# Supplemental “Transmit Simultaneously” Test Report

| | |
|---|---|
| **Report No.:** | RF200203E11-2 |
| **FCC ID:** | 2AF5PML2410 |
| **Test Model:** | ML2410 |
| **Series Model:** | ML2410XY<br>( where both X and Y can be A, B, C, D or blank. ) |
| **Received Date:** | Feb. 03, 2020 |
| **Test Date:** | Mar. 03 to 04, 2020 |
| **Issued Date:** | Apr. 01, 2020 |
| **Applicant:** | MTRLC LLC |
| **Address:** | 225 Franklin Street, 26th Floor, Boston, MA 02110 USA |
| **Issued By:** | Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory |
| **Lab Address:** | E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwa. |
| **Test Location:** | E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan. |
| **FCC Registration / Designation Number:** | 723255 / TW2022 |

## Table of Contents

## Release Control Record

| Issue No. | Description | Date Issued |
|---|---|---|
| RF200203E11-2 | Original release. | Apr. 01, 2020 |

## 1 Certificate of Conformity

| | |
|---|---|
| **Product:** | AC1900 LTE Router |
| **Brand:** | Motorola |
| **Test Model:** | ML2410 |
| **Series Model:** | ML2410XY<br>(where both X and Y can be A, B, C, D or blank. ) |
| **Sample Status:** | ENGINEERING SAMPLE |
| **Applicant:** | MTRLC LLC |
| **Test Date:** | Mar. 03 to 04, 2020 |
| **Standards:** | 47 CFR FCC Part 15, Subpart C (Section 15.247)<br>47 CFR FCC Part 15, Subpart E (Section 15.407)<br>FCC Part 27, Subpart H<br>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 :** _____ , **Date:** Apr. 01, 2020

Joyce Kuo / Specialist

**Approved by :** _____ , **Date:** Apr. 01, 2020

Clark Lin / Technical Manager

## 2 Summary of Test Results

| 47 CFR FCC Part 15, Subpart C, E (SECTION 15.247, 15.407)<br>FCC Part 27 | | | |
|---|---|---|---|
| FCC Clause | Test Item | Result | Remarks |
| 15.207<br>15.407(b)(6) | AC Power Conducted Emission | PASS | Meet the requirement of limit.<br>Minimum passing margin is -4.86dB at 20.24219MHz. |
| 15.205 / 15.209 / 15.247(d)<br>15.407(b)<br>(1/2/3/4(i/ii)/6) | Radiated Emissions and Band Edge Measurement | PASS | Meet the requirement of limit.<br>Minimum passing margin is -3.3dB at 48.58MHz. |
| 2.1053<br>27.53 | Radiated Spurious Emissions | PASS | Meet the requirement of limit.<br>Minimum passing margin is -41.85dB at 3498.5MHz. |

### 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) (±) |
|---|---|---|
| Conducted Emissions at mains ports | 150kHz ~ 30MHz | 1.8 dB |
| Radiated Emissions up to 1 GHz | 9kHz ~ 30MHz | 3.0 dB |
| | 30MHz ~ 1GHz | 5.1 dB |
| Radiated Emissions above 1 GHz | 1GHz ~ 6GHz | 5.1 dB |
| | 6GHz ~ 18GHz | 5.0 dB |
| | 18GHz ~ 40GHz | 5.2 dB |

### 2.2 Modification Record

There were no modifications required for compliance.

## 3 General Information

### 3.1 General Description of EUT

| | |
|---|---|
| Product | AC1900 LTE Router |
| Brand | Motorola |
| Test Model | ML2410 |
| Series Model | ML2410XY (where both X and Y can be A, B, C, D or blank. ) |
| Status of EUT | ENGINEERING SAMPLE |
| Power Supply Rating | 12Vdc from power adapter or 7.2Vdc from batttery |
| Modulation Type | CCK, DQPSK, DBPSK for DSSS<br>64QAM, 16QAM, QPSK, BPSK for OFDM<br>256QAM for OFDM in 11ac mode and VHT20/40 in 2.4GHz |
| Modulation Technology | DSSS,OFDM |
| Operating Frequency | **2.4GHz:** 2.412 ~ 2.462GHz<br>**5GHz:** 5.18 ~ 5.24GHz, 5.26 ~ 5.32 GHz, 5.50 ~ 5.72 GHz, 5.745 ~ 5.825GHz |
| Antenna Type | Refer to Note |
| Antenna Connector | Refer to Note |
| Accessory Device | Adapter × 1, Battery x1 |
| Data Cable Supplied | Ethernet cable x1 (Unshieled, 1.5m) |

Note:

1. The EUT contains certified WWAN module which FCC ID: XMR201808EC25AF (Brand: Quectel; Model: EC25-AF)
2. The EUT has below model names, which are identical to each other in all aspects except for the following table:

| 3. Brand | Model No. | Description |
|---|---|---|
| Motorola | ML2410 | For marketing purposes of identical hardware. |
| | ML2410XY<br>(where both X and Y can be A, B, C, D or blank) | |

From the above models, model: **ML2410** was selected as representative model for the test and its data was recorded in this report.

4. The EUT has below radios as following table:

| Radio 1 | Radio 2 | Radio 3 |
|---|---|---|
| WLAN (2.4GHz) | WLAN (5GHz) | WWAN |

5. Simultaneously transmission condition.

| Condition | Technology |
|---|---|
| 1 | WWAN + WLAN (2.4GHz) + WLAN (5GHz) |
| 2 | WWAN + WLAN (2.4GHz) |
| 3 | WWAN + WLAN (5GHz) |
| 4 | WLAN (2.4GHz) + WLAN (5GHz) |

