

## FCC Test Report

**Report No.:** RF161123E04

**FCC ID:** VECAP97

**Test Model:** AP97

**Received Date:** Nov. 23, 2016

**Test Date:** Nov. 29, 2016 to Jan. 17, 2017

**Issued Date:** Jan. 24, 2017

**Applicant:** ST Electronics (Satcom & Sensor Systems) Pte. Ltd.

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Singapore 567710

**Issued By:** Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch  
Hsin Chu Laboratory

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Taiwan R.O.C.

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### Release Control Record

| Issue No.   | Description       | Date Issued   |
|-------------|-------------------|---------------|
| RF161123E04 | Original release. | Jan. 24, 2017 |

## 1 Certificate of Conformity

**Product:** K-Band Miniature Microwave Doppler Transceiver Module

**Brand:** ST Electronics (Satcom & Sensor Systems) Pte. Ltd.

**Test Model:** AP97

**Sample Status:** ENGINEERING SAMPLE

**Applicant:** ST Electronics (Satcom & Sensor Systems) Pte. Ltd.

**Test Date:** Nov. 29, 2016 to Jan. 17, 2017

**Standards:** 47 CFR FCC Part 15, Subpart C (Section 15.245)  
ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

**Prepared by :** Midoli Peng , **Date:** Jan. 24, 2017  
Midoli Peng / Specialist

**Approved by :** May Chen , **Date:** Jan. 24, 2017  
May Chen / Manager

## 2 Summary of Test Results

| 47 CFR FCC Part 15, Subpart C (SECTION 15.245) |                             |        |                                                                                      |
|------------------------------------------------|-----------------------------|--------|--------------------------------------------------------------------------------------|
| FCC Clause                                     | Test Item                   | Result | Remarks                                                                              |
| 15.207                                         | AC Power Conducted Emission | PASS   | Meet the requirement of limit.<br>Minimum passing margin is -26.68dB at 24.00391MHz. |
| 15.245                                         | Radiated Emission Test      | PASS   | Meet the requirement of limit<br>Minimum passing margin is -8.4dB at 7751.43MHz      |
| 15.215 (c)                                     | 20dB Bandwidth              | PASS   | Meet the requirement of limit                                                        |
| 15.203                                         | Antenna Requirement         | PASS   | No antenna connector is used.                                                        |

### 2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

| Measurement                        | Frequency       | Expanded Uncertainty (k=2) ( $\pm$ ) |
|------------------------------------|-----------------|--------------------------------------|
| Conducted Emissions at mains ports | 150kHz ~ 30MHz  | 1.83 dB                              |
| Radiated Emissions up to 1 GHz     | 30MHz ~ 200MHz  | 5.36 dB                              |
|                                    | 200MHz ~1000MHz | 3.47 dB                              |
| Radiated Emissions above 1 GHz     | 1GHz ~ 18GHz    | 3.75 dB                              |
|                                    | 18GHz ~ 40GHz   | 3.30 dB                              |

### 2.2 Modification Record

There were no modifications required for compliance.

### 3 General Information

#### 3.1 General Description of EUT

|                     |                                                       |
|---------------------|-------------------------------------------------------|
| Product             | K-Band Miniature Microwave Doppler Transceiver Module |
| Brand               | ST Electronics (Satcom & Sensor Systems) Pte. Ltd.    |
| Test Model          | AP97                                                  |
| Status of EUT       | ENGINEERING SAMPLE                                    |
| Power Supply Rating | DC 5V                                                 |
| Modulation Type     | CW                                                    |
| Carrier Frequency   | 24.075~24.175GHz                                      |
| Number of Channel   | 1                                                     |
| Antenna Type        | Patch antenna                                         |
| Antenna Connector   | NA                                                    |
| Accessory Device    | NA                                                    |
| Data Cable Supplied | NA                                                    |

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

### 3.2 Description of Test Modes

1 channel is provided for test:

| Channel | Frequency |
|---------|-----------|
| 1       | 24130 MHz |

### 3.2.1 Test Mode Applicability and Tested Channel Detail

| EUT CONFIGURE MODE | APPLICABLE TO |       |     |    | DESCRIPTION |
|--------------------|---------------|-------|-----|----|-------------|
|                    | RE≥1G         | RE<1G | PLC | BW |             |
| -                  | √             | √     | √   | √  | -           |

Where **RE≥1G**: Radiated Emission above 1GHz & Bandedge Measurement **RE<1G**: Radiated Emission below 1GHz  
**PLC**: Power Line Conducted Emission **BW**: 20dB Bandwidth Measurement

**NOTE:** The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on Z-plane.

#### **Radiated Emission Test (Above 1GHz):**

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| TESTED CHANNEL | MODULATION TYPE |
|----------------|-----------------|
| 1              | CW              |

#### **Radiated Emission Test (Below 1GHz):**

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| TESTED CHANNEL | MODULATION TYPE |
|----------------|-----------------|
| 1              | CW              |

#### **Power Line Conducted Emission Test:**

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

| TESTED CHANNEL | MODULATION TYPE |
|----------------|-----------------|
| 1              | CW              |

#### **20dB Bandwidth Measurement:**

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

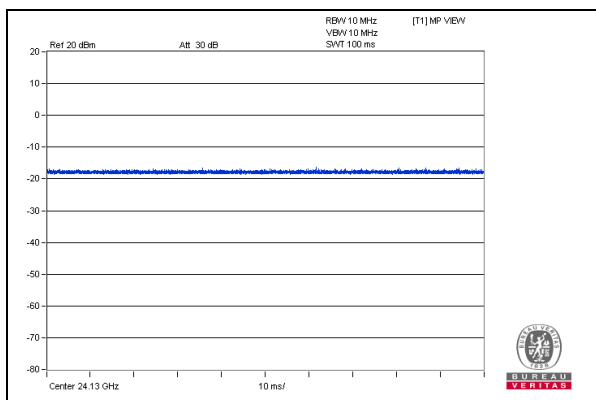
| TESTED CHANNEL | MODULATION TYPE |
|----------------|-----------------|
| 1              | CW              |

**Test Condition:**

| APPLICABLE TO | ENVIRONMENTAL CONDITIONS | INPUT POWER           | TESTED BY     |
|---------------|--------------------------|-----------------------|---------------|
| RE $\geq$ 1G  | 22deg. C, 67%RH          | DC 5V                 | Robert Cheng  |
| RE<1G         | 22deg. C, 66%RH          | DC 5V                 | Robert Cheng  |
| PLC           | 25deg. C, 75%RH          | 120Vac, 60Hz (system) | Andy Ho       |
| BW            | 22deg. C, 66%RH          | 120Vac, 60 Hz         | Anderson chen |

### 3.3 Duty Cycle of Test Signal

Duty cycle of test signal is 100 %, duty factor is not required.



