

# TEST REPORT



**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 : DRTFCC1707-0131
2. Customer
  - Name : Phychips Inc.
  - Address : (Yongsan-dong), Migun Technoworld 2, A-104, 187, Techno 2-ro, Yuseong-gu, Daejeon, South Korea
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : RFID Module / RED5  
FCC ID : Y3D-RED5
5. Test Method Used : FCC Part 15 Subpart C 247
6. Date of Test : 2017.07.21 ~ 2017.07.26
7. Testing Environment : See appended test report.
8. Test Result : Refer to the attached test result.

|             |                                |                               |
|-------------|--------------------------------|-------------------------------|
| Affirmation | Tested by                      | Technical Manager             |
|             | Name : JungWoo Kim (Signature) | Name : HyunSu Son (Signature) |

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2017 . 07 . 31 .

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

If this report is required to confirmation of authenticity, please contact to [report@dtnc.net](mailto:report@dtnc.net)

## Test Report Version

| Test Report No. | Date         | Description   |
|-----------------|--------------|---------------|
| DRTFCC1707-0131 | Jul. 31 2017 | Initial issue |
|                 |              |               |
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## 1. General Information

### 1.1 Testing Laboratory

| DT&C Co., Ltd.                                 |  |   |
|--|--|---|
| Standard                                       | Site number                                | Address   |
| FCC  | <input checked="" type="checkbox"/> 165783 | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|  | <input type="checkbox"/> 804488            | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|  | <input type="checkbox"/> 596748            | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|  | <input type="checkbox"/> 678747            | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080               |
| IC   | <input type="checkbox"/> 5740A-3           | 42, Yurim-ro 154 beon-gil, Cheoin -gu, Yongin-si, Gyeonggi -do, South Korea 449-935 |
|  | <input type="checkbox"/> 5740A-2           | 683-3, Yubang-dong, Cheoin-gu, Yongin-si, Kyeonggi-do, Korea, 449-080               |
| <a href="http://www.dtnc.net">www.dtnc.net</a> |  |   |
| Telephone                                      | :  | + 82-31-321-2664  |
| FAX  | :  | + 82-31-321-1664  |

### 1.2 Details of Applicant

Applicant : Phychips Inc.  
 Address : (Yongsan-dong), Migun Technoworld 2, A-104, 187, Techno 2-ro, Yuseong-gu, Daejeon, South Korea  
 Contact person : Khyungjoo Min

### 1.3 Description of EUT

|                                 |   |
|---------------------------------|---|
| <b>EUT</b>                      | RFID Module   |
| <b>Model Name</b>               | RED5  |
| <b>Add Model Name</b>           | NA  |
| <b>Serial Number</b>            | Identical prototype   |
| <b>Hardware version</b>         | 1.0   |
| <b>Software version</b>         | 1.0   |
| <b>Power Supply</b>             | DC 3.3 V  |
| <b>Frequency Range</b>          | 917.10 ~ 926.90 MHz   |
| <b>Modulation Technique</b>     | FSK   |
| <b>Number of Channels</b>       | 50(Channel Spacing 200kHz)  |
| <b>Antenna Type</b>             | Antenna 1 : External Antenna ( Microstrip patch antenna )<br>Antenna 2 : External Antenna ( PCB Antenna )<br>Antenna 3 : External Antenna ( PCB Antenna ) |
| <b>Antenna 1 / Antenna Gain</b> | Max. PK 6.00 dBi  |
| <b>Antenna 2 / Antenna Gain</b> | Max. PK 2.50 dBi  |
| <b>Antenna 3 / Antenna Gain</b> | Max. PK 0.00 dBi  |

### 1.4 Declaration by the manufacturer

- N/A

### 1.5 Test conditions

| Ambient Condition   |                 |
|---------------------|-----------------|
| ▪ Temperature       | +22 °C ~ +24 °C |
| ▪ Relative Humidity | 39 % ~ 48 %     |

## 1.6 Test Equipment List

| Type                                | Manufacturer           | Model                      | Cal.Date<br>(yy/mm/dd) | Next.Cal.Date<br>(yy/mm/dd) | S/N           |
|-------------------------------------|------------------------|----------------------------|------------------------|-----------------------------|---------------|
| Spectrum Analyzer                   | Agilent Technologies   | N9020A                     | 16/09/09               | 17/09/09                    | MY50200834    |
| Digital Multimeter                  | Agilent Technologies   | 34401A                     | 17/01/04               | 18/01/04                    | US36099541    |
| DC Power Supply                     | SM techno              | SDP30-5D                   | 17/01/05               | 18/01/05                    | 305DLJ204     |
| Attenuator                          | SMAJK                  | SMAJK-50-10                | 16/09/08               | 17/09/08                    | 15081901      |
| Signal Generator                    | Rohde Schwarz          | SMBV100A                   | 17/01/04               | 18/01/04                    | 255571        |
| Signal Generator                    | Rohde Schwarz          | SMF100A                    | 17/04/21               | 18/04/21                    | 102341        |
| Thermohygrometer                    | BODYCOM                | BJ5478                     | 17/04/11               | 18/04/11                    | 120612-2      |
| Loop Antenna                        | Schwarzbeck            | FMZB1513                   | 16/04/22               | 18/04/22                    | 1513-128      |
| Bilog Antenna                       | SCHAFFNER              | CBL6112B                   | 16/05/23               | 18/05/23                    | 2737          |
| Horn Antenna                        | ETS-LINDGREN           | 3117                       | 16/05/03               | 18/05/03                    | 00140394      |
| PreAmplifier                        | Agilent                | 8449B                      | 17/01/11               | 18/01/11                    | 3008A00370    |
| PreAmplifier                        | tsj                    | MLA-010K01-B01-27          | 17/03/06               | 18/03/06                    | 1844539       |
| EMI TEST RECEIVER                   | Rohde Schwarz          | ESR7                       | 16/10/18               | 17/10/18                    | 101109        |
| EMI TEST RECEIVER                   | Rohde Schwarz          | ESCI                       | 17/02/16               | 18/02/16                    | 100364        |
| Highpass Filter                     | Wainwright Instruments | WHKX12-935-1000-15000-40SS | 16/09/09               | 17/09/09                    | 7             |
| ARTIFICIAL MAINS NETWORK            | ROHDE&SCHWARZ          | ESH2-Z5                    | 16/09/08               | 17/09/08                    | 828739/006    |
| SINGLE-PHASE MASTER                 | NF                     | 4420                       | 16/09/08               | 17/09/08                    | 3049354420023 |
| Power Meter & Wide Bandwidth Sensor | Agilent Technologies   | N1911A                     | 16/10/19               | 17/10/19                    | MY53360016    |
|                                     |                        | N1921A                     |                        |                             | MY53360018    |

### 1.7 Summary of Test Results

| FCC Part<br>RSS Std.   | Parameter                     | Limit<br>(Using in 902-928 MHz)  | Test<br>Condition    | Status<br>Note 1   |
|--|-------------------------------|--|----------------------|--------------------|
| 15.247(a)<br>RSS-247(5.1)  | Carrier Frequency Separation  | >= 25 kHz or<br>>= 20 dB BW, whichever is greater.   | Conducted            | C                  |
|  | Number of Hopping Frequencies | >= 50 hops, if 20 dB BW < 250kHz<br>>= 25 hops, if 20 dB BW >= 250kHz  |                      | C                  |
|  | 20 dB Bandwidth               | < 500 kHz  |                      | C                  |
|  | Dwell Time                    | =< 0.4 seconds   |                      | C                  |
| 15.247(b)<br>RSS-247(5.4)  | Transmitter Output Power      | <b>For FCC</b><br>=< 1 Watt , if CHs >= 50<br>=< 0.25 W, if CHs >= 25, < 50<br><b>For IC</b><br>if CHs >= 50<br>=< 1 Watt For Conducted Power<br>=< 4 Watt For e.i.r.p,<br>if CHs >= 25, < 50<br>=< 0.25 W For Conducted Power.<br>=< 1 Watt For e.i.r.p |                      | C                  |
| 15.247(d)<br>RSS-247(5.5)  | Conducted Spurious Emissions  | The radiated emission to any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density.   |                      | C                  |
| RSS Gen(6.6)   | Occupied Bandwidth (99 %)     | N/A  |                      | NA                 |
| 15.247(d)<br>15.205 & 209<br>RSS-247(5.5)<br>RSS-Gen<br>(8.9 & 8.10) | Radiated Spurious Emissions   | FCC 15.209 Limits<br>RSS-Gen 8.9   | Radiated             | C <sup>Note2</sup> |
| 15.207<br>RSS-Gen(8.8)   | AC Conducted Emissions        | FCC 15.207 Limits  | AC Line<br>Conducted | C                  |
| 15.203<br>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.

Note 3 : The sample was tested according to the following specifications :

- ANSI C63.10-2013



### 1.8 Conclusion of worst-case and operation mode

The field strength of spurious emission was measured in three orthogonal EUT positions(X-axis, Y-axis and Z-axis).

Tested frequency information,

- Hopping Function: Enable

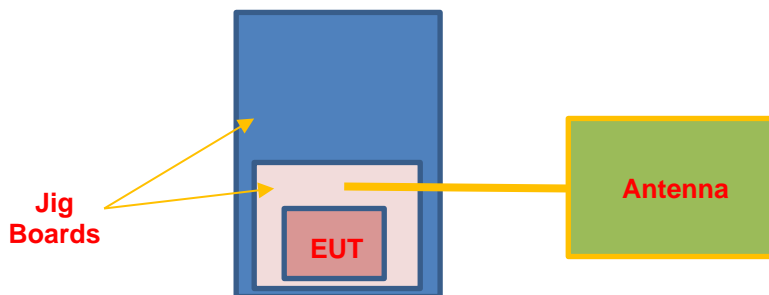
|                     | TX Frequency (MHz)  | RX Frequency (MHz)  |
|---------------------|---------------------|---------------------|
| <b>Hopping Band</b> | 917.10 ~ 926.90 MHz | 917.10 ~ 926.90 MHz |

- Hopping Function: Disable

| Channel                | TX Frequency (MHz) | RX Frequency (MHz) |
|------------------------|--------------------|--------------------|
| <b>Lowest Channel</b>  | 917.10             | 917.10             |
| <b>Middle Channel</b>  | 921.90             | 921.90             |
| <b>Highest Channel</b> | 926.90             | 926.90             |

### 1.9 Test configuration

For RF operations control and antenna connection, the EUT used the jig boards.



