# TEST REPORT


Dt&C

**DT&C Co., Ltd.**

42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea,17042
Tel : 031-321-2664, Fax : 031-321-1664


1. Report No : DRTFCC1611-0153
2. Customer
   - Name : PNF CO.,LTD
   - Address : (Sangdaewon-dong, Dayou-A-tech), 509, Dunchon-daero, Jungwon-gu, Seongnam-si, Gyeonggi-do South Korea 462-807
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : eBeam Smartmarker / IPBT-400
   FCC ID : ZGB-IPBT-400
6. Test Method Used : FCC Part 15 Subpart C.247
7. Date of Test : 2016-11-01 ~ 2016-11-21
8. Testing Environment : See appended test report.
9. Test Result : Refer to the attached Test Result.

| | | |
|---|---|---|
| Affirmation | Tested by<br>Name : JungWoo Kim (Signature) | Technical Manager<br>Name : WonJung Lee (Signature) |



**2016 . 11 . 24 .**

**DT&C Co., Ltd.**

# Test Report Version

| Test Report No. | Date | Description |
|---|---|---|
| DRTFCC1611-0153 | Nov. 24, 2016 | Initial issue |
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# Table of Contents

# 1. General Information

## 1.1 Testing Laboratory

| **DT&C Co., Ltd.** | | | |
|---|---|---|---|
| **Standard** | | **Site number** | **Address** |
| **FCC** | ☒ | **165783** | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
| | ☐ | **804488** | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
| | ☐ | **596748** | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
| | ☐ | **678747** | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080 |
| **IC** | ☐ | **5740A-3** | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
| | ☐ | **5740A-2** | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080 |
| www.dtnc.net | | | |
| Telephone | : | + 82-31-321-2664 | |
| FAX | : | + 82-31-321-1664 | |

## 1.2 Details of Applicant

| | | |
|---|---|---|
| Applicant | : | PNF CO.,LTD |
| Address | : | (Sangdaewon-dong, Dayou-A-tech), 509, Dunchon-daero, Jungwon-gu, Seongnam-si, Gyeonggi-do South Korea 462-807 |
| Contact person | : | Jin-gu KIM |

## 1.3 Description of EUT

| | |
|---|---|
| **EUT** | eBeam Smartmarker |
| **Model Name** | IPBT-400 |
| **Add Model Name** | N/A |
| **Serial Number** | Identical prototype |
| **Power Supply** | DC 3.7 V |
| **Frequency Range** | 2402 MHz ~ 2480 MHz |
| **Max. RF Output Power** | -9.01dBm |
| **Modulation Technique** | GFSK |
| **Antenna Specification** | Antenna Type: Chip Antenna<br>Gain: -0.3 dBi(PK) |

## 1.4 Declaration by the applicant / manufacturer

N/A

## 1.5 Test Conditions

| **Ambient Condition** | |
|---|---|
| ▪ Temperature | +22 ~ +23 ℃ |
| ▪ Relative Humidity | 42 % ~ 44 % |

## 1.6 Measurement Uncertainty

| Test items | Measurement uncertainty |
|---|---|
| Transmitter Output Power | 0.92 dB (The confidence level is about 95 %, k = 2) |
| Conducted spurious emission | 0.97 dB (The confidence level is about 95 %, k = 2) |
| AC conducted emission | 2.4 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission<br>(1 GHz Below) | 5.1 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission<br>(1 GHz ~ 18 GHz) | 5.4 dB (The confidence level is about 95 %, k = 2) |
| Radiated spurious emission<br>(18 GHz Above) | 5.3 dB (The confidence level is about 95 %, k = 2) |

## 1.7 Test Equipment List

| Type | Manufacturer | Model | Cal.Date (yy/mm/dd) | Next.Cal.Date (yy/mm/dd) | S/N |
|---|---|---|---|---|---|
| MXA Signal Analyzer | Agilent Technologies | N9020A | 16/08/18 | 17/08/18 | MY46471601 |
| MXA Signal Analyzer | Agilent Technologies | N9020A | 16/10/11 | 17/10/11 | MY46471251 |
| Thermohygrometer | BODYCOM | BJ5478 | 16/04/22 | 17/04/22 | 120612-2 |
| Vector Signal Generator | Rohde Schwarz | SMBV100A | 16/01/05 | 17/01/05 | 255571 |
| Signal Generator | Rohde Schwarz | SMF100A | 16/06/23 | 17/06/23 | 102341 |
| Multimeter | HP | 34401A | 16/02/25 | 17/02/25 | 3146A13475 |
| Loop Antenna | Schwarzbeck | FMZB1513 | 16/04/22 | 18/04/22 | 1513-128 |
| BILOG Antenna | Schwarzbeck | CB6112B | 16/05/23 | 18/05/23 | 2737 |
| Horn Antenna | ETS-LINDGREN | 3117 | 16/05/03 | 18/05/03 | 00140394 |
| Horn Antenna | A.H.Systems Inc. | SAS-574 | 15/04/30 | 17/04/30 | 154 |
| Highpass Filter | Wainwright Instruments | WHKX12-2580-3000-18000-80SS | 16/09/13 | 17/09/13 | 3 |
| Highpass Filter | Wainwright Instruments | WHNX6-6320-8000-26500-40CC | 16/09/09 | 17/09/09 | 1 |
| PreAmplifier | Agilent | 8449B | 16/10/19 | 17/10/19 | 3008A00370 |
| PreAmplifier | TSJ | MLA-010K01-B01-27 | 16/03/10 | 17/03/10 | 1844539 |
| EMI Test Receiver | Rohde Schwarz | ESU | 16/02/25 | 17/02/25 | 100469 |
| EMI Test Receiver | Rohde Schwarz | ESCI | 16/02/25 | 17/02/25 | 100364 |
| Single-Phase Master | NF | 4420 | 16/09/08 | 17/09/08 | 3049354420023 |
| Pulse Limiter | Rohde Schwarz | ESH3-Z2 | 16/01/05 | 17/01/05 | 101334 |
| Artificial Mains Network | Narda S.T.S / PMM | PMM L2-16B | 16/06/22 | 17/06/22 | 000WX20305 |
| Power Meter & Wide Bandwidth Sensor | Anritsu | ML2495A MA2490A | 16/10/19 | 17/10/19 | 1338003 1249304 |

## 1.8 Summary of Test Results

| FCC Part | RSS Std. | Parameter | Limit | Test Condition | Status Note 1 |
|---|---|---|---|---|---|
| 15.247(a) | RSS-247 [5.2] | 6 dB Bandwidth | > 500 kHz | Conducted | C |
| 15.247(b) | RSS-247 [5.4] | Transmitter Output Power | < 1 Watt | | C |
| 15.247(d) | RSS-247 [5.5] | Out of Band Emissions / Band Edge | 20 dBc in any 100 kHz BW | | C |
| 15.247(e) | RSS-247 [5.2] | Transmitter Power Spectral Density | < 8 dBm/3 kHz | | C |
| - | RSS-Gen [6.6] | Occupied Bandwidth (99 %) | RSS-Gen(6.6) | | NA |
| 15.247(d)<br>15.205<br>15.209 | RSS-247 [5.5]<br>RSS-GEN [8.9]<br>RSS-GEN [8.10] | General Field Strength Limits (Restricted Bands and Radiated Emission Limits) | FCC 15.209 limits | Radiated | C Note 2 |
| 15.207 | RSS-Gen [8.8] | AC Line Conducted Emissions | FCC 15.207 limits | AC Line Conducted | C |
| 15.203 | RSS-Gen[8.3] | Antenna Requirements | FCC 15.203 | - | C |

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable

Note 2: This test item was performed in each axis and the worst case data was reported.

# 2. Test Methodology

Generally the tests were performed according to the KDB558074 D01 v03r05. 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 KDB 558074.
So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10.
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 KDB 558074. 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 as stated on section 12.1 of the KDB 558074.
The EUT is placed on a non-conductive table. 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. In order to find out the highest emission, the relative positions of the EUT were rotated through three orthogonal axes.

## 2.4 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. The Bluetooth low energy mode with below low, middle and high channels were tested and reported.

| | Test Mode | Frequency [MHz] | | |
|---|---|---|---|---|
| | | Lowest Frequency | Middle Frequency | Highest Frequency |
| TM 1 | BT LE | 2402 | 2440 | 2480 |
| TM 2 | - | - | - | - |
| TM 3 | - | - | - | - |
| TM 4 | - | - | - | - |

## 2.5 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.

# 3. Test Result

## 3.1 Maximum Peak Conducted Output Power

### ▣ Test Requirements and limit, §15.247(b) & RSS-247 [5.4]

A transmitter antenna terminal of EUT is connected to the input of a spectrum analyzer.

Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.

**The maximum permissible conducted output power is 1 Watt.**

### 3.1.1 Test Setup

Refer to the APPENDIX I.