6. The EUT must be supplied with a power and the following different models could be chosen:

| Adapter | | | |
|---|---|---|---|
| No | Brand | Model No. | Spec. |
| 1 | T&W ELECTRONICS | S36B52-120A300-04 | Input: 100-240V, 1A, 50-60Hz<br>Output: 12V, 3A<br>DC output cable (Unshielded, 1.5 m) |
| 2 | HON-KWANG ELECTRIC CO., LTD. | HK-BE-120A300-US (HKSC-190178) | Input: 100-240V, 1A, 50-60Hz<br>Output: 12V, 3A<br>DC output cable (Unshielded, 1.5 m) |
| 3 | HON-KWANG ELECTRIC CO., LTD. | HK-BE-120A300-US (HKSC-190147) | Input: 100-240V, 1A, 50-60Hz<br>Output: 12V, 3A<br>DC output cable (Unshielded, 1.5 m) |
| Battery | | | |
| No | Brand | Model No. | Spec. |
| 1 | Getac Technolog(Kunshan) Co.,LTD | BP-15033-22/2150 S | 7.2V 4.3Ah 30.96Wh |

Note:
1. The adapter 3 is as same as adapter 2; except for DC plug is different.
2. From the above adapters, the AC Power Conducted Emissions test worst case was found in **Adapter No.: 1**. Therefore only the test data of the mode was recorded in this report.
3. From the above adapters and battery, the Radiated Emissions test worst case was found in **Adapter No.: 1**. Therefore only the test data of the mode was recorded in this report.

7. The antennas provided to the EUT, please refer to the following table:

| **WLAN Antenna** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ant. No. | RF Chain No. | Brand | Ant. Net Gain | Frequency Range (GHz) | Antenna Type | Connector Type | Cable Length (mm) |
| 1 | WiFi Chain0 | Airgain | 4.3 dBi,<br>4.3 dBi,<br>5.5 dBi | 2.4 to 2.49,<br>5.15 to 5.35,<br>5.47 to 5.85 | PCB | i-pex(MHF) | 140 |
| 2 | WiFi Chain1 | Airgain | 3.2 dBi,<br>4.4 dBi,<br>4.1 dBi | 2.4 to 2.49,<br>5.15 to 5.35,<br>5.47 to 5.85 | PCB | i-pex(MHF) | 170 |
| 3 | WiFi Chain2 | Airgain | 4.6 dBi,<br>4.9 dBi,<br>5.4 dBi | 2.4 to 2.49,<br>5.15 to 5.35,<br>5.47 to 5.85 | PCB | i-pex(MHF) | 100 |
| **WWAN Antenna** | | | | | | | |
| Ant. No. | RF Chain No. | Brand | Ant. Net Gain | Frequency Range (MHz) | Antenna Type | Connector Type | Cable Length (mm) |
| 1 | LTE MAIN | Cortec | 1.08 dBi<br>3.19 dBi | 617 ~ 894<br>1710 ~ 2200 | Dipole | SMA | 280 |
| 2 | LTE AUX | Cortec | 1.08 dBi<br>3.19 dBi | 617 ~ 894<br>1710 ~ 2200 | Dipole | SMA | 200 |

8. The EUT incorporates a MIMO function.

| 2.4GHz Band | | |
|---|---|---|
| **MODULATION MODE** | **TX & RX CONFIGURATION** | |
| **802.11b** | 3TX | 3RX |
| **802.11g** | 3TX | 3RX |
| **802.11n (HT20)** | 3TX | 3RX |
| **802.11n (HT40)** | 3TX | 3RX |
| **VHT20** | 3TX | 3RX |
| **VHT40** | 3TX | 3RX |
| **5GHz Band** | | |
| **MODULATION MODE** | **TX & RX CONFIGURATION** | |
| **802.11a** | 3TX | 3RX |
| **802.11n (HT20)** | 3TX | 3RX |
| **802.11n (HT40)** | 3TX | 3RX |
| **802.11ac (VHT20)** | 3TX | 3RX |
| **802.11ac (VHT40)** | 3TX | 3RX |
| **802.11ac (VHT80)** | 3TX | 3RX |

Note:
1. All of modulation mode support beamforming function except 802.11a/b/g modulation mode.
2. The EUT support Beamforming and non-beamforming mode, therefore both mode were investigated and the worst case scenario was identified. The worst case data were presented in test report.

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

### 3.1.1 Test Mode Applicability and Tested Channel Detail

| EUT Configure Mode | Applicable To | | | | Description |
|---|---|---|---|---|---|
| | RE≥1G | RE<1G | PLC | OB | |
| - | √ | √ | √ | √ | - |

Where **RE≥1G:** Radiated Emission above 1GHz **RE<1G:** Radiated Emission below 1GHz
**PLC:** Power Line Conducted Emission **OB:** Conducted Out-Band Emission Measurement

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

☒ The tested configurations represent the worst-case mode from all possible combinations by the maximum power.
☒ Following channel(s) was (were) selected for the final test as listed below.

| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE |
|---|---|---|---|---|
| 11b + 802.11a + LTE Band 12 | 1 to 11 | 6 | DSSS | DBPSK |
| | 36 to 64, 100 to 144, 149 to 165 | 165 | OFDM | BPSK |
| | 23017 to 23173 | 23017 | OFDMA | - |

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

☒ The tested configurations represent the worst-case mode from all possible combinations by the maximum power.
☒ Following channel(s) was (were) selected for the final test as listed below.

| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE |
|---|---|---|---|---|
| 11b + 802.11a + LTE Band 12 | 1 to 11 | 6 | DSSS | DBPSK |
| | 36 to 64, 100 to 144, 149 to 165 | 165 | OFDM | BPSK |
| | 23017 to 23173 | 23017 | OFDMA | - |

**Power Line Conducted Emission Test:**

☒ The tested configurations represent the worst-case mode from all possible combinations by the maximum power.
☒ Following channel(s) was (were) selected for the final test as listed below.

| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE |
|---|---|---|---|---|
| 11b + 802.11a + LTE Band 12 | 1 to 11 | 6 | DSSS | DBPSK |
| | 36 to 64, 100 to 144, 149 to 165 | 165 | OFDM | BPSK |
| | 23017 to 23173 | 23017 | OFDMA | - |

**Conducted Out-Band Emission Measurement:**

☒ The tested configurations represent the worst-case mode from all possible combinations by the maximum power.

