# TEST REPORT

| KOSTEC CO., Ltd.<br>28(175-20, Annyeong-dong) 406-gil sejaro,<br>Hwaseong-si, Gyeonggi-do, Korea<br>Tel:031-222-4251, Fax:031-222-4252 | Report No.: KST-FCR-170002(1) | KOSTEC Co., Ltd.<br>http://www.kostec.org |
|---|---|---|

1. Applicant

- Name : Telechips
- Address : 19~23 Floor, Luther Building, 7-20 Sincheon-dong, Songpa-gu, Seoul, 138-240, Korea

2. Test Item

- Product Name: Bluetooth module
- Model Name: TCM3901
- Brand: None
- FCC ID: 2ALS3-3901 • IC: 22661-3901

3. Manufacturer

- Name : Telechips
- Address : 19~23 Floor, Luther Building, 7-20 Sincheon-dong, Songpa-gu, Seoul, 138-240, Korea

4. Date of Test : 2017. 05. 15. ~ 2017. 05. 17.

5. Test Method Used :
FCC CFR 47, Part 15. Subpart C-15.247
DA 00-705
RSS-GEN Issue 4
RSS-247 Issue 2

6. Test Result : Compliance

7. Note: None

**Supplementary Information**

The device bearing the brand name and FCC ID& IC ID specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with measurement procedures specified in ANSI C 63.10-2013.

We attest to the accuracy of data and all measurements reported herein were performed by KOSTEC Co., Ltd. and were made under Chief Engineer's supervision. We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

| | | |
|---|---|---|
| Affirmation | Tested by<br>Name : Lee, Mi-Young (Signature) | Technical Manager<br>Name : Park, Gyeong-Hyeon (Signature) |

**2017. 06. 08.**

**KOSTEC Co., Ltd.**

# Table of Contents

**1. GENERAL INFORMATION ..... 3**
1.1 Test Facility ..... 3
1.2 Location ..... 3
1.3 Revision History of test report ..... 4
**2. EQUIPMENT DESCRIPTION ..... 5**
**3. SYSTEM CONFIGURATION FOR TEST ..... 6**
3.1 Characteristics of equipment ..... 6
3.2 Used peripherals list ..... 6
3.3 Product Modification ..... 6
3.4 Operating Mode ..... 6
3.5 Test Setup of EUT ..... 6
3.6 Parameters of Test Software Setting ..... 7
3.7 Table for Test condition ..... 8
3.8 Used Test Equipment List ..... 9
**4. SUMMARY TEST RESULTS ..... 11**
**5. MEASUREMENT RESULTS ..... 12**
5.1 Peak Output Power ..... 12
5.2 20 dB Bandwidth ..... 17
5.3 Channel Separation ..... 24
5.4 Number of Hopping Channels ..... 26
5.5 Time of Occupancy ..... 28
5.6 Conducted Spurious Emissions (Band-edge) ..... 32
5.7 Spurious RF Radiated emissions ..... 39
5.8 Antenna requirement ..... 44
5.9 AC Power Conducted emissions ..... 45

# 1. GENERAL INFORMATION

## 1.1 Test Facility

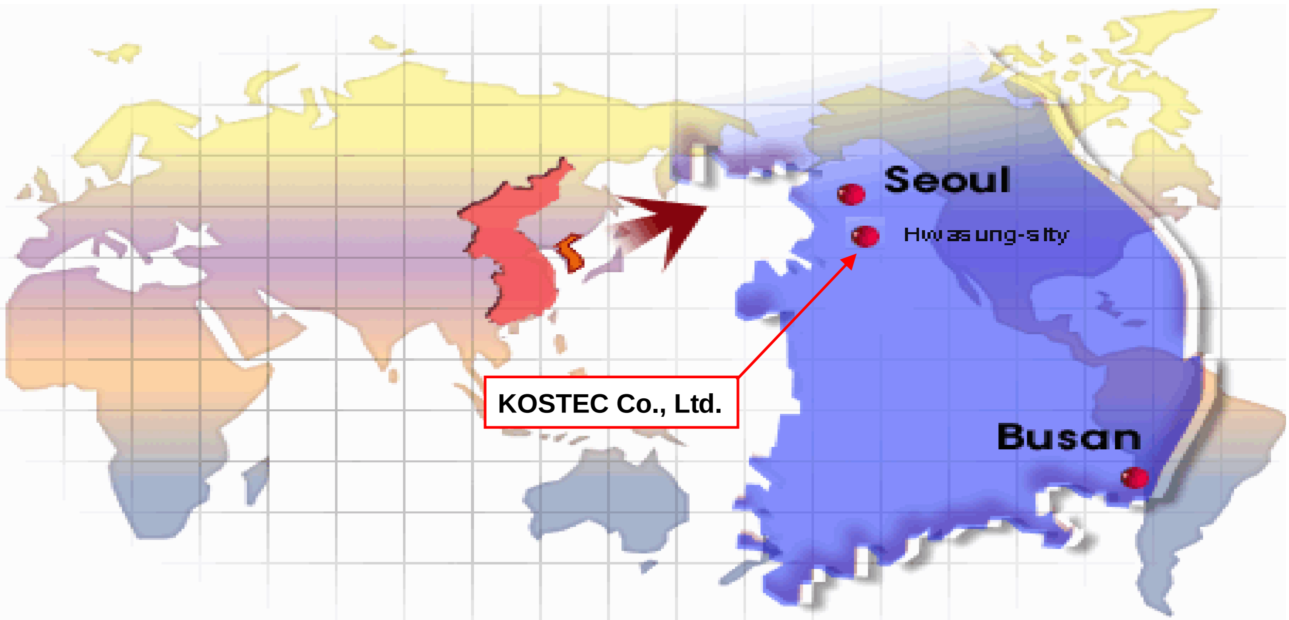
### Test laboratory and address

KOSTEC Co., Ltd.
128(175-20,Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea

### Registration information

KOLAS No. : 232
FCC Designation No. : KR0041
IC Registration Site No. : 8305A-1

## 1.2 Location



## 1.3 Revision History of test report

| Rev. | Revisions | Effect page | Reviewed | Date |
|---|---|---|---|---|
| - | Initial issue | All | Gyeong Hyeon, Park | 2017. 05. 22. |
| 1 | Revised IC registration site no | 3 | Gyeong Hyeon, Park | 2017. 06. 08. |

## 2. EQUIPMENT DESCRIPTION

The product specification described herein was declared by manufacturer. And refer to user's manual for the details.

| | |
|---|---|
| Equipment Name | Bluetooth module |
| Model No | TCM3901 |
| Usage | Bluetooth module |
| Serial Number | Proto type |
| Modulation type | FHSS |
| Emission Type | F1D/G1D |
| Maximum output power | 2.01 dBm |
| Operated Frequency | 2 402 MHz ~ 2 480 MHz |
| Channel Number | 79 |
| Operation temperature | -10 ℃ ~ 55 ℃ |
| Power Source | DC 3.3 V |
| Antenna Description | PCB antenna embed in PCB of EUT, max gain :1.5 dBi |
| Remark | 1. The device was operating at its maximum output power for all measurements.<br>2. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case (X) is shown in the report.<br>3. The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description. |
| FCC ID | 2ALS3-3901 |
| IC | 22661-3901 |

# 3. SYSTEM CONFIGURATION FOR TEST

## 3.1 Characteristics of equipment

Bluetooth module

## 3.2 Used peripherals list

| Description | Model No. | Serial No. | Manufacture | Remark |
|---|---|---|---|---|
| Notebook | BCM-1063 | 2Z7S1Z1 | Dell Inc | |
| Adapter | DA65NM111-00 | None | Dell Inc | For notebook |

## 3.3 Product Modification

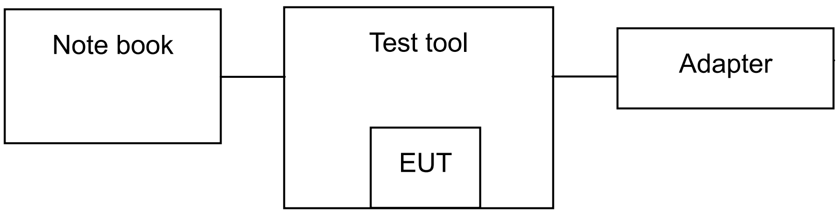
N/A

## 3.4 Operating Mode

Constantly transmitting with a modulated carrier at maximum power on the low, middle and high channels.

## 3.5 Test Setup of EUT

The measurements were taken in continuous transmit mode using the test mode which controlled by teraterm. The test command and the test Jig and cables were provided by the applicant.



## 3.6 Parameters of Test Software Setting

During testing, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

▣ TX Power setting value during test

| Band | TX Power setting value | | |
|---|---|---|---|
| | Low CH | Middle CH | High CH |
| 2.4 GHz band | 0 | 0 | 0 |

▣ Test Program

Teraterm

```
command> bredr_tx 0 4 1 4 27 9 0
Reset
Read_BD_ADDR
BD_ADDR is 0x0018CE0F4512
Reset
Local_Device_BD_ADDR : 0x0018CE0F4512
Hopping_Mode : 0x1
Frequency : 0
Modulation_Type : 4
Logical_Channel : 1
BB_Packet_Type : 4
BB_Packet_Length : 27
Tx_Power_Level : 9
Transmit_Power_Table_Index : 0
Enter BR/EDR TX Test...
BREDR_TX Complete!
```

| Parameter | Name | Infomation |
|---|---|---|
| 1 | Frequency | 0 (2402 MHz) ~ 39 (2441 MHz) ~ 78 (2480 MHz) |
| 2 | Modulation Type | 1 (ACL Basic), 3 (0xAA 8-bit Pattern), 4 (PRBS9 Pattern), 9 (0xF0 8-bit Pattern) |
| 3 | Logical Channel | 1 (ACL Basic) |
| 4 | BB Packet Type | 0 (NULL), 1 (POLL), 2 (FHS), 3 (DM1), 4 (DH1/2-DH1), 5 (HV1), 6 (HV2/2-EV3), 7 (HV3/EV3/3-EV3), 8 (DV/3-DH1), 9 (AUX1/PS), 10 (DM3/2-DH3), 11 (DH3/3-DH3), 12 (EV4/2-EV5), 13 (EV5/3-EV5), 14 (DM5/2-DH5), 15 (DH5/3-DH5) |
| 5 | BB Packet Length | 27 |
| 6 | Tx Power Level | Specific Power Table Index |
| 7 | Transmit Power Table Index | 0-7 |

## 3.7 Table for Test condition

| Test Items | Channel No | Frequency (㎒) | Operated Condition |
|---|---|---|---|
| Channel Separation | 39, 40 | 2 441, 2 442 | Hopping on and continuous modulation setting mode |
| Number of Hopping Channels | 0 ~ 78 | 2 402 ~ 2 480 | Hopping on mode |
| Time of occupancy | 39 | 2 441 | Hopping on mode |
| Peak Output Power | 0 | 2 402 | Hopping off and continuous modulation setting mode |
| | 39 | 2 441 | |
| | 78 | 2 480 | |
| Band-edge Compliance | 0 | 2 402 | Hopping off and continuous modulation setting mode |
| | 78 | 2 480 | |
| Spurious RF conducted emissions | - | - | Frequency band setting by required standard (FCC Rules)* |
| Spurious radiated emissions | - | - | |

*Note: Channel number is selected lowest, middle, highest channel and also hopping on/off mode operation

## 3.8 Used Test Equipment List

| No. | Instrument | Model | S/N | Manufacturer | Due to cal date | Cal interval | used |
|---|---|---|---|---|---|---|---|
| 1 | T & H Chamber | EY-101 | 90E14260 | TABAI ESPEC | 2017.09.07 | 1 year | ☐ |
| 2 | T & H Chamber | SH-641 | 92006831 | ESPEC CORP | 2018.02.02 | 1 year | ☐ |
| 3 | Spectrum Analyzer | 8563E | 3846A10662 | Agilent Technology | 2018.02.02 | 1 year | ☐ |
| 4 | Spectrum Analyzer | 8593E | 3710A02859 | Agilent Technology | 2018.02.02 | 1 year | ☐ |
| 5 | Spectrum Analyzer | FSV30 | 20-353063 | Rohde& Schwarz | 2018.02.01 | 1 year | ☒ |
| 6 | Signal Analyzer | N9010A | MY56070441 | Agilent Technologies | 2018.05.15 | 1 year | ☐ |
| 7 | EMI Test Receiver | ESCI7 | 100823 | Rohde& Schwarz | 2018.01.31 | 1 year | ☒ |
| 8 | EMI Test Receiver | ESI | 837514/004 | Rohde& Schwarz | 2017.09.07 | 1 year | ☒ |
| 9 | Vector Signal Analyzer | 89441A | 3416A02620 | Agilent Technology | 2018.02.03 | 1 year | ☐ |
| 10 | Network Analyzer | 8753ES | US39172348 | AGILENT | 2017.09.06 | 1 year | ☐ |
| 11 | EPM Series Power meter | E4418B | GB39512547 | Agilent Technology | 2018.02.01 | 1 year | ☐ |
| 12 | RF Power Sensor | E9300A | MY41496631 | Agilent Technology | 2018.02.01 | 1 year | ☐ |
| 13 | Microwave Frequency Counter | 5352B | 2908A00480 | Agilent Technology | 2018.02.01 | 1 year | ☐ |
| 14 | Modulation Analyzer | 8901A | 3538A07071 | Agilent Technology | 2018.02.02 | 1 year | ☐ |
| 15 | Audio Analyzer | 8903B | 3514A16919 | Agilent Technology | 2018.01.31 | 1 year | ☐ |
| 16 | Audio Telephone Analyzer | DD-5601CID | 520010281 | CREDIX | 2018.02.02 | 1 year | ☐ |
| 17 | Digital storage Oscilloscope | TDS3052 | B015962 | Tektronix | 2017.09.06 | 1 year | ☐ |
| 18 | ESG-D Series Signal Generator | E4436B | US39260458 | Agilent Technology | 2018.02.02 | 1 year | ☐ |
| 19 | Vector Signal Generator | SMBV100A | 257557 | Rohde & Schwarz | 2018.02.02 | 1 year | ☐ |
| 20 | Signal Generator | SMB100A | 179628 | Rohde & Schwarz | 2017.06.02 | 1 year | ☒ |
| 21 | Tracking Source | 85645A | 070521-A1 | Agilent Technology | 2018.02.03 | 1 year | ☐ |
| 22 | SLIDAC | None | 0207-4 | Myoung sung Ele. | 2018.01.31 | 1 year | ☐ |
| 23 | DC Power supply | DRP-5030 | 9028029 | Digital Electronic Co.,Ltd | 2018.02.01 | 1 year | ☐ |
| 24 | DC Power supply | 6038A | 3440A12674 | Agilent Technology | 2018.01.31 | 1 year | ☐ |
| 25 | DC Power supply | E3610A | KR24104505 | Agilent Technology | 2018.01.31 | 1 year | ☐ |
| 26 | DC Power supply | UP-3005T | 68 | Unicon Co.,Ltd | 2018.01.31 | 1 year | ☐ |
| 27 | DC Power Supply | SM 3004-D | 114701000117 | DELTA ELEKTRONIKA | 2018.01.31 | 1 year | ☐ |
| 28 | Dummy Load | 8173 | 3780 | Bird Electronic Co., Corp | 2018.02.03 | 1 year | ☐ |
| 29 | Attenuator | 50FH-030-500 | 140410 9433 | JEW Idustries Inc. | 2018.02.02 | 1 year | ☐ |
| 30 | Attenuator | 765-20 | 9703 | Narda | 2017.09.06 | 1 year | ☐ |
| 31 | Attenuator | 24-30-34 | BX5630 | Aeroflex / Weinschel | 2017.12.27 | 1 year | ☐ |
| 32 | Attenuator | 8498A | 3318A09485 | HP | 2018.02.01 | 1 year | ☐ |
| 33 | Step Attenuator | 8494B | 3308A32809 | HP | 2018.02.02 | 1 year | ☐ |
| 34 | Attenuator | 18B50W-20F | 64671 | INMET | 2018.02.02 | 1 year | ☐ |
| 35 | Attenuator | 10 dB | 1 | Rohde & Schwarz | 2018.05.18 | 1 year | ☐ |
| 36 | Attenuator | 10 dB | 2 | Rohde & Schwarz | 2018.05.18 | 1 year | ☐ |
| 37 | Attenuator | 10 dB | 3 | Rohde & Schwarz | 2018.05.18 | 1 year | ☐ |
| 38 | Attenuator | 10 dB | 4 | Rohde & Schwarz | 2018.05.18 | 1 year | ☐ |
| 39 | Attenuator | 54A-10 | 74564 | WEINSCHEL | 2018.05.18 | 1 year | ☒ |
| 40 | Attenuator | 56-10 | 66920 | WEINSCHEL | 2018.05.18 | 1 year | ☒ |
| 41 | Power divider | 11636B | 51212 | HP | 2018.02.01 | 1 year | ☐ |
| 42 | 3Way Power divider | KPDSU3W | 00070365 | KMW | 2017.09.06 | 1 year | ☐ |
| 43 | 4Way Power divider | 70052651 | 173834 | KRYTAR | 2018.02.01 | 1 year | ☐ |
| 44 | 3Way Power divider | 1580 | SQ361 | WEINSCHEL | 2018.05.18 | 1 year | ☐ |
| 45 | OSP | OSP120 | 101577 | Rohde & Schwarz | 2018.05.19 | 1 year | ☐ |
| 46 | White noise audio filter | ST31EQ | 101902 | SoundTech | 2017.09.07 | 1 year | ☐ |
| 47 | Dual directional coupler | 778D | 17693 | HEWLETT PACKARD | 2018.02.02 | 1 year | ☐ |
| 48 | Dual directional coupler | 772D | 2839A00924 | HEWLETT PACKARD | 2018.02.02 | 1 year | ☐ |
| 49 | Band rejection filter | 3TNF-0006 | 26 | DOVER Tech | 2018.02.03 | 1 year | ☐ |
| 50 | Band rejection filter | 3TNF-0008 | 317 | DOVER Tech | 2018.02.03 | 1 year | ☐ |