## 2. Maximum Peak Output Power Measurement

### 2.1 Test Setup

Refer to the APPENDIX I.

### 2.2 Limit

#### ■ FCC Requirements

The maximum peak output power of the intentional radiator shall not exceed the following :

- §15.247(b)(2), For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

#### ■ IC Requirements

- RSS-247(5.4)(1), For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

### 2.3 Test Procedure

- The RF output power was measured with a spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
- The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ;  
 Span = approximately 5 times of the 20 dB bandwidth, centered on a hopping channel  
 RBW  $\geq$  20 dB BW  
 VBW  $\geq$  RBW  
 Sweep = auto  
 Detector function = peak  
 Trace = max hold

### 2.4 Test Results

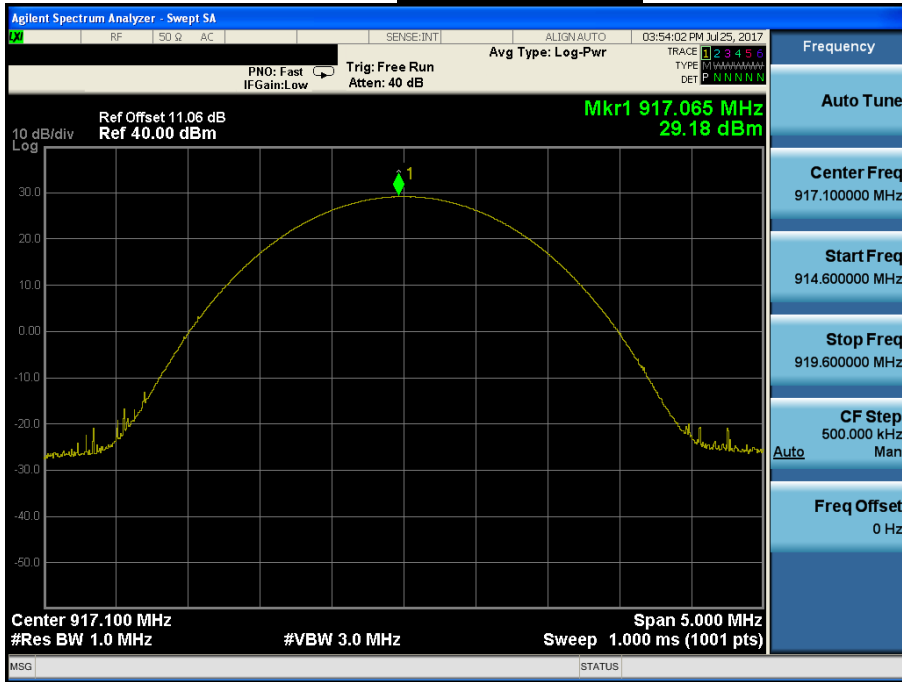
| Tested Channel | Frame Average Output Power |                | Peak Output Power |                |
|----------------|----------------------------|----------------|-------------------|----------------|
|                | dBm                        | mW             | dBm               | mW             |
| Lowest         | 27.740                     | 594.292        | 29.180            | 827.942        |
| Middle         | 27.820                     | 605.341        | 29.200            | 831.764        |
| Highest        | <b>27.970</b>              | <b>626.614</b> | <b>29.300</b>     | <b>851.138</b> |

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.

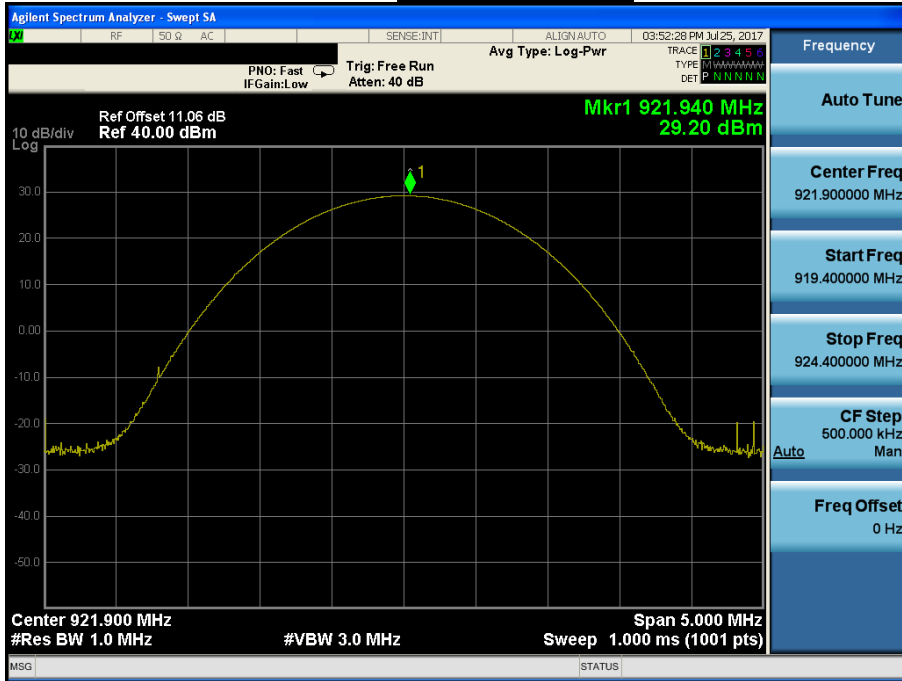
Peak Output Power

Lowest Channel



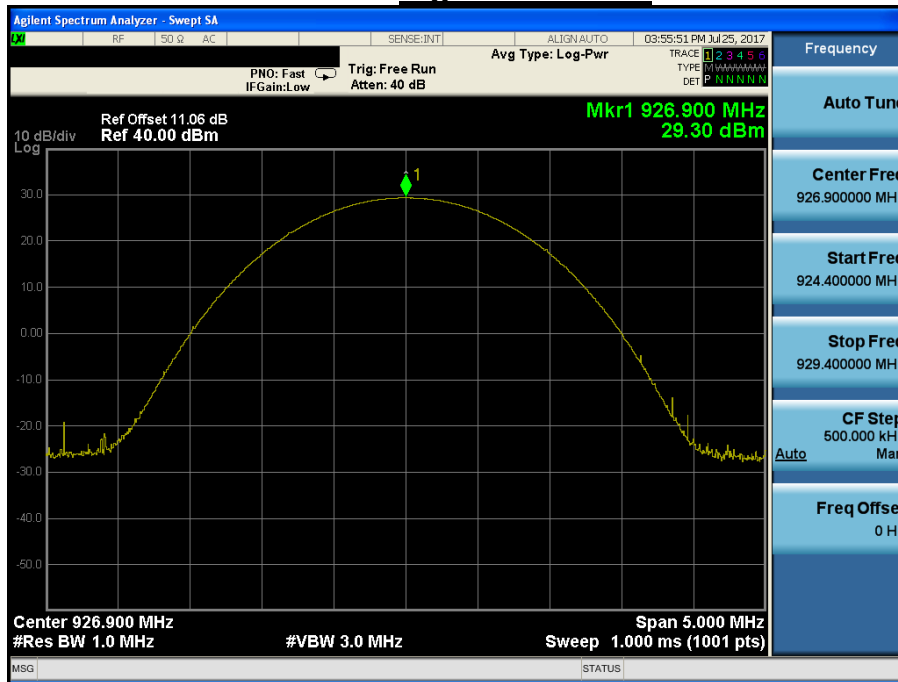
Peak Output Power

Middle Channel



Peak Output Power

*Highest Channel*



### 3. 20dBc BW

#### 3.1 Test Setup

Refer to the APPENDIX I.

#### 3.2 Limit

Limit: For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

#### 3.3 Test Procedure

1. The 20 dB bandwidth were measured with a spectrum analyzer connected to RF antenna Connector (conducted measurement) while EUT was operating in transmit mode. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using below setting: RBW shall be in the range of 1% to 5% of the 20 dB bandwidth and VBW  $\geq 3 \times$  RBW, Span = between two times and five times the 20 dB bandwidth.

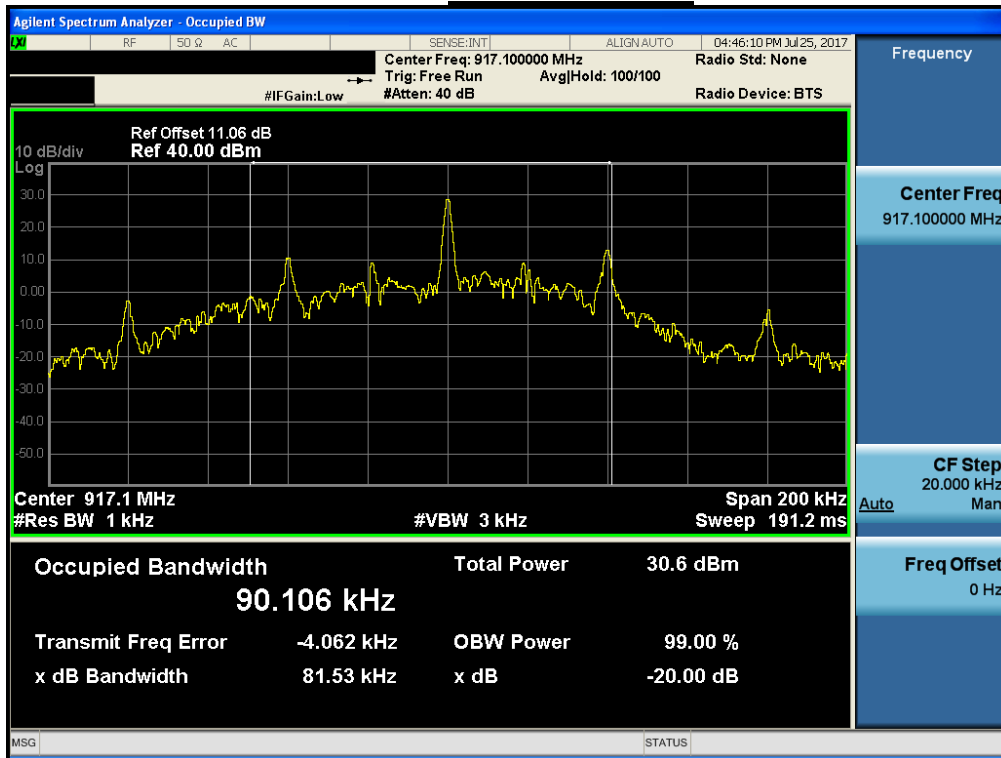
#### 3.4 Test Results

| Frequency (MHz) | Tested Channel | 20dBc BW (kHz) |
|-----------------|----------------|----------------|
| 917.10          | Lowest         | 81.53          |
| 921.90          | Middle         | 81.00          |
| 926.90          | Highest        | 80.51          |

Note 1: See next pages for actual measured spectrum plots.

