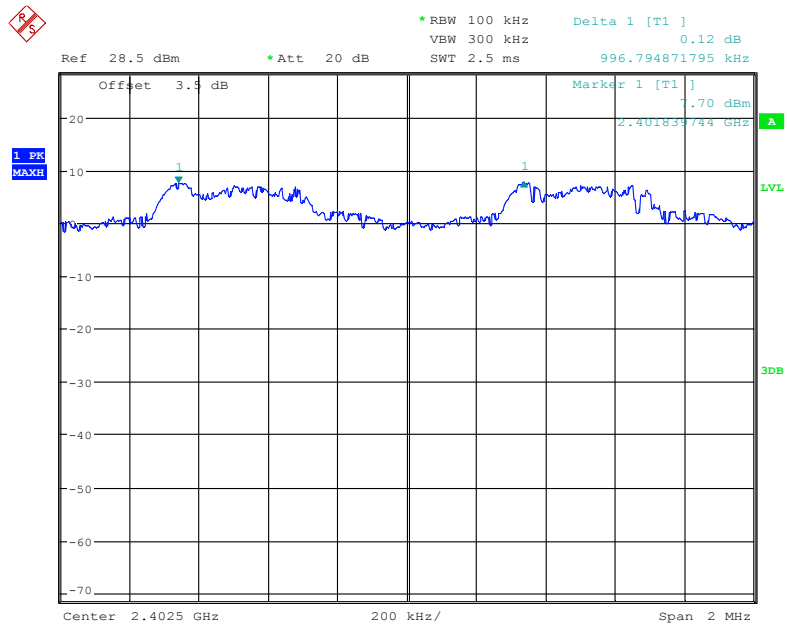
Date: 28.JUN.2019 18:30:42

### BDR (GFSK): High Channel



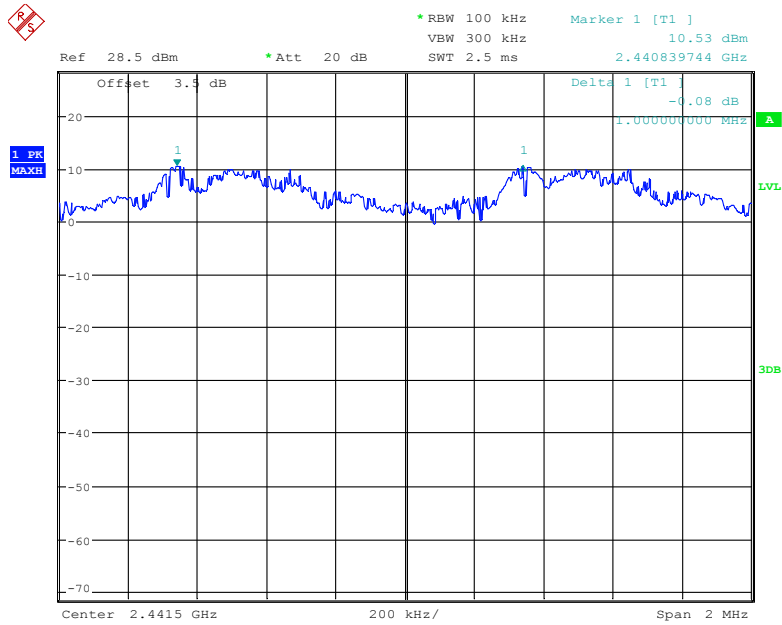
Date: 28.JUN.2019 18:33:28

### EDR ( $\pi/4$ -DQPSK): Low Channel



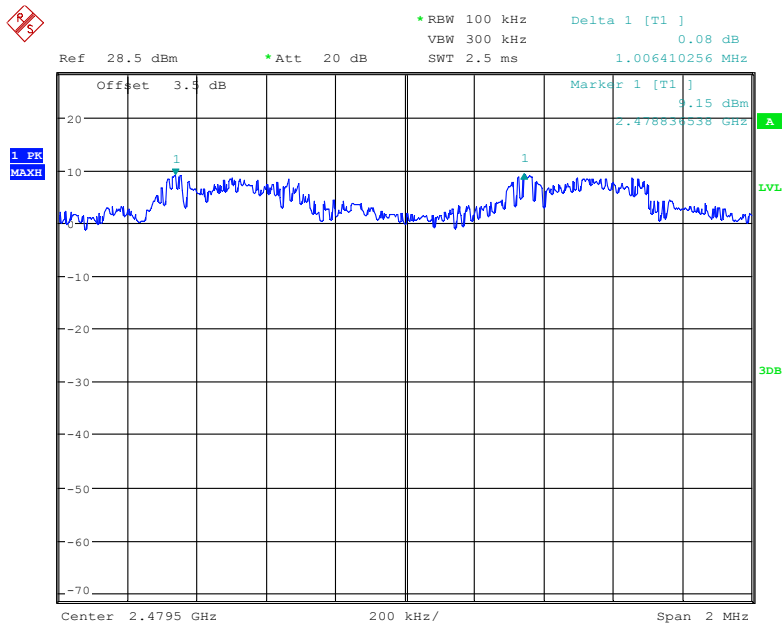
Date: 28.JUN.2019 18:39:58

### EDR ( $\pi/4$ -DQPSK): Middle Channel



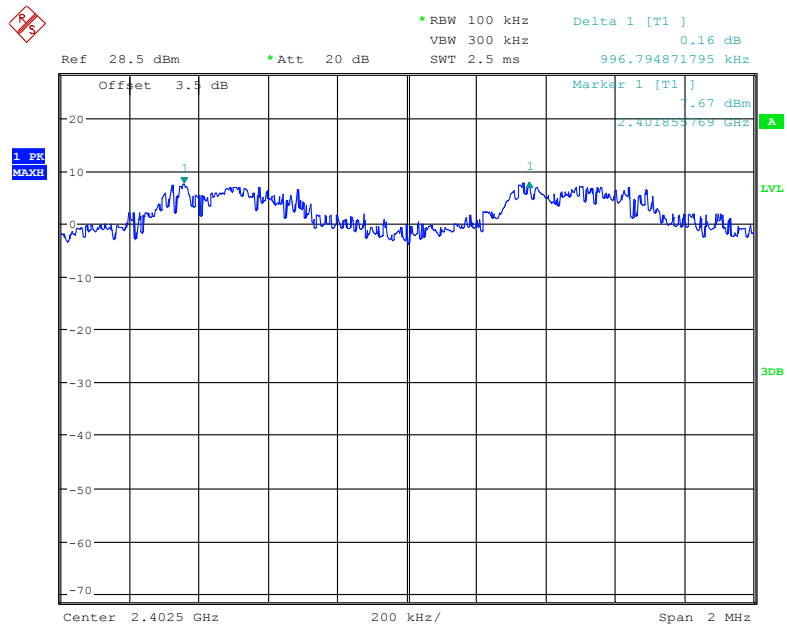
Date: 28.JUN.2019 18:36:36

### EDR ( $\pi/4$ -DQPSK): High Channel



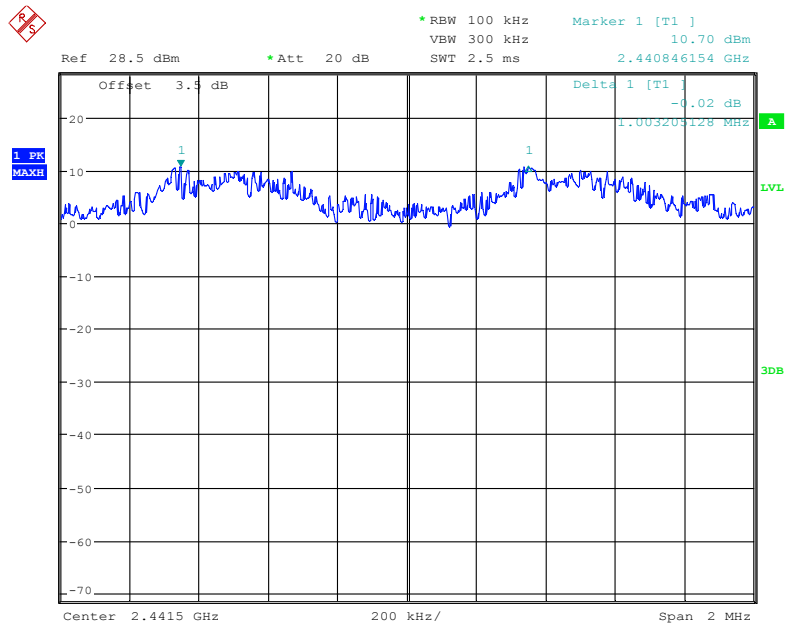
Date: 28.JUN.2019 18:35:09

### EDR (8DPSK): Low Channel



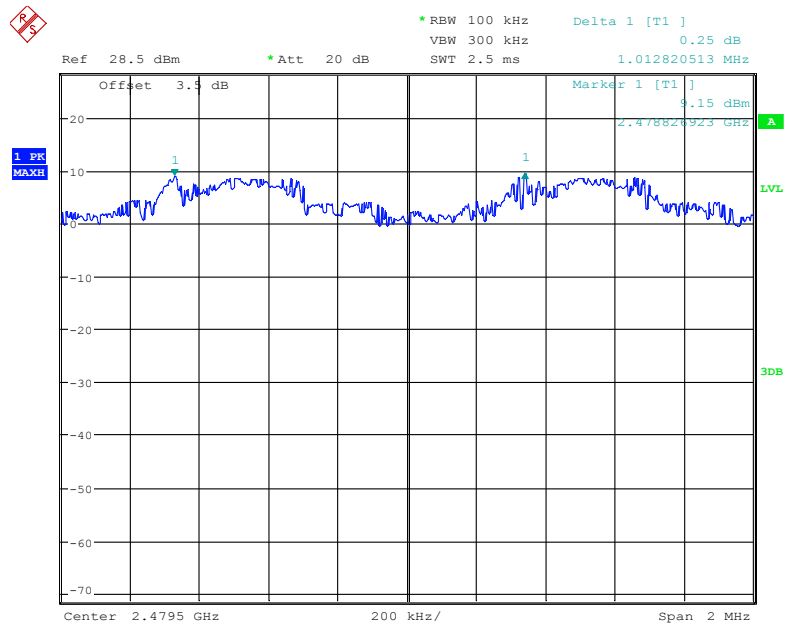
Date: 28.JUN.2019 18:41:34

### EDR (8DPSK): Middle Channel



Date: 28.JUN.2019 18:42:54

### EDR (8DPSK): High Channel



Date: 28.JUN.2019 18:45:21

**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**

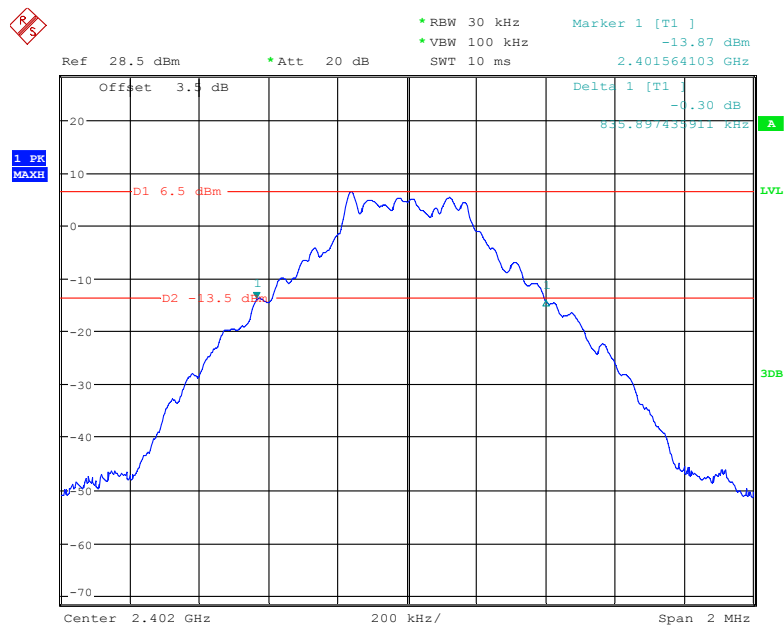
|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Leo Huang on 2019-06-28.*

