

# TEST REPORT

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                         |                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>KOSTEC Co., Ltd.</b><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-200020                              | <br><b>KOSTEC Co., Ltd.</b><br><a href="http://www.kostec.org">http://www.kostec.org</a> |
| <b>1. Applicant</b> <ul style="list-style-type: none"><li>• Name : HUMAN-LINE</li><li>• Address : 5F,sung-eun B/D, 396-4, Gyeongsu-daero, Gwonseon-gu, Suwon-si, Gyeonggi-do, Korea(16571)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                         |                                                                                                                                                                             |
| <b>2. Test Item</b> <ul style="list-style-type: none"><li>• Product Name: MentalDoctor Ezbalance</li><li>• Model Name: MEZ-300</li><li>• Brand: None</li><li>• FCC ID: 2AOBD-MEZ-300</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                         |                                                                                                                                                                             |
| <b>3. Manufacturer</b> <ul style="list-style-type: none"><li>• Name : HUMAN-LINE</li><li>• Address : 5F,sung-eun B/D, 396-4, Gyeongsu-daero, Gwonseon-gu, Suwon-si, Gyeonggi-do, Korea(16571)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                         |                                                                                                                                                                             |
| <b>4. Date of Test :</b> 2020. 11. 05. ~ 2020. 11. 06.<br>FCC CFR 47, Part 15. Subpart C-15.247                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                         |                                                                                                                                                                             |
| <b>5. Test Method Used :</b> 558074 D01 15.247 Meas Guidance v05r02<br>ANSI C 63.10-2013                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                         |                                                                                                                                                                             |
| <b>6. Test Result :</b> Compliance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                         |                                                                                                                                                                             |
| <b>7. Note:</b> -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                         |                                                                                                                                                                             |
| <b>Supplementary Information</b> <p>The device bearing the brand name and FCC 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 <u>ANSI C 63.10-2013</u>.</p> <p>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.</p> <p>The results shown in this test report refer only to the sample(s) tested unless otherwise stated.<br/>This test report is not related to KOLAS accreditation.</p> |                                                         |                                                                                                                                                                             |
| <b>Affirmation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Tested by</b><br>Name : Choo, Kwang-Yeol (Signature) | <b>Technical Manager</b><br>Name : Park, Gyeong-Hyeon (Signature)                                                                                                           |
| 2020. 11. 24.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                         |                                                                                                                                                                             |
| <b>KOSTEC Co., Ltd.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                         |                                                                                                                                                                             |

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## 1. GENERAL INFORMATION

### 1.1 Test Facility

#### Test laboratory and address

KOSTEC Co., Ltd.

28(175-20,Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea

Telephone Number: 82-31-222-4251

Facsimile Number: 82-31-222-4252

#### Registration information

KOLAS No.: KT232

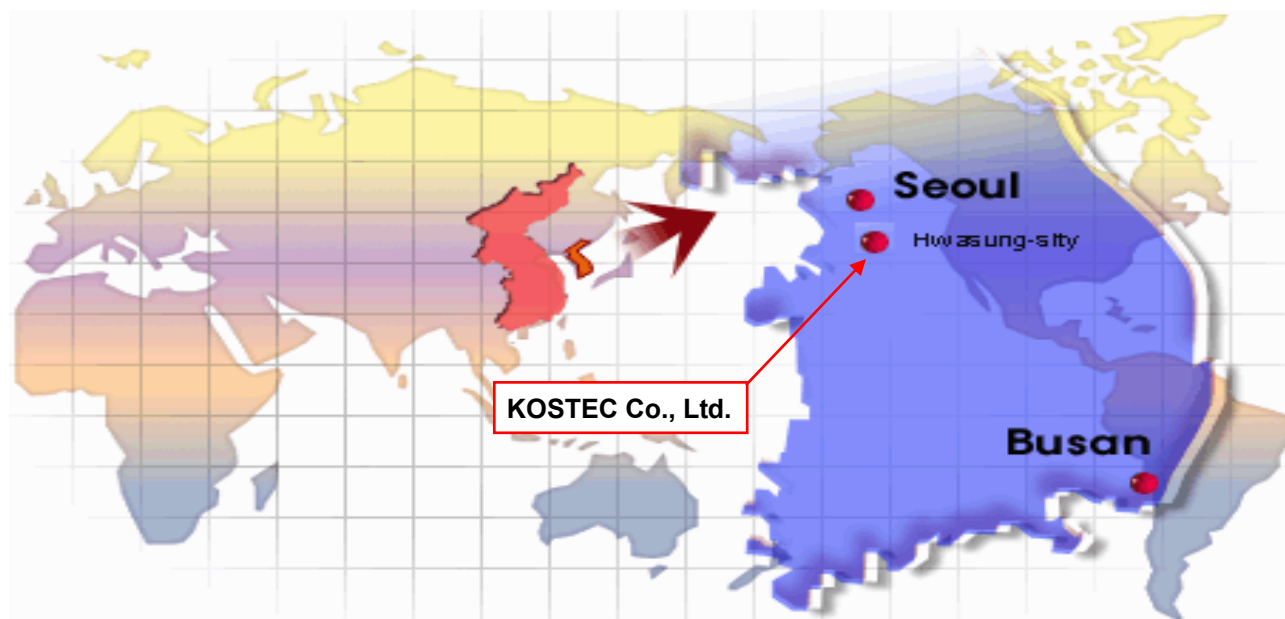
RRA (National Radio Research Agency): KR0041

FCC Designation No.: KR0041

IC Designation No.: KR0041

VCCI Membership No.: 2005

### 1.2 Location



### 1.3 Revision History of test report

| Rev. | Revisions     | Effect page | Reviewed           | Date          |
|------|---------------|-------------|--------------------|---------------|
| -    | Initial issue | All         | Gyeong Hyeon, Park | 2020. 11. 24. |
|      |               |             |                    |               |

## 2. EQUIPMENT DESCRIPTION

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

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Equipment Name        | MentalDoctor Ezbalance                                                                                                                                                                                                                                                                                                                                                                                                   |
| Model No              | MEZ-300                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Family Model          | EZ-400E                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Usage                 | MentalDoctor Ezbalance                                                                                                                                                                                                                                                                                                                                                                                                   |
| Serial Number         | Proto type                                                                                                                                                                                                                                                                                                                                                                                                               |
| Modulation technology | FHSS                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Modulation type       | GFSK(BDR 1 Mbps), $\pi/4$ -DQPSK(EDR 2 Mbps), 8DPSK(EDR 3 Mbps)                                                                                                                                                                                                                                                                                                                                                          |
| Emission Type         | F1D/G1D                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Maximum output power  | 8.23 dBm                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Operated Frequency    | 2 402 MHz ~ 2 480 MHz                                                                                                                                                                                                                                                                                                                                                                                                    |
| Channel Number        | 79                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Operation temperature | -10 °C ~ 55 °C                                                                                                                                                                                                                                                                                                                                                                                                           |
| Power Source          | DC 3.7 V(Li-ion Polymer Battery)                                                                                                                                                                                                                                                                                                                                                                                         |
| Antenna Description   | Internal PCB pattern antenna, gain : 1.139 dBi                                                                                                                                                                                                                                                                                                                                                                           |
| Remark                | <ol style="list-style-type: none"> <li>1. The device was operating at its maximum output power for all measurements.</li> <li>2. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case (X) is shown in the report.</li> <li>3. The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description.</li> </ol> |
| FCC ID                | 2AOBD-MEZ-300                                                                                                                                                                                                                                                                                                                                                                                                            |

### 3. SYSTEM CONFIGURATION FOR TEST

#### 3.1 Characteristics of equipment

The Equipment Under Test (EUT) contains the following capabilities: This equipment is MentalDoctor Ezbalance. The detailed explanation is refer as user manual.

#### 3.2 Used peripherals list

| Description | Model No.  | Serial No.                   | Manufacture                             | Remark       |
|-------------|------------|------------------------------|-----------------------------------------|--------------|
| Notebook    | NT300E4S   | 0T4391JJ800909K              | Samsung Electronics                     | -            |
| Adapter     | PA-1400-96 | CN60BA4400313AD<br>2VHJFP086 | LITE-ON TECHNOLOGY<br>CHANGZHOU CO.,LTD | For notebook |

#### 3.3 Product Modification

N/A

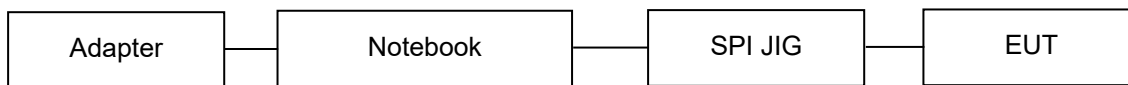
#### 3.4 Operating Mode

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 / receive mode using the TEST MODE.

For controlling the EUT as TEST MODE, the test program and the test cables were provided by the applicant.



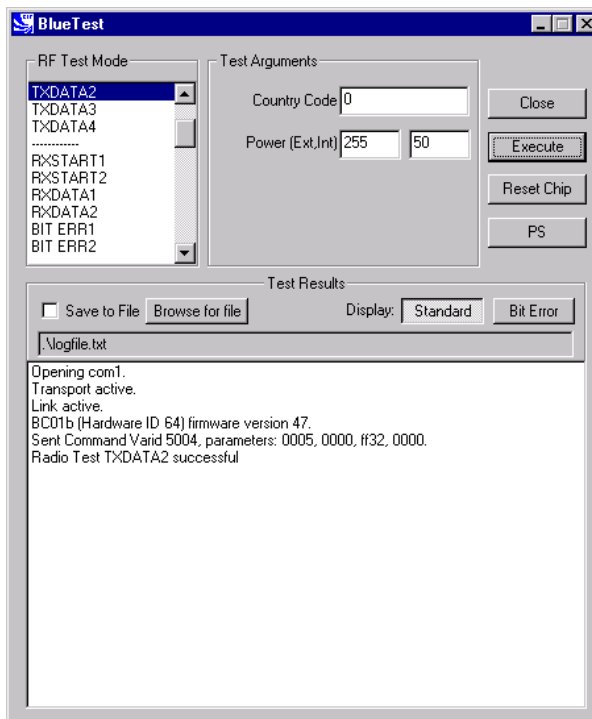
### 3.6 Parameters of Test Software Setting

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 | Default                | Default   | Default |

#### ■ Test Program : CSR BlueTest



### 3.7 Table for Test condition

| Test Items                      | Channel No | Frequency (MHz) | Operated Condition                                       |
|---------------------------------|------------|-----------------|----------------------------------------------------------|
| Channel Separation              | 38, 39     | 2 440, 2 441    | Hopping on and continuous modulation setting mode        |
| Number of Hopping Channels      | 0 ~ 78     | 2 402 ~ 2 480   | Hopping on mode                                          |
| Time of occupancy               | 38         | 2 440           | Hopping on mode                                          |
| Peak Output Power               | 0          | 2 402           | Hopping off and continuous modulation setting mode       |
|                                 | 38         | 2 440           |                                                          |
|                                 | 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               | Next Cal Date | Cal interval | used                                |
|-----|-------------------------------|--------------|--------------|----------------------------|---------------|--------------|-------------------------------------|
| 1   | T & H Chamber                 | PL-3J        | 15003623     | ESPEC CORP                 | 2021.11.04    | 1 year       | <input type="checkbox"/>            |
| 2   | T & H Chamber                 | SH-662       | 93000067     | ESPEC CORP                 | 2021.09.02    | 1 year       | <input type="checkbox"/>            |
| 3   | T & H Chamber                 | SH-641       | 92006831     | ESPEC CORP                 | 2021.03.31    | 1 year       | <input type="checkbox"/>            |
| 4   | Spectrum Analyzer             | 8563EC       | 3046A00527   | Agilent Technology         | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 5   | Spectrum Analyzer             | FSV30        | 104029       | Rohde & Schwarz            | 2021.09.01    | 1 year       | <input type="checkbox"/>            |
| 6   | Spectrum Analyzer             | FSV30        | 20-353063    | Rohde & Schwarz            | 2021.01.21    | 1 year       | <input checked="" type="checkbox"/> |
| 7   | Signal Analyzer               | FSW43        | 101294       | Rohde & Schwarz            | 2021.02.26    | 1 year       | <input type="checkbox"/>            |
| 8   | Signal Analyzer               | FSW85        | 101602       | Rohde & Schwarz            | 2021.06.21    | 1 year       | <input type="checkbox"/>            |
| 9   | EMI Test Receiver             | ESCI7        | 100823       | Rohde & Schwarz            | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 10  | EMI Test Receiver             | ESI          | 837514/004   | Rohde & Schwarz            | 2021.08.31    | 1 year       | <input checked="" type="checkbox"/> |
| 11  | Vector Signal Analyzer        | 89441A       | 3416A02620   | Agilent Technology         | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 12  | Network Analyzer              | 8753ES       | US39172348   | AGILENT                    | 2021.09.01    | 1 year       | <input type="checkbox"/>            |
| 13  | EPM Series Power meter        | E4418B       | GB39512547   | Agilent Technology         | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 14  | RF Power Sensor               | E9300A       | MY41496631   | Agilent Technology         | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 15  | Microwave Frequency Counter   | 5352B        | 2908A00480   | Agilent Technology         | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 16  | Audio Analyzer                | 8903B        | 3514A16919   | Agilent Technology         | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 17  | Audio Telephone Analyzer      | DD-5601CID   | 520010281    | CREDIX                     | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 18  | Modulation Analyzer           | 8901A        | 3041A05716   | H.P                        | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 19  | Digital storage Oscilloscope  | TDS3052      | B015962      | Tektronix                  | 2021.08.31    | 1 year       | <input type="checkbox"/>            |
| 20  | ESG-D Series Signal Generator | E4436B       | US39260458   | Agilent Technology         | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 21  | Vector Signal Generator       | SMBV100A     | 257557       | Rohde & Schwarz            | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 22  | GNSS Signal Generator         | TC-2800A     | 2800A000494  | TESCOM CO., LTD.           | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 23  | Signal Generator              | SMB100A      | 179628       | Rohde & Schwarz            | 2021.05.13    | 1 year       | <input checked="" type="checkbox"/> |
| 24  | Signal Generator              | N5173B       | MY57280148   | KEYSIGHT                   | 2021.06.11    | 1 year       | <input type="checkbox"/>            |
| 25  | SLIDAC                        | None         | 0207-4       | Myoung sung Ele.           | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 26  | DC Power supply               | DRP-5030     | 9028029      | Digital Electronic Co.,Ltd | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 27  | DC Power supply               | E3610A       | KR24104505   | Agilent Technology         | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 28  | DC Power supply               | UP-3005T     | 68           | Unicon Co.,Ltd             | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 29  | DC Power Supply               | SM 3004-D    | 114701000117 | DELTAELEKTRONIKA           | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 30  | DC Power supply               | 6632B        | MY43004005   | Agilent Technology         | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 31  | DC Power Supply               | 6632B        | MY43004137   | Agilent Technology         | 2021.01.20    | 1 year       | <input type="checkbox"/>            |
| 32  | Termination                   | 1433-3       | LM718        | WEINSCHEL                  | 2021.07.17    | 1 year       | <input type="checkbox"/>            |
| 33  | Termination                   | 1432-3       | QR946        | AEROFLEX/WEINSCHEL         | 2021.07.17    | 1 year       | <input type="checkbox"/>            |
| 34  | Attenuator                    | 24-30-34     | BX5630       | Aeroflex / Weinschel       | 2020.12.17    | 1 year       | <input type="checkbox"/>            |
| 35  | Attenuator                    | 8498A        | 3318A09485   | HP                         | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 36  | Step Attenuator               | 8494B        | 3308A32809   | HP                         | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 37  | RF Step Attenuator            | RSP          | 100091       | Rohde & Schwarz            | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 38  | Attenuator                    | 18B50W-20F   | 64671        | INMET                      | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 39  | Attenuator                    | 10 dB        | 1            | Rohde & Schwarz            | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 40  | Attenuator                    | 54A-10       | 74564        | WEINSCHEL                  | 2021.09.02    | 1 year       | <input checked="" type="checkbox"/> |
| 41  | Attenuator                    | 56-10        | 66920        | WEINSCHEL                  | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 42  | Attenuator                    | 48-20-11     | BV2658       | Aeroflex/Weinschel         | 2021.07.17    | 1 year       | <input type="checkbox"/>            |
| 43  | Attenuator                    | 48-30-33-LIM | BL5350       | Weinschel Corp.            | 2021.07.17    | 1 year       | <input type="checkbox"/>            |
| 44  | Power divider                 | 11636B       | 51212        | HP                         | 2021.01.23    | 1 year       | <input type="checkbox"/>            |
| 45  | 3Way Power divider            | KPDSU3W      | 00070365     | KMW                        | 2021.08.31    | 1 year       | <input type="checkbox"/>            |
| 46  | 4Way Power divider            | 70052651     | 173834       | KRYTAR                     | 2021.01.23    | 1 year       | <input type="checkbox"/>            |
| 47  | 3Way Power divider            | 1580         | SQ361        | WEINSCHEL                  | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 48  | OSP                           | OSP120       | 101577       | Rohde & Schwarz            | 2021.05.14    | 1 year       | <input type="checkbox"/>            |
| 49  | White noise audio filter      | ST31EQ       | 101902       | SoundTech                  | 2021.08.31    | 1 year       | <input type="checkbox"/>            |