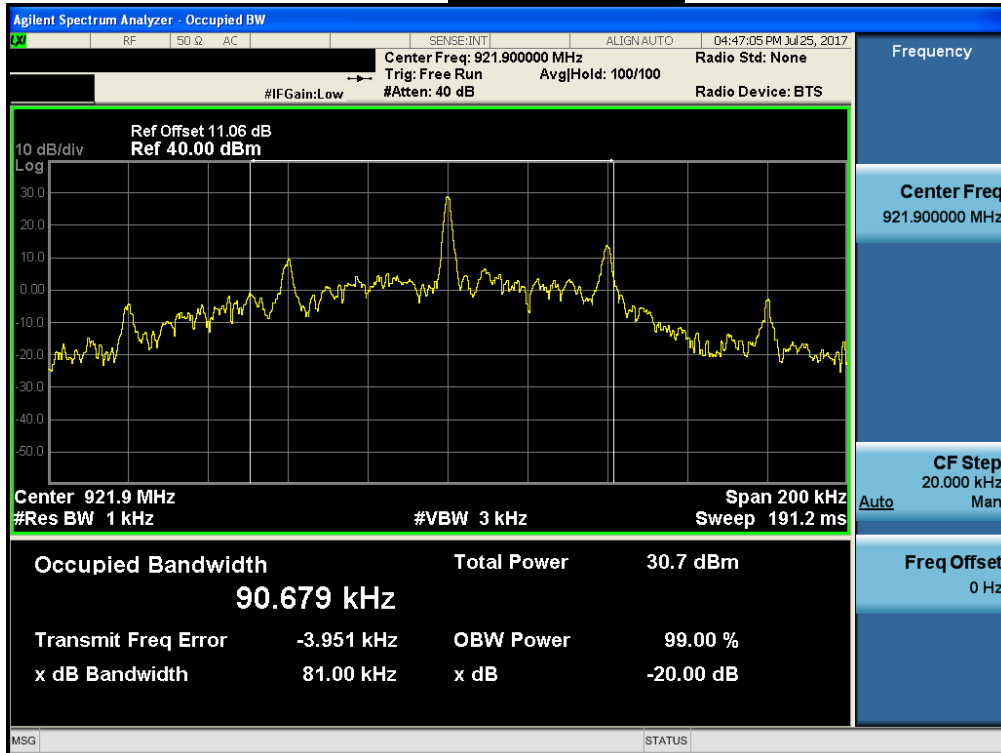
20dBc Bandwidth

Lowest Channel



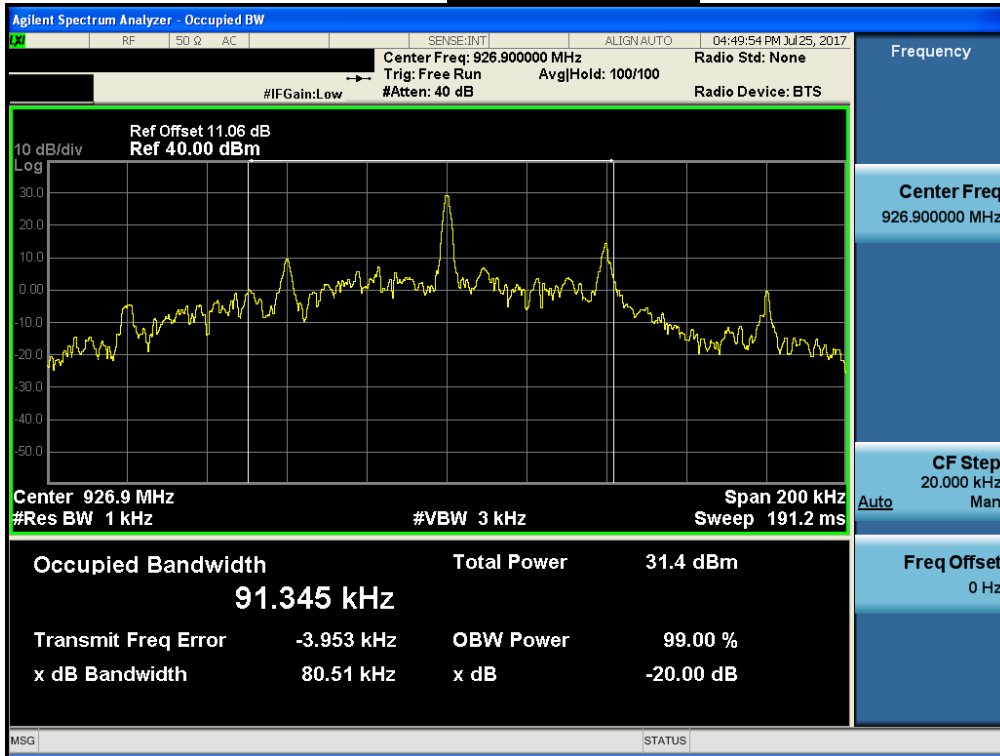
20dBc Bandwidth

Middle Channel



20dBc Bandwidth

Highest Channel



## 4. Carrier Frequency Separation

### 4.1 Test Setup

Refer to the APPENDIX I.

### 4.2 Limit

Limit :  $\geq 25$  kHz or  $\geq 20$  dB BW whichever is greater.

### 4.3 Procedure

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

After the trace being stable, the reading value between the peaks of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to :

Span = wide enough to capture the peaks of two adjacent channels

RBW = Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

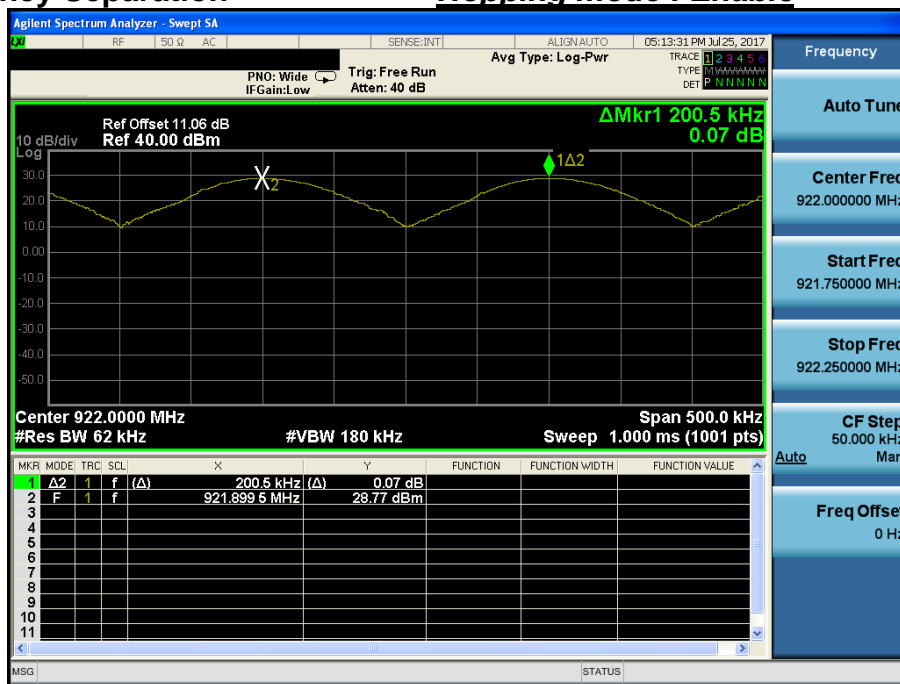
Trace = max hold

### 4.4 Test Results:

| Hopping Mode | Peak of center channel (MHz) | Peak of adjacent Channel (MHz) | Test Result (kHz) |
|--------------|------------------------------|--------------------------------|-------------------|
| Enable       | 921.900                      | 922.101                        | 201               |

## Carrier Frequency Separation

### Hopping mode : Enable







## 6. Time of Occupancy (Dwell Time)

### 6.1 Test Setup

Refer to the APPENDIX I.

### 6.2 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

### 6.3 Test Procedure

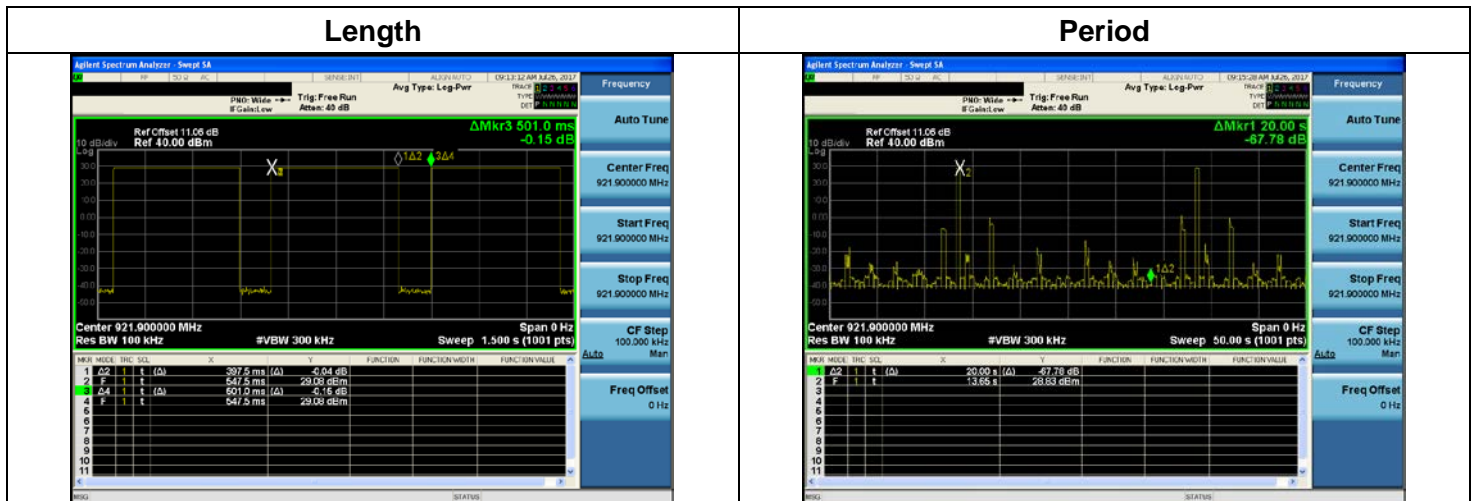
The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to :

- Center frequency = 915 MHz
- Span = zero
- RBW = 100 kHz (RBW shall be  $\leq$  channel spacing and where possible RBW should be set  $\gg 1 / T$ , where T is the expected dwell time per channel)
- VBW  $\geq$  RBW
- Trace = max hold
- Detector function = peak

### 6.4 Test Results

| Channel Frequency (MHz) | Length (ms) | Number | Dwell Time (ms) |
|-------------------------|-------------|--------|-----------------|
| 921.9                   | 397.5       | 1      | 397.500         |



## 7. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

### 7.1 Test Setup

Refer to the APPENDIX I.