*EUT operation mode: Transmitting*

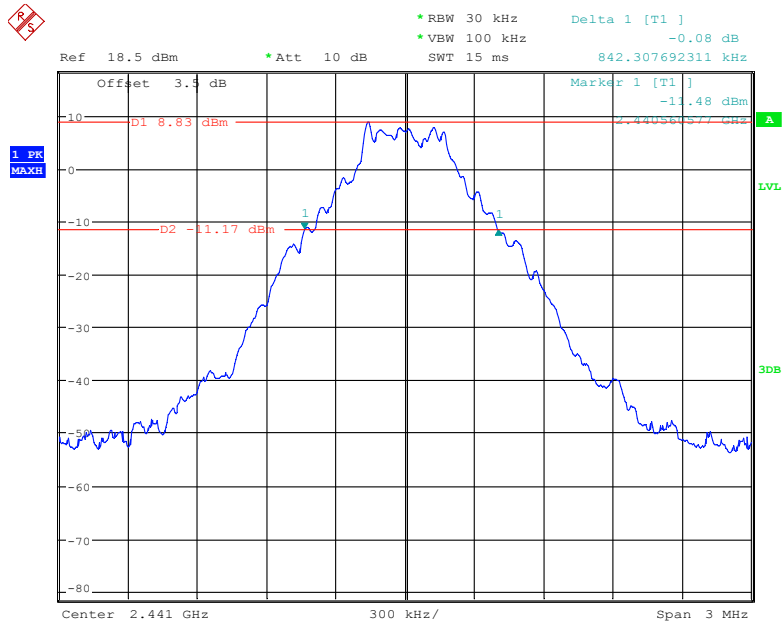
*Test Result: Compliance. Please refer to following table and plots.*

| Mode                                  | Channel | Frequency (MHz) | 20 dB Emission Bandwidth (MHz) |
|---------------------------------------|---------|-----------------|--------------------------------|
| <b>BDR (GFSK)</b>                     | Low     | 2402            | 0.836                          |
|                                       | Middle  | 2441            | 0.842                          |
|                                       | High    | 2480            | 0.789                          |
| <b>EDR (<math>\pi/4</math>-DQPSK)</b> | Low     | 2402            | 1.248                          |
|                                       | Middle  | 2441            | 1.243                          |
|                                       | High    | 2480            | 1.252                          |
| <b>EDR (8DPSK)</b>                    | Low     | 2402            | 1.258                          |
|                                       | Middle  | 2441            | 1.258                          |
|                                       | High    | 2480            | 1.271                          |