| No. | Instrument | Model | S/N | Manufacturer | Due to cal date | Cal interval | used |
|---|---|---|---|---|---|---|---|
| 51 | Band rejection filter | 3TNF-0007 | 311 | DOVER Tech | 2018.02.03 | 1 year | ☐ |
| 52 | Band rejection filter | WTR-BRF2442-84NN | 09020001 | WAVE TECH Co.,LTD | 2018.02.02 | 1 year | ☒ |
| 53 | Band rejection filter | WRCJV12-5695-5725-5825-5855-50SS | 1 | Wainwright Instruments GmbH | 2018.05.18 | 1 year | ☐ |
| 54 | Band rejection filter | WRCJV12-5120-5150-5350-5380-40SS | 4 | Wainwright Instruments GmbH | 2018.05.18 | 1 year | ☐ |
| 55 | Band rejection filter | WRCGV10-2360-2400-2500-2540-50SS | 2 | Wainwright Instruments GmbH | 2018.05.18 | 1 year | ☐ |
| 56 | Highpass Filter | WHJS1100-10EF | 1 | WAINWRIGHT | 2018.02.02 | 1 year | ☐ |
| 57 | Highpass Filter | WHJS3000-10EF | 1 | WAINWRIGHT | 2018.02.02 | 1 year | ☐ |
| 58 | Highpass Filter | WHNX6-5530-3000-26500-40CC | 2 | Wainwright Instruments GmbH | 2018.05.19 | 1 year | ☐ |
| 59 | Highpass Filter | WHNX6-2370-7000-26500-40CC | 4 | Wainwright Instruments GmbH | 2018.05.19 | 1 year | ☐ |
| 60 | WideBand Radio Communication Tester | CMW500 | 102276 | Rohde & Schwarz | 2018.02.03 | 1 year | ☐ |
| 61 | Radio Communication Tester | CMU 200 | 112026 | Rohde & Schwarz | 2018.02.03 | 1 year | ☐ |
| 62 | Bluetooth Tester | TC-3000B | 3000B6A0166 | TESCOM CO., LTD. | 2018.02.03 | 1 year | ☐ |
| 63 | RF Up/Down Converter | DCP-1780 | 980901003 | CREDIX | 2018.02.03 | 1 year | ☐ |
| 64 | DECT Test set | CMD60 | 840677/005 | Rohde& Schwarz | 2017.09.06 | 1 year | ☐ |
| 65 | Loop Antenna | 6502 | 9203-0493 | EMCO | 2017.06.04 | 2 year | ☒ |
| 66 | BiconiLog Antenna | 3142B | 9910-1432 | EMCO | 2018.04.25 | 2 year | ☒ |
| 67 | Trilog-Broadband Antenna | VULB 9168 | 9168-606 | SCHWARZBECK | 2018.09.09 | 2 year | ☐ |
| 68 | Horn Antenna | 3115 | 2996 | EMCO | 2018.02.11 | 2 year | ☒ |
| 69 | Horn Antenna | BBHA9170 | BBHA9170152 | SCHWARZBECK | 2019.04.25 | 2 year | ☒ |
| 70 | Antenna Master(3) | AT13 | None | AUDIX | N/A | N/A | ☒ |
| 71 | Turn Table(3) | None | None | AUDIX | N/A | N/A | ☒ |
| 72 | PREAMPLIFIER(3) | 8449B | 3008A02577 | Agilent | 2018.02.01 | 1 year | ☒ |
| 73 | Antenna Master(10) | MA4000-EP | None | inno systems GmbH | N/A | N/A | ☒ |
| 74 | Turn Table(10) | None | None | inno systems GmbH | N/A | N/A | ☒ |
| 75 | AMPLIFIER(10) | TK-PA6S | 120009 | TESTEK | 2018.01.31 | 1 year | ☒ |
| 76 | Antenna Mast | MA2000-EP | None | inno systems GmbH | N/A | N/A | ☐ |
| 77 | Turn Device | DE3700-RH | None | inno systems GmbH | N/A | N/A | ☐ |

# 4. SUMMARY TEST RESULTS

| Description of Test | FCC Rule | IC Rule | Reference Clause | Used | Test Result |
|---|---|---|---|---|---|
| Peak Output Power | § 15.247(b)(1) | RSS-247, 5.4.2 | Clause 5.1 | ☒ | Compliance |
| 20 dB Bandwidth | § 15.247(a)(1) | RSS-247, 5.1.1 | Clause 5.2 | ☒ | Compliance |
| Channel Separation | § 15.247(a)(1) | RSS-247, 5.1.2 | Clause 5.3 | ☒ | Compliance |
| Number of Hopping Channels | § 15.247(a)(1) | RSS-247, 5.1.4 | Clause 5.4 | ☒ | Compliance |
| Time of Occupancy | § 15.247(a)(1) | RSS-247, 5.1.2 | Clause 5.5 | ☒ | Compliance |
| Conducted Spurious Emissions | § 15.247(d) | RSS-247, 5.5 | Clause 5.6 | ☒ | Compliance |
| Radiated Spurious Emissions | § 15.247(d), § 15.209, and § 15.205 | RSS-GEN, 8.8 | Clause 5.7 | ☒ | Compliance |
| Antenna Requirement | § 15.203 | - | Clause 5.8 | ☒ | Compliance |
| AC Power Conducted emissions | § 15.207 | RSS-GEN, 8.8 | Clause 5.9 | ☒ | Compliance |
| Compliance: The EUT complies with the essential requirements in the standard.<br>Not Compliance : The EUT does not comply with the essential requirements in the standard.<br>N/A : The test was not applicable in the standard. | | | | | |

**Procedure Reference**

FCC CFR 47, Part 15. Subpart C-15.247
DA 00-705
RSS-GEN Issue 4
RSS-247 Issue 2
ANSI C 63.10-2013

# 5. MEASUREMENT RESULTS

## 5.1 Peak Output Power

### 5.1.1 Standard Applicable [FCC §15.247(b)(1) / RSS-247 5.4.2]

For frequency hopping systems operating in the 2 400 ~ 2 483.5 ㎒ band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 850 MHz band : 1 Watt. For all other frequency hopping systems in the 2400 ~ 2483.5 MHz band: 0.125 watts.

### 5.1.2 Test Environment conditions

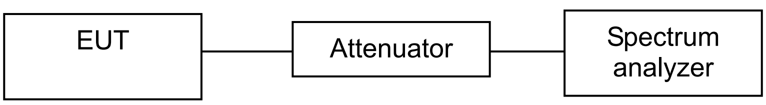
• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

### 5.1.3 Measurement Procedure

ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. The peak output power was measured using the marker to peak function of the spectrum analyzer.

The spectrum analyzer is set to the as follows :
• Span : approximately 5 times the 20 dB bandwidth
• RBW : > 20 dB bandwidth of the emission being measured
• VBW ≥ RBW.
• Sweep time = auto
• Detector = peak.
• Trace mode = max hold.
• Allow trace to fully stabilize.
• Use the peak marker function to determine the maximum amplitude level.

### 5.1.4 Test setup




### 5.1.5 Measurement Result

▣ BDR(GFSK)

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Test Results |
|---|---|---|---|---|
| 0 | 2 402 | -1.31 | 30 | Compliance |
| 39 | 2 441 | -0.95 | 30 | Compliance |
| 78 | 2 480 | -1.32 | 30 | Compliance |

▣ EDR(π/4DQPSK)

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Test Results |
|---|---|---|---|---|
| 0 | 2 402 | 1.10 | 30 | Compliance |
| 39 | 2 441 | 1.51 | 30 | Compliance |
| 78 | 2 480 | 1.06 | 30 | Compliance |

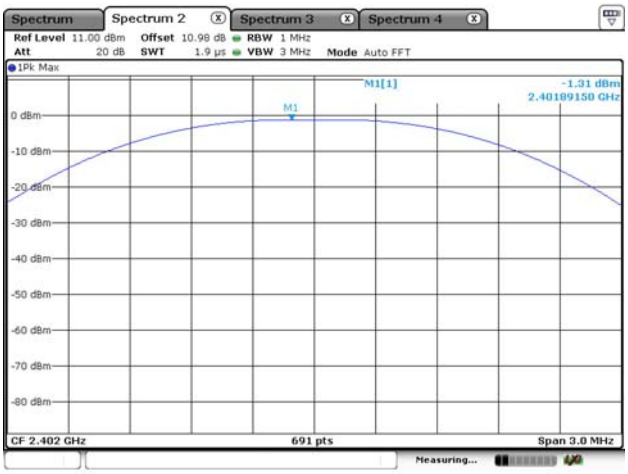
▣ EDR(8DPSK)

| Channel | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Test Results |
|---|---|---|---|---|
| 0 | 2 402 | 1.65 | 30 | Compliance |
| 39 | 2 441 | 2.01 | 30 | Compliance |
| 78 | 2 480 | 1.65 | 30 | Compliance |

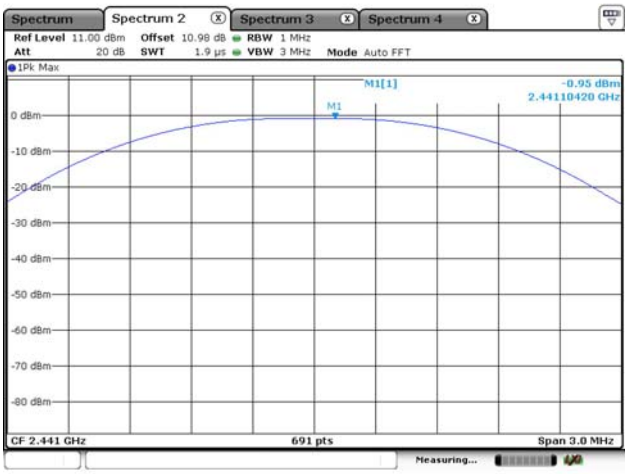
5.1.6 Test Plot

▣ BDR(GFSK)

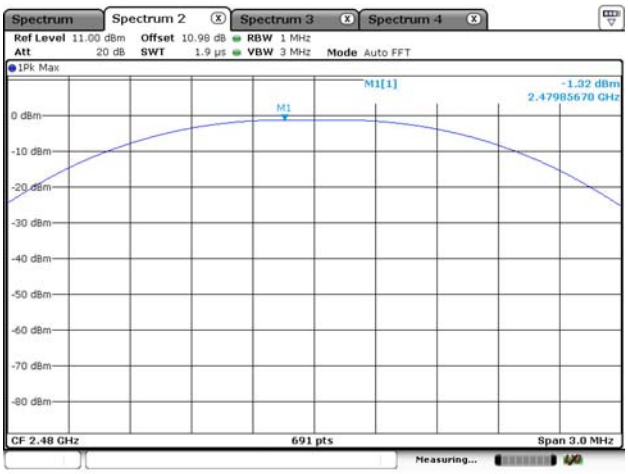
CH Low




CH Middle

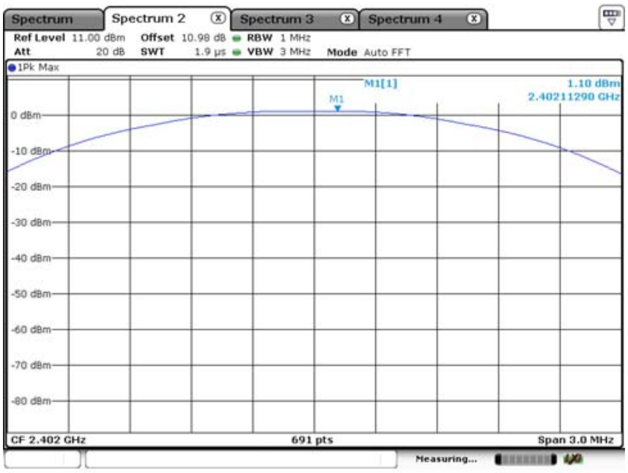



CH High

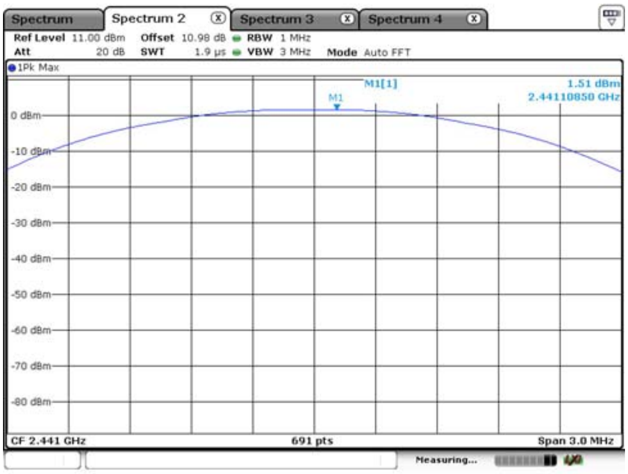


▣ EDR(π/4DQPSK)