| No. | Instrument                                       | Model                            | S/N         | Manufacturer                | Next Cal Date | Cal interval | used                                |
|-----|--------------------------------------------------|----------------------------------|-------------|-----------------------------|---------------|--------------|-------------------------------------|
| 50  | Dual directional coupler                         | 778D                             | 17693       | HEWLETT PACKARD             | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 51  | Dual directional coupler                         | 772D                             | 2839A00924  | HEWLETT PACKARD             | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 52  | Band rejection filter                            | 3TNF-0006                        | 26          | DOVER Tech                  | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 53  | Band rejection filter                            | 3TNF-0007                        | 311         | DOVER Tech                  | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 54  | Band rejection filter                            | WTR-BRF2442-84NN                 | 09020001    | WAVE TECH Co.,LTD           | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 55  | Band rejection filter                            | WRCJV12-5695-5725-5825-5855-50SS | 1           | Wainwright Instruments GmbH | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 56  | Band rejection filter                            | WRCJV12-5120-5150-5350-5380-40SS | 4           | Wainwright Instruments GmbH | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 57  | Band rejection filter                            | WRCGV10-2360-2400-2500-2540-50SS | 2           | Wainwright Instruments GmbH | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 58  | Band rejection filter                            | CTF-155M-S1                      | 001         | RF One Electronics          | 2021.08.31    | 1 year       | <input type="checkbox"/>            |
| 59  | Band rejection filter                            | CTF-435M-S1                      | 001         | RF One Electronics          | 2021.08.31    | 1 year       | <input type="checkbox"/>            |
| 60  | Highpass Filter                                  | WHJS1100-10EF                    | 1           | WAINWRIGHT                  | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 61  | Highpass Filter                                  | WHJS3000-10EF                    | 1           | WAINWRIGHT                  | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 62  | Highpass Filter                                  | WHNX6-5530-7000-26500-40CC       | 2           | Wainwright Instruments GmbH | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 63  | Highpass Filter                                  | WHNX6-2370-3000-26500-40CC       | 4           | Wainwright Instruments GmbH | 2021.05.13    | 1 year       | <input type="checkbox"/>            |
| 64  | WideBand Radio Communication Tester              | CMW500                           | 102276      | Rohde & Schwarz             | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 65  | WideBand Radio Communication Tester              | CMW500                           | 117235      | Rohde & Schwarz             | 2021.02.03    | 1 year       | <input type="checkbox"/>            |
| 66  | WideBand Radio Communication Tester(with CMX500) | CMW500                           | 167157      | Rohde & Schwarz             | 2021.04.03    | 1 year       | <input type="checkbox"/>            |
| 67  | Bluetooth Tester                                 | TC-3000B                         | 3000B6A0166 | TESCOM CO., LTD.            | 2021.01.22    | 1 year       | <input type="checkbox"/>            |
| 68  | Loop Antenna                                     | 6502                             | 9203-0493   | EMCO                        | 2021.05.27    | 2 year       | <input checked="" type="checkbox"/> |
| 69  | BiconiLog Antenna                                | 3142B                            | 1745        | EMCO                        | 2022.04.24    | 2 year       | <input type="checkbox"/>            |
| 70  | Trilog-Broadband Antenna <sub>(R)</sub>          | VULB 9168                        | 9168-606    | SCHWARZBECK                 | 2022.09.21    | 2 year       | <input checked="" type="checkbox"/> |
| 71  | Biconical Antenna <sub>(T)</sub>                 | VUBA9117                         | 9117-342    | Schwarz beck                | 2022.03.24    | 2 year       | <input type="checkbox"/>            |
| 72  | Horn Antenna                                     | 3115                             | 9605-4834   | EMCO                        | 2022.03.06    | 2 year       | <input type="checkbox"/>            |
| 73  | Horn Antenna <sub>(R)</sub>                      | 3117                             | 00135191    | ETS-LINDGREN                | 2022.04.29    | 2 year       | <input type="checkbox"/>            |
| 74  | Horn Antenna <sub>(T)</sub>                      | 3115                             | 2996        | EMCO                        | 2022.02.14    | 2 year       | <input checked="" type="checkbox"/> |
| 75  | Horn Antenna <sub>(R)</sub>                      | BBHA 9170                        | 9170-722    | SCHWARZBECK                 | 2022.05.12    | 2 year       | <input type="checkbox"/>            |
| 76  | Horn Antenna <sub>(T)</sub>                      | BBHA 9170                        | 743         | SCHWARZBECK                 | 2021.01.22    | 2 year       | <input checked="" type="checkbox"/> |
| 77  | AMPLIFIER(A_10)                                  | TK-PA6S                          | 120009      | TESTEK                      | 2021.01.21    | 1 year       | <input type="checkbox"/>            |
| 78  | AMPLIFIER(C_3)                                   | TK-PA01S                         | 200141-L    | TESTEK                      | 2021.09.23    | 1 year       | <input checked="" type="checkbox"/> |
| 79  | PREAMPLIFIER(C_3)                                | 8449B                            | 3008A02577  | Agilent                     | 2021.01.20    | 1 year       | <input checked="" type="checkbox"/> |
| 80  | AMPLIFIER                                        | TK-PA18                          | 150003      | TESTEK                      | 2021.01.21    | 1 year       | <input checked="" type="checkbox"/> |
| 81  | AMPLIFIER                                        | TK-PA1840H                       | 160010-L    | TESTEK                      | 2021.01.28    | 1 year       | <input checked="" type="checkbox"/> |
| 82  | Horn Antenna                                     | M19RH                            | T01         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 83  | Horn Antenna                                     | M19RH                            | R01         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 84  | Horn Antenna                                     | M12RH                            | T02         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 85  | Horn Antenna                                     | M12RH                            | R02         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 86  | Horn Antenna                                     | M08RH                            | T03         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 87  | Horn Antenna                                     | M08RH                            | R03         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 88  | Horn Antenna                                     | M05RH                            | T04         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 89  | Horn Antenna                                     | M05RH                            | R04         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 90  | Horn Antenna                                     | M03RH                            | T05         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 91  | Horn Antenna                                     | M03RH                            | R05         | OML, Inc.                   | 2022.05.29    | 2 year       | <input type="checkbox"/>            |
| 92  | Harmonic Mixer                                   | M12HWD                           | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 93  | Harmonic Mixer                                   | M08HWD                           | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 94  | Harmonic Mixer                                   | M05HWD                           | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 95  | Harmonic Mixer                                   | M03HWD                           | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 96  | Source Module                                    | S19MS-A                          | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 97  | Source Module                                    | S12MS-A                          | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 98  | Source Module                                    | S08MS-A                          | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 99  | Source Module                                    | S05MS-A                          | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |
| 100 | Source Module                                    | S03MS-A                          | 200529-1    | OML, Inc.                   | 2021.07.03    | 1 year       | <input type="checkbox"/>            |

## 4. SUMMARY TEST RESULTS

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

### Procedure Reference

FCC CFR 47, Part 15. Subpart C-15.247  
 558074 D01 15.247 Meas Guidance v05r02  
 ANSI C 63.10-2013

## 5. MEASUREMENT RESULTS

### 5.1 Peak Output Power

#### 5.1.1 Standard Applicable [FCC §15.247(b)(1)]

For frequency hopping systems operating in the 2 400 ~ 2 483.5 MHz 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 ~ 26) °C • Relative Humidity : (52 ~ 56) % R.H.

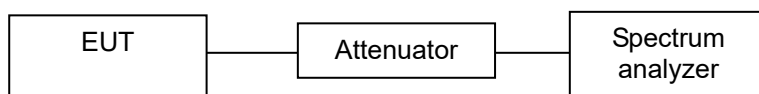
#### 5.1.3 Measurement Procedure

ANSI C63.10 (2013) : 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 | Limit [dBm] | Test Results |
|---------|-----------------|--------------|-------------|--------------|
|         |                 | [dBm]        |             |              |
| 0       | 2 402           | 7.15         | 30          | Compliance   |
| 38      | 2 440           | 7.54         | 30          | Compliance   |
| 78      | 2 480           | 8.23         | 30          | Compliance   |

■ EDR( $\pi/4$ DQPSK)

| Channel | Frequency [MHz] | Output Power | Limit [dBm] | Test Results |
|---------|-----------------|--------------|-------------|--------------|
|         |                 | [dBm]        |             |              |
| 0       | 2 402           | 5.82         | 30          | Compliance   |
| 38      | 2 440           | 6.46         | 30          | Compliance   |
| 78      | 2 480           | 7.30         | 30          | Compliance   |

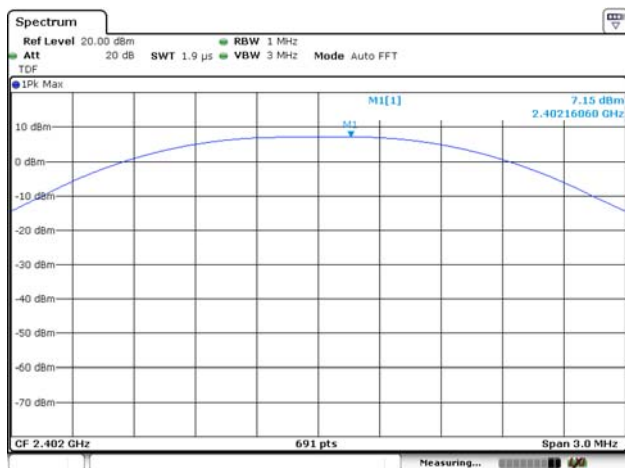
■ EDR(8DPSK)

| Channel | Frequency [MHz] | Output Power | Limit [dBm] | Test Results |
|---------|-----------------|--------------|-------------|--------------|
|         |                 | [dBm]        |             |              |
| 0       | 2 402           | 5.91         | 30          | Compliance   |
| 38      | 2 440           | 6.58         | 30          | Compliance   |
| 78      | 2 480           | 7.34         | 30          | Compliance   |

## 5.1.6 Test Plot

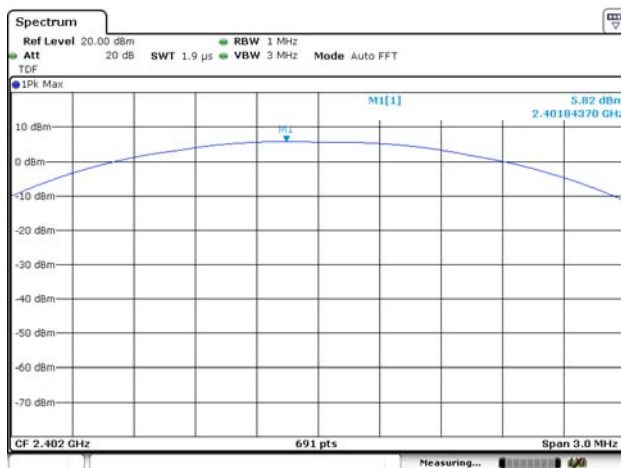
■ BDR(GFSK)

CH Low

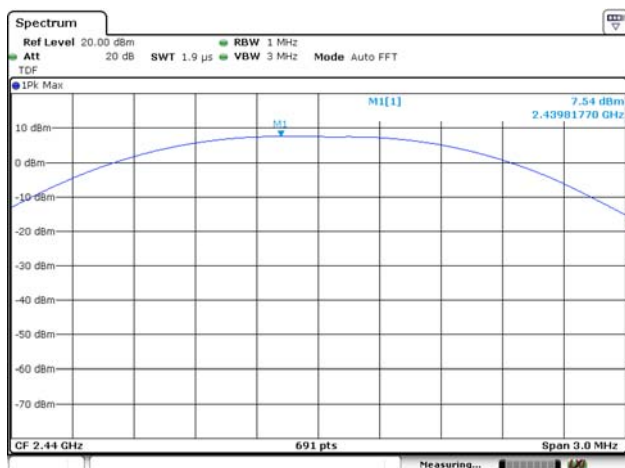


■ EDR( $\pi$ /4DQPSK)