**BDR (GFSK): Low Channel**

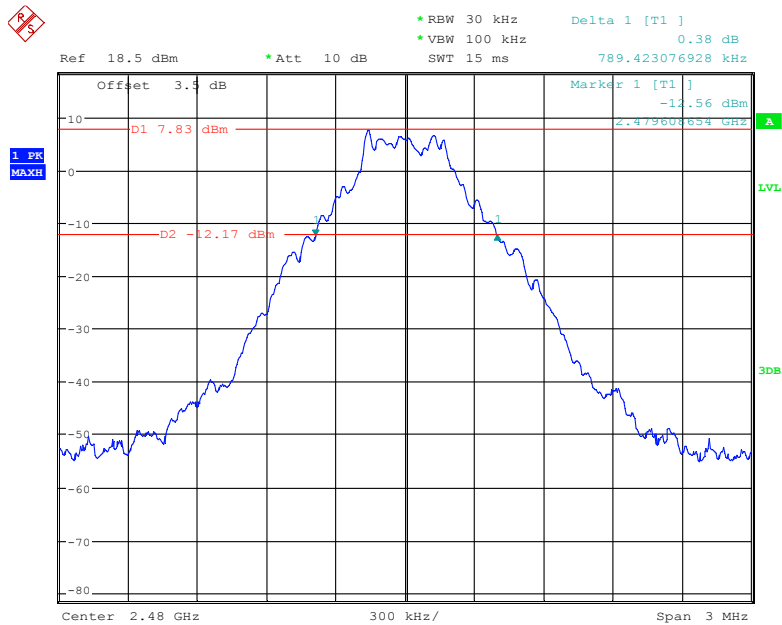
Date: 28.JUN.2019 18:47:22

### BDR (GFSK): Middle Channel



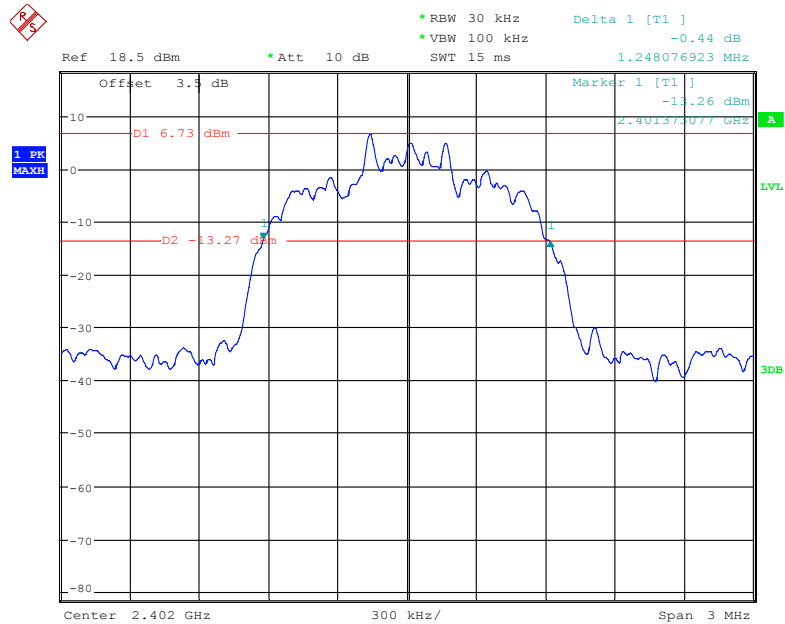
Date: 28.JUN.2019 13:29:34

### BDR (GFSK): High Channel



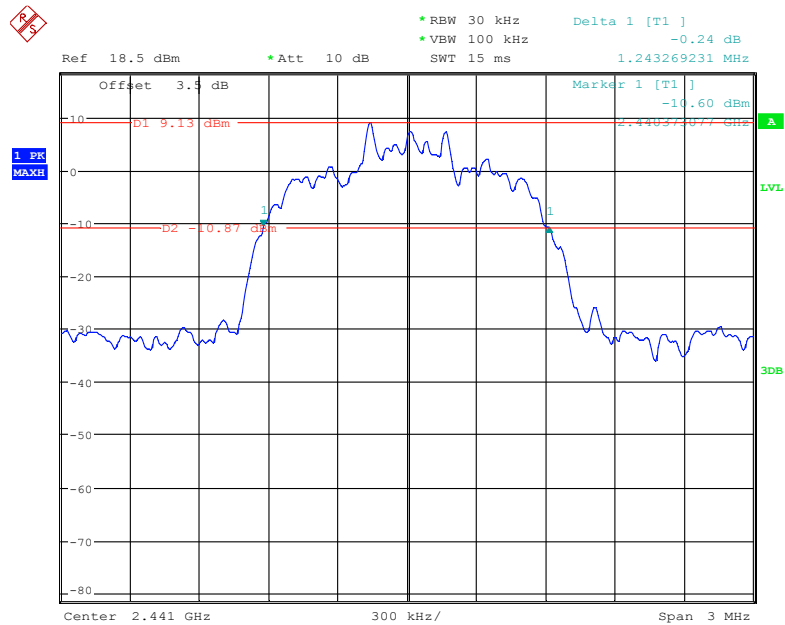
Date: 28.JUN.2019 13:28:01

### EDR ( $\pi/4$ -DQPSK): Low Channel



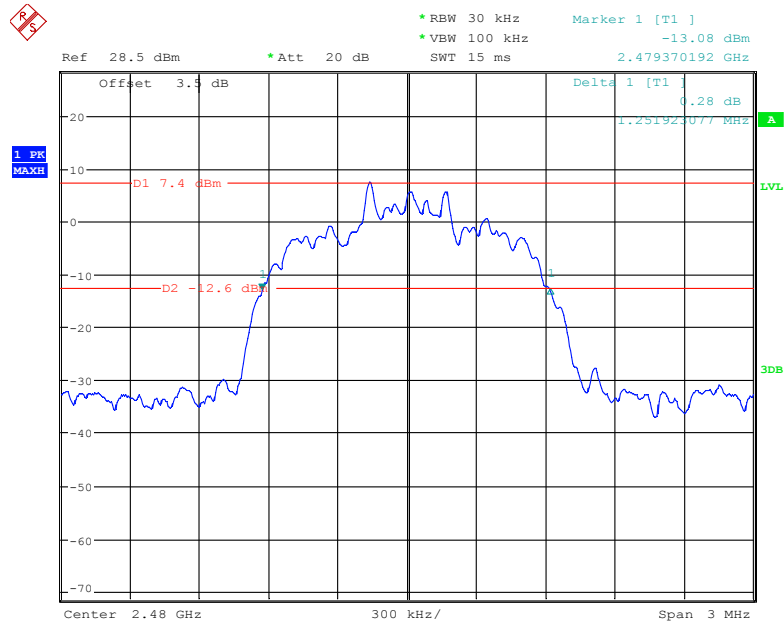
Date: 28.JUN.2019 13:20:26

### EDR ( $\pi/4$ -DQPSK): Middle Channel



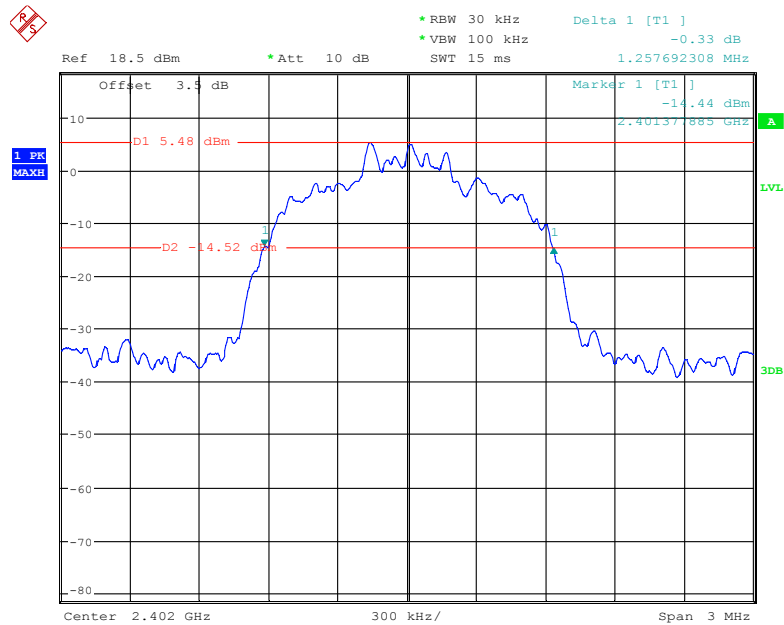
Date: 28.JUN.2019 13:23:32

### EDR ( $\pi/4$ -DQPSK): High Channel



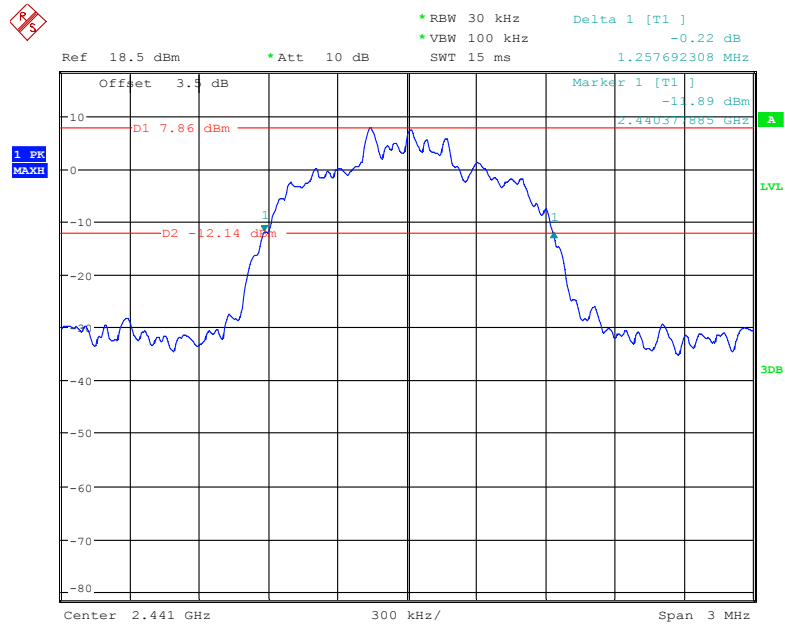
Date: 28.JUN.2019 18:49:07

### EDR (8DPSK): Low Channel



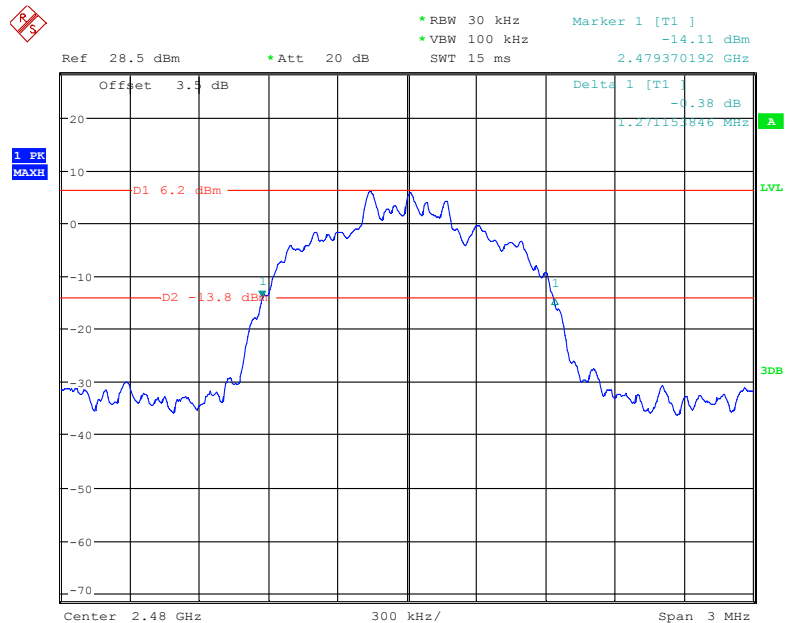
Date: 28.JUN.2019 13:18:07

### EDR (8DPSK): Middle Channel



Date: 28.JUN.2019 13:16:23

### EDR (8DPSK): High Channel



Date: 28.JUN.2019 18:50:21

## 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

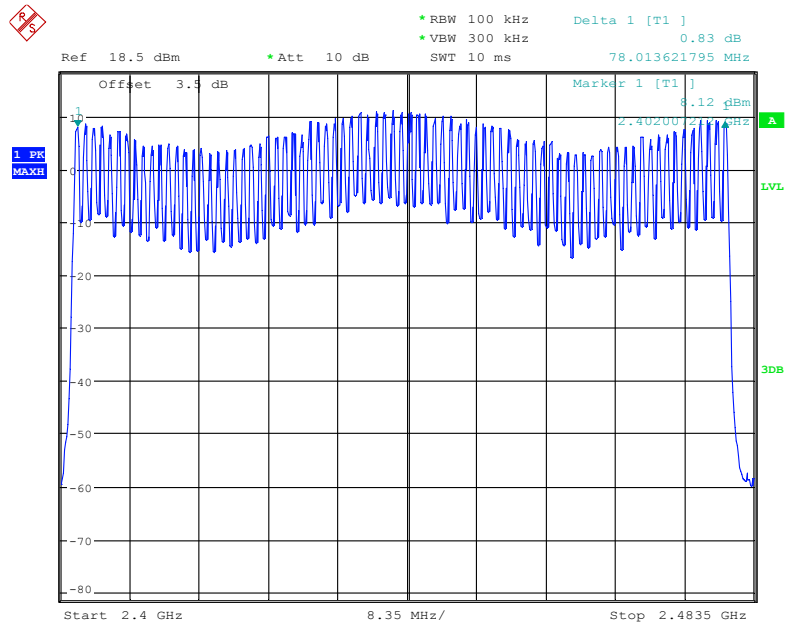
|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Leo Huang on 2019-06-28.*

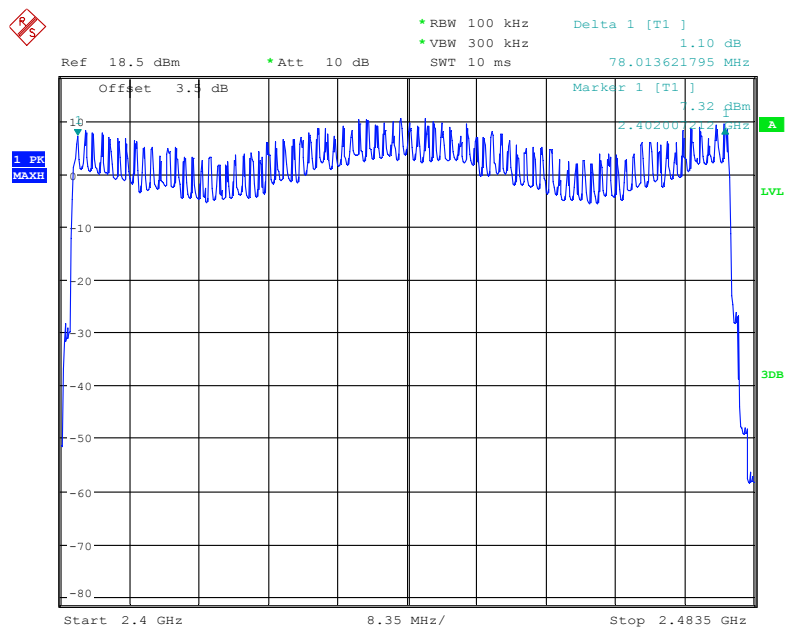
*EUT operation mode: Transmitting*

*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                             | $\geq 15$  |
| EDR ( $\pi/4$ -DQPSK) | 2400-2483.5           | 79                             | $\geq 15$  |
| EDR (8DPSK)           | 2400-2483.5           | 79                             | $\geq 15$  |

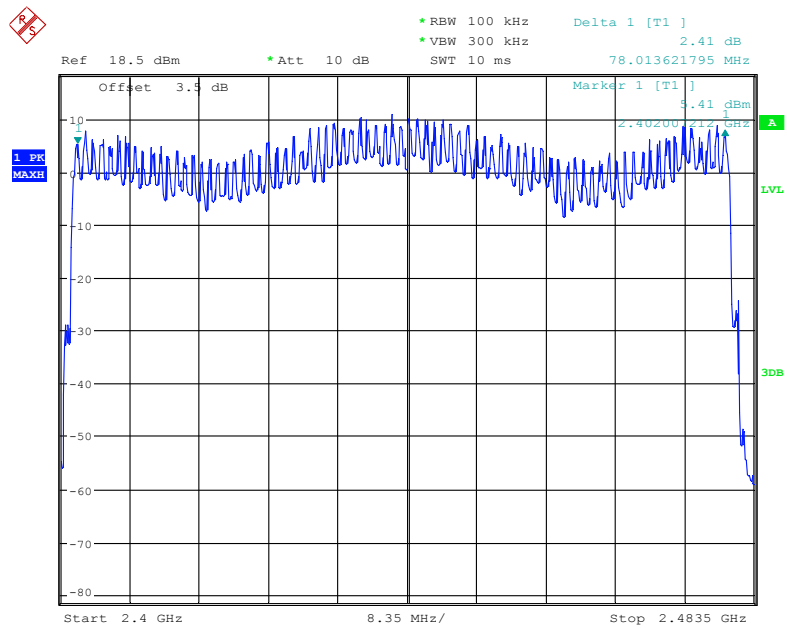
**BDR (GFSK): Number of Hopping Channels**

Date: 28.JUN.2019 13:36:17

**EDR ( $\pi/4$ -DQPSK): Number of Hopping Channels**

Date: 28.JUN.2019 13:39:33

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



Date: 28.JUN.2019 13:41:16

**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  $\geq 3 \times$  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**

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

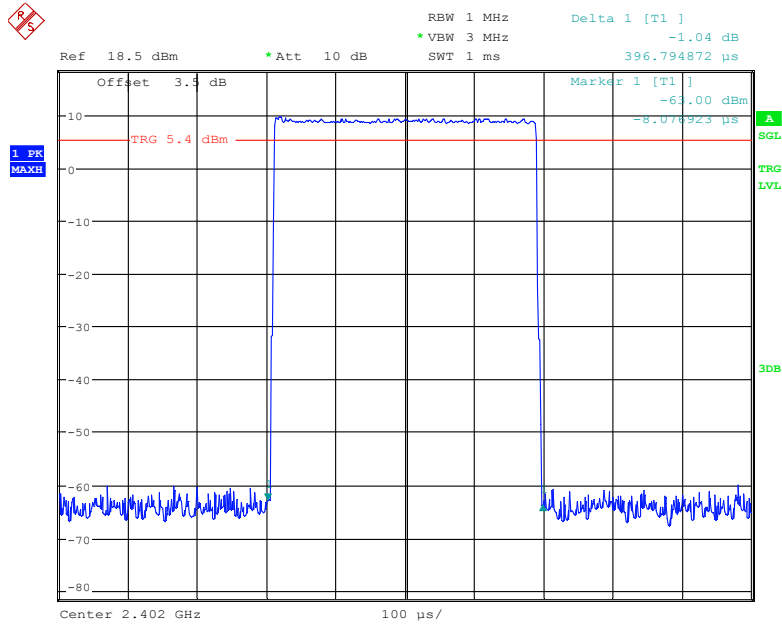
*The testing was performed by Leo Huang on 2019-06-28.*

*EUT operation mode: Transmitting*

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

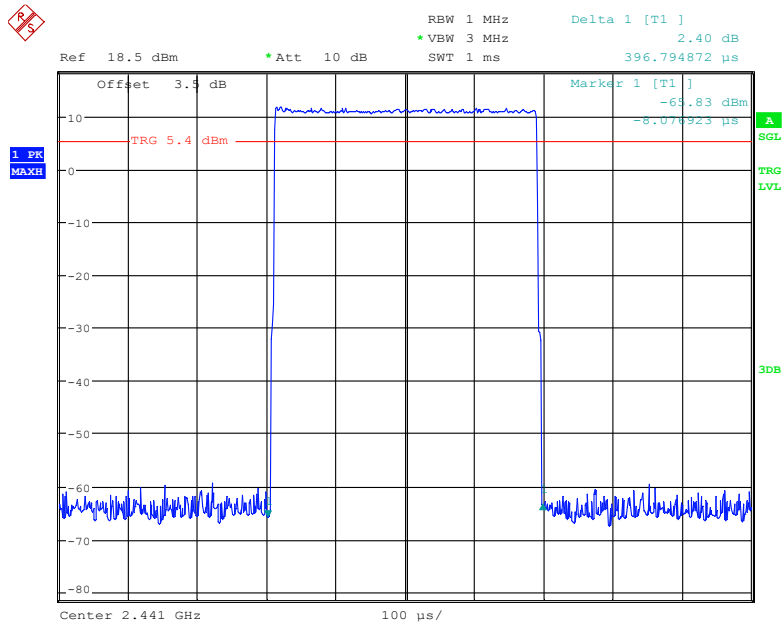
| Mode                  |       | Channel                                              | Pulse Width (ms) | Dwell Time (S) | Limit (S) | Result |
|-----------------------|-------|------------------------------------------------------|------------------|----------------|-----------|--------|
| BDR (GFSK)            | DH 1  | Low                                                  | 0.397            | 0.127          | 0.4       | Pass   |
|                       |       | Middle                                               | 0.397            | 0.127          | 0.4       | Pass   |
|                       |       | High                                                 | 0.397            | 0.127          | 0.4       | Pass   |
|                       |       | Note: DH1:Dwell time = Pulse time*(1600/2/79)*31.6S  |                  |                |           |        |
|                       | DH 3  | Low                                                  | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | Middle                                               | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | High                                                 | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | Note: DH3:Dwell time = Pulse time*(1600/4/79)*31.6S  |                  |                |           |        |