### 3.1.2 Test Procedures

Maximum Peak Conducted Output Power is measured using Measurement Procedure Option 1 of **KDB558074**

1. Set the RBW ≥ DTS bandwidth. **Actual RBW = 2 MHz**
2. Set VBW ≥ 3 x RBW. **Actual VBW = 6 MHz**
3. Set span **≥ 3 x RBW.**
4. Sweep time = **auto couple**
5. Detector = **peak**
6. Trace mode = **max hold**
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

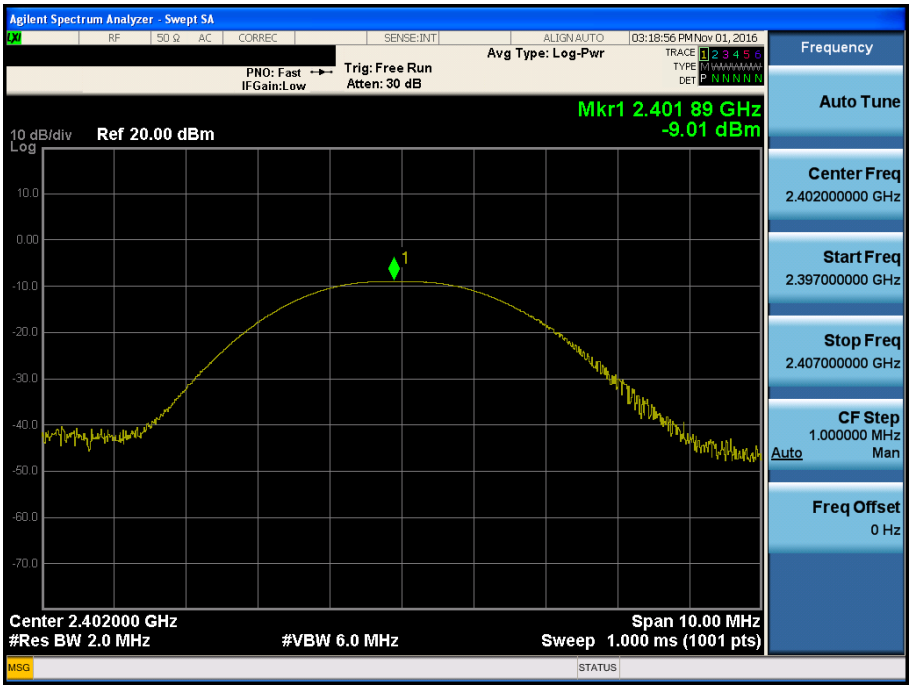
### 3.1.3 Test Results

| Modulation | Tested Channel | Frame Average Output Power | Peak Output Power |
|---|---|---|---|
| | | dBm | dBm |
| TM 1 | Lowest | **-10.86** | **-9.01** |
| | Middle | -13.84 | -11.93 |
| | Highest | -17.40 | -15.61 |

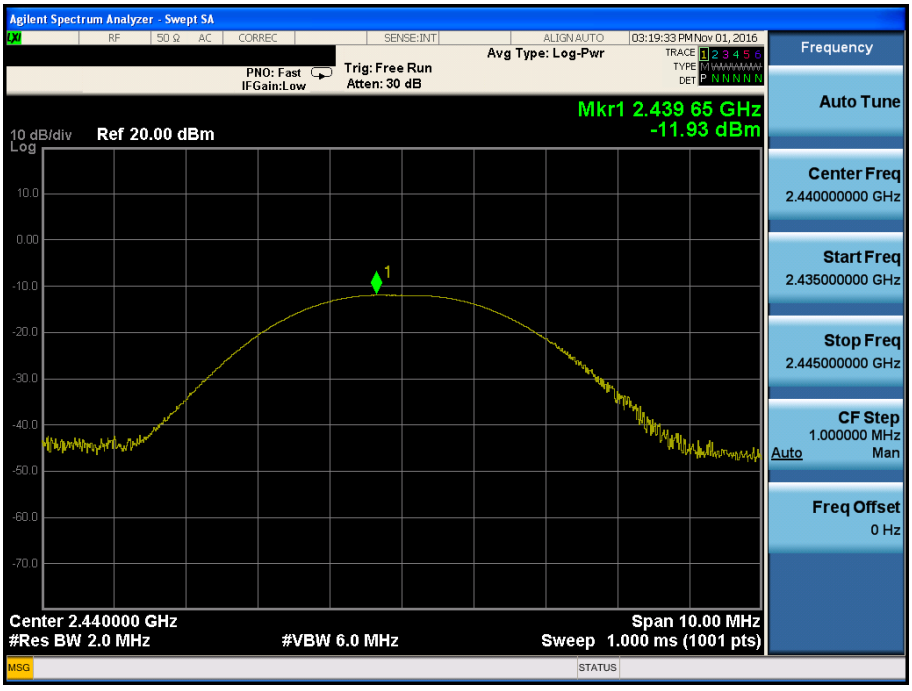
Note 1 : The frame average output power was tested using an average power meter for reference only.

Note 2 : See next pages for actual measured spectrum plots.

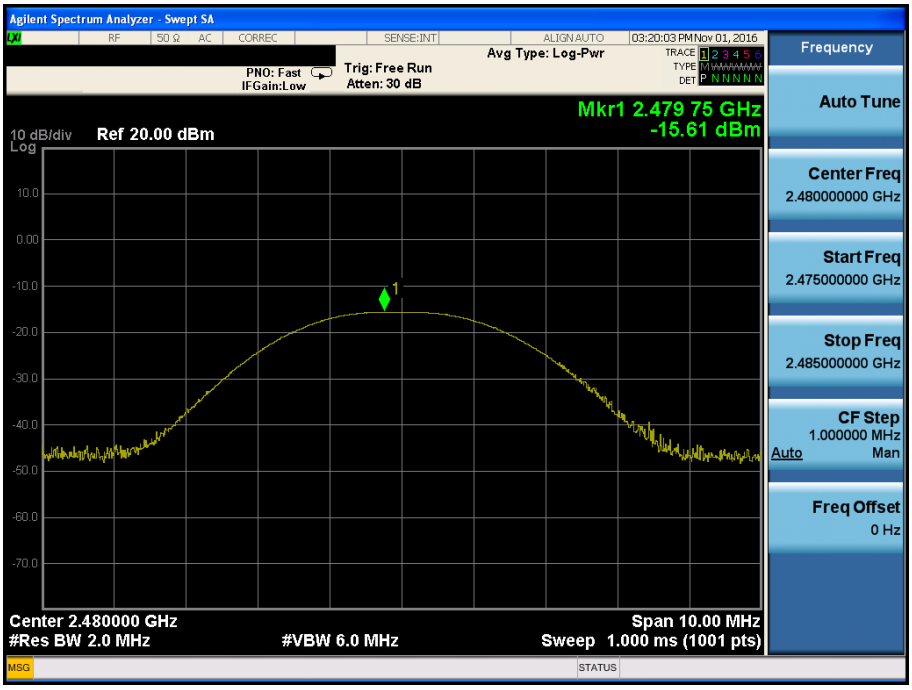
**Peak Output Power** Test Channel : Lowest




**Peak Output Power** Test Channel : Middle



**Peak Output Power** Test Channel : Highest



## 3.2 6 dB Bandwidth Measurement

### ▣ Test Requirements and limit, §15.247(a) & RSS-247 [5.2]

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.**

### 3.2.1 Test Setup

Refer to the APPENDIX I.

### 3.2.2 Test Procedures

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of **KDB558074**

1. Set resolution bandwidth (RBW) = 100 kHz
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
   **(RBW : 100 kHz / VBW : 300 kHz)**
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 ≥ 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 ≥ 6 dB.

### 3.2.3 Test Results

| Test Mode | Tested Channel | Test Results [MHz] |
|---|---|---|
| TM 1 | Lowest | 0.690 |
| | Middle | 0.698 |
| | Highest | 0.696 |

## 6 dB Bandwidth Test Channel : Lowest


## 6 dB Bandwidth Test Channel : Middle

## 6 dB Bandwidth

Test Channel : Highest

## 3.3 Maximum Power Spectral Density.

### ▣ Test requirements and limit, §15.247(e) & RSS-247 [5.2]

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.

**Minimum Standard**

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

### 3.3.1 Test Setup

Refer to the APPENDIX I.

### 3.3.2 Test Procedures

**Method PKPSD of KDB558074** is used.

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 ≤ RBW ≤ 100 kHz**.
4. Set the VBW ≥ **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.

### 3.3.3 Test Results

| Test Mode | Tested Channel | PKPSD [dBm] |
|---|---|---|
| TM 1 | Lowest | -22.60 |
| | Middle | -25.04 |
| | Highest | -28.00 |

**Maximum PKPSD** Test Channel : Lowest


**Maximum PKPSD** Test Channel : Middle

**Maximum PKPSD** Test Channel : Highest

## 3.4 Unwanted Emissions (Conducted)

▣ **Test requirements and limit, §15.247(d) & RSS-247 [5.5]**

**§15.247(d)** specifies that 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.

### 3.4.1 Test Setup

Refer to the APPENDIX I including path loss

### 3.4.2 Test Procedures

The transmitter output is connected to a spectrum analyzer.

**- Measurement Procedure 1 – Reference Level**

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to ≥ 1.5 times the DTS bandwidth.
3. Set the RBW = 100 kHz.
4. Set the VBW ≥ 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.**

**- Measurement Procedure 2 - Unwanted Emissions**

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 ≥ **3 x RBW.(Actual 3 MHz, See below note)**
4. Detector = **peak**.
5. Ensure that the number of measurement points ≥ 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.