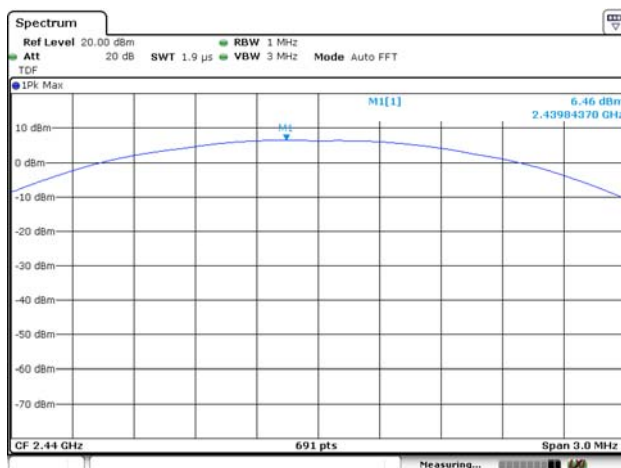
CH Low



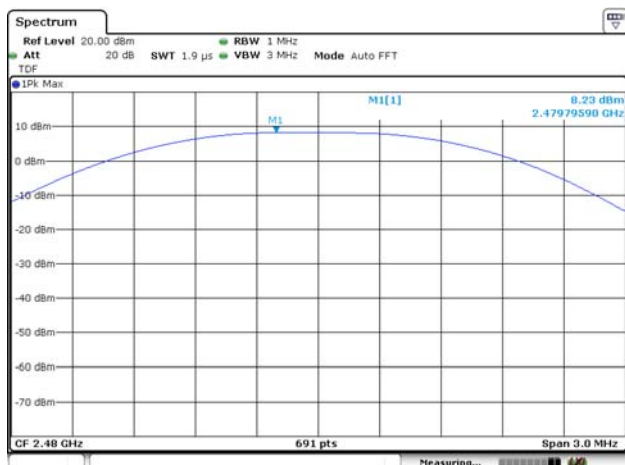
CH Middle



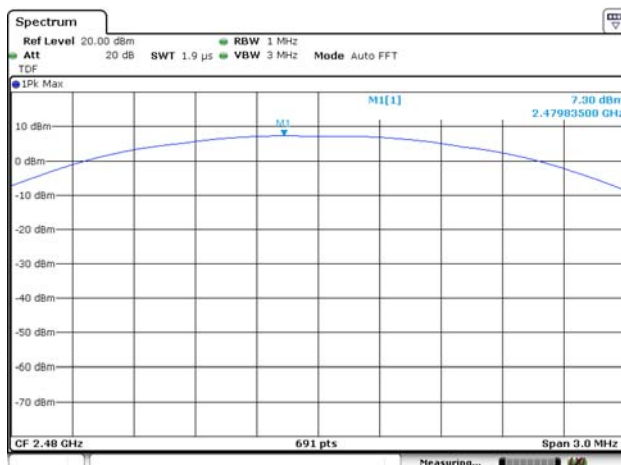
CH Middle



CH High

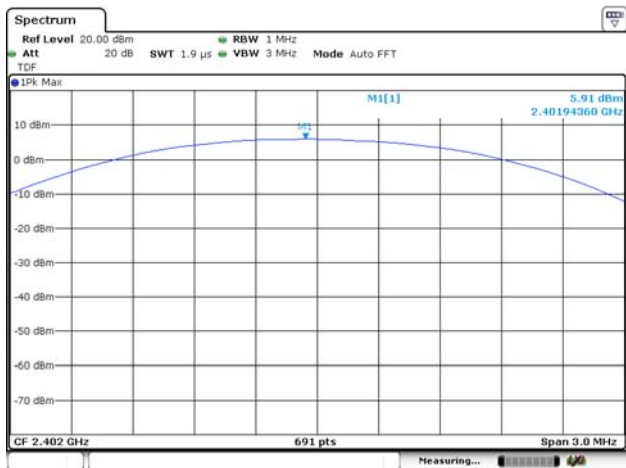


CH High

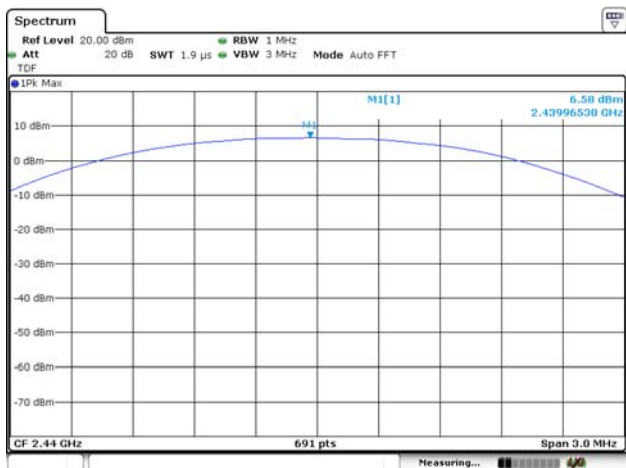


■ EDR(8DPSK)

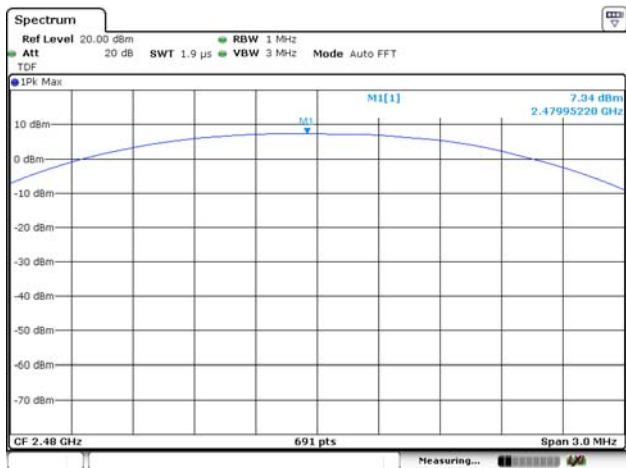
CH Low



CH Middle



CH High



## 5.2 20 dB Bandwidth

### 5.2.1 Standard Applicable [FCC §15.247(a)(1)]

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

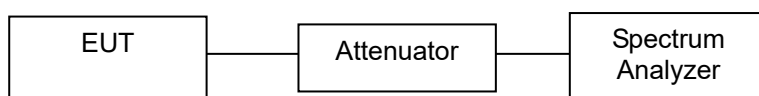
- Ambient temperature : (24 ~ 26) °C • Relative Humidity : (52 ~ 56) % R.H.

### 5.2.3 Measurement Procedure

ANSI C63.10 (2013): 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  $\geq$  1 % of the 20 dB bandwidth and VBW  $\geq$  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           | 0.925                 | 0.873                | -           | Compliance   |
|                     | 38      | 2 440           | 0.925                 | 0.868                | -           | Compliance   |
|                     | 78      | 2 480           | 0.925                 | 0.868                | -           | Compliance   |
| EDR( $\pi/4$ DQPSK) | 0       | 2 402           | 1.307                 | 1.168                | -           | Compliance   |
|                     | 38      | 2 440           | 1.307                 | 1.172                | -           | Compliance   |
|                     | 78      | 2 480           | 1.311                 | 1.181                | -           | Compliance   |
| EDR(8DPSK)          | 0       | 2 402           | 1.272                 | 1.177                | -           | Compliance   |
|                     | 38      | 2 440           | 1.268                 | 1.181                | -           | Compliance   |
|                     | 78      | 2 480           | 1.268                 | 1.181                | -           | Compliance   |

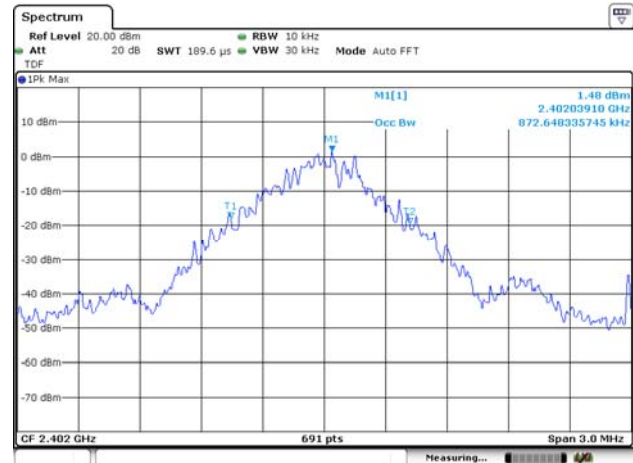
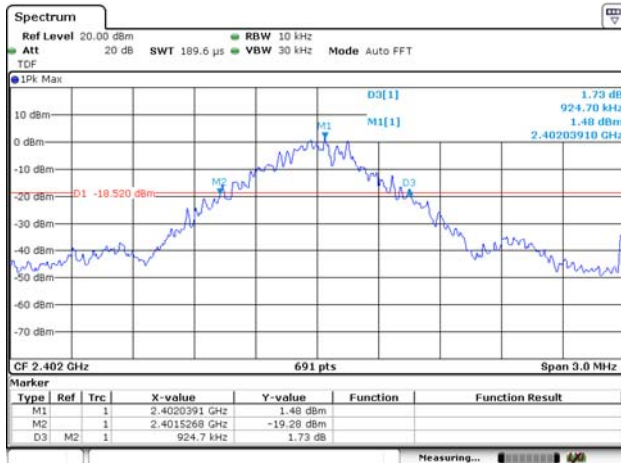
## 5.2.6 Test Plot

■ BDR(GFSK)

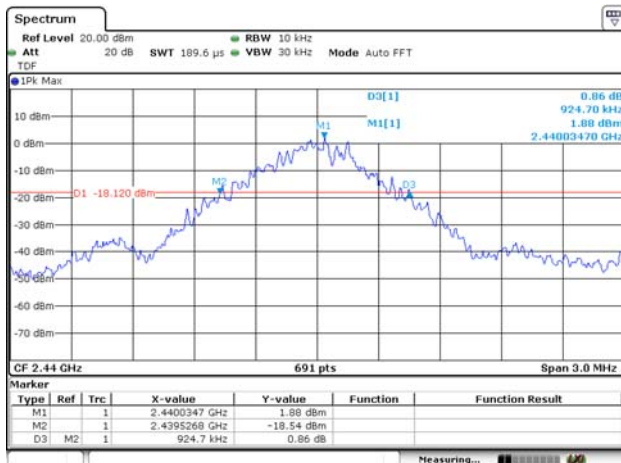
20 dB Bandwidth

CH Low

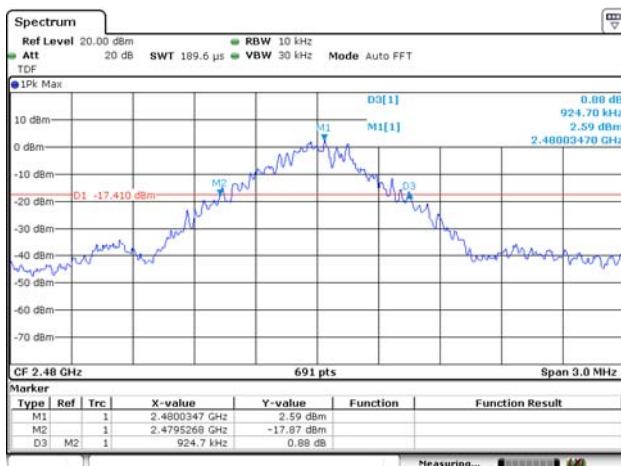
99 % Bandwidth



CH Middle



CH High

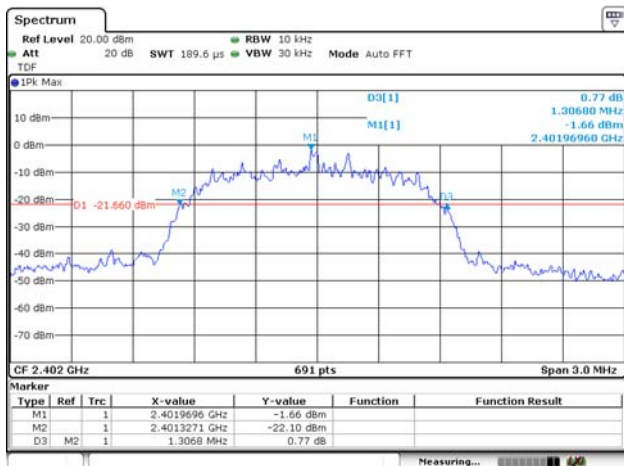


■ EDR( $\pi/4$ DQPSK)

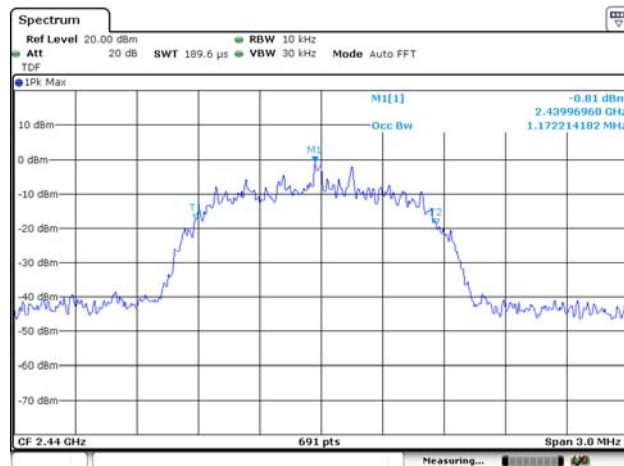
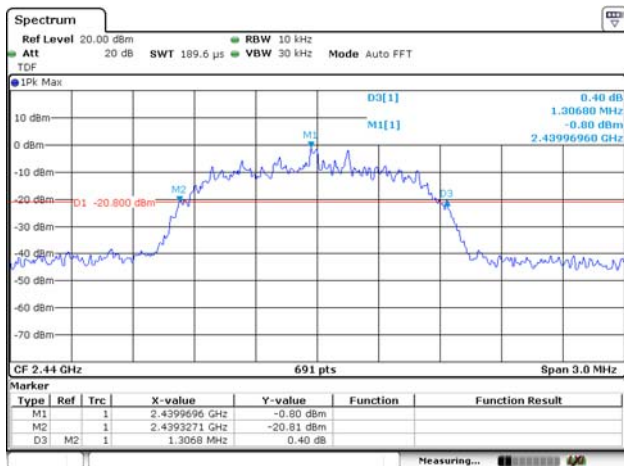
20 dB Bandwidth

