# **TEST REPORT**

# Dt&C Co., Ltd.

|                             |  |                   | Dt&C Co., Ltd.   |  |  |  |
|-----------------------------|--|-------------------|--|--|--|--|
| U                           | Dt&C   |                   | eon-gil, Cheoin-gu, Yongin<br>el : 031-321-2664, Fax : 0 | si, Gyeonggi-do, Korea, 17042<br>31-321-1664 |  |  |
|                             |  |                   |  |  |  |  |
| 1. Report N                 | lo: DRTFCC2303-0034  | 1                 |  |  |  |  |
| 2. Custome                  | er   |                   |  |  |  |  |
| • Name (F                   | CC) : MOTREX CO., LT   | D.                |  |  |  |  |
| <ul> <li>Address</li> </ul> | (FCC) : Seoyoung Bldg.<br>Gyeonggi-do,So   |                   | o 258beon-gil,Bundar                                     | ng-gu, Seongnam-si,                          |  |  |
| 3. Use of R                 | Report : FCC Original Gra  | nt                |  |  |  |  |
|                             | Name / Model Name : Sl<br>: BP9-MS400ACN7PE  | MART DISPLAY / N  | MS400ACN7PE  |  |  |  |
|                             | gulation(s): Part 15.247<br>hod used: KDB558074 D  | 001v05r02, ANSI C | 63.10-2013   |  |  |  |
| 6. Date of                  | Test : 2023.02.01 ~ 2023   | .03.14            |  |  |  |  |
| 7. Location                 | of Test : 🛛 Permanent  | Testing Lab       | On Site Testing  |  |  |  |
| 8. Testing I                | Environment : See apper  | ided test report. |  |  |  |  |
| 9. Test Res                 | sult : Refer to the attache  | d test result.    |  |  |  |  |
|                             | shown in this test report references on the second se |                   | e(s) tested unless other                                 | vise stated.                                 |  |  |
| Affirmation                 | Tested by  | 0                 | Technical Manager  | A  |  |  |
|                             | Name : SeungMin Gil  | (Signature)       | Name : JaeJin Lee  | (Signature)                                  |  |  |
|                             |  |                   |  | 10   |  |  |
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|                             |  |                   |  |  |  |  |
|                             |  | 2023.03.          | 29.  |  |  |  |
|                             | Dt&C Co., Ltd.   |                   |  |  |  |  |

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

# **Test Report Version**

| Test Report No. | Date          | Description   | Revised by   | Reviewed by |
|-----------------|---------------|---------------|--------------|-------------|
| DRTFCC2303-0034 | Mar, 29. 2023 | Initial issue | SeungMin Gil | JaeJin Lee  |
|                 |               |               |              |             |
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# **1. General Information**

# 1.1. Description of EUT

| Equipment Class                           | Digital Transmission System (DTS)                            |
|---|--|
| Product Name                              | SMART DISPLAY  |
| Model Name                                | MS400ACN7PE  |
| Add Model Name                            | -  |
| Firmware Version<br>Identification Number | Rev 0.1  |
| EUT Serial Number                         | No Specified   |
| Power Supply                              | DC 12 V  |
| Modulation Technique                      | • 802.11b: CCK, DSSS<br>• 802.11g/n: OFDM                    |
| Antenna Specification                     | Antenna Type: Dielectric Chip Antenna<br>Gain: 4.49 dBi (PK) |

| Band    | Mode           | Tx. frequency(MHz) | Max. conducted<br>power(dBm) |
|---------|----------------|--------------------|------------------------------|
| 2.4 GHz | 802.11b        | 2 412 ~ 2 462      | 7.33                         |
|         | 802.11g        | 2 412 ~ 2 462      | 14.69                        |
|         | 802.11n (HT20) | 2 412 ~ 2 462      | 15.75                        |

# 1.2. Declaration by the applicant / manufacturer

N/A

# **1.3. Testing Laboratory**

#### Dt&C Co., Ltd.

The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042.

The test site complies with the requirements of Part 2.948 according to ANSI C63.4-2014.

#### - FCC & IC MRA Designation No. : KR0034

#### - ISED#: 5740A

| www.dtnc.net |   |                  |
|--------------|---|------------------|
| Telephone    | : | + 82-31-321-2664 |
| FAX          | : | + 82-31-321-1664 |

## 1.4. Testing Environment

| Ambient Condition                     |                 |
|---------------------------------------|-----------------|
| <ul> <li>Temperature</li> </ul>       | +20 °C ~ +25 °C |
| <ul> <li>Relative Humidity</li> </ul> | +35 % ~ +45 %   |

## 1.5. Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C63.4-2014 and ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence.

| Parameter                          | Measurement uncertainty                               |
|------------------------------------|---|
| Antenna-port conducted emission    | 1.1 dB (The confidence level is about 95 %, $k = 2$ ) |
| Radiated emission (1 GHz Below)    | 4.8 dB (The confidence level is about 95 %, $k = 2$ ) |
| Radiated emission (1 GHz ~ 18 GHz) | 5.0 dB (The confidence level is about 95 %, k = 2)    |
| Radiated emission (18 GHz Above)   | 5.2 dB (The confidence level is about 95 %, $k = 2$ ) |

# 1.6. Test Equipment List

| Туре                                   | Manufacturer           | Model                            | Cal.Date<br>(yy/mm/dd) | Next.Cal.Date<br>(yy/mm/dd) | S/N                  |
|--|------------------------|----------------------------------|------------------------|-----------------------------|----------------------|
| Spectrum Analyzer                      | Agilent Technologies   | N9020A                           | 22/12/16               | 23/12/16                    | MY48010133           |
| Spectrum Analyzer                      | Agilent Technologies   | N9020A                           | 22/12/16               | 23/12/16                    | MY48011700           |
| Spectrum Analyzer                      | Agilent Technologies   | N9020A                           | 22/06/24               | 23/06/24                    | US47360812           |
| DC Power Supply                        | Agilent Technologies   | 66332A                           | 22/06/24               | 23/06/24                    | US37473627           |
| DC Power Supply                        | SM techno              | SDP30-5D                         | 22/06/24               | 23/06/24                    | 305DMG288            |
| Multimeter                             | FLUKE                  | 17B+                             | 22/12/16               | 23/12/16                    | 36390701WS           |
| Signal Generator                       | Rohde Schwarz          | SMBV100A                         | 22/12/16               | 23/12/16                    | 255571               |
| Signal Generator                       | ANRITSU                | MG3695C                          | 22/12/16               | 23/12/16                    | 173501               |
| Thermohygrometer                       | BODYCOM                | BJ5478                           | 22/12/16               | 23/12/16                    | 120612-1             |
| Thermohygrometer                       | BODYCOM                | BJ5478                           | 22/12/16               | 23/12/16                    | 120612-2             |
| Thermohygrometer                       | BODYCOM                | BJ5478                           | 22/06/24               | 23/06/24                    | N/A                  |
| Loop Antenna                           | ETS-Lindgren           | 6502                             | 22/12/16               | 24/12/16                    | 00226186             |
| Hybrid Antenna                         | Schwarzbeck            | VULB 9160                        | 22/12/16               | 23/12/16                    | 3362                 |
| Horn Antenna                           | ETS-Lindgren           | 3117                             | 22/06/24               | 23/06/24                    | 00143278             |
| Horn Antenna                           | A.H.Systems Inc.       | SAS-574                          | 22/06/24               | 23/06/24                    | 155                  |
| PreAmplifier                           | tsj                    | MLA-0118-B01-40                  | 22/12/16               | 23/12/16                    | 1852267              |
| PreAmplifier                           | tsj                    | MLA-1840-J02-45                  | 22/06/24               | 23/06/24                    | 16966-10728          |
| PreAmplifier                           | H.P                    | 8447D                            | 22/12/16               | 23/12/16                    | 2944A07774           |
| High Pass Filter                       | Wainwright Instruments | WHKX12-935-1000-<br>15000-40SS   | 22/06/24               | 23/06/24                    | 8                    |
| High Pass Filter                       | Wainwright Instruments | WHKX10-2838-3300-<br>18000-60SS  | 22/06/24               | 23/06/24                    | 1                    |
| High Pass Filter                       | Wainwright Instruments | WHNX8.0/26.5-6SS                 | 22/06/24               | 23/06/24                    | 3                    |
| Attenuator                             | Hefei Shunze           | SS5T2.92-10-40                   | 22/06/24               | 23/06/24                    | 16012202             |
| Attenuator                             | Aeroflex/Weinschel     | 56-3                             | 22/06/24               | 23/06/24                    | Y2370                |
| Attenuator                             | SMAJK                  | SMAJK-2-3                        | 22/06/24               | 23/06/24                    | 3                    |
| Attenuator                             | SMAJK                  | SMAJK-2-3                        | 22/06/24               | 23/06/24                    | 2                    |
| Attenuator                             | Aeroflex/Weinschel     | 86-10-11                         | 22/06/24               | 23/06/24                    | 408                  |
| Power Meter & Wide<br>Bandwidth Sensor | Anritsu                | ML2496A<br>MA2411B               | 22/12/16               | 23/12/16                    | 1338004<br>1911481   |
| Cable                                  | Dt&C                   | Cable                            | 23/01/04               | 24/01/04                    | G-2                  |
| Cable                                  | HUBER+SUHNER           | SUCOFLEX 100                     | 23/01/04               | 24/01/04                    | G-3                  |
| Cable                                  | Dt&C                   | Cable                            | 23/01/04               | 24/01/04                    | G-4                  |
| Cable                                  | OMT                    | YSS21S                           | 23/01/04               | 24/01/04                    | G-5                  |
| Cable                                  | HUBER+SUHNER           | SUCOFLEX100                      | 23/01/04               | 24/01/04                    | M-01                 |
| Cable                                  | HUBER+SUHNER           | SUCOFLEX100                      | 23/01/04               | 24/01/04                    | M-02                 |
| Cable                                  | JUNKOSHA               | MWX241/B                         | 23/01/04               | 24/01/04                    | M-03                 |
| Cable                                  | JUNFLON                | J12J101757-00                    | 23/01/04               | 24/01/04                    | M-07                 |
| Cable                                  | HUBER+SUHNER           | SUCOFLEX106                      | 23/01/04               | 24/01/04                    | M-09                 |
| Cable                                  | RADIALL                | TESTPRO 3                        | 23/01/04               | 24/01/04                    | RFC-70               |
| Test Software                          | tsj                    | Radiated Emission<br>Measurement | NA                     | NA                          | Version<br>2.00.0147 |

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.

Note2: The cable is not a regular calibration item, so it has been calibrated by Dt&C itself.



# 2. Test Methodology

The measurement procedures described in the ANSI C63.10-2013 and the guidance provided in KDB558074 D01v05r02 were used in measurement of the EUT.

The EUT was tested per the guidance of KDB558074 D01v05r02. And ANSI C63.10-2013 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing.