**Note :** The conducted spurious emission was tested with below settings.

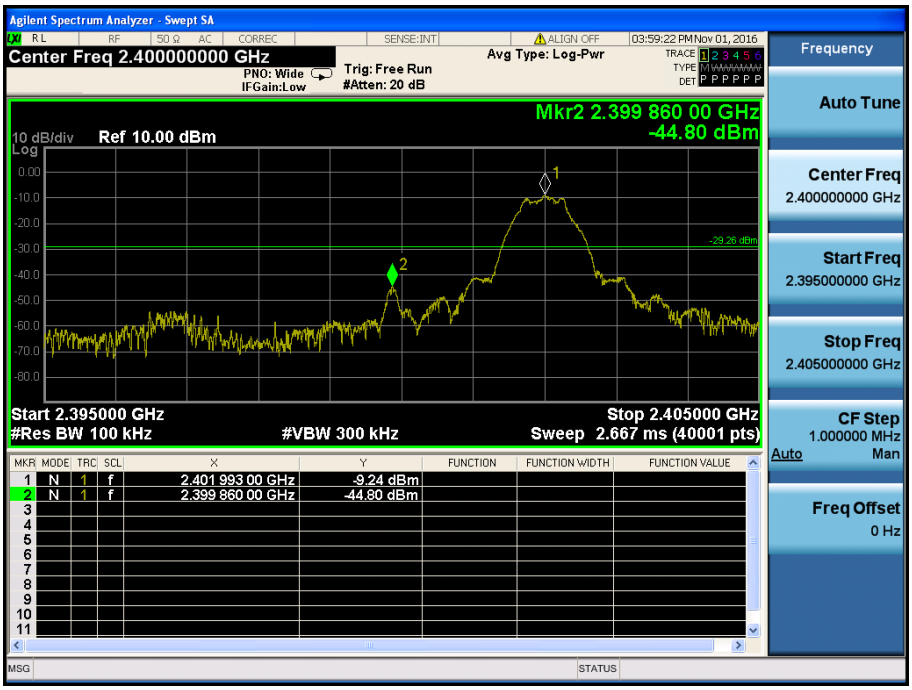
| Frequency range | RBW | VBW | Detector | Trace | Sweep Point |
|---|---|---|---|---|---|
| 9 kHz ~ 30 MHz | 100 kHz | 300 kHz | Peak | Max Hold | 40001 |
| 30 MHz ~ 10 GHz | 1 MHz | 3 MHz | | | |
| 10 GHz ~ 25 GHz | 1 MHz | 3 MHz | | | |

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 = 2001 to get accurate emission level within 100 kHz BW.

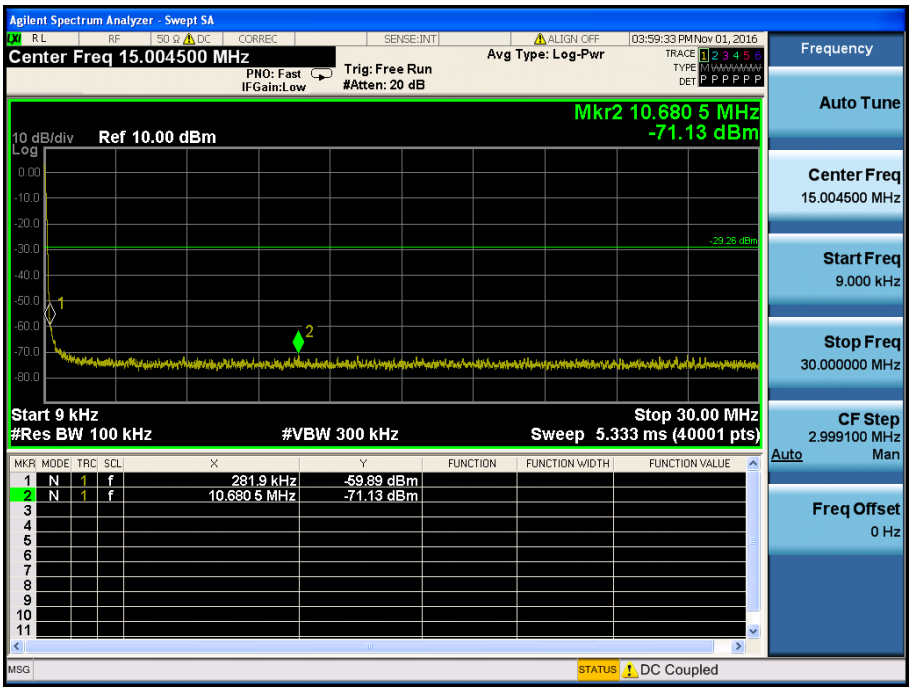
### 3.4.3 Test Results

**Reference** (Test Channel : Lowest)

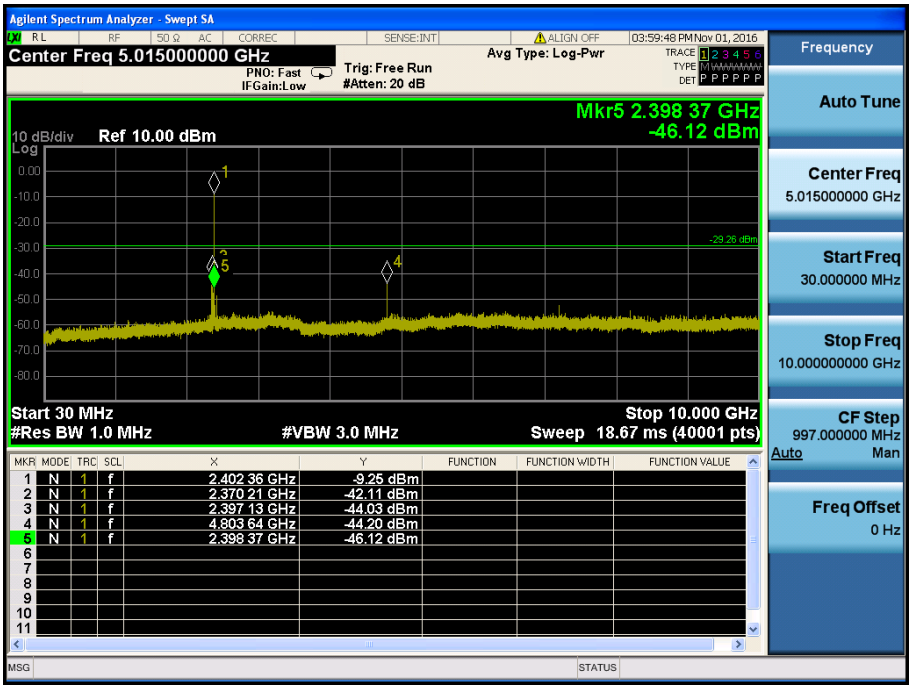

**Low Band-edge** (Test Channel : Lowest)



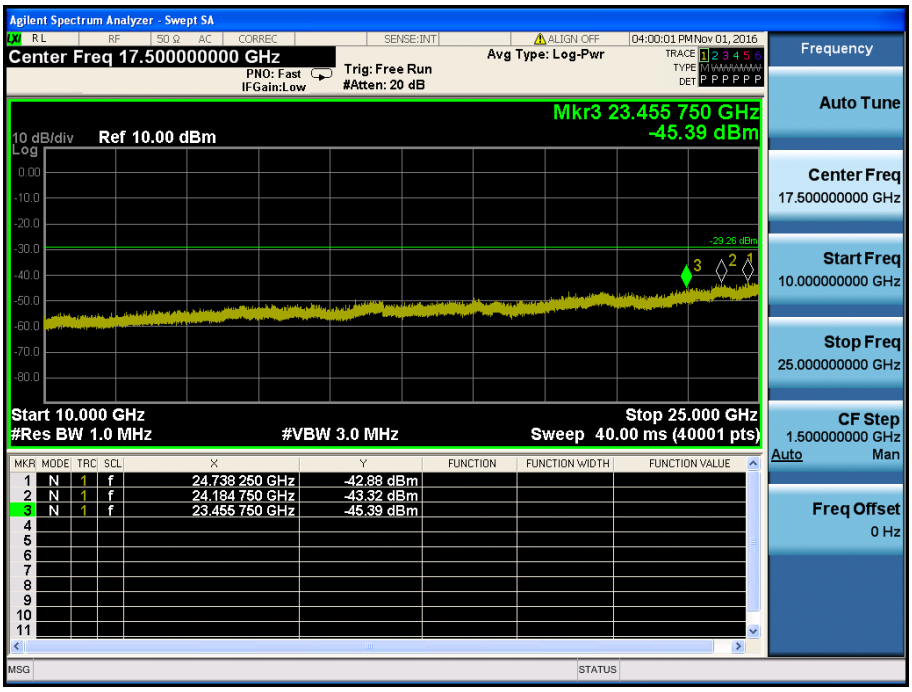
## **Conducted Spurious Emissions 1** (Test Channel : Lowest)