☒ Following channel(s) was (were) selected for the final test as listed below.

| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION TECHNOLOGY | MODULATION TYPE |
|---|---|---|---|---|
| 11b + 802.11a | 1 to 11 | 6 | DSSS | DBPSK |
| | 36 to 64, 100 to 144, 149 to 165 | 165 | OFDM | BPSK |

**Test Condition:**

| Applicable To | Environmental Conditions | Input Power | Tested By |
|---|---|---|---|
| **RE≥1G** | 23deg. C, 67%RH | 120Vac, 60Hz | Ryan Du |
| **RE<1G** | 23deg. C, 63%RH | 120Vac, 60Hz | Kevin Ko |
| **PLC** | 25deg. C, 75%RH | 120Vac, 60Hz | Kevin Ko |
| **OB** | 25deg. C, 60%RH | 120Vac, 60Hz | Anderson Chen |

## 3.2 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.

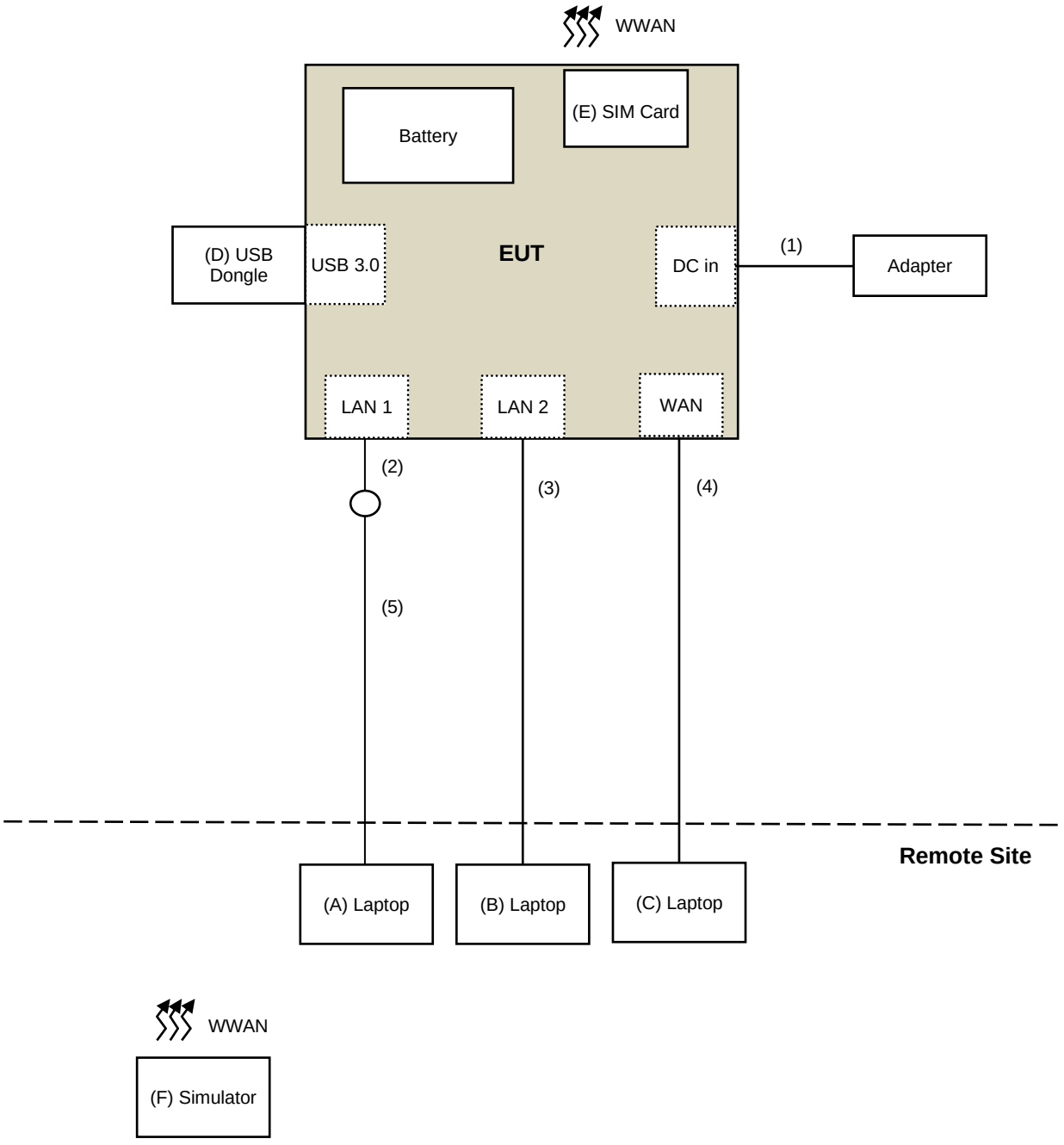
| ID | Product | Brand | Model No. | Serial No. | FCC ID | Remarks |
|---|---|---|---|---|---|---|
| A. | Laptop | DELL | E5430 | HYV4VY1 | FCC DoC | Provided by Lab |
| B. | Laptop | SONY | SVS151A12P | 275548477001150 | NA | Provided by Lab |
| C. | Laptop | DELL | E5430 | 4N1SKV1 | FCC DoC | Provided by Lab |
| D. | USB Dongle | Sandisk | 128G | NA | NA | Provided by Lab |
| E. | SIM Card | Anritsu | NA | NA | NA | Provided by Lab |
| F. | Simulator | Anritsu | MT8820C | 6201127458 | 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 | 1.5 | No | 0 | Supplied by client |
| 2. | RJ-45 Cable | 1 | 1.5 | No | 0 | Supplied by client |
| 3. | RJ-45 Cable | 1 | 10 | No | 0 | Provided by Lab |
| 4. | RJ-45 Cable | 1 | 10 | No | 0 | Provided by Lab |
| 5. | RJ-45 Cable | 1 | 10 | No | 0 | Provided by Lab |

### 3.2.1 Configuration of System under Test



# 4 Test Types and Results

## 4.1 Radiated Emission and Bandedge Measurement

### 4.1.1 Limits of Radiated Emission and Bandedge Measurement

For 47 CFR FCC Part 15:
Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table.

| Frequencies (MHz) | Field Strength (microvolts/meter) | Measurement Distance (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.