# 2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

## 2.2. EUT Exercise

The EUT was operated in the test mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

## 2.3. General Test Procedures

#### **Conducted Emissions**

The power-line conducted emission test procedure is not described on the KDB558074 D01v05r02.

So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10-2013.

The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and Average detector.

#### **Radiated Emissions**

Basically the radiated tests were performed with KDB558074 D01v05r02. But some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10-2013 as stated on section 12.1 of the KDB558074 D01v05r02.

The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

#### 2.4. Instrument Calibration

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.



#### 2.5. Description of Test Modes

The EUT has been tested with the operating condition for maximizing the emission characteristics. A test program is used to control the EUT for staying in continuous transmitting.

#### **Transmitting Configuration of EUT**

| Mode          | Data rate        |
|---------------|------------------|
| 802.11b       | 1 Mbps ~ 11 Mbps |
| 802.11g       | 6 Mbps ~ 54 Mbps |
| 802.11n(HT20) | MCS 0 ~ MCS 7    |

#### **EUT** Operation test setup

#### - Test Software: Teraterm 4.105

- **Power setting:** Refer to the table below.

#### **Test Mode**

| Test mode | Worst case data rate   | Power setting | Tested Frequency (MHz) |       |       |
|-----------|------------------------|---------------|------------------------|-------|-------|
| TM 1      | 802.11b<br>1 Mbps      | 7             | 2 412                  | 2 437 | 2 462 |
| TM 2      | 802.11g<br>6 Mbps      | -4            | 2 412                  | 2 437 | 2 462 |
| ТМ 3      | 802.11n(HT20)<br>MCS 0 | -4            | 2 412                  | 2 437 | 2 462 |

Note1: The worst case data rate was determined according to the power measurements.

Note2: The power measurement results for all modes and data rate were reported.

# 3. Antenna Requirements

#### According to Part 15.203

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

The antenna is attached on the PCB by means of unique connector. Therefore this E.U.T complies with the requirement of Part 15.203

# 4. Summary of Test Result

| FCC part section(s)           | Test Description   | Limit  | Test<br>Condition    | Status<br>Note 1 |
|-------------------------------|--|--|----------------------|------------------|
| 15.247(a)                     | 6 dB Bandwidth   | > 500 kHz                                    |                      | С                |
| 15.247(b)                     | Maximum Peak Output Power  | < 1 Watt                                     |                      | С                |
| 15.247(d)                     | Unwanted Emissions(Conducted)  | 20 dBc in any<br>100 kHz BW                  | Conducted            | с                |
| 15.247(e)                     | Power Spectral Density   | Power Spectral Density < 8 dBm / 3 kHz       |                      | с                |
| 15.247(d)<br>15.205<br>15.209 | Unwanted Emissions(Radiated)   | Part 15.209 limits<br>(Refer to section 5.5) | Radiated             | с                |
| 15.207                        | 15.207AC Power-Line Conducted EmissionsPart 15.207 limits<br>(Refer to section 5.6)  |  | AC Line<br>Conducted | NA Note 3        |
| 15 203 Antenna Requirements   |  | Part 15.203<br>(Refer to section 3)          | -                    | С                |
| Note 2: For radiated emiss    | Not Comply NT=Not Tested NA=Not Ap<br>sion tests below 30 MHz were performed on s<br>alled in a car. Therefore the power source is a | emi-anechoic chamber whic                    | h is correlated with | OATS.            |



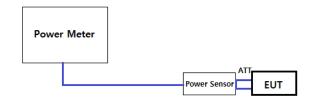
# 5. Test Result

## 5.1. Maximum Peak Conducted Output Power

### Test Requirements and limit, Part 15.247(b)

The maximum permissible conducted output power is 1 Watt.

#### 5.1.1. Test Setup



#### 5.1.2. Test Procedures

- KDB558074 D01v05r02 Section 8.3.1.3
- ANSI C63.10-2013 Section 11.9.1.3

#### RBW ≥ DTSPKPM1 Peak-reading power meter method

The maximum conducted output powers were measured using a broadband peak RF power meter which has greater video bandwidth than DUT's DTS bandwidth and utilize a fast-responding diode detector.

- KDB558074 D01v05r02 Section 8.3.2.3
- ANSI C63.10-2013 Section 11.9.2.3

#### Method AVGPM-G

The average conducted output powers were measured using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

#### 5.1.3. Test Results

- Refer to the next page



| Mode    | Freq.<br>(MHz) | Det. | Maximum Peak Conducted Output Power (dBm) |      |      |      |   |   |   |   |
|---------|----------------|------|---|------|------|------|---|---|---|---|
|         |                |      |   |      |      |      |   |   |   |   |
|         |                |      | 1   | 2    | 5.5  | 11   | - | - | - | - |
|         | 2 412          | PK   | 7.33                                      | 7.25 | 7.23 | 7.22 | - | - | - | - |
|         |                | AV   | 4.17                                      | 4.13 | 4.14 | 4.13 | - | - | - | - |
| 802.11b | 2 437          | PK   | 7.17                                      | 7.10 | 7.07 | 7.04 | - | - | - | - |
| 002.110 |                | AV   | 4.01                                      | 3.98 | 3.94 | 3.91 | - | - | - | - |
|         | 2 462          | PK   | 6.68                                      | 6.59 | 6.51 | 6.45 | - | - | - | - |
|         |                | AV   | 3.41                                      | 3.35 | 3.33 | 3.26 | - | - | - | - |

| Mode    | Freq.<br>(MHz) | Det. | Maximum Peak Conducted Output Power (dBm) |       |       |       |       |       |       |       |
|---------|----------------|------|---|-------|-------|-------|-------|-------|-------|-------|
|         |                |      | Data Rate (Mbps)                          |       |       |       |       |       |       |       |
|         |                |      | 6   | 9     | 12    | 18    | 24    | 36    | 48    | 54    |
|         | 2 412          | PK   | 14.69                                     | 14.60 | 13.78 | 13.47 | 12.53 | 12.67 | 11.84 | 11.80 |
|         |                | AV   | 3.80                                      | 3.74  | 3.75  | 3.32  | 3.30  | 3.22  | 3.40  | 3.25  |
| 802.11g | 2 437          | PK   | 14.24                                     | 14.17 | 13.36 | 13.19 | 12.14 | 12.22 | 11.59 | 11.43 |
| 602.11g |                | AV   | 3.37                                      | 3.29  | 3.28  | 2.95  | 2.91  | 2.88  | 2.93  | 2.87  |
|         | 2 462          | PK   | 13.51                                     | 13.43 | 12.91 | 12.56 | 11.99 | 11.97 | 11.43 | 11.26 |
|         |                | AV   | 2.70                                      | 2.43  | 2.46  | 2.42  | 2.39  | 2.24  | 2.48  | 2.32  |

| Mode    | Freq.<br>(MHz) | Det. | Maximum Peak Conducted Output Power (dBm) |       |       |       |       |       |       |       |
|---------|----------------|------|---|-------|-------|-------|-------|-------|-------|-------|
|         |                |      |   |       |       |       |       |       |       |       |
|         |                |      | 0   | 1     | 2     | 3     | 4     | 5     | 6     | 7     |
|         | 2 412          | PK   | 15.75                                     | 14.54 | 14.56 | 13.73 | 14.25 | 14.01 | 13.26 | 14.36 |
|         |                | AV   | 3.81                                      | 3.82  | 3.87  | 3.49  | 3.56  | 3.65  | 3.66  | 3.66  |
| 802.11n | 2 437          | PK   | 15.02                                     | 14.15 | 14.09 | 13.52 | 13.68 | 13.62 | 13.49 | 13.83 |
| (HT20)  |                | AV   | 3.51                                      | 3.49  | 3.53  | 3.21  | 3.19  | 3.37  | 3.38  | 3.32  |
|         | 2 462          | PK   | 14.09                                     | 13.76 | 13.73 | 13.15 | 13.28 | 13.18 | 13.09 | 13.54 |
|         |                | AV   | 2.80                                      | 2.73  | 2.79  | 2.49  | 2.47  | 2.63  | 2.62  | 2.58  |

# 5.2.6 dB Bandwidth

# Test Requirements and limit, Part 15.247(a)

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the EUT's antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6 dB bandwidth is 500 kHz.

# 5.2.1. Test Setup

Refer to the APPENDIX I.

# 5.2.2. Test Procedures

- KDB558074 D01v05r02 Section 8.2
- ANSI C63.10-2013 Section 11.8.2
- 1. Set resolution bandwidth (RBW) = 100 kHz
- 2. Set the video bandwidth (VBW)  $\ge$  3 x RBW.
- 3. Detector = **Peak**.
- 4. Trace mode = **max hold**.
- 5. Sweep = auto couple.
- 6. Allow the trace to stabilize.
- 7. Option 1 Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Option 2 - The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW  $\ge$  3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be  $\ge$  6 dB.

#### 5.2.3. Test Results

| Test Mode | Frequency | Test Results (MHz) |
|-----------|-----------|--------------------|
|           | 2 412     | 7.10               |
| TM 1      | 2 437     | 7.07               |
|           | 2 462     | 7.13               |
|           | 2 412     | 16.11              |
| TM 2      | 2 437     | 16.12              |
|           | 2 462     | 16.06              |
|           | 2 412     | 17.13              |
| TM 3      | 2 437     | 16.92              |
|           | 2 462     | 17.17              |

TM 1 & 2412



#### nt Spectrum Analyzer - Occupied BW j SENSE:PUCE ALIGN OFF Center Freq: 2.43700000 GHz → Trig: Free Run Avg|Hold: 500/500 #Atten: 20 dB 02:42:15 PM Mar 14, 2023 Radio Std: None BL Frequency Center Freq 2.437000000 GHz Radio Device: BTS #IFGain:Low Ref 10.00 dBm 10 dB/div og Center Freq many man 2.437000000 GHz Center 2.437 GHz #Res BW 100 kHz Span 40 MHz Sweep 3.867 ms CF Step 4.000000 MHz #VBW 300 kHz Man Auto Total Power Occupied Bandwidth 11.4 dBm 10.120 MHz Freq Offset 0 Hz -12.891 kHz **OBW Power** 99.00 % Transmit Freq Error x dB Bandwidth 7.072 MHz x dB -6.00 dB STATUS

#### 6 dB Bandwidth

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<u>TM 1 & 24</u>37

TM 1 & 2462 ent Spectrum Analyzer - Occupied BW CORREC SENSE:PULSE ▲ ALIGN OFF GHz Center Freq: 2.462000000 GHz Trig: Freq Run Avg|Hold: 500/500 #/IFGain:Low #Atten: 20 dB 02:49:44 PM Mar 14, 2023 Radio Std: None Frequency Center Freq 2.462000000 GHz Radio Device: BTS Ref 10.00 dBm Center Freq anna ሥሌሌ በ 2.462000000 GHz Center 2.462 GHz #Res BW 100 kHz Span 40 MHz Sweep 3.867 ms CF Step 4.000000 MHz Man #VBW 300 kHz <u>Auto</u> Total Power Occupied Bandwidth 11.5 dBm 10.105 MHz Freq Offset Transmit Freq Error -15.734 kHz OBW Power 99.00 % 0 Hz x dB Bandwidth -6.00 dB 7.128 MHz x dB STATUS



#### 6 dB Bandwidth

#### TM 2 & 2437





**Dt&C** 



#### 6 dB Bandwidth

### <u>TM 3 & 2437</u>



#### Pages: 18 / 68



## Test requirements and limit, Part 15.247(e)

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

#### 5.3.1. Test Setup

Refer to the APPENDIX I.