|                       | DH 5  | Low                                                  | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | Middle                                               | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | High                                                 | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | Note: DH5:Dwell time = Pulse time*(1600/6/79)*31.6S  |                  |                |           |        |
| EDR ( $\pi/4$ -DQPSK) | 2DH 1 | Low                                                  | 0.402            | 0.129          | 0.4       | Pass   |
|                       |       | Middle                                               | 0.402            | 0.129          | 0.4       | Pass   |
|                       |       | High                                                 | 0.402            | 0.129          | 0.4       | Pass   |
|                       |       | Note: 2DH1:Dwell time = Pulse time*(1600/2/79)*31.6S |                  |                |           |        |
|                       | 2DH 3 | Low                                                  | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | Middle                                               | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | High                                                 | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | Note: 2DH3:Dwell time = Pulse time*(1600/4/79)*31.6S |                  |                |           |        |
|                       | 2DH 5 | Low                                                  | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | Middle                                               | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | High                                                 | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | Note: 2DH5:Dwell time = Pulse time*(1600/6/79)*31.6S |                  |                |           |        |
| EDR (8DPSK)           | 3DH 1 | Low                                                  | 0.402            | 0.129          | 0.4       | Pass   |
|                       |       | Middle                                               | 0.402            | 0.129          | 0.4       | Pass   |
|                       |       | High                                                 | 0.402            | 0.129          | 0.4       | Pass   |
|                       |       | Note: 3DH1:Dwell time = Pulse time*(1600/2/79)*31.6S |                  |                |           |        |
|                       | 3DH 3 | Low                                                  | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | Middle                                               | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | High                                                 | 1.680            | 0.269          | 0.4       | Pass   |
|                       |       | Note: 3DH3:Dwell time = Pulse time*(1600/4/79)*31.6S |                  |                |           |        |
|                       | 3DH 5 | Low                                                  | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | Middle                                               | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | High                                                 | 2.939            | 0.313          | 0.4       | Pass   |
|                       |       | Note: 3DH5:Dwell time = Pulse time*(1600/6/79)*31.6S |                  |                |           |        |