### 3.4 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| ID | Product         | Brand   | Model No. | Serial No. | FCC ID | Remarks         |
|----|-----------------|---------|-----------|------------|--------|-----------------|
| A  | DC POWER SUPPLY | Topward | 6603D     | 795558     | NA     | Provided by Lab |

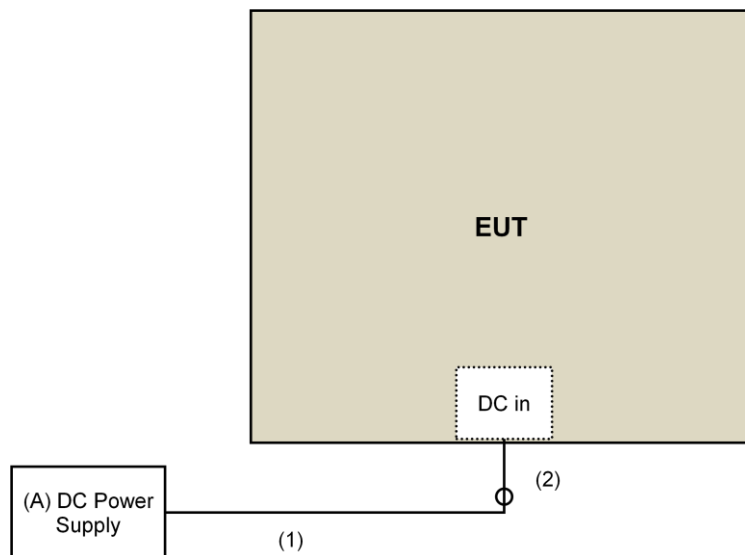
Note:

1. All power cords of the above support units are non-shielded (1.8m).

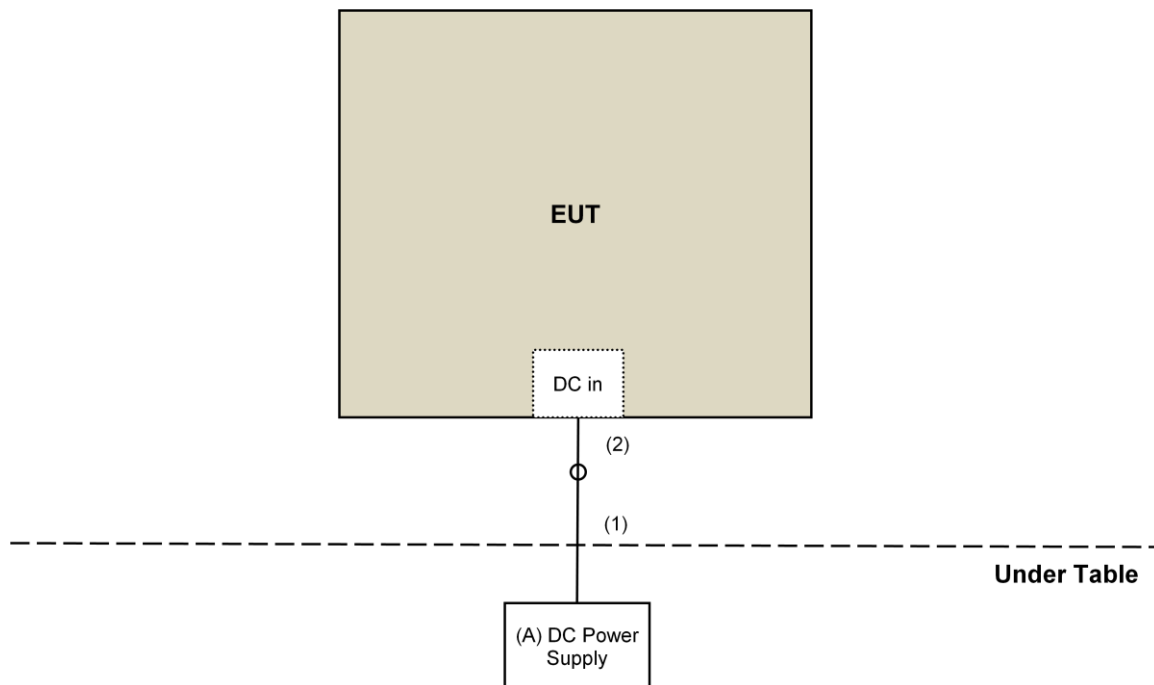
| ID | Descriptions | Qty. | Length (m) | Shielding (Yes/No) | Cores (Qty.) | Remarks         |
|----|--------------|------|------------|--------------------|--------------|-----------------|
| 1  | DC Cable     | 1    | 2.2        | No                 | 0            | Provided by Lab |
| 2  | DC Cable     | 1    | 0.2        | No                 | 0            | Provided by Lab |

### 3.4.1 Configuration of System under Test

#### For conducted emission



#### For radiated emission



### 3.5 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

**FCC Part 15, Subpart C (15.245)**

ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

## 4 Test Types and Results

### 4.1 Radiated Emission and Bandedge Measurement

#### 4.1.1 Limits of Radiated Emission and Bandedge Measurement

According to 15.245 the field strength of emissions from intentional radiators operated under these frequencies bands shall not exceed the following:

| Fundamental Frequency<br>(MHz) | Field Strength of Fundamental (dBuV/m) |         |
|--------------------------------|----------------------------------------|---------|
|                                | Peak                                   | Average |
| 24075 ~ 24175                  | 147.9                                  | 127.9   |
|                                | Field Strength of Harmonics (dBuV/m)   |         |
|                                | 107.9                                  | 87.9    |

Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

| Application                                                                                                                                                                | Field Strength of Harmonics<br>(dBuV/m) |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| Field disturbance sensors operating in the 24075-24175 MHz band and for Other field disturbance sensors designed for use only within a building or to open building doors. | 87.9                                    |
| All other field disturbance sensors                                                                                                                                        | 77.5                                    |

Note: Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands, other than the second and third harmonics from devices operating in the 24075-24175 MHz band, fully comply with the limits given in Section 15.209.

- (1) Field strength limits are specified at a distance of 3 meters.
- (2) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209, whichever is the lesser attenuation.

Emissions radiated outside of the specified bands, shall be according to the general radiated limits in 15.209 as following:

| Frequencies<br>(MHz) | Field strength<br>(microvolts/meter) | Measurement distance<br>(meters) |
|----------------------|--------------------------------------|----------------------------------|
| 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                                |