### 7.2 Limit

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

According to § 15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

| Frequency (MHz) | Limit (uV/m)  | Measurement Distance (meter) |
|-----------------|---------------|------------------------------|
| 0.009 ~ 0.490   | 2400/F (kHz)  | 300                          |
| 0.490 ~ 1705    | 24000/F (kHz) | 30                           |
| 1705 ~ 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.

According to § 15.205(a) and (b), 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 ~ 12.52025 | 149.9 ~ 150.05        | 1645.5 ~ 1646.5 | 7.25 ~ 7.75  | 17.7 ~ 21.4   |
| 4.125 ~ 4.128     | 12.57675 ~ 12.57725 | 156.52475 ~ 156.52525 | 1660 ~ 1710     | 8.025 ~ 8.5  | 22.01 ~ 23.12 |
| 4.17725 ~ 4.17775 | 13.36 ~ 13.41       | 156.7 ~ 156.9         | 1718.8 ~ 1722.2 | 9.0 ~ 9.2    | 23.6 ~ 24.0   |
| 4.20725 ~ 4.20775 | 16.42 ~ 16.423      | 162.0125 ~ 167.17     | 2200 ~ 2300     | 9.3 ~ 9.5    | 31.2 ~ 31.8   |
| 6.215 ~ 6.218     | 16.69475 ~ 16.69525 | 167.72 ~ 173.2        | 2310 ~ 2390     | 10.6 ~ 12.7  | 36.43 ~ 36.5  |
| 6.26775 ~ 6.26825 | 16.80425 ~ 16.80475 | 240 ~ 285             | 2483.5 ~ 2500   | 13.25 ~ 13.4 | Above 38.6    |
| 6.31175 ~ 6.31225 | 25.5 ~ 25.67        | 322 ~ 335.4           | 2655 ~ 2900     |              |               |
| 8.291 ~ 8.294     | 37.5 ~ 38.25        | 399.90 ~ 410          | 3260 ~ 3267     |              |               |
| 8.362 ~ 8.366     | 73 ~ 74.6           | 608 ~ 614             | 3332 ~ 3339     |              |               |
| 8.37625 ~ 8.38675 | 74.8 ~ 75.2         | 960 ~ 1240            | 3345.8 ~ 3358   |              |               |
|                   |                     |                       | 3600 ~ 4400     |              |               |

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.

## 7.3 Test Procedures

### 7.3.1 Test Procedures for Radiated Spurious Emissions

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.  
The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 1 or 3 meter away from the interference-receiving antenna.
3. For measurements above 1GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.
4. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
7. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE 1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.

NOTE 2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.

NOTE 3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz for Average detection (AV) at frequency above 1 GHz.

### 7.3.2 Test Procedures for Conducted Spurious Emissions

1. The transmitter output was connected to the spectrum analyzer.
2. The **reference level** of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 kHz, VBW = 300 kHz.
3. The conducted spurious emission was tested each ranges were set as below.

**Frequency range : 9 kHz ~ 30 MHz**

RBW = 100 kHz, VBW = 300 kHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

**Frequency range : 30 MHz ~ 10 GHz**

RBW = 1 MHz, VBW = 3 MHz, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD, SWEEP POINT : 40001

**LIMIT LINE = 20 dB below of the reference level of above measurement procedure Step 2. (RBW = 100 kHz, VBW = 300 kHz)**

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.

Also the path loss for conducted measurement setup was used as described on the Appendix I of this test report.

## 7.4 Test Results

### 7.4.1 Radiated Emission

Note 1: Attached plot of worst data, refer to the APPENDIX II.

#### 9kHz ~ 10GHz Data\_ANT 1

##### ▪ Lowest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2751.407        | V       | Z                                  | PK            | 53.58          | -0.07      | N/A         | 53.51           | 74.00          | 20.49       |
| 2751.353        | V       | Z                                  | AV            | 50.27          | -0.07      | N/A         | 50.20           | 54.00          | 3.80        |
| 3668.503        | V       | Z                                  | PK            | 52.54          | 1.76       | N/A         | 54.30           | 74.00          | 19.70       |
| 3668.427        | V       | Z                                  | AV            | 48.87          | 1.76       | N/A         | 50.63           | 54.00          | 3.37        |

##### ▪ Middle Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2765.558        | V       | Z                                  | PK            | 54.40          | -0.03      | N/A         | 54.37           | 74.00          | 19.63       |
| 2765.743        | V       | Z                                  | AV            | 50.96          | -0.03      | N/A         | 50.93           | 54.00          | 3.07        |
| 3687.708        | V       | Z                                  | PK            | 53.08          | 1.86       | N/A         | 54.94           | 74.00          | 19.06       |
| 3687.635        | V       | Z                                  | AV            | 49.71          | 1.86       | N/A         | 51.57           | 54.00          | 2.43        |

##### ▪ Highest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2780.630        | V       | Z                                  | PK            | 54.67          | 0.01       | N/A         | 54.68           | 74.00          | 19.32       |
| 2780.725        | V       | Z                                  | AV            | 51.57          | 0.01       | N/A         | 51.58           | 54.00          | 2.42        |
| 3707.653        | V       | Z                                  | PK            | 49.87          | 1.95       | N/A         | 51.82           | 74.00          | 22.18       |
| 3707.623        | V       | Z                                  | AV            | 45.67          | 1.95       | N/A         | 47.62           | 54.00          | 6.38        |

#### **Note.**

1. No other spurious and harmonic emissions were reported greater than listed emissions above table.
2. Above listed point data is the worst case data.
3. The limit is applied as below,  
 Restricted band = FCC Part 15.209  
 Non-restricted band = Fundamental level – 20dB  
 \*= Non-restricted band
4. Sample Calculation.  

$$\text{Margin} = \text{Limit} - \text{Result} \quad / \quad \text{Result} = \text{Reading} + \text{T.F} + \text{DCF} \quad / \quad \text{T.F} = \text{AF} + \text{CL} - \text{AG}$$
 Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,  
 DCF = Duty Cycle Correction Factor

**9kHz ~ 10GHz Data ANT 2**
**▪ Lowest Channel**

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2751.295        | H       | Z                                  | PK            | 52.48          | -0.07      | N/A         | 52.41           | 74.00          | 21.59       |
| 2751.333        | H       | Z                                  | AV            | 49.28          | -0.07      | N/A         | 49.21           | 54.00          | 4.79        |
| 3668.587        | H       | Y                                  | PK            | 51.15          | 1.76       | N/A         | 52.91           | 74.00          | 21.09       |
| 3668.415        | H       | Y                                  | AV            | 46.49          | 1.76       | N/A         | 48.25           | 54.00          | 5.75        |

**▪ Middle Channel**

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2765.740        | H       | Z                                  | PK            | 52.45          | -0.03      | N/A         | 52.42           | 74.00          | 21.58       |
| 2765.702        | H       | Z                                  | AV            | 49.10          | -0.03      | N/A         | 49.07           | 54.00          | 4.93        |
| 3687.745        | H       | Y                                  | PK            | 50.22          | 1.86       | N/A         | 52.08           | 74.00          | 21.92       |
| 3687.640        | H       | Y                                  | AV            | 45.19          | 1.86       | N/A         | 47.05           | 54.00          | 6.95        |

**▪ Highest Channel**

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2780.835        | H       | Z                                  | PK            | 53.28          | 0.01       | N/A         | 53.29           | 74.00          | 20.71       |
| 2780.708        | H       | Z                                  | AV            | 49.57          | 0.01       | N/A         | 49.58           | 54.00          | 4.42        |
| 3707.638        | H       | Y                                  | PK            | 49.20          | 1.95       | N/A         | 51.15           | 74.00          | 22.85       |
| 3707.642        | H       | Y                                  | AV            | 43.62          | 1.95       | N/A         | 45.57           | 54.00          | 8.43        |

**Note.**

1. No other spurious and harmonic emissions were reported greater than listed emissions above table.
2. Above listed point data is the worst case data.
3. The limit is applied as below,

Restricted band = FCC Part 15.209

Non-restricted band = Fundamental level – 20dB

\*= Non-restricted band

4. Sample Calculation.

$$\text{Margin} = \text{Limit} - \text{Result} \quad / \quad \text{Result} = \text{Reading} + \text{T.F} + \text{DCF} \quad / \quad \text{T.F} = \text{AF} + \text{CL} - \text{AG}$$

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

DCF = Duty Cycle Correction Factor

**9kHz ~ 10GHz Data ANT 3**
**▪ Lowest Channel**

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2751.443        | H       | Z                                  | PK            | 52.91          | -0.07      | N/A         | 52.84           | 74.00          | 21.16       |
| 2751.298        | H       | Z                                  | AV            | 48.99          | -0.07      | N/A         | 48.92           | 54.00          | 5.08        |
| 3668.430        | H       | Y                                  | PK            | 51.18          | 1.76       | N/A         | 52.94           | 74.00          | 21.06       |
| 3668.427        | H       | Y                                  | AV            | 47.22          | 1.76       | N/A         | 48.98           | 54.00          | 5.02        |