Limits of unwanted emission out of the restricted bands

<table>
<tr><td colspan="3">Applicable To</td><td colspan="2">Limit</td></tr>
<tr><td colspan="3" rowspan="2">789033 D02 General UNII Test Procedure New Rules v02r01</td><td colspan="2">Field Strength at 3m</td></tr>
<tr><td>PK:74 (dBµV/m)</td><td>AV:54 (dBµV/m)</td></tr>
<tr><td>Frequency Band</td><td colspan="2">Applicable To</td><td>EIRP Limit</td><td>Equivalent Field Strength at 3m</td></tr>
<tr><td>5150~5250 MHz</td><td colspan="2">15.407(b)(1)</td><td rowspan="3">PK:-27 (dBm/MHz)</td><td rowspan="3">PK:68.2(dBµV/m)</td></tr>
<tr><td>5250~5350 MHz</td><td colspan="2">15.407(b)(2)</td></tr>
<tr><td>5470~5725 MHz</td><td colspan="2">15.407(b)(3)</td></tr>
<tr><td rowspan="2">5725~5850 MHz</td><td>☒</td><td>15.407(b)(4)(i)</td><td>PK:-27 (dBm/MHz) *1<br>PK:10 (dBm/MHz) *2<br>PK:15.6 (dBm/MHz) *3<br>PK:27 (dBm/MHz) *4</td><td>PK: 68.2(dBµV/m) *1<br>PK:105.2 (dBµV/m) *2<br>PK: 110.8(dBµV/m) *3<br>PK:122.2 (dBµV/m) *4</td></tr>
<tr><td>☐</td><td>15.407(b)(4)(ii)</td><td colspan="2">Emission limits in section 15.247(d)</td></tr>
<tr><td colspan="5">*1 beyond 75 MHz or more above of the band edge.<br>*2 below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above.<br>*3 below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above.<br>*4 from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.</td></tr>
</table>

**Note:**

The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength:

$$E = \frac{1000000\sqrt{30P}}{3}$$ µV/m, where P is the eirp (Watts).

For FCC Part 27:

According to FCC 27.53(g) for operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

### 4.1.2 Test Instruments

| Description & Manufacturer | Model no. | Serial No. | Calibrated DATE | Calibrated Until |
|---|---|---|---|---|
| Test Receiver Keysight | N9038A | MY54450088 | July 03, 2019 | July 02, 2020 |
| Pre-Amplifier EMCI | EMC001340 | 980142 | May 30, 2019 | May 29, 2020 |
| Loop Antenna Electro-Metrics | EM-6879 | 269 | Sep. 16, 2019 | Sep. 15, 2020 |
| RF Cable | NA | LOOPCAB-001 | Jan. 08, 2020 | Jan. 07, 2021 |
| RF Cable | NA | LOOPCAB-002 | Jan. 08, 2020 | Jan. 07, 2021 |
| Pre-Amplifier Mini-Circuits | ZFL-1000VH2B | AMP-ZFL-05 | Apr. 30, 2019 | Apr. 29, 2020 |
| Trilog Broadband Antenna SCHWARZBECK | VULB 9168 | 9168-361 | Nov. 11, 2019 | Nov. 10, 2020 |
| RF Cable | 8D | 966-3-1 | Mar. 18, 2019 | Mar. 17, 2020 |
| RF Cable | 8D | 966-3-2 | Mar. 18, 2019 | Mar. 17, 2020 |
| RF Cable | 8D | 966-3-3 | Mar. 18, 2019 | Mar. 17, 2020 |
| Fixed attenuator Mini-Circuits | UNAT-5+ | PAD-3m-3-01 | Sep. 26, 2019 | Sep. 25, 2020 |
| Horn_Antenna SCHWARZBECK | BBHA9120-D | 9120D-406 | Nov. 24, 2019 | Nov. 23, 2020 |
| Pre-Amplifier EMCI | EMC12630SE | 980384 | Jan. 15, 2020 | Jan. 14, 2021 |
| RF Cable | EMC104-SM-SM-1200 | 160922 | Jan. 15, 2020 | Jan. 14, 2021 |
| RF Cable | EMC104-SM-SM-2000 | 180601 | June 10, 2019 | June 09, 2020 |
| RF Cable | EMC104-SM-SM-6000 | 180602 | June 10, 2019 | June 09, 2020 |
| Spectrum Analyzer Keysight | N9030A | MY54490679 | July 17, 2019 | July 16, 2020 |
| Pre-Amplifier EMCI | EMC184045SE | 980387 | Jan. 15, 2020 | Jan. 14, 2021 |
| Horn_Antenna SCHWARZBECK | BBHA 9170 | BBHA9170519 | Nov. 24, 2019 | Nov. 23, 2020 |
| RF Cable | EMC102-KM-KM-1200 | 160924 | Jan. 15, 2020 | Jan. 14, 2021 |
| RF Cable | EMC102-KM-KM-4500 | 181205 | Aug. 26, 2019 | Aug. 25, 2020 |
| Software | ADT_Radiated_V8.7.08 | NA | NA | NA |
| Antenna Tower & Turn Table 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 test was performed in 966 Chamber No. 3.
3. Loop antenna was used for all emissions below 30 MHz.
4. Tested Date: Mar. 03 to 04, 2020

### 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. Parallel, perpendicular, and ground-parallel orientations 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 above 30MHz**

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 detects 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:**

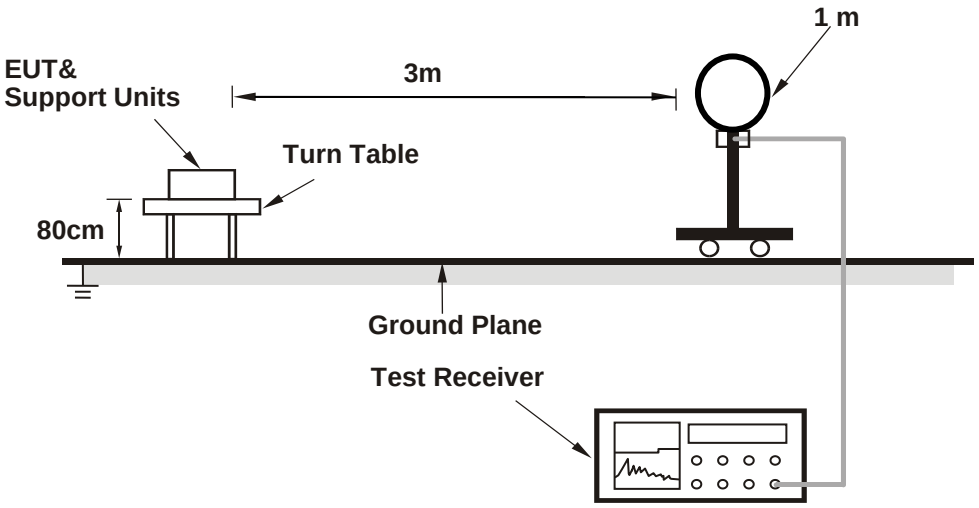
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