**NOTE:**

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

#### 4.1.2 Test Instruments

##### Below 40GHz test:

| DESCRIPTION & MANUFACTURER                     | MODEL NO.                                                   | SERIAL NO.                    | CALIBRATED DATE | CALIBRATED UNTIL |
|------------------------------------------------|-------------------------------------------------------------|-------------------------------|-----------------|------------------|
| Test Receiver<br>Agilent                       | N9038A                                                      | MY50010156                    | Aug. 18, 2016   | Aug. 17, 2017    |
| Pre-Amplifier <sup>(*)</sup><br>EMCI           | EMC001340                                                   | 980142                        | Jan. 20, 2016   | Jan. 19, 2018    |
| Loop Antenna <sup>(*)</sup><br>Electro-Metrics | EM-6879                                                     | 264                           | Dec. 16, 2016   | Dec. 15, 2018    |
| RF Cable                                       | NA                                                          | LOOPCAB-001<br>LOOPCAB-002    | Jan. 18, 2016   | Jan. 17, 2017    |
| Pre-Amplifier<br>Mini-Circuits                 | ZFL-1000VH2B                                                | AMP-ZFL-05                    | May 07, 2016    | May 06, 2017     |
| Trilog Broadband Antenna<br>SCHWARZBECK        | VULB 9168                                                   | 9168-361                      | Dec. 29, 2016   | Dec. 28, 2017    |
| RF Cable                                       | 8D                                                          | 966-3-1<br>966-3-2<br>966-3-3 | Apr. 02, 2016   | Apr. 01, 2017    |
| Fixed attenuator<br>Mini-Circuits              | UNAT-5+                                                     | PAD-3m-3-01                   | Oct. 05, 2016   | Oct. 04, 2017    |
| Horn_Antenna<br>SCHWARZBECK                    | BBHA9120-D                                                  | 9120D-406                     | Dec. 28, 2016   | Dec. 27, 2017    |
| Pre-Amplifier<br>Agilent                       | 8449B                                                       | 3008A02465                    | Apr. 05, 2016   | Apr. 04, 2017    |
| RF Cable                                       | EMC104-SM-SM-2000<br>EMC104-SM-SM-5000<br>EMC104-SM-SM-5000 | 150317<br>150321<br>150322    | Mar. 30, 2016   | Mar. 29, 2017    |
| Spectrum Analyzer<br>Keysight                  | N9030A                                                      | MY54490520                    | July 29, 2016   | July 28, 2017    |
| Pre-Amplifier<br>EMCI                          | EMC184045                                                   | 980143                        | Jan. 14, 2017   | Jan. 13, 2018    |
| Horn_Antenna<br>SCHWARZBECK                    | BBHA 9170                                                   | BBHA9170608                   | Dec. 15, 2016   | Dec. 14, 2017    |
| RF Cable                                       | SUCOFLEX 102                                                | 36432/2<br>36433/2            | Jan. 15, 2017   | Jan. 14, 2018    |
| Software                                       | ADT_Radiated_V8.7.08                                        | NA                            | NA              | NA               |
| Antenna Tower & Turn Table<br>Max-Full         | MF-7802                                                     | MF780208406                   | NA              | NA               |
| Boresight Antenna Fixture                      | FBA-01                                                      | FBA-SIP01                     | NA              | NA               |

##### Note:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. \*The calibration interval of the above test instruments is 24 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Loop antenna was used for all emissions below 30 MHz.
4. The test was performed in 966 Chamber No. 3.
5. The FCC Site Registration No. is 147459
- 6 The CANADA Site Registration No. is 20331-1
7. Tested Date: Jan. 16, 2017

**Above 40GHz test:**

| DESCRIPTION & MANUFACTURER                                                                  | MODEL NO. | SERIAL NO.  | CALIBRATED DATE | CALIBRATED UNTIL |
|---------------------------------------------------------------------------------------------|-----------|-------------|-----------------|------------------|
| Spectrum Analyzer<br>Agilent                                                                | E4446A    | MY48250253  | Dec. 21, 2016   | Dec. 20, 2017    |
| *Harmonic Mixer (33~55GHz)<br>OML                                                           | M22HWD    | 110215-1    | Apr. 07, 2015   | Apr. 06, 2017    |
| *Horn Antenna (33~55GHz)<br>OML                                                             | M22RH     | 110215-1    | Apr. 07, 2015   | Apr. 06, 2017    |
| *Harmonic Mixer (50~75GHz)<br>OML                                                           | M15RH     | 110215-1    | Apr. 09, 2015   | Apr. 08, 2017    |
| *Horn Antenna (50~75GHz)<br>OML                                                             | M15HWD    | 110215-1    | Apr. 09, 2015   | Apr. 08, 2017    |
| *Harmonic Mixer (75~110GHz)<br>OML                                                          | M10HWD    | 110215-1    | Apr. 14, 2015   | Apr. 13, 2017    |
| *Horn Antenna (75~110GHz)<br>OML                                                            | M10RH     | 110215-1    | Apr. 14, 2015   | Apr. 13, 2017    |
| *Diplexer<br>EMCI                                                                           | DPL26     | DPL26_01    | Apr. 06, 2015   | Apr. 05, 2017    |
| *Diplexer<br>EMCI                                                                           | DPL26     | DPL26_02    | Apr. 06, 2015   | Apr. 05, 2017    |
| *Precision 30dB Attenuator<br>Keysight                                                      | 11708A    | MY55260015  | June 24, 2015   | June 23, 2017    |
| *Zero-Bias Detector (50~75GHz)<br>Vdi                                                       | WR15ZBD   | WR15R5 1-30 | July 30, 2015   | July 29, 2017    |
| 4CH Infiniivision Oscilloscope<br>Keysight                                                  | DSOX6004A | MY55190202  | Dec. 09, 2016   | Dec. 08, 2017    |
| *WR15CH Conical Horn<br>Keysight                                                            | WR15CH    | WR15CH-01   | Sep. 08, 2015   | Sep. 07, 2017    |
| *WR10CH Conical Horn<br>Keysight                                                            | WR10CH    | WR10CH-01   | Sep. 08, 2015   | Sep. 07, 2017    |
| *Millimeter-Wave Signal Generator<br>Frequency Extension Module<br>(50~75 GHz)<br>Keysight  | E8257DV15 | US54250106  | Dec. 22, 2015   | Dec. 21, 2017    |
| *Millimeter-Wave Signal Generator<br>Frequency Extension Module<br>(75~110 GHz)<br>Keysight | E8257DV10 | US53250009  | Dec. 22, 2015   | Dec. 21, 2017    |
| Antenna Tower & Turn Table<br>CT                                                            | NA        | NA          | NA              | NA               |

**Note:**

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. \*The calibration interval of the above test instruments is 24 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. The test was performed in 966 Chamber No. 3
4. The FCC Site Registration No. is 966073.
5. The VCCI Site Registration No. is G-137.
6. The CANADA Site Registration No. is IC 7450H-2.
7. Test Date: Jan. 17, 2017

#### 4.1.3 Test Procedures

##### **For Radiated emission: Below 30MHz**

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Both X and Y axes of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

##### **NOTE:**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

##### **For Radiated emission: 30MHz ~ 18GHz**

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna 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.
- d. 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

##### **Note:**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for Peak detection (PK) at frequency from 1GHz to 40GHz.
3. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 10Hz for Average detection (AV) at frequency from 1GHz to 40GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

### For Radiated emission: Above 18GHz

External harmonic mixers are utilized.

- The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meters chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- The distance at which limits are typically specified is 3 meter; however, closer measurement distances may be utilized.
- Begin handheld measurements with the test antenna (horn) at a distance of 1 meter from the EUT, in a horizontally polarized position. Slowly adjust its position, entirely covering the plane 1 meter from the EUT.
- Repeat (b) with the horn in a vertically polarized position.
- If the emission cannot be detected at 1 meter, reduce the RBW in order to increase system sensitivity. Note the value. If the emission still cannot be detected, move the horn closer to the EUT, noting the distance at which a measurement is made.
- Note the maximum level indicated on the Spectrum Analyzer.
- Based on the distance at which the measurement was made and the calculated distance to the edge of the far field, determine the appropriate distance attenuation factor. Apply this factor to the calculated field strength in order to determine the equivalent field strength at the distance at which the regulatory limit is specified. Compare to the appropriate limits
- Repeat (a) - (f) for every emission that must be measured, up through the required frequency range of investigation

### NOTE:

- The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 50MHz for Peak and Average detection at frequency above 40GHz.
- Shorter measurement distances may be used to improve the measurement system's noise floor. As ANSI C63.10 description is based on the measurement in distance of 3 meters, the data obtained at 0.8-meter distance was extrapolate results to the 3-m distance:

Test value at 3-meter distance (dBuV)

= Test value at 0.8 meter distance (dBuV) -20log(3/0.8)(dB)

= Test value at 0.8 meter distance (dBuV) -11.5(dB).