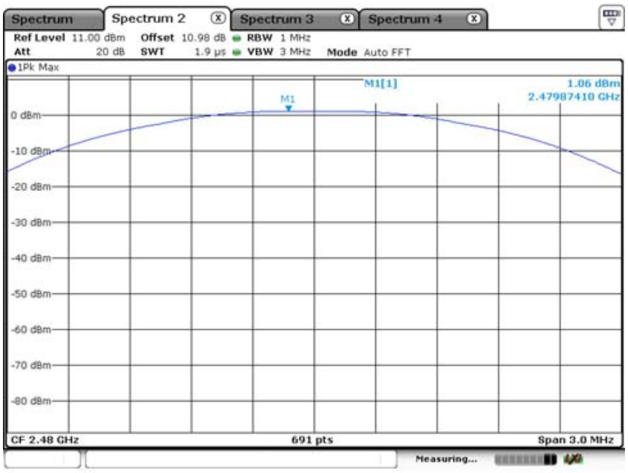
CH Low




CH Middle

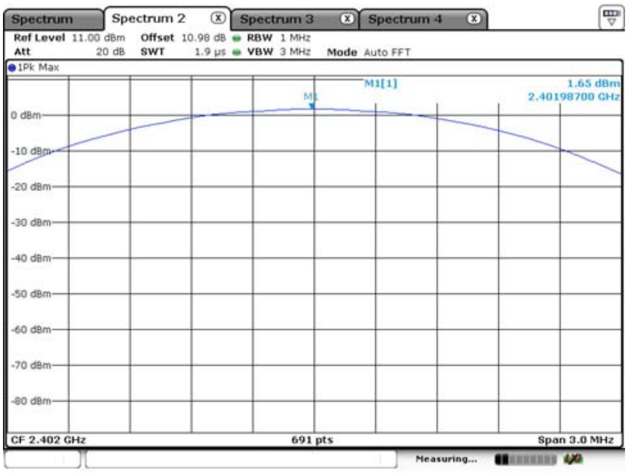



CH High

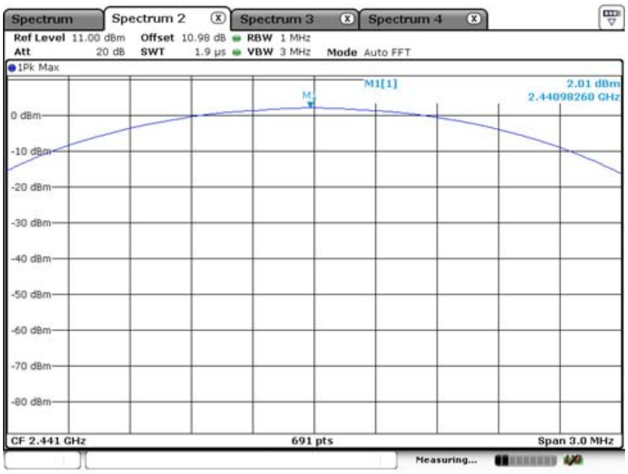


▣ EDR(8DPSK)

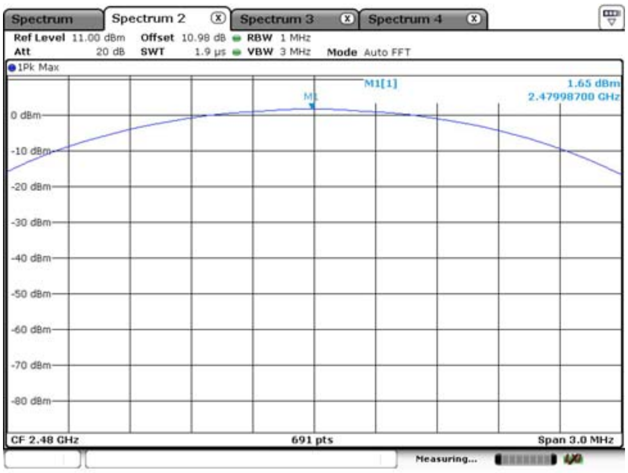
CH Low




CH Middle




CH High



## 5.2 20 dB Bandwidth

### 5.2.1 Standard Applicable [FCC §15.247(a)(1) / RSS-247, 5.1.1]

Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 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.

### 5.2.2 Test Environment conditions

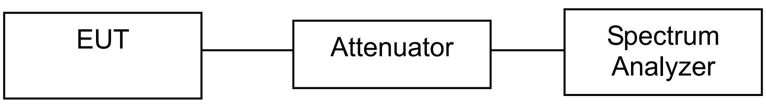
• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

### 5.2.3 Measurement Procedure

ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW ≥ 1 % of the 20 dB bandwidth and VBW ≥ RBW.
3. Measured the spectrum width with power higher than 20 dB below carrier.

### 5.2.4 Test setup



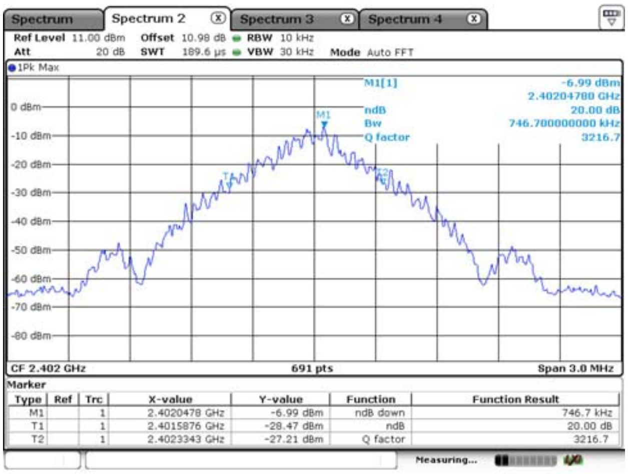

### 5.2.5 Measurement Result

| Modulation Type | Channel | Frequency [MHz] | 20 dB Bandwidth [MHz] | 99 % Bandwidth [MHz] | Limit [MHz] | Test Results |
|---|---|---|---|---|---|---|
| BDR(GFSK) | 0 | 2 402 | 0.747 | 0.860 | - | Compliance |
| | 39 | 2 441 | 0.747 | 0.864 | - | Compliance |
| | 78 | 2 480 | 0.708 | 0.860 | - | Compliance |
| EDR(π/4DQPSK) | 0 | 2 402 | 1.329 | 1.185 | - | Compliance |
| | 39 | 2 441 | 1.329 | 1.185 | - | Compliance |
| | 78 | 2 480 | 1.333 | 1.185 | - | Compliance |
| EDR(8DPSK) | 0 | 2 402 | 1.320 | 1.194 | - | Compliance |
| | 39 | 2 441 | 1.324 | 1.194 | - | Compliance |
| | 78 | 2 480 | 1.324 | 1.198 | - | Compliance |

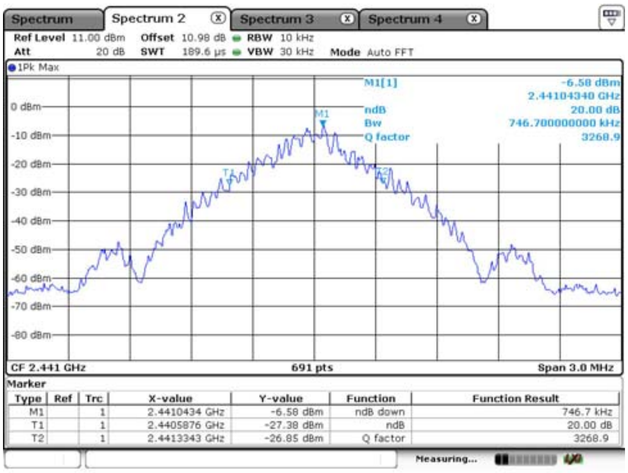
### 5.2.6 Test Plot (20 dB bandwidth)

▣ BDR(GFSK)

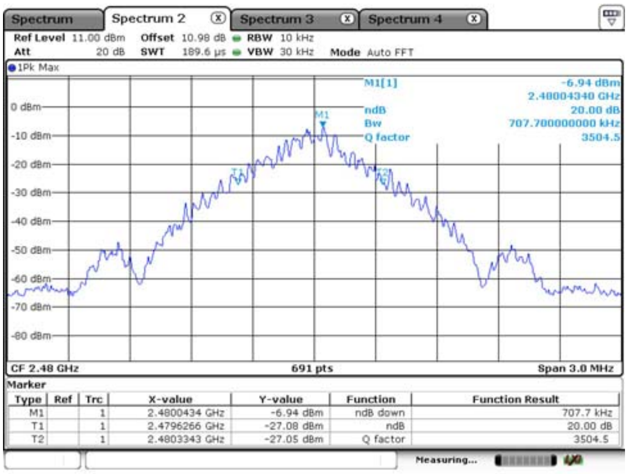
CH Low




CH Middle

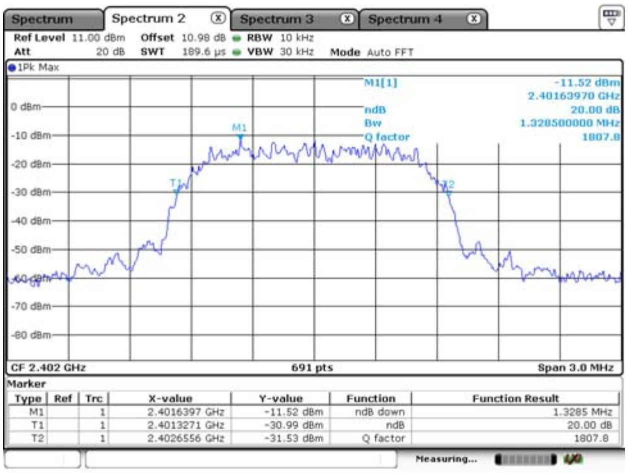



CH High

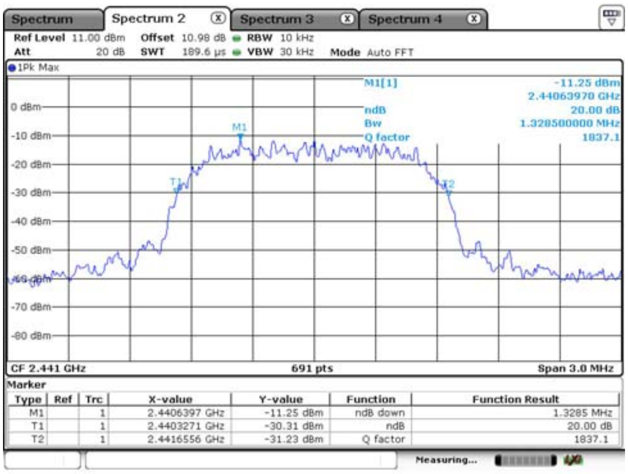


▣ EDR(π/4DQPSK)

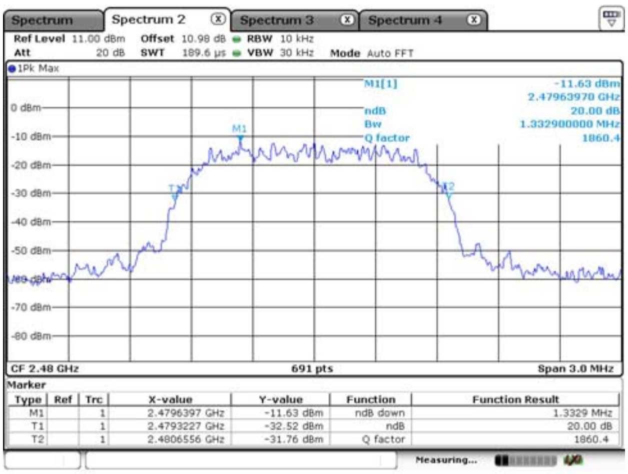
CH Low




CH Middle

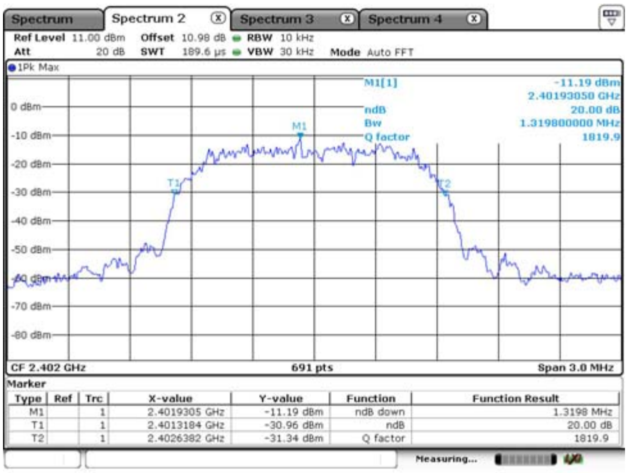



CH High

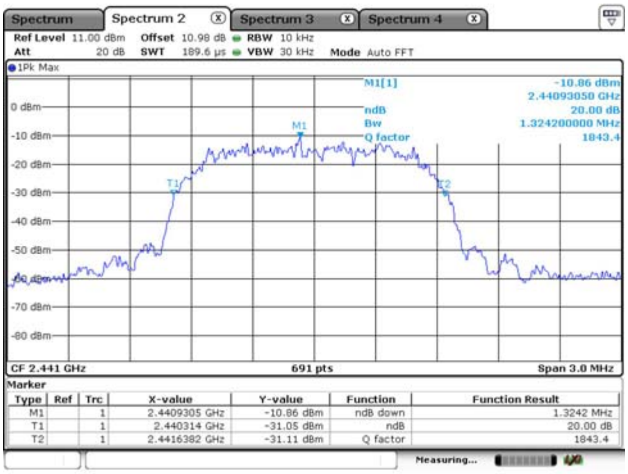


▣ EDR(8DPSK)

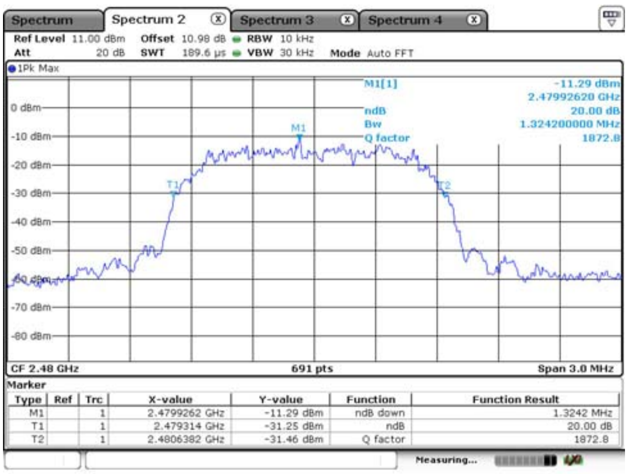
CH Low




CH Middle



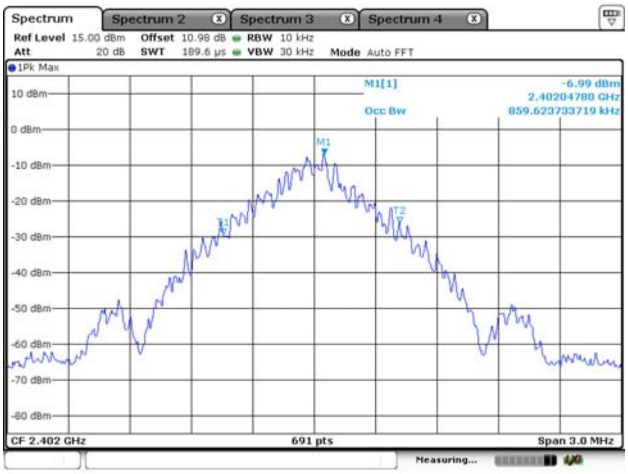

CH High



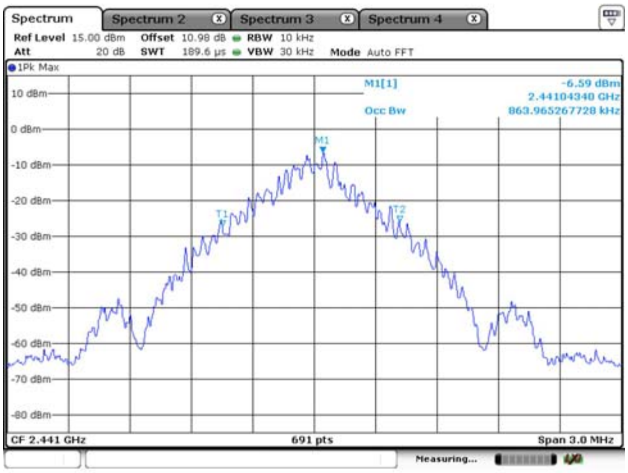
Test Plot (99 % bandwidth)

▣ BDR(GFSK)