#### 5.3.2. Test Procedures

- KDB558074 D01v05r02 Section 8.4
- ANSI C63.10-2013 Section 11.10.2

#### Method PKPSD (peak PSD)

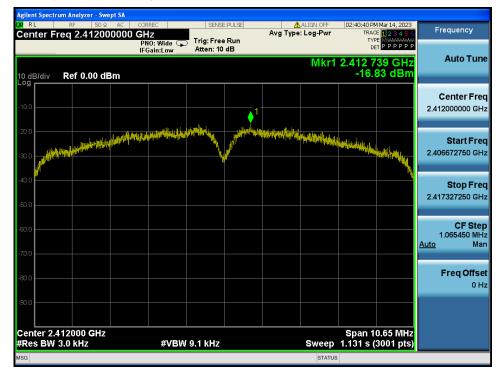
- 1. Set analyzer center frequency to DTS channel center frequency.
- 2. Set the span to 1.5 times the DTS bandwidth.
- 3. Set the RBW : 3 kHz  $\leq$  RBW  $\leq$  100 kHz.
- 4. Set the VBW  $\geq$  3 x RBW.
- 5. Detector = peak.
- 6. Sweep time = **auto couple.**
- 7. Trace mode = max hold.
- 8. Allow trace to fully stabilize.
- 9. Use the **peak marker function** to determine the maximum amplitude level within the RBW.
- 10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

#### 5.3.3. Test Results

| Test Mode | Frequency | RBW   | PKPSD (dBm) | Limit (dBm / 3 kHz) |
|-----------|-----------|-------|-------------|---------------------|
|           | 2 412     | 3 kHz | -16.83      | 8.00                |
| TM 1      | 2 437     | 3 kHz | -17.32      | 8.00                |
|           | 2 462     | 3 kHz | -17.22      | 8.00                |
|           | 2 412     | 3 kHz | -19.78      | 8.00                |
| TM 2      | 2 437     | 3 kHz | -20.20      | 8.00                |
|           | 2 462     | 3 kHz | -20.56      | 8.00                |
|           | 2 412     | 3 kHz | -19.73      | 8.00                |
| TM 3      | 2 437     | 3 kHz | -19.77      | 8.00                |
|           | 2 462     | 3 kHz | -19.95      | 8.00                |



TM 1 & 2412



#### Power Spectral Density

#### TM 1 & 2437



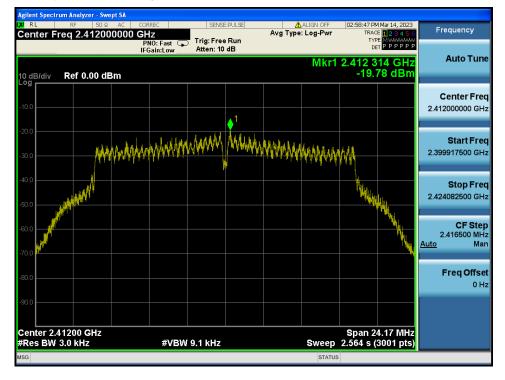


TM 1 & 2462





TM 2 & 2412



# **Power Spectral Density**

#### TM 2 & 2437



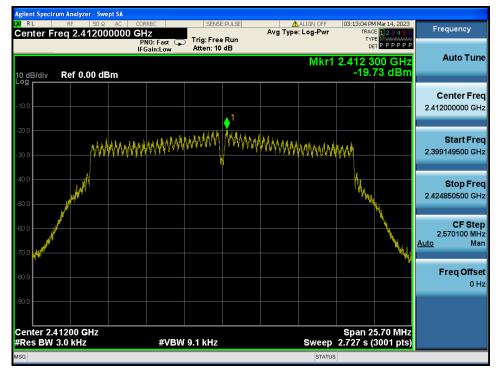


TM 2 & 2462



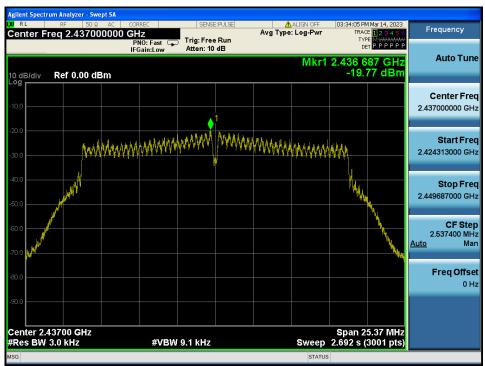


TM 3 & 2412



#### Power Spectral Density

#### TM 3 & 2437





TM 3 & 2462



# 5.4. Unwanted Emissions (Conducted)

#### Test requirements and limit, Part 15.247(d)

In any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions :

If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level. If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured inband average PSD level. In either case, attenuation to levels below the general emission limits specified in §15.209(a) is not required.

## 5.4.1. Test Setup

Refer to the APPENDIX I including path loss

#### 5.4.2. Test Procedures

- KDB558074 D01v05r02 Section 8.5
- ANSI C63.10-2013 Section 11.11

#### **Reference level measurement**

- 1. Set instrument center frequency to DTS channel center frequency.
- 2. Set the span to  $\geq$  1.5 times the DTS bandwidth.
- 3. Set the RBW = 100 kHz.
- 4. Set the VBW  $\geq$  3 x RBW.
- 5. Detector = peak.
- 6. Sweep time = auto couple.
- 7. Trace mode = max hold.
- 8. Allow trace to fully stabilize.
- 9. Use the peak marker function to determine the maximum PSD level LIMIT LINE = 20 dB below of the reference level.

#### Emission level measurement

- 1. Set the center frequency and span to encompass frequency range to be measured.
- 2. Set the RBW = 100 kHz.(Actual 1 MHz , See below note)
- 3. Set the VBW  $\ge$  3 x RBW.(Actual 3 MHz, See below note)
- 4. Detector = peak.
- 5. Ensure that the number of measurement points  $\geq$  span / RBW
- 6. Sweep time = auto couple.
- 7. Trace mode = max hold.
- 8. Allow the trace to stabilize (this may take some time, depending on the extent of the span).
- 9. Use the peak marker function to determine the maximum amplitude level.

| <b>Note.</b> The unwanted emission(conducted) was tested with below settings. |         |         |          |          |             |  |  |  |
|---|---------|---------|----------|----------|-------------|--|--|--|
| Frequency range   | RBW     | VBW     | Detector | Trace    | Sweep Point |  |  |  |
| 9 kHz ~ 30 MHz  | 100 kHz | 300 kHz |          |          |             |  |  |  |
| 30 MHz ~ 10 GHz   | 1 MHz   | 3 MHz   | Peak     | Max Hold | 40 001      |  |  |  |
| 10 GHz ~ 25 GHz   | 1 MHz   | 3 MHz   |          |          |             |  |  |  |

Note: The unwanted emission(conducted) was tested with below settings.

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2 001 to get accurate emission level within 100 kHz BW.