99 % Bandwidth

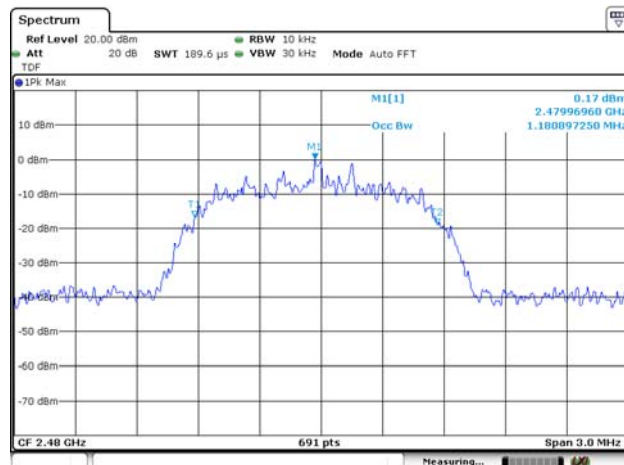
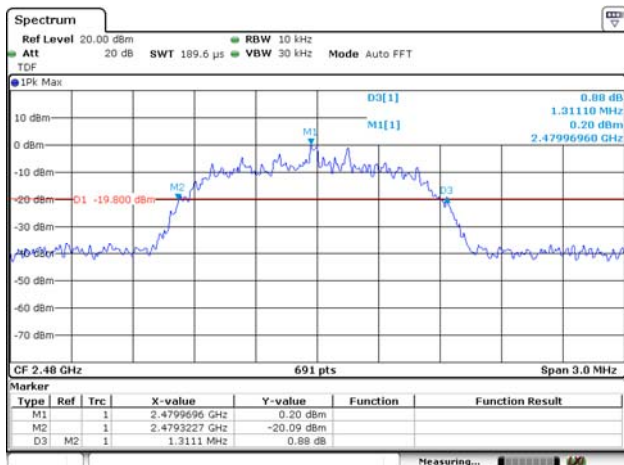
CH Low



CH Middle



CH High

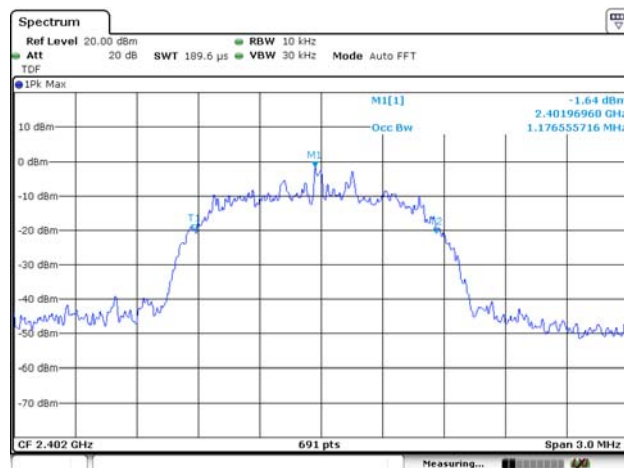
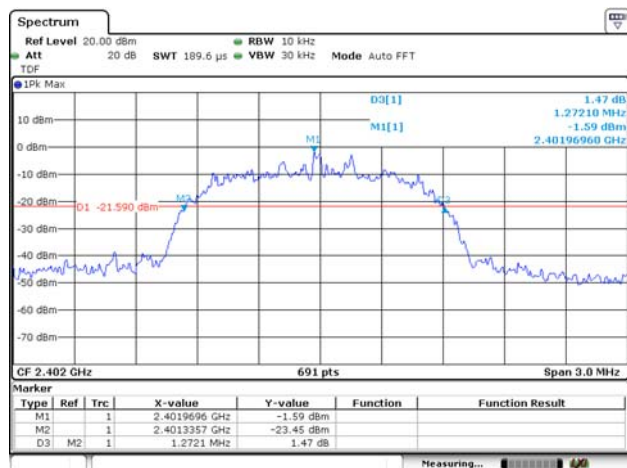


■ EDR(8DPSK)

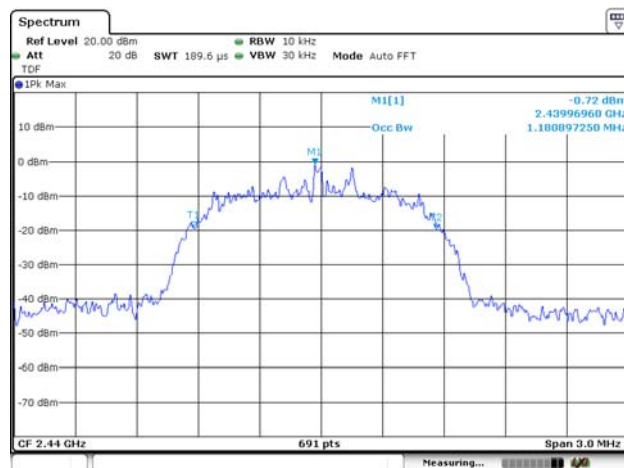
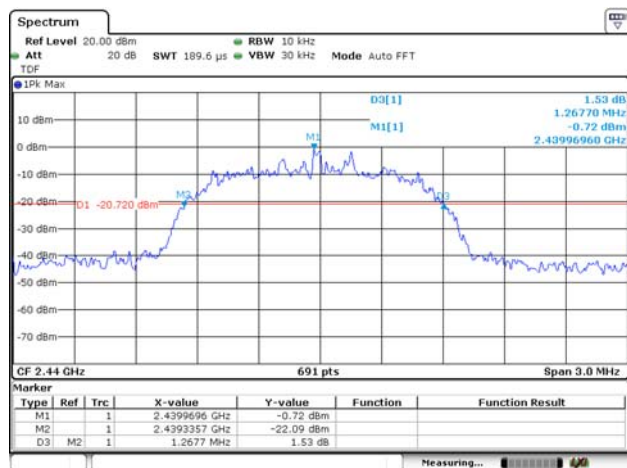
20 dB Bandwidth

99 % Bandwidth

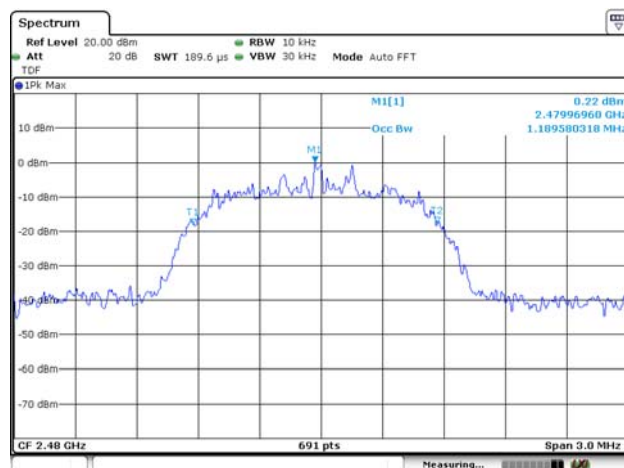
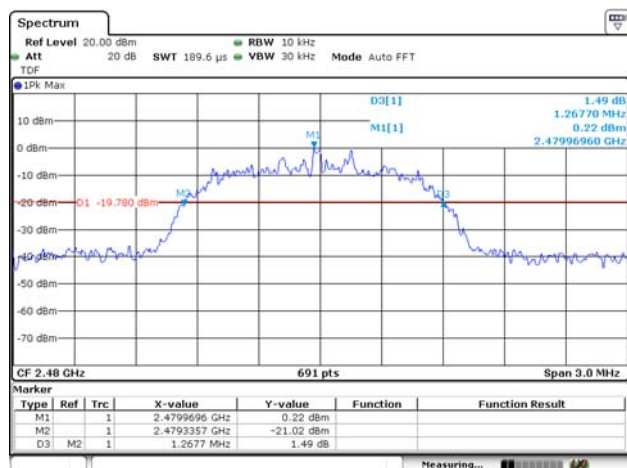
CH Low



CH Middle



CH High



## 5.3 Channel Separation

### 5.3.1 Standard Applicable [FCC §15.247(a)(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.

### 5.3.2 Test Environment conditions

- Ambient temperature : (24 ~ 26) °C • Relative Humidity : (52 ~ 56) % R.H.

### 5.3.3 Measurement Procedure

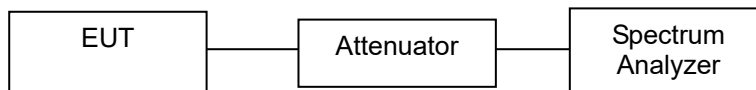
ANSI C63.10 (2013) : Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

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 :  $\geq 1\%$  of the span
- VBW :  $\geq$  RBW
- Sweep : auto
- Detector function : peak
- Trace : max hold

### 5.3.4 Test setup



### 5.3.5 Measurement Result

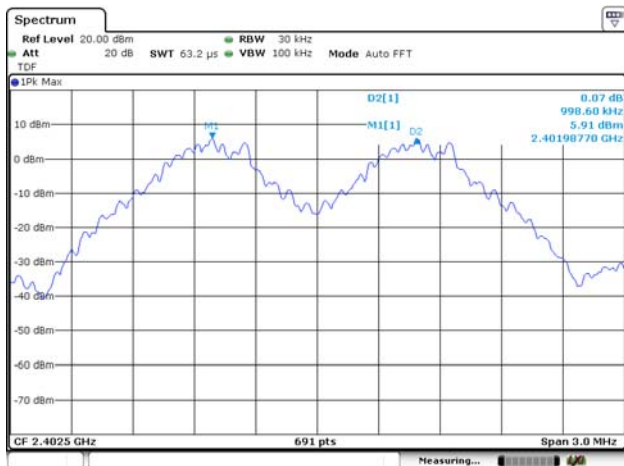
| Modulation Type     | Channel | Frequency[MHz] | Channel Separation(MHz) | Limit(MHz)   | Test Results |
|---------------------|---------|----------------|-------------------------|--------------|--------------|
| BDR(GFSK)           | 00      | 2 402          | 0.999                   | $\geq 0.617$ | Compliance   |
|                     | 38      | 2 440          | 1.003                   | $\geq 0.617$ | Compliance   |
|                     | 78      | 2 480          | 1.003                   | $\geq 0.617$ | Compliance   |
| EDR( $\pi/4$ DQPSK) | 00      | 2 402          | 0.999                   | $\geq 0.871$ | Compliance   |
|                     | 38      | 2 440          | 1.003                   | $\geq 0.871$ | Compliance   |
|                     | 78      | 2 480          | 0.999                   | $\geq 0.871$ | Compliance   |
| EDR(8DPSK)          | 00      | 2 402          | 0.999                   | $\geq 0.848$ | Compliance   |
|                     | 38      | 2 440          | 0.999                   | $\geq 0.845$ | Compliance   |
|                     | 78      | 2 480          | 0.999                   | $\geq 0.845$ | Compliance   |

\* Limit :  $\geq 25$  kHz or two-thirds of the 20 dB bandwidth

### 5.3.6 Test plot

■ BDR(GFSK)

Channel 00

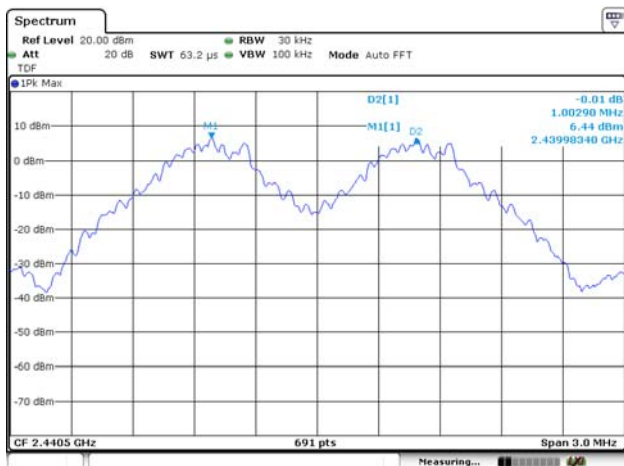


■ EDR( $\pi$ /4DQPSK)

Channel 00



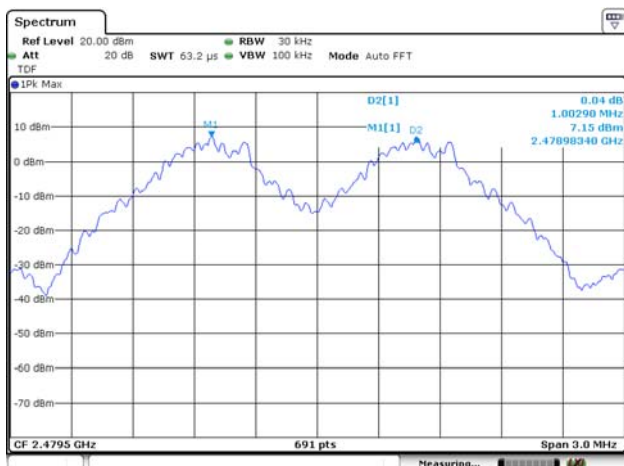
Channel 38



Channel 38



Channel 78

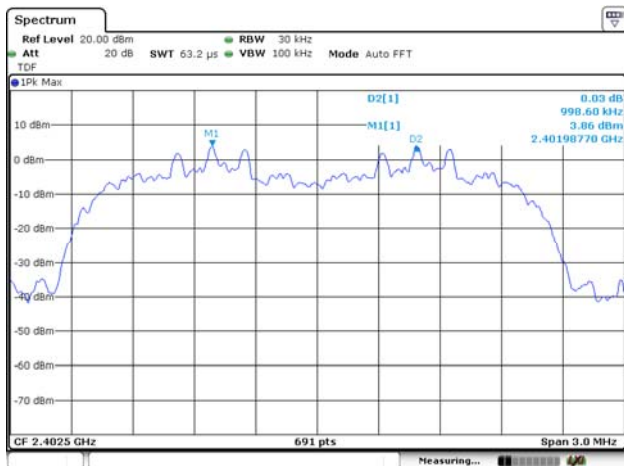


Channel 78



■ EDR(8DPSK)

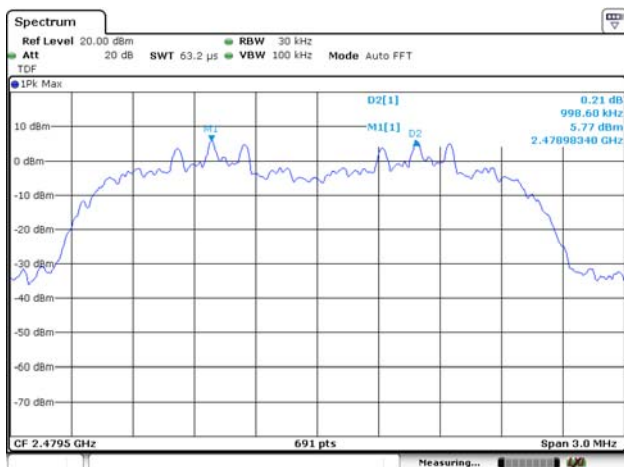
Channel 00



Channel 38



Channel 78



## 5.4 Number of Hopping Channels

### 5.4.1 Standard Applicable [FCC §15.247(a)(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)(iii) Frequency hopping systems in the 2400 - 2483.5 MHz band shall use at least 15 channels.