### 4.1.4 Deviation from Test Standard

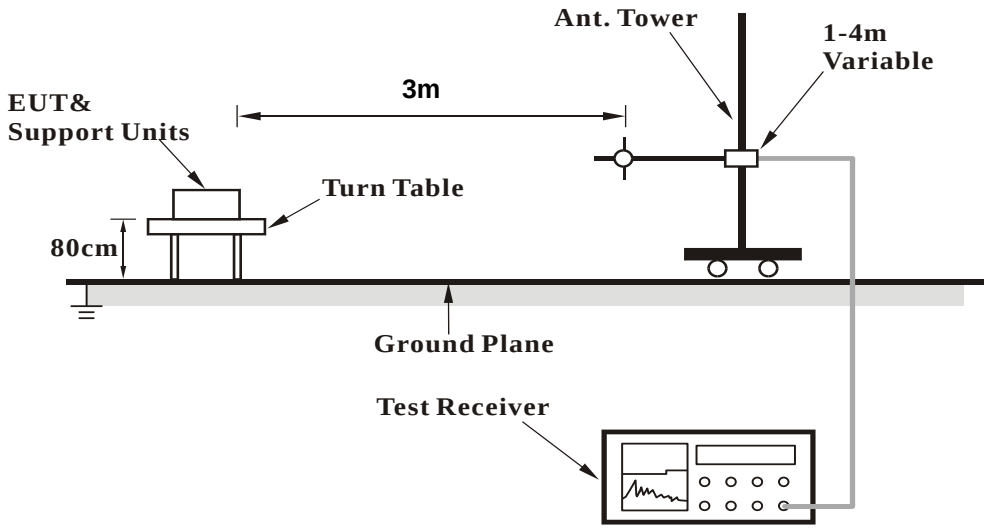
No deviation.

4.1.5 Test Setup

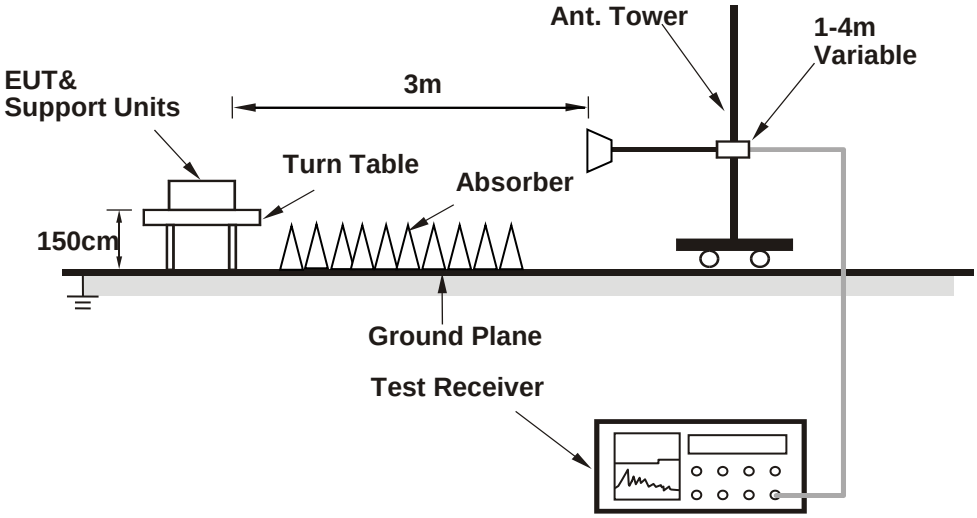
**For Radiated emission below 30MHz**




**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

a. Connected the EUT with the Laptop is placed on remote site.
b. Controlling software (WLAN: package_UIv2.05_DLLv4.08_20190312 / WWAN: EUT link Simulator) has been activated to set the EUT on specific status.

### 4.1.7 Test Results

**Above 1GHz Data**

| FREQUENCY RANGE | 1GHz ~ 40GHz | DETECTOR FUNCTION | Peak (PK)<br>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 | 4874.00 | 43.9 PK | 74.0 | -30.1 | 1.00 H | 178 | 41.8 | 2.1 |
| 2 | 4874.00 | 31.6 AV | 54.0 | -22.4 | 1.00 H | 178 | 29.5 | 2.1 |
| 3 | 7311.00 | 44.5 PK | 74.0 | -29.5 | 2.25 H | 205 | 36.4 | 8.1 |
| 4 | 7311.00 | 32.9 AV | 54.0 | -21.1 | 2.25 H | 205 | 24.8 | 8.1 |
| 5 | 11650.00 | 52.2 PK | 74.0 | -21.8 | 1.48 H | 312 | 39.8 | 12.4 |
| 6 | 11650.00 | 40.1 AV | 54.0 | -13.9 | 1.48 H | 312 | 27.7 | 12.4 |
| 7 | #17475.00 | 48.9 PK | 68.2 | -19.3 | 1.52 H | 177 | 31.9 | 17.0 |
| **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 | 4874.00 | 47.0 PK | 74.0 | -27.0 | 3.90 V | 106 | 44.9 | 2.1 |
| 2 | 4874.00 | 34.6 AV | 54.0 | -19.4 | 3.90 V | 106 | 32.5 | 2.1 |
| 3 | 7311.00 | 44.4 PK | 74.0 | -29.6 | 2.48 V | 283 | 36.3 | 8.1 |
| 4 | 7311.00 | 32.5 AV | 54.0 | -21.5 | 2.48 V | 283 | 24.4 | 8.1 |
| 5 | 11650.00 | 53.8 PK | 74.0 | -20.2 | 3.97 V | 280 | 41.4 | 12.4 |
| 6 | 11650.00 | 41.4 AV | 54.0 | -12.6 | 3.97 V | 280 | 29.0 | 12.4 |
| 7 | #17475.00 | 45.0 PK | 68.2 | -23.2 | 1.48 V | 52 | 28.0 | 17.0 |