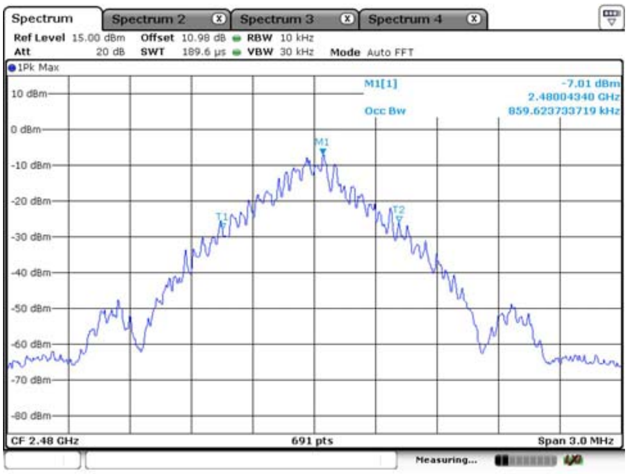
CH Low




CH Middle

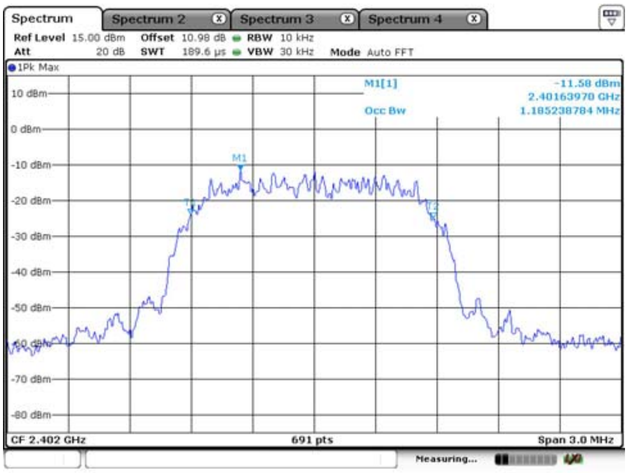



CH High

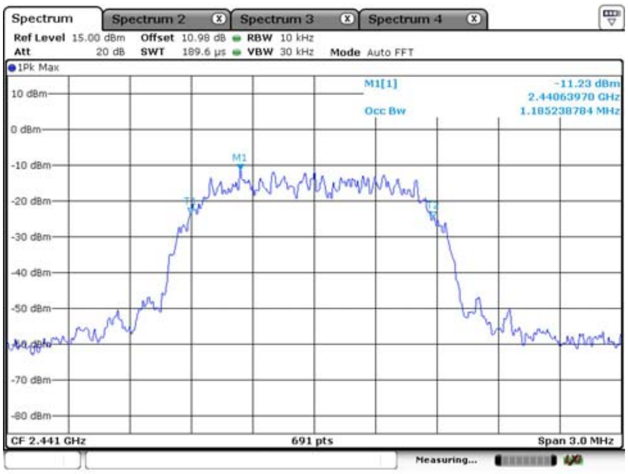


▣ EDR(π/4DQPSK)

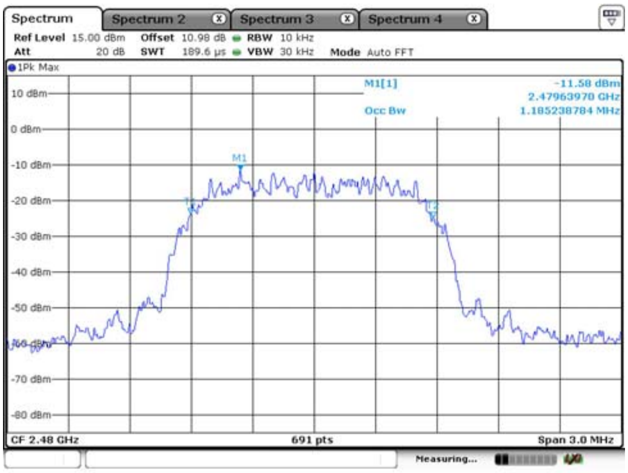
CH Low




CH Middle

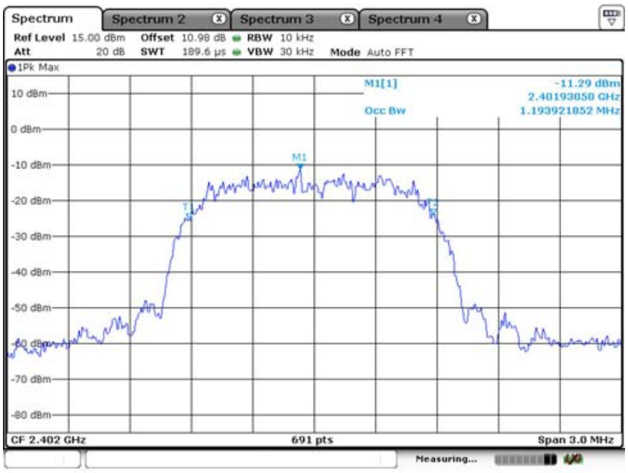



CH High

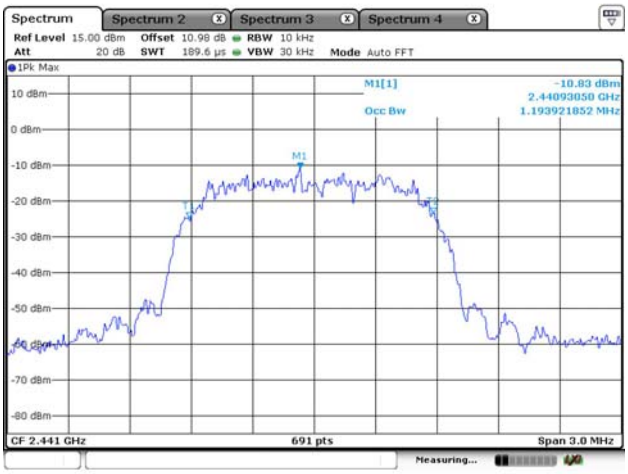


▣ EDR(8DPSK)

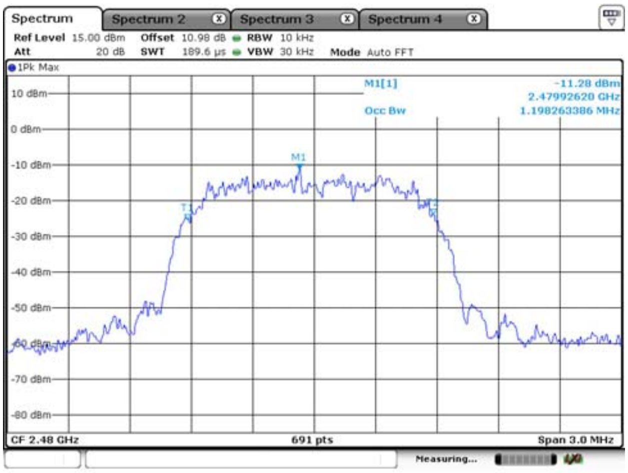
CH Low




CH Middle




CH High



## 5.3 Channel Separation

### 5.3.1 Standard Applicable [ FCC §15.247(a)(1) / RSS-247, 5.1.2]

Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 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.

### 5.3.2 Test Environment conditions

• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

### 5.3.3 Measurement Procedure

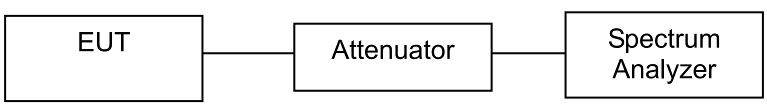
ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. The resolution bandwidth of 30 kHz and the video bandwidth of 100 kHz were used.
3. After the trace being stable, the reading value between the peak of the adjacent channels using the marker- Delta function was recorded as the measurement results.

The spectrum analyzer is set to the as follows :

• Span : wide enough to capture the peak of two adjacent channels
• RBW : ≥ 1% of the span
• VBW : ≥ RBW
• Sweep : auto
• Detector function : peak
• Trace : max hold

### 5.3.4 Test setup



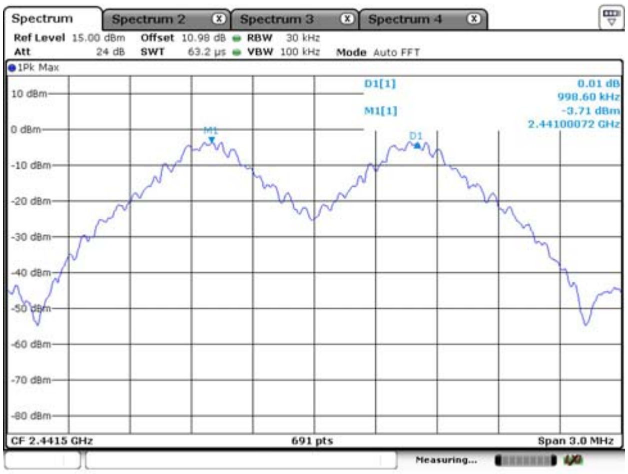

### 5.3.5 Measurement Result

| Modulation Type | Channel | Frequency[MHz] | Channel Separation(MHz) | Limit(MHz) | Test Results |
|---|---|---|---|---|---|
| BDR(GFSK) | 39 | 2441 | 0.999 | ≥0.498 | Compliance |
| EDR(π/4DQPSK) | 39 | 2441 | 0.999 | ≥0.889 | Compliance |
| EDR(8DPSK) | 39 | 2441 | 0.999 | ≥0.883 | Compliance |

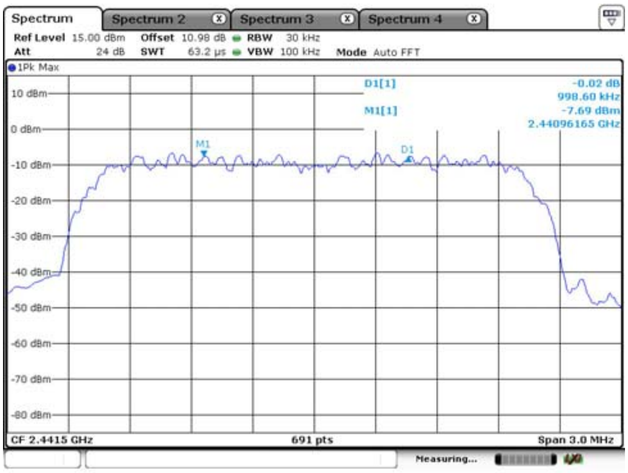
* Limit : ≥ 25 kHz or two-thirds of the 20 dB bandwidth

## 5.3.6 Test plot

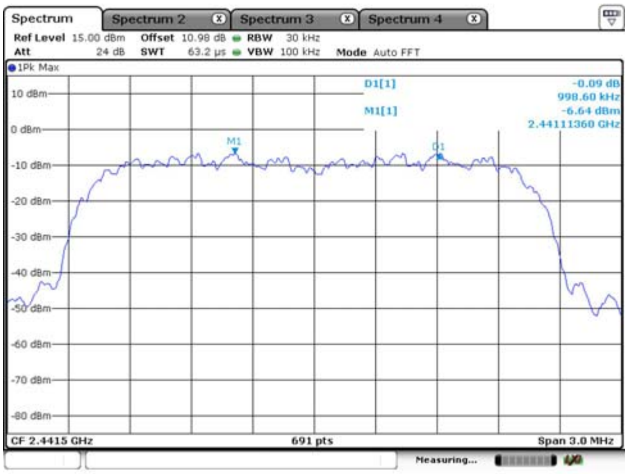
▣ BDR(GFSK)




EDR(π/4DQPSK)




EDR(8DPSK)



## 5.4 Number of Hopping Channels

### 5.4.1 Standard Applicable [FCC §15.247(a)(1) / RSS-247, 5.1.4]

Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(1)(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

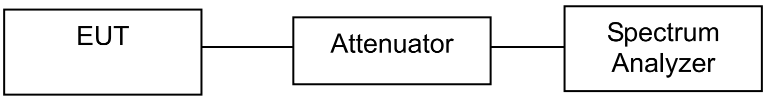
### 5.4.2 Test Environment conditions

• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

### 5.4.3 Measurement Procedure

ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

### 5.4.4 Test setup

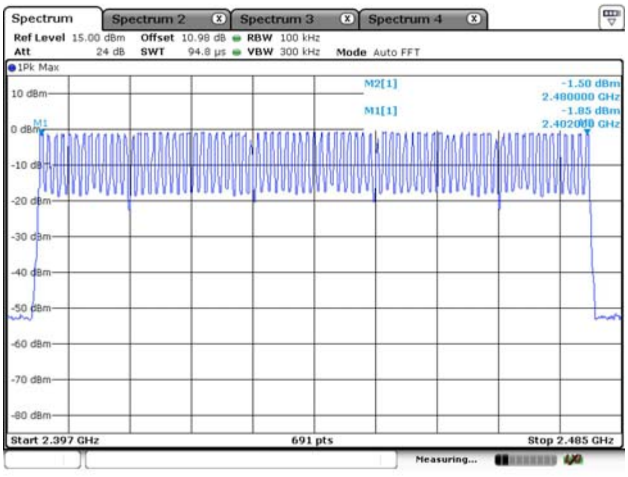



### 5.4.5 Measurement Result

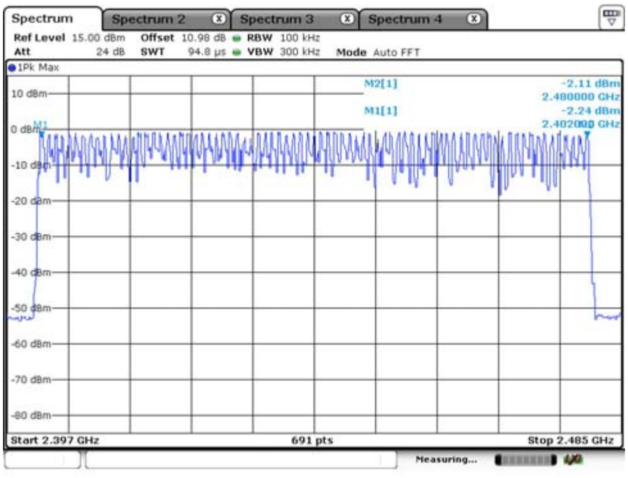
| Modulation Type | Hopping channels number | Limit | Test Results |
|---|---|---|---|
| BDR(GFSK) | 79 | ≥15 | Compliance |
| EDR(π/4DQPSK) | 79 | ≥15 | Compliance |
| EDR(8DPSK) | 79 | ≥15 | Compliance |

5.4.6 Test plot

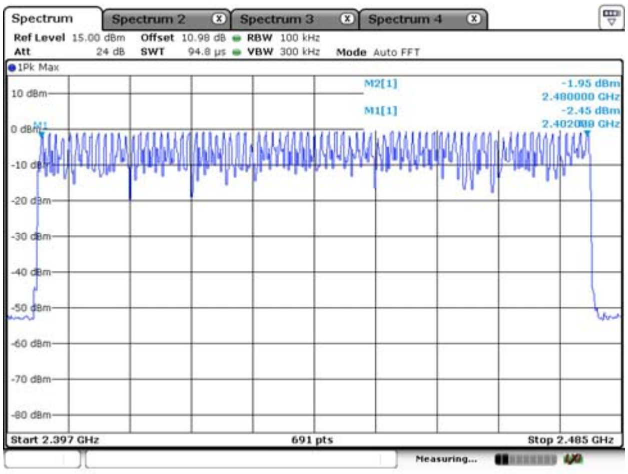
▣ BDR(GFSK)




EDR(π/4DQPSK)




EDR(8DPSK)



## 5.5 Time of Occupancy

### 5.5.1 Standard Applicable [FCC §15.247(a)(1) / RSS-247, 5.1.2]

(1)(iii) 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.

### 5.5.2 Test Environment conditions

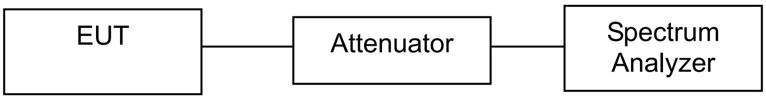
• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

### 5.5.3 Measurement Procedure

ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled. After used the marker-delta function to determine the dwell time.