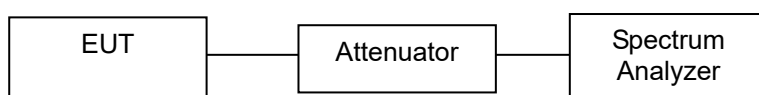
### 5.4.2 Test Environment conditions

• Ambient temperature : (24 ~ 26) °C • Relative Humidity : (52 ~ 56) % 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

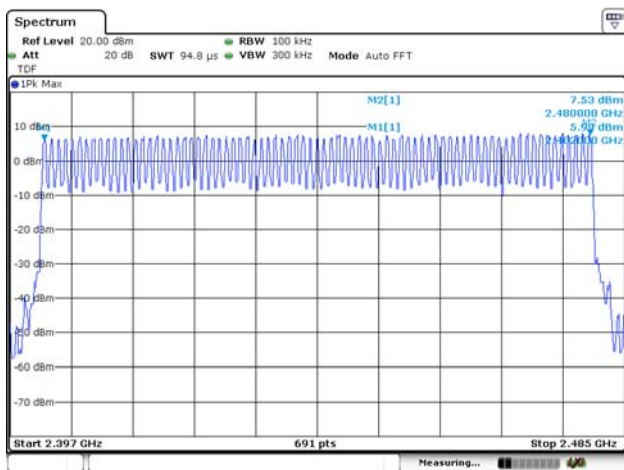


### 5.4.5 Measurement Result

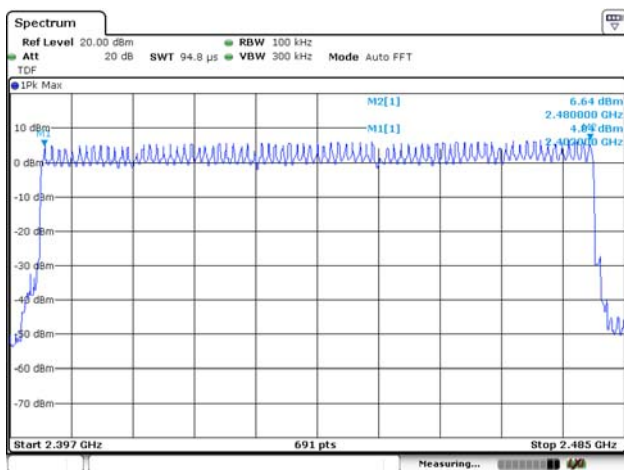
| Modulation Type     | Hopping channels number | Limit | Test Results |
|---------------------|-------------------------|-------|--------------|
| BDR(GFSK)           | 79                      | ≥15   | Compliance   |
| EDR( $\pi/4$ DQPSK) | 79                      | ≥15   | Compliance   |
| EDR(8DPSK)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

## 5.4.6 Test plot

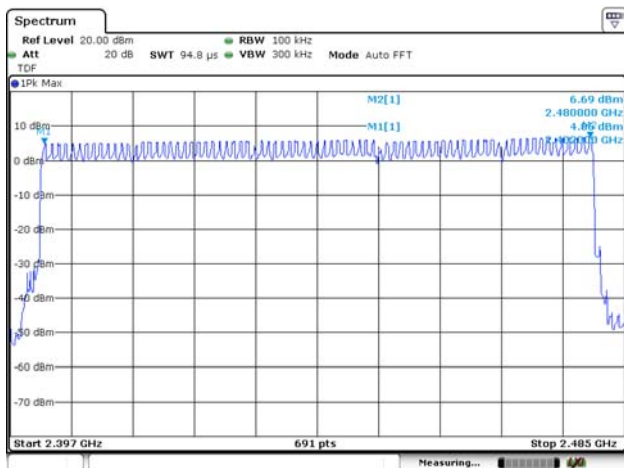
### ■ BDR(GFSK)



### ■ EDR( $\pi/4$ DQPSK)



### ■ EDR(8DPSK)



## 5.5 Time of Occupancy

### 5.5.1 Standard Applicable [FCC §15.247(a)(1)]

(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

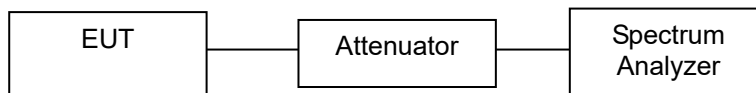
- Ambient temperature : (24 ~ 26) °C • Relative Humidity : (52 ~ 56) % R.H.

### 5.5.3 Measurement Procedure

ANSI C63.10 (2013) : 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)<br>(Time slot) |      |       | Test Results    |            |            |
|---------------------------------------------|------|-------|-----------------|------------|------------|
|                                             |      |       | Dwell time (ms) | Limit      | Result     |
| BDR(GFSK)                                   | DH1  | 0.391 | 0.125           | $\leq 0.4$ | Compliance |
|                                             | DH3  | 1.638 | 0.262           | $\leq 0.4$ | Compliance |
|                                             | DH5  | 2.906 | 0.310           | $\leq 0.4$ | Compliance |
| EDR( $\pi/4$ DQPSK)                         | 2DH1 | 0.391 | 0.125           | $\leq 0.4$ | Compliance |
|                                             | 2DH3 | 1.638 | 0.262           | $\leq 0.4$ | Compliance |
|                                             | 2DH5 | 2.906 | 0.310           | $\leq 0.4$ | Compliance |
| EDR(8DPSK)                                  | 3DH1 | 0.391 | 0.125           | $\leq 0.4$ | Compliance |
|                                             | 3DH3 | 1.638 | 0.262           | $\leq 0.4$ | Compliance |
|                                             | 3DH5 | 2.906 | 0.310           | $\leq 0.4$ | 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).

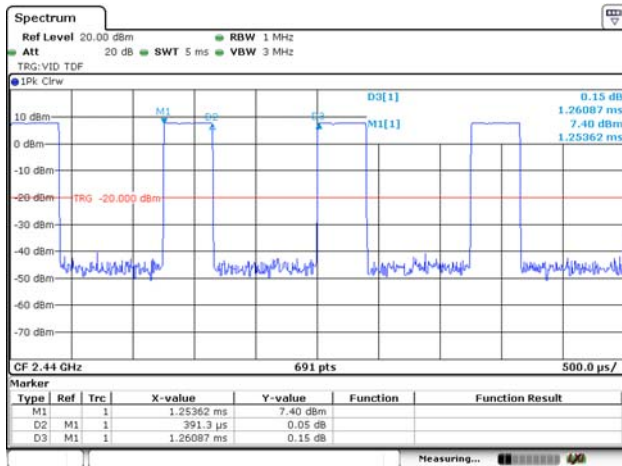
Therefore, dwell Time can be calculated as follows:

| 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

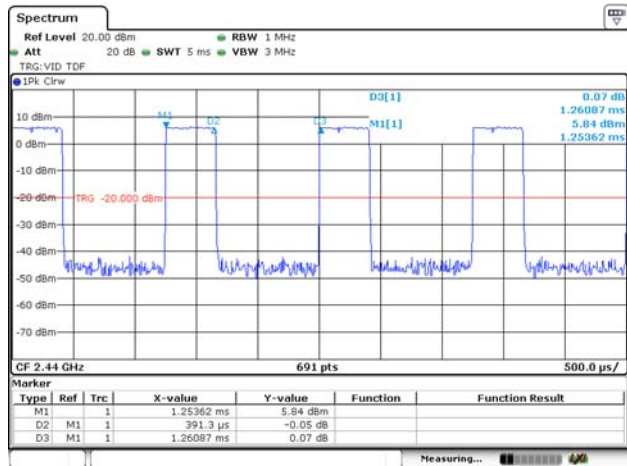
■ BDR(GFSK)

DH1

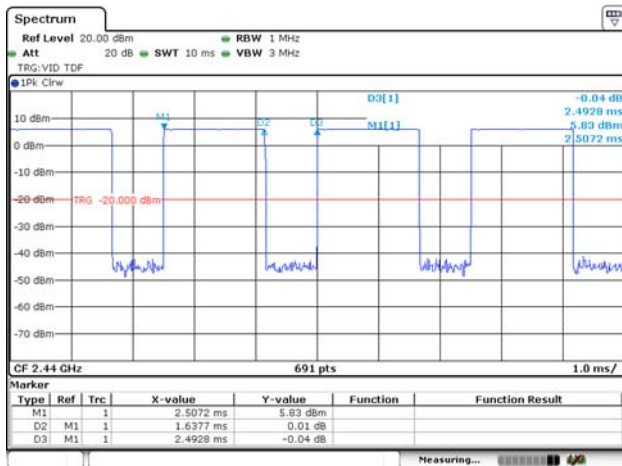


■ EDR( $\pi/4$ DQPSK)

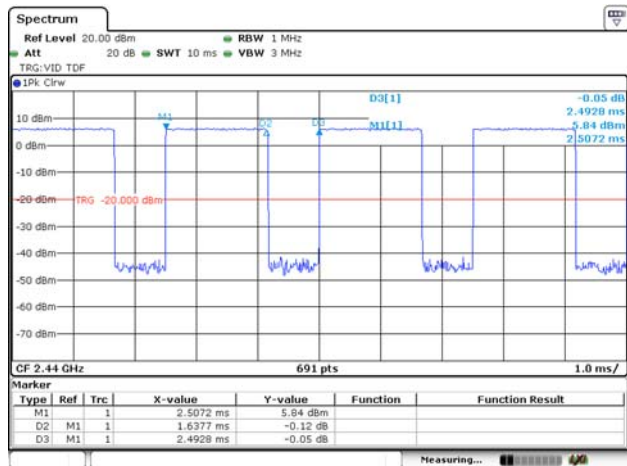
2DH1



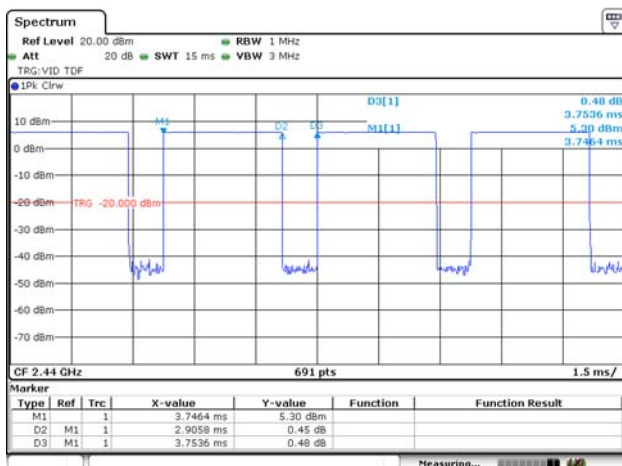
DH3



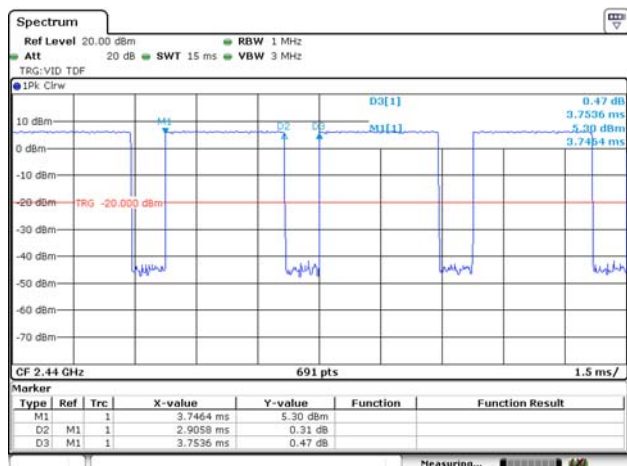
2DH3



DH5

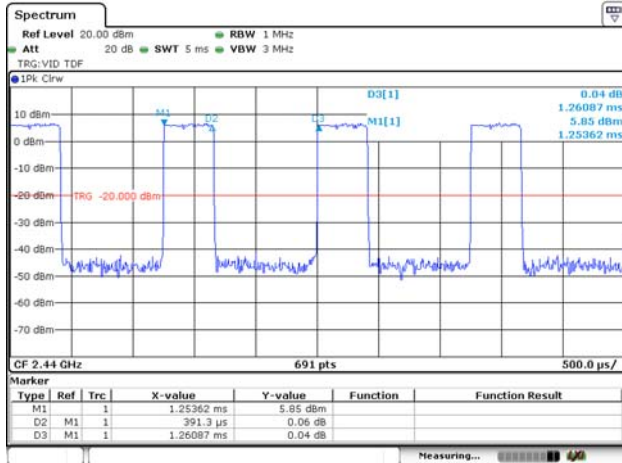


2DH5

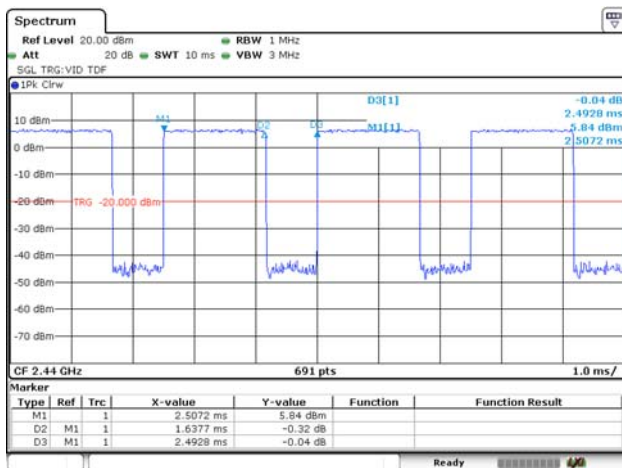


■ EDR(8DPSK)

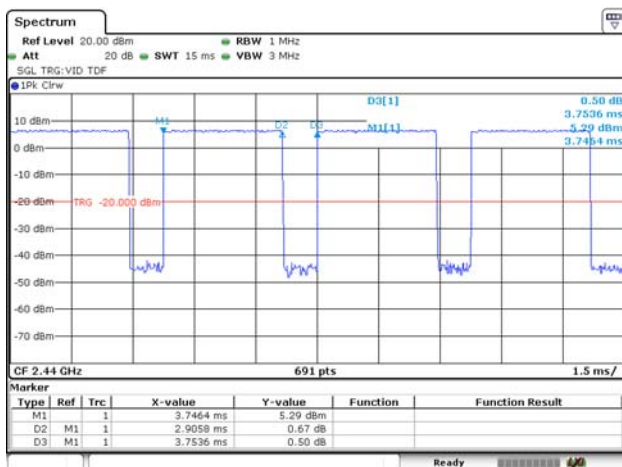
3DH1



3DH3



3DH5



## 5.6 Conducted Spurious Emissions (Band-edge)

### 5.6.1 Standard Applicable [FCC §15.247(d)]

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 KHz bandwidth within the band that contains the highest level of the desired power, based on RF conducted.