\* Measurements made at 0.8 meter distance. Test value converted to account for 3-meter measurement distance.

### FAR FIELD BOUNDARY CALCULATIONS

The far-field boundary is given as:

$$R \text{ far field} = (2 * L^2) / \lambda$$

where: L = Largest Antenna Dimension, including the reflector, in meters

$\lambda$  = wavelength in meters

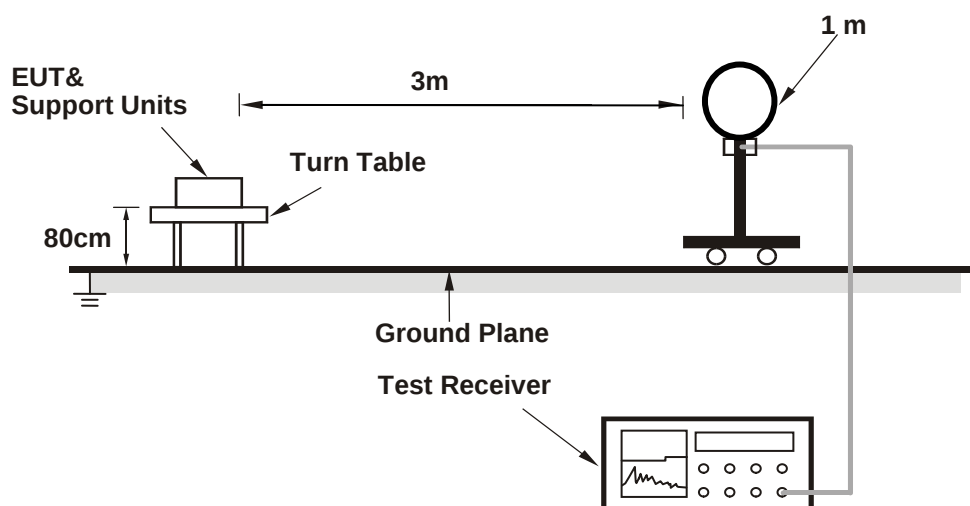
| FREQUENCY<br>(GHz ) | L (m) | Lambda (m) | R (Far Field)<br>(m) |
|---------------------|-------|------------|----------------------|
| 24.13               | 0.065 | 0.0124     | 0.6815               |

#### 4.1.4 Deviation from Test Standard

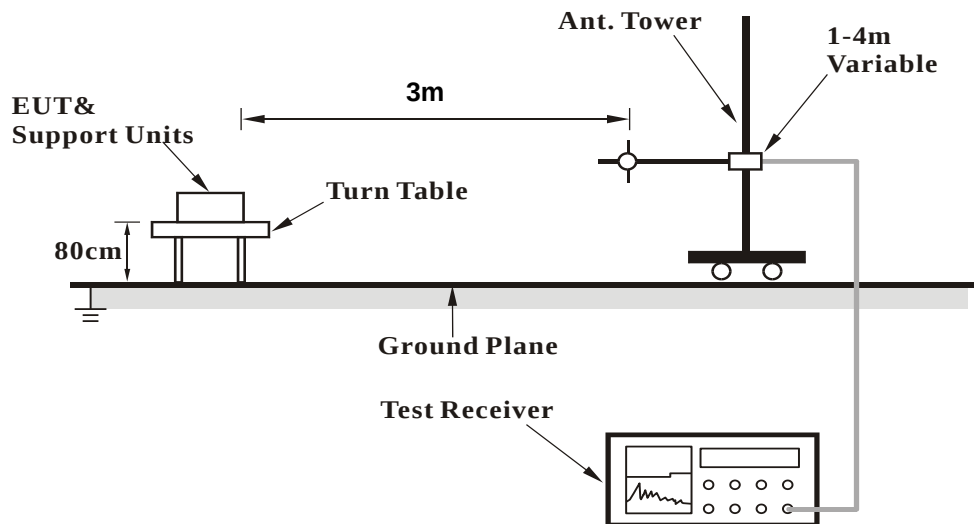
No deviation.

#### 4.1.5 Test Setup

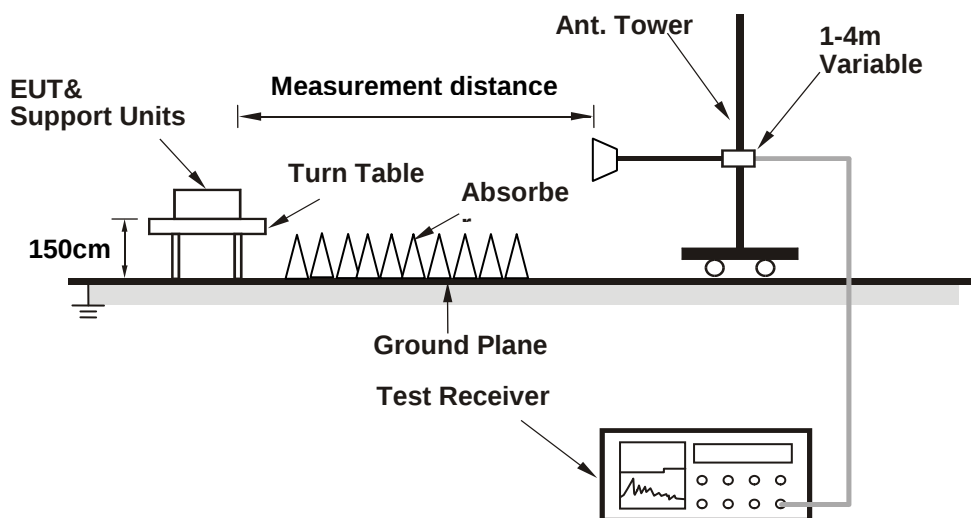
##### For Radiated emission below 30MHz



##### For Radiated emission 30MHz to 1GHz



## For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

### 4.1.6 EUT Operating Conditions

Set the EUT under transmission / receiver condition continuously at specific channel frequency.