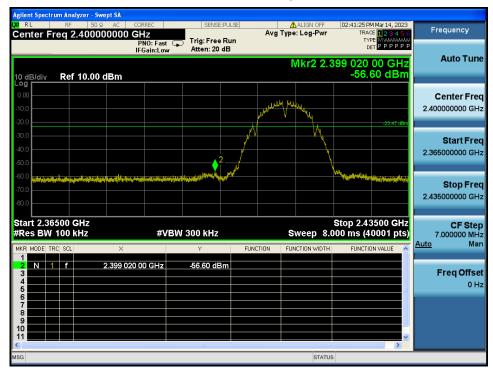
## 5.4.3. Test Results

TM 1 & 2412

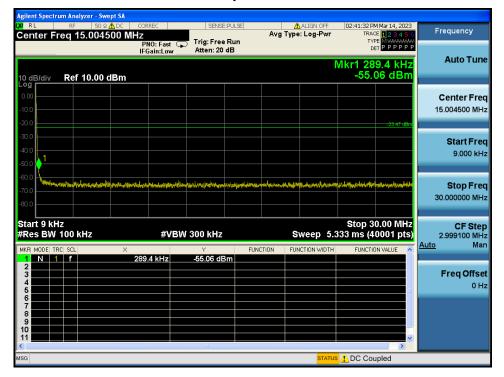


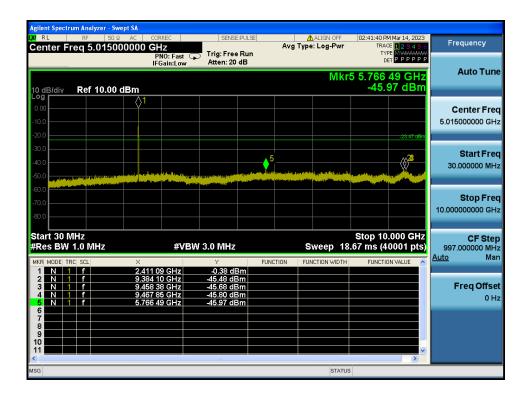
#### Reference

#### Low Band-edge









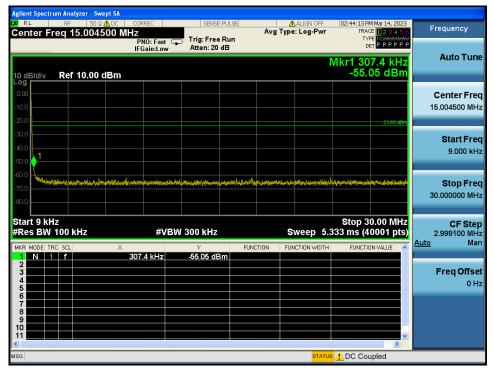




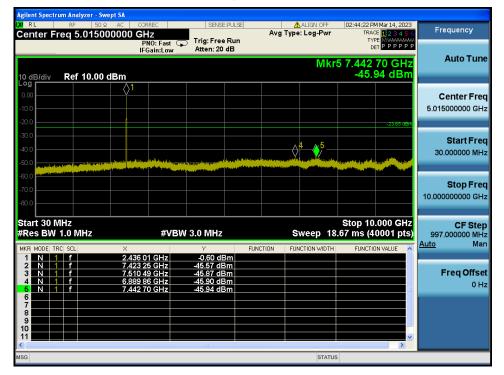
### TM 1 & 2437

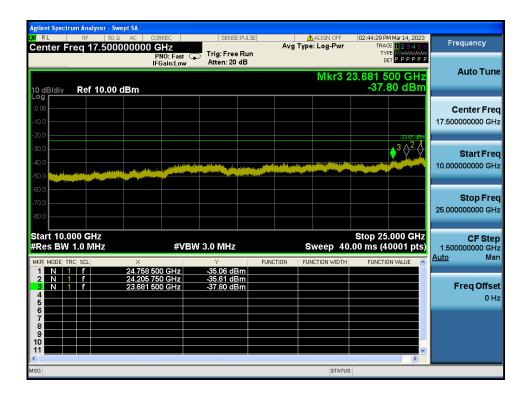
#### Reference









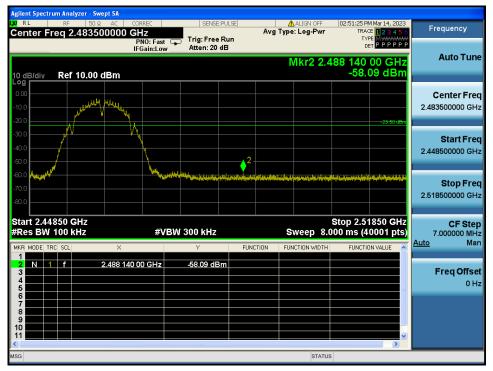


### TM 1 & 2462

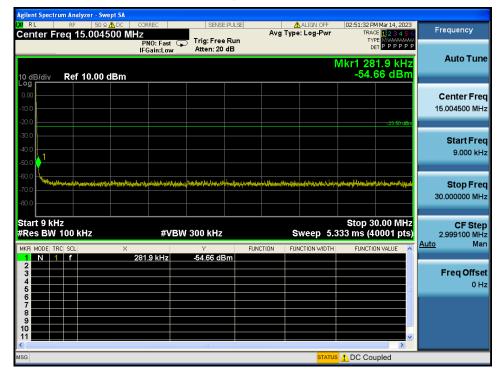
#### Reference

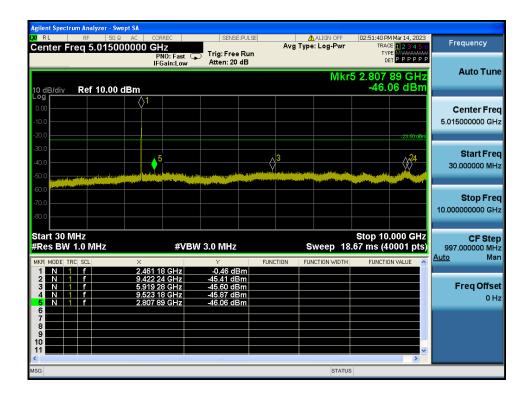


### **High Band-edge**









| Agilent Spectrum Analyzer -          |                                  |                                |                                |   |                              |
|--------------------------------------|----------------------------------|--------------------------------|--------------------------------|---|------------------------------|
| Center Freq 17.50                    | 0 Ω AC CORREC                    | SENSE:PULSE                    | ALIGN OFF<br>Avg Type: Log-Pwr | 02:51:48 PM Mar 14, 2023<br>TRACE 1 2 3 4 5 6 | Frequency                    |
|                                      | PNO: Fast<br>IFGain:Low          | Trig: Free Run<br>Atten: 20 dB |                                |   |                              |
|                                      |                                  |                                | Mkr3                           | 24.363 250 GHz                                | Auto Tune                    |
| 10 dB/div Ref 10.0                   | 0 dBm                            |                                |                                | -36.07 dBm                                    |                              |
| 0.00                                 |                                  |                                |                                |   | Center Freq                  |
| -10.0                                |                                  |                                |                                |   | 17.50000000 GHz              |
| -20.0                                |                                  |                                |                                | -23.50 dBm                                    |                              |
| -30.0                                |                                  |                                |                                |   | Start Freq                   |
| -50.0 <b>Manufacture and a state</b> |                                  |                                |                                |   | 10.00000000 GHz              |
| -60.0                                |                                  |                                |                                |   |                              |
| -70.0                                |                                  |                                |                                |   | Stop Freq<br>25.00000000 GHz |
| -80.0                                |                                  |                                |                                |   | 25.00000000 GH2              |
| Start 10.000 GHz                     |                                  |                                |                                | Stop 25.000 GHz                               | CF Step                      |
| #Res BW 1.0 MHz                      | #VE                              | SW 3.0 MHz                     | Sweep 40                       | 0.00 ms (40001 pts)                           | 1.500000000 GHz<br>Auto Man  |
| MKR MODE TRC SCL                     | ×<br>24.707 125 GHz              | ,<br>-34.98 dBm                | FUNCTION FUNCTION WIDTH        | FUNCTION VALUE                                | Adto Mari                    |
| 2 N 1 f<br>3 N 1 f                   | 24.228 625 GHz<br>24.363 250 GHz | -35.80 dBm<br>-36.07 dBm       |                                |   | Freq Offset                  |
|                                      | 24.303 230 GHz                   |                                |                                |   | 0 Hz                         |
| 6                                    |                                  |                                |                                | =   |                              |
| 8                                    |                                  |                                |                                |   |                              |
| 9                                    |                                  |                                |                                |   |                              |
| 11                                   |                                  | iu -                           |                                | ×   |                              |
| MSG                                  |                                  |                                | STATU                          | IS  |                              |