### 5.5.4 Test setup




### 5.5.5 Measurement Result

| Burst width per one hop (ms) (Time slot) | | | Test Results | | |
|---|---|---|---|---|---|
| | | | Dwell time (ms) | Limit | Result |
| BDR(GFSK) | DH1 | 0.384 | 0.123 | ≤ 0.4 | Compliance |
| | DH3 | 1.638 | 0.262 | ≤ 0.4 | Compliance |
| | DH5 | 2.899 | 0.309 | ≤ 0.4 | Compliance |
| EDR(π/4DQPSK) | 2DH1 | 0.391 | 0.125 | ≤ 0.4 | Compliance |
| | 2DH3 | 1.638 | 0.262 | ≤ 0.4 | Compliance |
| | 2DH5 | 2.899 | 0.309 | ≤ 0.4 | Compliance |
| EDR(8DPSK) | 3DH1 | 0.391 | 0.125 | ≤ 0.4 | Compliance |
| | 3DH3 | 1.626 | 0.260 | ≤ 0.4 | Compliance |
| | 3DH5 | 2.899 | 0.309 | ≤ 0.4 | Compliance |

Note:
DH1 Packet permit maximum 1600 / 79 / 2 hops per second in each channel (1 time slot RX, 1 time slot TX).
DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).
DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

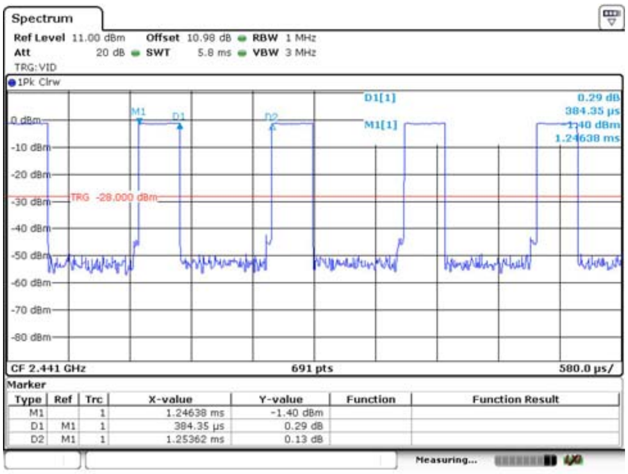
Therefore, dwell Time can be calculated as follows:

| Data Packet | Dwell Time(s) |
|---|---|
| DH1/2DH1/3DH1 | 1600/79/2*0.4*79*(MkrDelta)/1000 |
| DH3/2DH3/3DH3 | 1600/79/4*0.4*79*(MkrDelta)/1000 |
| DH5/2DH5/3DH5 | 1600/79/6*0.4*79*(MkrDelta)/1000 |

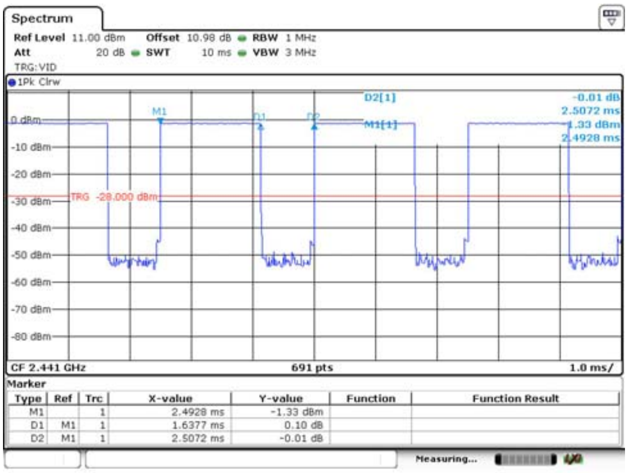
### 5.5.6 Test plot

▣ BDR(GFSK)

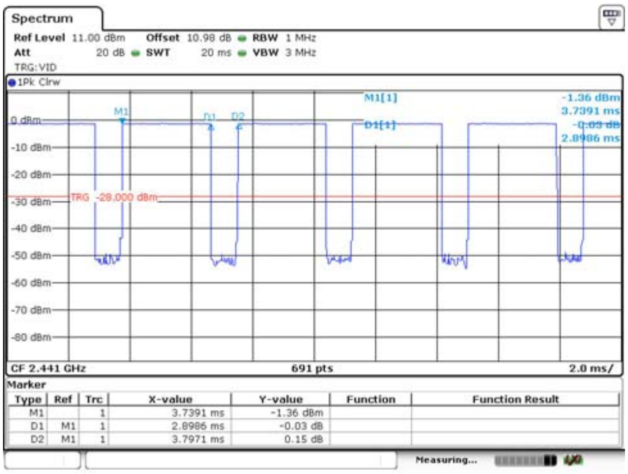
DH1




DH3

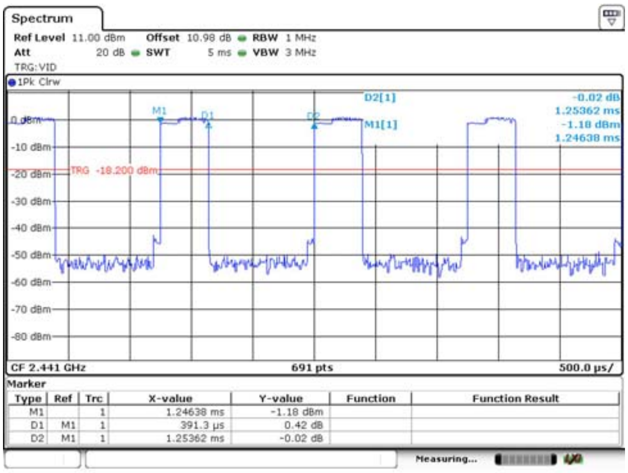



DH5

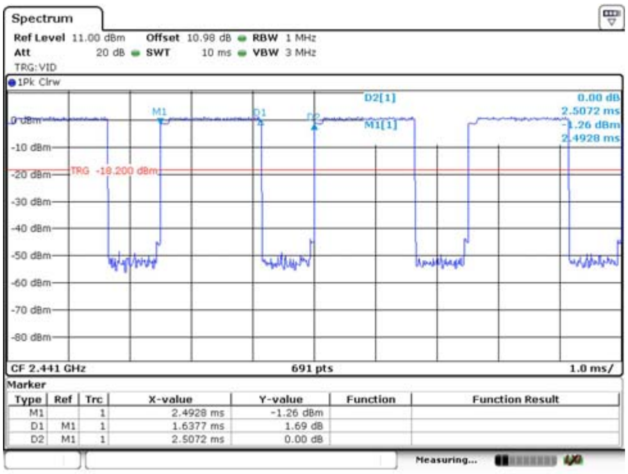


▣ EDR(π/4DQPSK)

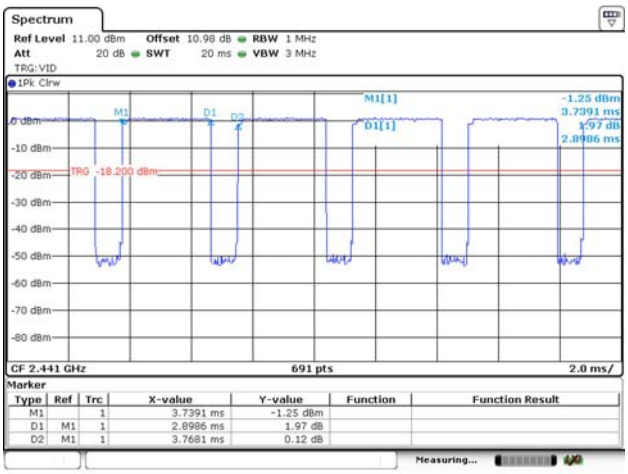
2DH1




2DH3

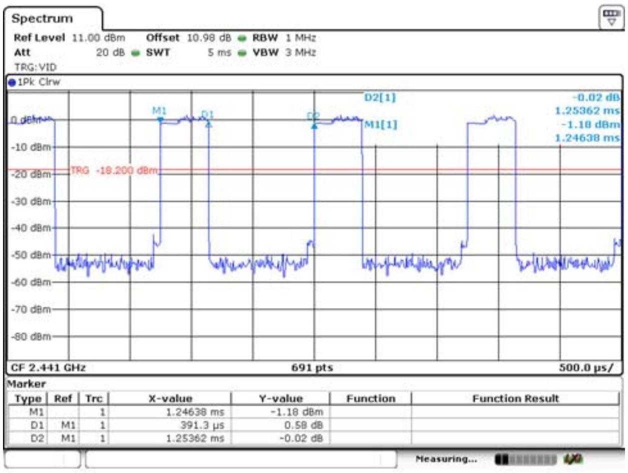



2DH5

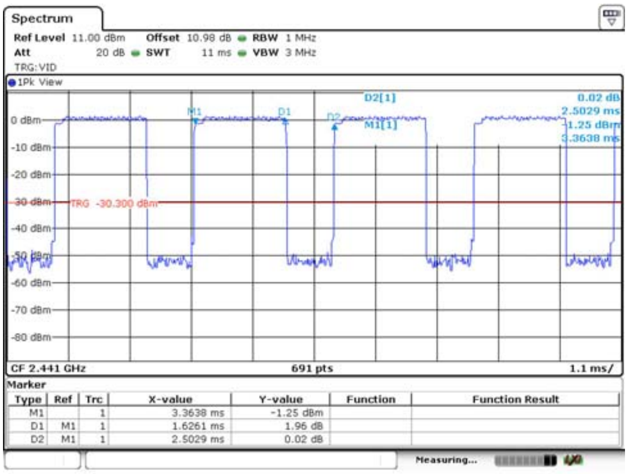


▣ EDR(8DPSK)

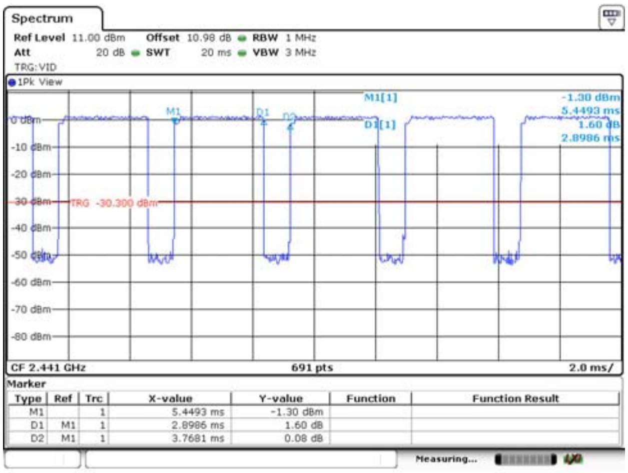
3DH1




3DH3




3DH5



## 5.6 Conducted Spurious Emissions (Band-edge)

### 5.6.1 Standard Applicable [FCC §15.247(d) / RSS-247, 5.5]

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 RF conducted.

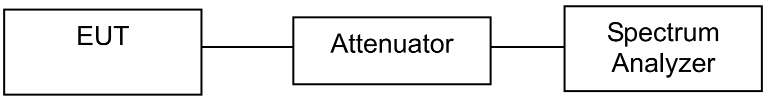
### 5.6.2 Test Environment conditions

• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

### 5.6.3 Measurement Procedure

(1) The transmitter output was connected to the spectrum analyzer through an attenuator.
(2) Conducted spurious emission the bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=100 KHz and VBW=300KHz.
(3) Below -20dB of the highest emission level in operating band.

### 5.6.4 Test setup




### 5.6.5 Measurement Result

| Setting Channel | | Test Results | | | |
|---|---|---|---|---|---|
| | | Measured value [dB] | | Limit [dB] | Result |
| | | Hop on | Hop off | | |
| BDR(GFSK) | CH 0 | -50.25 | -50.63 | ≤ 20 than PSD level | Compliance |
| | CH 78 | -49.39 | -48.20 | | Compliance |
| EDR(π/4DQPSK) | CH 0 | -50.07 | -49.55 | | Compliance |
| | CH 78 | -48.66 | -49.96 | | Compliance |
| EDR(8DPSK) | CH 0 | -51.00 | -50.64 | | Compliance |
| | CH 78 | -49.14 | -49.75 | | Compliance |

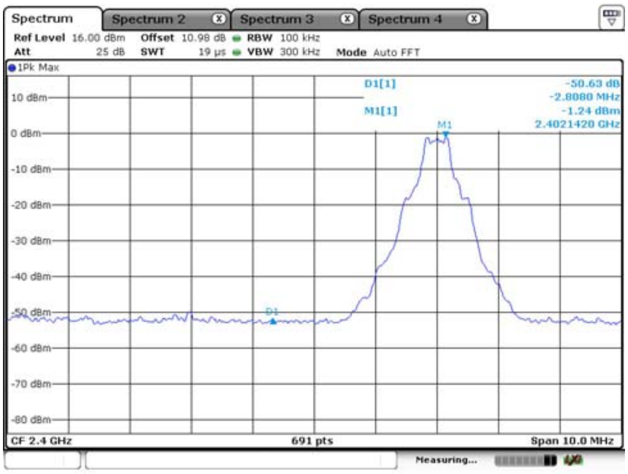
Note: The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria. Plots are also presented showing the band edge compliance.

### 5.6.6 Test Plot (Band-edge)

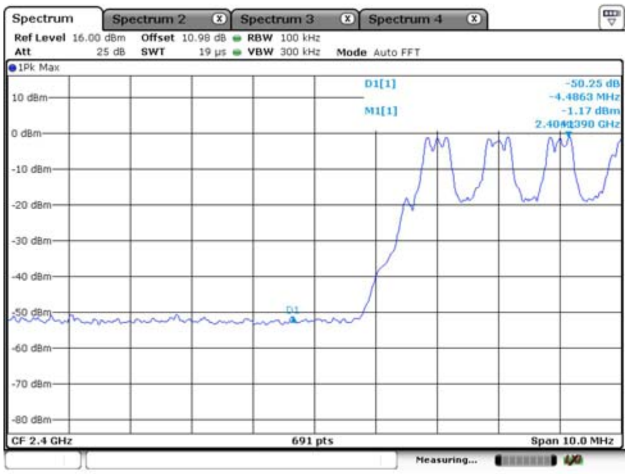
▣ BDR(GFSK)

CH Low

Hop off

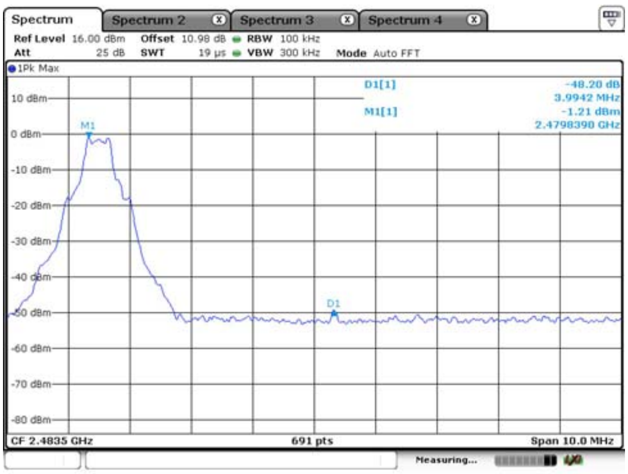



Hop on

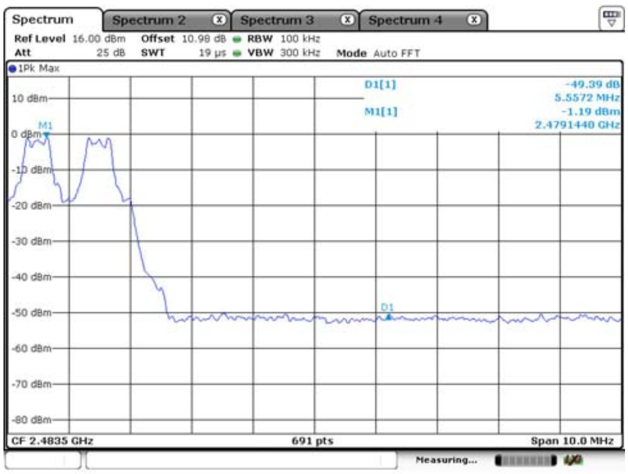



CH High

Hop off



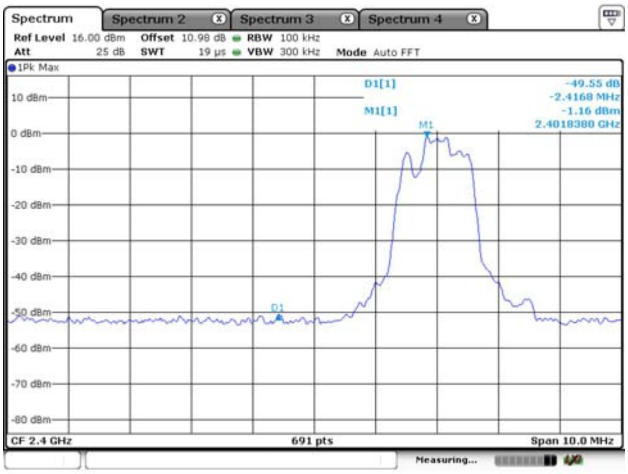

Hop on



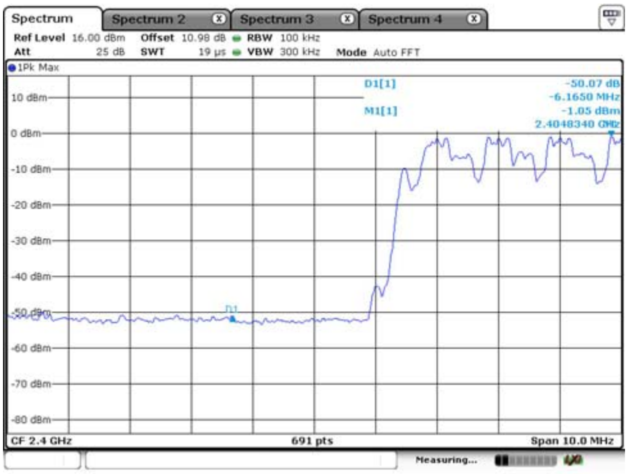
▣ EDR(π/4DQPSK)