**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. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " # ": The radiated frequency is out of the restricted band.

| Mode | TX channel 23071 | Frequency Range | Above 1GHz |
|---|---|---|---|

| Antenna Polarity & Test Distance: Horizontal at 3 M | | | | | | |
|---|---|---|---|---|---|---|
| No. | Freq. (MHz) | Reading (dBm) | Correction Factor (dB) | EIRP (dBm) | Limit (dBm) | Margin (dB) |
| 1 | 1399.4 | 36.79 | -95.26 | -58.47 | -13 | -45.47 |
| 2 | 2099.1 | 36.43 | -95.26 | -58.83 | -13 | -45.83 |
| 3 | 2798.8 | 40.07 | -95.26 | -55.19 | -13 | -42.19 |
| **4** | **3498.5** | **40.41** | **-95.26** | **-54.85** | **-13** | **-41.85** |
| Antenna Polarity & Test Distance: Vertical at 3 M | | | | | | |
| No. | Freq. (MHz) | Reading (dBm) | Correction Factor (dB) | EIRP (dBm) | Limit (dBm) | Margin (dB) |
| 1 | 1399.4 | 34.97 | -95.26 | -60.29 | -13 | -47.29 |
| 2 | 2099.1 | 35.37 | -95.26 | -59.89 | -13 | -46.89 |
| 3 | 2798.8 | 37.63 | -95.26 | -57.63 | -13 | -44.63 |
| 4 | 3498.5 | 38.09 | -95.26 | -57.17 | -13 | -44.17 |

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

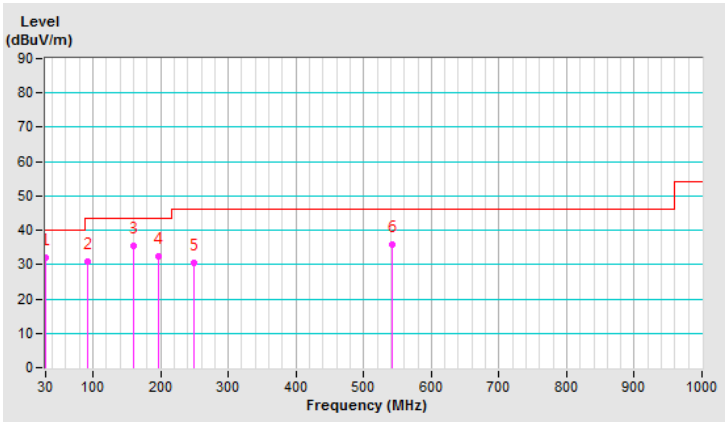
## Below 1GHz Data:

| FREQUENCY RANGE | 9kHz ~ 1GHz | DETECTOR FUNCTION | Quasi-Peak (QP) |
|---|---|---|---|

| 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 | 30.05 | 32.1 QP | 40.0 | -7.9 | 1.00 H | 47 | 40.7 | -8.6 |
| 2 | 91.86 | 30.8 QP | 43.5 | -12.7 | 2.00 H | 58 | 44.0 | -13.2 |
| 3 | 160.42 | 35.3 QP | 43.5 | -8.2 | 1.50 H | 69 | 42.4 | -7.1 |
| 4 | 197.16 | 32.2 QP | 43.5 | -11.3 | 1.00 H | 71 | 42.5 | -10.3 |
| 5 | 250.02 | 30.5 QP | 46.0 | -15.5 | 1.00 H | 360 | 38.9 | -8.4 |
| 6 | 542.50 | 35.8 QP | 46.0 | -10.2 | 1.50 H | 276 | 36.6 | -0.8 |

**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. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

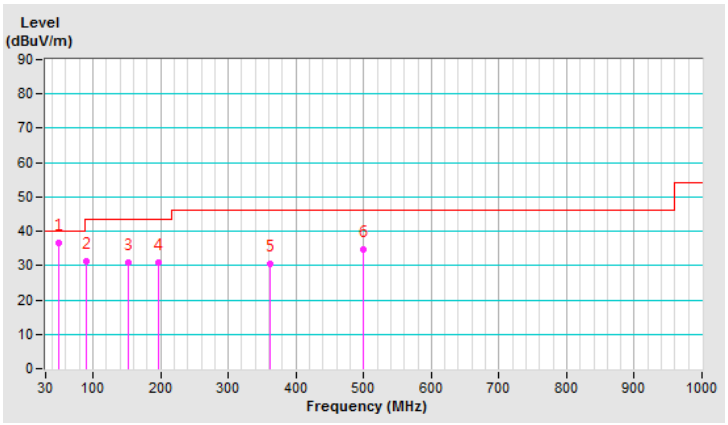


| FREQUENCY RANGE | 9kHz ~ 1GHz | DETECTOR FUNCTION | Quasi-Peak (QP) |
|---|---|---|---|

| 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** | **48.58** | **36.7 QP** | **40.0** | **-3.3** | **1.00 V** | **360** | **44.4** | **-7.7** |
| 2 | 89.73 | 31.3 QP | 43.5 | -12.2 | 2.00 V | 360 | 44.7 | -13.4 |
| 3 | 152.49 | 30.8 QP | 43.5 | -12.7 | 1.00 V | 128 | 37.9 | -7.1 |
| 4 | 196.06 | 30.8 QP | 43.5 | -12.7 | 1.00 V | 360 | 41.1 | -10.3 |
| 5 | 361.72 | 30.6 QP | 46.0 | -15.4 | 1.50 V | 19 | 35.3 | -4.7 |
| 6 | 500.01 | 34.8 QP | 46.0 | -11.2 | 1.00 V | 74 | 36.4 | -1.6 |