## **Conducted Spurious Emissions 2** (Test Channel : Lowest)

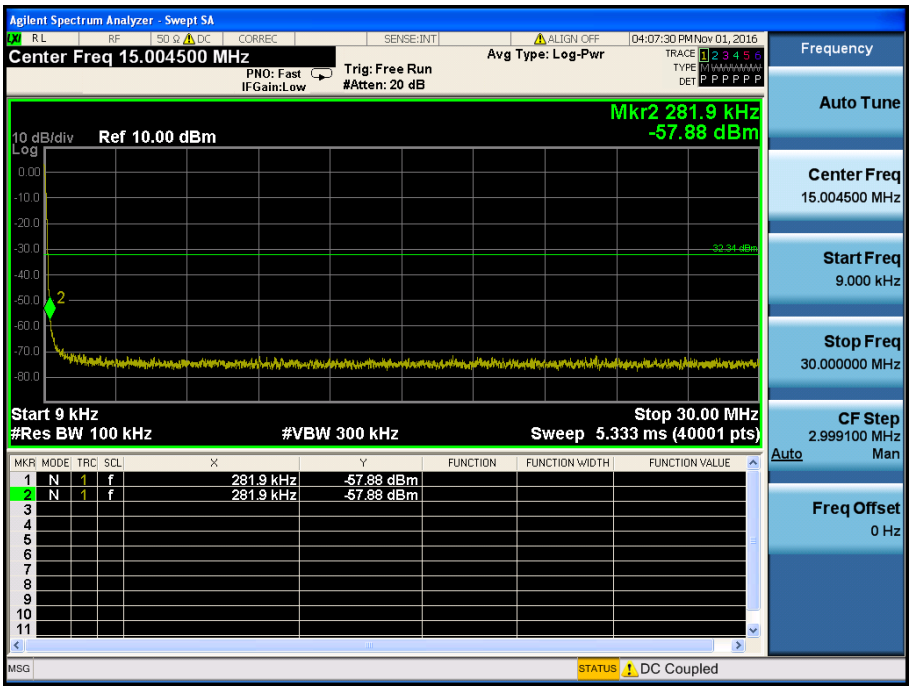


**Conducted Spurious Emissions 3** (Test Channel : Lowest)

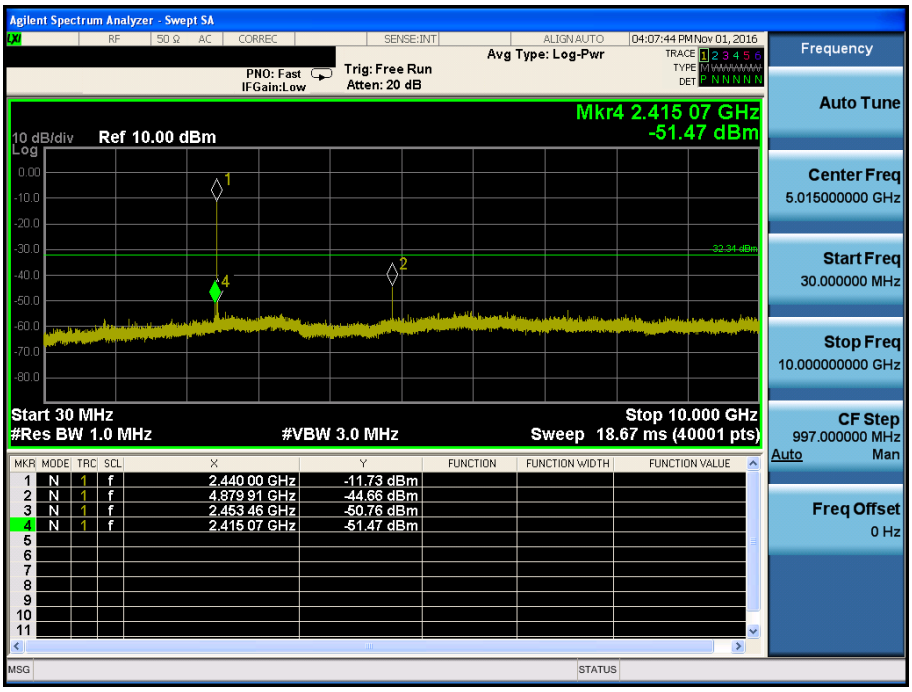


**Reference** (Test Channel : Middle)

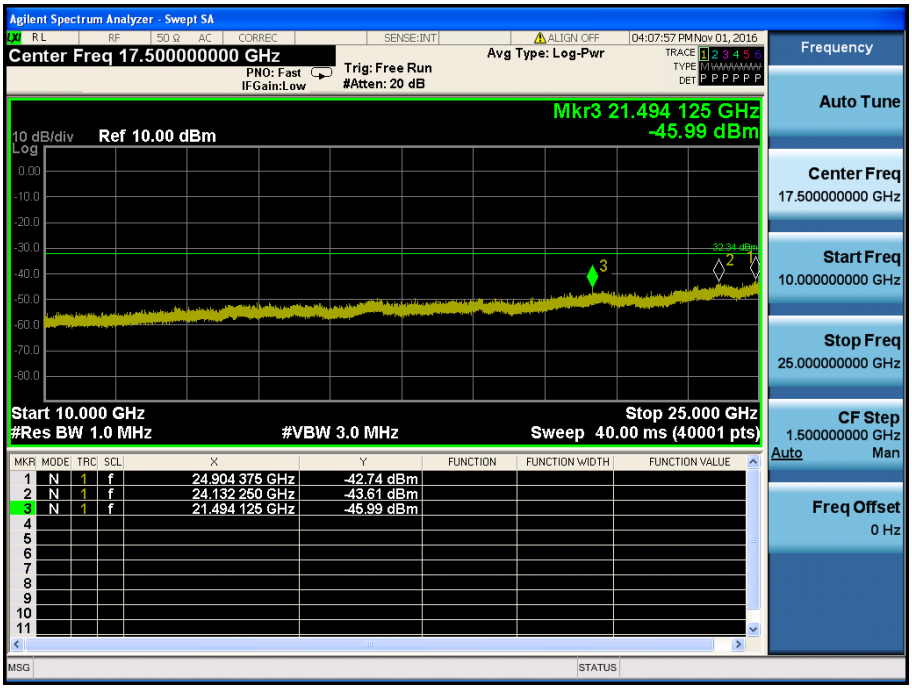

**Conducted Spurious Emissions 1** (Test Channel : Middle)



## **Conducted Spurious Emissions 2** (Test Channel : Middle)

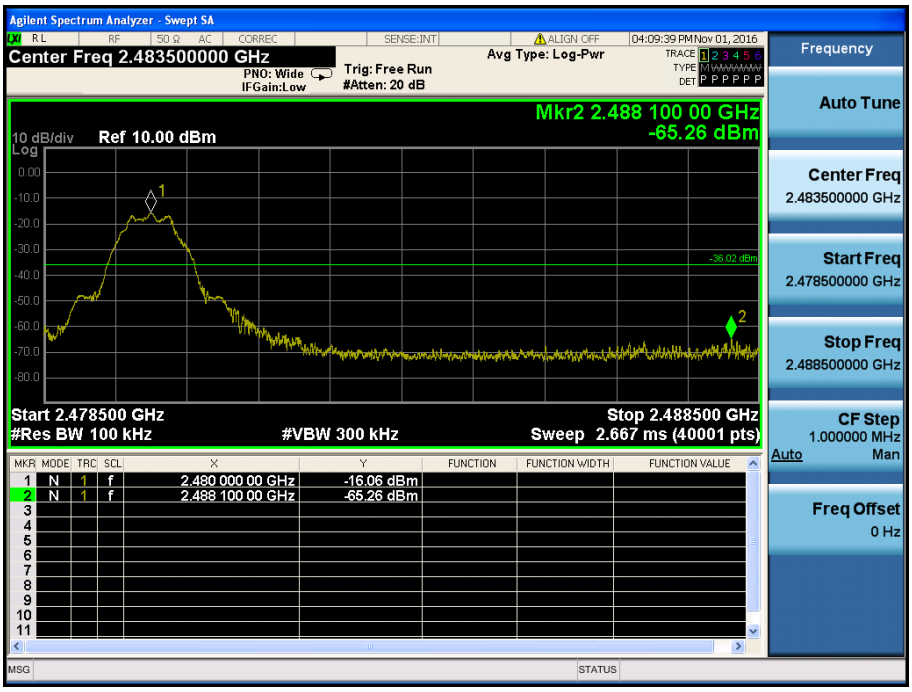



## **Conducted Spurious Emissions 3** (Test Channel : Middle)

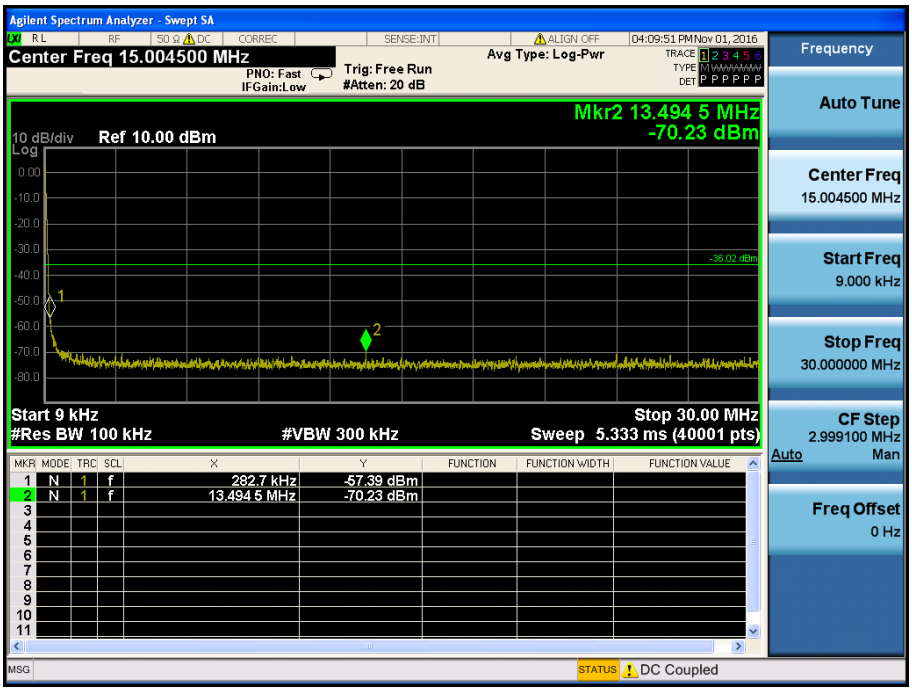


**Reference** (Test Channel : Highest)

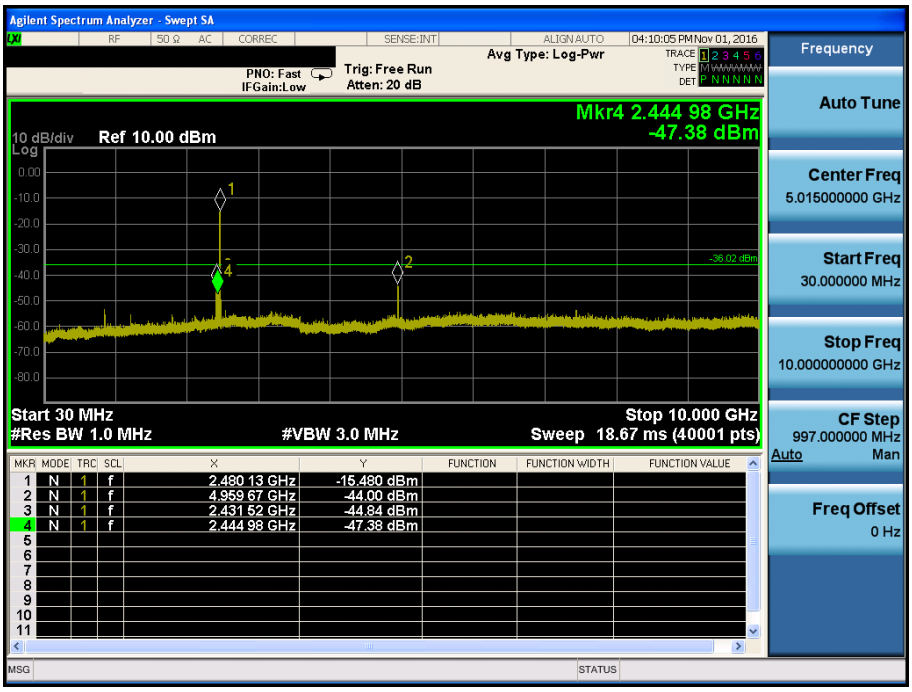

**High Band-edge** (Test Channel : Highest)



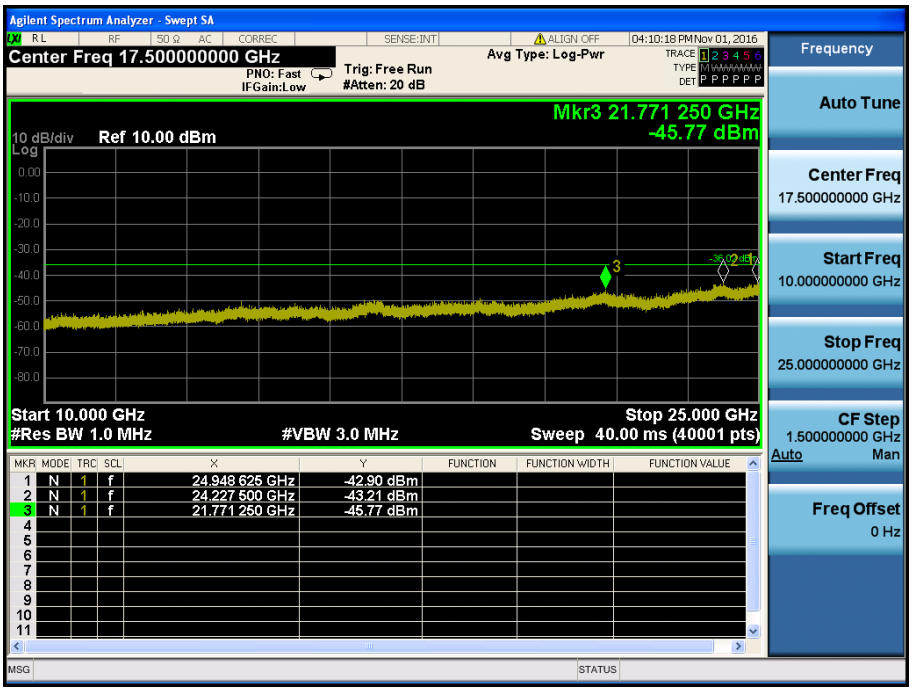
## **Conducted Spurious Emissions 1** (Test Channel : Highest)




## **Conducted Spurious Emissions 2** (Test Channel : Highest)



**Conducted Spurious Emissions 3** (Test Channel : Highest)



## 3.5 Unwanted Emissions (Radiated)

▣ **Test Requirements and limit,**

**§15.247(d), §15.205, §15.209 & RSS-247 [5.5], RSS-Gen [8.9], RSS-Gen [8.10]**

In any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table below has to be followed

▪ **FCC Part 15.209(a) and (b)**

| Frequency (MHz) | Limit (uV/m) | Measurement Distance (meter) |
|---|---|---|
| 0.009 ~ 0.490 | 2400/F (kHz) | 300 |
| 0.490 ~ 1.705 | 24000/F (kHz) | 30 |
| 1.705 ~ 30.0 | 30 | 30 |
| 30 ~ 88 | 100 ** | 3 |
| 88 ~ 216 | 150 ** | 3 |
| 216 ~ 960 | 200 ** | 3 |
| Above 960 | 500 | 3 |