CH Low

Hop off

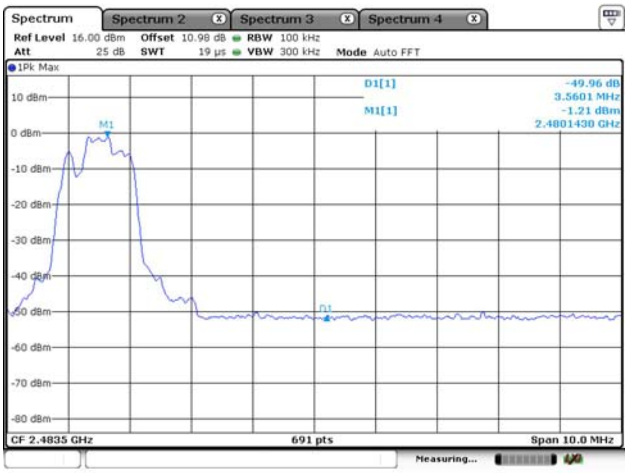



Hop on

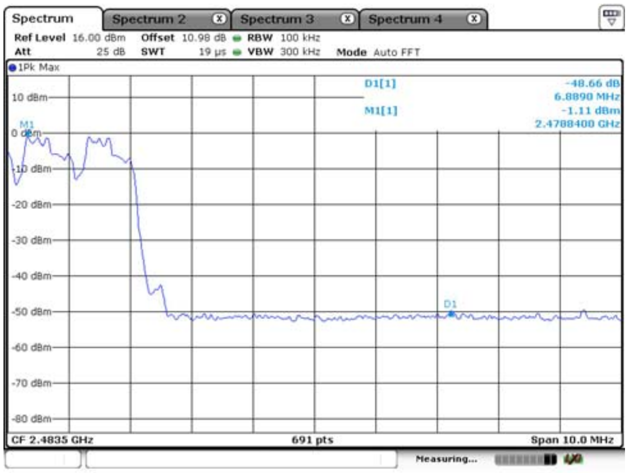



CH High

Hop off



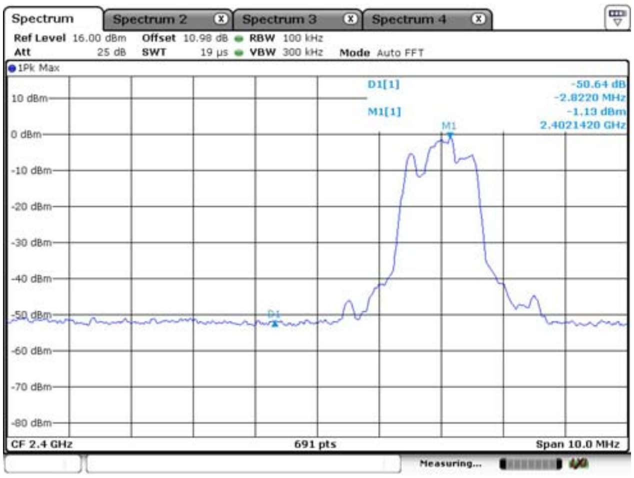

Hop on



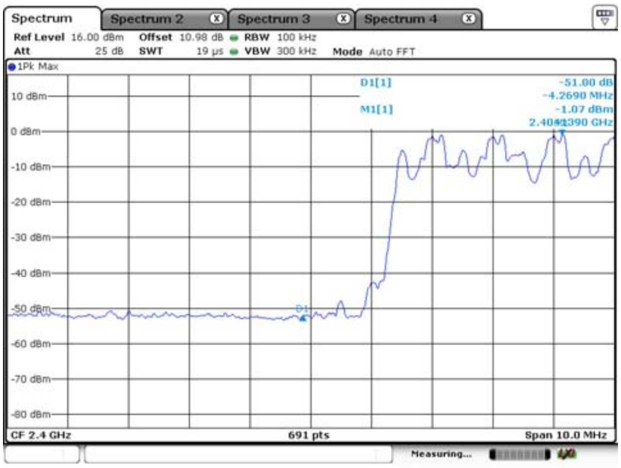
▣ EDR(8DPSK)

CH Low

Hop off

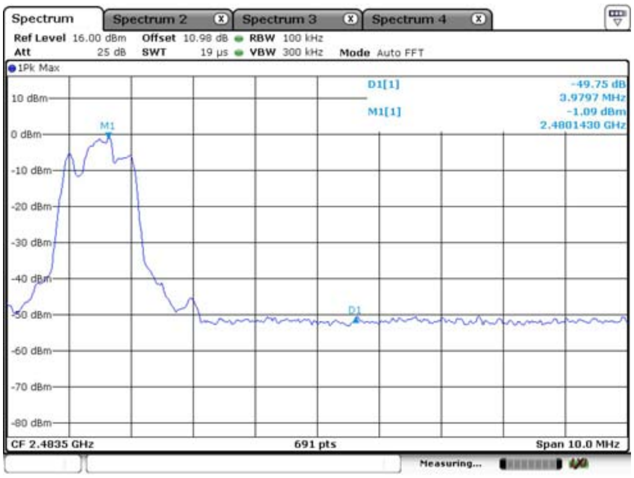


Hop on

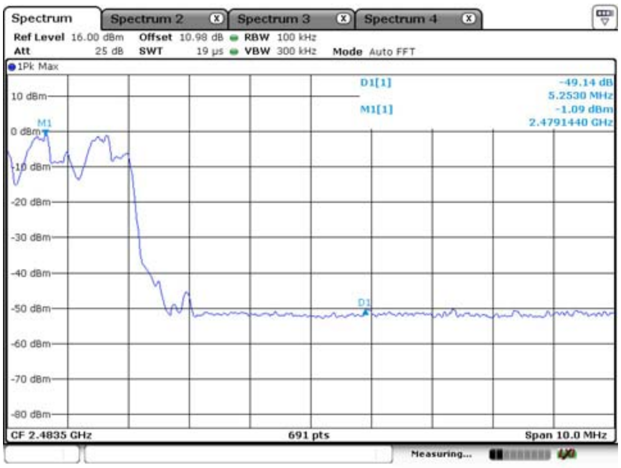


CH High

Hop off



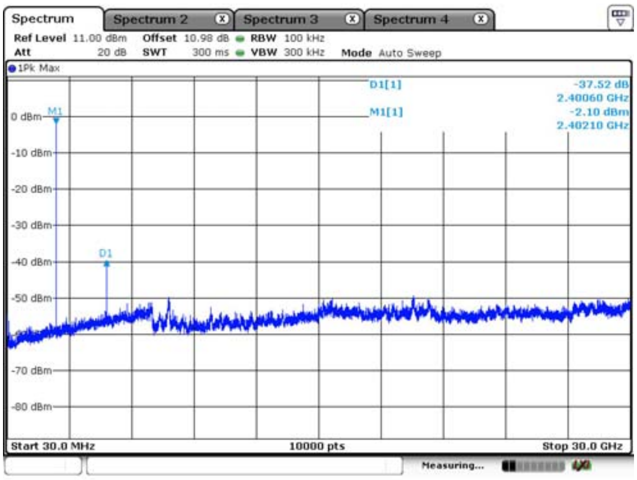
Hop on



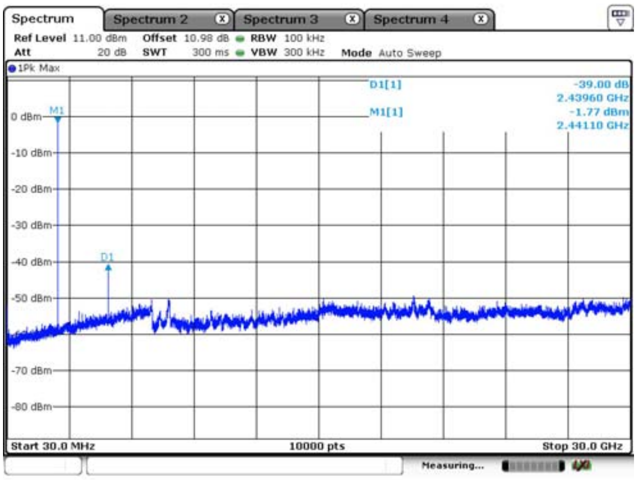
Test Plot (Conducted spurious emissions)

▣ BDR(GFSK)

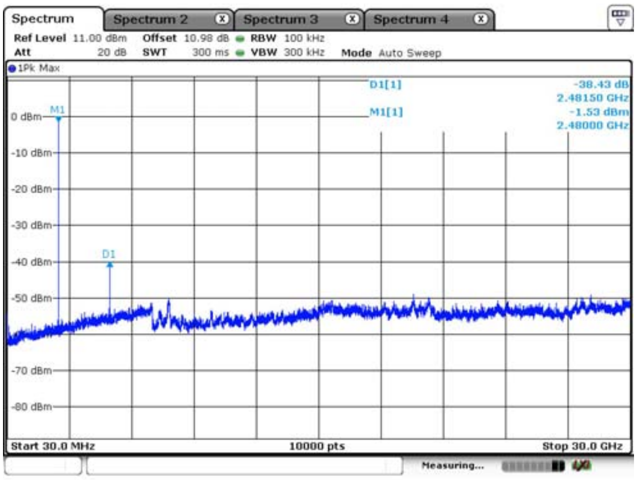
CH Low




CH Middle



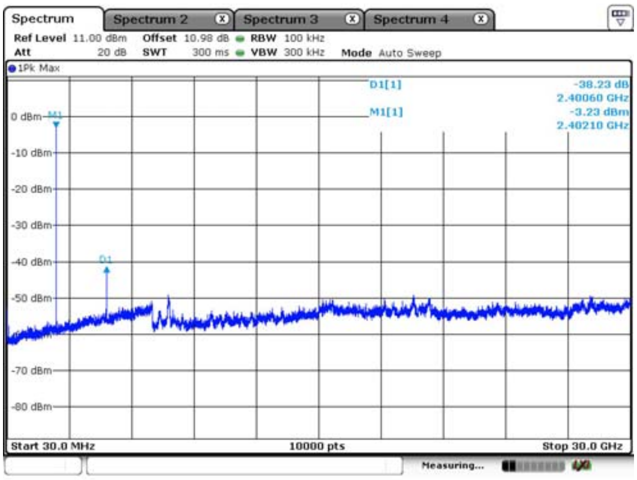

CH High



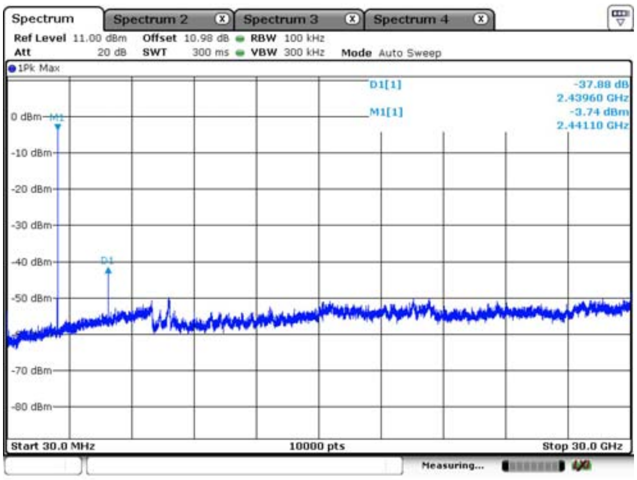

**Note**: It is not recorded on the report that the reading of emissions are attenuated more than 20 dB below the permissible limits

▣ EDR(π/4DQPSK)

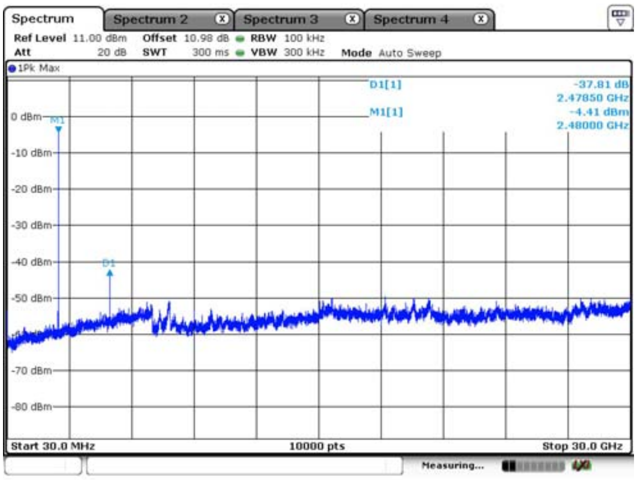
CH Low




CH Middle



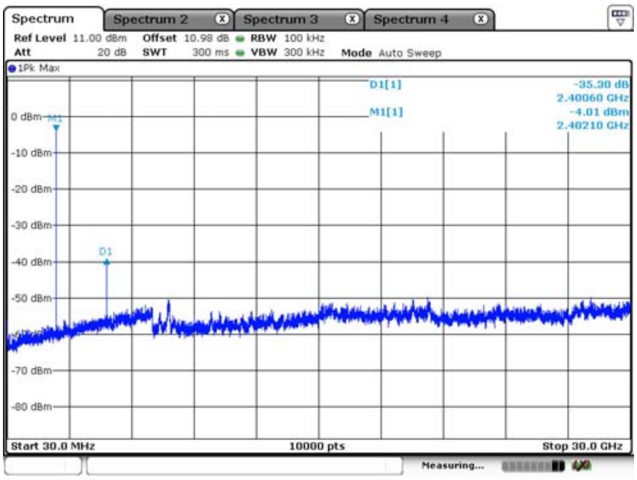

CH High



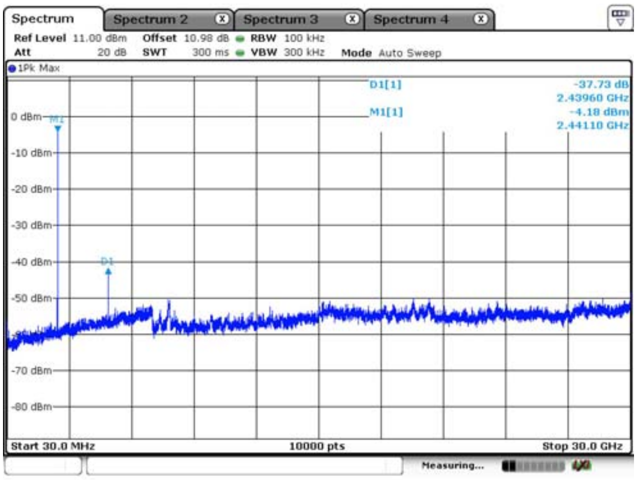

**Note**: It is not recorded on the report that the reading of emissions are attenuated more than 20 dB below the permissible limits

▣ EDR(8DPSK)