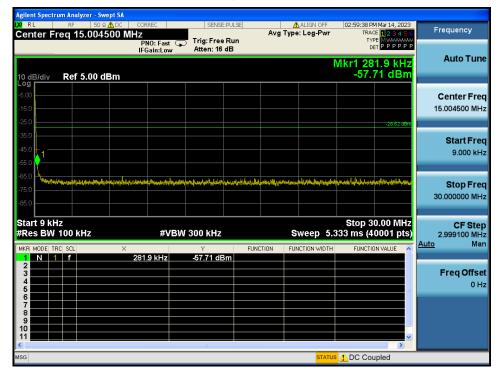
# TM 2 & 2412

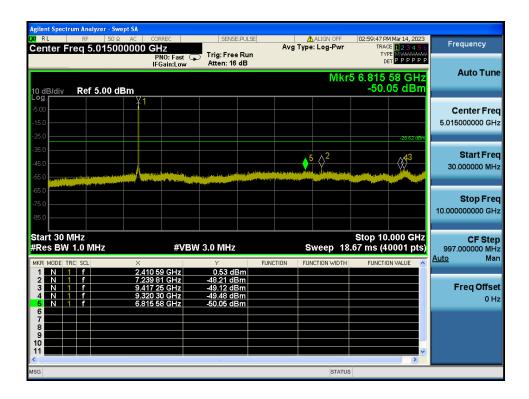
#### Reference



#### Low Band-edge







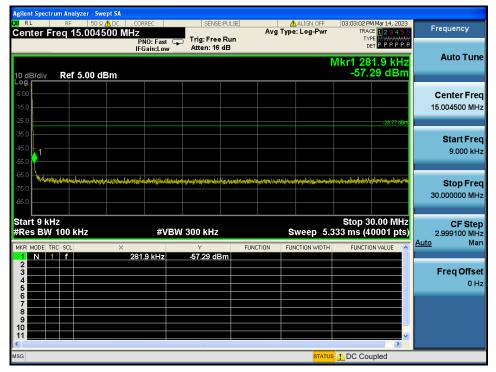




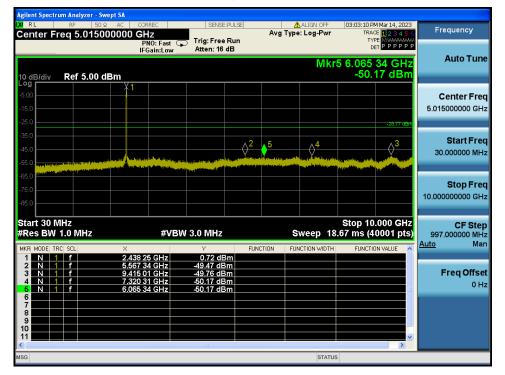
## TM 2 & 2437

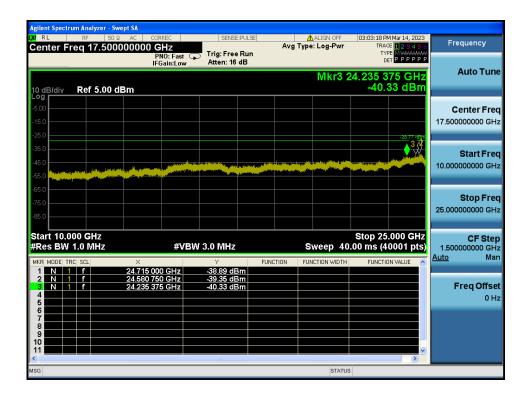
#### Reference











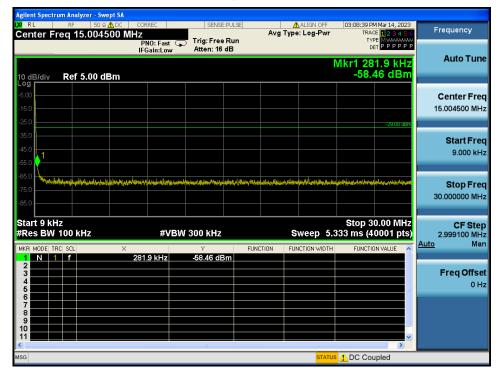
## TM 2 & 2462

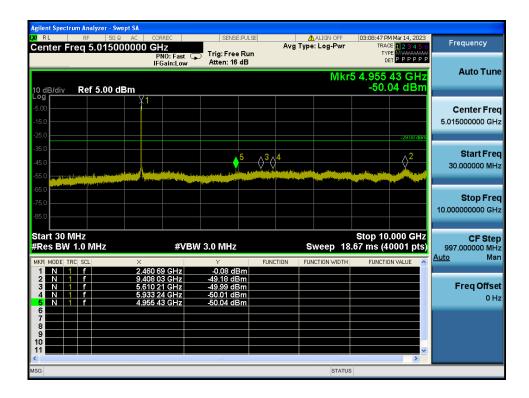
#### Reference



## **High Band-edge**









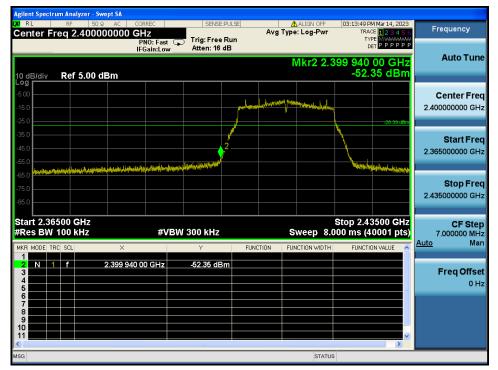


## TM 3 & 2412

#### Reference



## Low Band-edge



| RL                             | RF 5                 |                                    | ORREC                   | SENSE                   |                                 | ALIGN                   | Daar TRA                           | PM Mar 14, 2023<br>ACE <b>1 2 3 4 5 6</b> | Frequency             |
|--------------------------------|----------------------|------------------------------------|-------------------------|-------------------------|---------------------------------|-------------------------|------------------------------------|---|-----------------------|
|                                | req 15.00            | F                                  | PNO: Fast (<br>Gain:Low | Trig: Free<br>Atten: 16 | Run                             |                         | т т                                |   | Auto Tur              |
| 0 dB/div                       | Ref 5.00             | dBm                                |                         |                         |                                 |                         |                                    | 81.9 kHz<br>.24 dBm                       | Auto Tun              |
| og<br>5.00                     |                      |                                    |                         |                         |                                 |                         |                                    |   | Center Fre            |
| 25.0                           |                      |                                    |                         |                         |                                 |                         |                                    | -28.39 dBm                                | 15.004500 MH          |
| 35.0                           |                      |                                    |                         |                         |                                 |                         |                                    |   | Start Fre             |
| 45.0 <b>1</b><br>55.0 <b>1</b> |                      |                                    |                         |                         |                                 |                         |                                    |   | 9.000 kH              |
| 55.0                           | den har def benjaker | n Market Same Bater Maddager Shipe | international figure    | the solution around the | ringle/propertiespeerte/hystole | need, while the Mashine | ite to algebije weet to the second | wayoolafighterstikkiyaater                | Stop Fre              |
| 75.0<br>35.0                   |                      |                                    |                         |                         |                                 |                         |                                    |   | 30.000000 MH          |
| tart 9 kH<br>Res BW            | lz<br>100 kHz        |                                    | <br>#VB                 | W 300 kHz               |                                 | Sweep                   | Stop 3<br>5.333 ms (4              | 30.00 MHz<br>40001 pts)                   | CF Ste<br>2.999100 MH |
| IKR MODE TR                    |                      | ×<br>28'                           | 1.9 kHz                 | ∨<br>-59.24 d⊟          | FUNCTIO                         | I FUNCTION W            | /IDTH FUNCT                        | ION VALUE                                 | <u>Auto</u> Ma        |
| 2 3 4                          |                      |                                    |                         |                         |                                 |                         |                                    |   | Freq Offs             |
| 5                              |                      |                                    |                         |                         |                                 |                         |                                    | 3   | 0 H                   |
| 7<br>8<br>9                    |                      |                                    |                         |                         |                                 |                         |                                    |   |                       |
| 0                              |                      |                                    |                         |                         |                                 |                         |                                    | ~   |                       |
|                                |                      |                                    |                         |                         |                                 |                         |                                    | >   |                       |

| RL RF 50 :  |  | SENSE:PULSE  | ALIGN OFF               | 03:14:04 PM Mar 14, 2023                | Frequency                          |
|---|--|--|-------------------------|---|------------------------------------|
| enter Freq 5.0150                                   | IOOOOO GHZ<br>PNO: Fast ⊂<br>IEGain:Low                                      | Trig: Free Run<br>Atten: 16 dB                                   | Avg Type: Log-Pwr       | TRACE 123456<br>TYPE MWWWW<br>DET PPPPP | Trequency                          |
| 0 dB/div Ref 5.00 d                                 |  |  | Mk                      | r5 7.494 29 GHz<br>-49.89 dBm           | Auto Tun                           |
| <b>5</b> .00<br>15.0                                | ¥1   |  |                         | -28-39 dBm                              | Center Fre<br>5.015000000 GH       |
| 35.0<br>45.0<br>56.0                                |  |  |                         |   | Start Free<br>30.000000 MH         |
| 75.0<br>75.0<br>35.0                                |  |  |                         |   | <b>Stop Fre</b><br>10.000000000 GH |
| tart 30 MHz<br>Res BW 1.0 MHz                       | #VB  | W 3.0 MHz  | Sweep 1                 | Stop 10.000 GHz<br>8.67 ms (40001 pts)  | CF Ste<br>997.000000 MH            |
| IKR MODE TRC SCL                                    | X  |  | FUNCTION FUNCTION WIDTH | H FUNCTION VALUE                        | <u>Auto</u> Ma                     |
| 1 N 1 f<br>2 N 1 f<br>3 N 1 f<br>4 N 1 f<br>5 N 1 f | 2.409 84 GHz<br>9.346 72 GHz<br>5.556 62 GHz<br>6.046 65 GHz<br>7.494 29 GHz | 0.49 dBm<br>-49.60 dBm<br>-49.71 dBm<br>-49.80 dBm<br>-49.89 dBm |                         |   | Freq Offse<br>0 H                  |
| 6 7 8 9 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0         |  |  |                         |   |                                    |
|   |  |  |                         | <b>▼</b>                                |                                    |
| G   |  |  | STAT                    | 19                                      |                                    |

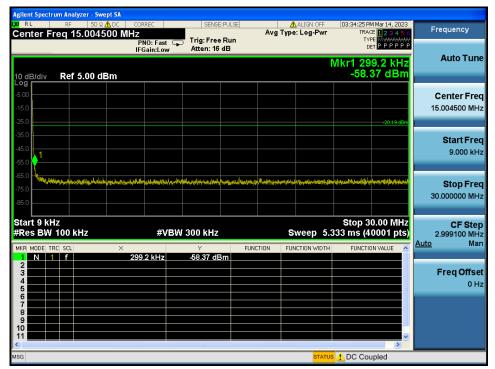




## TM 3 & 2437

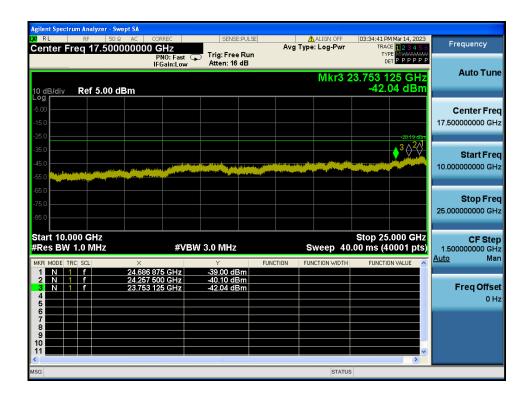
#### Reference







| Agilent Spectrum Analyzer - Sw           |  |  |   |   |                                      |
|--|--|--|---|---|--------------------------------------|
| RL RF 50 G<br>Center Freq 5.0150         |  | SENSE:PULSE  | ALIGN OFF<br>Avg Type: Log-Pwr  | 03:34:34 PM Mar 14, 2023<br>TRACE 1 2 3 4 5 6     | Frequency                            |
|  | PNO: Fast G<br>IFGain:Low                                    | Trig: Free Run<br>Atten: 16 dB                       |   | түре Милинин<br>Det P P P P P P<br>5 6.759 75 GHz | Auto Tune                            |
| 10 dB/div Ref 5.00 d                     | IBm  |  |   | -49.56 dBm  |                                      |
| -5.00                                    |  |  |   |   | Center Freq<br>5.015000000 GHz       |
| -25.0                                    |  |  | 5 <sup>1</sup> ∧4   | -20.19 dDm  | Start Freq<br>30.000000 MHz          |
| -55.0<br>-65.0                           |  |  | ne et la de la consecta que en a plut de la consecta que de la dela de la consecta por<br>La dela de la consecta de la del factor de la consecta de la del de la consecta de la del de la consecta de la<br>La dela dela del de la del de la dela del |   | Stop Freq                            |
| -75.0                                    |  |  |   |   | 10.000000000 GH                      |
| Start 30 MHz<br>#Res BW 1.0 MHz          |  | V 3.0 MHz  |   | Stop 10.000 GHz<br>.67 ms (40001 pts)             | CF Step<br>997.000000 MH<br>Auto Mar |
| MKR MODE TRC SCL                         | ×<br>2.435 01 GHz  | Y FU<br>0.70 dBm                                     | NCTION FUNCTION WIDTH   | FUNCTION VALUE                                    | <u>Hato</u> Indi                     |
| 2 N 1 F<br>3 N 1 F<br>4 N 1 F<br>5 N 1 F | 6.841 01 GHz<br>9.398 06 GHz<br>7.312 84 GHz<br>6.759 75 GHz | -49.19 dBm<br>-49.37 dBm<br>-49.53 dBm<br>-49.56 dBm |   |   | Freq Offse<br>0 Ha                   |
| 6<br>7<br>8<br>9<br>10                   |  |  |   |   |                                      |
| 11                                       |  | Litt   |   | ×   |                                      |
| ISG                                      |  |  | STATUS  | 5   |                                      |



## TM 3 & 2462

#### Reference



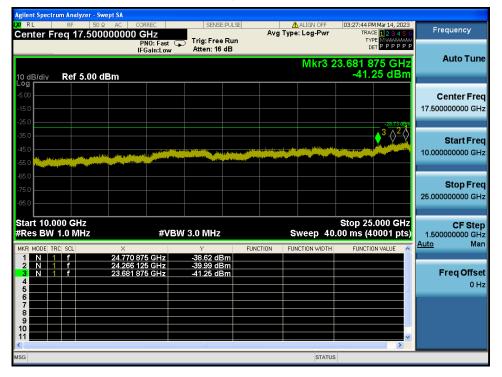
## **High Band-edge**



| Agilent Spectrum Analyzer - Sw<br>XI RL RF 50 G<br>Center Freq 15.004 | 2 <u>A</u> DC CORREC   | SENSE:PULS                             | Avg Typ                             | ALIGN OFF   | 03:27:28 PM Mar 14<br>TRACE 1 2<br>TYPE MW   | 3456 Frequency               |
|---|--|--|-------------------------------------|---|--|------------------------------|
| 10 dB/div Ref 5.00 d  | PNO: Fast 0<br>IFGain:Low _  | Atten: 16 dB                           |                                     |   | vikr1 292.4<br>-58.70 d  | KHZ Auto Tune                |
| -5.00<br>-15.0<br>-25.0   |  |  |                                     |   |  | Center Freq<br>15.004500 MHz |
| -35.0<br>-45.0<br>-55.0   |  |  |                                     |   | -20  | Start Fred<br>9.000 kHz      |
| -65.0<br>-75.0<br>-85.0   | int wind and a starting the starting the second | nally Indiana a si Kadi Maadi Maadi Ma | henderander bereiten ander bei here | uning him de de la constant de la co | ĸţuPrisyto <sup>n</sup> istonil <sup>i</sup> ni <del>teriali</del> ter <del>ijali</del> tet <del>ien</del> i | Stop Free<br>30.000000 MHz   |
| Start 9 kHz<br>#Res BW 100 kHz<br>MKR MODE TRC SCL                    | ×  | W 300 kHz<br>Y                         |                                     | Sweep 5.3   | Stop 30.00<br>333 ms (40001<br>FUNCTION VALU   | pts) 2.999100 MHz            |
| 1 N 1 f<br>2 3 4<br>4 5<br>6 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8    | 292.4 kHz  | -58.70 dBm                             |                                     |   |  | Freq Offset                  |
| 7<br>8<br>9<br>10<br>11   |  |  |                                     |   |  | ×                            |
| MSG   |  | And                                    |                                     | STATUS  | L DC Coupled   |                              |