** Except as provided in 15.209(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.

▪ **FCC Part 15.205 (a) :** Only spurious emissions are permitted in any of the frequency bands listed below :

| MHz | MHz | MHz | MHz | GHz | GHz |
|---|---|---|---|---|---|
| 0.009 ~ 0.110 | 8.41425 ~ 8.41475 | 108 ~ 121.94 | 1300 ~ 1427 | 4.5 ~ 5.15 | 14.47 ~ 14.5 |
| 0.495 ~ 0.505 | 12.29 ~ 12.293 | 123 ~ 138 | 1435 ~ 1626.5 | 5.35 ~ 5.46 | 15.35 ~ 16.2 |
| 2.1735 ~ 2.1905 | 12.51975 ~ | 149.9 ~ 150.05 | 1645.5 ~ 1646.5 | 7.25 ~ 7.75 | 17.7 ~ 21.4 |
| 4.125 ~ 4.128 | 12.52025 | 156.52475 ~ | 1660 ~ 1710 | 8.025 ~ 8.5 | 22.01 ~ 23.12 |
| 4.17725 ~ 4.17775 | 12.57675 ~ | 156.52525 | 1718.8 ~ 1722.2 | 9.0 ~ 9.2 | 23.6 ~ 24.0 |
| 4.20725 ~ 4.20775 | 12.57725 | 156.7 ~ 156.9 | 2200 ~ 2300 | 9.3 ~ 9.5 | 31.2 ~ 31.8 |
| 6.215 ~ 6.218 | 13.36 ~ 13.41 | 162.0125 ~ 167.17 | 2310 ~ 2390 | 10.6 ~ 12.7 | 36.43 ~ 36.5 |
| 6.26775 ~ 6.26825 | 16.42 ~ 16.423 | 167.72 ~ 173.2 | 2483.5 ~ 2500 | 13.25 ~ 13.4 | Above 38.6 |
| 6.31175 ~ 6.31225 | 16.69475 ~ | 240 ~ 285 | 2655 ~ 2900 | | |
| 8.291 ~ 8.294 | 16.69525 | 322 ~ 335.4 | 3260 ~ 3267 | | |
| 8.362 ~ 8.366 | 16.80425 ~ | 399.90 ~ 410 | 3332 ~ 3339 | | |
| 8.37625 ~ 8.38675 | 16.80475 | 608 ~ 614 | 3345.8 ~ 3358 | | |
| | 25.5 ~ 25.67 | 960 ~ 1240 | 3600 ~ 4400 | | |
| | 37.5 ~ 38.25 | | | | |
| | 73 ~ 74.6 | | | | |
| | 74.8 ~ 75.2 | | | | |

▪ **FCC Part 15.205(b) :** The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

### 3.5.1 Test Setup

Refer to the APPENDIX I.