**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. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



| Mode | TX channel 23017 | Frequency Range | Above 1GHz |
|---|---|---|---|

| Antenna Polarity & Test Distance: Horizontal at 3 M | | | | | | |
|---|---|---|---|---|---|---|
| No. | Freq. (MHz) | Reading (dBm) | Correction Factor (dB) | EIRP (dBm) | Limit (dBm) | Margin (dB) |
| 1 | 62.01 | 26.92 | -95.26 | -68.34 | -13 | -55.34 |
| 2 | 88.9 | 29.41 | -95.26 | -65.85 | -13 | -52.85 |
| 3 | 131.91 | 25.47 | -95.26 | -69.79 | -13 | -56.79 |
| 4 | 235.7 | 30.65 | -95.26 | -64.61 | -13 | -51.61 |
| 5 | 510.39 | 32.36 | -95.26 | -62.90 | -13 | -49.90 |
| 6 | 612.89 | 35.69 | -95.26 | -59.57 | -13 | -46.57 |
| Antenna Polarity & Test Distance: Vertical at 3 M | | | | | | |
| No. | Freq. (MHz) | Reading (dBm) | Correction Factor (dB) | EIRP (dBm) | Limit (dBm) | Margin (dB) |
| 1 | 83.17 | 34.31 | -95.26 | -60.95 | -13 | -47.95 |
| 2 | 138.2 | 34.19 | -95.26 | -61.07 | -13 | -48.07 |
| 3 | 286.9 | 31.87 | -95.26 | -63.39 | -13 | -50.39 |
| 4 | 344.99 | 32.35 | -95.26 | -62.91 | -13 | -49.91 |
| 5 | 470.51 | 32.99 | -95.26 | -62.27 | -13 | -49.27 |
| 6 | 737.06 | 40.3 | -95.26 | -54.96 | -13 | -41.96 |

Remarks:
1. Emission Value (dBm) = S.G Value (dBm) + Correction Factor (dB).
2. Correction Factor (dB) = Substitution Antenna Gain (dB) + Cable Loss (dB).

## 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 R&S | ESCS 30 | 847124/029 | Oct. 23, 2019 | Oct. 22, 2020 |
| Line-Impedance Stabilization Network (for EUT) R&S | ESH3-Z5 | 848773/004 | Oct. 23, 2019 | Oct. 22, 2020 |
| Line-Impedance Stabilization Network (for Peripheral) R&S | ESH3-Z5 | 835239/001 | Mar. 17, 2019 | Mar. 16, 2020 |
| 50 ohms Terminator | 50 | 3 | Oct. 23, 2019 | Oct. 22, 2020 |
| RF Cable | 5D-FB | COCCAB-001 | Sep. 27, 2019 | Sep. 26, 2020 |
| Fixed attenuator EMCI | STI02-2200-10 | 003 | Mar. 14, 2019 | Mar. 13, 2020 |
| Software BVADT | BVADT_Cond_ 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 Conduction 1.
3 Tested Date: Mar. 03, 2020

### 4.2.3 Test Procedures

a. 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.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

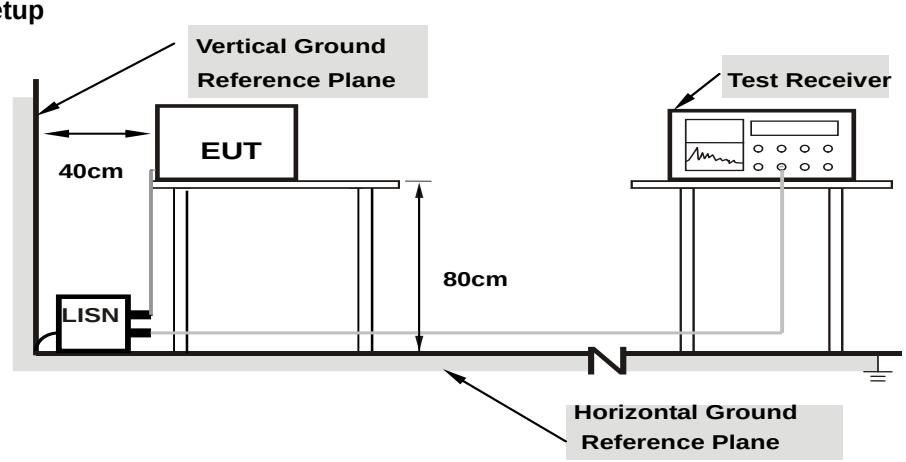
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

**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.

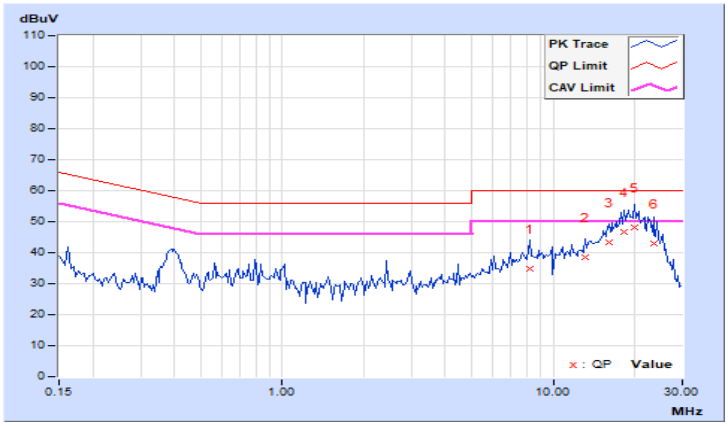
### 4.2.7 Test Results

| 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 | 8.19922 | 10.53 | 24.16 | 18.51 | 34.69 | 29.04 | 60.00 | 50.00 | -25.31 | -20.96 |
| 2 | 13.19141 | 10.88 | 27.56 | 21.34 | 38.44 | 32.22 | 60.00 | 50.00 | -21.56 | -17.78 |
| 3 | 16.02344 | 11.09 | 32.35 | 26.23 | 43.44 | 37.32 | 60.00 | 50.00 | -16.56 | -12.68 |
| 4 | 18.21484 | 11.24 | 35.54 | 29.70 | 46.78 | 40.94 | 60.00 | 50.00 | -13.22 | -9.06 |
| 5 | 19.98828 | 11.37 | 36.92 | 31.36 | 48.29 | 42.73 | 60.00 | 50.00 | -11.71 | -7.27 |
| 6 | 23.60938 | 11.50 | 31.61 | 25.32 | 43.11 | 36.82 | 60.00 | 50.00 | -16.89 | -13.18 |