#### 4.1.7 Test Results

##### Above 1GHz Data :

|                        |              |                          |              |
|------------------------|--------------|--------------------------|--------------|
| <b>CHANNEL</b>         | TX Channel 1 | <b>DETECTOR FUNCTION</b> | Peak (PK)    |
| <b>FREQUENCY RANGE</b> | 1GHz ~ 18GHz |                          | Average (AV) |

| ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M |             |                         |                |             |                    |                      |                  |                          |
|-----------------------------------------------------|-------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| NO.                                                 | FREQ. (MHz) | EMISSION LEVEL (dBuV/m) | LIMIT (dBuV/m) | MARGIN (dB) | ANTENNA HEIGHT (m) | TABLE ANGLE (Degree) | RAW VALUE (dBuV) | CORRECTION FACTOR (dB/m) |
| 1                                                   | 7751.43     | 57.6 PK                 | 74.0           | -16.4       | 1.50 H             | 117                  | 47.8             | 9.8                      |
| 2                                                   | 7751.43     | 45.6 AV                 | 54.0           | -8.4        | 1.50 H             | 117                  | 35.8             | 9.8                      |
| ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M   |             |                         |                |             |                    |                      |                  |                          |
| NO.                                                 | FREQ. (MHz) | EMISSION LEVEL (dBuV/m) | LIMIT (dBuV/m) | MARGIN (dB) | ANTENNA HEIGHT (m) | TABLE ANGLE (Degree) | RAW VALUE (dBuV) | CORRECTION FACTOR (dB/m) |
| 1                                                   | 6842.39     | 57.1 PK                 | 74.0           | -16.9       | 1.50 V             | 90                   | 49.6             | 7.5                      |
| 2                                                   | 6842.39     | 44.2 AV                 | 54.0           | -9.8        | 1.50 V             | 90                   | 36.7             | 7.5                      |

#### REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

|                 |               |                      |              |
|-----------------|---------------|----------------------|--------------|
| CHANNEL         | TX Channel 1  | DETECTOR<br>FUNCTION | Peak (PK)    |
| FREQUENCY RANGE | 18GHz ~ 40GHz |                      | Average (AV) |

| ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M |                |                               |                   |                |                          |                            |                        |                                |
|-----------------------------------------------------|----------------|-------------------------------|-------------------|----------------|--------------------------|----------------------------|------------------------|--------------------------------|
| NO.                                                 | FREQ.<br>(MHz) | EMISSION<br>LEVEL<br>(dBuV/m) | LIMIT<br>(dBuV/m) | MARGIN<br>(dB) | ANTENNA<br>HEIGHT<br>(m) | TABLE<br>ANGLE<br>(Degree) | RAW<br>VALUE<br>(dBuV) | CORRECTION<br>FACTOR<br>(dB/m) |
| 1                                                   | 24075.00       | 54.2 PK                       | 74.0              | -19.8          | 1.50 H                   | 89                         | 68.9                   | -14.7                          |
| 2                                                   | 24075.00       | 43.2 AV                       | 54.0              | -10.8          | 1.50 H                   | 89                         | 57.9                   | -14.7                          |
| 3                                                   | *24130.00      | 105.6 PK                      | 147.9             | -42.3          | 1.50 H                   | 89                         | 120.0                  | -14.4                          |
| 4                                                   | *24130.00      | 105.3 AV                      | 127.9             | -22.6          | 1.50 H                   | 89                         | 119.7                  | -14.4                          |
| 5                                                   | 24175.00       | 46.1 PK                       | 74.0              | -27.9          | 1.50 H                   | 89                         | 60.5                   | -14.4                          |
| 6                                                   | 24175.00       | 34.2 AV                       | 54.0              | -19.8          | 1.50 H                   | 89                         | 48.6                   | -14.4                          |
| ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M   |                |                               |                   |                |                          |                            |                        |                                |
| NO.                                                 | FREQ.<br>(MHz) | EMISSION<br>LEVEL<br>(dBuV/m) | LIMIT<br>(dBuV/m) | MARGIN<br>(dB) | ANTENNA<br>HEIGHT<br>(m) | TABLE<br>ANGLE<br>(Degree) | RAW<br>VALUE<br>(dBuV) | CORRECTION<br>FACTOR<br>(dB/m) |
| 1                                                   | 24075.00       | 47.3 PK                       | 74.0              | -26.7          | 1.50 V                   | 103                        | 62.0                   | -14.7                          |
| 2                                                   | 24075.00       | 35.2 AV                       | 54.0              | -18.8          | 1.50 V                   | 103                        | 49.9                   | -14.7                          |
| 3                                                   | *24130.00      | 92.8 PK                       | 147.9             | -55.1          | 1.50 V                   | 103                        | 107.2                  | -14.4                          |
| 4                                                   | *24130.00      | 92.4 AV                       | 127.9             | -35.5          | 1.50 V                   | 103                        | 106.8                  | -14.4                          |
| 5                                                   | 24175.00       | 46.1 PK                       | 74.0              | -27.9          | 1.50 V                   | 103                        | 60.5                   | -14.4                          |
| 6                                                   | 24175.00       | 34.2 AV                       | 54.0              | -19.8          | 1.50 V                   | 103                        | 48.6                   | -14.4                          |

**REMARKS:**

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " \* ": Fundamental frequency.

|                        |                |                              |              |
|------------------------|----------------|------------------------------|--------------|
| <b>CHANNEL</b>         | TX Channel 1   | <b>DETECTOR<br/>FUNCTION</b> | Peak (PK)    |
| <b>FREQUENCY RANGE</b> | 40GHz ~ 100GHz |                              | Average (AV) |

| ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M |             |                               |                   |             |                     |                            |                                   |
|-----------------------------------------------------|-------------|-------------------------------|-------------------|-------------|---------------------|----------------------------|-----------------------------------|
| NO.                                                 | FREQ. (GHz) | EMISSION<br>LEVEL<br>(dBuV/m) | LIMIT<br>(dBuV/m) | MARGIN (dB) | EIRP Level<br>(dBm) | Measured<br>Power<br>(dBm) | Receiver<br>Antenna<br>Gain (dBi) |
| 1                                                   | 48.26       | 75.7 PK                       | 97.5              | -21.8       | -19.5               | -59.8                      | 23.9                              |
| 2                                                   | 48.26       | 61.1 AV                       | 77.5              | -16.4       | -34.1               | -74.4                      | 23.9                              |
| 3                                                   | 72.39       | 76.5 PK                       | 97.5              | -21.0       | -18.7               | -62.5                      | 23.9                              |
| 4                                                   | 72.39       | 62.7 AV                       | 77.5              | -14.8       | -32.5               | -76.3                      | 23.9                              |
| 5                                                   | 96.52       | -                             | -                 | -           | -                   | -                          | -                                 |
| ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M   |             |                               |                   |             |                     |                            |                                   |
| NO.                                                 | FREQ. (GHz) | EMISSION<br>LEVEL<br>(dBuV/m) | LIMIT<br>(dBuV/m) | MARGIN (dB) | EIRP Level<br>(dBm) | Measured<br>Power<br>(dBm) | Receiver<br>Antenna<br>Gain (dBi) |
| 1                                                   | 48.26       | 74.5 PK                       | 97.5              | -23.0       | -20.7               | -61.0                      | 23.9                              |
| 2                                                   | 48.26       | 61.7 AV                       | 77.5              | -15.8       | -33.5               | -73.8                      | 23.9                              |
| 3                                                   | 72.39       | 76.4 PK                       | 97.5              | -21.1       | -18.8               | -62.6                      | 23.9                              |
| 4                                                   | 72.39       | 62 AV                         | 77.5              | -15.5       | -33.2               | -77.0                      | 23.9                              |
| 5                                                   | 96.52       | -                             | -                 | -           | -                   | -                          | -                                 |

#### REMARKS:

1. The measured power level is converted to EIRP using the Friis equation:

$$EIRP = P_T * G_T = (P_R / G_R) * (4 * \pi * D / \lambda)^2$$

where:

PR is the power of the receive measurement

GR is the gain of the receive measurement antenna

D is the measurement distance

$\lambda$  is the wavelength

2. Field strength is then converted to EIRP as follows:

$$EIRP = ((E * D)^2) / 30$$

Working in dB units, the above equation is equivalent to:

$$EIRP[dBm] = E[dBuV/m] + 20 \log(D[meters]) - 104.8$$

$$E = EIRP - 20 * \log(D) + 104.8$$

3. " - ": The emission levels were too low to be detected.