### 3.5.2 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.**

**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**> 1GHz**

1. RBW = 1 MHz (unless otherwise specified).
2. VBW ≥ 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/x), where x is the duty cycle.
2) If linear voltage averaging mode was used in step 4, then the applicable correction factor is 20 log(1/x), where x 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 | Duty Cycle (%) | $T_{on}$ (ms) | $T_{on}$+ $T_{off}$ (ms) | DCF = 10 log(1/Duty) (dB) |
|---|---|---|---|---|
| **TM 1** | 66.24 | 0.414 | 0.625 | 1.79 |

Note : Refer to appendix II for duty cycle measurement procedure and plots

### 3.5.3 Test Results

## Frequency Range : 9 kHz ~ 25 GHz

### ▪ Lowest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2335.84 | V | Z | PK | 46.57 | 0.33 | N/A | N/A | 46.90 | 74.00 | 27.10 |
| 2335.96 | V | Z | AV | 34.10 | 0.33 | 1.79 | N/A | 36.22 | 54.00 | 17.78 |
| 7205.32 | V | Z | PK | 47.36 | 11.23 | N/A | N/A | 58.59 | 74.00 | 15.41 |
| 7205.40 | V | Z | AV | 39.20 | 11.23 | 1.79 | N/A | 52.22 | 54.00 | 1.78 |

### ▪ Middle Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 7320.55 | V | Z | PK | 46.14 | 11.20 | N/A | N/A | 57.34 | 74.00 | 16.66 |
| 7320.28 | V | Z | AV | 37.83 | 11.20 | 1.79 | N/A | 50.82 | 54.00 | 3.18 |

### ▪ Highest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2483.50 | H | Z | PK | 48.92 | 1.10 | N/A | N/A | 50.02 | 74.00 | 23.98 |
| 2483.53 | H | Z | AV | 34.51 | 1.10 | 1.79 | N/A | 37.40 | 54.00 | 16.60 |
| 7440.67 | V | Z | PK | 47.35 | 11.34 | N/A | N/A | 58.69 | 74.00 | 15.31 |
| 7440.19 | V | Z | AV | 38.93 | 11.34 | 1.79 | N/A | 52.06 | 54.00 | 1.94 |

▪ **Note.**

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.
2. Information of Distance Factor

   For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor(-9.54 dB) is applied to the result.

   - Calculation of distance factor = 20 log( applied distance / required distance ) = **20 log( 1 m / 3 m )** = **-9.54 dB**

   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
3. Sample Calculation.

   Margin = Limit – Result / Result = Reading + T.F + D.C.F / T.F = AF + CL – AG

   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

   DCF = Duty Cycle Correction Factor.

## 3.6 Power line Conducted Emissions

▣ **Test Requirements and limit, §15.207 & RSS-Gen [8.8]**

For 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 μH/50 ohms line impedance stabilization network (LISN).

| Frequency Range (MHz) | Conducted Limit (dBuV) | |
|---|---|---|
| | 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

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

### 3.6.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

### 3.6.2 Test Procedures

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

1. 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.

### 3.6.3 Test Results

## AC Line Conducted Emissions (Graph) = TM 1 & Test Channel : Middle

# Results of Conducted Emission

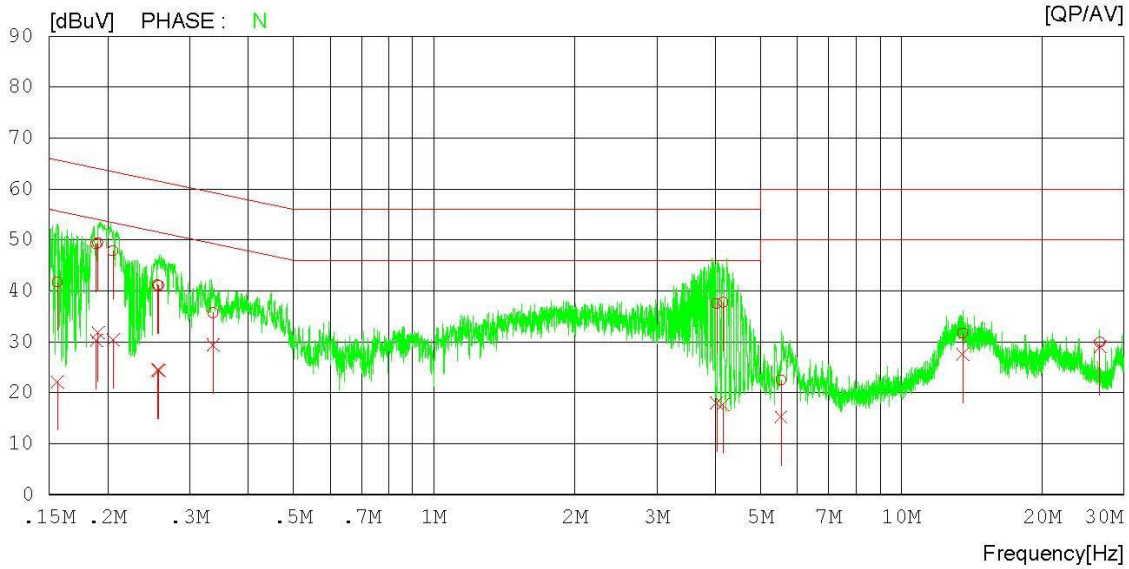
DTNC

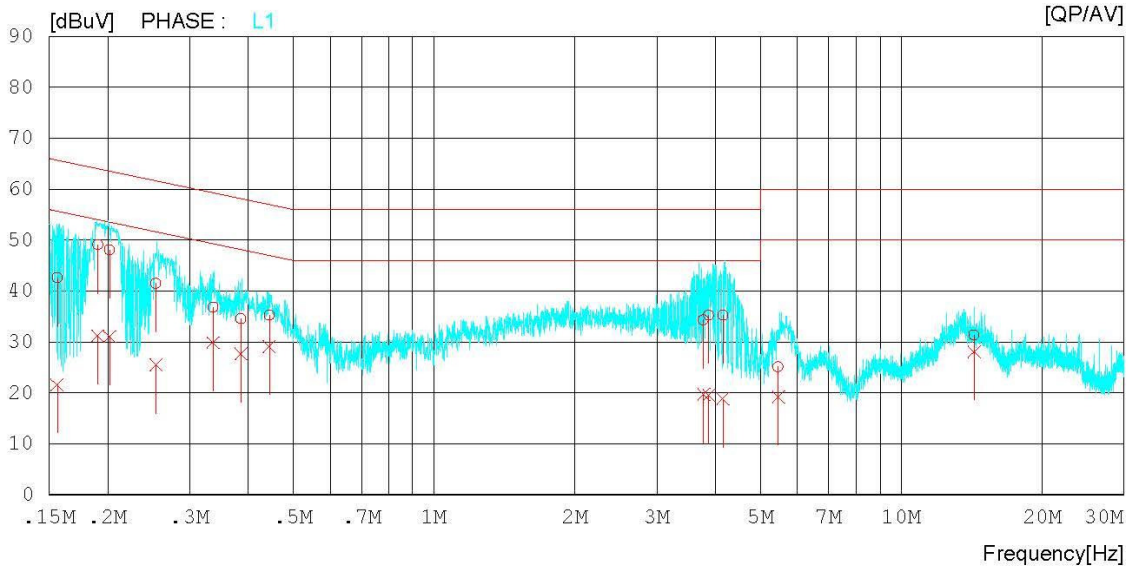
Date : 2016-11-21

| | | | | | |
|---|---|---|---|---|---|
| Order No. | : | DTNC1610-06490 | Referrence No. | : | |
| Model No. | : | IPBT-400 | Power Supply | : | 120V / 60Hz |
| Serial No. | : | | Temp/Humi. | : | 23℃ / 43% |
| Test Condition | : | BLE | Operator | : | Jungwoo Kim |

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV



## AC Line Conducted Emissions (List) = TM 1 & Test Channel : Middle

# Results of Conducted Emission

DTNC

Date : 2016-11-21

| | | | | | |
|---|---|---|---|---|---|
| Order No. | : | DTNC1610-06490 | Referrence No. | : | |
| Model No. | : | IPBT-400 | Power Supply | : | 120V / 60Hz |
| Serial No. | : | | Temp/Humi. | : | 23℃ / 43% |
| Test Condition | : | BLE | Operator | : | Jungwoo Kim |

Memo :