**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

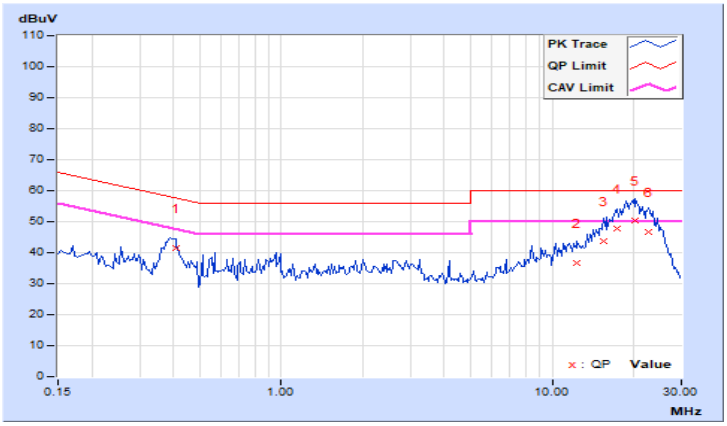


| Phase | Neutral (N) | Detector Function | Quasi-Peak (QP) / Average (AV) |
|---|---|---|---|

| 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 | 0.40781 | 10.01 | 31.29 | 21.86 | 41.30 | 31.87 | 57.69 | 47.69 | -16.39 | -15.82 |
| 2 | 12.39063 | 10.71 | 26.14 | 20.40 | 36.85 | 31.11 | 60.00 | 50.00 | -23.15 | -18.89 |
| 3 | 15.51953 | 10.88 | 32.69 | 27.05 | 43.57 | 37.93 | 60.00 | 50.00 | -16.43 | -12.07 |
| 4 | 17.31250 | 10.97 | 36.64 | 30.98 | 47.61 | 41.95 | 60.00 | 50.00 | -12.39 | -8.05 |
| **5** | **20.24219** | **11.12** | **39.18** | **34.02** | **50.30** | **45.14** | **60.00** | **50.00** | **-9.70** | **-4.86** |
| 6 | 22.74609 | 11.18 | 35.33 | 29.55 | 46.51 | 40.73 | 60.00 | 50.00 | -13.49 | -9.27 |

**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

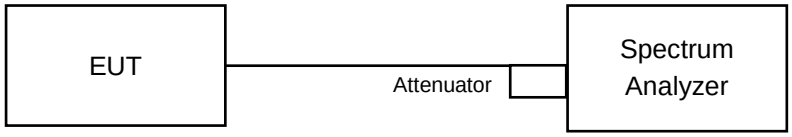


## 4.3 Conducted Out of Band Emission Measurement

### 4.3.1 Limits of Conducted Out of Band Emission Measurement

Below 30dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

### 4.3.2 Test Setup




### 4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

### 4.3.4 Test Procedures

**MEASUREMENT PROCEDURE REF**

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

**MEASUREMENT PROCEDURE OOBE**

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

### 4.3.5 Deviation from Test Standard

No deviation.

### 4.3.6 EUT Operating Conditions

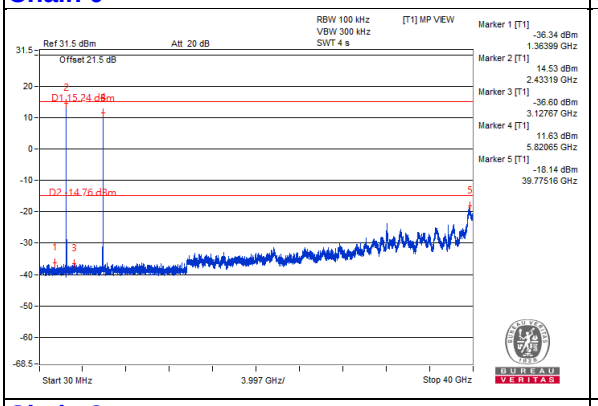
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

### 4.3.7 Test Results

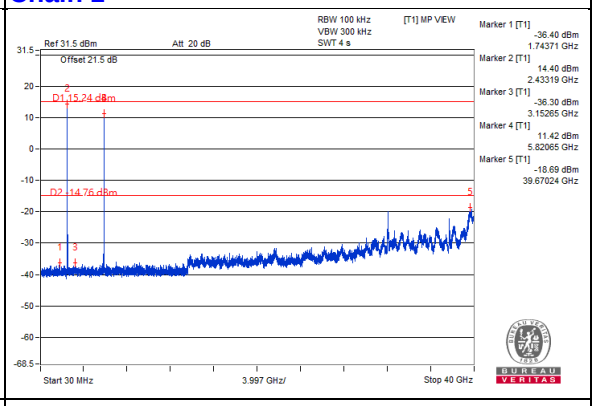
The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 30dB offset below D1. It shows compliance with the requirement.

## 2.4GHz_11b CH6 + 5GHz_802.11a CH165

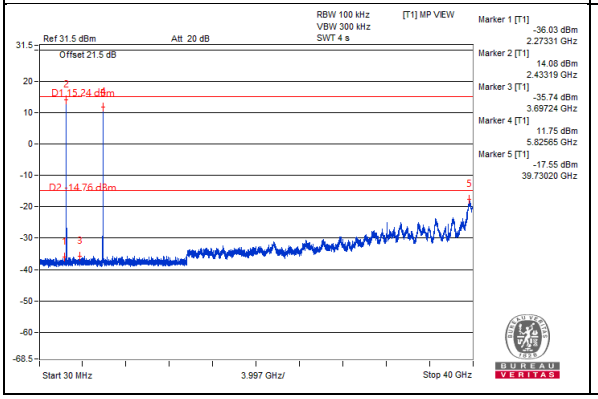
### Chain 0




### Chain 1




### Chain 2



## 5 Pictures of Test Arrangements

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

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

**--- END ---**