4. Shorter measurement distances may be used to improve the measurement system's noise floor. As ANSI C63.10 description is based on the measurement in distance of 3 meters, the data obtained at 0.8-meter distance was extrapolate results to the 3-m distance:

Test value at 3-meter distance (dBuV)

$$= \text{Test value at 0.8 meter distance (dBuV)} - 20 \log(3/0.8)(dB)$$

$$= \text{Test value at 0.8 meter distance (dBuV)} - 11.5(dB).$$

\*Measurements made at 0.8 meter distance. Test value converted to account for 3-meter measurement distance.

#### Below 1GHz Data:

|                        |              |                              |                 |
|------------------------|--------------|------------------------------|-----------------|
| <b>CHANNEL</b>         | TX Channel 1 | <b>DETECTOR<br/>FUNCTION</b> | Quasi-Peak (QP) |
| <b>FREQUENCY RANGE</b> | 30MHz ~ 1GHz |                              |                 |

| ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M |                |                               |                   |                |                          |                            |                        |                                |
|-----------------------------------------------------|----------------|-------------------------------|-------------------|----------------|--------------------------|----------------------------|------------------------|--------------------------------|
| NO.                                                 | FREQ.<br>(MHz) | EMISSION<br>LEVEL<br>(dBuV/m) | LIMIT<br>(dBuV/m) | MARGIN<br>(dB) | ANTENNA<br>HEIGHT<br>(m) | TABLE<br>ANGLE<br>(Degree) | RAW<br>VALUE<br>(dBuV) | CORRECTION<br>FACTOR<br>(dB/m) |
| 1                                                   | 39.24          | 28.2 QP                       | 40.0              | -11.8          | 1.24 H                   | 200                        | 37.3                   | -9.1                           |
| 2                                                   | 71.62          | 26.1 QP                       | 40.0              | -13.9          | 1.34 H                   | 241                        | 36.9                   | -10.8                          |
| 3                                                   | 275.42         | 25.1 QP                       | 46.0              | -20.9          | 1.65 H                   | 210                        | 33.2                   | -8.1                           |
| 4                                                   | 474.85         | 26.1 QP                       | 46.0              | -19.9          | 1.65 H                   | 244                        | 29.0                   | -2.9                           |
| 5                                                   | 644.68         | 30.1 QP                       | 46.0              | -15.9          | 1.65 H                   | 301                        | 29.4                   | 0.7                            |
| 6                                                   | 810.64         | 27.7 QP                       | 46.0              | -18.3          | 1.00 H                   | 360                        | 24.6                   | 3.1                            |
| ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M   |                |                               |                   |                |                          |                            |                        |                                |
| NO.                                                 | FREQ.<br>(MHz) | EMISSION<br>LEVEL<br>(dBuV/m) | LIMIT<br>(dBuV/m) | MARGIN<br>(dB) | ANTENNA<br>HEIGHT<br>(m) | TABLE<br>ANGLE<br>(Degree) | RAW<br>VALUE<br>(dBuV) | CORRECTION<br>FACTOR<br>(dB/m) |
| 1                                                   | 65.21          | 21.1 QP                       | 40.0              | -18.9          | 1.25 V                   | 300                        | 30.6                   | -9.5                           |
| 2                                                   | 196.21         | 26.8 QP                       | 43.5              | -16.7          | 1.65 V                   | 100                        | 38.1                   | -11.3                          |
| 3                                                   | 246.85         | 26.1 QP                       | 46.0              | -19.9          | 1.65 V                   | 302                        | 35.6                   | -9.5                           |
| 4                                                   | 437.02         | 23.2 QP                       | 46.0              | -22.8          | 1.00 V                   | 113                        | 26.8                   | -3.6                           |
| 5                                                   | 599.38         | 25.3 QP                       | 46.0              | -20.7          | 1.00 V                   | 54                         | 25.5                   | -0.2                           |
| 6                                                   | 795.96         | 28.5 QP                       | 46.0              | -17.5          | 1.00 V                   | 50                         | 25.4                   | 3.1                            |

#### REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

## 4.2 Conducted Emission Measurement

### 4.2.1 Limits of Conducted Emission Measurement

| Frequency (MHz) | Conducted Limit (dBuV) |         |
|-----------------|------------------------|---------|
|                 | Quasi-peak             | Average |
| 0.15 - 0.5      | 66 - 56                | 56 - 46 |
| 0.50 - 5.0      | 56                     | 46      |
| 5.0 - 30.0      | 60                     | 50      |

Note: 1. The lower limit shall apply at the transition frequencies.

2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

### 4.2.2 Test Instruments

| DESCRIPTION & MANUFACTURER                                         | MODEL NO.               | SERIAL NO. | CALIBRATED DATE | CALIBRATED UNTIL |
|--------------------------------------------------------------------|-------------------------|------------|-----------------|------------------|
| Test Receiver<br>R&S                                               | ESCS 30                 | 847124/029 | Oct. 24, 2016   | Oct. 23, 2017    |
| Line-Impedance<br>Stabilization Network<br>(for EUT)<br>R&S        | ESH3-Z5                 | 848773/004 | Oct. 26, 2016   | Oct. 25, 2017    |
| Line-Impedance<br>Stabilization Network<br>(for Peripheral)<br>R&S | ENV216                  | 100072     | June 13, 2016   | June 12, 2017    |
| RF Cable                                                           | 5D-FB                   | COCCAB-001 | Sep. 30, 2016   | Sep. 29, 2017    |
| 10 dB PAD<br>Mini-Circuits                                         | HAT-10+                 | CONATT-004 | June 20, 2016   | June 19, 2017    |
| Software<br>BVADT                                                  | BVADT_Cond_<br>V7.3.7.4 | NA         | NA              | NA               |

#### Note:

1. The calibration interval of the above test instruments are 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in Shielded Room No. 1.
- 4 Tested Date: Nov. 29, 2016

#### 4.2.3 Test Procedures

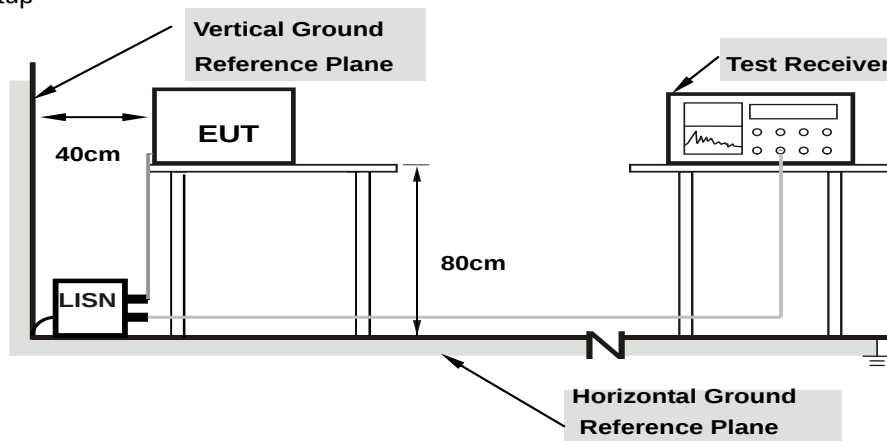
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

**NOTE:** The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

#### 4.2.4 Deviation from Test Standard

No deviation.