# **BDR (GFSK):** **Pulse time, Low Channel, DH1**



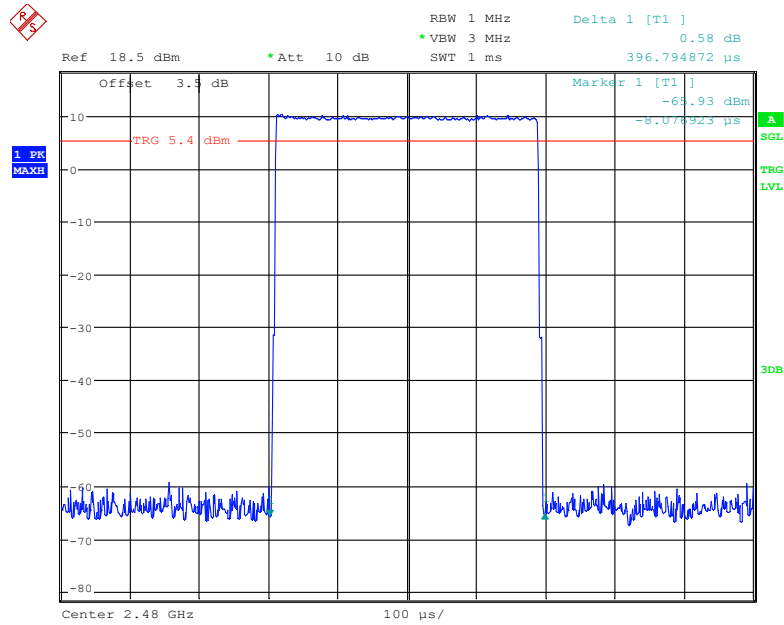
Date: 28.JUN.2019 13:53:06

# **Pulse time, Middle Channel, DH1**



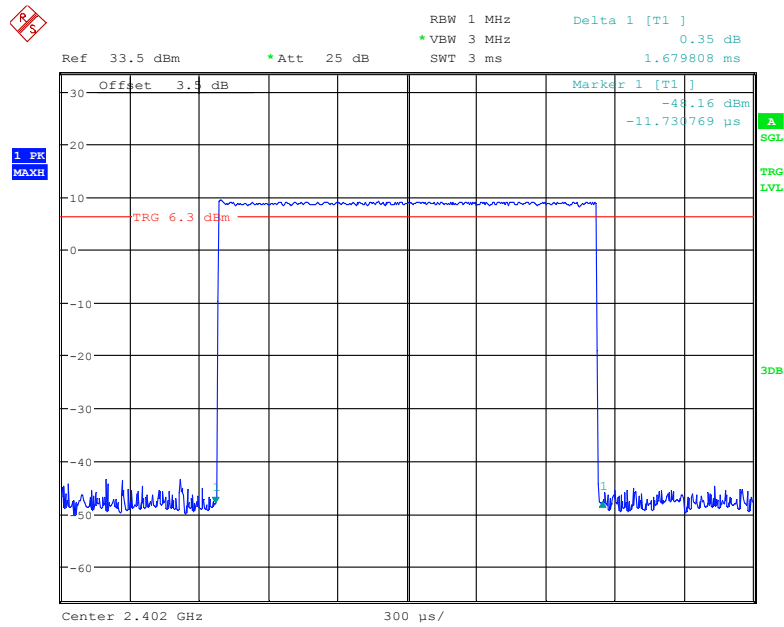
Date: 28.JUN.2019 13:52:00

### Pulse time, High Channel, DH1



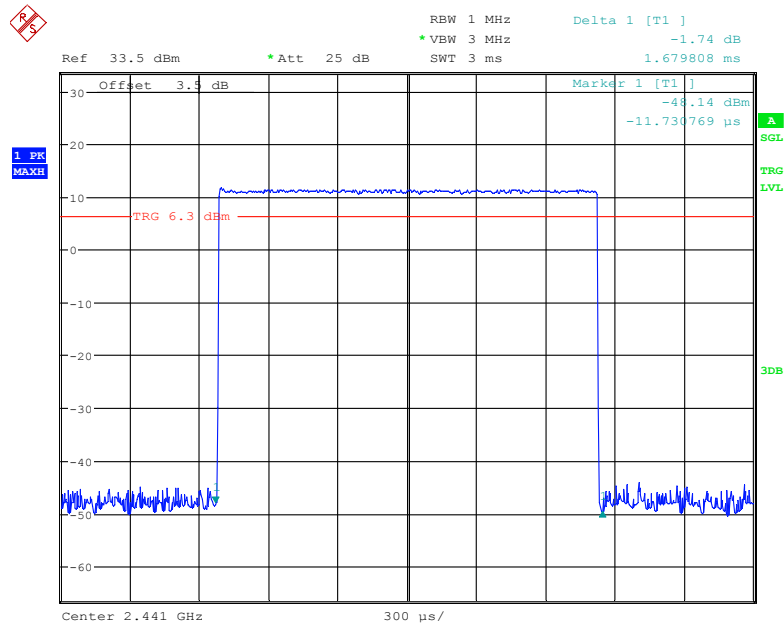
Date: 28.JUN.2019 13:52:37

### Pulse time, Low Channel, DH3



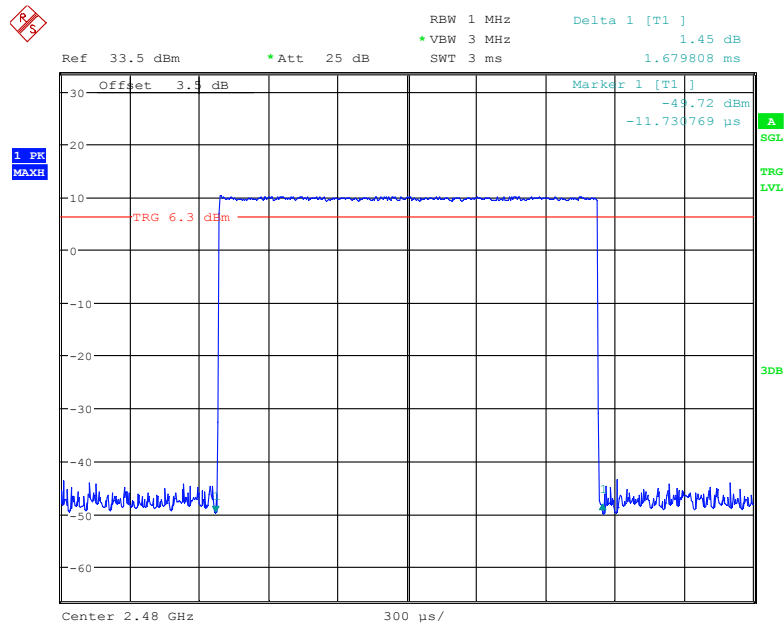
Date: 28.JUN.2019 15:00:22

### Pulse time, Middle Channel, DH3



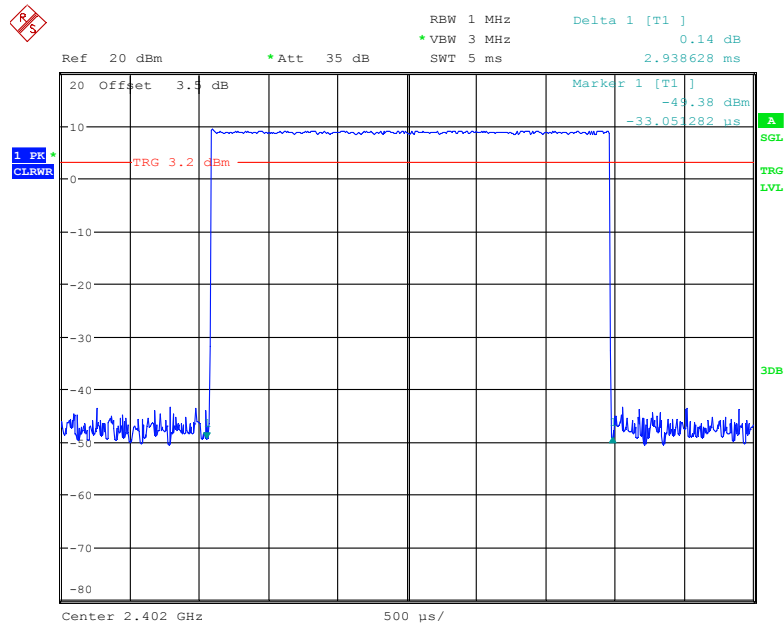
Date: 28.JUN.2019 15:01:38

### Pulse time, High Channel, DH3



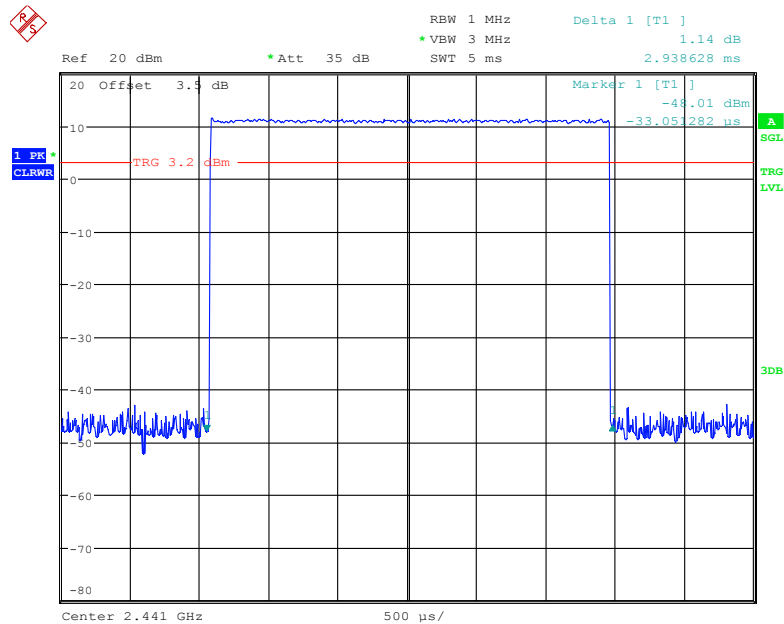
Date: 28.JUN.2019 15:02:18

### Pulse time, Low Channel, DH5



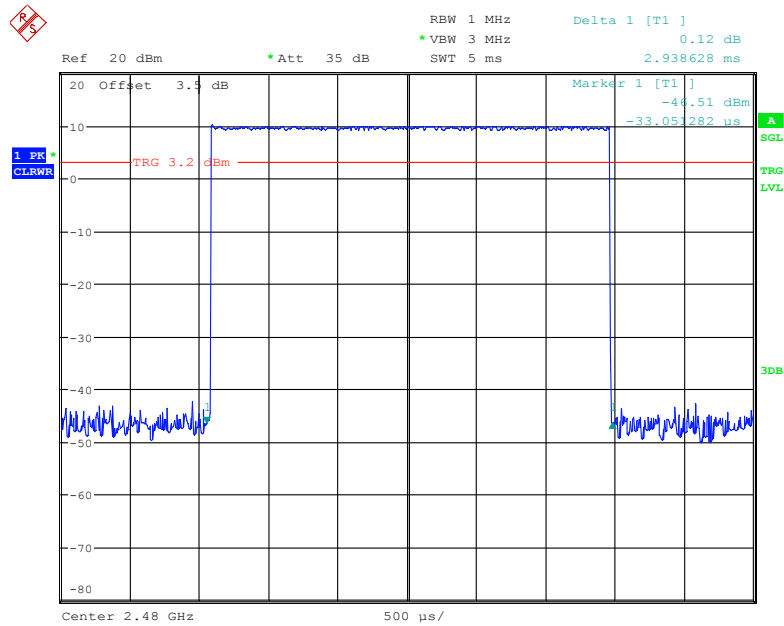
Date: 28.JUN.2019 15:24:54

### Pulse time, Middle Channel, DH5



Date: 28.JUN.2019 15:26:50

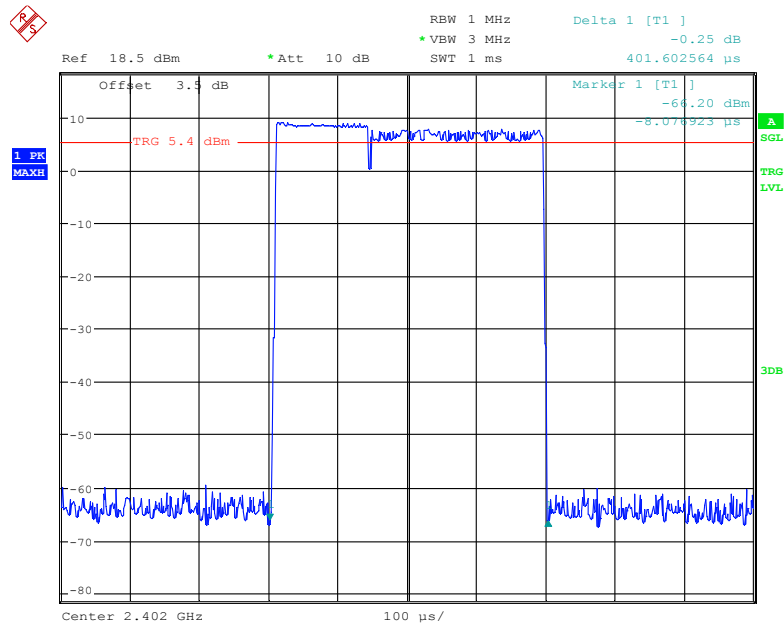
### Pulse time, High Channel, DH5



Date: 28.JUN.2019 15:27:26

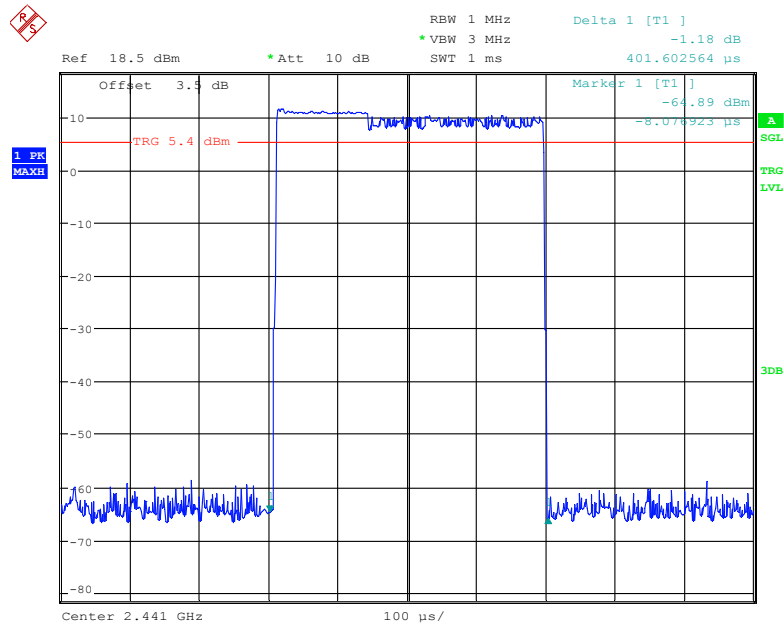
### EDR ( $\pi/4$ -DQPSK):