**▪ Middle Channel**

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2765.582        | H       | Z                                  | PK            | 52.28          | -0.03      | N/A         | 52.25           | 74.00          | 21.75       |
| 2765.745        | H       | Z                                  | AV            | 47.81          | -0.03      | N/A         | 47.78           | 54.00          | 6.22        |
| 3687.565        | H       | Y                                  | PK            | 50.80          | 1.86       | N/A         | 52.66           | 74.00          | 21.34       |
| 3687.625        | H       | Y                                  | AV            | 46.06          | 1.86       | N/A         | 47.92           | 54.00          | 6.08        |

**▪ Highest Channel**

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F. (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|-------------|-----------------|----------------|-------------|
| 2780.745        | H       | Z                                  | PK            | 52.45          | 0.01       | N/A         | 52.46           | 74.00          | 21.54       |
| 2780.763        | H       | Z                                  | AV            | 47.45          | 0.01       | N/A         | 47.46           | 54.00          | 6.54        |
| 3707.528        | H       | Y                                  | PK            | 52.18          | 1.95       | N/A         | 54.13           | 74.00          | 19.87       |
| 3707.667        | H       | Y                                  | AV            | 47.10          | 1.95       | N/A         | 49.05           | 54.00          | 4.95        |

**Note.**

1. No other spurious and harmonic emissions were reported greater than listed emissions above table.
2. Above listed point data is the worst case data.
3. The limit is applied as below,

Restricted band = FCC Part 15.209

Non-restricted band = Fundamental level – 20dB

\*= Non-restricted band

4. Sample Calculation.

$$\text{Margin} = \text{Limit} - \text{Result} \quad / \quad \text{Result} = \text{Reading} + \text{T.F} + \text{DCF} \quad / \quad \text{T.F} = \text{AF} + \text{CL} - \text{AG}$$

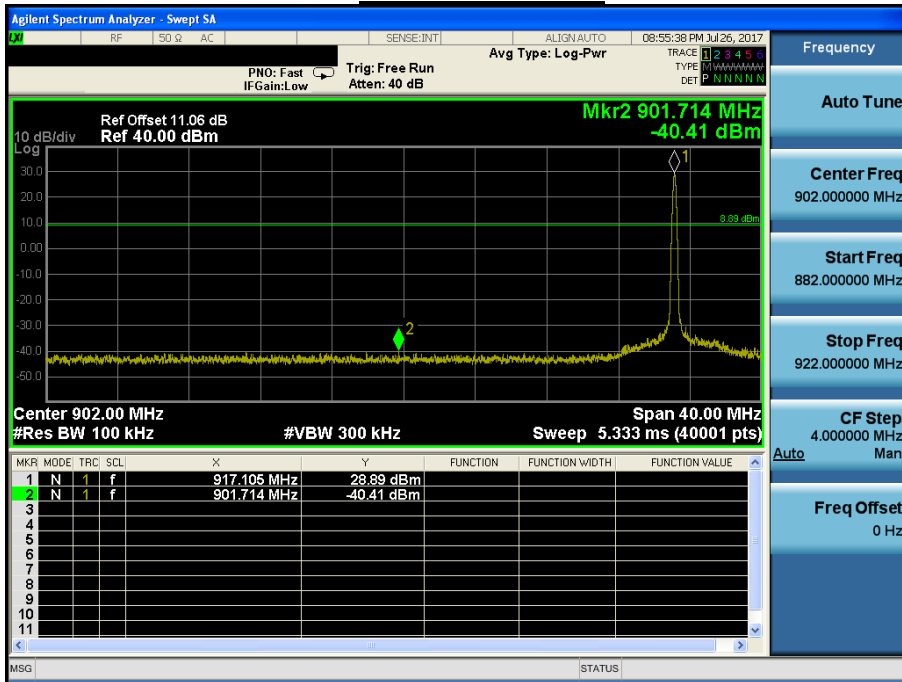
Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

DCF = Duty Cycle Correction Factor

7.4.2 Conducted Spurious Emissions

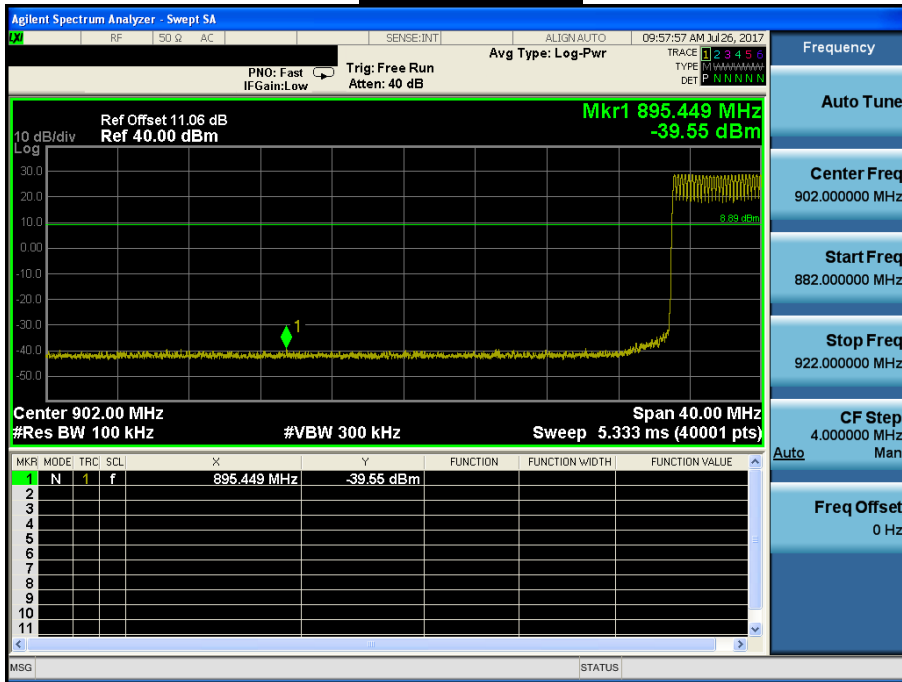
Low Band-edge

**Lowest Channel**



Low Band-edge

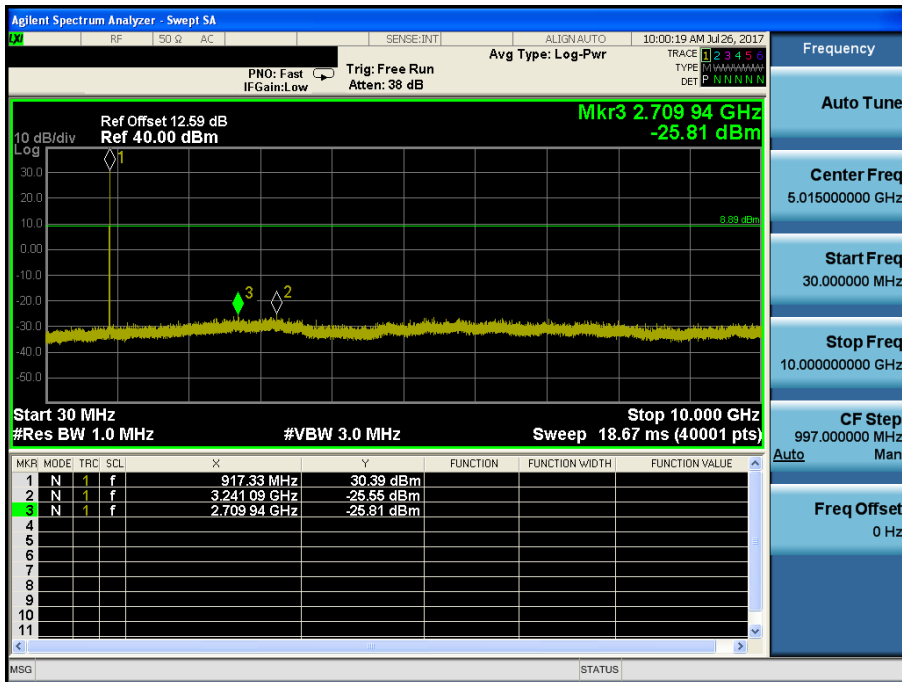
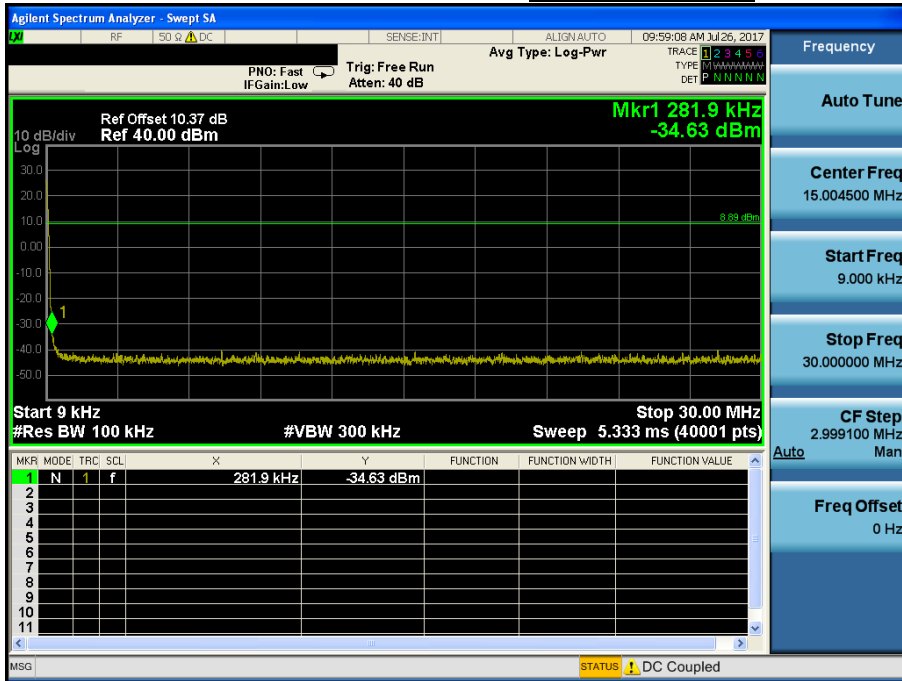
**Hopping mode**