| RL RF 50 9                               |  | SENSE:PULSE  | 🛕 ALIGN OFF            | 03:27:36 PM Mar 14, 2023                            | Frequency                    |
|--|--|--|------------------------|---|------------------------------|
| enter Freq 5.0150                        | 00000 GHz<br>PNO: Fast<br>IFGain:Low                         | ➡ Trig: Free Run<br>Atten: 16 dB                     | Avg Type: Log-Pwr      | TRACE 1 2 3 4 5 6<br>TYPE MWWWWW<br>DET P P P P P P | Frequency                    |
| 0 dB/div Ref 5.00 c                      |  |  | Mkr                    | 5 6.791 65 GHz<br>-49.36 dBm                        | Auto Tun                     |
| <b>.00</b><br>5.00<br>15.0<br>25.0       | X1   |  |                        | -28.73 dBm  | Center Fre<br>5.015000000 GH |
| 35.0                                     |  |  |                        |   | Start Fre<br>30.000000 MH    |
| 65.0<br>75.0<br>85.0                     |  |  |                        |   | Stop Fre<br>10.000000000 G⊦  |
| Start 30 MHz<br>Res BW 1.0 MHz           | #VB  | W 3.0 MHz  | Sweep 18               | Stop 10.000 GHz<br>.67 ms (40001 pts)               | CF Ste<br>997.000000 M⊦      |
| IN 1 F                                   | ×<br>2.460 94 GHz  | Y FL<br>0.19 dBm                                     | INCTION FUNCTION WIDTH | FUNCTION VALUE                                      | Auto Ma                      |
| 2 N 1 F<br>3 N 1 F<br>4 N 1 F<br>5 N 1 F | 5.546 65 GHz<br>9.411 02 GHz<br>7.439 45 GHz<br>6.791 65 GHz | -48.87 dBm<br>-49.21 dBm<br>-49.25 dBm<br>-49.36 dBm |                        |   | Freq Offs<br>0 ⊦             |
| 6<br>7<br>8<br>9<br>9                    |  |  |                        |   |                              |
|  |  |  |                        | ×   |                              |
|  |  |  | STATUS                 |   |                              |





## 5.5. Unwanted Emissions (Radiated)

## Test Requirements and limit,

## Part 15.247(d), Part 15.205, Part 15.209

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of Part 15.247 the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

| Frequency (MHz) | FCC Limit (uV/m) | Measurement Distance (m) |
|-----------------|------------------|--------------------------|
| 0.009 - 0.490   | 2 400 / F (kHz)  | 300                      |
| 0.490 – 1.705   | 24 000 / F (kHz) | 30                       |
| 1.705 - 30.0    | 30               | 30                       |

#### - Part 15 200. General requirement

| Frequency (MHz) | FCC Limit (uV/m) | Measurement Distance (m) |
|-----------------|------------------|--------------------------|
| 30 ~ 88         | 100 **           | 3                        |
| 88 ~ 216        | 150 **           | 3                        |
| 216 ~ 960       | 200 **           | 3                        |
| Above 960       | 500              | 3                        |

\*\*Except as provided in paragraph (g), fundamental emissions from intentional radiators operating 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, e.g., §§15.231 and 15.241.



## - Part 15.205(a): Restricted band of operation

| MHz                 | MHz                   | MHz                     | MHz               | GHz          | GHz           |
|---------------------|-----------------------|-------------------------|-------------------|--------------|---------------|
| 0.009 ~ 0.110       | 8.414 25 ~ 8.414 75   | 108 ~ 121.94            | 1 300 ~ 1 427     | 4.5 ~ 5.15   | 14.47 ~ 14.5  |
| 0.495 ~ 0.505       | 12.29 ~ 12.293        | 123 ~ 138               | 1 435 ~ 1 626.5   | 5.35 ~ 5.46  | 15.35 ~ 16.2  |
| 2.173 5 ~ 2.190 5   | 12.519 75 ~ 12.520 25 | 149.9 ~ 150.05          | 1 645.5 ~ 1 646.5 | 7.25 ~ 7.75  | 17.7 ~ 21.4   |
| 4.125 ~ 4.128       | 12.576 75 ~ 12.577 25 | 156.524 75 ~ 156.525 25 | 1 660 ~ 1 710     | 8.025 ~ 8.5  | 22.01 ~ 23.12 |
| 4.177 25 ~ 4.177 75 | 13.36 ~ 13.41         | 156.7 ~ 156.9           | 1 718.8 ~ 1 722.2 | 9.0 ~ 9.2    | 23.6 ~ 24.0   |
| 4.207 25 ~ 4.207 75 | 16.42 ~ 16.423        | 162.012 5 ~ 167.17      | 2 200 ~ 2 300     | 9.3 ~ 9.5    | 31.2 ~ 31.8   |
| 6.215 ~ 6.218       | 16.694 75 ~ 16.695 25 | 167.72 ~ 173.2          | 2 310 ~ 2 390     | 10.6 ~ 12.7  | 36.43 ~ 36.5  |
| 6.267 75 ~ 6.268 25 | 16.804 25 ~ 16.804 75 | 240 ~ 285               | 2 483.5 ~ 2 500   | 13.25 ~ 13.4 | Above 38.6    |
| 6.311 75 ~ 6.312 25 | 25.5 ~ 25.67          | 322 ~ 335.4             | 2 655 ~ 2 900     |              |               |
| 8.291 ~ 8.294       | 37.5 ~ 38.25          | 399.90 ~ 410            | 3 260 ~ 3 267     |              |               |
| 8.362 ~ 8.366       | 73 ~ 74.6             | 608 ~ 614               | 3 332 ~ 3 339     |              |               |
| 8.376 25 ~ 8.386 75 | 74.8 ~ 75.2           | 960 ~ 1 240             | 3 345.8 ~ 3 358   |              |               |
|                     |                       |                         | 3 600 ~ 4 400     |              |               |

## 5.5.1. Test Setup

Refer to the APPENDIX I.

## 5.5.2. Test Procedures

- 1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m.
- 2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
- 3. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
- 4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 6. Repeat above procedures until the measurements for all frequencies are complete.

### Note: Measurement Instrument Setting for Radiated Emission Measurements.

- KDB558074 D01v05r02 Section 8.6
- ANSI C63.10-2013 Section 11.12

### 1. Frequency Range Below 1 GHz

RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

#### 2. Frequency Range > 1 GHz

Peak Measurement > 1 GHz

RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes Average Measurement > 1 GHz

- 1. RBW = 1 MHz (unless otherwise specified).
- 2. VBW  $\geq$  3 x RBW.
- 3. Detector = RMS (Number of points ≥ 2 x Span / RBW)
- 4. Averaging type = power (i.e., RMS).
- 5. Sweep time = auto.
- 6. Perform a trace average of at least 100 traces.
- 7. A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
  - 1) If power averaging (RMS) mode was used in step 4, then the applicable correction factor is  $10 \log(1 / D)$ , where D is the duty cycle.
  - 2) If linear voltage averaging mode was used in step 4, then the applicable correction factor is 20 log(1 / D), where D is the duty cycle.
  - 3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

| Test Mode | Date rate | T <sub>on</sub> (ms) T <sub>on+off</sub> (ms) |        | $D=T_{on}/(T_{on+off})$ | DCCF = 10 log(1/D) (dB) |  |  |  |  |  |  |  |  |
|-----------|-----------|---|--------|-------------------------|-------------------------|--|--|--|--|--|--|--|--|
| TM 1      | 1 Mbps    | 12.420  | 12.510 | 0.992 8                 | 0.03                    |  |  |  |  |  |  |  |  |
| TM 2      | 6 Mbps    | 2.063   | 2.166  | 0.952 4                 | 0.21                    |  |  |  |  |  |  |  |  |
| TM 3      | MCS 0     | 1.920   | 2.023  | 0.949 1                 | 0.23                    |  |  |  |  |  |  |  |  |

#### Duty Cycle Correction factor

Note1: Where, T= Transmission duration / D= Duty cycle

Note2: Please refer to the appendix II for duty cycle plots.

## 5.5.3. Test Results

#### **Test Notes** -

1. The radiated emissions were investigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found below listed frequencies.

2. Information of Distance Correction Factor

For finding emissions, measurements may be performed at a distance closer than that specified in the regulations.

In this case, the distance factor is applied to the result.

- Calculation of distance correction factor

At frequencies below 30 MHz = 40 log( tested distance / specified distance )

At frequencies at or above 30 MHz = 20 log( tested distance / specified distance )

When distance factor is "N/A", the measurements were performed at the specified distance and distance factor is not applied.

3. Sample Calculation.

Margin = Limit – Result / Result = Reading + TF+ DCCF + DCF / TF = AF + CL + HL + AL – AG Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain, HL = High pass filter Loss, AL = Attenuator Loss, DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor

| Tested<br>Frequency<br>(MHz) | Frequency<br>(MHz) | ANT<br>Pol | EUT<br>Position<br>(Axis) | Detector<br>Mode | Reading<br>(dBuV) | TF<br>(dB/m) | DCCF<br>(dB) | DCF<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin(dB) |
|------------------------------|--------------------|------------|---------------------------|------------------|-------------------|--------------|--------------|-------------|--------------------|-------------------|------------|
|                              | 2 389.89           | V          | Х                         | PK               | 51.45             | 4.60         | N/A          | N/A         | 56.05              | 74.00             | 17.95      |
|                              | 2 389.86           | V          | Х                         | AV               | 41.26             | 4.60         | N/A          | N/A         | 45.86              | 54.00             | 8.14       |
| 2,412                        | 4 824.99           | V          | Х                         | PK               | 50.02             | 2.34         | N/A          | N/A         | 52.36              | 74.00             | 21.64      |
| 2 412                        | 4 825.49           | V          | Х                         | AV               | 39.48             | 2.34         | N/A          | N/A         | 41.82              | 54.00             | 12.18      |
|                              | 5 000.12           | V          | Х                         | PK               | 52.71             | 2.69         | N/A          | N/A         | 55.40              | 74.00             | 18.60      |
|                              | 5 000.09           | V          | Х                         | AV               | 44.83             | 2.69         | N/A          | N/A         | 47.52              | 54.00             | 6.48       |
|                              | 4 872.55           | V          | Х                         | PK               | 49.92             | 2.18         | N/A          | N/A         | 52.10              | 74.00             | 21.90      |
| 2 437                        | 4 871.98           | V          | Х                         | AV               | 39.44             | 2.18         | N/A          | N/A         | 41.62              | 54.00             | 12.38      |
| 2 437                        | 5 000.16           | V          | Х                         | PK               | 52.77             | 2.69         | N/A          | N/A         | 55.46              | 74.00             | 18.54      |
|                              | 5 000.06           | V          | Х                         | AV               | 44.99             | 2.69         | N/A          | N/A         | 47.68              | 54.00             | 6.32       |
|                              | 2 488.64           | V          | Х                         | PK               | 52.69             | 5.69         | N/A          | N/A         | 58.38              | 74.00             | 15.62      |
|                              | 2 488.29           | V          | Х                         | AV               | 41.61             | 5.69         | N/A          | N/A         | 47.30              | 54.00             | 6.70       |
| 2 462                        | 4 924.82           | V          | Х                         | PK               | 49.35             | 2.57         | N/A          | N/A         | 51.92              | 74.00             | 22.08      |
| 2 402                        | 4 925.35           | V          | Х                         | AV               | 38.99             | 2.57         | N/A          | N/A         | 41.56              | 54.00             | 12.44      |
|                              | 4 999.93           | V          | Х                         | PK               | 52.28             | 2.69         | N/A          | N/A         | 54.97              | 74.00             | 19.03      |
|                              | 4 999.98           | V          | Х                         | AV               | 44.94             | 2.69         | N/A          | N/A         | 47.63              | 54.00             | 6.37       |