### 5.6.2 Test Environment conditions

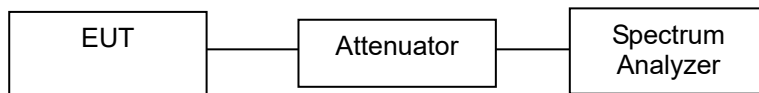
- Ambient temperature : (24 ~ 26) °C • Relative Humidity : (52 ~ 56) % R.H.

### 5.6.3 Measurement Procedure

ANSI C63.10 (2013) : Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

- (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  | -43.62              | -43.07  | ≤ 20 than PSD level | Compliance |
|                     | CH 78 | -51.92              | -57.40  |                     | Compliance |
| EDR( $\pi$ /4DQPSK) | CH 0  | -38.83              | -37.03  |                     | Compliance |
|                     | CH 78 | -49.82              | -58.04  |                     | Compliance |
| EDR(8DPSK)          | CH 0  | -37.27              | -37.15  |                     | Compliance |
|                     | CH 78 | -50.89              | -56.67  |                     | Compliance |

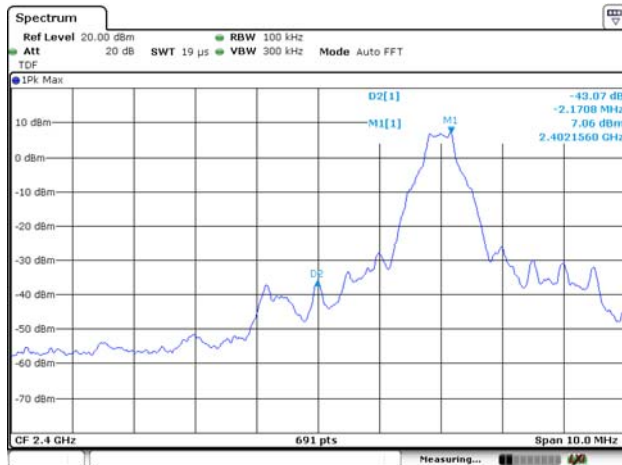
Note: The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria. Plots are also presented showing the band edge compliance.

## 5.6.6 Test Plot (Band-edge)

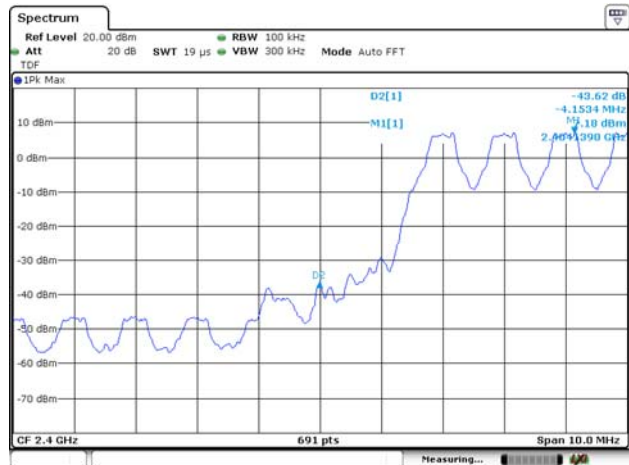
■ BDR(GFSK)

CH Low

Hop off

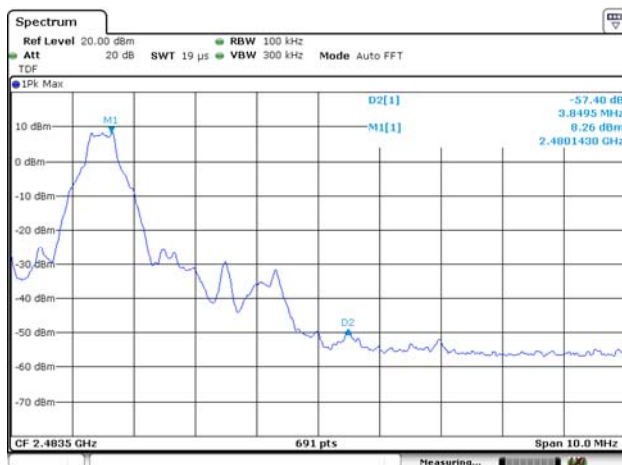


Hop on

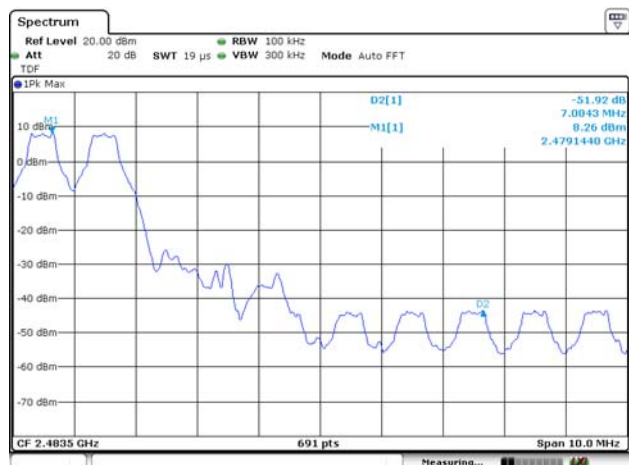


CH High

Hop off



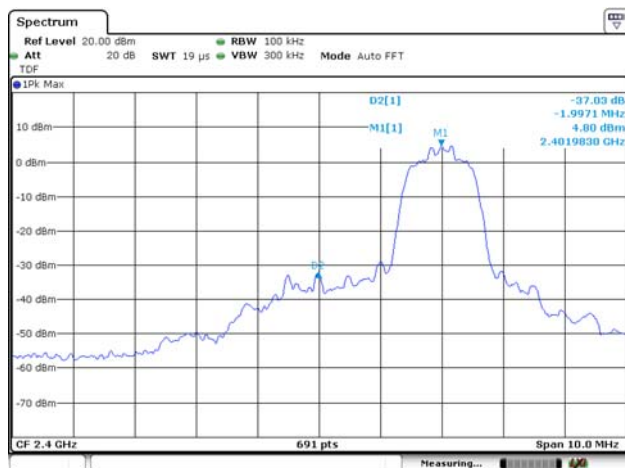
Hop on



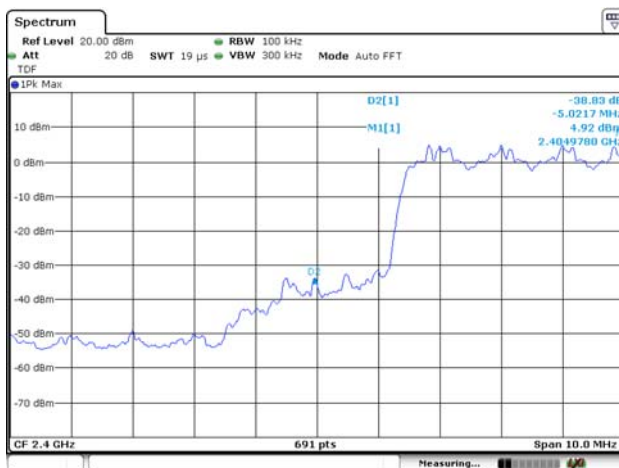
■ EDR( $\pi/4$ DQPSK)

CH Low

Hop off

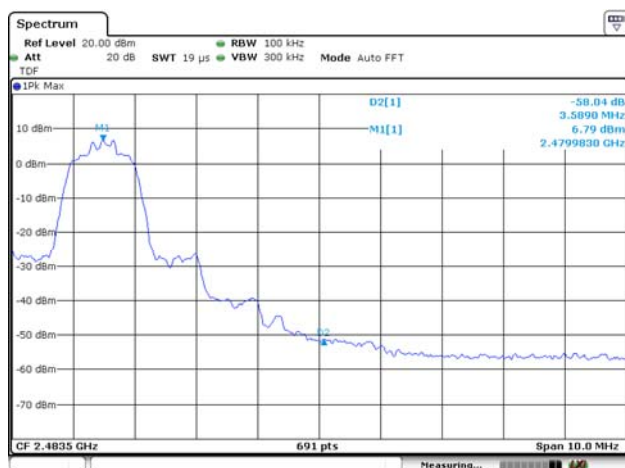


Hop on

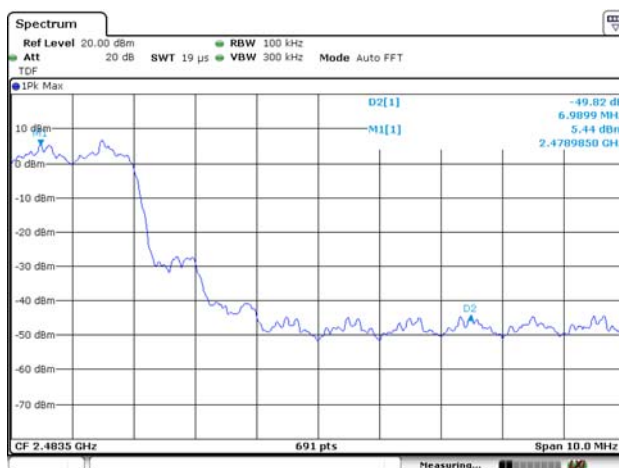


CH High

Hop off



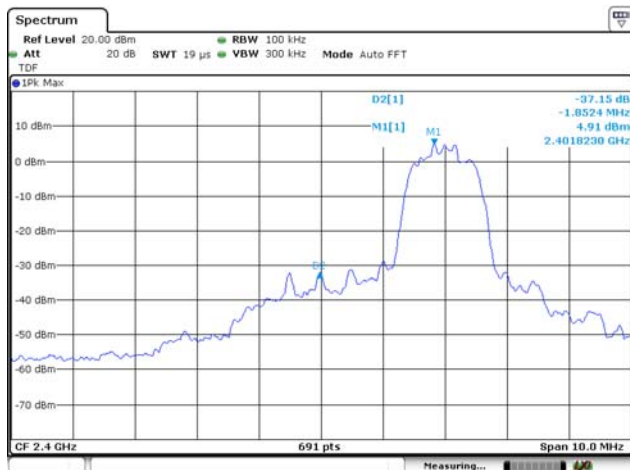
Hop on



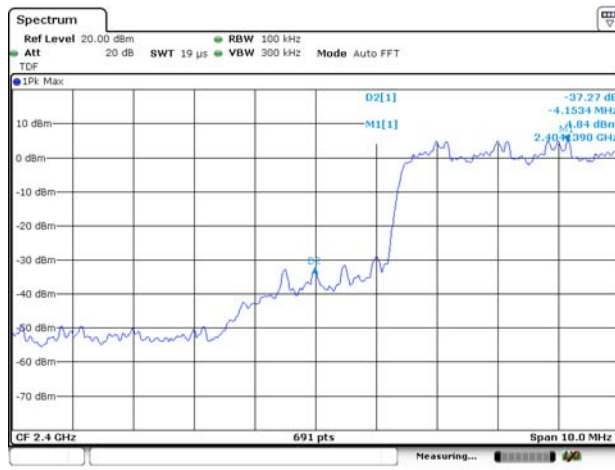
■ EDR(8DPSK)

CH Low

Hop off

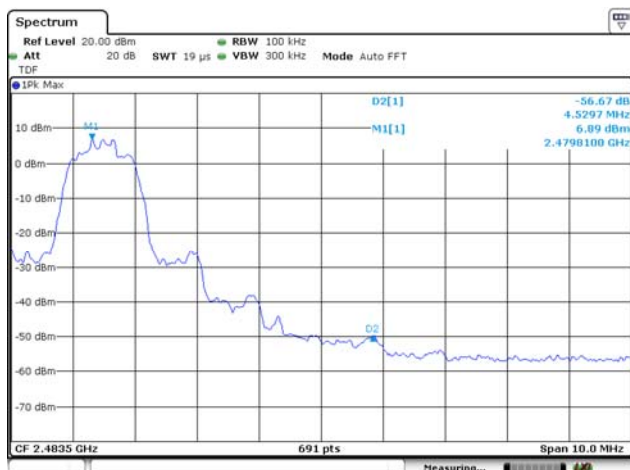


Hop on

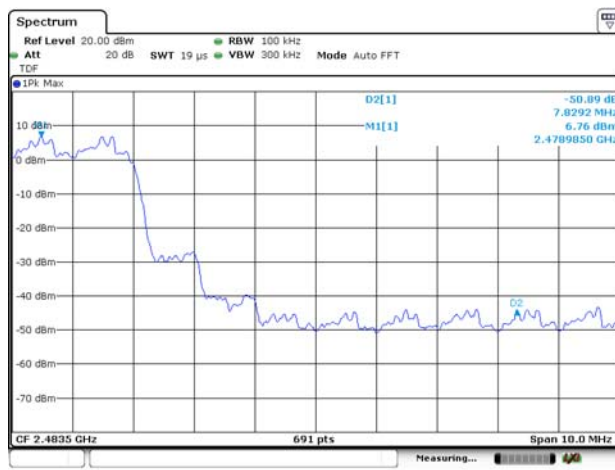


CH High

Hop off



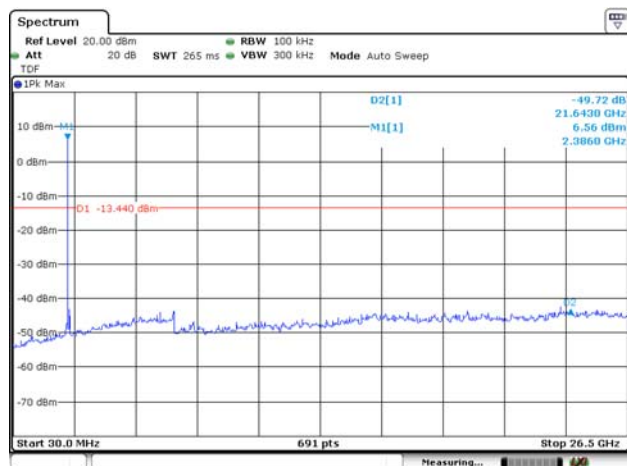
Hop on



## Test Plot (Conducted spurious emissions)

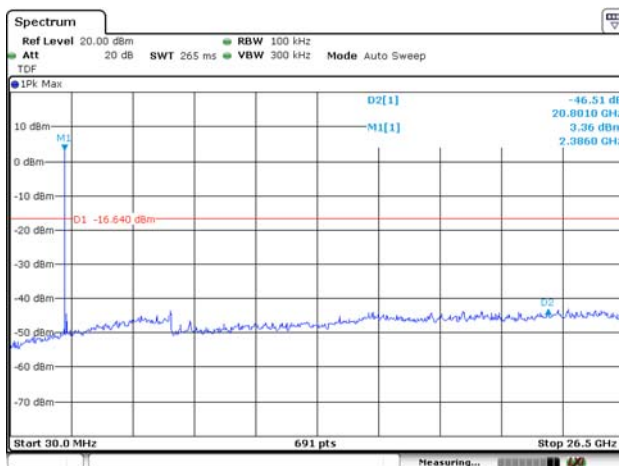
■ BDR(GFSK)