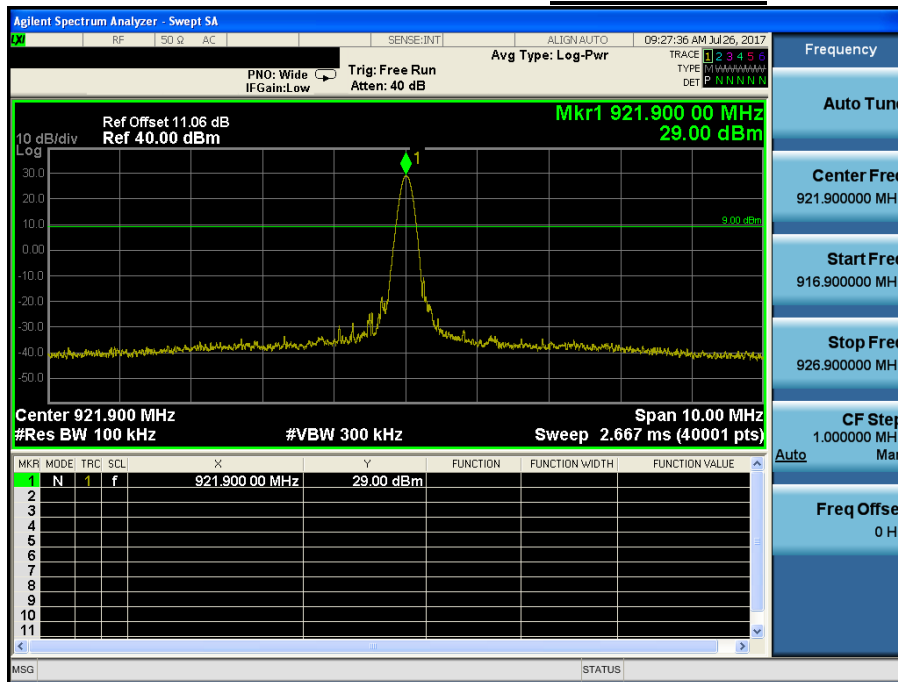
Conducted Spurious Emissions

Lowest Channel



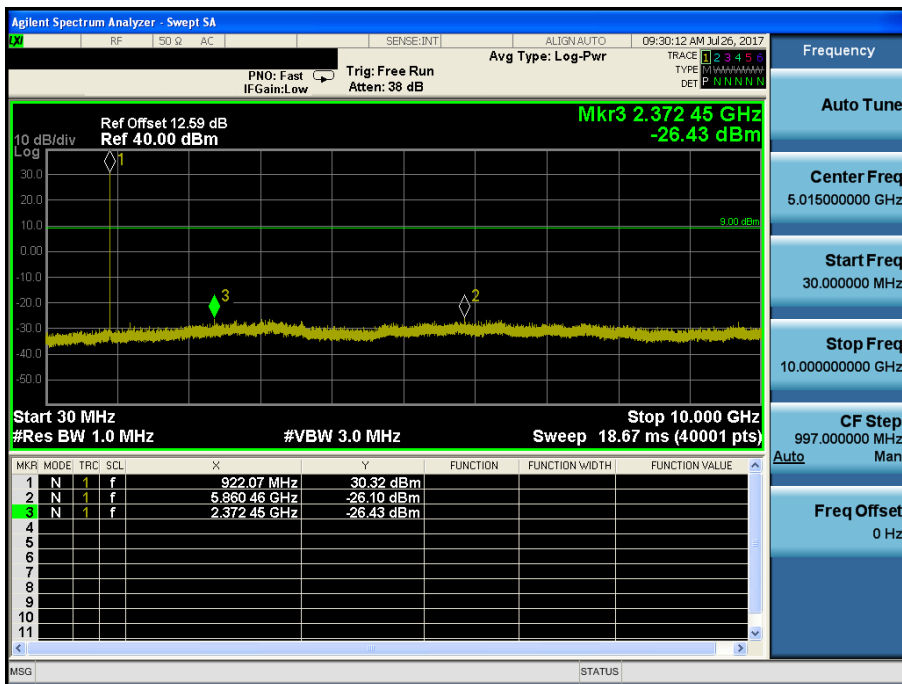
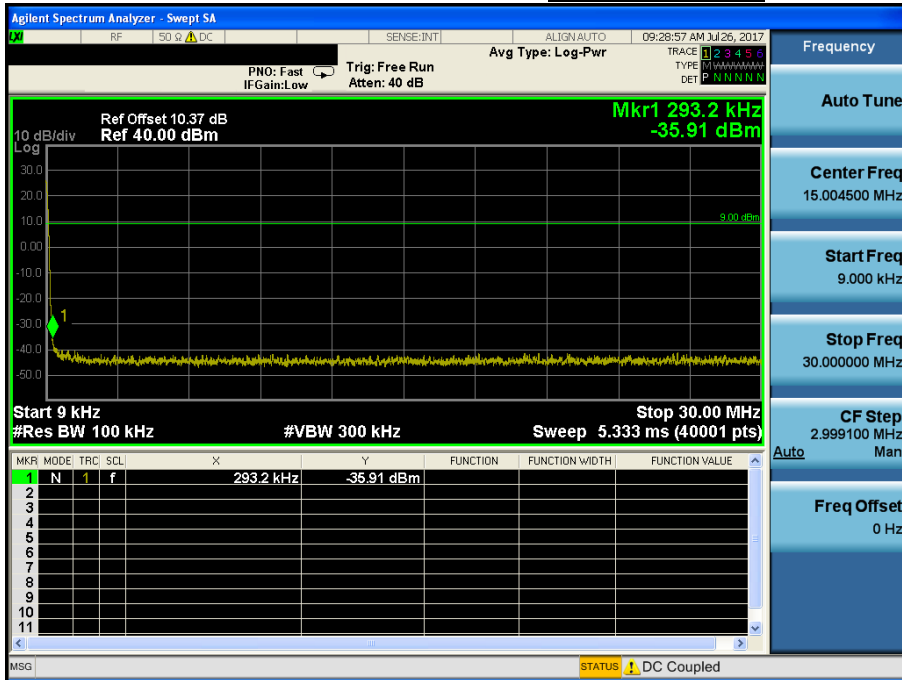
Reference for limit