## Radiated Emissions data(9 kHz ~ 25 GHz) : TM 1

| Tested<br>Frequency<br>(MHz) | Frequency<br>(MHz) | ANT<br>Pol | EUT<br>Position<br>(Axis) | Detector<br>Mode | Reading<br>(dBuV) | TF<br>(dB/m) | DCCF<br>(dB) | DCF<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin(dB) |
|------------------------------|--------------------|------------|---------------------------|------------------|-------------------|--------------|--------------|-------------|--------------------|-------------------|------------|
|                              | 2 387.70           | V          | Х                         | PK               | 53.17             | 4.61         | N/A          | N/A         | 57.78              | 74.00             | 16.22      |
|                              | 2 388.07           | V          | Х                         | AV               | 42.33             | 4.61         | 0.21         | N/A         | 47.15              | 54.00             | 6.85       |
| 0.440                        | 4 825.27           | V          | Х                         | PK               | 49.36             | 2.34         | N/A          | N/A         | 51.70              | 74.00             | 22.30      |
| Z 41Z                        | 4 825.81           | V          | Х                         | AV               | 39.53             | 2.34         | 0.21         | N/A         | 42.08              | 54.00             | 11.92      |
|                              | 5 000.06           | V          | Х                         | PK               | 52.05             | 2.69         | N/A          | N/A         | 54.74              | 74.00             | 19.26      |
|                              | 5 000.03           | V          | Х                         | AV               | 44.80             | 2.69         | N/A          | N/A         | 47.49              | 54.00             | 6.51       |
|                              | 4 872.93           | V          | Х                         | PK               | 49.33             | 2.18         | N/A          | N/A         | 51.51              | 74.00             | 22.49      |
| 2 412<br>2 437<br>2 462      | 4 872.30           | V          | Х                         | AV               | 39.64             | 2.18         | 0.21         | N/A         | 42.03              | 54.00             | 11.97      |
| 2 437                        | 5 000.02           | V          | Х                         | PK               | 52.32             | 2.69         | N/A          | N/A         | 55.01              | 74.00             | 18.99      |
|                              | 5 000.07           | V          | Х                         | AV               | 44.80             | 2.69         | N/A          | N/A         | 47.49              | 54.00             | 6.51       |
|                              | 2 486.75           | V          | Х                         | PK               | 53.02             | 5.66         | N/A          | N/A         | 58.68              | 74.00             | 15.32      |
|                              | 2 485.85           | V          | Х                         | AV               | 42.04             | 5.65         | 0.21         | N/A         | 47.90              | 54.00             | 6.10       |
| 0.460                        | 4 925.40           | V          | Х                         | PK               | 49.44             | 2.57         | N/A          | N/A         | 52.01              | 74.00             | 21.99      |
| Z 40Z                        | 4 925.18           | V          | Х                         | AV               | 39.21             | 2.57         | 0.21         | N/A         | 41.99              | 54.00             | 12.01      |
|                              | 4 999.90           | V          | Х                         | PK               | 52.02             | 2.69         | N/A          | N/A         | 54.71              | 74.00             | 19.29      |
|                              | 4 999.99           | V          | Х                         | AV               | 44.79             | 2.69         | N/A          | N/A         | 47.48              | 54.00             | 6.52       |

# Radiated Emissions data(9 kHz ~ 25 GHz) : TM 2

## Radiated Emissions data(9 kHz ~ 25 GHz) : TM 3

| Tested<br>Frequency<br>(MHz) | Frequency<br>(MHz) | ANT<br>Pol | EUT<br>Position<br>(Axis) | Detector<br>Mode | Reading<br>(dBuV) | TF<br>(dB/m) | DCCF<br>(dB) | DCF<br>(dB) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin(dB) |
|------------------------------|--------------------|------------|---------------------------|------------------|-------------------|--------------|--------------|-------------|--------------------|-------------------|------------|
|                              | 2 388.08           | V          | Х                         | PK               | 50.62             | 4.61         | N/A          | N/A         | 55.23              | 74.00             | 18.77      |
|                              | 2 388.03           | V          | Х                         | AV               | 41.16             | 4.61         | 0.23         | N/A         | 46.00              | 54.00             | 8.00       |
| 2 412                        | 4 824.03           | V          | Х                         | PK               | 50.26             | 2.34         | N/A          | N/A         | 52.60              | 74.00             | 21.40      |
| 2412                         | 4 824.48           | V          | Х                         | AV               | 39.53             | 2.34         | 0.23         | N/A         | 42.10              | 54.00             | 11.90      |
|                              | 5 000.23           | V          | Х                         | PK               | 52.00             | 2.69         | N/A          | N/A         | 54.69              | 74.00             | 19.31      |
|                              | 5 000.09           | V          | Х                         | AV               | 44.62             | 2.69         | N/A          | N/A         | 47.31              | 54.00             | 6.69       |
|                              | 4 871.75           | V          | Х                         | PK               | 49.87             | 2.18         | N/A          | N/A         | 52.05              | 74.00             | 21.95      |
| 0.407                        | 4 872.06           | V          | Х                         | AV               | 39.61             | 2.18         | 0.23         | N/A         | 42.02              | 54.00             | 11.98      |
| 2 437                        | 5 000.09           | V          | Х                         | PK               | 52.22             | 2.69         | N/A          | N/A         | 54.91              | 74.00             | 19.09      |
|                              | 5 000.18           | V          | Х                         | AV               | 44.80             | 2.69         | N/A          | N/A         | 47.49              | 54.00             | 6.51       |
|                              | 2 485.96           | V          | Х                         | PK               | 51.48             | 5.65         | N/A          | N/A         | 57.13              | 74.00             | 16.87      |
|                              | 2 485.49           | V          | Х                         | AV               | 40.04             | 5.64         | 0.23         | N/A         | 45.91              | 54.00             | 8.09       |
| 2.462                        | 4 924.48           | V          | Х                         | PK               | 49.57             | 2.57         | N/A          | N/A         | 52.14              | 74.00             | 21.86      |
| 2 462                        | 4 924.74           | V          | Х                         | AV               | 38.96             | 2.57         | 0.23         | N/A         | 41.76              | 54.00             | 12.24      |
|                              | 5 000.09           | V          | Х                         | PK               | 51.90             | 2.69         | N/A          | N/A         | 54.59              | 74.00             | 19.41      |
|                              | 5 000.13           | V          | Х                         | AV               | 44.71             | 2.69         | N/A          | N/A         | 47.40              | 54.00             | 6.60       |



## 5.6. AC Power-Line Conducted Emissions

## Test Requirements and limit, Part 15.207

An 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 frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

| Frequency Range (MHz) | Conducted Limit (dBuV) |            |  |
|-----------------------|------------------------|------------|--|
|                       | Quasi-Peak             | Average    |  |
| 0.15 ~ 0.5            | 66 to 56 *             | 56 to 46 * |  |
| 0.5 ~ 5.0             | 56                     | 46         |  |
| 5 ~ 30                | 60                     | 50         |  |

\* Decreases with the logarithm of the frequency

## 5.6.1. Test Setup

## NA

## 5.6.2. Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10-2013.

- The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
- 2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
- 3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
- 4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

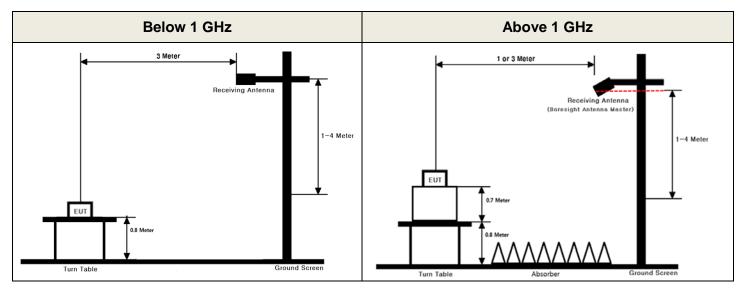
### 5.6.3. Test Results

NA

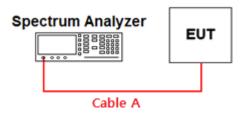
## **APPENDIX I**

## Test set up diagrams

## Radiated Measurement



## Conducted Measurement





## **APPENDIX II**

## **Duty cycle plots**

## Test Procedures

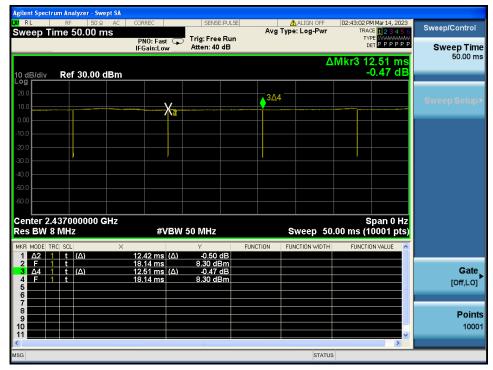
## - KDB558074 D01v05r02 - Section 6

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW  $\geq$  OBW if possible; otherwise, set RBW to the largest available value. Set VBW  $\geq$  RBW. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are > 50 /T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T  $\leq$  16.7 microseconds.)