### Pulse time, Low Channel, 2DH1



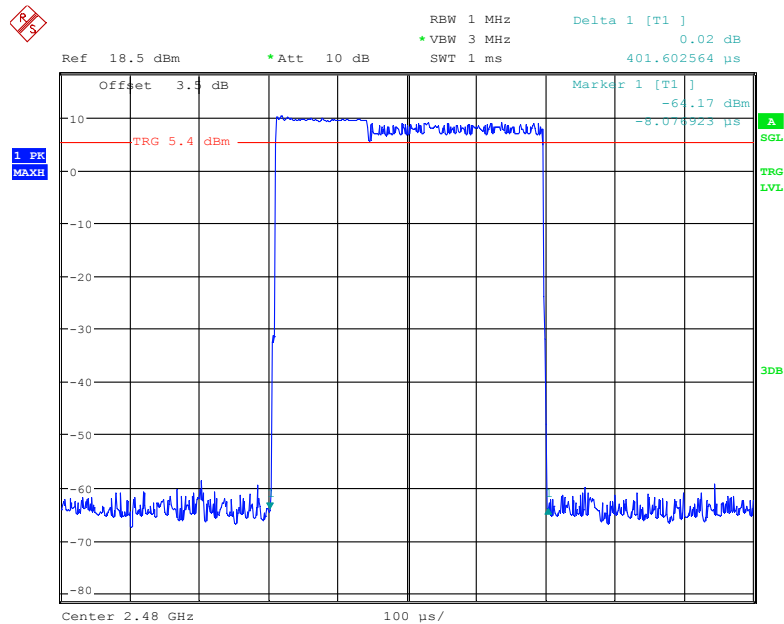
Date: 28.JUN.2019 13:55:16

### Pulse time, Middle Channel, 2DH1



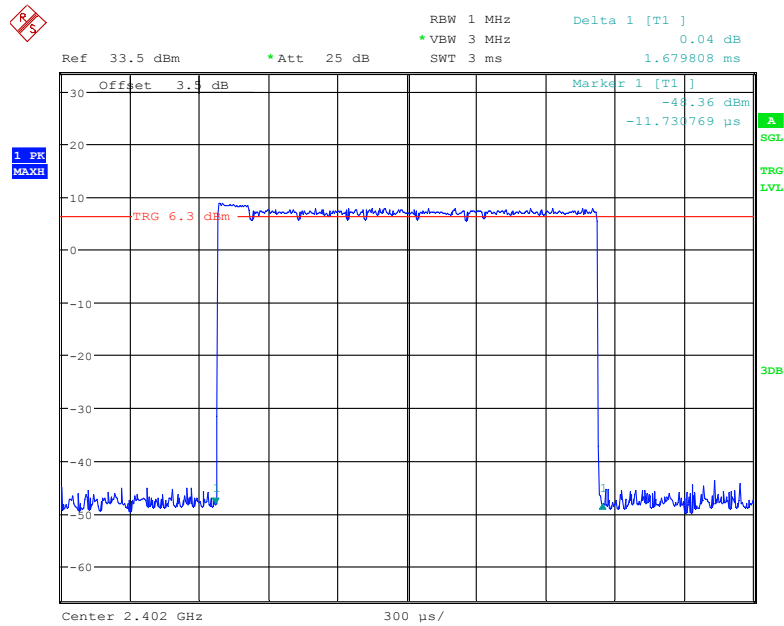
Date: 28.JUN.2019 13:56:20

### Pulse time, High Channel, 2DH1



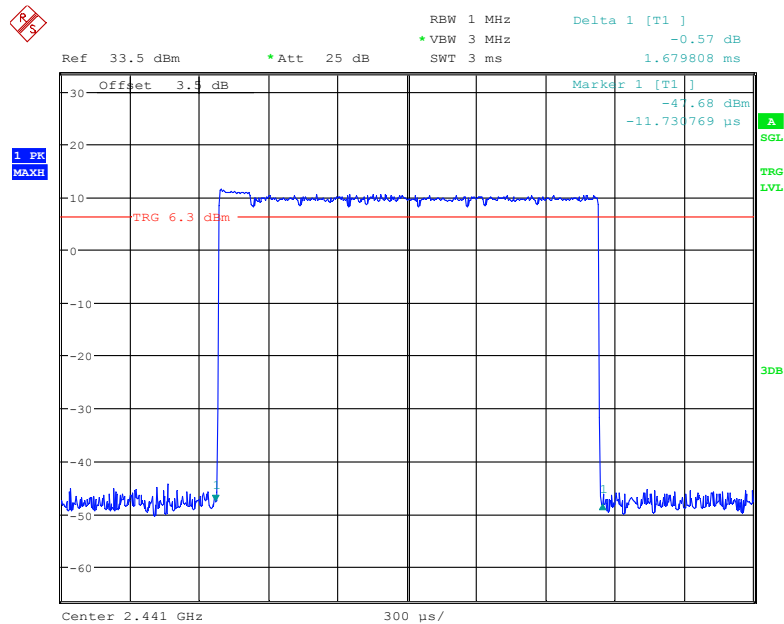
Date: 28.JUN.2019 13:56:57

### Pulse time, Low Channel, 2DH3



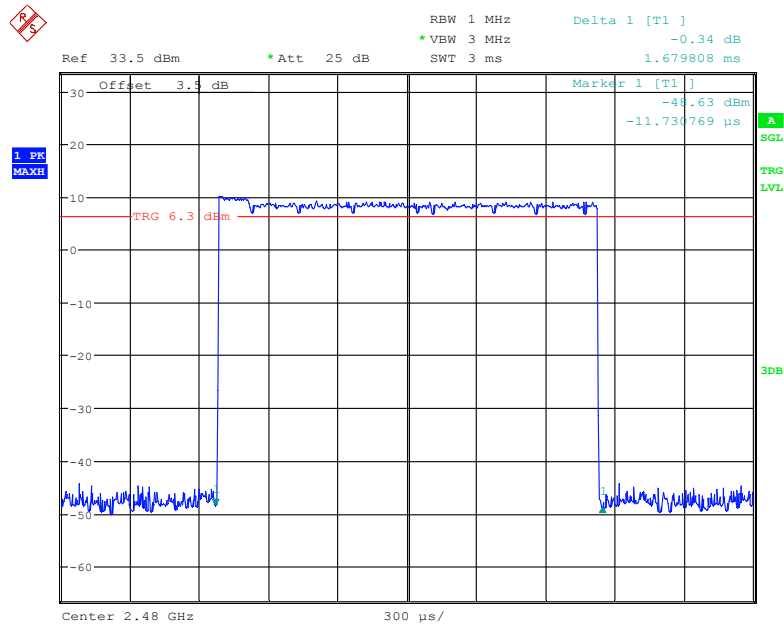
Date: 28.JUN.2019 15:04:25

### Pulse time, Middle Channel, 2DH3



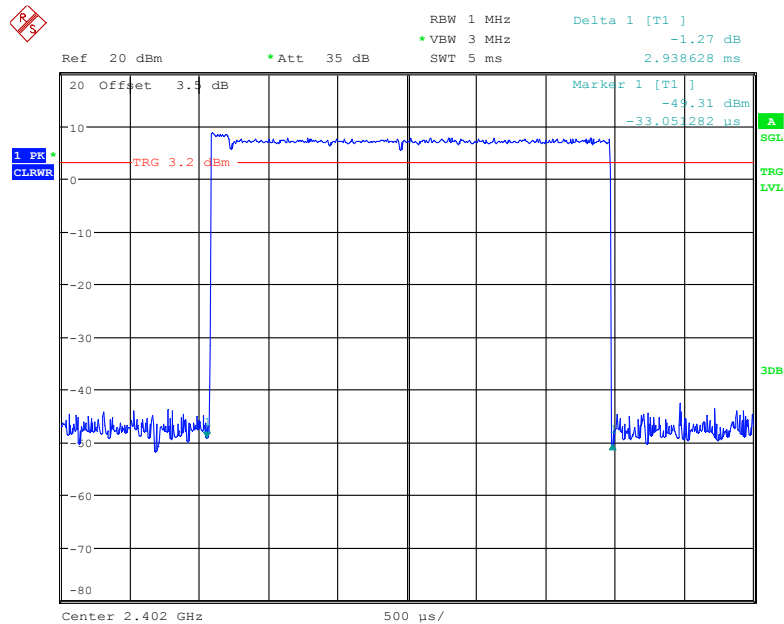
Date: 28.JUN.2019 15:03:34

### Pulse time, High Channel, 2DH3



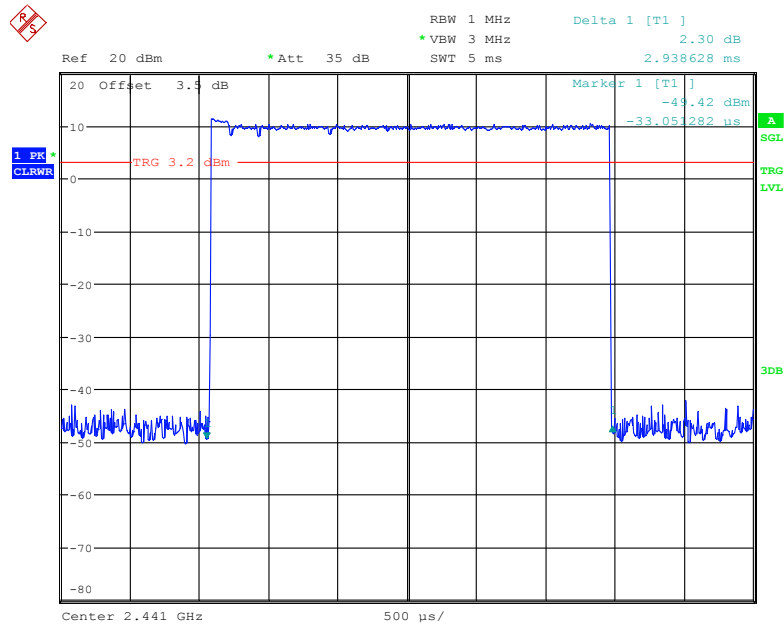
Date: 28.JUN.2019 15:03:12

### Pulse time, Low Channel, 2DH5



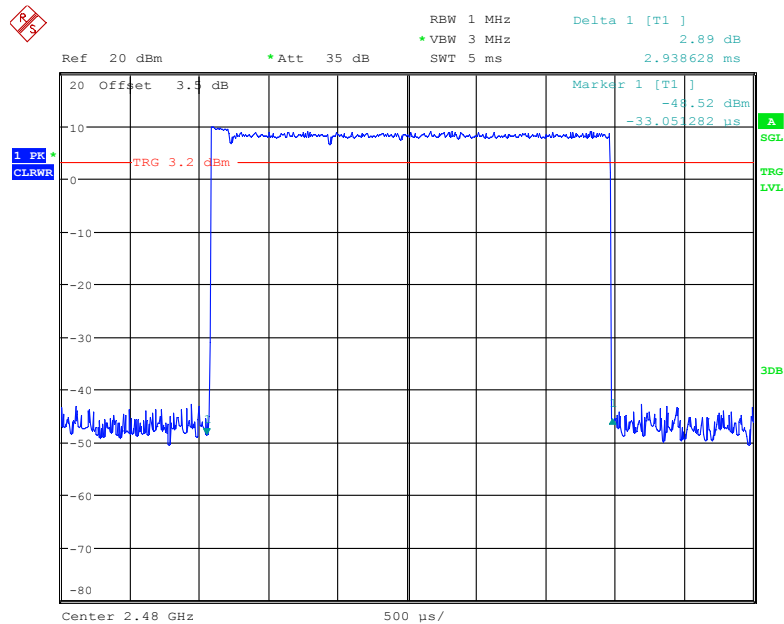
Date: 28.JUN.2019 15:30:22

### Pulse time, Middle Channel, 2DH5



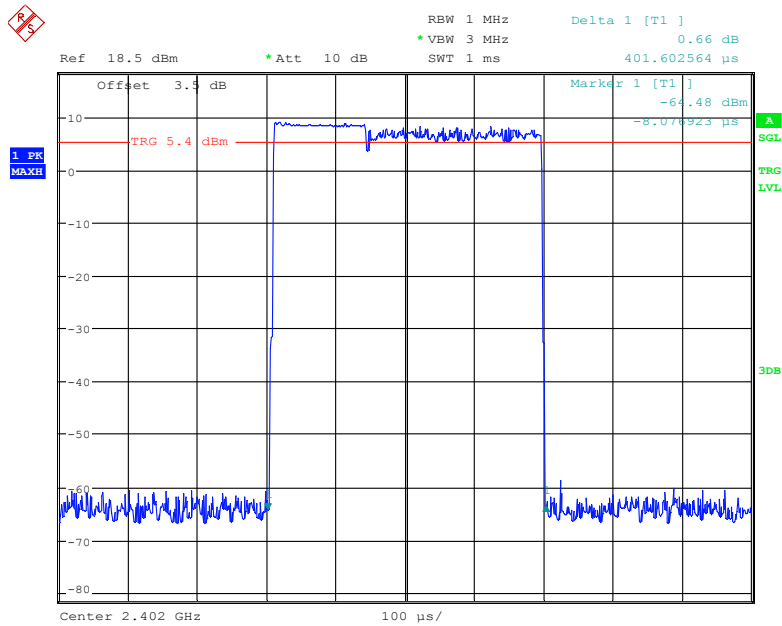
Date: 28.JUN.2019 15:29:56

### Pulse time, High Channel, 2DH5



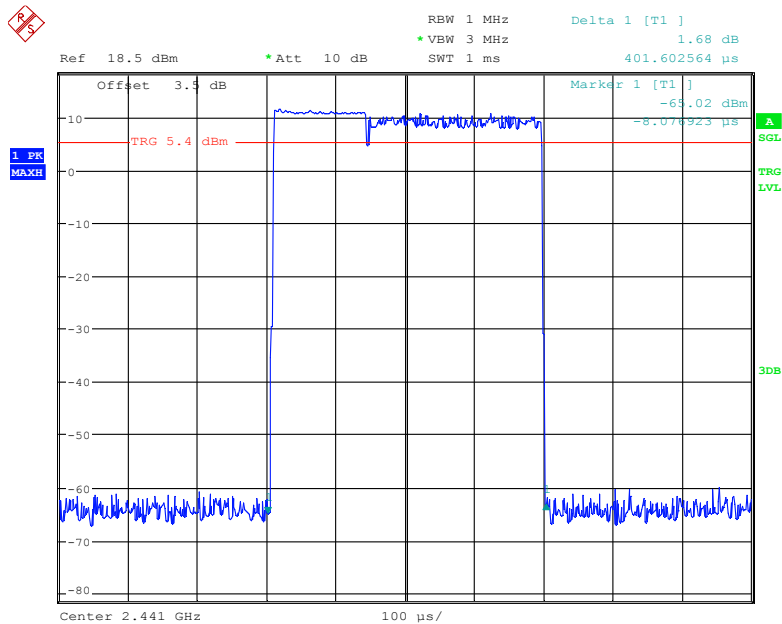
Date: 28.JUN.2019 15:28:18

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



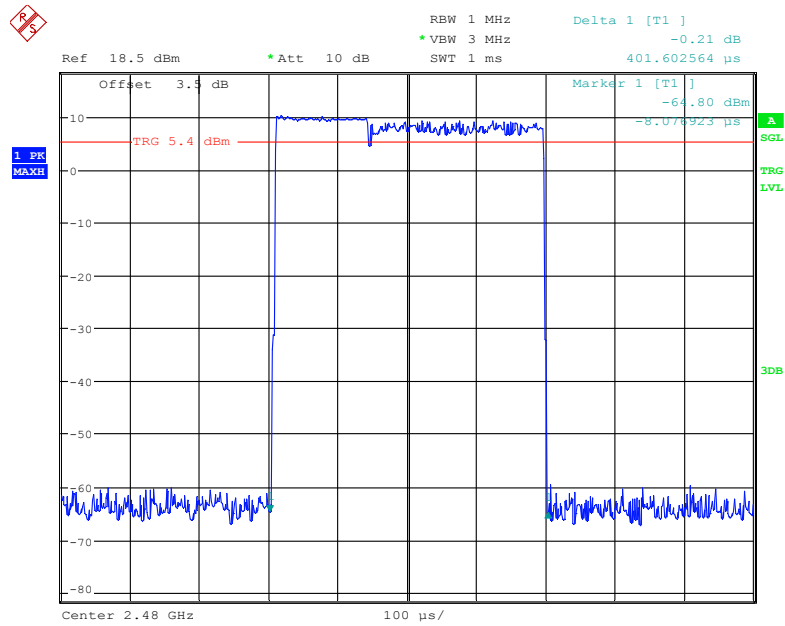
Date: 28.JUN.2019 13:58:48

### Pulse time, Middle Channel, 3DH1



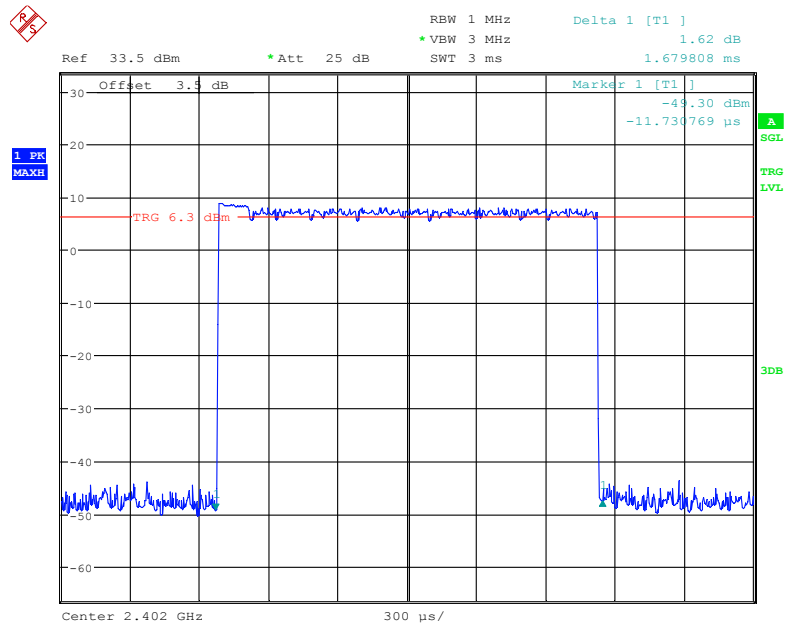
Date: 28.JUN.2019 13:58:10

### Pulse time, High Channel, 3DH1



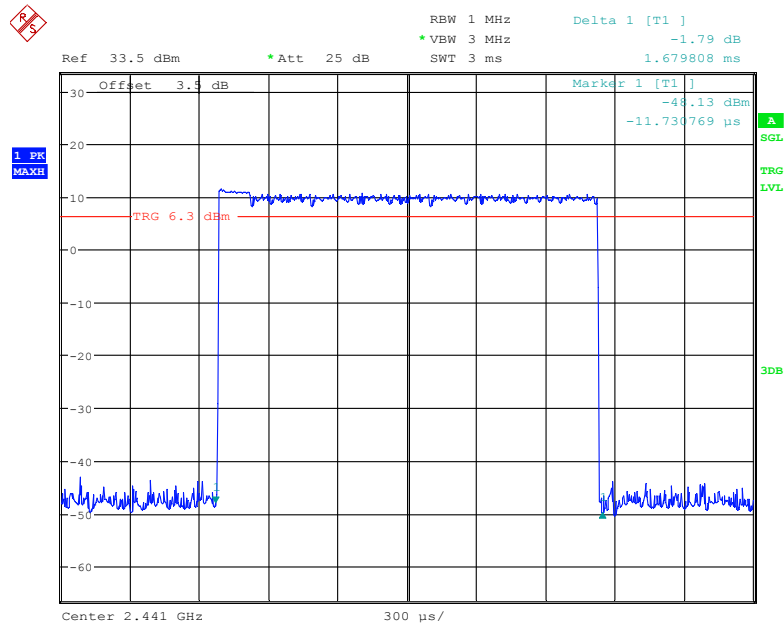
Date: 28.JUN.2019 13:57:43

### Pulse time, Low Channel, 3DH3



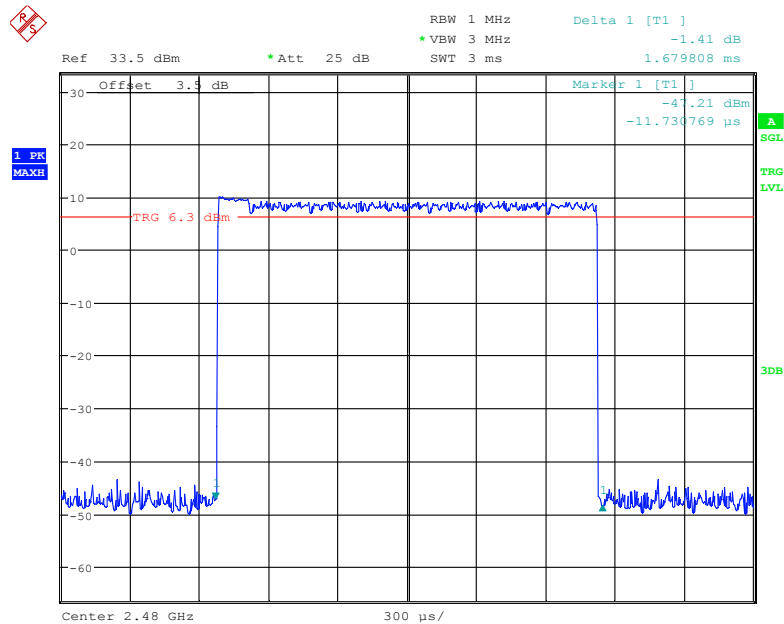
Date: 28.JUN.2019 15:05:32

### Pulse time, Middle Channel, 3DH3



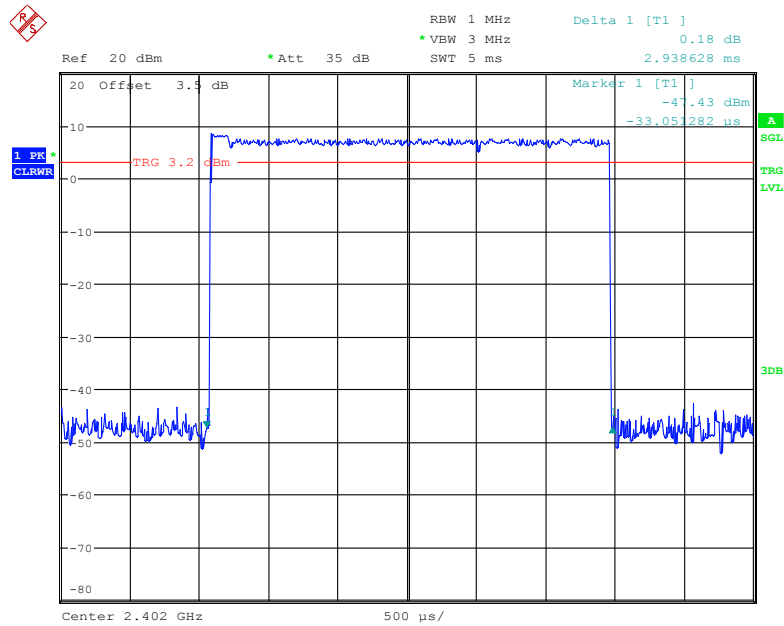
Date: 28.JUN.2019 15:06:29

### Pulse time, High Channel, 3DH3



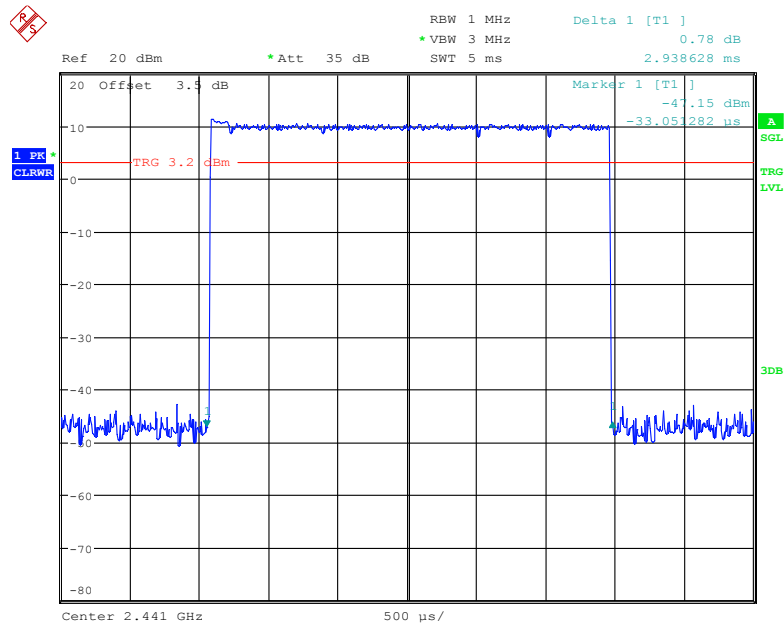
Date: 28.JUN.2019 15:06:59

### Pulse time, Low Channel, 3DH5



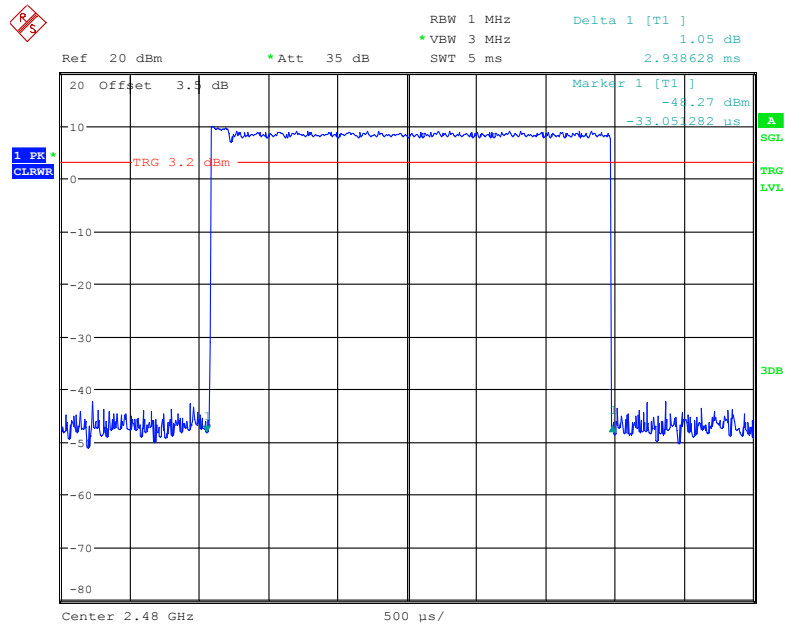
Date: 28.JUN.2019 15:31:27

### Pulse time, Middle Channel, 3DH5



Date: 28.JUN.2019 15:32:33