Middle Channel



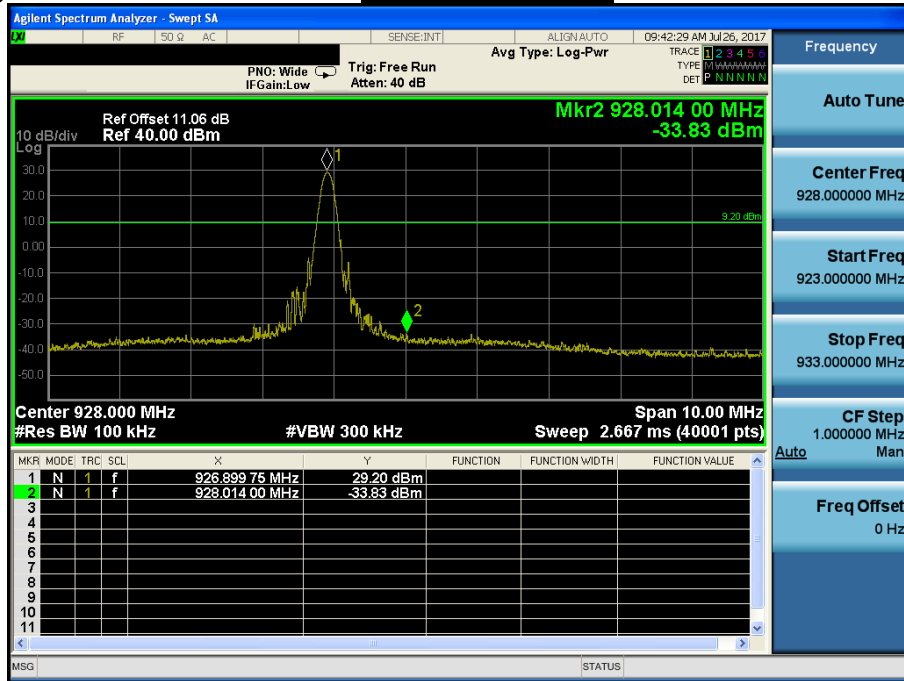
Conducted Spurious Emissions

Middle Channel



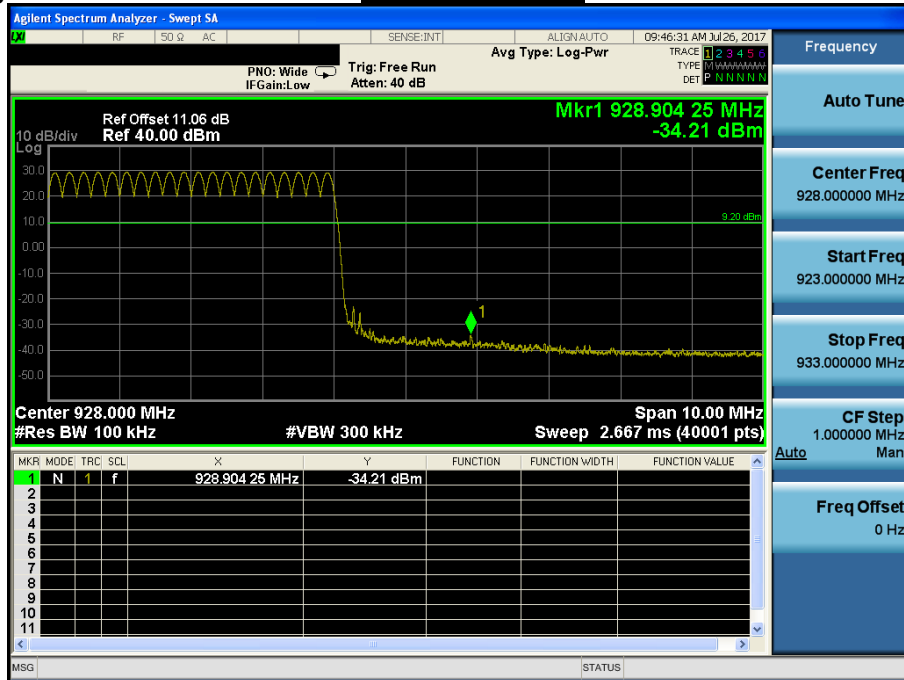
High Band-edge

*Highest Channel*



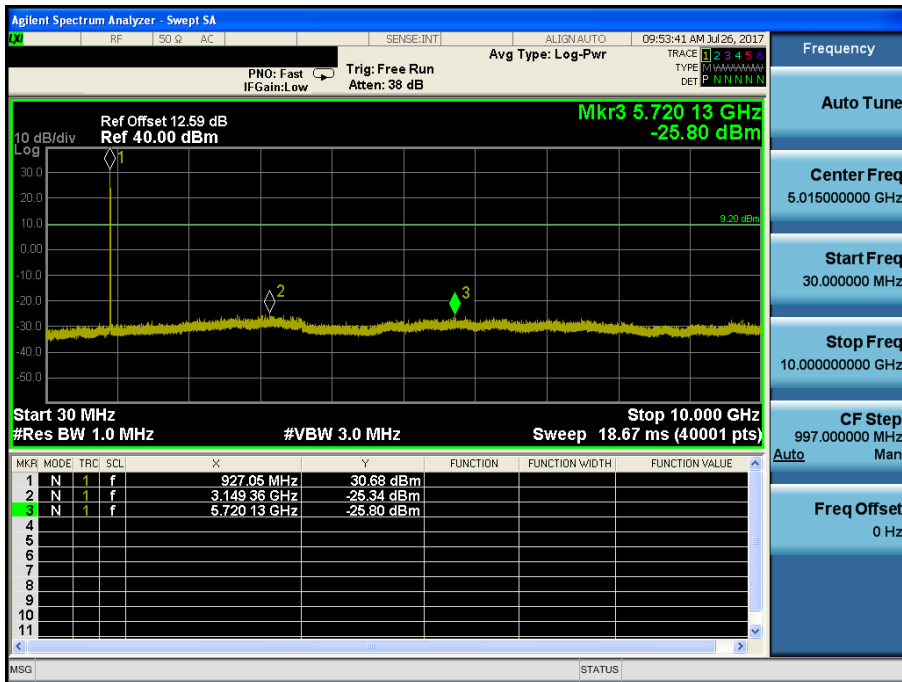
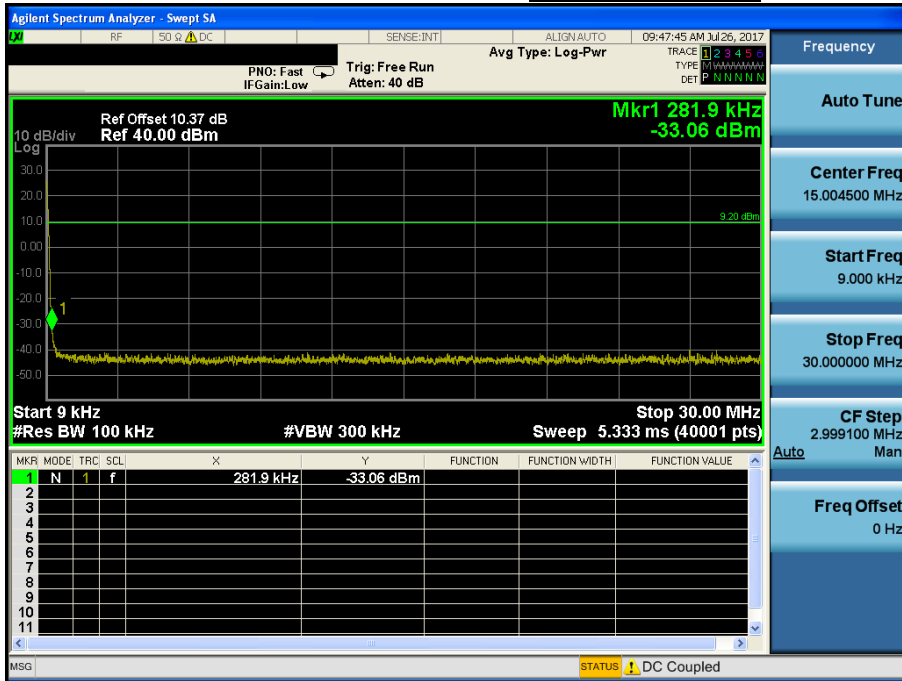
High Band-edge

*Hopping mode*



Conducted Spurious Emissions

Highest Channel



## 8. Transmitter AC Power Line Conducted Emission

### 8.1 Test Setup

**Comply**

### 8.2 Limit

According to §15.207(a) 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 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               | 56                     | 46         |
| 5 ~ 30                | 60                     | 50         |

\* Decreases with the logarithm of the frequency

### 8.3 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.

**8.4. Test Results**

**AC Line Conducted Emissions (Graph)\_ANT 1**

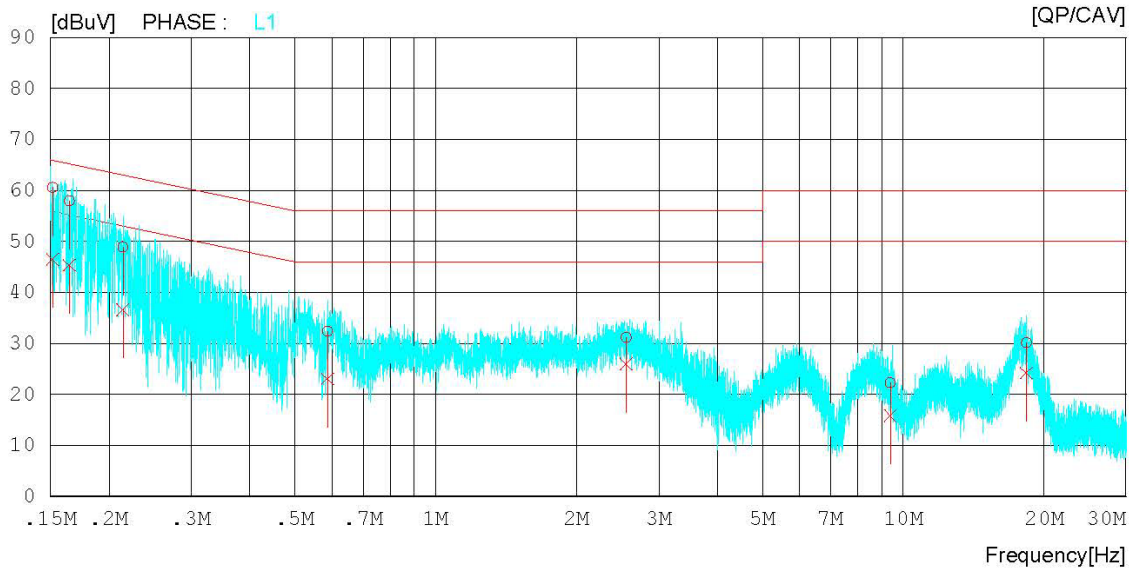
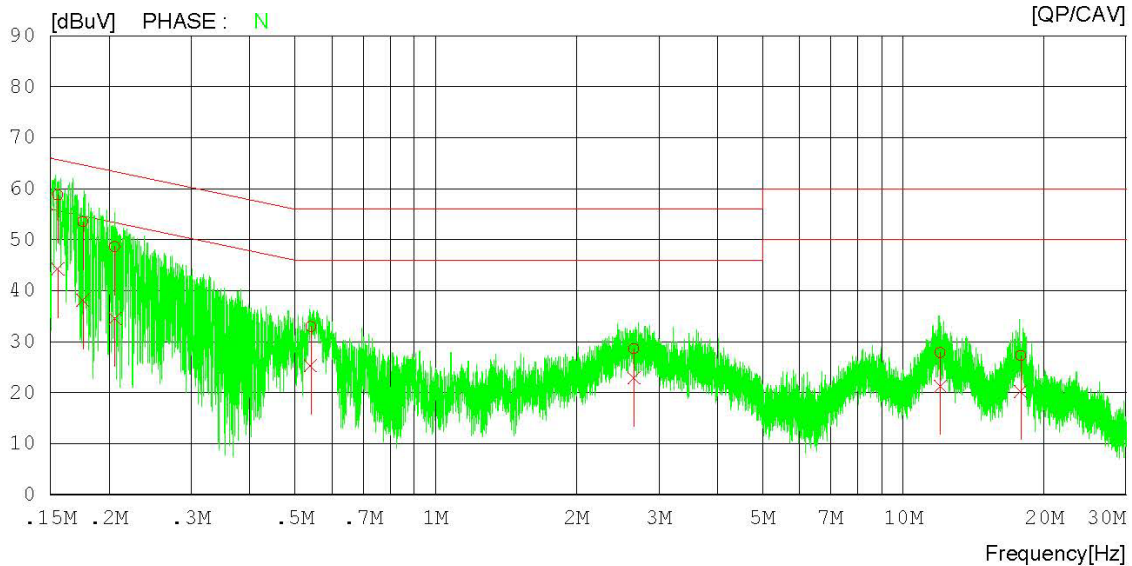
Results of Conducted Emission

DT&C Date 2017-07-26

|                |             |              |                |
|----------------|-------------|--------------|----------------|
| Model          | RED5        | Temp/Humi.   | 23 'C 48 %     |
| Function       | 900MHz RFID | Power Supply | AC 120 V 60 Hz |
| Mode           |             | Operator     | J.W.Kim        |
| Test condition |             |              |                |

Memo

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



## AC Line Conducted Emissions (List)\_ANT 1

### Results of Conducted Emission

DT&C Date 2017-07-26

|                |             |              |                |
|----------------|-------------|--------------|----------------|
| Model          | RED5        | Temp/Humi.   | 23 'C 48 %     |
| Function       | 900MHz RFID | Power Supply | AC 120 V 60 Hz |
| Mode           |             | Operator     | J.W.Kim        |
| Test condition |             |              |                |