## **Duty Cycle**

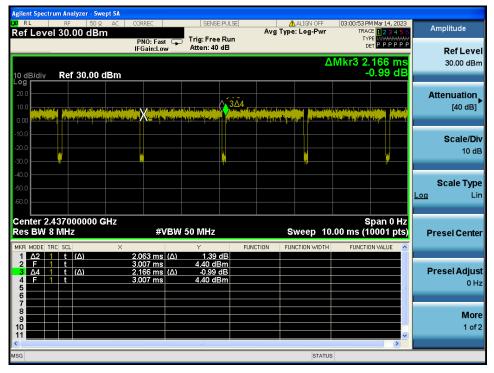
TM 1 & 2 437 MHz



## **Duty Cycle**

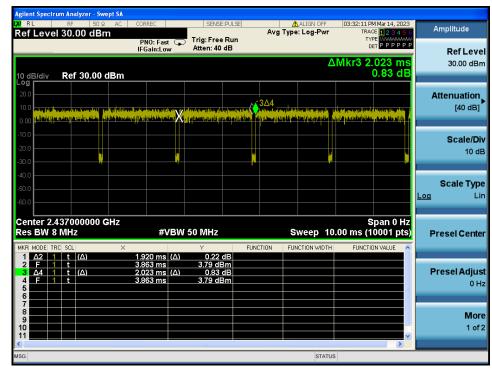
🛈 Dt&C

TM 2 & 2 437 MHz



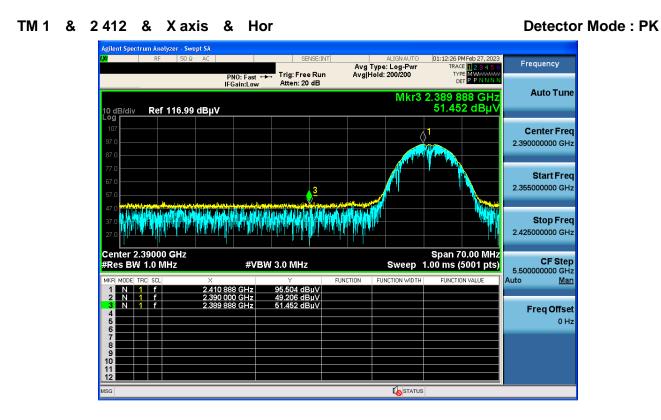
## TM 3 & 2 437 MHz

# Duty Cycle



## **APPENDIX III**

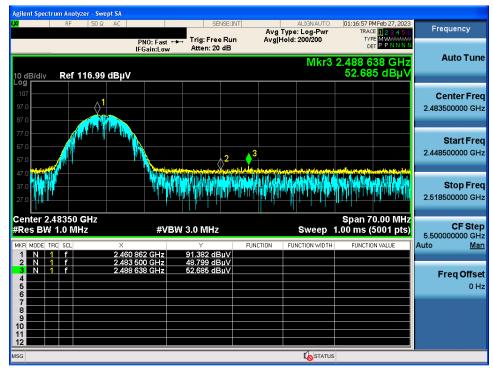
## **Unwanted Emissions (Radiated) Test Plot**



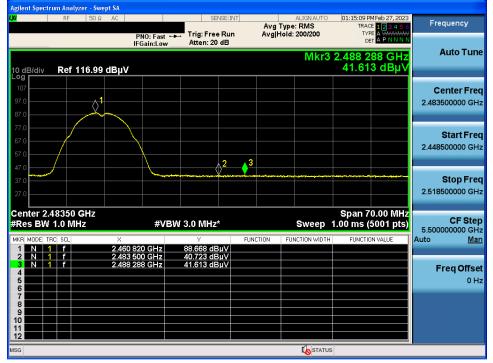
## TM 1 & 2412 & Xaxis & Hor

| Agilent Spectrum Analyzer - Swept SA  |                                |                                |                           |   |                                      |  |  |
|---|--------------------------------|--------------------------------|---------------------------|---|--------------------------------------|--|--|
| <b>LXI</b> RF 50 Ω  | AC                             | SENSE:INT                      | ALIGN AUTO                | 11:18:08 AM Feb 27, 2023<br>TRACE 1 2 3 4 5 6 | Frequency                            |  |  |
|   | PNO: Fast<br>IFGain:Low        | Trig: Free Run<br>Atten: 20 dB | Avg Hoid: 200/200<br>Mkr3 | 2.389 860 GHz                                 | Auto Tune                            |  |  |
| 10 dB/div Ref 116.99  | dBµV                           |                                |                           | 41.259 dBµ∨                                   |                                      |  |  |
| 97.0  |                                |                                |                           | 1   | Center Freq<br>2.390000000 GHz       |  |  |
| 77.0           67.0           57.0  |                                |                                |                           |   | <b>Start Freq</b><br>2.355000000 GHz |  |  |
| 47.0<br>37.0<br>27.0  |                                | 3                              |                           |   | <b>Stop Freq</b><br>2.425000000 GHz  |  |  |
| Center 2.39000 GHz Span 70.00 MHz<br>#Res BW 1.0 MHz #VBW 3.0 MHz* Sweep 1.00 ms (5001 pts) |                                |                                |                           |   | CF Step<br>5.50000000 GHz            |  |  |
| MKR MODE TRC SCL  | ×<br>2.410 986 GHz             | Y<br>92.266 dBµV               | FUNCTION FUNCTION WIDTH   | FUNCTION VALUE                                | Auto <u>Man</u>                      |  |  |
| 2 N 1 f<br>3 N 1 f<br>4   | 2.390 000 GHz<br>2.389 860 GHz | 40.618 dBµV<br>41.259 dBµV     |                           |   | <b>Freq Offset</b><br>0 Hz           |  |  |
| 7<br>8<br>9<br>10   |                                |                                |                           |   |                                      |  |  |
| 11<br>12<br>MSG   |                                |                                | STATUS                    |   |                                      |  |  |

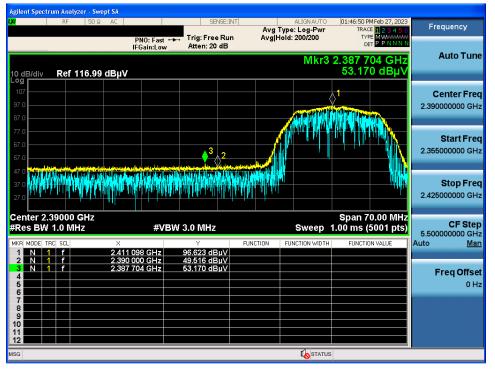
## TM 1 & 2462 & Xaxis & Hor



#### TM 1 & 2462 & X axis & Hor



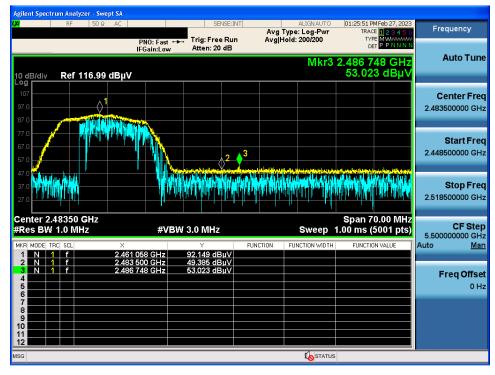
## TM 2 & 2412 & Xaxis & Hor



## TM 2 & 2412 & X axis & Hor



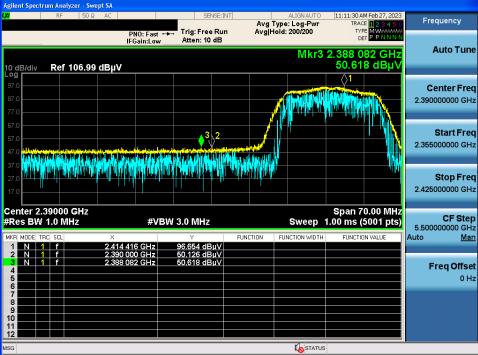
## TM 2 & 2462 & X axis & Hor



#### TM 2 & 2462 & X axis & Hor



## TM 3 & 2412 & Xaxis & Hor



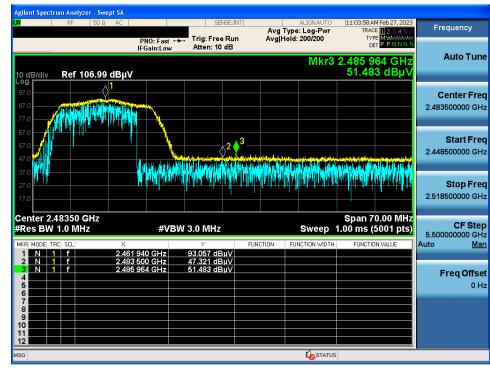
#### TM 3 & 2412 & X axis & Hor

## **Detector Mode : AV**

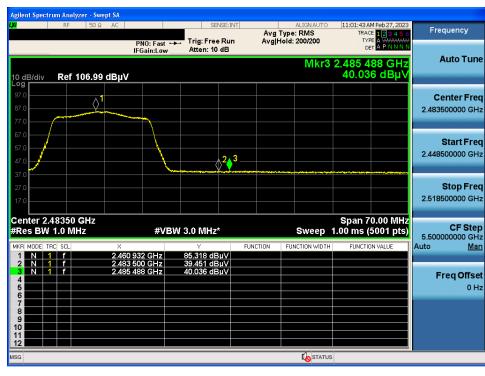
#### lvzer - Swent SA SENSE:INT 11:10:12 A Frequency Avg Type: RMS Avg|Hold: 200/200 TRACE 12345 TYPE A WARMAN DET A P N N N PNO: Fast +++ Trig: Free Run IFGain:Low Atten: 10 dB Auto Tune Mkr3 2.388 026 GHz 41.160 dBµ\ 10. 0g Ref 106.99 dBµV dB/div ¢1 **Center Freq** 2.39000000 GHz Start Freq 2.355000000 GHz <mark>}3</mark><u>}2</u> Stop Freq 2.425000000 GHz Center 2.39000 GHz #Res BW 1.0 MHz Span 70.00 MHz 1.00 ms (5001 pts) **CF Step** 5.500000000 GHz uto <u>Man</u> #VBW 3.0 MHz\* Sweep FUNCTION luto 00 GHz 026 GHz 40.348 dBµ\ 41.160 dBµ\ Freq Offset 0 Hz 11 12 **I**STATUS

## TM 3 & 2 462 & X axis & Hor

## **Detector Mode : PK**



### TM 3 & 2462 & Xaxis & Hor

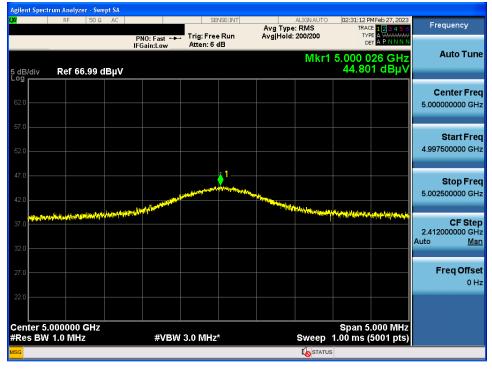


## TM 1 & 2 437 & X axis & Ver



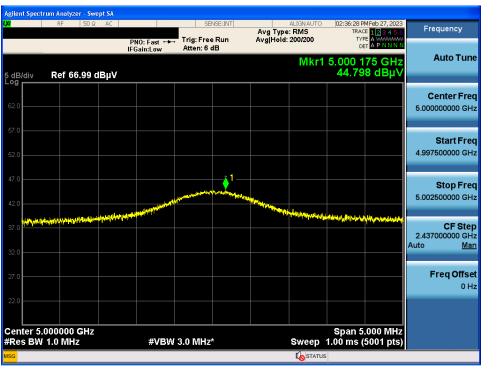


## TM 2 & 2412 & Xaxis & Ver



**Detector Mode : AV** 

## TM 3 & 2 437 & X axis & Ver



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