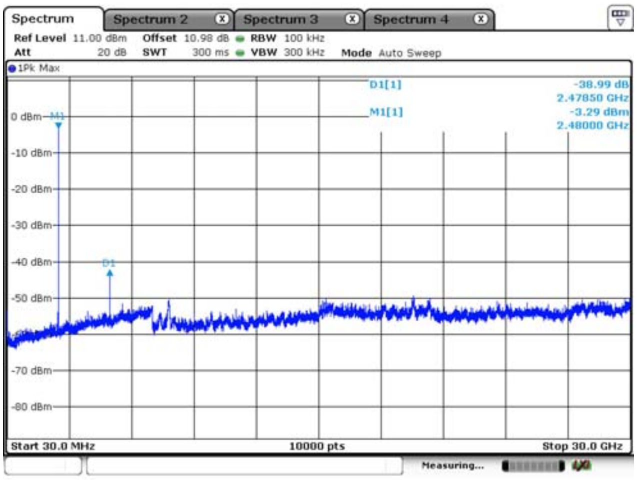
CH Low




CH Middle




CH High




**Note**: It is not recorded on the report that the reading of emissions are attenuated more than 20 dB below the permissible limits

## 5.7 Spurious RF Radiated emissions

### 5.7.1 Standard Applicable [ FCC §15.247(d) / RSS-GEN, 8.8]

**FCC**

All other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a). And according to §15.33(a)(1), for an intentional radiator operates below 10 GHz, the frequency Range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, Whichever is lower. In addition, radiated emissions which fall in the restricted bands, as defined in Sec.15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a)

**IC**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

§15.209 and RSS-Gen limits for radiated emissions measurements (distance at 3 m)

| Frequency Band [MHz] | DISTANCE [Meters] | Limit [㎶/m] | Limit [dB㎶/m] | Detector |
|---|---|---|---|---|
| 0.009 ~ 0.490 | 300 | 2400/F(kHz) | 67.6-20log(F) | Peak |
| 0.490 ~ 1.705 | 30 | 24000/F(kHz) | 87.6-20log(F) | Peak |
| 1.705 ~ 30.0 | 30 | 30 | 29.54 | Peak |
| 30 - 88 | 3 | 100 ** | 40.00 | Quasi peak |
| 88 - 216 | 3 | 150 ** | 43.52 | Quasi peak |
| 216 - 960 | 3 | 200 ** | 46.02 | Quasi peak |
| Above 960 | 3 | 500 | 54.00 | Average |
| Above 1000 | 3 | 74.0 dB㎶/m (Peak), 54.0 dB㎶/m (Average) | | |
| ** fundamental emissions from intentional radiators operation under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz, or 470-806 MHz. However, operation within these Frequency bands is permitted under other sections of this Part Section 15.231 and 15.241 | | | | |

§15.205. Restrict Band of Operation for FCC

| [MHz] | [MHz] | [MHz] | [GHz] |
|---|---|---|---|
| 0.090 - 0.110 | 16.42 - 16.423 | 399.9 - 410 | 4.5 - 5.15 |
| 0.495 - 0.505** | 16.694 75 - 16.695 25 | 608 - 614 | 5.35 - 5.46 |
| 2.173 5 - 2.190 5 | 16.804 25 - 16.804 75 | 960 – 1 240 | 7.25 - 7.75 |
| 4.125 - 4.128 | 25.5 - 25.67 | 1 300 – 1 427 | 8.025 - 8. |
| 4.177 25 - 4.177 75 | 37.5 -38.25 | 1 435 – 1 626.5 | 9.0 - 9.2 |
| 4.207 25 - 4.207 75 | 73 - 74.6 | 1 645.5 – 1 646.5 | 9.3 - 9.5 |
| 6.215 - 6.218 | 74.8 - 75.2 | 1 660 – 1 710 | 10.6 - 12.7 |
| 6.267 75 - 6.268 25 | 108 - 121.94 | 1 718.8 -1 722.2 | 13.25 - 13.4 |
| 6.311 75 - 6.312 25 | 123 - 138 | 2 200 – 2 300 | 14.47 - 14.5 |
| 8.291 - 8.294 | 149.9 - 150.05 | 2 310 – 2 390 | 15.35 - 16.2 |
| 8.362 - 8.366 | 156.524 75 - 156.525 25 | 2 483.5 – 2 500 | 17.7 - 21.4 |
| 8.376 25 - 8.38 6 75 | 156.7 - 156.9 | 2 690 – 2 900 | 22.01 - 23.12 |
| 8.414 25 - 8.414 75 | 162.012 5 - 167.17 | 3 260 – 3 267 | 23.6 - 24.0 |
| 12.29 - 12.293 | 167.72 - 173.2 | 3 332 – 3 339 | 31.2 - 31.8 |
| 12.519 75 - 12.520 25 | 240 - 285 | 3 345.8 – 3 358 | 36.43 - 36.5 |
| 12.576 75 - 12.577 25 | 322 - 335.4 | 3 600 – 4 400 | Above 38.6 |
| 13.36 - 13.41 | | | |

** Until February 1, 1999, this restricted band shall be 0.490-0.510

§15.205. Restrict Band of Operation for IC

| [MHz] | [MHz] | [MHz] | [GHz] |
|---|---|---|---|
| 0.090 - 0.110 | 12.519 75 - 12.520 25 | 399.9 - 410 | 5.35 - 5.46 |
| 2.173 5 - 2.190 5 | 12.576 75 - 12.577 25 | 608 - 614 | 7.25 - 7.75 |
| 3.020 - 3.026 | 13.36 - 13.41 | 960 - 1 427 | 8.025 - 8. |
| 4.125 - 4.128 | 16.42 - 16.423 | 1 435 - 1 626.5 | 9.0 - 9.2 |
| 4.177 25 - 4.177 75 | 16.694 75 - 16.695 25 | 1 645.5 - 1 646.5 | 9.3 - 9.5 |
| 4.207 25 - 4.207 75 | 16.804 25 - 16.804 75 | 1 660 - 1 710 | 10.6 - 12.7 |
| 5.677 - 5.683 | 25.5 - 25.67 | 1 718.8 -1 722.2 | 13.25 - 13.4 |
| 6.215 - 6.218 | 37.5 -38.25 | 2 200 - 2 300 | 14.47 - 14.5 |
| 6.26775–6.26825 | 73 - 74.6 | 2 310 - 2 390 | 15.35 - 16.2 |
| 6.31175–6.31225 | 74.8 - 75.2 | 2 655 - 2 900 | 17.7 - 21.4 |
| 8.291 - 8.294 | 108 - 138 | 3 260 - 3 267 | 22.01 - 23.12 |
| 8.362 - 8.366 | 156.524 75 - 156.525 25 | 3 332 - 3 339 | 23.6 - 24.0 |
| 8.376 25 - 8.38 6 75 | 156.7 - 156.9 | 3 345.8 - 3 358 | 31.2 - 31.8 |
| 8.414 25 - 8.414 75 | 240 - 285 | 3 500 - 4 400 | 36.43 - 36.5 |
| 12.29 - 12.293 | 322 - 335.4 | 4 500 - 5 150 | Above 38.6 |

## 5.7.2 Test Environment conditions

• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

## 5.7.3 Measurement Procedure

The measurements procedure of the Spurious RF Radiated emissions is as following describe method.

1. The EUT was placed on the top of a rotating table (0.8 meters for below 1 ㎓ and 1.5 meters for above 1 ㎓) above the ground at a 3 meter camber. The table was rotated 360 degree to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna master.
3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both Horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotating table was turned from 0 - 360 degrees to find the maximum reading.
5. The measuring receiver was set to peak detector and specified bandwidth with max hold function.
6. Low, Middle and high channels were measured, and radiation measurements are performed in X, Y, Z axis positioning. And found the worst axis position and only the test worst case mode is recorded in the report.

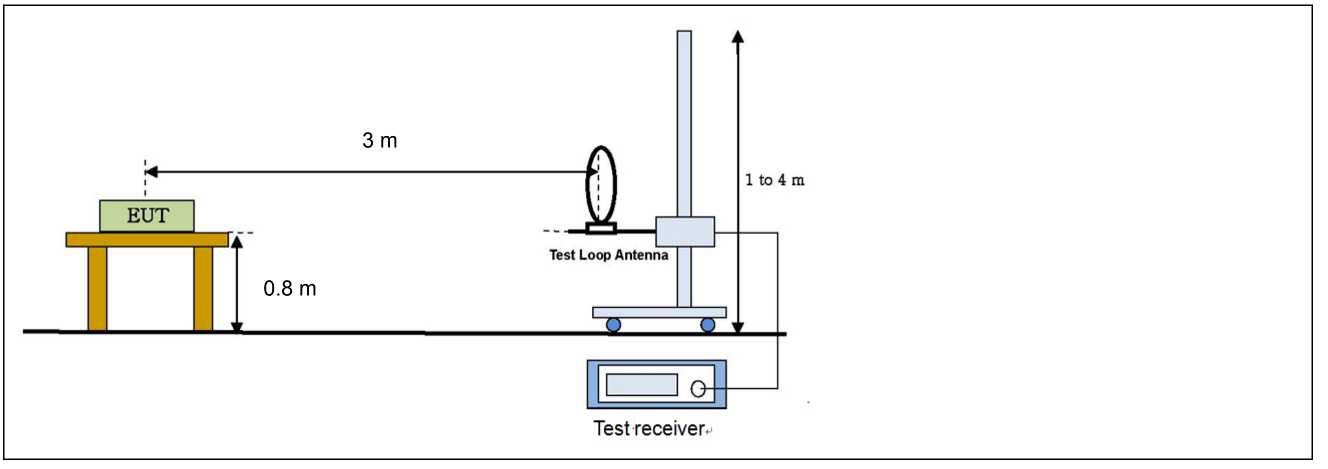
• The measurement results are obtained as described below:
  Result(dB㎶/m) = Reading(dB㎶) + Antenna factor(dB/m)+ CL(dB) + other applicable factor (dB)
• The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 3 ㎒ for RMS Average (Duty cycle < 98 %) for Average detection (AV) at frequency above 1 ㎓, then the measurement results was added to a correction factor (10 log(1/duty cycle)).
• The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 10 ㎐ (Duty cycle ≥ 98 %) for Average detection (AV) at frequency above 1 ㎓.
• According to §15.33 (a)(1), Frequency range of radiated measurement is performed the tenth harmonic.

## 5.7.4 Measurement Uncertainty

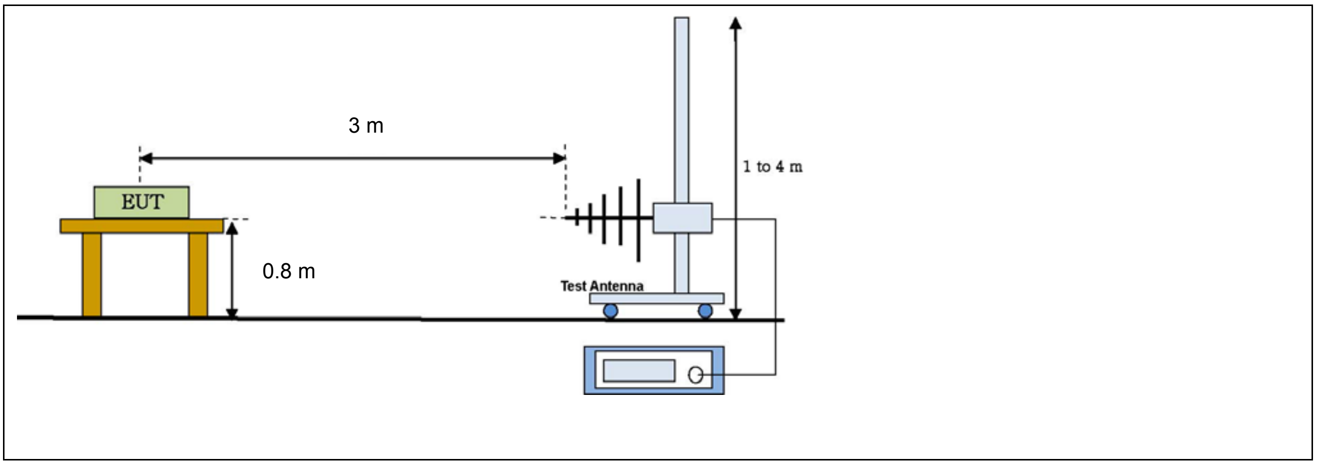
Radiated Emission measurement: Below 1 GHz : 4.32 dB (CL: Approx 95 %, *k*=2)
Above 1 GHz : 4.14 dB (CL: Approx 95 %, *k*=2)

## 5.7.5 Test Configuration

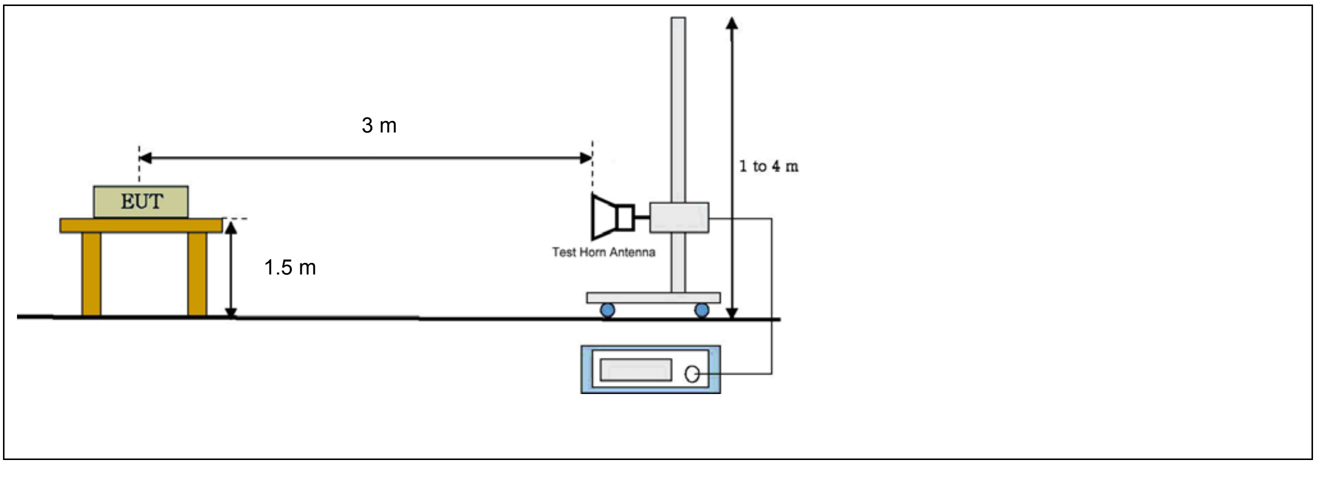
Radiated emission setup, Below 30 MHz




Radiated emission setup, Below 1 000 MHz




Radiated emission setup, Above 1 GHz



## 5.7.6 Measurement Result

After having pre-scan all modulation mode, found the GFSK modulation which it was worst case, so only the worst case's data on the test report.

Above 1 GHz

CH Low (2 402 MHz)

| Freq. (GHz) | Reading (dBµV/m) | | Table (Deg) | Antenna | | | CL (dB) | AMP (dB) | Meas Result (dBµV/m) | | Limit (dBµV/m ) | | Mgn. (dB) | | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PK | AV | | Height (m) | Pol. (H/V) | Fctr. (dB/m) | | | PK | AV | PK | AV | PK | AV | |
| 2.387* | 44.58 | 32.43 | 180 | 1.0 | V | 28.87 | 2.61 | -30.69 | 45.37 | 33.22 | 74 | 54 | 28.63 | 20.78 | Compliance |
| 2.387* | 39.53 | 27.68 | 180 | 1.0 | H | 28.87 | 2.61 | -30.69 | 40.32 | 28.47 | 74 | 54 | 33.68 | 25.53 | Compliance |

* Restrict band emissions.

CH Middle (2 440 MHz)

| Freq. (GHz) | Reading (dBµV/m) | | Table (Deg) | Antenna | | | CL (dB) | AMP (dB) | Meas Result (dBµV/m) | | Limit (dBµV/m ) | | Mgn. (dB) | | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PK | AV | | Height (m) | Pol. (H/V) | Fctr. (dB/m) | | | PK | AV | PK | AV | PK | AV | |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | Compliance |
| - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | Compliance |

* There were no spurious emissions

CH High (2 480 MHz)

| Freq. (GHz) | Reading (dBµV/m) | | Table (Deg) | Antenna | | | CL (dB) | AMP (dB) | Meas Result (dBµV/m) | | Limit (dBµV/m ) | | Mgn. (dB) | | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PK | AV | | Height (m) | Pol. (H/V) | Fctr. (dB/m) | | | PK | AV | PK | AV | PK | AV | |
| 2.484 | 44.13 | 32.26 | 180 | 1.0 | V | 29.26 | 2.51 | -30.54 | 45.36 | 33.49 | 74 | 54 | 28.64 | 20.51 | Compliance |
| 2.484 | 38.63 | 25.90 | 180 | 1.0 | H | 29.26 | 2.51 | -30.54 | 39.86 | 27.13 | 74 | 54 | 34.14 | 26.87 | Compliance |

* Restrict band emissions.