Memo

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

| NO | FREQ<br>[MHz] | READING      |               | C. FACTOR<br>[dB] | RESULT       |               | LIMIT        |               | MARGIN |       | PHASE |
|----|---------------|--------------|---------------|-------------------|--------------|---------------|--------------|---------------|--------|-------|-------|
|    |               | QP<br>[dBuV] | CAV<br>[dBuV] |                   | QP<br>[dBuV] | CAV<br>[dBuV] | QP<br>[dBuV] | CAV<br>[dBuV] |        |       |       |
| 1  | 0.15544       | 58.58        | 44.06         | 0.22              | 58.80        | 44.28         | 65.70        | 55.70         | 6.90   | 11.42 | N     |
| 2  | 0.17589       | 53.32        | 37.92         | 0.21              | 53.53        | 38.13         | 64.68        | 54.68         | 11.15  | 16.55 | N     |
| 3  | 0.20628       | 48.48        | 34.46         | 0.20              | 48.68        | 34.66         | 63.35        | 53.35         | 14.67  | 18.69 | N     |
| 4  | 0.54021       | 32.73        | 25.02         | 0.22              | 32.95        | 25.24         | 56.00        | 46.00         | 23.05  | 20.76 | N     |
| 5  | 2.65720       | 28.26        | 22.52         | 0.34              | 28.60        | 22.86         | 56.00        | 46.00         | 27.40  | 23.14 | N     |
| 6  | 12.00440      | 27.05        | 20.48         | 0.85              | 27.90        | 21.33         | 60.00        | 50.00         | 32.10  | 28.67 | N     |
| 7  | 17.82800      | 26.07        | 19.00         | 1.24              | 27.31        | 20.24         | 60.00        | 50.00         | 32.69  | 29.76 | N     |
| 8  | 0.15154       | 60.30        | 46.32         | 0.18              | 60.48        | 46.50         | 65.92        | 55.92         | 5.44   | 9.42  | L1    |
| 9  | 0.16456       | 57.76        | 45.12         | 0.18              | 57.94        | 45.30         | 65.23        | 55.23         | 7.29   | 9.93  | L1    |
| 10 | 0.21413       | 48.67        | 36.46         | 0.17              | 48.84        | 36.63         | 63.04        | 53.04         | 14.20  | 16.41 | L1    |
| 11 | 0.58671       | 32.19        | 22.81         | 0.21              | 32.40        | 23.02         | 56.00        | 46.00         | 23.60  | 22.98 | L1    |
| 12 | 2.55380       | 30.83        | 25.61         | 0.32              | 31.15        | 25.93         | 56.00        | 46.00         | 24.85  | 20.07 | L1    |
| 13 | 9.38060       | 21.46        | 15.01         | 0.77              | 22.23        | 15.78         | 60.00        | 50.00         | 37.77  | 34.22 | L1    |
| 14 | 18.34280      | 28.77        | 22.81         | 1.36              | 30.13        | 24.17         | 60.00        | 50.00         | 29.87  | 25.83 | L1    |



## 9. Antenna Requirement

### 9.1 Procedure

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.

### 9.2 Conclusion

: **Comply**

The external antennas (ANT1&2&3) employs a unique antenna connector (CMJ type) using the cable.

#### Minimum Standard:

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

## 10. Occupied Bandwidth (99 %)

### 10.1 Test Setup

Refer to the APPENDIX I.

### 10.2 Limit

Limit : Not Applicable

### 10.3 Test Procedure

The 99 % power bandwidth was measured with a calibrated spectrum analyzer.

The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately  $3 \times$  RBW.

Spectrum analyzer plots are included on the following pages.

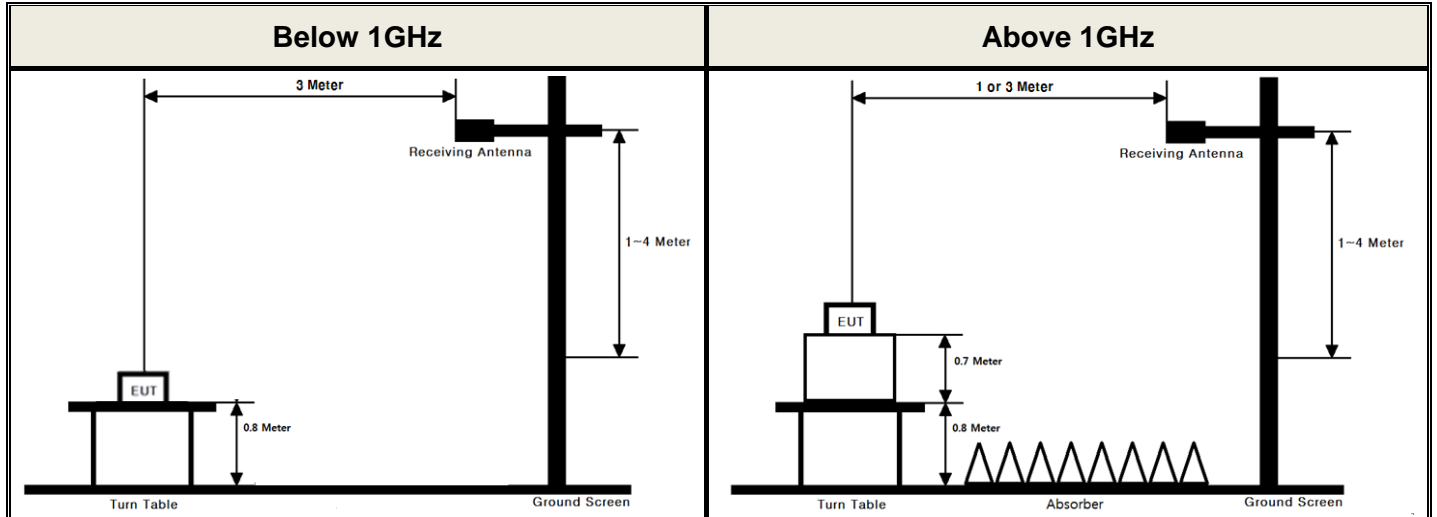
### 10.4 Test Results

**Not Applicable**

# APPENDIX I

## Test set up diagrams

### ▪ Radiated Measurement



### ▪ Conducted Measurement



Path loss information

| Frequency (MHz)       | Path Loss (dB) | Frequency (MHz) | Path Loss (dB) |
|-----------------------|----------------|-----------------|----------------|
| 30                    | 10.37          | 1000            | 11.09          |
| 500                   | 10.84          | 5000            | 12.25          |
| 917.1 & 921.9 & 926.9 | 11.06          | 10000           | 12.59          |
| -                     | -              | -               | -              |

Note 1 : The path loss from EUT to Spectrum analyzer were measured and used for test.

Path loss ( S/A's Correction factor) = Cable A + Attenuator

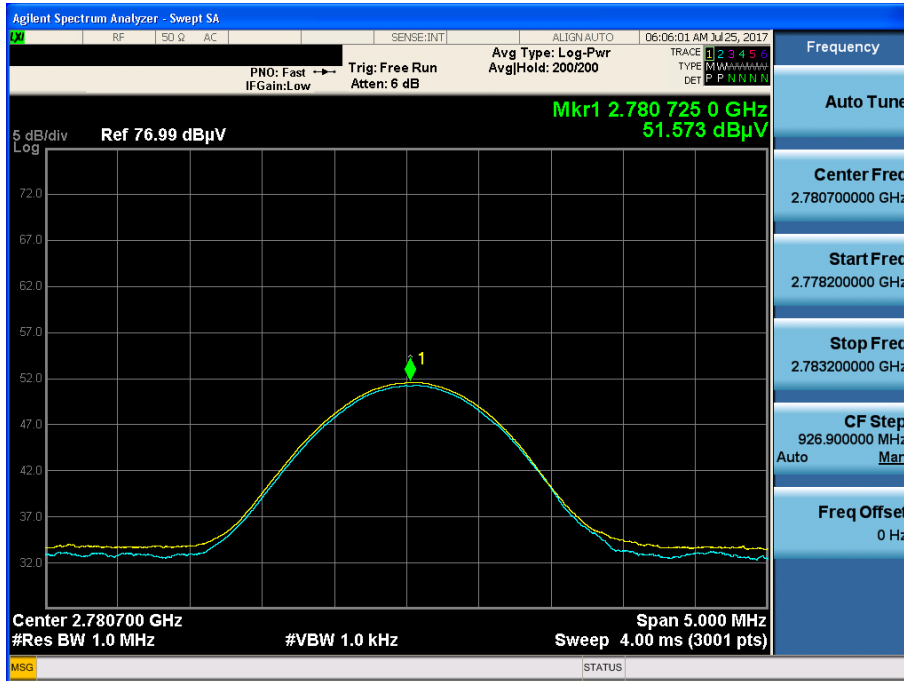
## APPENDIX II

### Unwanted Emissions (Radiated) Test Plot

<ANT 1>

Highest & Z & Ver

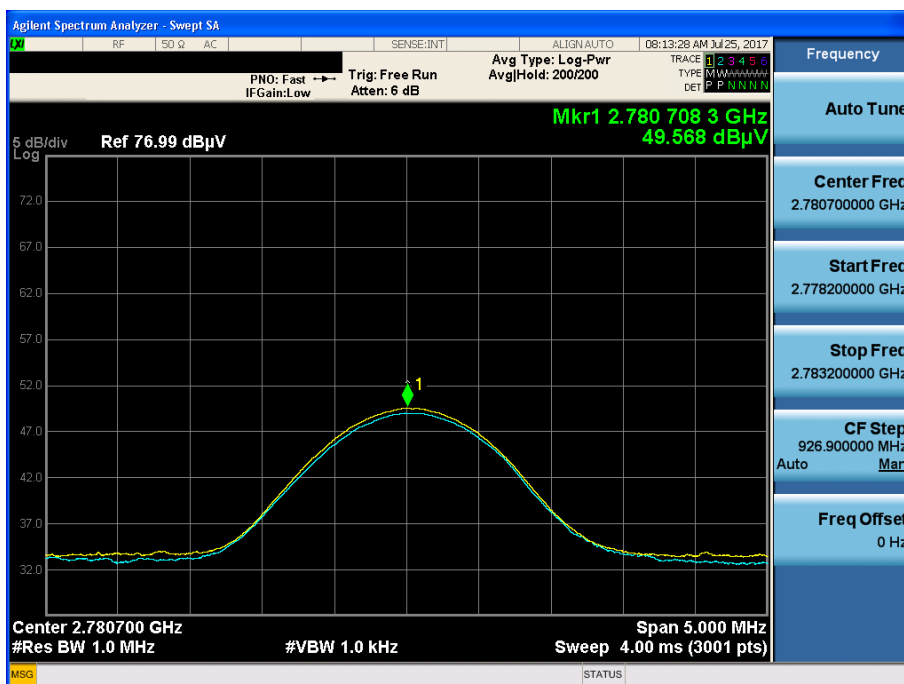
Detector Mode : AV



<ANT 2>

Highest & Z & Hor

Detector Mode : AV



<ANT 3>

Highest & Y & Hor

Detector Mode : AV