LIMIT : FCC P15.207 QP
FCC P15.207 AV

| NO | FREQ | READING | | C.FACTOR | RESULT | | LIMIT | | MARGIN | | PHASE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | QP | AV | | QP | AV | QP | AV | QP | AV | |
| | [MHz] | [dBuV] | [dBuV] | [dB] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | [dBuV] | |
| 1 | 0.15630 | 31.6 | 12.0 | 10.2 | 41.8 | 22.2 | 65.7 | 55.7 | 23.9 | 33.5 | N |
| 2 | 0.18927 | 39.0 | 20.0 | 10.2 | 49.2 | 30.2 | 64.1 | 54.1 | 14.9 | 23.9 | N |
| 3 | 0.19084 | 39.2 | 21.5 | 10.2 | 49.4 | 31.7 | 64.0 | 54.0 | 14.6 | 22.3 | N |
| 4 | 0.20544 | 37.7 | 20.2 | 10.2 | 47.9 | 30.4 | 63.4 | 53.4 | 15.5 | 23.0 | N |
| 5 | 0.25608 | 31.0 | 14.3 | 10.2 | 41.2 | 24.5 | 61.6 | 51.6 | 20.4 | 27.1 | N |
| 6 | 0.25756 | 30.8 | 14.2 | 10.2 | 41.0 | 24.4 | 61.5 | 51.5 | 20.5 | 27.1 | N |
| 7 | 0.33644 | 25.5 | 19.2 | 10.2 | 35.7 | 29.4 | 59.3 | 49.3 | 23.6 | 19.9 | N |
| 8 | 4.02560 | 27.2 | 7.7 | 10.3 | 37.5 | 18.0 | 56.0 | 46.0 | 18.5 | 28.0 | N |
| 9 | 4.15420 | 27.4 | 7.4 | 10.3 | 37.7 | 17.7 | 56.0 | 46.0 | 18.3 | 28.3 | N |
| 10 | 5.53080 | 12.0 | 4.7 | 10.5 | 22.5 | 15.2 | 60.0 | 50.0 | 37.5 | 34.8 | N |
| 11 | 13.55680 | 20.7 | 16.6 | 11.0 | 31.7 | 27.6 | 60.0 | 50.0 | 28.3 | 22.4 | N |
| 12 | 26.62320 | 18.0 | 17.1 | 11.9 | 29.9 | 29.0 | 60.0 | 50.0 | 30.1 | 21.0 | N |
| 13 | 0.15602 | 32.4 | 11.4 | 10.1 | 42.5 | 21.5 | 65.7 | 55.7 | 23.2 | 34.2 | L1 |
| 14 | 0.19050 | 38.9 | 21.1 | 10.1 | 49.0 | 31.2 | 64.0 | 54.0 | 15.0 | 22.8 | L1 |
| 15 | 0.20215 | 38.0 | 20.9 | 10.1 | 48.1 | 31.0 | 63.5 | 53.5 | 15.4 | 22.5 | L1 |
| 16 | 0.25400 | 31.3 | 15.3 | 10.1 | 41.4 | 25.4 | 61.6 | 51.6 | 20.2 | 26.2 | L1 |
| 17 | 0.33608 | 26.6 | 19.6 | 10.2 | 36.8 | 29.8 | 59.3 | 49.3 | 22.5 | 19.5 | L1 |
| 18 | 0.38614 | 24.3 | 17.4 | 10.2 | 34.5 | 27.6 | 58.1 | 48.1 | 23.6 | 20.5 | L1 |
| 19 | 0.44387 | 25.0 | 18.9 | 10.2 | 35.2 | 29.1 | 57.0 | 47.0 | 21.8 | 17.9 | L1 |
| 20 | 3.77320 | 24.0 | 9.4 | 10.3 | 34.3 | 19.7 | 56.0 | 46.0 | 21.7 | 26.3 | L1 |
| 21 | 3.87400 | 24.9 | 9.1 | 10.3 | 35.2 | 19.4 | 56.0 | 46.0 | 20.8 | 26.6 | L1 |
| 22 | 4.15200 | 24.9 | 8.5 | 10.3 | 35.2 | 18.8 | 56.0 | 46.0 | 20.8 | 27.2 | L1 |
| 23 | 5.45360 | 14.6 | 8.7 | 10.5 | 25.1 | 19.2 | 60.0 | 50.0 | 34.9 | 30.8 | L1 |
| 24 | 14.33300 | 20.3 | 17.0 | 11.0 | 31.3 | 28.0 | 60.0 | 50.0 | 28.7 | 22.0 | L1 |

# 4. ANTENNA REQUIREMENTS

▣ **According to FCC 47 CFR §15.203 & RSS-Gen [8.3]**

"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."

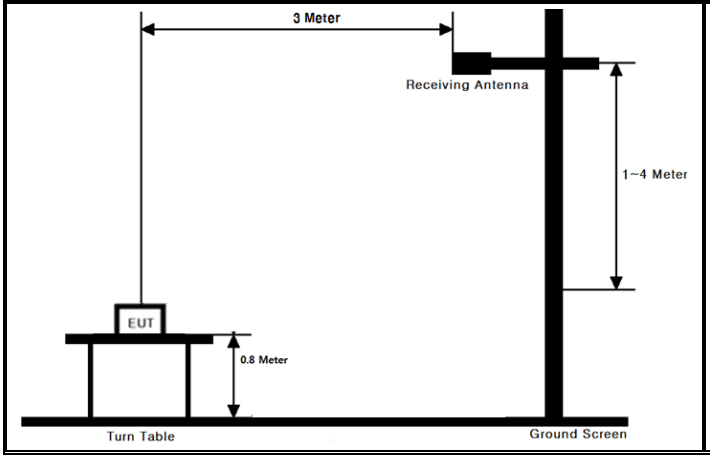
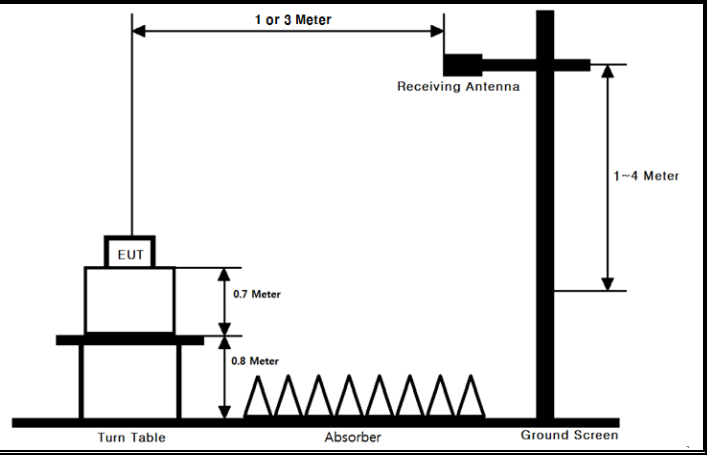
**The antenna is permanently attached on PCB. (Refer to Internal photo file.)**

**Therefore this E.U.T Complies with the requirement of §15.203**

# APPENDIX I

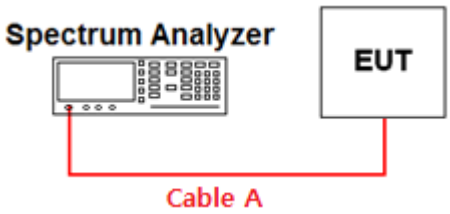
## Test set up diagrams

- **Radiated Measurement**

| Below 1GHz | Above 1GHz |
|---|---|
|  |  |



- **Conducted Measurement**




**Path loss information**

| Frequency (GHz) | Path Loss (dB) | Frequency (GHz) | Path Loss (dB) |
|---|---|---|---|
| 0.03 | 0.18 | 15 | 5.16 |
| 1 | 1.08 | 20 | 5.61 |
| 2.402 & 2.440 & 2.480 | 1.75 | 25 | 7.00 |
| 5 | 2.57 | - | - |
| 10 | 4.13 | - | - |

Note 1: The path loss from EUT to Spectrum analyzer was measured and used for test.
Path loss (S/A's correction factor) = Cable A
(Attenuator, Applied only when it was used externally)

# APPENDIX II

## Duty cycle plots

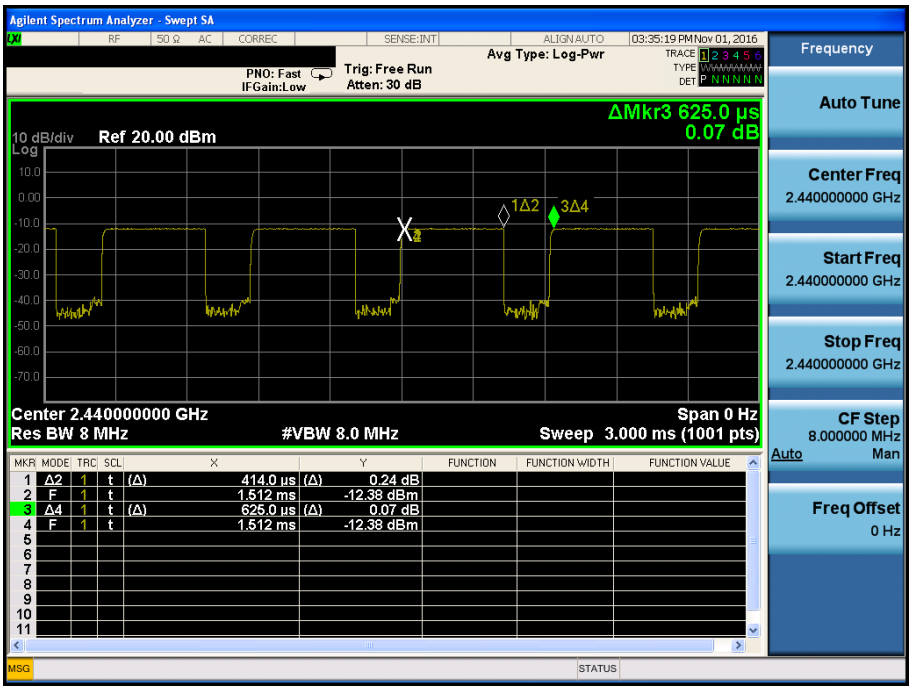
- **Test Procedure**

**Duty Cycle** was measured using **section 6.0 b) of KDB558074 :**

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 ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ 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 ≤ 16.7 microseconds.)