### Pulse time, High Channel, 3DH5



Date: 28.JUN.2019 15:33:07

## 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

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

The testing was performed by Leo Huang on 2019-06-28.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table.

| Mode                                  | Channel | Frequency (MHz) | Peak Output Power |       | Limit (mW) |
|---------------------------------------|---------|-----------------|-------------------|-------|------------|
|                                       |         |                 | (dBm)             | (mW)  |            |
| <b>BDR (GFSK)</b>                     | Low     | 2402            | 9.76              | 9.46  | 125        |
|                                       | Middle  | 2441            | 11.89             | 15.45 | 125        |
|                                       | High    | 2480            | 10.49             | 11.19 | 125        |
| <b>EDR (<math>\pi/4</math>-DQPSK)</b> | Low     | 2402            | 9.43              | 8.77  | 125        |
|                                       | Middle  | 2441            | 11.89             | 15.45 | 125        |
|                                       | High    | 2480            | 10.59             | 11.46 | 125        |
| <b>EDR (8DPSK)</b>                    | Low     | 2402            | 9.42              | 8.75  | 125        |
|                                       | Middle  | 2441            | 11.88             | 15.42 | 125        |
|                                       | High    | 2480            | 10.61             | 11.51 | 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 °C     |
| Relative Humidity: | 56 %      |
| ATM Pressure:      | 101.0 kPa |

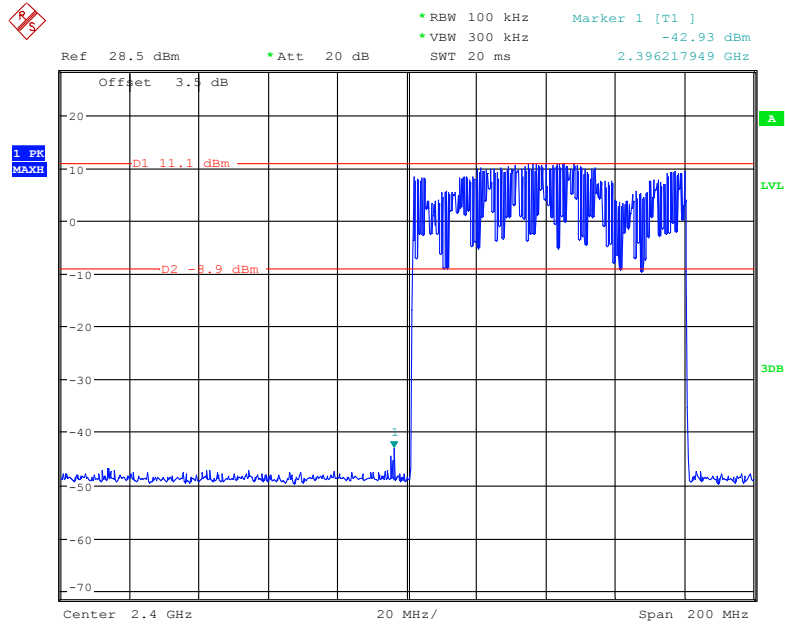
*The testing was performed by Leo Huang on 2019-06-28.*