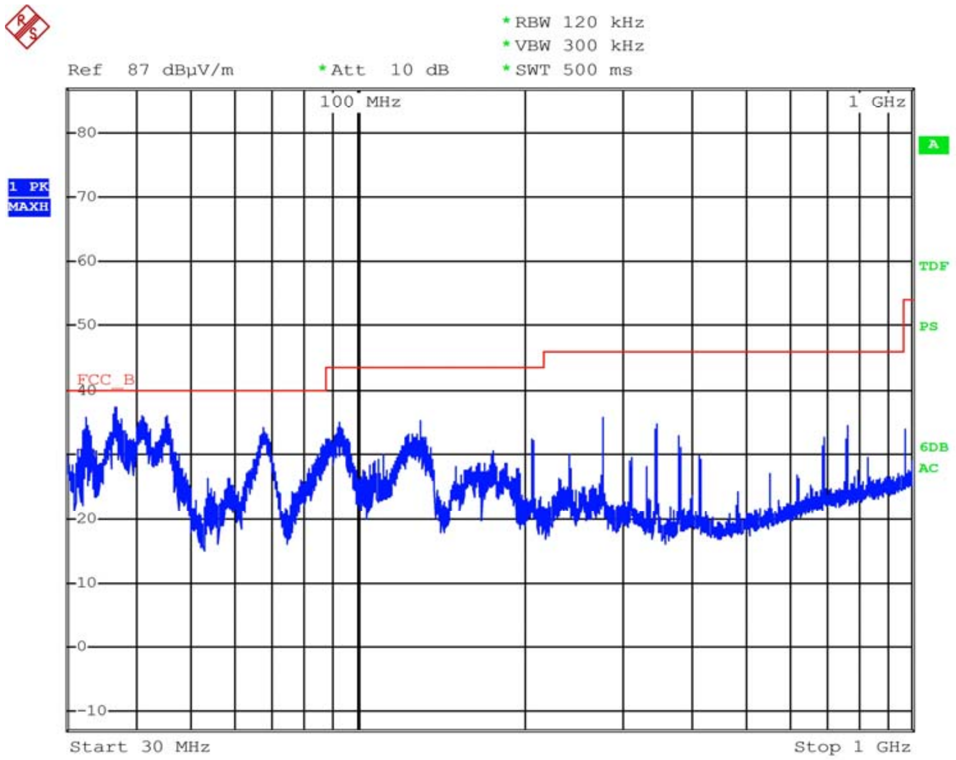
**※Note**

- Above 1 GHz is measured average and peak detector mode on Spectrum analyzer in accordance with FCC Rule15.35
- Limit: 54 dBµV/m(Average), 74 dBµV/m(Peak), Attenuated more than 20 dB below the permissible value.
- It is not recorded on the report that the reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to measured.
- For the below 30 MHz and above 2.499 GHz, measured any other signal is not detected on test receiver
- The transmitter radiated spectrum was investigated from 9 kHz to 26.5 GHz.

Below 1 GHz

| Freq. (MHz) | Reading (dB㎶/m) | Table (Deg) | Antenna | | | CL (dB) | AMP (dB) | Meas Result (dB㎶/m) | Limit (dB㎶/m ) | Mgn (dB) | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Height (m) | Pol. (H/V) | Fctr. (dB/m) | | | | | | |
| 67.70 | 53.21 | 130 | 2.0 | H | 5.76 | 1.30 | -41.61 | 18.65 | 40.00 | 21.35 | Compliance |
| 67.70 | 64.81 | 130 | 1.2 | V | 5.76 | 1.30 | -41.61 | 30.25 | 40.00 | 9.75 | Compliance |
| 92.83 | 45.23 | 180 | 2.0 | H | 7.91 | 1.47 | -41.60 | 13.02 | 43.52 | 30.50 | Compliance |
| 92.83 | 62.43 | 180 | 1.2 | V | 7.91 | 1.47 | -41.60 | 30.22 | 43.52 | 13.30 | Compliance |
| 277.10 | 59.21 | 130 | 1.5 | H | 13.50 | 2.31 | -40.92 | 34.10 | 46.02 | 11.92 | Compliance |
| 277.10 | 50.97 | 130 | 1.2 | V | 13.50 | 2.31 | -40.92 | 25.86 | 46.02 | 20.16 | Compliance |
| 346.35 | 52.67 | 110 | 2.0 | H | 15.74 | 2.50 | -40.70 | 30.21 | 46.02 | 15.81 | Compliance |
| 346.35 | 49.33 | 110 | 1.5 | V | 15.74 | 2.50 | -40.70 | 26.87 | 46.02 | 19.15 | Compliance |
| 415.10 | 43.97 | 170 | 1.8 | H | 17.75 | 2.71 | -40.62 | 23.81 | 46.02 | 22.21 | Compliance |
| 415.10 | 47.16 | 170 | 1.5 | V | 17.75 | 2.71 | -40.62 | 27.00 | 46.02 | 19.02 | Compliance |

Freq.(㎒) : Measurement frequency, Reading(dB㎶/m) : Indicated value for test receiver, Table (Deg) : Directional degree of Turn table
Antenna (Height, Pol, Fctr) : Antenna Height, Polarization and Factor, Cbl(dB) : Cable loss, Pre AMP(dB) : Preamplifier gain(dB)
Meas Result (dB㎶/m ) :Reading(dB㎶/m)+ Antenna factor.(dB/m )+ CL(dB) - Pre AMP(dB)
Limit(dB㎶/m): Limit value specified with FCC Rule, Mgn(dB) : FCC Limit (dB㎶/m) – Meas Result(dB㎶/m)




Date: 17.MAY.2017 16:34:32

## 5.8 Antenna requirement

### 5.8.1 Standard applicable [ FCC §15.203]

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

The use of a permanently attached antenna or of an antenna that user 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 broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

### 5.8.2 Antenna details

| Frequency Band | Antenna Type | Gain [dBi] | Results |
|---|---|---|---|
| 2.4 GHz | PCB pattern antenna | 1.5 | Compliance |

## 5.9 AC Power Conducted emissions

### 5.9.1 Standard Applicable [ FCC §15.207(a) / RSS-Gen 8.8 ]

For intentional radiator that is designed to be connected to the public utility(AC)power line, the radio frequency. Voltage that is conducted back onto the AC power line on any frequencies hopping mode within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line Impedance stabilization network(LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

§15.207 limits for AC line conducted emissions;

| Frequency of Emission(㎒) | Conducted Limit (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 ~ 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 ~ 5 | 56 | 46 |
| 5 ~ 30 | 60 | 50 |

* Decreases with the logarithm of the frequency

### 5.9.2 Test Environment conditions

• Ambient temperature : (24 ~ 25) ℃ • Relative Humidity : (49 ~ 55) % R.H.

### 5.9.3 Measurement Procedure

EUT was placed on a non- metallic table height of 0.8 m above the reference ground plane. Cables connected to EUT were fixed to cause maximum emission. Test was made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna was varied in height above the conducting ground plane to obtain the Maximum signal strength.

### 5.9.4 Used equipment

| Equipment | Model No. | Serial No. | Manufacturer | Next cal date | Cal interval | Used |
|---|---|---|---|---|---|---|
| Test receiver | ESCS30 | 100111 | Rohde & Schwarz | 2018. 01. 31 | 1 year | ☒ |
| LISN | ESH2-Z5 | 100044 | R&S | 2018. 01. 31 | 1 year | ☐ |
| | ESH3-Z5 | 100147 | R&S | 2018. 01. 31 | 1 year | ☒ |

*Test Program: “ ESXS-K1 V2.2”
<u>Measurement uncertainty</u>
Conducted Emission measurement: 4.48 dB (CL: Approx 95 %, *k*=2)

## 5.9.5 Measurement Result

| Freq. | Factor [dB] | | POL | QP | | | CISPR AV | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Limit | Reading | Result | Limit | Reading | Result |
| [MHz] | LISN | CABLE +P/L | | [dBμV] | [dBμV] | [dBμV] | [dBμV] | [dBμV] | [dBμV] |
| 0.150 | 0.11 | 9.96 | N | 66.00 | 46.78 | 46.89 | 56.00 | 22.50 | 22.61 |
| 0.170 | 0.15 | 9.96 | L | 64.98 | 40.09 | 40.24 | 54.98 | 27.90 | 28.05 |
| 0.181 | 0.14 | 9.95 | L | 64.43 | 48.28 | 48.42 | 54.43 | 28.40 | 28.54 |
| 0.209 | 0.14 | 9.95 | L | 63.26 | 44.01 | 44.15 | 53.26 | 31.90 | 32.04 |
| 0.287 | 0.11 | 9.96 | N | 60.62 | 38.87 | 38.98 | 50.62 | 25.40 | 25.51 |
| 0.341 | 0.14 | 9.96 | L | 59.17 | 52.69 | 52.83 | 49.17 | 45.10 | 45.24 |
| 0.541 | 0.14 | 9.97 | L | 56.00 | 37.89 | 38.03 | 46.00 | 29.50 | 29.64 |
| 0.599 | 0.12 | 9.97 | N | 56.00 | 35.45 | 35.57 | 46.00 | 17.90 | 18.02 |

* LISN: LISN insertion Loss, Cable: Cable Loss, P/L:pulse limiter factor
* L: Line. Live, N: Line. Neutral
* Reading: test receiver reading value (with cable loss & pulse limiter factor)
* Result = LISN + Reading

# Line. Live

Kostec Co., Ltd. 17 May 2017 14:54

Conducted Emission

EUT:
Manuf:
Op Cond: AC 120 V, 50 Hz
Operator: Lee
Test Spec: FCC
Comment: Live

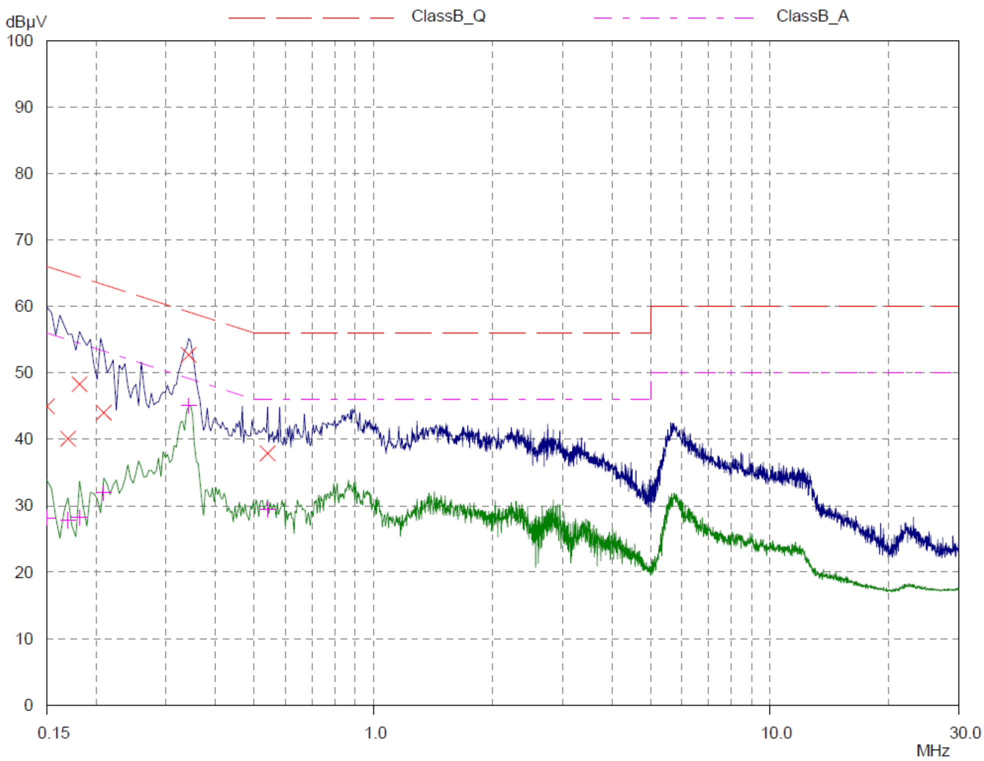
Result File: 0037_L.dat : New Measurement

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 150kHz | 30MHz | 3.9063kHz | 9kHz | PK+AV | 10msec | 15 dB | OFF | 60dB |

| Transducer | No. | Start | Stop | Name |
|---|---|---|---|---|
| | 12 | 9kHz | 30MHz | CNEFactor |

Final Measurement: Detectors: X QP / + AV
Meas Time: 1sec
Subranges: 25
Acc Margin: 50 dB




PAGE 1

Line. Neutral

Kostec Co., Ltd. 17 May 2017 15:02

Conducted Emission

EUT:
Manuf:
Op Cond: AC 120 V, 50 Hz
Operator: Lee
Test Spec: FCC
Comment: Neutral

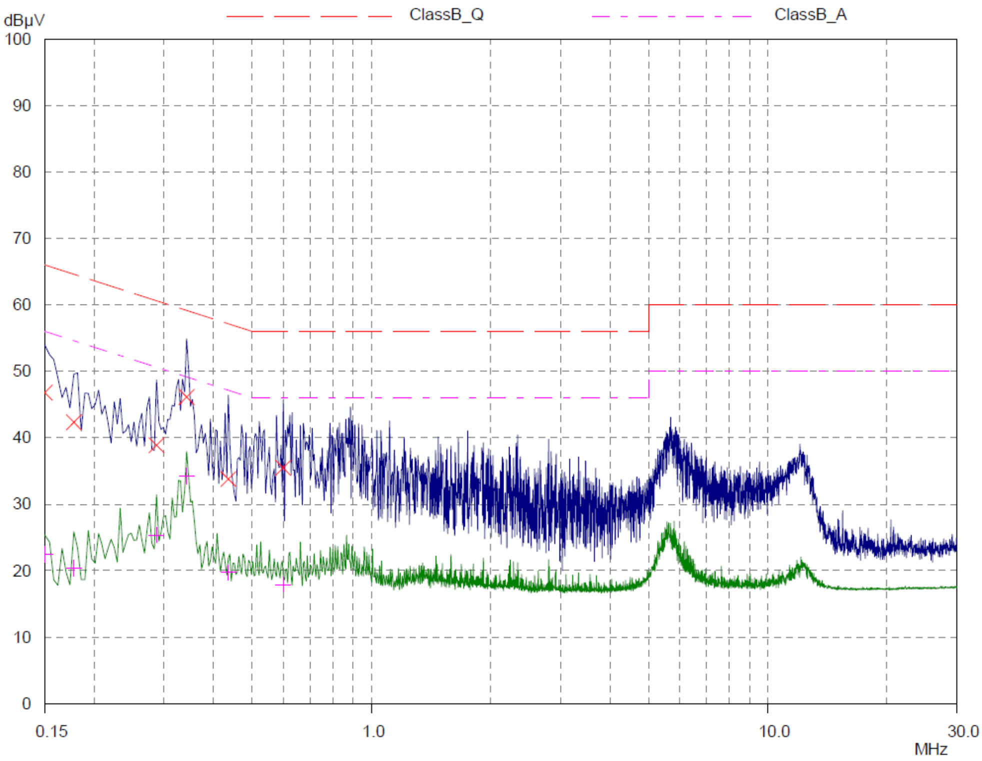
Result File: 0037_N.dat : New Measurement

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 150kHz | 30MHz | 3.9063kHz | 9kHz | PK+AV | 10msec | 15 dB | OFF | 60dB |

| Transducer | No. | Start | Stop | Name |
|---|---|---|---|---|
| | 12 | 9kHz | 30MHz | CNEFactor |

Final Measurement: Detectors: X QP / + AV
Meas Time: 1sec
Subranges: 25
Acc Margin: 50 dB




PAGE 1