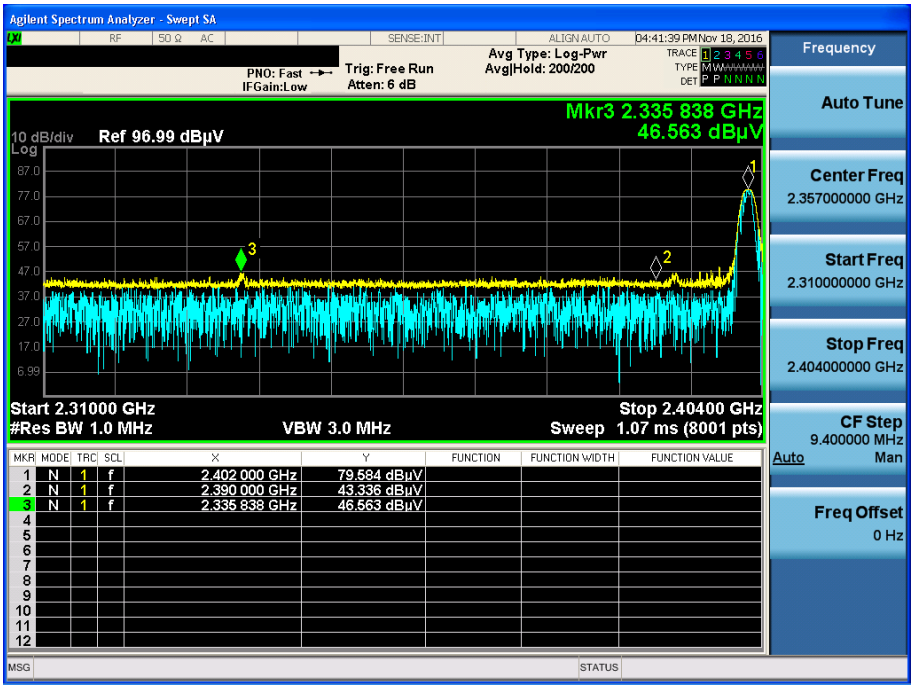
**Duty Cycle** **Test Channel : Middle**



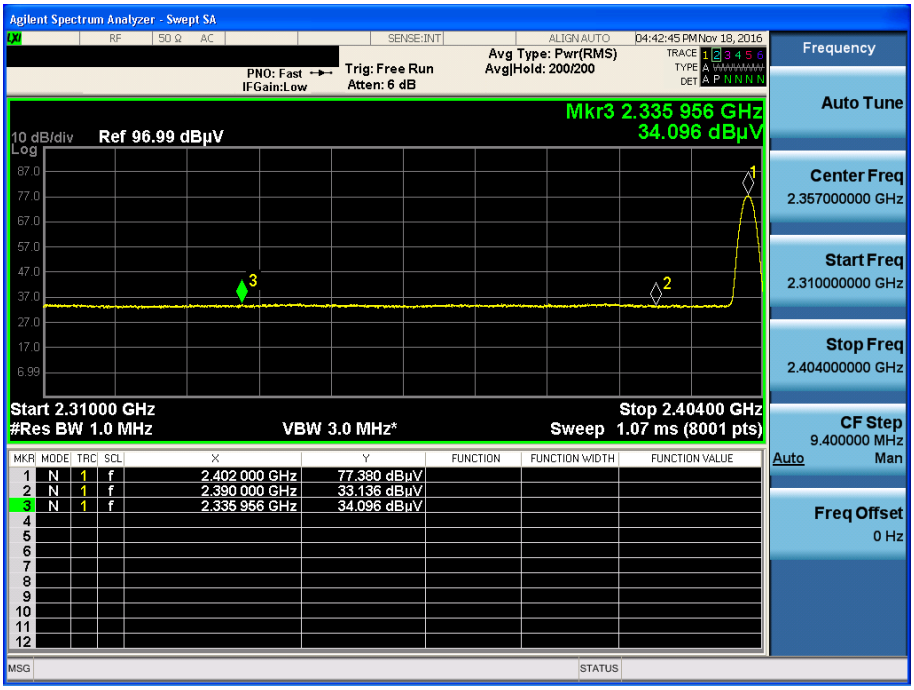
# APPENDIX III

## Unwanted Emissions (Radiated) Test Plot

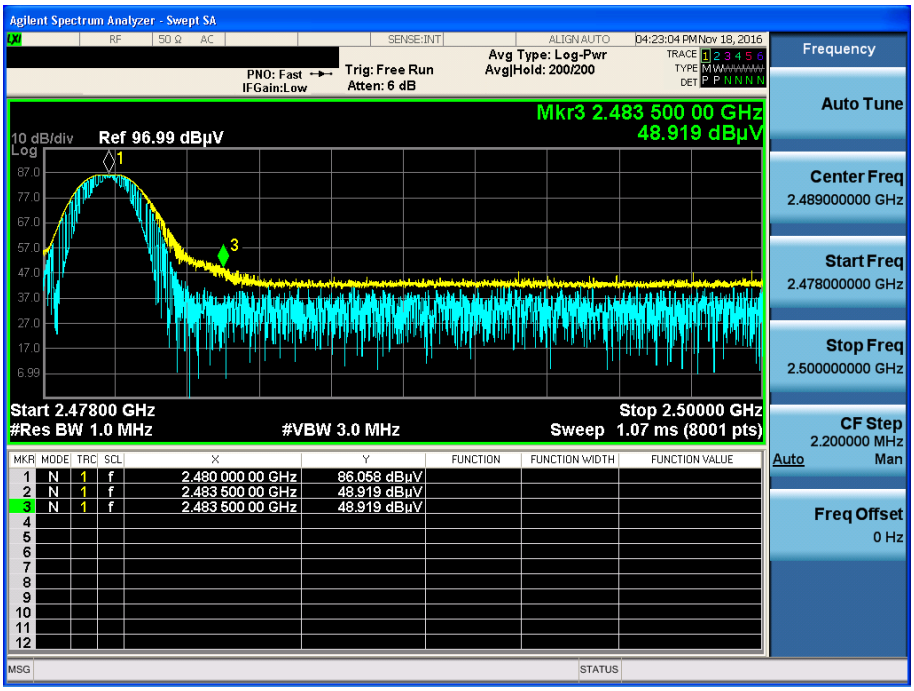
### TM1 & Lowest & Z & Ver — Detector Mode : PK



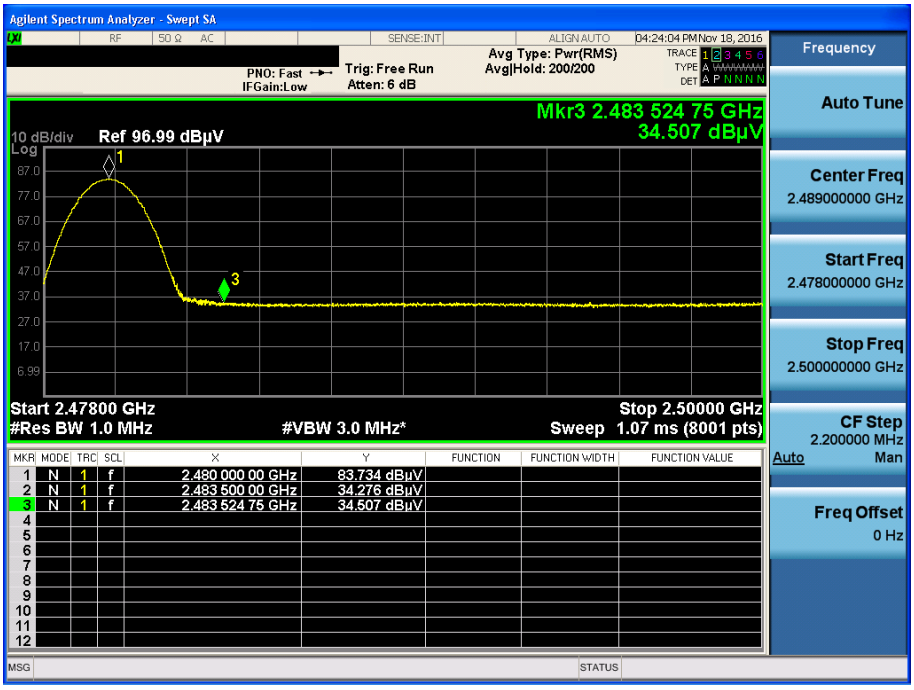

### TM1 & Lowest & Z & Ver — Detector Mode : AV



**TM1 & Highest & Z & Hor** **Detector Mode : PK**




**TM1 & Highest & Z & Hor** **Detector Mode : AV**



**TM1 & Lowest & Z & Ver** **Detector Mode : AV**