#### 4.2.5 Test Setup



**Note:** 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

#### 4.2.6 EUT Operating Conditions

Same as 4.1.6.

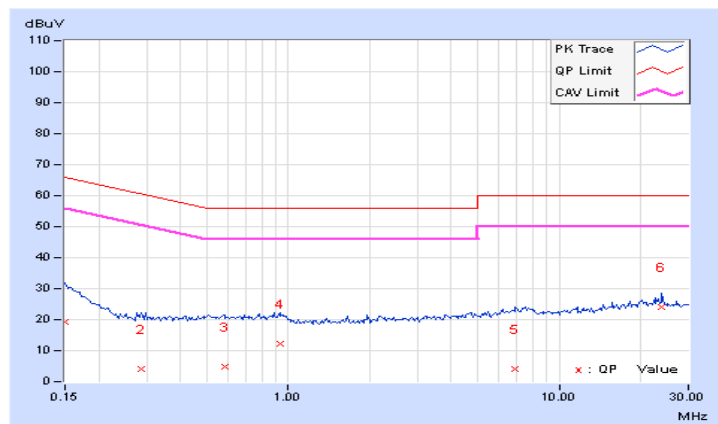
#### 4.2.7 Test Results

| Phase | Line (L) | Detector Function | Quasi-Peak (QP) / Average (AV) |
|-------|----------|-------------------|--------------------------------|
|-------|----------|-------------------|--------------------------------|

| Phase Of Power : Line (L) |                 |                        |                      |       |                       |       |              |       |             |        |
|---------------------------|-----------------|------------------------|----------------------|-------|-----------------------|-------|--------------|-------|-------------|--------|
| No                        | Frequency (MHz) | Correction Factor (dB) | Reading Value (dBuV) |       | Emission Level (dBuV) |       | Limit (dBuV) |       | Margin (dB) |        |
|                           |                 |                        | Q.P.                 | AV.   | Q.P.                  | AV.   | Q.P.         | AV.   | Q.P.        | AV.    |
| 1                         | 0.15000         | 10.19                  | 9.23                 | 1.50  | 19.42                 | 11.69 | 66.00        | 56.00 | -46.58      | -44.31 |
| 2                         | 0.28672         | 10.20                  | -6.04                | -8.48 | 4.16                  | 1.72  | 60.62        | 50.62 | -56.46      | -48.90 |
| 3                         | 0.58359         | 10.23                  | -5.58                | -8.09 | 4.65                  | 2.14  | 56.00        | 46.00 | -51.35      | -43.86 |
| 4                         | 0.93125         | 10.26                  | 2.00                 | 1.31  | 12.26                 | 11.57 | 56.00        | 46.00 | -43.74      | -34.43 |
| 5                         | 6.90625         | 10.39                  | -6.15                | -7.73 | 4.24                  | 2.66  | 60.00        | 50.00 | -55.76      | -47.34 |
| 6                         | 24.00391        | 11.42                  | 12.73                | 11.88 | 24.15                 | 23.30 | 60.00        | 50.00 | -35.85      | -26.70 |

#### Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

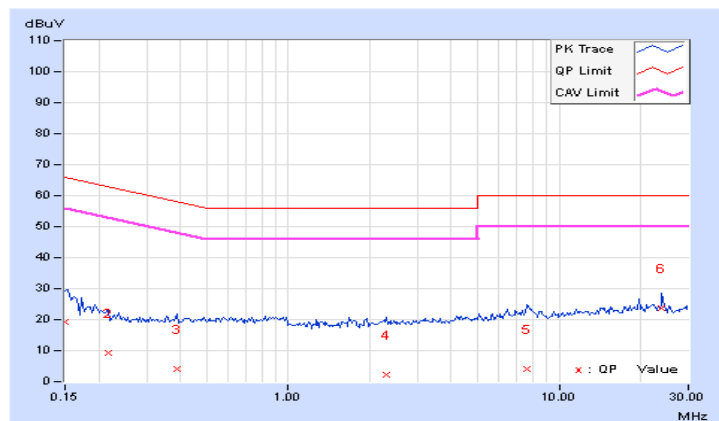


|       |             |                   |                                |
|-------|-------------|-------------------|--------------------------------|
| Phase | Neutral (N) | Detector Function | Quasi-Peak (QP) / Average (AV) |
|-------|-------------|-------------------|--------------------------------|

| Phase Of Power : Neutral (N) |                 |                        |                      |       |                       |       |              |       |             |        |
|------------------------------|-----------------|------------------------|----------------------|-------|-----------------------|-------|--------------|-------|-------------|--------|
| No                           | Frequency (MHz) | Correction Factor (dB) | Reading Value (dBuV) |       | Emission Level (dBuV) |       | Limit (dBuV) |       | Margin (dB) |        |
|                              |                 |                        | Q.P.                 | AV.   | Q.P.                  | AV.   | Q.P.         | AV.   | Q.P.        | AV.    |
| 1                            | 0.15000         | 10.18                  | 8.95                 | -5.38 | 19.13                 | 4.80  | 66.00        | 56.00 | -46.87      | -51.20 |
| 2                            | 0.21641         | 10.16                  | -0.86                | -8.15 | 9.30                  | 2.01  | 62.96        | 52.96 | -53.66      | -50.95 |
| 3                            | 0.38828         | 10.21                  | -6.09                | -8.26 | 4.12                  | 1.95  | 58.10        | 48.10 | -53.98      | -46.15 |
| 4                            | 2.30469         | 10.26                  | -7.88                | -8.69 | 2.38                  | 1.57  | 56.00        | 46.00 | -53.62      | -44.43 |
| 5                            | 7.58594         | 10.36                  | -6.14                | -7.62 | 4.22                  | 2.74  | 60.00        | 50.00 | -55.78      | -47.26 |
| 6                            | 24.00391        | 11.08                  | 12.61                | 12.24 | 23.69                 | 23.32 | 60.00        | 50.00 | -36.31      | -26.68 |

**Remarks:**

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value



### 4.3 20dB bandwidth Measurement

#### 4.3.1 Limits of 20dB bandwidth Measurement

According to 15.215(c), the requirement is to ensure the 20dB bandwidth of the emission, or whatever bandwidth may otherwise be specified, is contained within the frequency band designated in the rule section under which the equipment is operated.