CH Low

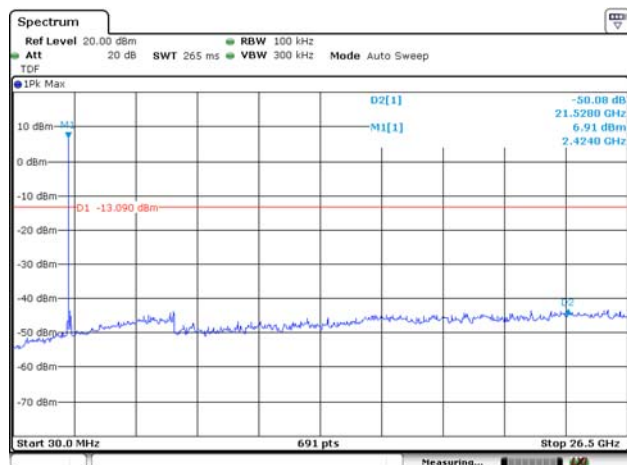


■ EDR( $\pi/4$ QPSK)

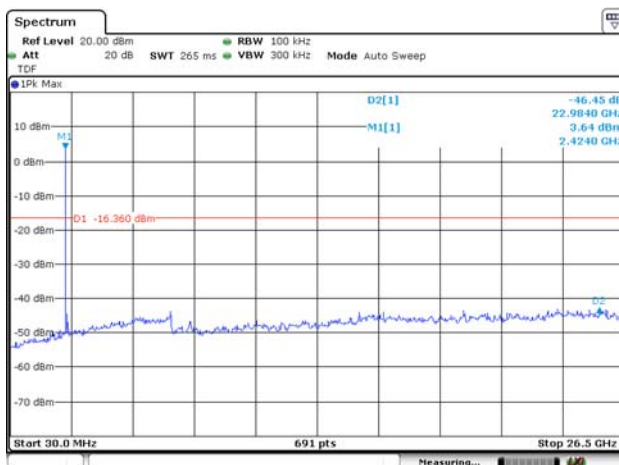
CH Low



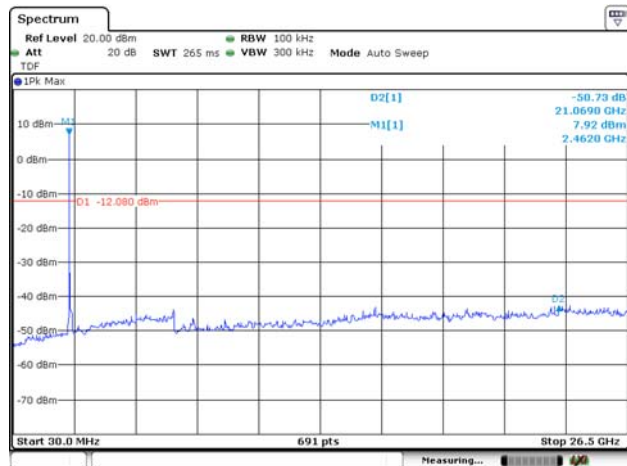
CH Middle



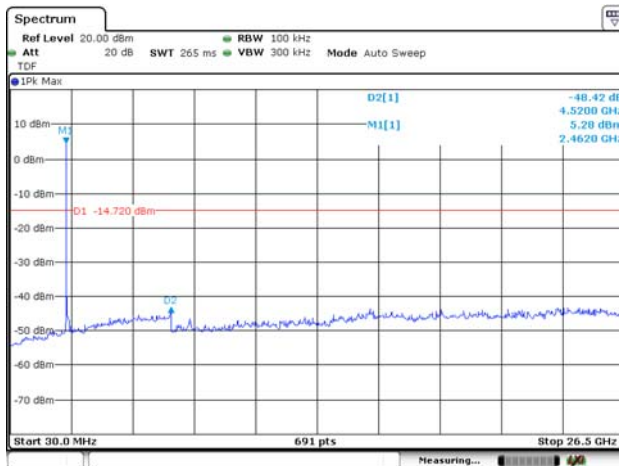
CH Middle



CH High



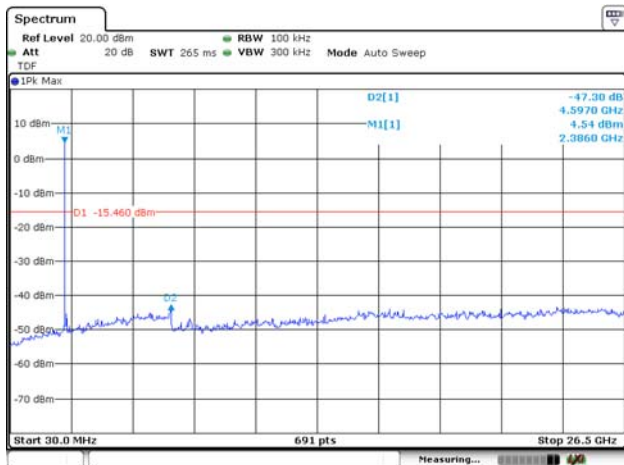
CH High



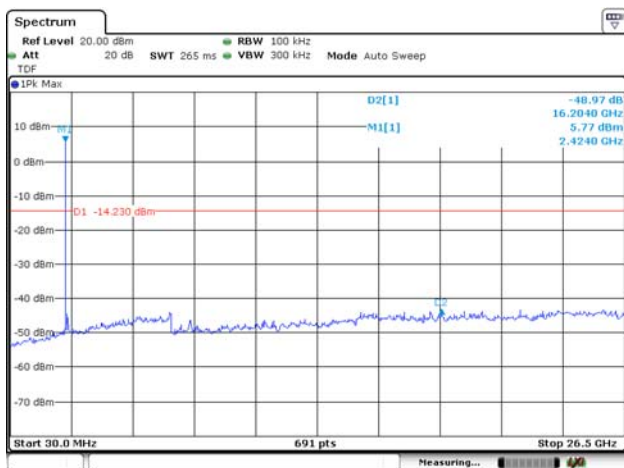
**Note:** It is not recorded on the report that the reading of emissions are attenuated more than 20 dB below the permissible limits

■ EDR(8DPSK)

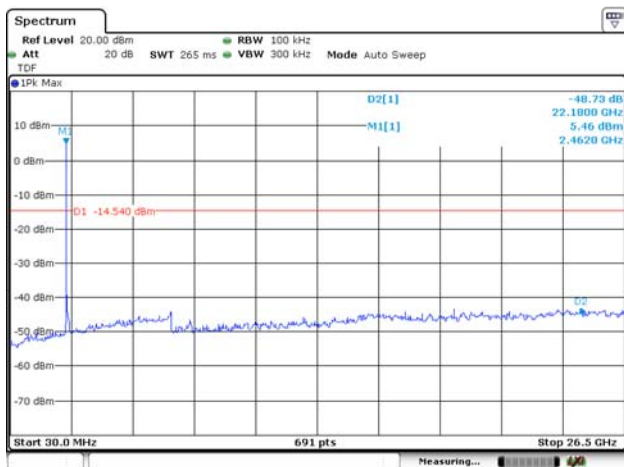
CH Low



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)]

#### 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)

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

| Frequency Band [MHz]                                                                                                                                                                                                                                                                                     | DISTANCE [Meters] | Limit [ $\mu\text{V}/\text{m}$ ]                                                | Limit [dB $\mu\text{V}/\text{m}$ ] | 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 $\mu\text{V}/\text{m}$ (Peak), 54.0 dB $\mu\text{V}/\text{m}$ (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

### 5.7.2 Test Environment conditions

- Ambient temperature : (21 ~ 22) °C • Relative Humidity : (54 ~ 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 GHz and 1.5 meters for above 1 GHz) 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:  
 $\text{Result(dB}\mu\text{V/m)} = \text{Reading(dB}\mu\text{V)} + \text{Antenna factor(dB/m)} + \text{CL(dB)} + \text{other applicable factor (dB)}$
  - The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for RMS Average (Duty cycle < 98 %) for Average detection (AV) at frequency above 1 GHz, then the measurement results was added to a correction factor ( $10 \log(1/\text{duty cycle})$ ).
  - The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz (Duty cycle  $\geq$  98 %) for Average detection (AV) at frequency above 1 GHz.
  - According to §15.33 (a)(1), Frequency range of radiated measurement is performed the tenth harmonic.

Above test was performed in accordance with ANSI C63.10-2013 Section 6.10.5 & 6.4, 6.5, 6.6

### 5.7.4 Measurement Uncertainty

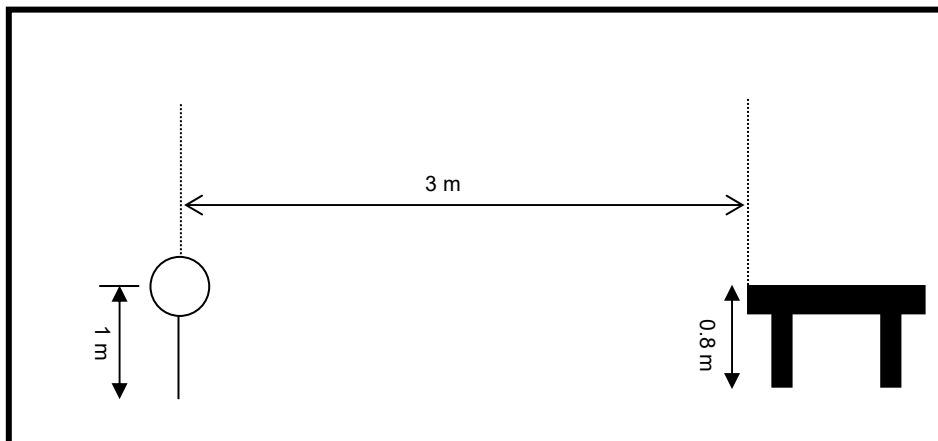
The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of  $k = 2$  to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the UCISPR measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Radiated Emission measurement: Below 1 GHz: 3.62 dB (CL: Approx 95 %,  $k=2$ )

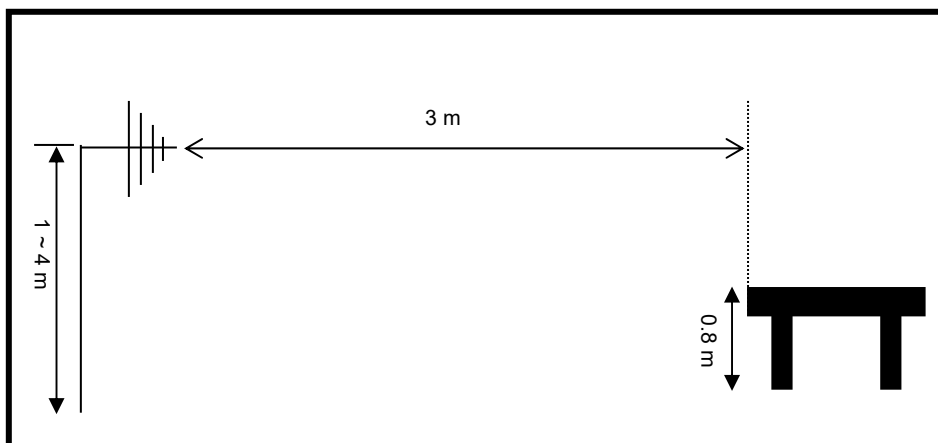
Above 1 GHz: 4.06 dB (CL: Approx 95 %,  $k=2$ )

### 5.7.5 Test Configuration

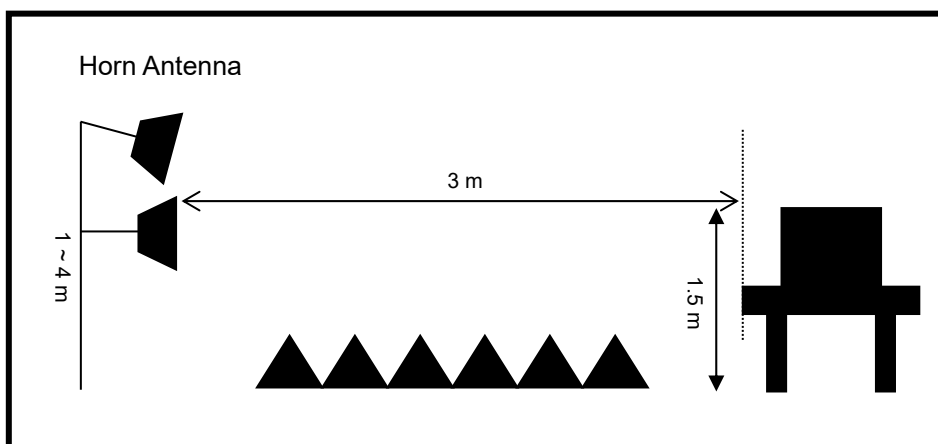
Radiated emission setup, below 30 MHz



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 BDR(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.<br>(GHz) | Reading<br>(dB $\mu$ V/m) |       | Table<br>(Deg) | Antenna       |               |                 | CL<br>(dB) | AMP<br>(dB) | Meas Result<br>(dB $\mu$ V/m) |       | Limit<br>(dB $\mu$ V/m ) |    | Mgn.<br>(dB) |       | Result     |
|----------------|---------------------------|-------|----------------|---------------|---------------|-----------------|------------|-------------|-------------------------------|-------|--------------------------|----|--------------|-------|------------|
|                | PK                        | AV    |                | Height<br>(m) | Pol.<br>(H/V) | Fctr.<br>(dB/m) |            |             | PK                            | AV    | PK                       | AV | PK           | AV    |            |
| 2.350*         | 38.94                     | 35.46 | 300            | 1.5           | H             | 28.10           | 7.10       | -31.04      | 43.10                         | 39.62 | 74                       | 54 | 30.90        | 14.38 | Compliance |
| 2.350*         | 42.10                     | 39.86 | 300            | 1.5           | V             | 28.10           | 7.10       | -31.04      | 46.26                         | 44.02 | 74                       | 54 | 27.74        | 9.98  | Compliance |
| 4.804          | 34.19                     | 21.76 | 270            | 1.5           | H             | 33.00           | 9.20       | -29.97      | 46.42                         | 33.99 | 74                       | 54 | 27.58        | 20.01 | Compliance |
| 4.804          | 34.77                     | 22.05 | 270            | 1.5           | V             | 33.00           | 9.20       | -29.97      | 47.00                         | 34.28 | 74                       | 54 | 27.00        | 19.72 | Compliance |

\* Band-edge emissions.