*EUT operation mode: Transmitting*

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

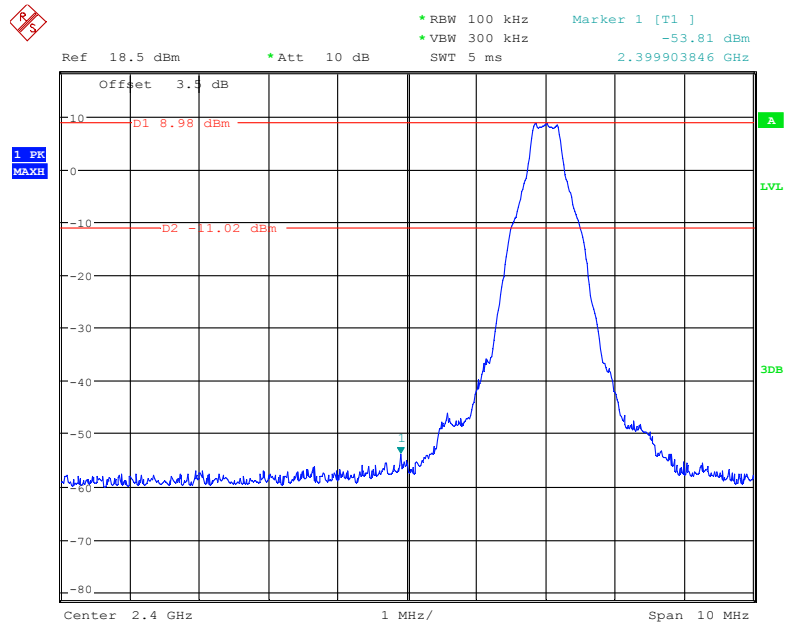
# BDR (GFSK): Band Edge-Left Side

## Hopping



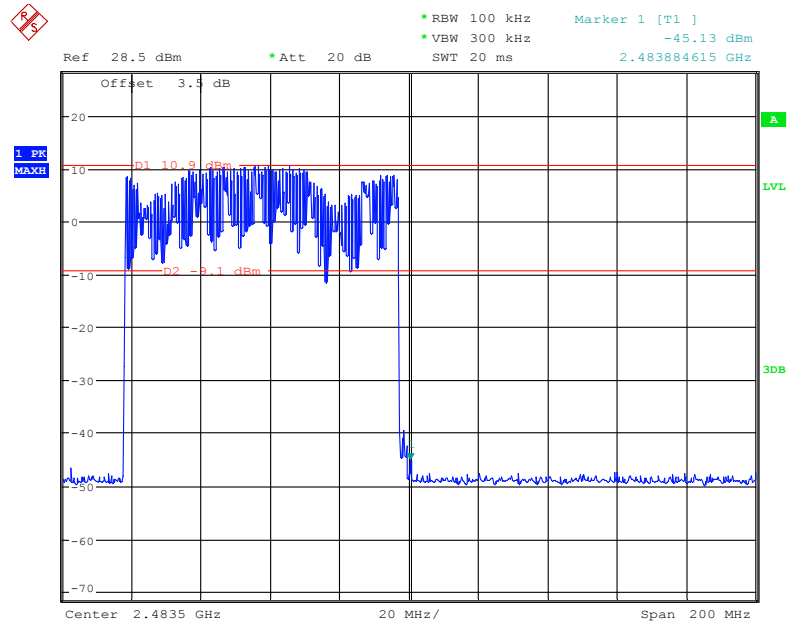
Date: 28.JUN.2019 18:59:36

## Single



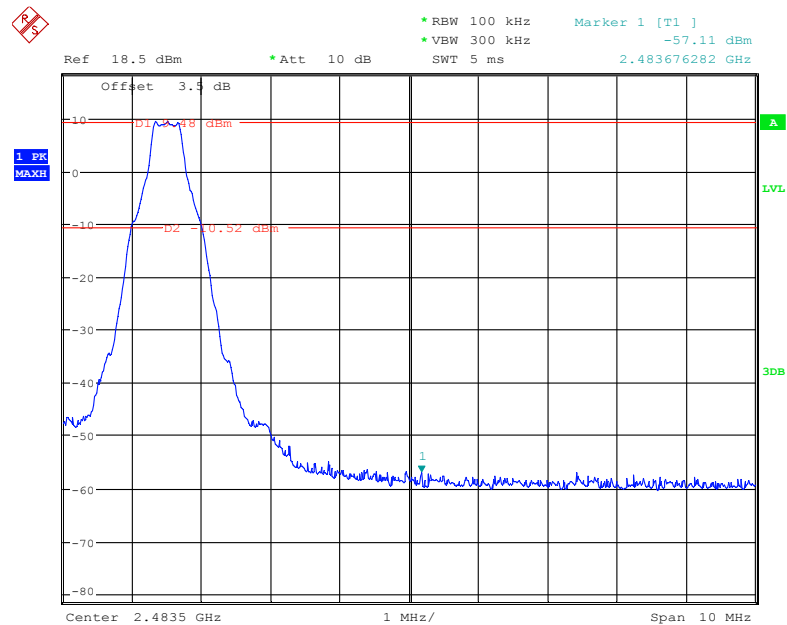
Date: 28.JUN.2019 11:49:31

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



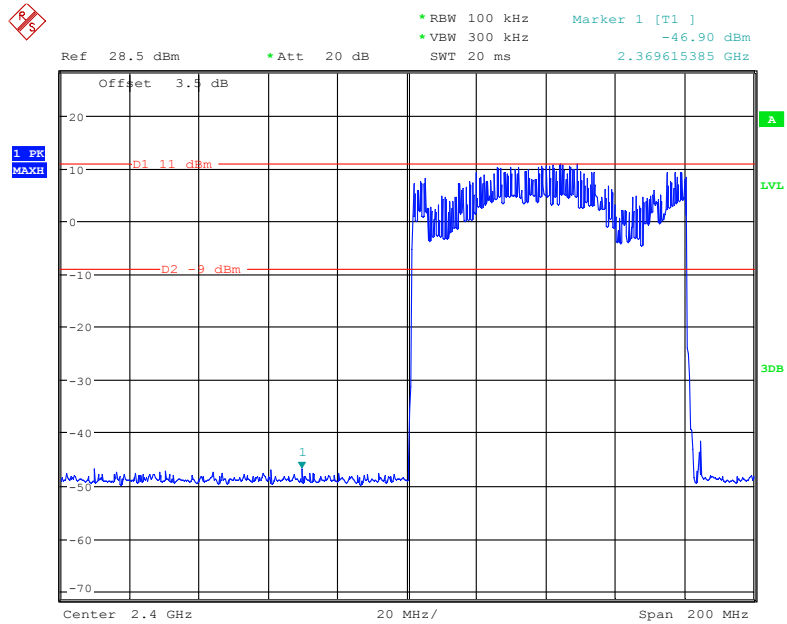
Date: 28.JUN.2019 18:56:53

## **Single**



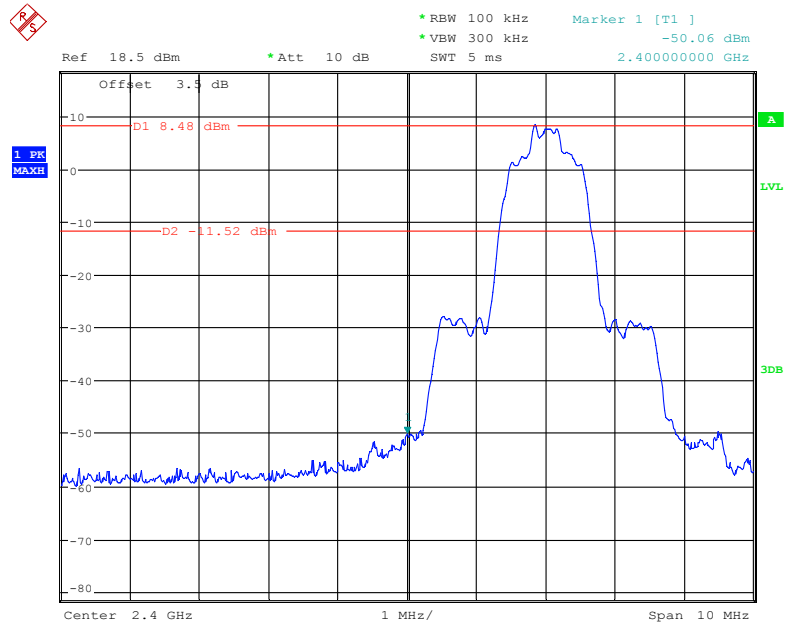
Date: 28.JUN.2019 11:50:07

# EDR ( $\pi/4$ -DQPSK): Band Edge-Left Side Hopping



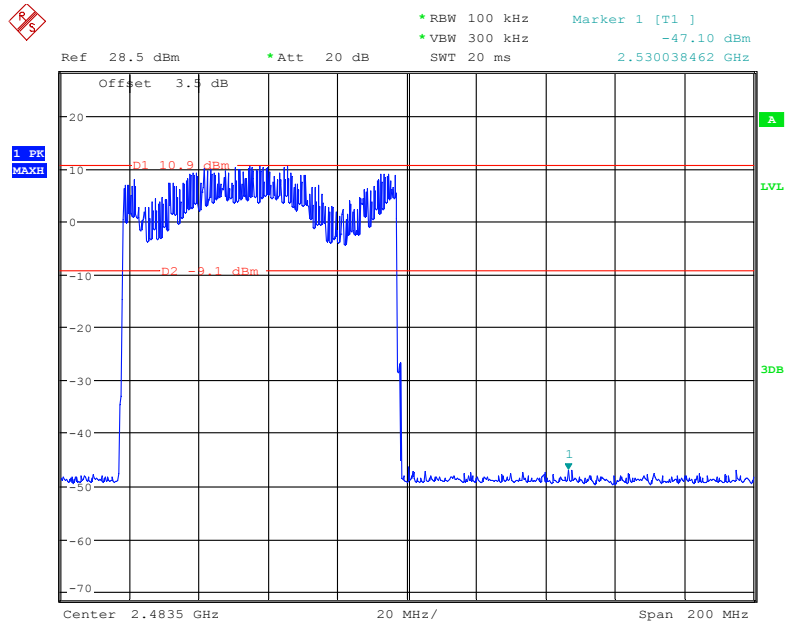
Date: 28.JUN.2019 18:53:34

## Single



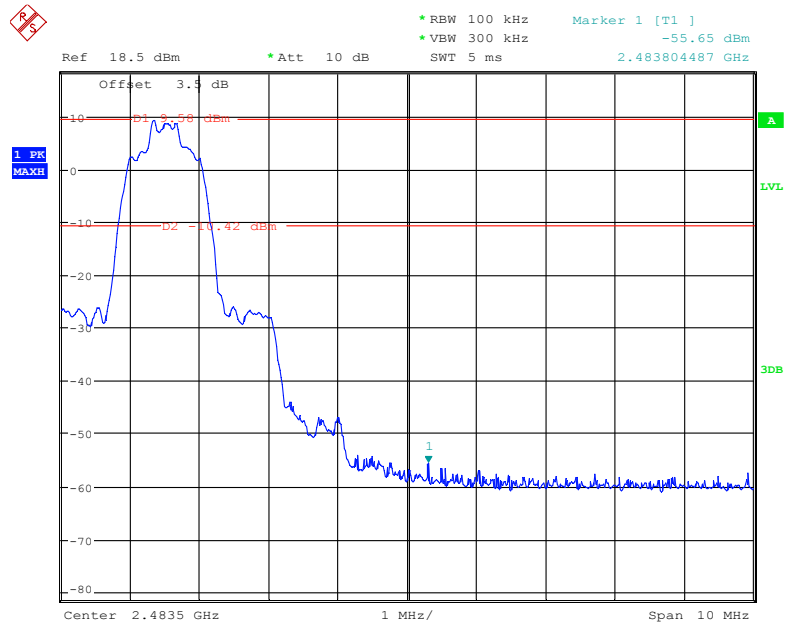
Date: 28.JUN.2019 11:48:54

# EDR ( $\pi/4$ -DQPSK): Band Edge-Right Side Hopping



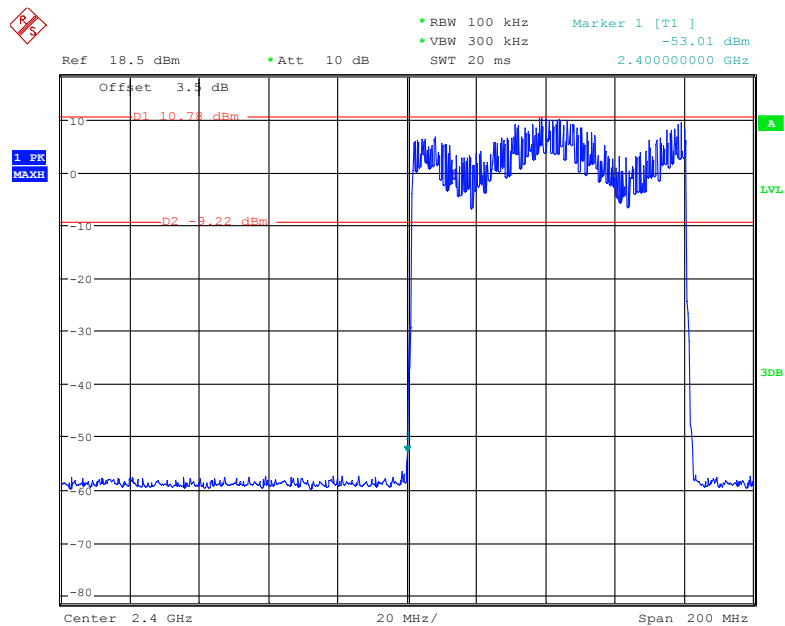
Date: 28.JUN.2019 18:55:21

## Single



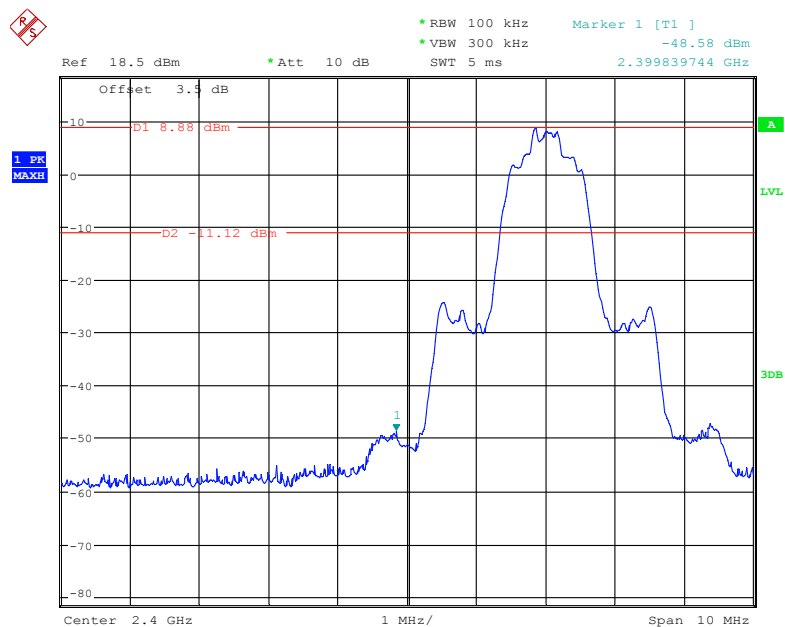
Date: 28.JUN.2019 11:47:59

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



Date: 28.JUN.2019 13:11:33

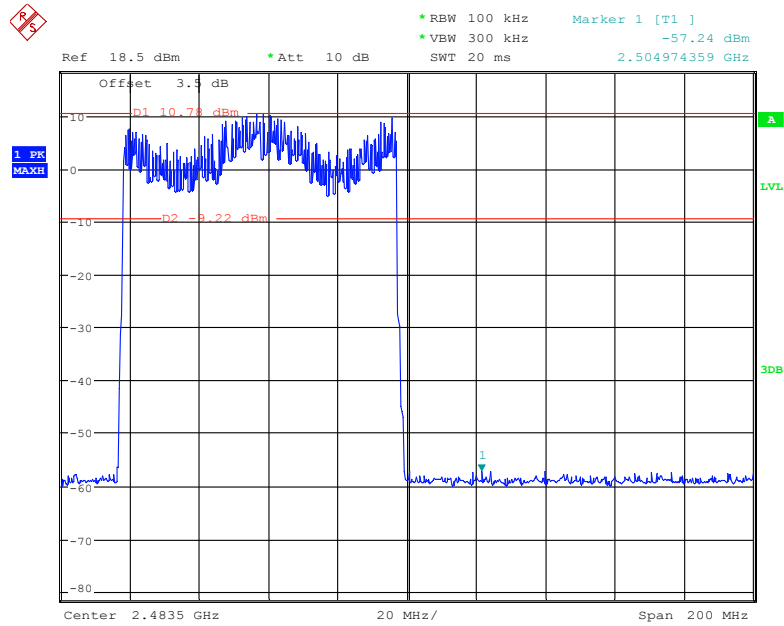
### Single



Date: 28.JUN.2019 11:46:31

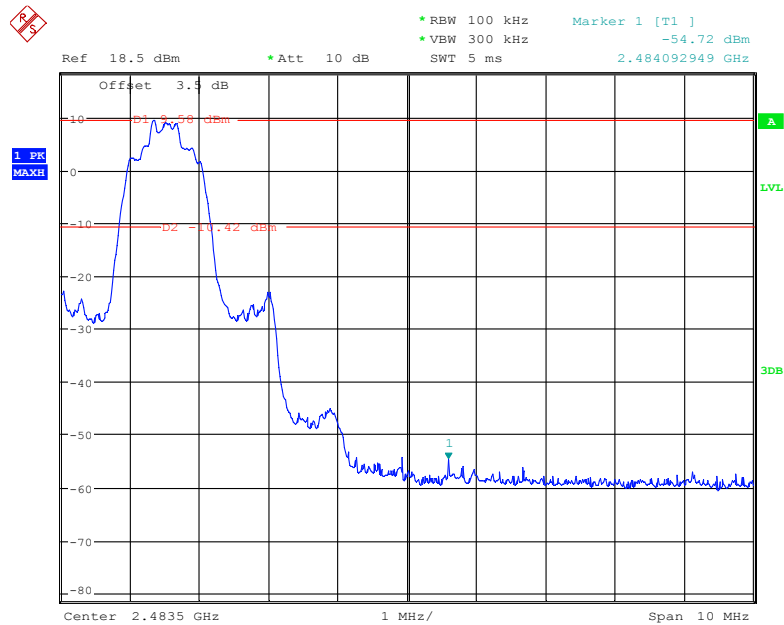
# EDR (8DPSK): Band Edge-Right Side

## Hopping



Date: 28.JUN.2019 13:09:48

## Single



Date: 28.JUN.2019 11:47:22

\*\*\*\*\* END OF REPORT \*\*\*\*\*