#### 4.3.2 Test Instruments

| DESCRIPTION & MANUFACTURER | MODEL NO. | SERIAL NO. | CALIBRATED DATE | CALIBRATED UNTIL |
|----------------------------|-----------|------------|-----------------|------------------|
| Spectrum Analyzer R&S      | FSV40     | 100964     | June 28, 2016   | June 27, 2017    |

#### Note:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. Tested date : Jan. 16, 2017

#### 4.3.3 Test Procedures

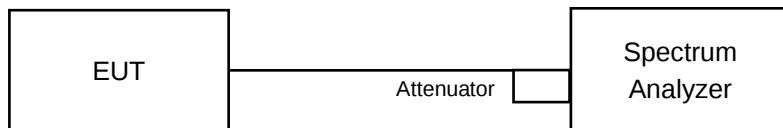
The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 300kHz VBW. The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

Set both RBW and VBW of spectrum analyzer to 100 kHz and 300kHz with suitable frequency span from band edge. The bandedge was measured and recorded.

#### 4.3.4 Deviation from Test Standard

No deviation

#### 4.3.5 Test Setup

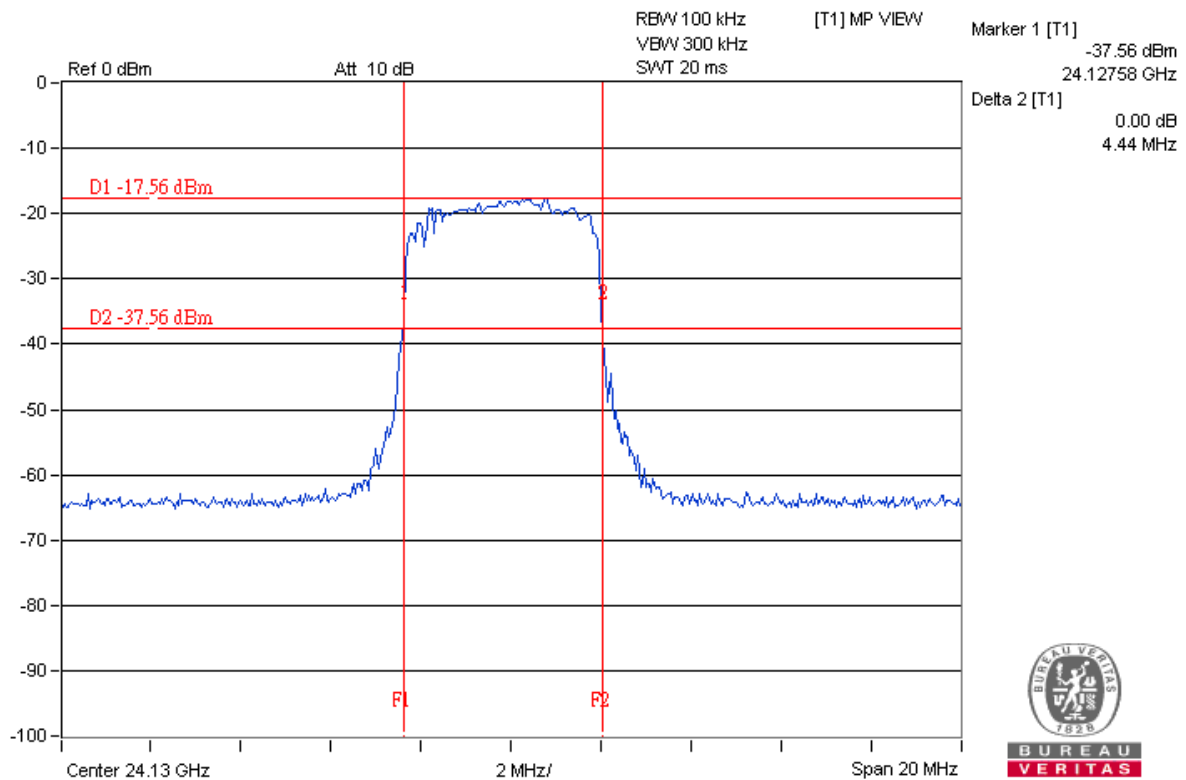


#### 4.3.6 EUT Operating Conditions

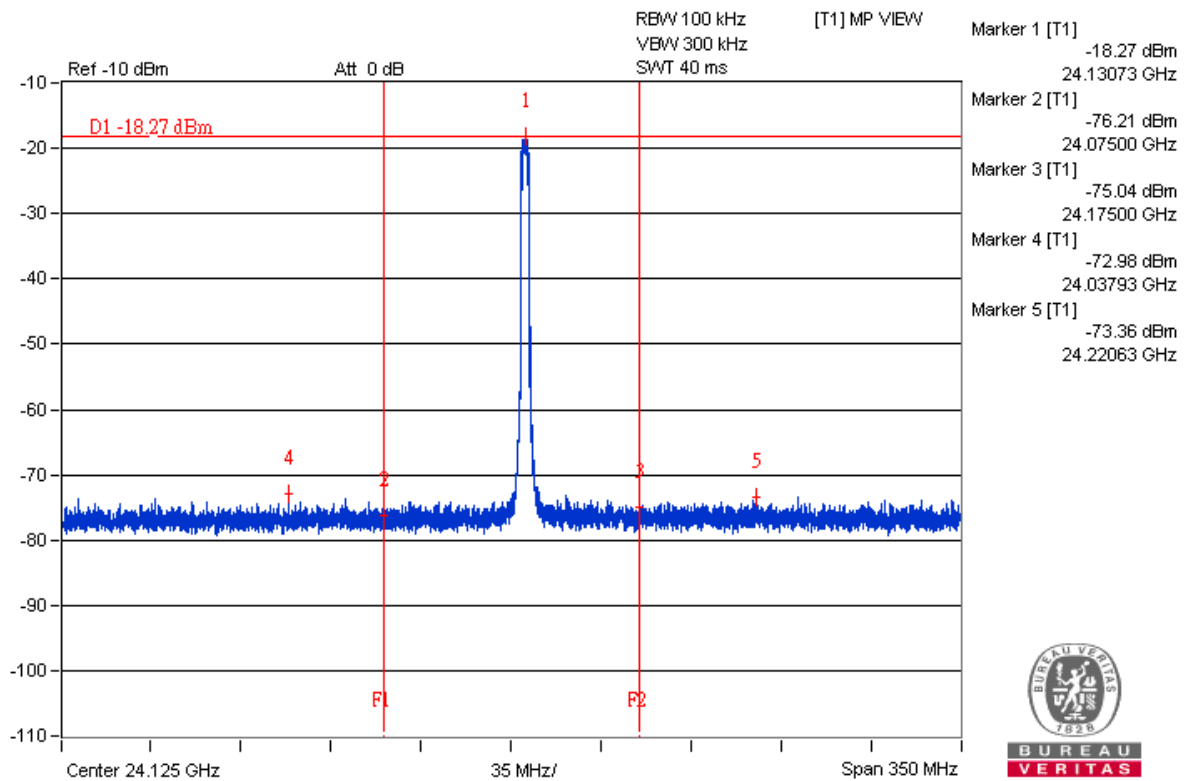
Set the EUT under transmission / receiver condition continuously.

#### 4.3.7 Test Results

##### For 20dB Bandwidth



##### For Bandedge



## 5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

## Appendix – Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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**Web Site:** [www.bureauveritas-adt.com](http://www.bureauveritas-adt.com)

The address and road map of all our labs can be found in our web site also.

--- END ---