CH Middle (2 440 MHz)

| Freq.<br>(GHz) | Reading<br>(dB $\mu$ V/m) |       | Table<br>(Deg) | Antenna       |               |                 | CL<br>(dB) | AMP<br>(dB) | Meas Result<br>(dB $\mu$ V/m) |       | Limit<br>(dB $\mu$ V/m ) |    | Mgn.<br>(dB) |       | Result     |
|----------------|---------------------------|-------|----------------|---------------|---------------|-----------------|------------|-------------|-------------------------------|-------|--------------------------|----|--------------|-------|------------|
|                | PK                        | AV    |                | Height<br>(m) | Pol.<br>(H/V) | Fctr.<br>(dB/m) |            |             | PK                            | AV    | PK                       | AV | PK           | AV    |            |
| 4.880          | 35.02                     | 21.58 | 270            | 1.5           | H             | 33.00           | 9.36       | -29.91      | 47.46                         | 34.02 | 74                       | 54 | 26.54        | 19.98 | Compliance |
| 4.880          | 36.52                     | 22.70 | 270            | 1.5           | V             | 33.00           | 9.36       | -29.91      | 48.96                         | 35.14 | 74                       | 54 | 25.04        | 18.86 | Compliance |

CH High (2 480 MHz)

| Freq.<br>(GHz) | Reading<br>(dB $\mu$ V/m) |       | Table<br>(Deg) | Antenna       |               |                 | CL<br>(dB) | AMP<br>(dB) | Meas Result<br>(dB $\mu$ V/m) |       | Limit<br>(dB $\mu$ V/m ) |    | Mgn.<br>(dB) |       | Result     |
|----------------|---------------------------|-------|----------------|---------------|---------------|-----------------|------------|-------------|-------------------------------|-------|--------------------------|----|--------------|-------|------------|
|                | PK                        | AV    |                | Height<br>(m) | Pol.<br>(H/V) | Fctr.<br>(dB/m) |            |             | PK                            | AV    | PK                       | AV | PK           | AV    |            |
| 2.492*         | 36.03                     | 29.35 | 300            | 1.5           | H             | 28.68           | 7.33       | -30.86      | 41.17                         | 34.49 | 74                       | 54 | 32.83        | 19.51 | Compliance |
| 2.484*         | 40.19                     | 32.43 | 300            | 1.5           | V             | 28.65           | 7.30       | -30.87      | 45.27                         | 37.51 | 74                       | 54 | 28.73        | 16.49 | Compliance |
| 4.960          | 35.63                     | 21.55 | 270            | 1.5           | H             | 33.12           | 9.35       | -29.86      | 48.24                         | 34.16 | 74                       | 54 | 25.76        | 19.84 | Compliance |
| 4.960          | 36.91                     | 23.31 | 270            | 1.5           | H             | 33.12           | 9.35       | -29.86      | 49.52                         | 35.92 | 74                       | 54 | 24.48        | 18.08 | Compliance |

\* Restrict band & Band-edge emissions.

### ※Note

- Above 1 GHz is measured average and peak detector mode on Spectrum analyzer in accordance with FCC Rule15.35
- Limit: 54 dB $\mu$ V/m(Average), 74 dB $\mu$ V/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 4.960 GHz, measured any other signal is not detected on test receiver
- The transmitter radiated spectrum was investigated from 9 kHz to 40 GHz.

■ Below 1 GHz

| Freq.<br>(MHz) | Reading<br>(dB $\mu$ V/m) | Table<br>(Deg) | Antenna       |               |                 | CL<br>(dB) | AMP<br>(dB) | Meas<br>Result<br>(dB $\mu$ V/m) | Limit<br>(dB $\mu$ V/m ) | Mgn<br>(dB) | Result     |
|----------------|---------------------------|----------------|---------------|---------------|-----------------|------------|-------------|----------------------------------|--------------------------|-------------|------------|
|                |                           |                | Height<br>(m) | Pol.<br>(H/V) | Fctr.<br>(dB/m) |            |             |                                  |                          |             |            |
| 31.07          | 60.90                     | 180            | 2.0           | V             | 18.55           | 0.44       | -46.31      | 33.57                            | 40.0                     | 6.43        | Compliance |
| 97.00          | 67.61                     | 60             | 1.0           | V             | 14.55           | 1.31       | -46.46      | 37.01                            | 43.5                     | 6.49        | Compliance |
| 124.92         | 62.24                     | 180            | 2.0           | V             | 17.59           | 1.55       | -46.45      | 34.93                            | 43.5                     | 8.57        | Compliance |
| 124.92         | 64.76                     | 180            | 2.0           | H             | 17.59           | 1.55       | -46.45      | 37.45                            | 43.5                     | 6.05        | Compliance |
| 157.53         | 62.33                     | 120            | 1.5           | H             | 18.78           | 1.72       | -46.43      | 36.40                            | 43.5                     | 7.10        | Compliance |
| 191.78         | 64.86                     | 120            | 1.5           | H             | 16.52           | 1.87       | -46.41      | 36.84                            | 43.5                     | 6.66        | Compliance |
| 227.02         | 65.47                     | 180            | 2.0           | H             | 16.84           | 2.07       | -46.35      | 38.02                            | 46.0                     | 7.98        | Compliance |

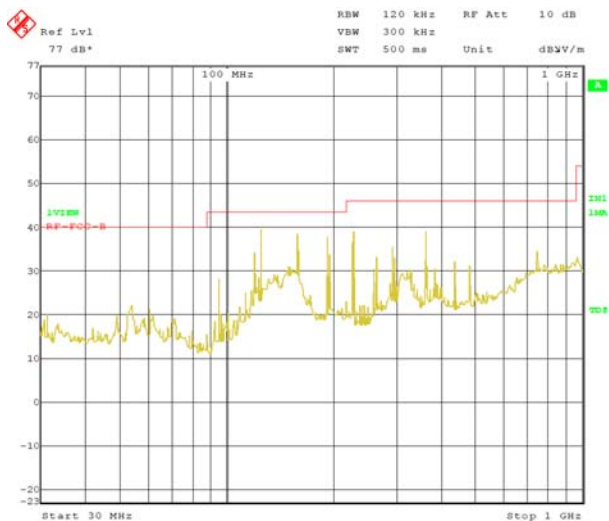
Freq.(MHz) : Measurement frequency, Reading(dB  $\mu$ V/m) : Indicated value for test receiver, Table (Deg) : Directional degree of Turn table  
 Antenna (Height, Pol, Fctr) : Antenna Height, Polarization and Factor, Cbl(dB) : Cable loss, Pre AMP(dB) : Preamplifier gain(dB)  
 Meas Result (dB  $\mu$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

### 5.7.7 Plots

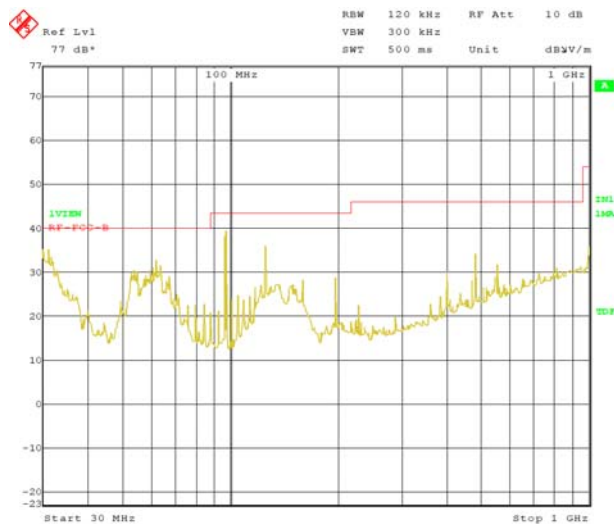
\*The worst case only.

- Below 1 GHz

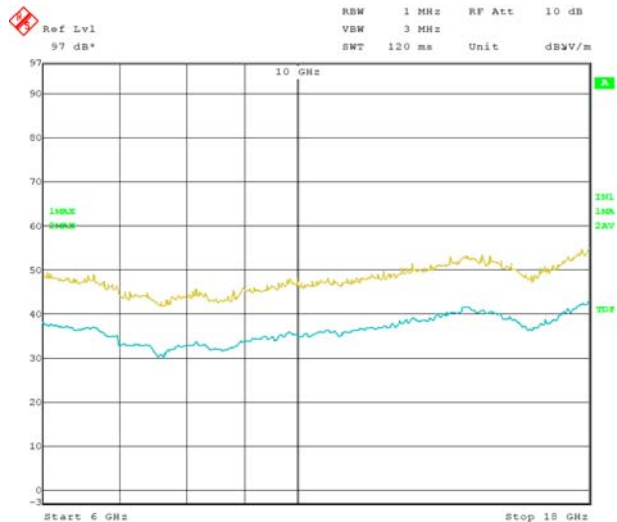
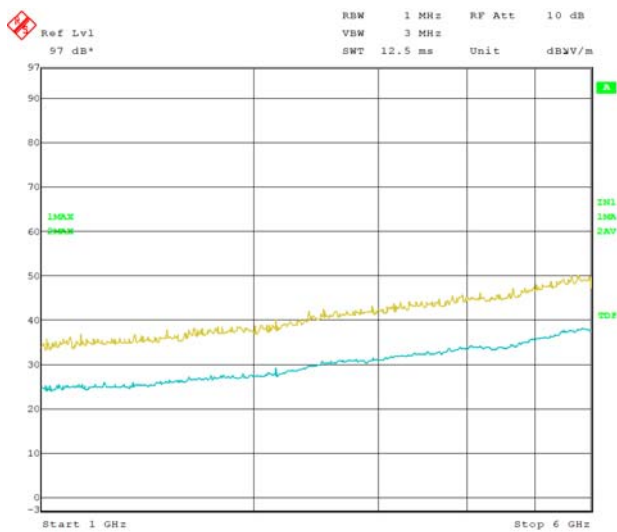
Horizontal



Vertical



- Above 1 GHz





## 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        | Internal PCB pattern antenna | 1.139 dBi  | Compliance |



## 5.9 AC Power Conducted emissions

### 5.9.1 Standard Applicable [FCC §15.207(a)]

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  $\mu$ H/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(MHz) | Conducted Limit (dB $\mu$ V) |            |
|----------------------------|------------------------------|------------|
|                            | 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 : (23 ~ 25) °C • Relative Humidity : (52 ~ 56) % 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 | 2021. 01. 21  | 1 year       | <input checked="" type="checkbox"/> |
| Pulse Limiter | ESH3-Z2   | 100097     | Rohde & Schwarz | 2021. 01. 21  | 1 year       | <input checked="" type="checkbox"/> |
| LISN          | ESH2-Z5   | 100044     | R&S             | 2021. 01. 21  | 1 year       | <input checked="" type="checkbox"/> |
|               | ESH3-Z5   | 100147     | R&S             | 2021. 01. 22  | 1 year       | <input checked="" type="checkbox"/> |

\*Test Program: " ESXS-K1 V2.2"

#### Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of  $k = 2$  to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

0.009 ~ 0.15 MHz : 3.94 dB(CL: Approx 95 %,  $k=2$ )

0.15 ~ 30 MHz : 3.32 dB(CL: Approx 95 %,  $k=2$ )

## 5.9.5 Measurement Result

| Freq.<br>[MHz] | Factor<br>[dB] |               | POL | QP      |         |         | CISPR AV |         |         |
|----------------|----------------|---------------|-----|---------|---------|---------|----------|---------|---------|
|                |                |               |     | Limit   | Reading | Result  | Limit    | Reading | Result  |
|                | LISN           | CABLE<br>+P/L |     | [dB/μV] | [dB/μV] | [dB/μV] | [dB/μV]  | [dB/μV] | [dB/μV] |
| 0.302          | 0.12           | 10.06         | L   | 60.18   | 38.94   | 39.06   | 50.18    | 32.57   | 32.69   |
| 0.451          | 0.12           | 10.06         | L   | 56.86   | 39.71   | 39.83   | 46.86    | 32.40   | 32.52   |
| 0.466          | 0.12           | 10.06         | L   | 56.58   | 40.57   | 40.69   | 46.58    | 33.73   | 33.85   |
| 0.517          | 0.12           | 10.06         | L   | 56.00   | 43.40   | 43.52   | 46.00    | 38.04   | 38.16   |
| 0.568          | 0.12           | 10.06         | L   | 56.00   | 31.94   | 32.06   | 46.00    | 26.52   | 26.64   |
| 0.677          | 0.12           | 10.06         | L   | 56.00   | 33.94   | 34.06   | 46.00    | 26.94   | 27.06   |
| 0.193          | 0.12           | 10.05         | N   | 63.91   | 41.23   | 41.35   | 53.91    | 24.96   | 25.08   |
| 0.302          | 0.12           | 10.06         | N   | 60.18   | 37.76   | 37.88   | 50.18    | 25.73   | 25.85   |
| 0.466          | 0.12           | 10.06         | N   | 56.58   | 43.59   | 43.71   | 46.58    | 31.08   | 31.20   |
| 0.502          | 0.12           | 10.06         | N   | 56.00   | 44.84   | 44.96   | 46.00    | 33.87   | 33.99   |
| 0.529          | 0.12           | 10.06         | N   | 56.00   | 38.93   | 39.05   | 46.00    | 28.15   | 28.27   |
| 0.693          | 0.13           | 10.06         | N   | 56.00   | 31.84   | 31.97   | 46.00    | 18.25   | 18.38   |

- \* 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

